Revitalizing Philippine Irrigation: A Systems and Governance Assessment for the 21st Century

Edited by Roehlano M. Briones

Philippine Institute for Development Studies
Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas

“Irrigation is one of the key infrastructures that can successfully increase farm productivity and incomes, and thus boost socioeconomic progress in the countryside. This is why the government is determined to accelerate the development of national irrigation systems to cover around 1.3 million hectares of land across the country identified as “irrigable”.

For our part at the Department of Agriculture, we pursue the development of effective, appropriate, and efficient irrigation and water management technologies even as we encourage greater public sector investment in national irrigation and impounding systems following the Build-Transfer mechanism.

We therefore welcome the publication of this book, *Revitalizing Philippine Irrigation: A Systems and Governance Assessment for the 21st Century*, which provides a comprehensive assessment of the country’ s irrigation program.

Our strong endorsement for this book hinges on its successful attempt to gather articles that provide valuable insights and expertise in discussing current sectoral developments and issues, and advocating needed strategies to hasten the national irrigation program towards stronger growth and competitiveness of the crops subsector and the agri-fishery industry, in general.”

William D. Dar
Secretary of Agriculture
Republic of the Philippines

"This new publication by the Philippine Institute for Development Studies (PIDS) is timely and comprehensive.

The collection of studies from various PIDS researches on Philippine irrigation provides a comprehensive assessment of the country's approach to irrigation development and is a useful reference for decisionmakers.

Specific issues, such as in the Free Irrigation Service Act, which I authored, are noted. Indeed, as an agricultural country, the sector is truly essential in economic growth as well as in poverty reduction.

The holistic and integrated approach to water management, involving other agencies of government, to sustain soil productivity and efficiency in the critical watershed areas in the country supervised by the Department of Environment and Natural Resources, Department of the Interior and Local Government, local government units, irrigators' associations, and the farmer-beneficiaries themselves, is timely.

I highly recommend this book to policymakers and other stakeholders."

Cynthia A. Villar
Senator
Chairperson, Committee on Agriculture
Senate of the Philippines, Congress of the Philippines

"I would like to extend my sincere commendation to the Philippine Institute for Development Studies (PIDS) for the timely publication of this collection of studies and research projects undertaken both by the PIDS and other research organizations and individuals as a source of fundamental information on the Philippine irrigation system.

Accelerating irrigation development through the construction and rehabilitation of large- and small-scale systems is essential in increasing the productivity and income of farmers. Hence, this is included in our *Philippine Development Plan 2017-2022*.

In my capacity as Chairperson of the House Committee on Agriculture and Food (18th Congress), I will ensure that the various bills filed on irrigation sector development will be fully deliberated and acted upon and this publication will serve as rich source of information in crafting a better, effective, and responsive Philippine irrigation development legislations.

Again, I affirm my support and applaud the PIDS and the people behind this publication for their continued commitment in providing us in Congress relevant, reliable, and timely policy research to guide the legislators in carrying out our legislative tasks and functions."

Wilfrido Mark M. Enverga
Representative, First District of Quezon
Chairperson, Committee on Agriculture and Food
House of Representatives, Congress of the Philippines

"The state of the country's irrigation systems is a microcosm of the agricultural and rural economy: comparatively underperforming, falling far short of potentials due mainly to uninformed policy and governance decisions, both at the local (sectoral) and national (economywide) levels. Thus, assessing the performance of irrigation systems and understanding why governments do what they do in irrigation, a primary vehicle to raise farm productivity, is crucial to building the narrative on the agricultural economy's underperformance for most of the post-Second World War period. This book succeeds in deepening our understanding of the context, structure, and performance of irrigation systems and providing nuanced policy perspectives and cost-effective solutions to the irrigation problem moving forward. The book's contributors represent some of the country's foremost experts on irrigation governance, water resource management and engineering, and agricultural and resource economics. Thus, the book is an excellent resource for policymakers, development practitioners, governance advocates, and students seeking ways to revitalize irrigation toward sustainable food security and rural development."

Arsenio M. Balisacan
Chairperson, Philippine Competition Commission
Former Socioeconomic Planning Secretary and
Director-General, National Economic and Development Authority

"While agricultural productivity growth is key to achieving structural transformation, expanding the irrigation system, together with adopting modern varieties and land tenure reforms, have been indispensable components of the country's successful agricultural development. Irrigation, particularly, not only improved agricultural productivity, but also facilitated income smoothing for farmers by enabling cropping even during dry seasons, thus helping mitigate both chronic and transient poverty. This book provides a comprehensive picture of the history, institutions, achievements, and challenges of the Philippines' irrigation system. It is a must-read book for policymakers, researchers, and students, who are interested in issues related to irrigation, agricultural development, and poverty in the Philippines and in other countries facing similar challenges."

Yasuyuki Sawada
Chief Economist and Director-General
Economic Research and Regional Cooperation Department
Asian Development Bank

"This book was long in coming but well worth the wait. It contains valuable information on the national and communal irrigation systems in the Philippines.

Reorganizing irrigation governance is an essential step if the haphazard process of decisionmaking is to be avoided. This entails the support and cooperation of the government and the private sector. But there is no time like the present to start."

Randolph Barker
Professor Emeritus
Cornell University

“Comprehensive, interdisciplinary, and up-to-date—this book, *Revitalizing Philippine Irrigation: A Systems and Governance Assessment for the 21st Century*, provides a wealth of information and knowledge about irrigation in the Philippines.

It presents the natural, physical, and socioeconomic dimensions of this all-important agriculture resource, making this a condensed reference material for the understanding of irrigation’s overall ecology in the Philippines and for crafting irrigation policies and decisions.

By publishing this book, the Philippine Institute for Development Studies once again reiterates the indispensable role of agriculture in ensuring food security and in sustaining the country’s socioeconomic development.”

Jose V. Camacho Jr.
Chancellor
University of the Philippines Los Baños

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Please address all inquiries to:

Philippine Institute for Development Studies
18th Floor, Three Cyberpod Centris - North Tower
EDSA corner Quezon Avenue, 1100 Quezon City
Telephone: (63-2) 8877-4000
Fax: (63-2) 8877-4099
E-mail: publications@mail.pids.gov.ph
Website: https://www.pids.gov.ph

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Foreword

It has been more than two years already since the Philippine government adopted the radical policy of exempting farmers from payment of irrigation fees. Through the passage of the Free Irrigation Service Act (FISA), the government has affirmed its commitment to contribute to the lowering of the cost of production and further relieve the farmers from the burden and consequence of unpaid irrigation service fees.

However, the passage of FISA is not a panacea for all the ills besieging the Philippine irrigation system. For instance, a study by the Philippine Institute for Development Studies (PIDS) found that while the beneficiaries of the free irrigation are poorer than average, a large majority of them are nonpoor.

To provide a basis for discussing the issues of the current irrigation policy framework, PIDS compiles existing quantitative and qualitative studies that address the technical, physical, and institutional aspects of the performance of the country's irrigation systems. This book focuses on the works done by the Institute in recent years to assist the government in crafting reforms toward cost-effective irrigation sector development.

The Institute hopes that this book will help inform the discussions on the Philippine irrigation system and how it is managed, and thus contribute to the objective of the country to create a more effective and sustainable irrigation system.

CELIA M. REYES
President

Preface

Irrigation has been part of the Philippine agriculture since precolonial times. Despite changes in the policy framework governing the sector, irrigation has only become more relevant. This is understandable given the rapid expansion of the Philippine population, with corresponding increased pressures on the food supply. More crops simply mean higher demands for irrigation water.

This has inspired us to come up with a book that zeroes in on the Philippine irrigation system. This book features contributions from esteemed researchers from various institutions and organizations, thus providing a comprehensive assessment of the country's irrigation development program. Hopefully, the assessment will serve as basis for the policy reforms in the area.

We are indebted to the Philippine Institute for Development Studies for fueling this project and providing us an avenue to share a wide variety of perspectives on irrigation. This book is our humble contribution to the literature on irrigation, particularly the national and communal systems and their entire project cycle.

While there has been a tremendous increase in the amount of public investments in irrigation, the reality is that its development is still hampered by several issues. This publication offers recommendations to address them.

The Authors

Acknowledgment

This book has been years in the making. It began with the pioneering work of the late Wilfredo David, former Chancellor of University of the Philippines Los Baños and continued by the studies of Cristina David, former Senior Research Fellow of the Philippine Institute for Development Studies (PIDS). Throughout, PIDS has overseen this project, from the tenure of President Josef Yap, through to Gilberto Llanto, and, currently, Celia Reyes. The Department of Budget and Management, under Secretary Florencio Abad, funded the “Rapid appraisal of irrigation investments” under the Zero-Based Budgeting Program Studies. Said project was headed by Cristina David and Arlene Inocencio. Other contributors had authored articles on related studies, including Miriam Nguyen, Tolentino Moya, Mona de los Reyes, and Alma de la Cruz.

Staff who at the time served as research assistants and associates had been instrumental to these studies, including Cristina Alvarez, Cristeta Foronda, Alex Baulita, Armand Christopher Rola, Joseph Daniel Sandoval, Jayson Fumera, Mae Marie Garcia, Faith Villarma, Kristel Tapire, Arman Baulita, Kris Francisco, Francis Quimba, Ivory Galang, and Isabel Espineli. Sheila Siar and the Research Information Department Staff, especially Maria Judith Sablan and Gizelle Manuel, diligently shepherded these studies to publication. Chito Madamba is the source of the striking image for the book cover.

The National Irrigation Administration (NIA) has been unwavering in its support of the PIDS evaluation studies from the 2000s up to the present, providing access to its offices, data, staff, and network of stakeholders, from NIA Central Office down to its regional and field offices. The Authors are grateful to the stakeholders of irrigation sector governance, especially the Department of Agriculture - Bureau of Soils and Water Management, the National Economic and Development Authority, and, of course, the farmers and operators of the various irrigators’ associations, for their valuable time and insights on the state of the sector.

List of Acronyms

AFMA	– Agriculture and Fisheries Modernization Act
AMM	– asset management method
AMP	– asset management plan
AMPLE	– Agricultural Market Model for Policy Evaluation
AMRIS	– Angat-Maasim River Irrigation System
ARMM	– Autonomous Region in Muslim Mindanao
ASEAN	– Association of Southeast Asian Nations
AWD	– alternate wetting and drying
BAR	– Bureau of Agricultural Research
BCA	– benefit-cost analysis
BCR	– benefit-cost ratio
BOT	– board of trustees
BPW	– Bureau of Public Works
BSWM	– Bureau of Soils and Water Management
CAR	– Cordillera Administrative Region
CARP	– Comprehensive Agrarian Reform Program
CIDP	– Communal Irrigation Development Project
CIP	– communal irrigation projects
CIRDUP	– Comprehensive Irrigation Research and Development Umbrella Program
CIS	– communal irrigation systems
CMS	– cubic meters per second
CRA	– Community Relations Assistant
DA	– Department of Agriculture
DAR	– Department of Agrarian Reform
DBM	– Department of Budget and Management
DE	– detailed engineering
DEM	– digital elevation maps
DENR	– Department of Environment and Natural Resources
DILG	– Department of the Interior and Local Government
DP	– Discussion Paper
EC	– electrical conductivity
EIRR	– economic internal rate of return
FAO	– Food and Agriculture Organization
FGD	– focus group discussion
FGIS	– farmland geographic information system
FIELDS	– fertilizer, irrigation, extension, loans for inputs

FISA	– Free Irrigation Service Act
FMB	– Forest Management Bureau
FS	– feasibility study
FSSP	– Food Staples Sufficiency Program
FUSA	– firmed-up service area
GIS	– geographic information system
ha	– hectare
HEC-HMS	– Hydrologic Engineering Center - Hydrologic Modeling System
HEC-RAS	– Hydrologic Engineering Center-River Analysis System
IA	– irrigators' association
ICC	– Investment Coordination Committee
IDD	– Institutional Development Division
IDMCs	– irrigation and drainage management companies
IDO	– irrigators development officers
IDP	– Institutional Development Program
IfSAR	– interferometric synthetic aperture radar
IMO	– irrigation management office
IMT	– irrigation management transfer
IPI	– irrigation performance index
IROR	– internal rate of return
IRR	– implementing rules and regulations
IS	– irrigation system
ISC	– irrigators' service cooperative
ISF	– irrigation service fee
IWM	– integrated watershed management
JICA	– Japan International Cooperation Agency
kg	– kilogram
KII	– key informant interview
km	– kilometer
LGC	– Local Government Code
LGU	– local government units
LPS	– liter per second
m	– meter
MAO	– municipal agricultural office
MARIIS	– Magat River Integrated Irrigation System
MASSCOTE	– Mapping System and Services for Canal Operation Techniques
MAV	– minimum access volume
MFN	– most-favored-nation
MIMAROPA	– Mindoro, Marinduque, Romblon, and Palawan

NOAH	– Nationwide Operational Assessment of Hazards
MOA	– memorandum of agreement
MT	– metric ton
MW	– megawatt
MWSS	– Metro Manila's Metropolitan Waterworks and Sewerage System
NAMRIA	– National Mapping and Resource Information Authority
NEDA	– National Economic and Development Authority
NGO	– nongovernment organization
NHC	– National Hydraulic Research Center
NIA	– National Irrigation Administration
NIMP	– National Irrigation Master Plan
NIP	– national irrigation project
NIS	– national irrigation systems
NMC	– north main canal
NPC	– National Power Corporation
NWRB	– National Water Resources Board
O&M	– operations and maintenance
PCA	– Principal Component Analysis
PCs	– principal components
PDC	– provincial development council
PDP	– *Philippine Development Plan*
PDRIS	– Pampanga Delta River Integrated System
PHP	– Philippine peso
PIS	– pump irrigation system
POWs	– program of works
PRDP	– Philippine Rural Development Program
PSA	– Philippine Statistics Authority
QR	– quantitative restriction
RatPlan	– rationalization plan
RBCO	– River Basin Control Office
RDC	– regional development council
RIO	– regional irrigation office
RIS	– river irrigation system
ROW	– right-of-way
RPMC	– Regional Project Monitoring Committee
SDD	– small diversion dam
SFR	– small farm reservoir
SOCCSKSARGEN	– South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos

SSIS	– small-scale irrigation systems
STW	– shallow tubewell
SWAT	– Soil and Water Assessment Tool
SWIP	– small water impounding project
SWISA	– Small Water Impounding System Association
TCP3	– Technical Cooperation Project 3
UPLBFI	– University of the Philippines Los Baños Foundation Incorporated
UPRIIS	– Upper Pampanga River Integrated Irrigation Systems
US	– United States
USLE	– universal soil loss equation
VEVA	– Value Engineering/Value Analysis/Assessment
VIG	– Variable Incentive Grant
WB	– World Bank
WRDP	– Water Resources Development Project
WRRC	– water resource research centers
WTO	– World Trade Organization

Chapter 1

Irrigation and Agricultural Development

Arlene B. Inocencio and Roehlano M. Briones

Introduction

Irrigation is a well-known technology for water management. It boosts agricultural production by allowing more intensive cropping over the same plot of land and increasing yield on that land. In the Philippines, irrigation development is largely determined by public sector investment. Ensuring irrigation service delivery is mandated under key legislations for agriculture, particularly the Magna Carta of Small Farmers (Republic Act [RA] 7607) and the Agriculture and Fisheries Modernization Act or AFMA (RA 8435). However, budgetary allocations have waxed and waned over the decades.

Irrigation investments peaked in the 1970s to early 1980s under an ambitious rice sector modernization program. Irrigation development languished, as government struggled with a tight fiscal bind. However, the world food crisis of 2008 and the widening of fiscal space in the ensuing years caused a resurgence in the government's irrigation investments. Appropriations for irrigation rose from PHP 8 billion in 2008 to PHP 24.4 billion in 2012. Over the next six years, budget appropriations for the irrigation program averaged at PHP 32.3 billion a year. The *Philippine Development Plan* (PDP) *2017–2022* aims at an irrigation area ratio of 65.07 percent by 2022, up from 57.33 percent in 2015, or an additional 233,700 hectares (ha) of irrigated area over a six-year period. This corresponds to PHP 70.2 billion at PHP 300,000 development cost per hectare.

After over a decade of implementation of the resurgent program, careful stock-taking is in order. This book aims at such a comprehensive assessment. It shall cover both national and communal system and span the entire project cycle from planning to implementation, operations, monitoring, and evaluation. It also examines performance, design, management, and governance issues and compares the benefits of the program with program costs. It also offers recommendations regarding the ongoing implementation of the irrigation development program. This chapter provides an overview of a set of studies, which address the technical, physical, and institutional aspects of performance of the country's irrigation systems (Box 1).

Most of the government's budget for irrigation development has gone to the National Irrigation Administration (NIA). The NIA is mainly responsible for the national irrigation systems (NIS), the larger irrigation systems in the country. It develops and operates NIS, though with varying extent of participation of users organized as irrigators' associations (IAs). The smaller irrigation systems also developed by NIA are the communal irrigation systems (CIS), which are then turned over to IAs for management and operation. Other small-scale irrigation systems (SSIS) are implemented by the Department of Agriculture (DA), often under the Bureau of Soils and Water Management (BSWM). They include small-water impounding projects (SWIPs), diversion dams, and small farm reservoirs.

Rationale for public investment in irrigation

The theory of change associated with irrigation investments is represented in Figure 1. Irrigation involves the capture, storage, conveyance, distribution, and application of water for crop farming. In the case of rice, it offers two types of benefits. It enables the farmer to plant during the dry season, thereby increasing cropping intensity (i.e., frequency of harvest per unit of physical land area). It also leads to an increase in yield through greater exposure of *palay* to sunlight during the dry season and controlled timing of water delivery during the wet season.

Box 1. References to research reports from the assessment of the resurgent irrigation program of the Philippines by the Philippine Institute for Development Studies

The full reports of studies from which the chapters of this book are drawn were earlier disseminated as Discussion Papers (DPs) by the Philippine Institute for Development Studies. Interested readers may refer to these for a more detailed discussion and presentation of the relevant data. Note, however, that DPs represent prepublication versions of the papers compiled in this volume.

Briones, R. 2018. Benefit-cost analysis of the resurgent irrigation system program of the Philippines. PIDS Discussion Paper Series No. 2018-47. Quezon City, Philippines: Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps1847.pdf (accessed on September 1, 2019).

Briones, R., R. Clemente, A. Inocencio, R. Luyun, and A. Rola. 2019. Assessment of the Free Irrigation Service Act. PIDS Discussion Paper Series No. 2019-04. Quezon City, Philippines: Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps1914.pdf (accessed on December 1, 2019).

Clemente, R., A. Fajardo, V. Ballaran, J.C. Ureta, A. Baulita, and K.C. Tapire. 2020. Assessing the resurgent irrigation development program of the Philippines - national irrigation systems component. PIDS Discussion Paper Series 2020-01. Quezon City, Philippines: Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2001.pdf (accessed on February 10, 2020).

Inocencio, A.B., C. Ureta, A. Baulita, A. Baulita, R.S. Clemente, R.A. Luyun, Jr., and D.D. Elazegui. 2016. Technical and institutional evaluation of selected national and communal irrigation systems and characterization of irrigation sector governance structure. PIDS Discussion Paper Series 2016-12. Quezon City, Philippines: Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps1612.pdf (accessed on October 1, 2019).

Luyun, R.A. Jr. and D.D. Elazegui. 2020. Assessing the resurgent irrigation development program of the Philippines - communal irrigation systems component. PIDS Discussion Paper Series 2020-02. Quezon City, Philippines: Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2002.pdf (accessed on March 15, 2020).

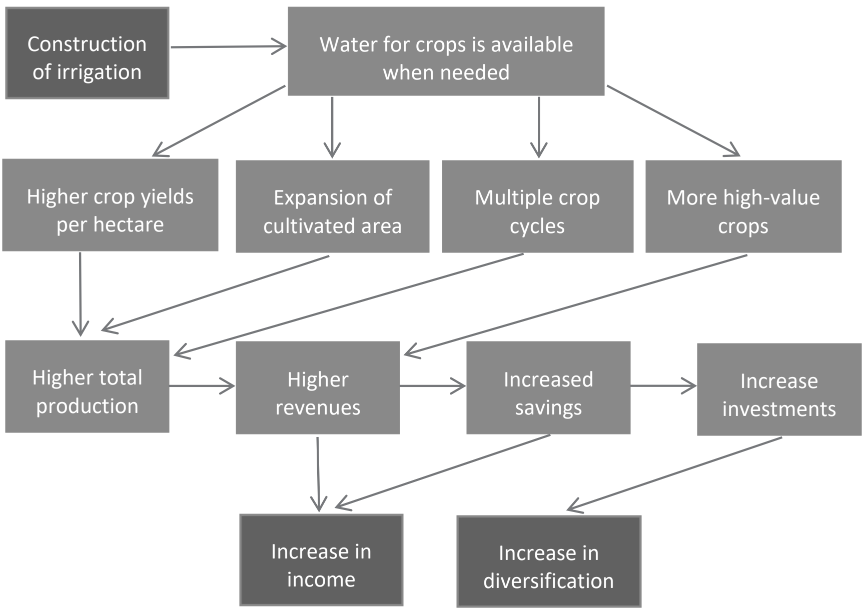
Rola, A.C., T.R. Olviga, F.J.F. Faderogao, and C.J.P. Faulmino. 2020. Assessing the resurgent irrigation development program of the Philippines - institutional arrangements for irrigation governance. PIDS Discussion Paper Series 2020-08. Quezon City, Philippines: Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2008.pdf (accessed on June 30, 2020).

Tabios, G.Q. III and T.P.Z. de Leon. 2020. Assessing the resurgent irrigation development program of the Philippines - water resources component. PIDS Discussion Paper Series 2020-11. Quezon City, Philippines: Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2011.pdf (accessed on July 30, 2020).

The increased income from irrigation may lead to increased savings that can then be reinvested either in farming or in other complementary activities. The farmer can experience an increase in the level and/or diversification of household incomes. Furthermore, in addition to the considerations found in Figure 1, irrigation systems have other benefits, namely, water storage/impounding, provision of potable water, aquaculture or reservoir fishery, and power generation.

Some farmers who have the resources provide irrigation for their own needs. They do this by tapping smaller sources of water, such as creeks, springs, small rivers, shallow aquifer using low-cost technology, such as pumps and sprinklers. While river or groundwater systems may require more extensive projects, private investments can finance these projects with a view to a long-run return on investment. In fact, irrigation is prone to market failure, which inhibits private investment. This suggests that state investment in irrigation is a public good.

Figure 1. Theory of change for irrigation systems



Source: Adapted from Andersen et al. (2015)

A *private good* is characterized by *rivalry* and *exclusivity*. Hence, it is expected that a public good is one that does not have these characteristics. The provision of water is a rival. This means that a liter of water given to a farmer in plot A is no longer available to a farmer in plot B. However, exclusivity in the provision of water is problematic owing to difficulty in defining and enforcing property rights in water resources. Downstream users may be willing to pay for irrigation services but are unable to gain access without the cooperation of the upstream users. Moreover, precisely owing to rivalry, it may be essential to meter the use of water and charge accordingly. However, installing water meters may be expensive and not worth the benefits to the investor from being able to charge by the quantity of water used.

Worldwide, therefore, irrigation programs have largely been subsidized by governments both for capital expenditure and, in many cases, even recurrent or operational expenditure. In the case of the Philippines, the type of subsidies varies by cost category and type of irrigation system. Prior to the Free Irrigation Service Act (FISA) of 2017 (RA 10969), investments in CIS were partly or fully recovered, though investments in NIS were not. Operations and maintenance (O&M) costs were partly recovered from NIS systems, while in CIS, users were solely responsible.

The economic rationale for public intervention in the case of market failure does not mean that all government expenditure in the sector is socially justified. In some public irrigation projects, political motivations, such as catering to the interests of a politically influential group, may trump economic criteria. In some cases, the government may allocate excessive funding for irrigation investment. On the other hand, some economically justified projects may end up not being funded owing to a lack of constituency for these projects. The question of efficiency of research investment, considering its impact and cost, is a key research question to be revisited in the remainder of this book.

History of irrigation development in the Philippines[1]

Precolonial and colonial periods

Before 1521, an estimated 25,000 ha in the country were made up of farmer-built, small canal systems (de los Reyes 2017). These excluded the upland rice terraces, an interesting case for which the historical record is intact. In these systems, no individual had exclusive rights to the use of water, though the area around the local summit was

[1] Much of this section up to the first Aquino administration largely draws from NIA (1990).

reserved for untouched forest. The topmost terraces, while having priority to water from the spring or stream flowing down from the peak, were obliged to release excess water for the lower terraces. Similar water-sharing arrangements were used in other traditional irrigation systems in the country.

During the **Spanish colonial government** (1521–1898), development of irrigation systems was limited to the friar lands and few small irrigation systems. Construction was carried out by able-bodied residents of the respective estates through forced labor. Meanwhile, irrigation associations were started as early as 1630, mostly in the Ilocos area. Known as the *Zanjera* cooperative irrigation societies, their function was simply to procure a stable, reliable supply of water for the use of their members. The privileges of the members of a Zanjera included the allotment to rights to a portion of the system's water and the right to vote within the *sitio* unit and the larger association. Their major responsibility was to provide labor and construction materials and other resources required to operate and maintain the system.

Irrigation development under the **American period** (1898–1946) commenced in August 1907, when the Philippine Legislature appropriated a permanent reimbursable sum of PHP 250,000 for irrigation construction. In 1908, an Irrigation Division under the Bureau of Public Works (BPW) was created by law. Four years later, the Irrigation Act was passed to regulate the appropriation of public waters, prescribe rules on water rights, and provide for construction, O&M of irrigation systems, and payments from farmers. The San Miguel River Irrigation System in Tarlac was constructed in 1913, the first NIS in the country. Eleven more NIS were built from 1922 to 1930. Along with small canal irrigation systems for rice monocultures, 12 medium-sized NIS with a total service area of 91,000 ha of rice farms were constructed during the American regime (de los Reyes 2017).

Commonwealth Act 87 authorized the President, through the Director of Public Works, to administer public irrigation systems. In 1938, legislators arrogated discretionary funding for CIS, effectively deploying "pork barrel". Throughout the Commonwealth period, government funds for CIS were coursed through legislators. Such politicized allocation tends to follow a "divide by N" principle, which resulted in the construction of dams across streams with insufficient water or on sites where foundations were unstable and, in many instances, even irrigation projects that were never completed.

The American period was interrupted by the Japanese Occupation (1941–1945), where Japanese authorities required farmers to turn over one-half of their palay produce to the government to feed the occupation army and to serve the wider Japanese empire. Irrigation development activity during this period was minimal as safety and survival during the war against the Japanese invasion was the overriding concern of the nation. At the end of this period, many irrigation systems were in a bad state of deterioration and disrepair (de los Reyes 2017).

Post-war period: 1946–1965

After the Second World War, the **Roxas administration** (1946–1948) focused on rehabilitating existing systems damaged during the World War II. It implemented a program to increase rice production, entailing cultivation of 100,000 ha of new areas every year for five years by developing disposable forest lands and lands of public domain. Hence, it implemented a war settlement program under Commonwealth Act 694 in 1945. In 1947, the Irrigation Division of BPW was reactivated. Subsequently, the Quirino administration (1948–1953) established the Rice and Corn Production Administration in 1949 to increase production of rice and corn. The Irrigation Pump Administration was also created.

The **Magsaysay administration** (1953–1957) formulated a program to attain self-sufficiency in rice as one of the major objectives of his administration. The administration made more funds available for irrigation development and accelerated the construction of CIS. By the end of 1957, the total irrigated area in the country was about 400,000 ha (de los Reyes 2017).

The **Garcia administration** (1957–1961) shifted the government's thrust to foreign affairs, keeping agricultural development in *status quo*. In 1958, RA 2084 was signed into law, creating the Rice and Corn Production Coordinating Committee to attain self-sufficiency in cereals. However, palay yields declined in this period, leading to large volumes of rice imports.

The **Macapagal administration** (1961–1964) crafted a "Five-Year Integrated Socio-Economic Program" aiming at self-sufficiency in rice and corn at prices within the reach of the masses. To achieve this, the government had to provide improved irrigation and water control facilities. In 1962, the National Economic Council and the United States Agency for International Development concluded an agreement to establish a planning program for water resources development in seven major river basins in the country. The program included an investigation and completion of a feasibility report for a selected multipurpose project in Central Luzon. The United States Bureau of Reclamation provided a team of technical consultants to work with the Philippine government agencies in the formulation of water resources development plans. In 1963, RA 3601 was passed, granting corporate status, broad powers, functions, and objectives to NIA, as well as raising its capital.

The modern era (1965 to the present)

The **Marcos administration** (1965–1986) invested heavily in irrigation development. NIA was tasked to make 10- to 20-year period plans upon the passage of RA 3601. In 1974, the National Water Resources Council was created by virtue of Presidential Decree (PD) 424 for overall water allocation and coordination. In the same year, PD 552 granted NIA broader powers and authority to undertake program-oriented and comprehensive water resource projects for irrigation purposes, as well as concomitant activities. The law increased its capitalization, authorized it to incur foreign loans, empowered it to administer all CIS, and reconstituted its board of directors.

NIA also implemented an upward adjustment of the irrigation service fees (ISF) together with the nationwide information campaign to encourage irrigation users to cooperate and be involved in the O&M of irrigation systems. The Water Code of the Philippines revised and consolidated the laws governing the ownership, appropriation, utilization, exploitation, development, conservation, and protection of water resources in the country. Irrigation was identified as the second priority during times of scarcity. During the 1980s, NIA introduced the participatory approach, in which CIS were developed then turned over to IAs for O&M.

The national recovery program under the **first Aquino administration** (1986–1992) placed agriculture at the center of development. It adhered to the following policy goals: (a) free the economy from unnecessary and costly government institutional and policy interventions; (b) provide the farmers access to land, technology, credit, infrastructure facilities, and market information, and for landless wage earners, greater employment opportunities; and (c) increase the effectiveness of the various government agencies concerned in pursuing the new thrusts in the agriculture and rural sector.

Priority in the irrigation development program was given to areas with high production capabilities, mainly the major river basins as identified in the agricultural sector program. In depressed areas with potential for increased yields and higher income, irrigation and related inputs were given special attention. NIA began implementing the Community Employment Development Program in 1986. In this period, farmer-organizing programs were integrated under the Institutional Development Department of NIA. The same year, NIA started implementing the irrigation component of the Comprehensive Agrarian Reform Program (CARP).

Under the **Ramos administration** (1992–1998), DA instituted the key production area approach. Following accession to the World Trade Organization (WTO), it launched *Gintong Ani* in 1996, a safety net for the General Agreement on Tariffs and

Trade. The Congress approved a lump-sum appropriation under the Office of the Secretary to finance the various rice support programs, such as subsidized seeds, fertilizers, and credit and the construction of new and rehabilitation of irrigation systems, with focus on small-scale irrigation. Whereas the WTO Agreement required the lifting of the quantitative restrictions (QRs) on imports and the conversion of these into equivalent tariffs, the country managed to obtain a special treatment for rice allowing QRs to be kept for the next 10 years (up to 2005).

The AFMA was passed in the final year of the Ramos administration. For irrigation, AFMA included the (1) prevention of further destruction of watersheds, (2) rehabilitation of existing irrigation systems, and (3) promotion of the development of effective, affordable, and efficient irrigation systems. The implementing rules and regulations (IRR) of AFMA amended the composition of the NIA Board by adding the Field Operations Service and BSWM of DA as members. They delineated the jurisdictions of NIA and the BSWM for reservoir projects based on the height of the dams. AFMA also granted additional funds for agriculture modernization, allocating 30 percent for irrigation.

The short-lived administration of **Joseph Estrada** (1998–2001) implemented *Agrikulturang Makamasa* as its banner program. Initially, ISF was suspended upon the pronouncement of the President. However, it was later reimposed under a socialized structure.

Meanwhile, the **Arroyo administration** (2001–2010) implemented a *Ginintuang Masaganang Ani*-Countrywide Assistance for Rural Employment and Services in 2001, with special emphasis on social equity. The national rice program provided greater focus and support to the adoption of hybrid rice by giving incentives in the form of free hybrid seeds, pesticides, and fertilizers to encourage irrigated rice farmers to shift from inbreds to hybrids. The administration negotiated for an extension of special treatment up to June 30, 2012. As a concession, minimum access volume (MAV) rose from 238,940 tons to 350,000 tons. In 2008, it adopted an irrigation management transfer (IMT) policy as stated in Memorandum Circular 47, with subsequent amendments.

The rice price crisis of 2008 led to the launch of the FIELDS (fertilizer, irrigation, extension, loans for inputs including shallow tubewells and surface-water pumps, dryers, other postharvest facilities, and seed subsidy) program. FIELDS led to a resurgence in irrigation investment aimed at achieving the government's rice production targets.

In 2009, the Climate Change Act of 2009 mainstreamed climate change in public policy. All departments, including the DA, were mandated to integrate climate change in all their programs. NIA carried out pilot projects for climate proofing of its irrigation investments. It is yet to mainstream climate change in its programs.

The **second Aquino administration** (2010–2016) implemented the *Agri-Pinoy* program based on four guiding principles: (1) sustainable agriculture, (2) food security and self-sufficiency, (3) broad-based local partnerships, and (4) support services from farm to table. Among its priority thrusts were irrigation services, extension services, establishments of trading centers, organic agriculture, and public-private partnerships.

Part of the Agri-Pinoy was the Food Staples Sufficiency Program (FSSP) designed to ensure self-sufficiency in rice while calling for diversification for other staples. FSSP identified three sets of interventions: (1) raising farm productivity and competitiveness, (2) enhancing economic incentives and enabling mechanisms, and (3) managing food staples consumption. Accelerating the expansion of irrigation services and further investing in small-scale irrigation systems were key interventions under number (1). The Aquino administration again successfully negotiated for a waiver postponing tariffication until July 2017.

The current **Duterte administration** (2016–present) has adopted and even intensified the previous administration's commitment to irrigation development (Table 1). From 2011 to 2018, budgetary appropriations for irrigation have more than tripled, from PHP 13.3 billion to PHP 44.3 billion. Increasing allocation for irrigation is commensurate with the overall budgetary outlays for agriculture under the DA system, which allocates about 37–44 percent for irrigation. In 2012, the share of irrigation even rose to 47 percent. NIA obtains about 95 percent of the irrigation budget, though in recent years the share of the budget being administered directly by DA has been increasing, i.e., allotted to regional field offices, BSWM, and the Office of the Secretary.

Trends in irrigation development

Public sector irrigation investments

Massive public investments in irrigation began in the 1970s as part of the Green Revolution in rice farming.

NIA's mandate to develop and construct irrigation systems requires huge investment outlays usually not recovered from water users. The government funds the capital

Table 1. Budget appropriation of the Department of Agriculture (DA) for irrigation, in PHP millions (current prices)

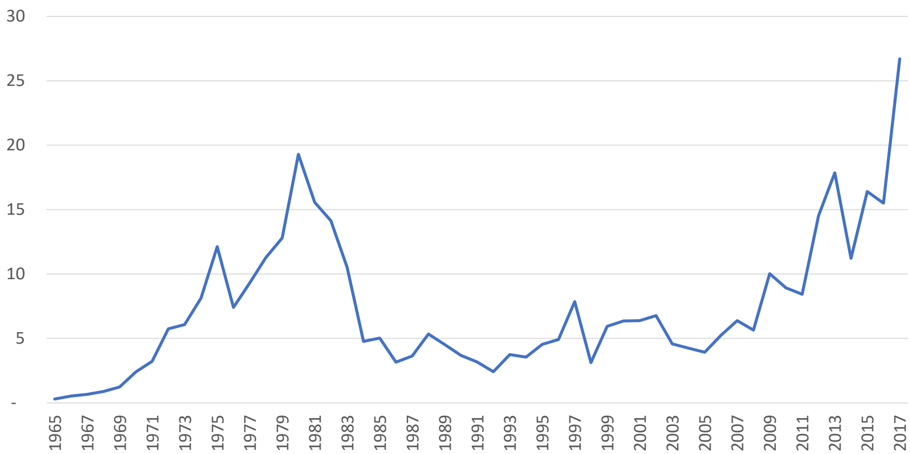
	NIA	DA	Total Irrigation Allocation	Total DA System Budget	Share of irrigation in DA System Allocation (%)	Share of NIA in total Irrigation Allocation (%)
2011	12,791	510	13,301	34,758	38.3	96.2
2012	24,454	618	25,072	52,931	47.4	97.5
2013	27,156	1,282	28,438	64,504	44.1	95.5
2014	21,183	1,143	22,326	68,553	32.6	94.9
2015	28,750	1,338	30,088	67,807	44.4	95.6
2016	32,743	1,198	33,941	91,206	37.2	96.5
2017	38,376	3,292	41,668	95,014	43.9	92.1
2018	41,669	2,669	44,338	109,945	40.3	94.0

Notes: The direct appropriations for DA were through its regional field offices, Bureau of Soils and Water Management, and the Office of the Secretary. In 2015 and 2016, NIA was taken out of the DA system budget and moved to other executive offices. The ratios were computed as NIA budget divided by DA plus NIA budgets to be consistent with other years. The total DA budgets include those for all bureaus and attached corporations.
NIA = National Irrigation Administration; PHP = Philippine peso
Source: Department of Budget and Management (Various years)

requirements of NIA through the annual national allocation provided in the General Appropriations Act. Capital investments have accounted for the bulk of irrigation expenditures of government, averaging 85 percent of total public expenditures for irrigation from 1976 to 2015.

Significant public sector outlays for irrigation really began in the 1970s (Figure 2). During this period, the government promoted the Green Revolution. Irrigation expenditure grew rapidly from 1965 to 1975 from a very low base. Angat and the Pantabangan, the biggest irrigation systems in the country and the first of the multipurpose dams, were completed in the 1970s. Irrigation became the largest single item in the budget for agriculture reaching up to 30–45 percent and as high as 12 percent of public investment in infrastructure (David and Inocencio 2012). These investments have primarily benefited the rice sector, as the government budget mostly went to gravity systems suited for rice cultivation.

Figure 2. Public investments in irrigation, in PHP millions (2000 prices), 1965–2017



PHP = Philippine peso
Sources: NIA Annual and Year-end Reports (Various years)

Changes in public expenditures in irrigation have tracked changes in world commodity prices.

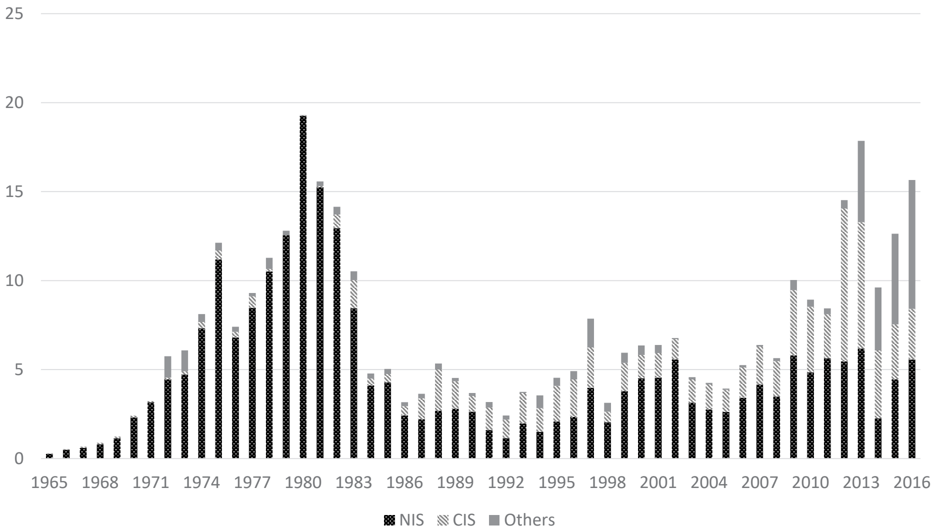
Hayami and Kikuchi (1978) systematically analyzed the drivers of public irrigation investments. They were able to establish that the increase in irrigation spending by governments has been influenced by short-term changes in world prices of rice. This is expected as such short-term changes affect the marginal rate of return to irrigation investment (Azarcon and Barker 1994; Kikuchi et al. 2003). Public investments in irrigation peaked in the 1970s, declined in the early 1980s, but partly recovered in the 1990s, with the increases in investment following the rise in world rice prices.

From the late-1980s until mid-2000s, public spending on irrigation slumped. The share of irrigation in public agricultural spending fell by more than half. Its share in the total infrastructure spending also declined to just 6 percent (David and Inocencio 2012). Since 2005, public expenditures on irrigation have begun a new phase of resurgence, getting an additional boost in 2008 with the world rice price crisis and continuing until today.

Investments in irrigation were initially concentrated on NIS. Since the 1990s, communal systems became more prominent.

From the 1960s to early 1980s, most of government spending on irrigation was poured on national systems (Figure 3). The share of communal systems only began to rise by the mid-1980s, from less than 5 percent in the 1970s to more than 40 percent in the early 1990s. Much of the impetus for CIS development was the CARP in 1988, where development of agrarian reform communities often involved construction of CIS. Moreover, donor agencies during this period focused on poverty reduction, which appeared to be better targeted for smaller systems in disadvantaged communities.

Figure 3. Irrigation investments by type of system in PHP billions (2000 prices), 1965–2016



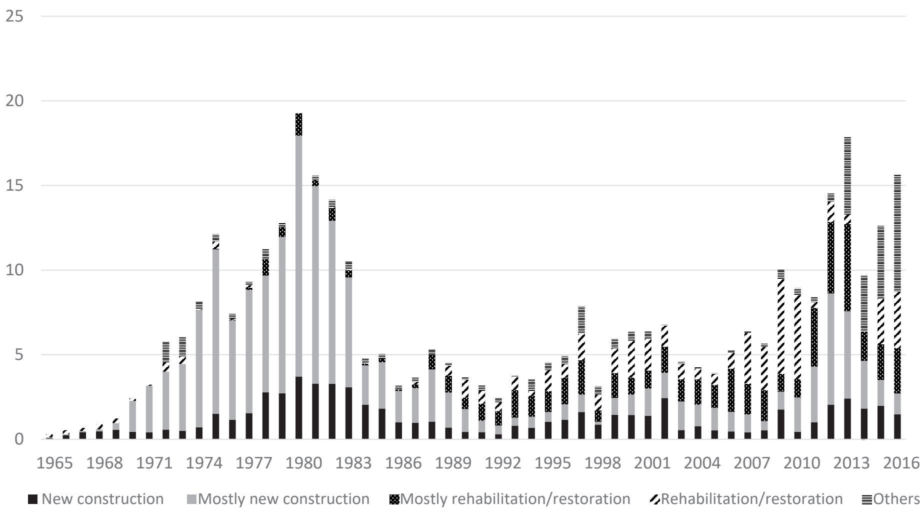
Notes: "Others" includes private irrigation systems and other government-funded systems. The 2016 values were preliminary results from the NIA annual report.
CIS = communal irrigation systems; NIS = national irrigation systems; PHP = Philippine peso
Sources: NIA Annual and Year-end Reports (Various years)

Public investments in irrigation were initially concentrated on new construction. From the 1980s onward, expenditures began to shift toward rehabilitation and restoration.

From the 1970s to 1980s, irrigation investments were mostly allocated to new construction (Figure 4 and Table 2). Only about 12 percent of irrigation investments were for rehabilitation and restoration purposes.

Figure 4. Real irrigation investments by type of project, in PHP billions (2000 prices), 1965–2016

Notes: “New construction” refers to projects that generate only new irrigated areas. “Mostly new



construction” refers to those with more than 50 percent of the irrigated area new, with much smaller percentage that are rehabilitated and/or restored areas. “Mostly rehabilitation/restoration” is loosely defined as those with more than 50 percent of the irrigated area rehabilitated and restored, with much smaller share for new irrigated areas. “Rehabilitation and restoration” refers to projects fully dedicated to rehabilitation/restoration of existing irrigated areas. “Others” refers to projects or components neither new nor rehabilitated areas. Others increased starting 2013 due to the provisions for noncomponent of San Roque Multipurpose project paid to National Power Corporation-Power Sector Assets and Liabilities Management Corporation. It includes the World Bank-funded Watershed and Erosion Management Project in the early 1980s.
Sources: NIA Annual and Year-end Reports (Various years)

Investments included medium and large pump systems that drew water from major rivers, such as the Abra River in Abra, Libmanan Cabusao in Bicol, and Lower

Table 2. Distribution of irrigation investments by type of project, system, and funding source, 1965–2016

	1965–1969	1970–1979	1980–1989	1990–1999	2000–2009	2010–2016
All projects						
New construction only	49	16	24	20	17	13
Mostly new construction	18	74	65	17	21	26
Mostly rehab/restoration	0	2	6	29	25	19
Rehab and restoration	33	2	1	22	33	35
Others	0	6	3	12	44	8
Total	100	100	100	100	100	100
National irrigation systems						
New construction only	50	17	28	35	22	12
Mostly new construction	14	78	64	21	23	34
Mostly rehab/restoration	0	2	6	12	25	24
Rehab and restoration	36	3	1	32	30	30
Subtotal	100	100	100	100	100	100
Communal irrigation systems						
New construction only	41	21	1	5	8	26
Mostly new construction	59	79	92	17	19	45
Mostly rehab/restoration	0	0	7	65	29	10
Rehab and restoration	0	0	0	13	44	20
Subtotal	100	100	100	100	100	100
By funding source:						
Foreign-assisted projects						
New construction only	51	11	24	33	29	8
Mostly new construction	49	85	69	28	35	44
Mostly rehab/restoration	0	2	2	20	32	46
Rehab and restoration	0	1	1	17	5	3
Others	0	2	4	3	0	0
Subtotal	100	100	100	100	100	100
Locally funded projects						
New construction only	49	41	25	5	8	13
Mostly new construction	11	16	26	4	9	23
Mostly rehab/restoration	0	5	46	40	20	19
Rehab and restoration	40	11	3	28	57	36
Others	0	27	0	23	7	8
Subtotal	100	100	100	100	100	100

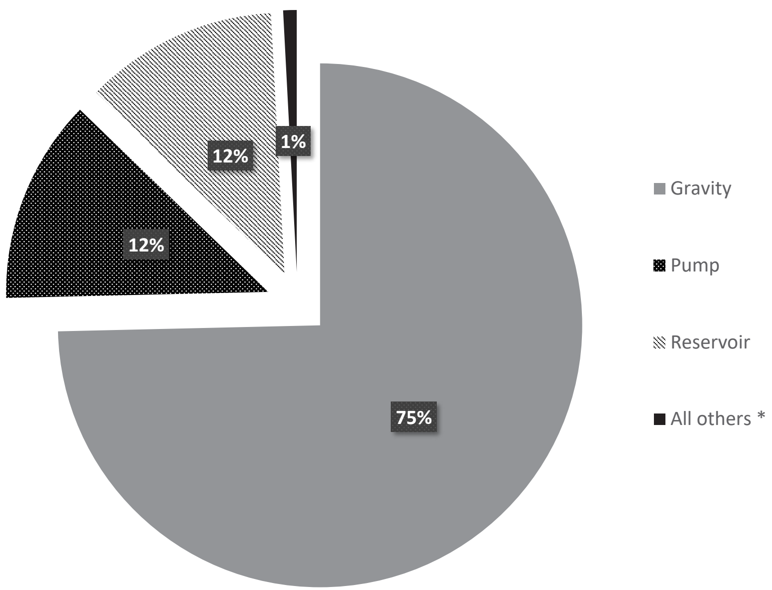
Note: "Others" increased starting 2013 due to the provisions for noncomponent of San Roque Multipurpose project paid to National Power Corporation-Power Sector Assets and Liabilities Management Corporation. It includes the World Bank-funded Watershed and Erosion Management Project in the early 1980s.
rehab = rehabilitation
Sources: NIA Annual and Year-end Reports (Various years)

Agusan in Mindanao (David and Inocencio 2012; Inocencio et al. 2013; Inocencio 2016; Inocencio and Barker 2018). As shown in Table 2, the distribution of type of projects has changed over the decades. From the late 1960s to the 1980s, new or mostly new constructions dominated. From 2000 onwards, irrigation spending by government shifted to more rehabilitation or mostly rehabilitation/restoration projects.

Most irrigation systems in the country are diversion (as opposed to reservoir) systems.

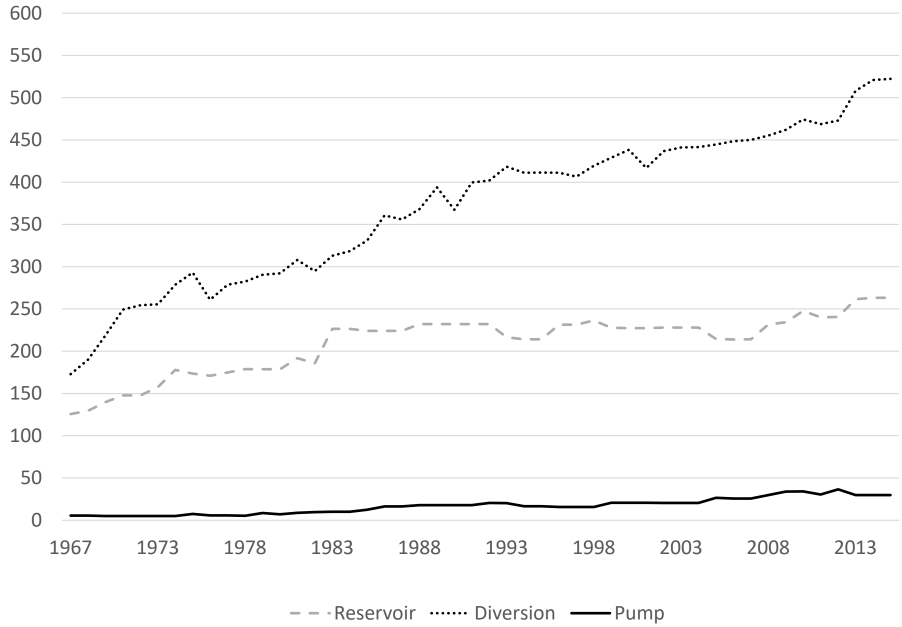
In terms of technology, for 2015–2017, run-of-the-river diversion systems account for 75 percent of the total irrigated area, while storage or reservoir systems account for only 12 percent (Figure 5). According to Figure 6, there had been more rapid growth for diversion systems. Reservoir systems very slightly increased while there is very little improvement in pump systems.

Figure 5. Average distribution of irrigated area by technology, 2015–2017



Note: "All others" include small farm reservoir and small water impounding system, among others.
Sources: NIA (2015, 2016a, 2017a)

Figure 6. Irrigated area by type of technology, '000 hectares (1967–2015)



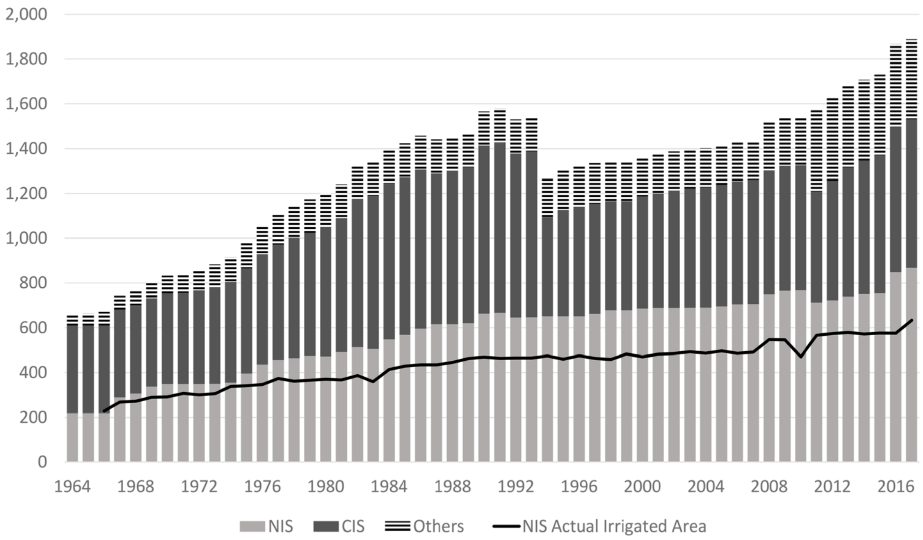
Sources: NIA Annual Reports (Various years) and NIA-Systems Management Division (Various years)

Irrigated areas

The change in irrigated area has largely coincided with the size of public irrigation investment.

Figure 7 shows a measure of irrigation performance, namely, area irrigated. From mid-2000 onwards, the irrigated area has been growing at an increasing rate, from less than 1 percent in the second half of the 1990s to close to 3 percent from 2015 to 2017. While NIS are generally and consistently bigger, the CIS have also been growing even at seemingly slower rate. Note that the drop in 1994 in CIS was due to a correction that NIA did after validation from the regional offices. This growth comes from other types of irrigation in 2005–2010, CIS in 2010–2015, and NIS in the most recent period.

Figure 7. Area irrigated by type of system, '000 hectares, 1964–2017



Note: "Others" include private irrigation systems and other government agencies-assisted irrigation systems.
NIS = national irrigation systems; CIS = communal irrigation systems
Source: NIA Corporate Planning Services (Various years)

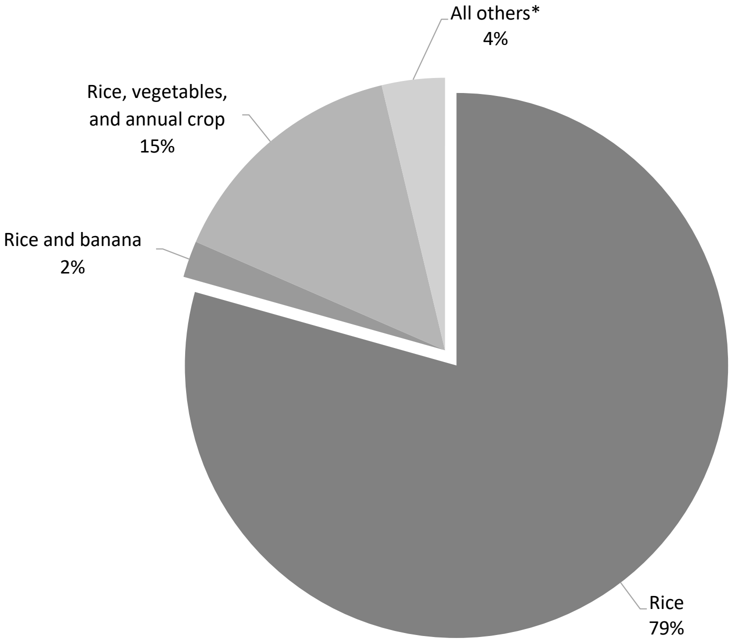
The overwhelming proportion of irrigated areas are under rice monoculture or rice-based systems.

From 2015–2017, rice monoculture and rice-based areas accounted for 96 percent of the irrigated areas (Figure 8). The country's irrigation systems are largely for the benefit of rice agriculture, and irrigation investments largely focus on rice-growing areas. Rice-other crop combinations largely occur in four regions: Cordillera Administrative Region (CAR), Region 1, Region 3 (including Upper Pampanga River Integrated Irrigation Systems [UPRIIS]), and Region 11.

Area harvested, production, and yield of irrigated palay are larger than that of rainfed palay and have been rising over time.

To see the trends in production and productivity, the study used the data of the Philippine Statistics Authority over time as NIA does not have consistently generated data on these variables from its irrigation systems. Figure 9 presents panels (a) and (b) for irrigated and rainfed palay production, respectively.

Figure 8. Average distribution of irrigated area by crop (%), 2015–2017



Note: "All others" include vegetables, diversified crops, banana, fishpond and rice, corn, and unclassified.
Sources: NIA (2015, 2016a, 2017a)

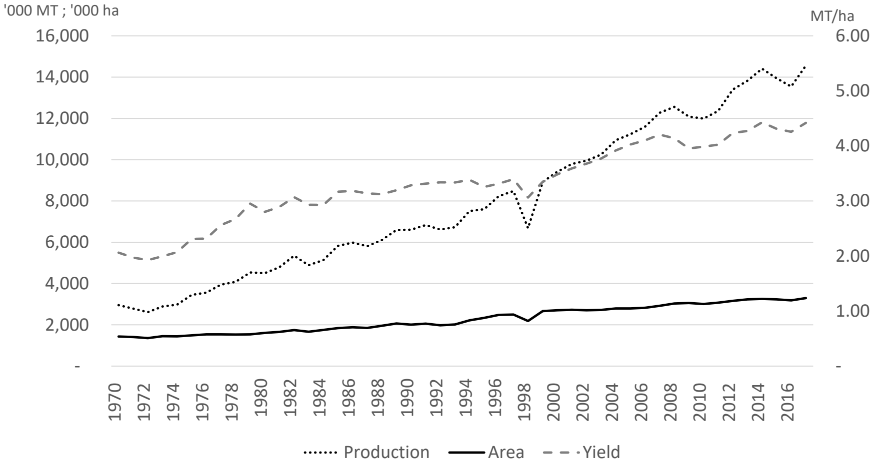
Irrigated production and yield are much higher than those for rainfed palay. Irrigated area is slightly increasing while rainfed area is decreasing, as confirmed by the trend lines and corresponding regression equations.

Regional trends in irrigated production and harvested area vary substantially across regions. Yield advantage of irrigated vs. rainfed harvested areas has been narrowing down over time.

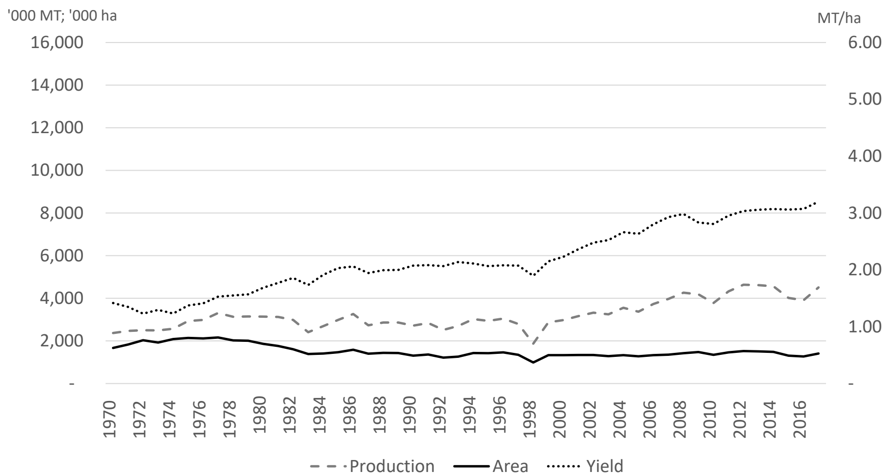
Figure 10 shows the regional trends in ratios of irrigated palay production and area harvested to total production and area, respectively. In CAR, Regions 2, 3, 10, 11, and 12, the contributions of the irrigated areas to production were significantly above 50 percent. In almost all regions over time, the shares of irrigated area have generally

Figure 9. Trends in irrigated palay production, area, yield, 1970–2017

(a) Irrigated



(b) Rainfed



ha = hectares; MT = metric ton
Source: PSA (2018)

been lower than the percent contributions to production, indicating the higher productivity of irrigated lands relative to rainfed areas.

On the other hand, the contribution to production of irrigated areas in the Autonomous Region in Muslim Mindanao (ARMM) has generally been lower than 50 percent. Region 6 just slightly exceeded the 50-percent mark in terms of contribution to production. Meanwhile, the yield advantage of irrigated over rainfed palay (Figure 11) differs widely across the regions. They appear to be higher in Region 2, CALABARZON, and Region 8, but with decreasing trends from 1970 to 2017. Of all regions, only in CAR is this ratio increasing, indicating the rising gap between irrigated and rainfed yields.

Figure 10. Ratios of irrigated to total palay production and area harvested, by region, 1970–2017

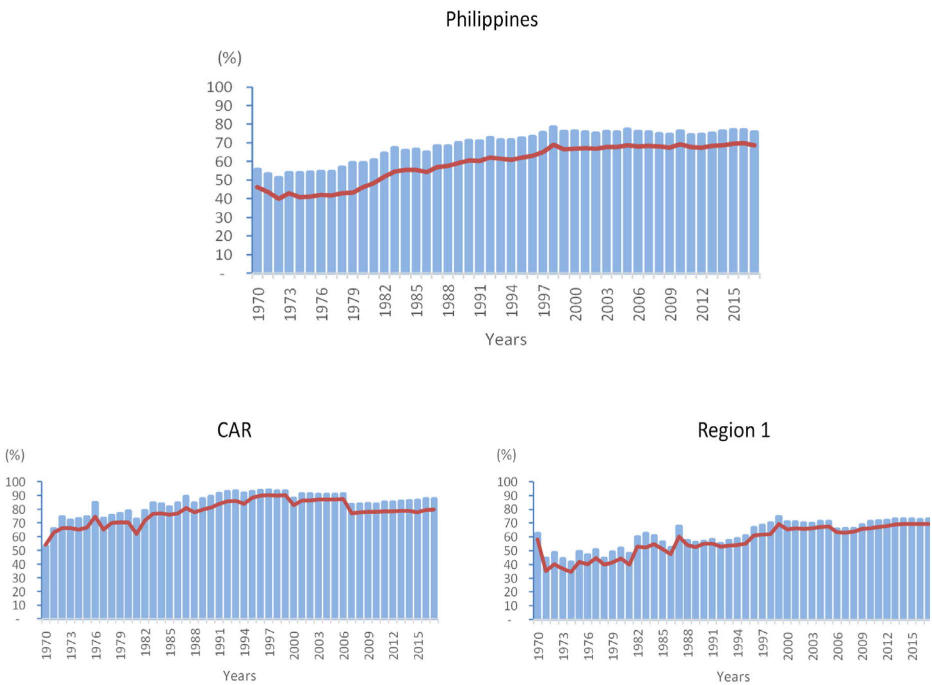


Figure 10. Continued

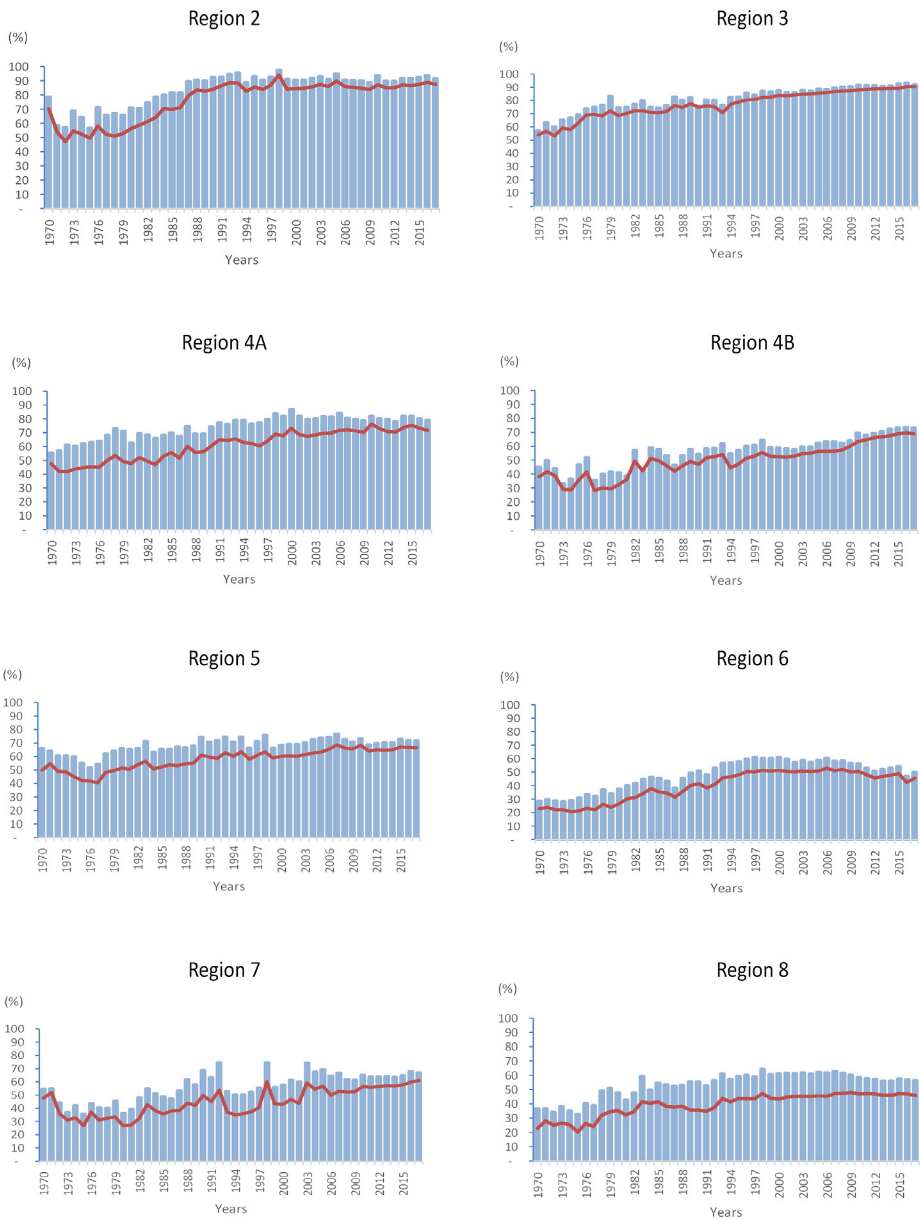
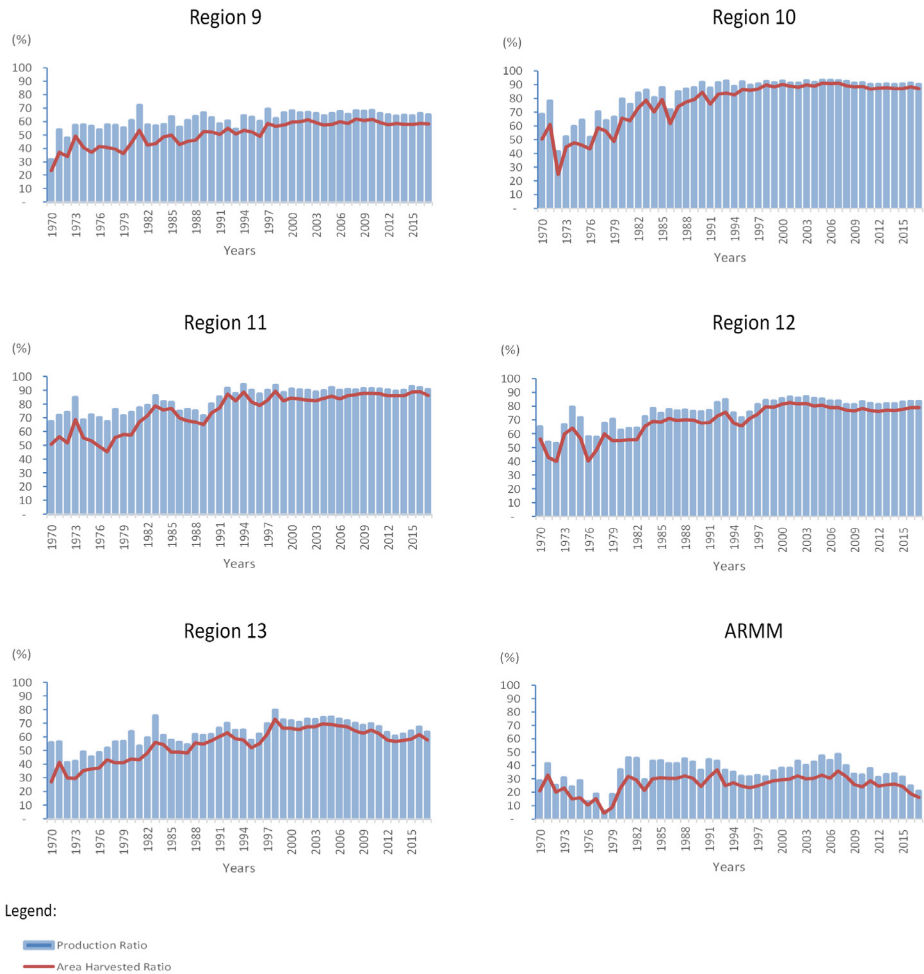


Figure 10. Continued



CAR = Cordillera Administrative Region; ARMM = Autonomous Region in Muslim Mindanao
Source: PSA (2018)

Figure 11. Yield advantage of irrigated over rainfed palay by region (%), 1970–2017

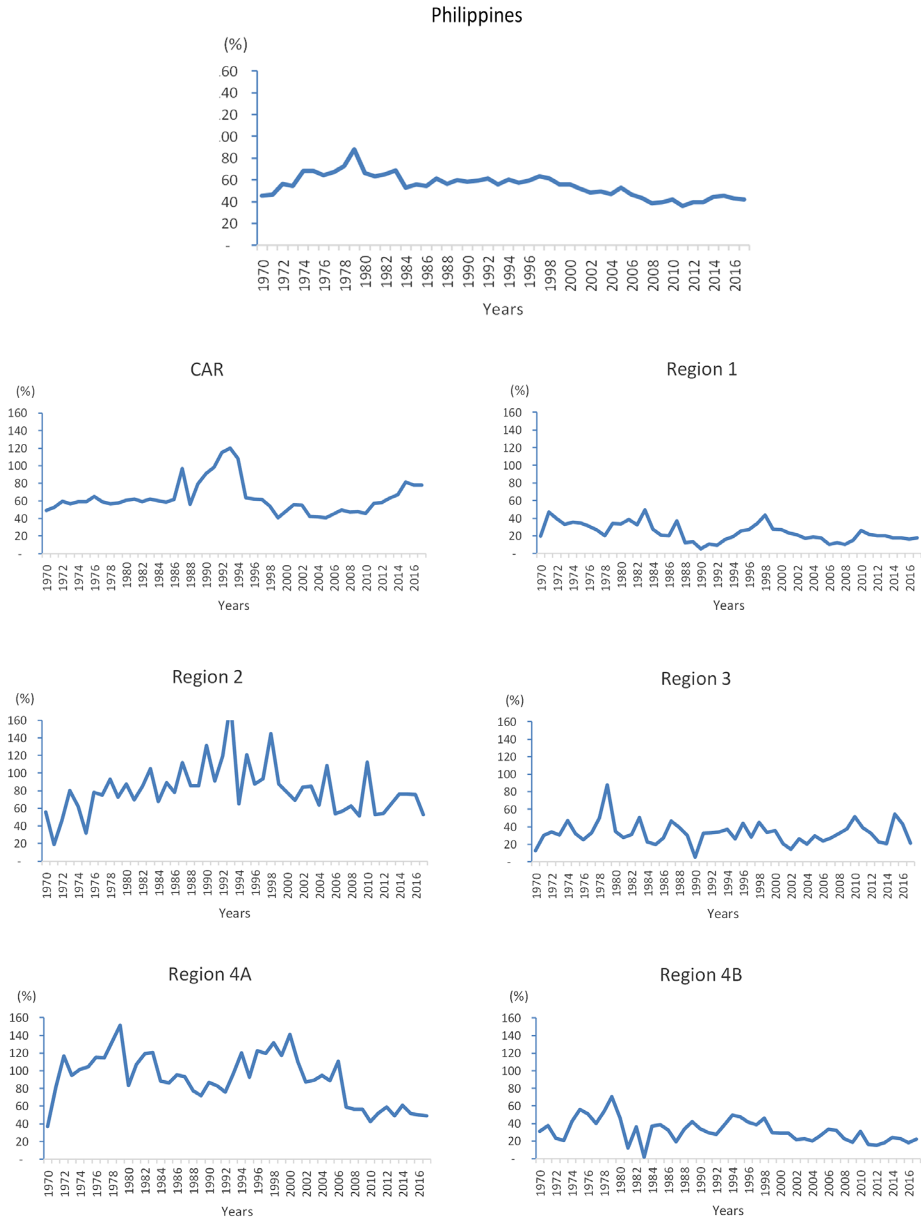


Figure 11. Continued

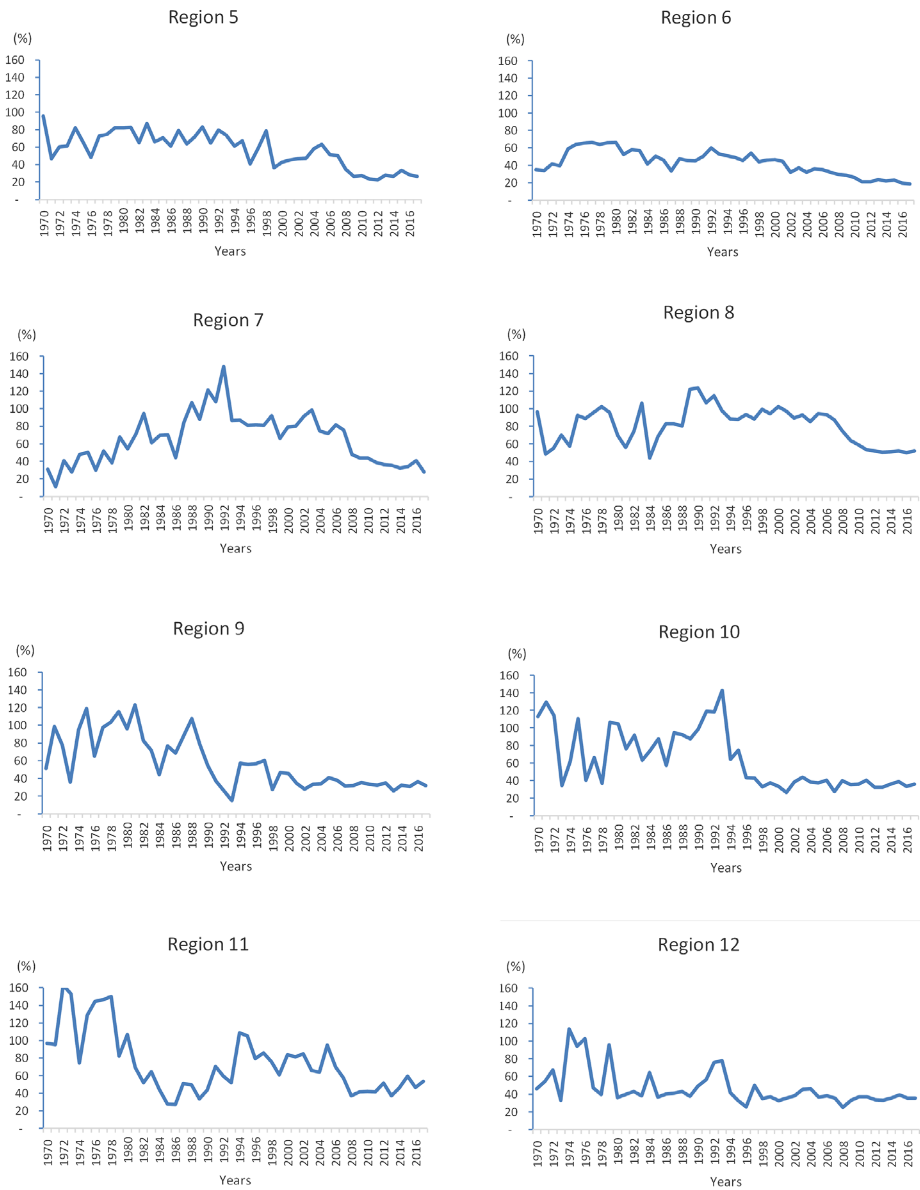
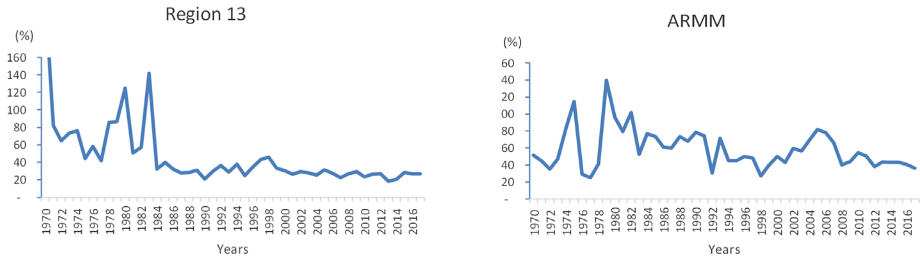


Figure 11. Continued



CAR = Cordillera Administrative Region; ARMM = Autonomous Region in Muslim Mindanao
Source: PSA (2018)

Accomplishments of NIA in terms of expansion of irrigated area have often fallen below physical targets.

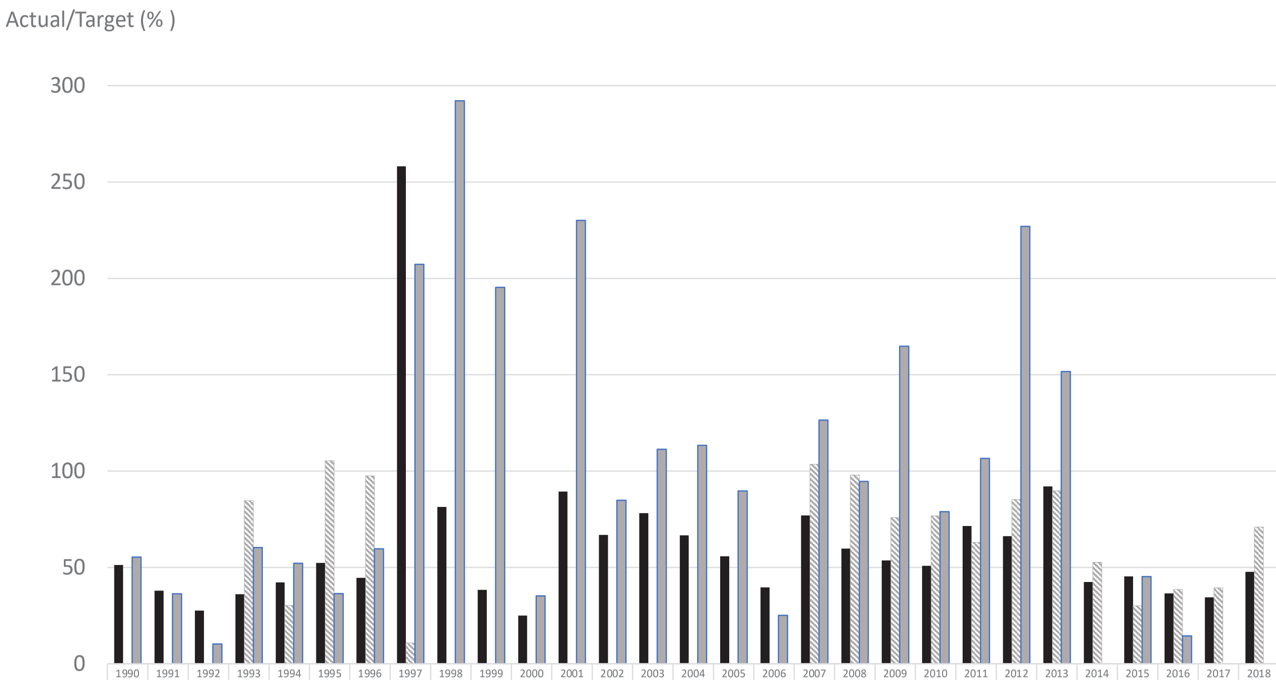
NIA has seldom met its annual physical targets for new area development (Figure 12). The same is the case for restoration. Both would have contributed to increase in annual growth rate area generated. It is possible that the potential irrigable area has been overestimated, making it difficult to realize unrealistic target.

Irrigation intensity

Irrigation intensity is usually below 100 percent. Improvements in irrigation service indicators have slowed down considerably in recent vintages (relative to older vintages).

NIS irrigation intensities for the dry season has generally been rising before they fluctuated around 70 percent, or 80 percent relative to firmed-up service area (FUSA), since the early 2000s. In the last decade, the intensities have generally been flat for NIS and lower than 90 percent (Figure 13). Irrigation intensities for CIS have even been lower than those for NIS. From 2001 to 2012, the ratio of irrigated area to FUSA was around 70 percent. However, the ratio of irrigated area to design area was only about 55 percent. The ratio of *effective* irrigated area to the design area may even be lower at 40 percent, if the low ISF collections from farmers dissatisfied with reliability of irrigation service are an indication (Chapter 6).

Figure 12. Trends in actual vs target irrigated area by type of project (new, restore, rehabilitation), 1990–2018

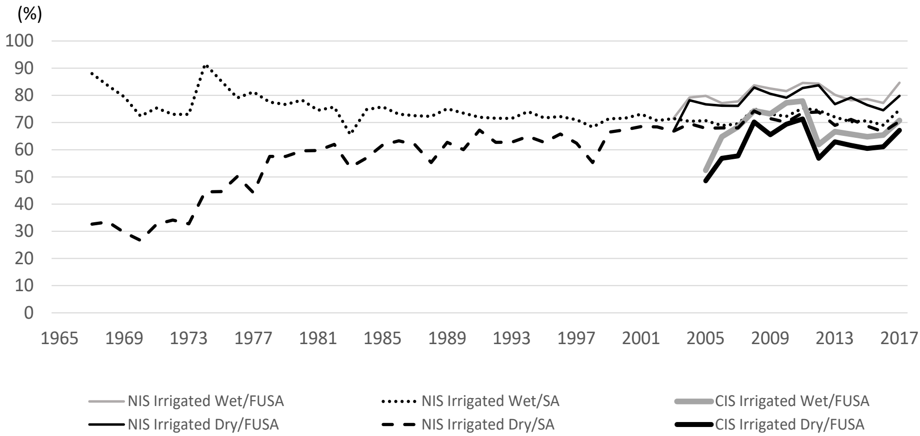


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
New	51	38	28	36	42	52	45	258	81	38	25	89	67	78	67
Restored	0	0	0	85	30	105	98	11	0	0	0	0	0	0	0
Rehab	55	36	10	60	52	36	60	207	292	195	35	230	85	111	113

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
New	56	40	77	60	54	51	72	66	92	42	45	37	34	48
Restored	0	0	104	98	76	77	63	85	90	53	30	39	39	71
Rehab	90	25	126	95	165	79	107	227	152		45	15	0	0

Sources: NIA Annual Reports (Various years)

Figure 13. Trends in irrigation intensities in NIS and CIS, 1965–2017



NIS = national irrigation systems; CIS = communal irrigation systems; FUSA = firmed-up service area; SA = service area
Sources: NIA-Systems Management Division (Various years)

Moreover, a worrisome trend in NIS is the downward trend for most indicators, namely, service area, FUSA, and irrigated area, among others. Irrigated area as a ratio to design area managed to reach 60 percent for earlier vintages of irrigation systems. However, the proportion had fallen to less than 40 percent for NIS build after the mid-1990s.

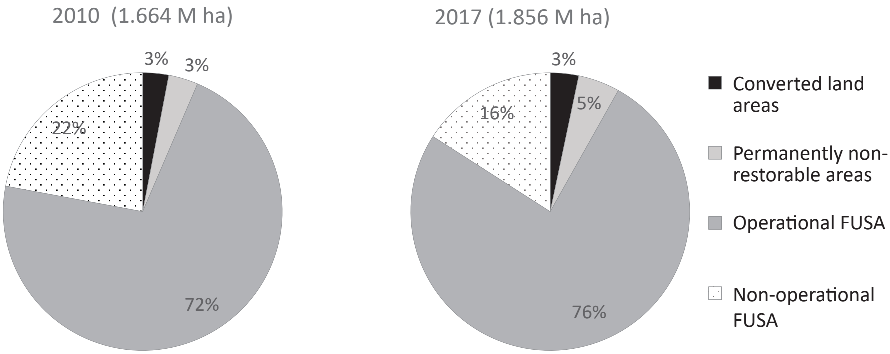
Converted, nonrestorable, and nonoperational area

The share of operational FUSA has been increasing over time, owing to a decline in nonoperational area.

NIA has also been collecting data within its service areas covering nonoperational area, converted area, and permanently nonrestorable area, such as canals and access/service roads, among others. Since 2010, the share of nonoperational area has fallen because of the rehabilitation and restoration projects of government (Figure 14).

Meanwhile, the share of permanently nonrestorable land has risen, from 3 to 5 percent. Converted areas have remained fairly constant at 3 percent of service area, contrary to common perception that they have been increasingly eroding gains

Figure 14. Shares in irrigation service area by operationality (%), 2010 and 2017



M = million; ha = hectares; FUSA = firmed-up service area
Sources: NIA (2010, 2017)

from irrigation investments. Hence, operational FUSA increased to 76 percent, from 72 percent.

The irrigation development program of the Philippines: Key issues

Philippine Development Plan (2017–2022)

The current administration has adopted the PDP 2017–2022. It is the first plan anchored on *AmBisyon Natin 2040*. It aims to lay a strong foundation for inclusive growth, a high-trust society, and a globally competitive economy toward realizing the vision by 2040.

Poverty in agriculture and in lagging regions with high poverty incidence and inequality will be targeted. Climate-resilient small-scale irrigation systems will be constructed or retrofitted, as necessary. The construction of these irrigation systems will be accelerated in areas with high irrigation development potential, such as Central Luzon, Cagayan Valley, SOCCSKSARGEN, ARMM, and Bicol Region. An integrated watershed management approach will be implemented to sustain soil productivity and water efficiency, particularly in the 143 critical watersheds in the country.

The PDP 2017–2022 targets for irrigation are presented in Table 3. From the baseline, it aims to grow the new irrigated area by 7.74 percent by 2022, or an average of 1.29 percent per year. With this target, the cropping intensity, or the actual wet plus actual dry season irrigated area divided by FUSA, is expected to increase to 157 percent by the end of the period, or a total growth of 13.42 percent from the baseline. These targets are broken down into growth in new service areas by type of systems and scale. For national systems, it is expected to have a total increase of 225,526 ha and for SSIS, 130,799 ha. A total of about 194,500 ha would be restored for the same period.

Table 3. PDP targets for irrigation, 2017–2022

	Base	2017	2018	2019	2020	2021	2022
Irrigated area ('000 ha)	1,731	1,781	1,825	1,864	1,898	1,929	1,965
Ratio, irrigated to potential area (%)	57.33	59	60.43	61.72	62.86	63.87	65.07
Cropping intensity (%)	143.58	144	147	150	152	155	157
Canals (km)	1,259	1,600	1,700	1,700	1,800	1,900	2,000

PDP = Philippine Development Plan; ha = hectares; km = kilometers
Source: NEDA (2019)

Irrigation master plan

The PDP mandates the preparation of irrigation master plan to set the direction for irrigation development and a framework for capital and O&M financing of irrigation projects will be formulated. The overall plan and framework aim to

- institutionalize a policy providing government subsidy for capital investment and O&M of irrigation facilities;
- strengthen the capacity of personnel;
- strengthen the implementation of the IMT program;
- review and rationalize ISFs;
- establish and rehabilitate small-scale and community-based irrigation projects in areas not served by NIS;
- prioritize small over large irrigation projects and rehabilitation over construction of facilities; and
- conduct complete technical work and site validation in the project planning stage to eliminate the causes of delays in project implementation.

Luyun (2016) summarizes the data on water resources of the country. The annual water potential of the country is about 146 million cubic meters. Of this figure, 126 million cubic meters is surface water and the remaining 20 million cubic meters is groundwater. As of 2013, water permits granted for surface water cover about 80.6 million in total. Hence, there appears to be enough water resources available on the aggregate for the targeted expansion. However, as will be discussed in subsequent chapters, aggregate availability is no guarantee of local availability.

The new masterplan will make new estimates of potential irrigable areas and recalibrate the PDP targets for irrigation. Past estimates of irrigable area at the system level have been prone to overestimation owing to absence of site-specific design criteria. For instance, NIA adopts a standard assumption of 1.5 liters per second per ha as the irrigation requirement, despite large variations in requirement by site depending on terrain, soil type, or climate (Ella 2016).

PDP also identifies a legislative agendum on abolishing ISFs for small farmers. The reason is that many of them cannot pay the ISF, though a minimal fee may be imposed for pump irrigation systems. This agendum is consistent with the campaign promise of President Duterte. Subsequently, Congress passed the FISA in 2018. An extensive discussion of the FISA is reserved for Chapter Six.

Rice industry liberalization and Road Map

The QR regime in rice importation was maintained until 2017 when the waiver provided by WTO ended. In 2018, the current administration pushed for a new law on rice industry liberalization, which provided for tariffication of the import QRs. The law was enacted in early 2019 and its IRR were promulgated in March the same year.

The law liberalizes rice importation subject to the payment of import duties, equivalent to the following:

- 35 percent for imports from countries with the Association of Southeast Asian Nations (ASEAN);
- 40 percent for imports from other countries under MAV, equal to 350,000 tons; and
- 180 percent for imports outside ASEAN and beyond MAV.

The law also provides for allocation of the rice import tariff back to rice farmers as production support in the form of the Rice Competitiveness Enhancement Fund. The Rice Fund does not contain allocations for irrigation, setting aside rather the first PHP 10 billion for rice mechanization, seed dissemination, rice farmer credit, and rice farmer extension. Meanwhile, the excess of over PHP 10 billion in tariff revenues is allocated to rice farmer financial assistance, including those exiting rice farming, titling of agricultural rice lands under the agrarian reform program, expanded rice crop insurance, and crop diversification program.

The law also provides for the development of a rice roadmap. The *Philippine Rice Roadmap* was conceptualized to contribute toward attaining the *AmBisyon Natin 2040* long-term goal of having a *Matatag, Maginhawa, at Panatag na Buhay* for Filipinos. It aims to achieve three goals: improved competitiveness, enhanced resiliency to disasters and climate risks, and ensured access to safe nutritious rice. The Road Map explicitly relaxes the goal of 100-percent self-sufficiency by adding the provision that import substitution be done at globally competitive prices.

The Road Map anticipates that rice farms in the country will need to adjust to lower palay prices, with some even exiting rice production. It introduces the concept of priority provinces that will be the focus of interventions spread across the rice value chain, including marketing, while nonpriority provinces will have interventions to transition from rice to other sources of income (Table 4).

Irrigation development will focus on the priority provinces, particularly on medium-yield provinces. This covers both NIA projects and DA projects, such as SWIPs and solar-powered irrigation, among others. The incoming *National Irrigation Masterplan* for 2020–2030 will take into account the Rice Road Map and priority provinces.

Past studies and assessments

While the goals of the irrigation development program under PDP are laudable, serious concerns have been raised in our analysis of past trends (Section 4) as well as past assessments of irrigation project performance.

The first wave of irrigation investments in the 1970s and early 1980s was followed by several evaluations in the 1990s. David (1990) observed that gains in cropping intensity and yield were low, owing to poor performance of the country's irrigation systems. For the nation's flagship irrigation projects, such as the UPRIIS, he noted the following technical problems:

- Assumptions on water availability, efficiency, water requirement, and sediment inflow, were systematically over/understated to raise the economic internal rate of return (EIRR). For example, at feasibility study stage, UPRIIS was appraised at EIRR of 13 percent, but ex post was reappraised at 8.9 percent, which falls below the 12-percent cutoff.

Table 4. Priority provinces of the Rice Industry Road Map 2030

High Yield (More than 4 MT/hectare)		Medium Yield (3 to 4 MT/hectare)	
Low Cost (Below PHP 12 per kg)	**Medium Cost (PHP 12 to 17 per kg)**	**Low Cost (Below PHP 12 per kg)**	**Medium Cost (PHP 12 to 17 per kg)**
Nueva Ecija	Cotabato	Camarines Sur	Compostela Valley
Isabela	Tarlac	South Cotabato	Negros Oriental
Bukidnon	Cagayan	Leyte	Bohol
Zamboanga del Sur	Pangasinan	Negros Occidental	Occidental Mindoro
Pampanga	Bulacan	Iloilo	
Misamis Occidental	Nueva Vizcaya	Capiz	
Lanao del Norte	Ilocos Norte	Albay	
Biliran	Davao Oriental	Maguindanao	
Bataan	Davao del Sur	Agusan del Norte	
Aurora	Davao del Norte	Antique	
Kalinga	Southern Leyte	Sorsogon	
	Laguna	Masbate	
	Zambales	Palawan	
	Quirino	Cavite	
	Misamis Oriental	Lanao del Sur	
	Zamboanga Sibugay	Samar (Western Samar)	
	La Union	Surigao del Sur	
	Ilocos Sur	Aklan	

PHP = Philippine peso; MT = metric tons; kg = kilogram
Source: Department of Agriculture (2019)

- Design philosophy tends to be highly unrealistic. For instance, UPRIIS design engineers introduced double-gated water control structures that are too sophisticated for farmers and watermasters to operate.
- Irrigation-related agencies fail to coordinate. Design engineers do not communicate with O&M engineers for feedback and advice. Agencies in charge of watershed management are not spurred to action by alarmingly high sedimentation rates, up to 375 percent above appraisal estimate.

Similar findings were broached in the World Bank (1992a) report. The study noted that the potential for increased palay yield and improved irrigation performance was lower than is commonly supposed. Investment in irrigation should be evaluated on a project-by-project basis, adopting realistic assumptions and clear economic criteria. Design improvements are warranted. This means that greater attention should be devoted to siltation, erosion, and related problems and a more realistic approach to water control is required, toward staggered and rotational rather than continuous supply.

A review of the literature up to the mid-1990s (David 1995) confirms these findings, with some additional observations. On average, the actual irrigated area was only 75 percent of design service area. Moreover, large systems had a smaller ratio than small systems. New irrigation projects (after 1972) tended to have much lower ratios (56%) compared to older systems (94% for projects before 1965).

Similarly, David et al. (2012) reviewed irrigation post-AFMA and concluded that the Act had very little positive impact on irrigated agriculture. The same problems detected in the 1980s and 1990s, such as design mistakes, inadequate O&M, and lack of coordination, persist in irrigation projects even after AFMA. A rapid appraisal of NIS (Inocencio et al. 2013) found the following:

- Project identification is often based on a flawed measure of potential irrigable area.
- Design area is overestimated owing to high-resolution features of the intended service area not properly characterized, i.e., presence of built-up, flooded, or elevated areas.
- Routine maintenance activities are underfunded, raising the cost of subsequent rehabilitation.

Conclusion

There is a sound economic rationale for supposing that market failures are pervasive in the provision of irrigation services as private actors are not willing to develop and operate the requisite irrigation systems without subsidy. For big systems, the capital requirement would be large, the commercial risks too high with farmer incomes generally low leading to likely high defaults in times of calamities. Hence the argument goes, if irrigation is to be developed, then public-sector involvement in terms of capital and even operating subsidy becomes necessary.

Since the 1960s, the Philippines has taken the route of large public expenditure outlays for irrigation development, both to construct systems, as well as in systems operation. The result has been enormous benefit for Philippine agriculture, particularly rice. Irrigated area has been rising over time, which leads to an expansion in area harvested of irrigated rice. This, in turn, exhibits a distinct yield advantage over rainfed rice.

These gains should not obscure some very real issues concerning the cost-effectiveness of public expenditures:

- Irrigation intensities remain persistently below unity, are lower for CIS, and have plateaued over time. Some of the difficulties in raising irrigation density relate to the scarcity of water, especially during the dry season.
- The long history of irrigation development implies a preponderance of ageing systems in varying states of deterioration, siltation, and damage. Actual irrigated area is often below design area. Hence, irrigation expenditures are shifting toward rehabilitation/restoration and away from entirely new construction.
- Since the 1990s, to relieve the burden on public treasury, governments have encouraged cost-sharing with farmers, as well as delegating wider responsibility in operations, maintenance, and even ownership of irrigation. However, this policy appears to be headed for a complete reversal owing to FISA.

There are, in fact, reasons to doubt that purely economic and equity rationale had motivated the massive public investments. The irrigation programs over several administrations have been part of a public support package for rice, a heavily politicized commodity. That package also typically involves isolating domestic from international rice markets, toward a popular goal of rice self-sufficiency.

The existing policy framework exhibits contrasting features, some of which are consistent with past policies, and some of which represent a policy shift or reorientation. On the one hand, the subsidy orientation has escalated as capital budgeting for irrigation systems has ramped up, together with operating cost subsidy, to the point that irrigation service is now free. On the other hand, rice importation has been liberalized, compelling the government to genuinely aim for domestic food sufficiency under more competitive conditions, though free trade prices are off the table given the high levels of remaining tariffs. Far from simply pouring more money into the problem, the government should study and implement a package of reforms toward cost-effective irrigation sector development.

Chapter 2

National Irrigation Systems

**Roberto S. Clemente, Arthur L. Fajardo,
Vicente G. Ballaran Jr., and Julie Carl P. Ureta**

Introduction

National irrigation systems (NIS) are irrigation systems managed by the National Irrigation Administration (NIA) with an irrigated area that exceeds 1,000 hectares (ha). In the Philippines, NIS has a total firmed-up service area (FUSA) of about 723,000 ha numbering to about 220. Most NIS are run-of-the-river type systems. Larger NIS are typically reservoir systems that account for the three largest systems in the country with service areas ranging from about 30,000 to 110,000 ha. Some NIS use large pumps installed along major river systems to lift water.

From 1966 to 2012, the government capital outlays for irrigation were more for NIS, accounting for approximately 78 percent. For 2008-2012, it went down to 47 percent, as public resources were reallocated for communal irrigation systems and other smaller irrigation systems. Nonetheless, NIS continue to account for the majority of capital outlays.

For years, several studies have underscored the large gap between actual irrigated area and design area in NIS. World Bank (1992a) summarized the reasons for the poor performance of NIS, which include overly optimistic technical and economic design assumptions, inadequate water source supply, inappropriate irrigation system design, and difficulties in system operation and maintenance.

There have been various initiatives to improve planning, construction, operation and maintenance, and rehabilitation of NIS. Technical data are regularly collected through field-level measurements while more technical data through remote sensing are accessible. The availability of new technology (GIS analysis, mathematical modeling, and simulations) boost the technical capacity to undertake more modern and rigorous methodologies for analysis and design. However, the evaluation and continuous refinement of the involvement of farmers to promote participatory governance of the irrigation sector from planning to rehabilitation remains relevant. The prevalent constraint seems to be the insignificant demand for improved and effective governance of the sector.

Given existing performance gaps, this assessment examines the factors explaining these gaps in NIS.

Related literature

An indicator of NIS performance is irrigation efficiency. Problems with irrigation efficiency have plagued irrigation systems worldwide. In the case of Maharashtra, India, Mahato (2013) and Pradeep et al. (2015) identified the following reasons for low water use efficiency: (i) insufficient or nonmaintenance of canals/distributaries/minors of irrigation systems resulting in growth of weed and vegetation, siltation, and damages in lining; (ii) distortion of canal sections due to siltation or collapse of slopes resulting in some channels carrying much less and some other channels carrying much more than their design discharges; (iii) nonprovision of lining in canal reaches passing through permeable soil strata; (iv) leakages in gates and shutters and damaged structures; (v) lack of regulation gates on head regulators of minors causing uneven distribution of water; (vi) over-irrigation due to nonavailability of control structures and facilities for volumetric supply of irrigation water to farmers; (vii) poor management practices; and (viii) lack of awareness among farmers about correct irrigation practices and cropping patterns.

The problem of inappropriate design criteria has always been a major constraint to irrigation development in the Philippines. Due to inadequate baseline information and poor institutional capacity for project planning, designers and builders of irrigation facilities fail to establish the appropriate design criteria (Horst 1998; Plusquellec 2002; David 2003, 2008, 2009.) Design engineers are not required to test-run the systems they designed in collaboration with those who are supposed to operate and maintain them. As a result, design errors repeatedly occur from system to system without being rectified.

Moya (2014) reported several issues that caused the low performance of 14 irrigation systems studied, including, among others: (1) field water requirements used in the design of most irrigation systems had been grossly underestimated; (2) water losses throughout the system were underestimated; and (3) many irrigation systems are littered with redundant turnouts and unresponsive and long farm ditches that had increased project costs due to the use of conventional approach in designing canals and water control and regulating appurtenances based on maximum flow conditions.

Water quality is an oft-neglected problem in irrigation systems. The salinity of the water would be a problem if salt accumulates in the crop root zone to a certain level, leading to a loss in the yield (Ayers and Westcot 1994). Excessive salt in the root zone would hinder the crops from extracting enough water from the soil. This could lead to slow growth and maturity of the crops that can significantly affect the yield. Accumulation of toxic ions at sufficiently large concentrations also causes damaged crops and reduced yields (Ayers and Westcot 1994). In Viet Nam, yield loss due to water pollution was estimated at 0.57–0.75 tons per hectare per crop (Huynh and Yabe 2012). Water pollution also increased the rice production cost and inflicted a 26-percent profit loss.

Various studies have been undertaken to determine the different factors affecting the irrigation performance and agricultural productivity (e.g., crop yield) using Principal Component Analysis (PCA), a quantitative approach for estimating a summary performance index (Box 1) for an irrigation system or an associated governance structure (e.g., user association). Tiewtoy et al. (2010) evaluated the performance of two projects in the Tha Chin Basin, namely, the Kamphaengsaen and Phophraya irrigation projects, based on key indicators using PCA. Results indicated that net farm income, awareness on irrigation water use, management of water delivery schedule and agricultural operation, and field application ratio are the major indicators of performance for Kamphaengsaen. For Phophraya, on the other hand, the analysis showed that irrigation sustainability is affected by four key indicators—perception of drained water quality, satisfaction on the adequacy of water distribution, field application ratio, and net farm income.

Fang et al. (2017) studied the driving factors of irrigation water-use change based on 21 measures covering climatic change, resource endowment, economic

Box 1. Principal components analysis

> Principal component analysis (PCA) is a statistical procedure that clusters a large set of variables into small components called "summary indices", while maintaining most of the information of the larger set. The summary indices allow for better visualization and analysis; thus, PCA is commonly used for developing indexes, particularly when considering multiple indicators. Principal components are derived from *eigenvalues*, which are the amount of variance explained by each technical, socioeconomic, institutional, and environmental indicators/attribute. The irrigation performance index (IPI) was developed based on the principal components defined as linear combinations of the variables that account for maximum variance within the data set. IPI was formulated using the score of key indicators obtained earlier by PCA.

situation, technological level, and management mode. Data from 31 provinces of China in 2009 were analyzed using the PCA method to extract the main driving factors affecting the irrigation water-use efficiency change. Results revealed that differences in irrigation use efficiency could be attributed to, among others, variation in agricultural economic development, adoption of water-saving irrigation technology, and water resource endowment.

Methodology

Scope

The NIS case studies covered 22 systems in Luzon, 9 in the Visayas, and 8 in Mindanao (Table 1), representing 151 irrigators' associations (IAs). They represent a diversity of characteristics such as location (nationwide), size (small to large), performance (successful/nonsuccessful), and irrigation technology (gravity/pump).

Data collection

The assessment was based on primary and secondary data related to NIS. Secondary data collected include:

- Technical data (i.e., system profile, service area, irrigation efficiency, construction cost, rehabilitation cost, yield, cropping calendar, cropping intensity, feasibility studies, technical drawings, layout map); and

Table 1. List of NIS cases covered in this report

Island group	Region	Number	Province	System
Luzon	1	2	Ilocos Norte	Nueva Era River Irrigation System (RIS) and Bonga Pump #2 Pump Irrigation System (PIS)
	1	1	Ilocos Sur	Banaoang PIS
	1	2	Pangasinan	Ambayoan RIS and Dipalo RIS
	2	3	Cagayan	Magapit PIS, Solana PIS and Visitacion RIS
	2	2	Isabela	Divisions 2 and 4 of Magat River Integrated Irrigation System (MARIIS)
	3	3	Nueva Ecija	Divisions 2, 3, and 4 of Upper Pampanga River Integrated Irrigation System (UPRIIS)
	3	1	Pampanga	Pampanga Delta RIS (PDRIS)
	3	3	Tarlac	TGIS, Tarlac RIS, and San Miguel-O'Donnell RIS
	3	1	Bulacan	Angat-Maasim RIS
	4B	1	Occidental Mindoro	Caguray RIS
	4A	1	Cavite	Balayungan RIS
	4A	1	Quezon	Dumacaa RIS
	5	1	Camarines Sur	Libmanan-Cabusao PIS
Visayas	6	1	Capiz	Mambusao RIS
	6	3	Iloilo	Jalaur-Suague RIS, Sibalom-Tigbauan RIS and Barotac Viejo RIS
	7	3	Bohol	Malinao Irrigation System (IS), Bayongan IS and Capayas IS
	8	2	Leyte	Binahaan-Tibak RIS and Daguitan-Guinarona-Marabong RIS
Mindanao	10	3	Bukidnon	Manupali RIS, Pulangui RIS, and Roxas-Kuya RIS
	11	1	Davao del Sur	Padada RIS
	12	2	North Cotabato	M'lang RIS and Maridagao RIS (MalMar 2)
	12	2	South Cotabato	Marbel #1 RIS and Banga RIS
	Total	39		

Source: Authors' compilation

- Status of IAs (i.e., profile/institutional report of IAs, source of funding, financial status/viability, the program of works [POWs] for all available years, and national irrigation system performance).

Data were collected in two cycles. The first cycle (2015) covered Luzon NIS, while the second cycle (2018) covered Visayas and Mindanao NIS. Primary data were collected through site visits, field measurements, and key informant interviews (KIIs) and focus group discussions (FGDs) that were partly based on structured questionnaires. Most of the questions were derived from the rapid appraisal procedure of Mapping System and Services for Canal Operation Techniques or MASSCOTE (Renault et al. 2007).

Walkthroughs and actual field measurements were also conducted to determine the status and conditions of the irrigation facilities. Measurements in the field were performed using portable equipment (e.g., flow meters, water quality kits, etc.). Measurements included canal and structure dimensions, canal length, canal flow, silt depth, and water quality parameters. Depending on the size of the irrigation system, sections selected were: (a) near the dam or headgate (upstream), (b) in the middle (midstream), or (c) at the tail end of the system (downstream). These structures/facilities were photographed and geotagged. Conveyance losses were measured on selected main and lateral canals. Lastly, water quality parameters covered pH for acidity/alkalinity, dissolved oxygen for the presence of ambient organic matter, and electrical conductivity (EC) for the presence of dissolved salts and other solids. Cutoffs for good water quality are <300 microsiemens per centimeter, 6 parts per million for dissolved oxygen, and around 6 (or neutral) for pH.

Analytical methods

Digital maps were used extensively in the assessment. Available digital elevation maps (DEM), soil erosion maps, soil maps, built-up area maps, and groundwater potential maps were compiled for the assessment. Maps were obtained from the DA and its bureaus (Bureau of Agricultural Research [BAR] and BSWM), Department of Environment and Natural Resources (DENR) and its attached agencies (National Water Resources Board [NWRB], National Mapping and Resource Information Authority [NAMRIA]), the Comprehensive Irrigation Research and Development Umbrella Program (CIRDUP), and Google Maps.

Service area maps were digitized if no shapefiles were available. Walkthrough maps of specific NIS cases covered were developed using the service area map and GPS readings of headworks, canal structures and water flow, and quality measurement points. Spatial analysis was done by generating hillshade effect on the DEMs acquired through remotely sensed images from Advanced Spaceborne Thermal Emission and Reflection Radiometer. The erosion map was then juxtaposed with the DEM to explain sources of siltation visually.

KIIs of key system personnel (e.g., irrigation management offices, system managers, irrigators development officers [IDOs], operations staff, and IA president/officer) engaged in the NIS operation were also conducted. FGDs with IAs were undertaken in the upstream, midstream, and downstream sections of the selected NIS.

PCA was applied to assess the performance of the NIS cases at the IA level. Four major categories of indicators were employed: technical/physical, institutional/organizational, economic, and environmental. The following steps were performed:

1. A selection of technical, socioeconomic, institutional, and environmental factors was conducted for the study area.
2. T-test was used to test the normality of data distribution, and Cronbach's alpha was used to test the reliability of the questionnaire. Furthermore, bivariate analysis was used to test the correlation of data.
3. PCA was used to find the irrigation performance index based on principal components (Box 1). The index can reflect the technical and institutional effectiveness of the project cycle from project identification and feasibility up to operations and maintenance (O&M).

Findings based on rapid appraisal

Performance indicators

The performance of the NIS varies widely. Differences in the availability of water, siltation, and quality of maintenance may account for these variations.

The cropping intensity of selected NIS cases is presented in Figure 1 for the crop years 2005–2017; here, cropping intensity is defined as the dry and wet season area irrigated, divided by FUSA (in percentage). Ideally, cropping intensity should be 200 percent. Note that cropping intensity for some of these systems is lower than the **irrigation cropping intensity** (which includes a third season, if applicable). Variations in cropping intensity may be due to the numerator, i.e., irrigated area (mostly for rice, but for some systems such as Ambayoan-Dapalo RIS, Padada RIS, and Manupali RIS, it includes other crops in some seasons) include other crops in some seasons. Variations may also be due to the denominator, e.g., decreases in FUSA due to land-use conversion, or increases due to system rehabilitation (though adjustments in FUSA are likely to be accompanied by adjustments in the numerator as well).

The average cropping intensity (2005-2017) for the NIS cases ranges from 71 to 205 percent; the range is narrower for Luzon NIS (71 to 195 percent). The average cropping intensity for the Visayas NIS ranges from 68 to 185 percent. Average cropping intensity for Mindanao NIS is in a much higher range, from 119 to 205 percent. Systems with low cropping intensity were characterized by siltation and low water supply, e.g., Pampanga Delta RIS and Caguray RIS. The relatively higher cropping intensity, especially of South Cotabato NIS, may be attributed to the high percentage of lined canals and the synchronized scheduling. The cropping intensities by the pump irrigation systems (Banaoang and Libmanan-Cabusao) were among the lowest. The performance of large reservoir-type system (MARIIS and UPRIIS) was relatively higher than the smaller one (Bohol NIS).

Figure 1. FUSA, program and actual irrigated areas, and cropping intensities of selected NIS

(a) Luzon NIS

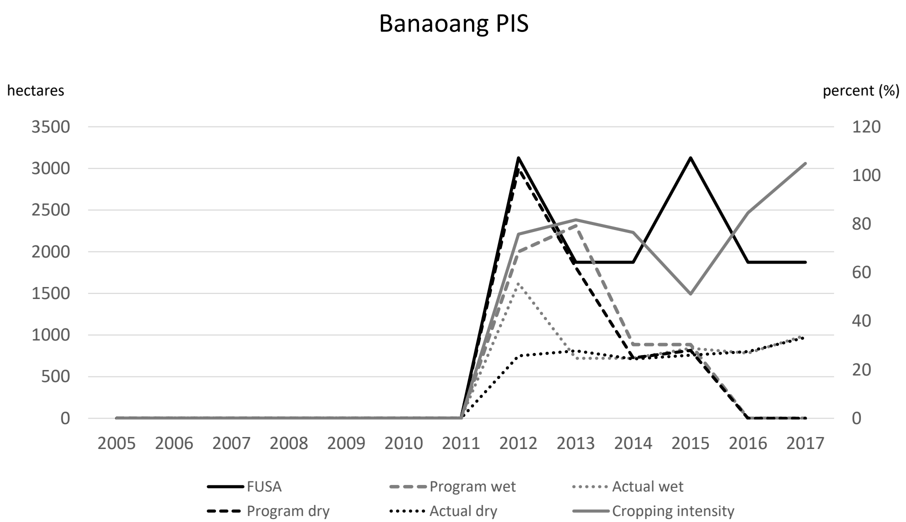
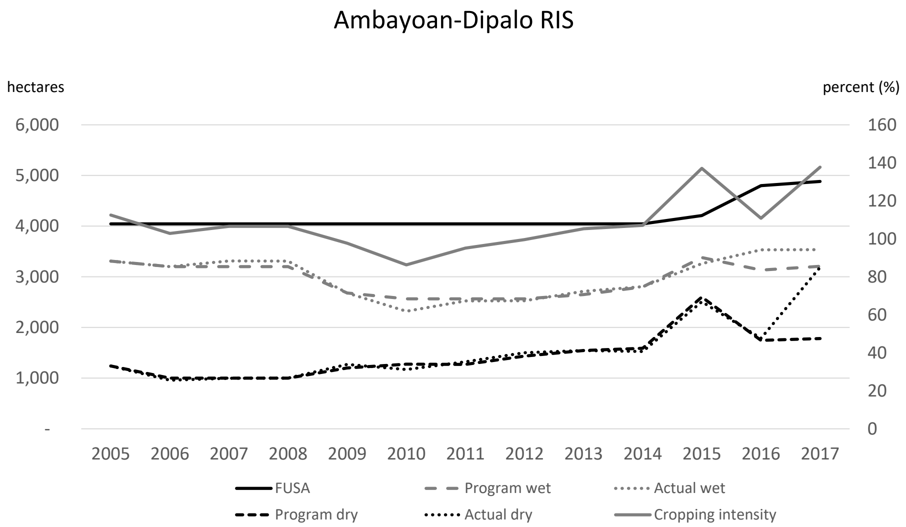
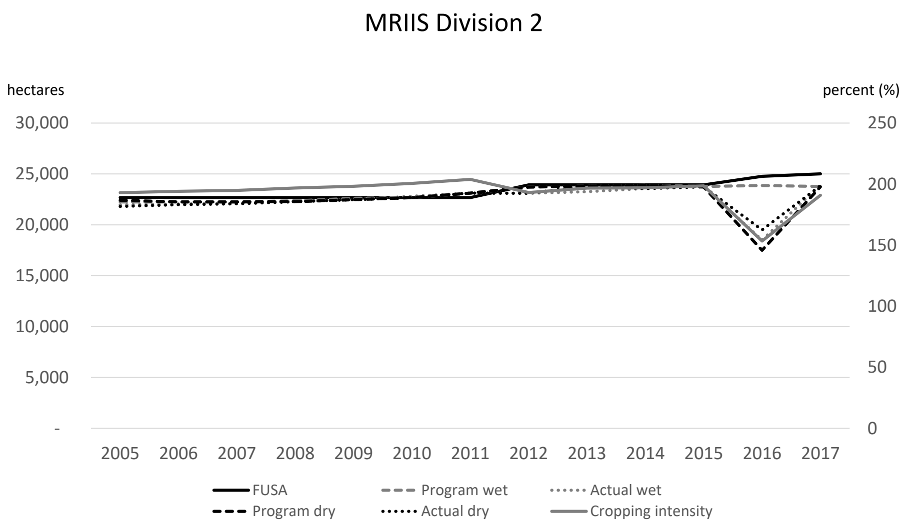


Figure 1. Continued





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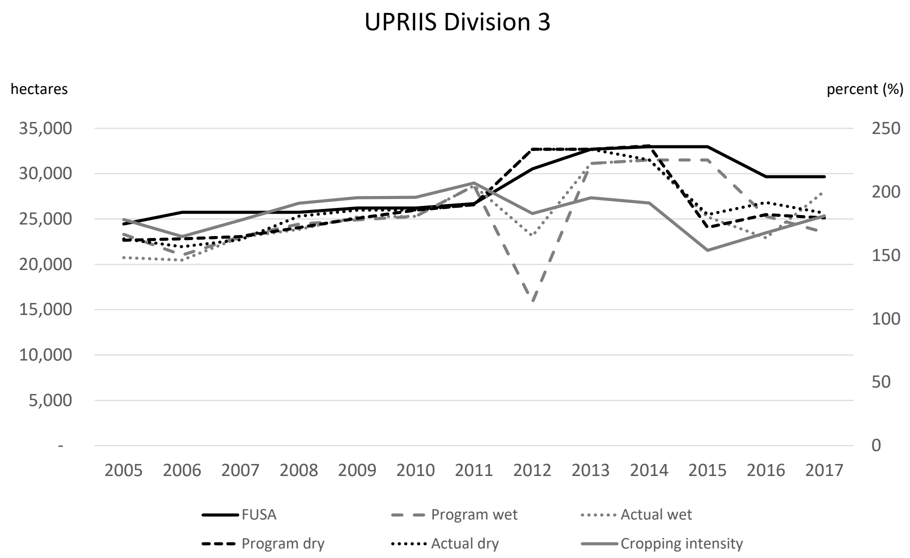

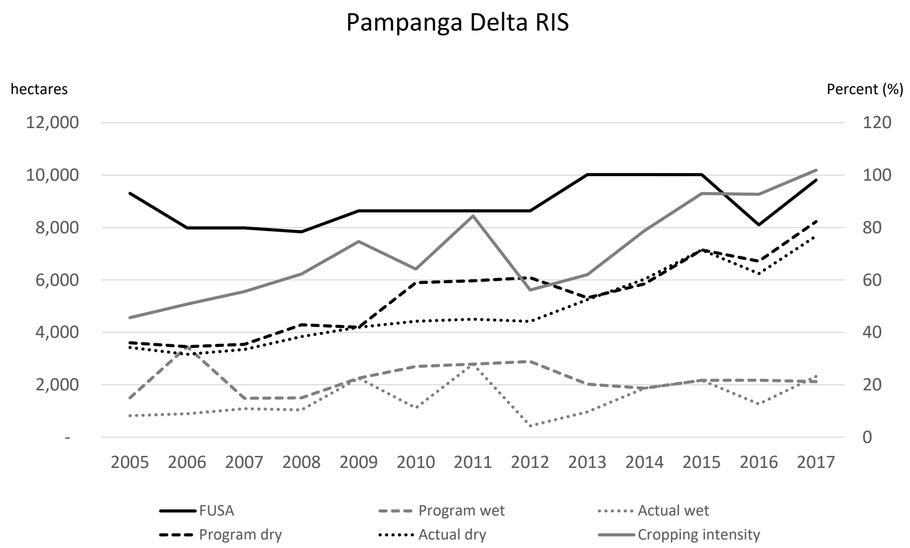

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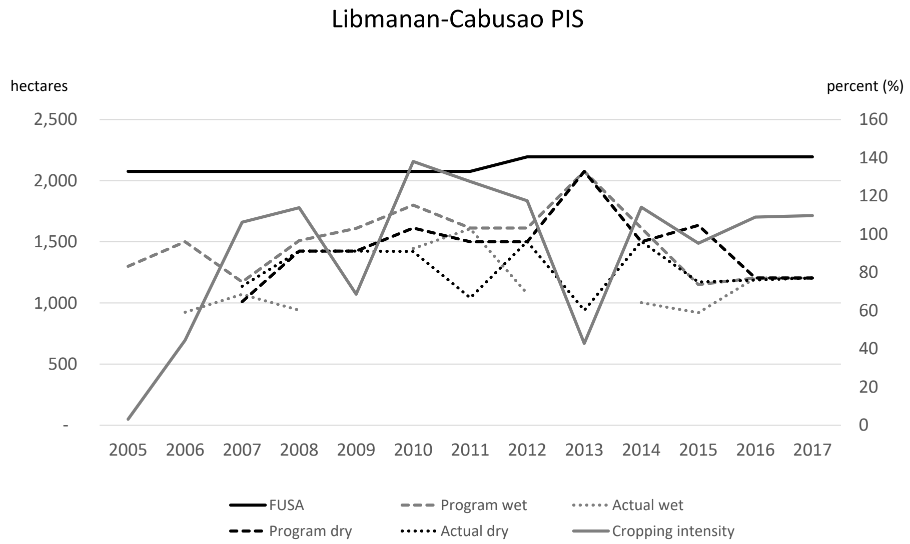
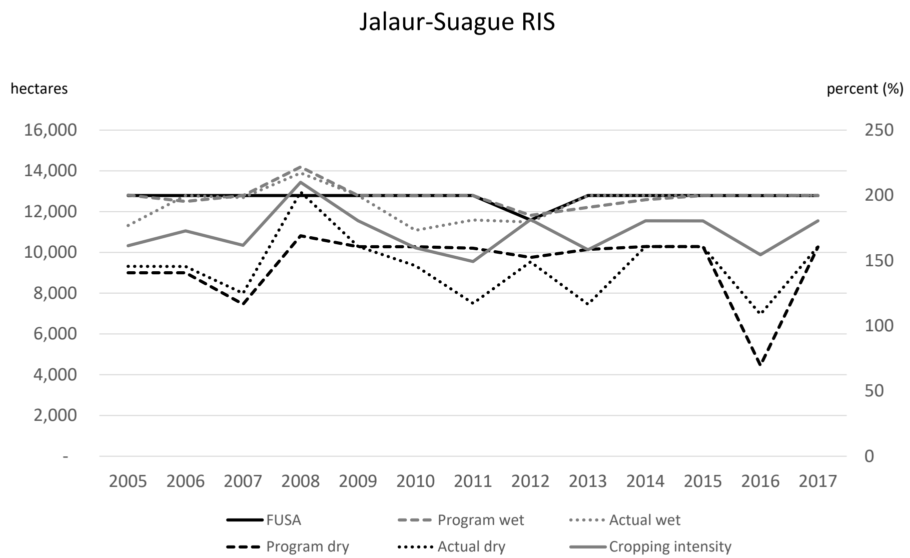


(b) Visayas NIS



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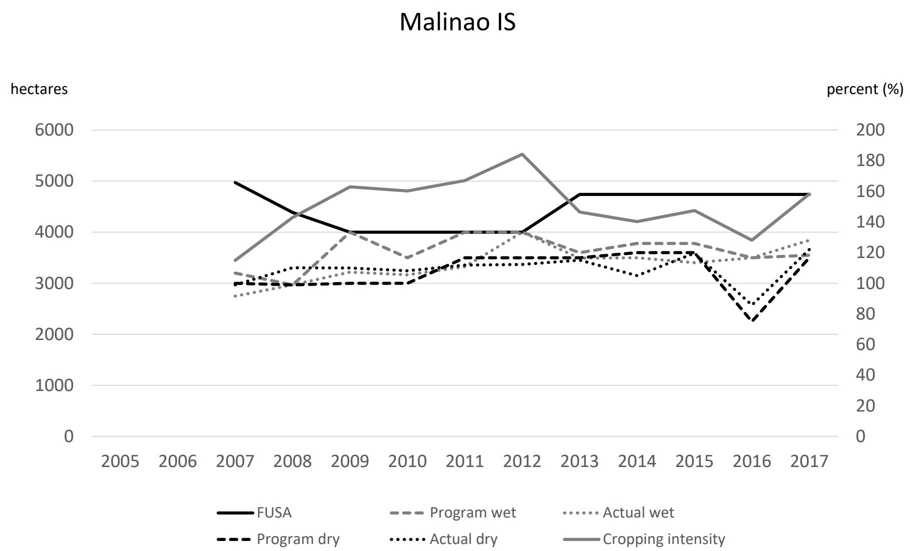

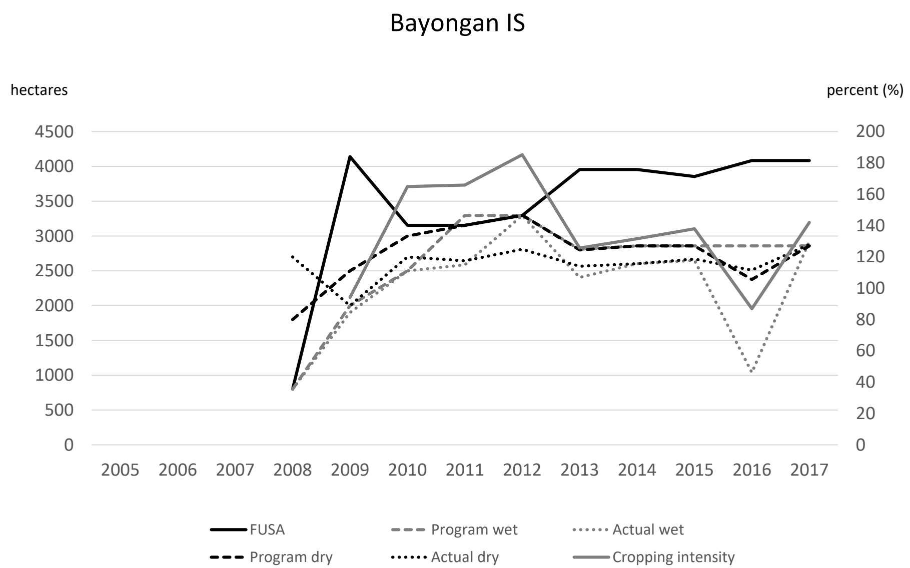

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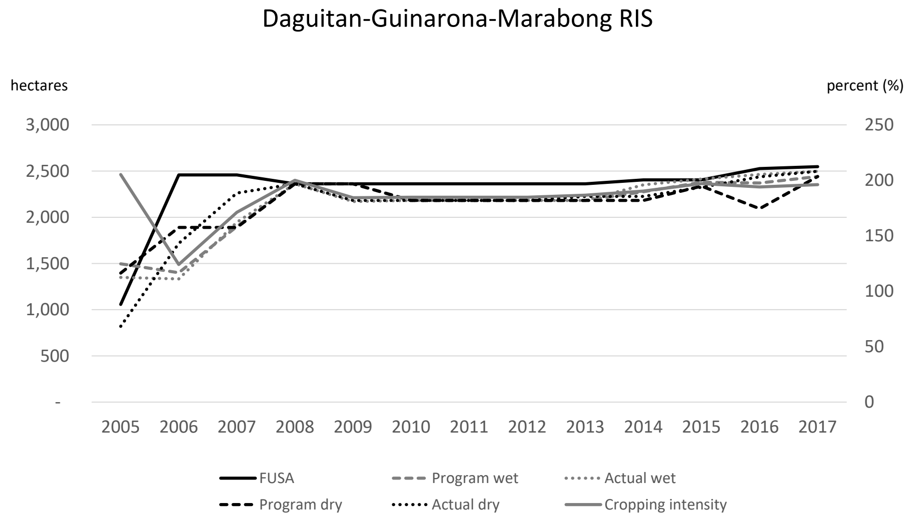
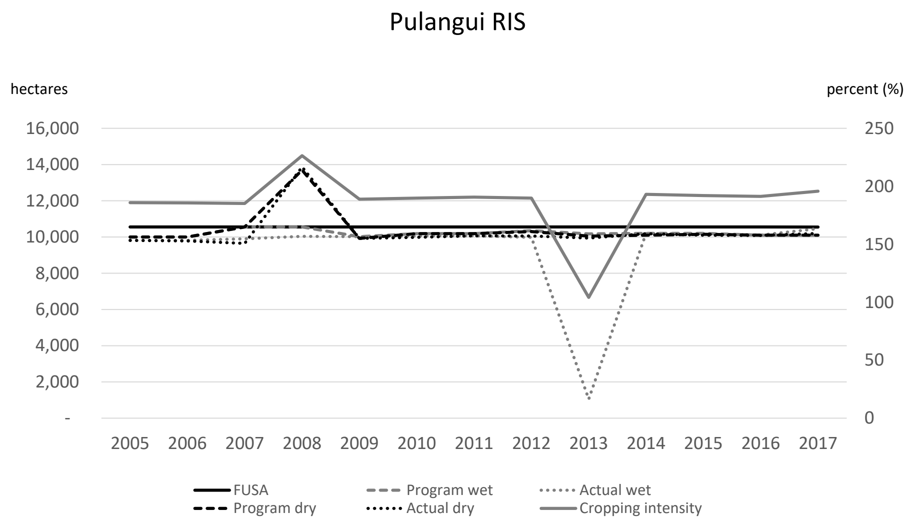


(c) Mindanao NIS



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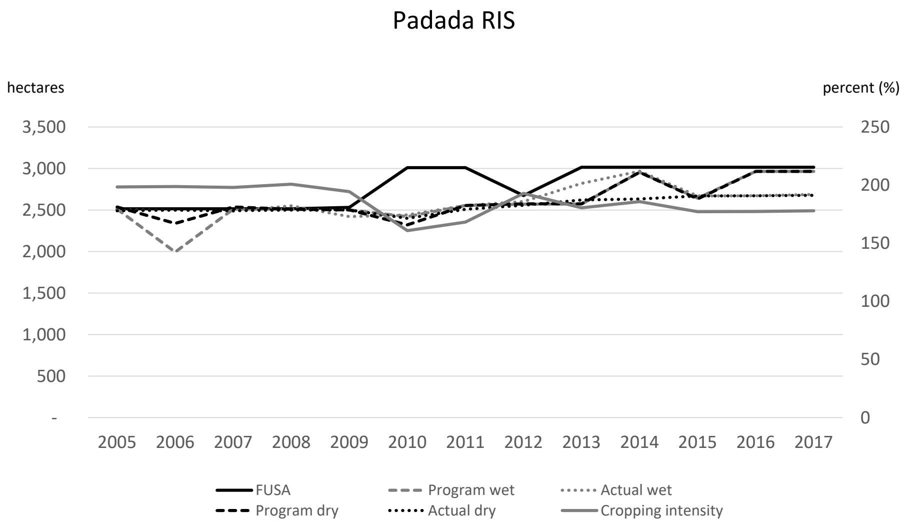

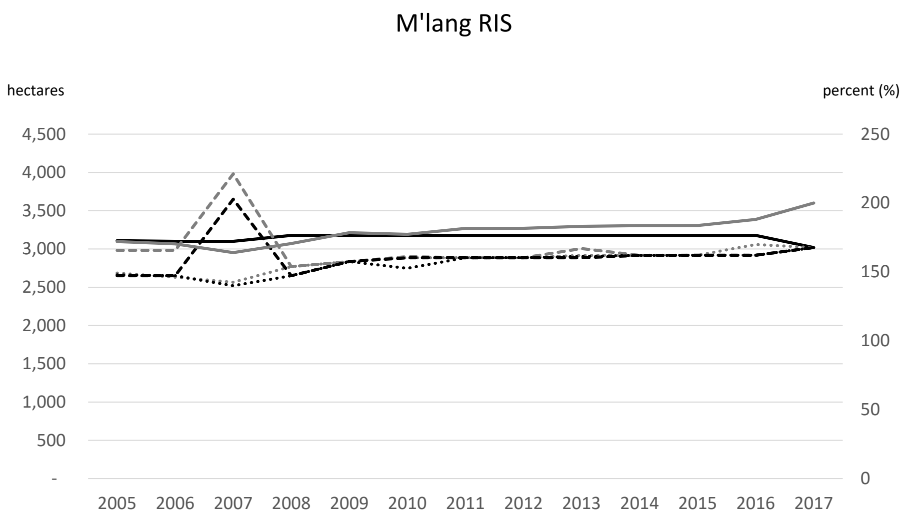

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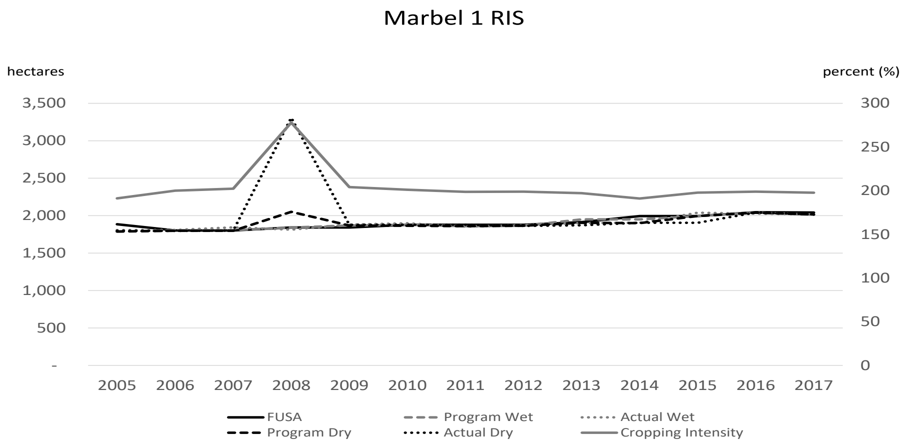
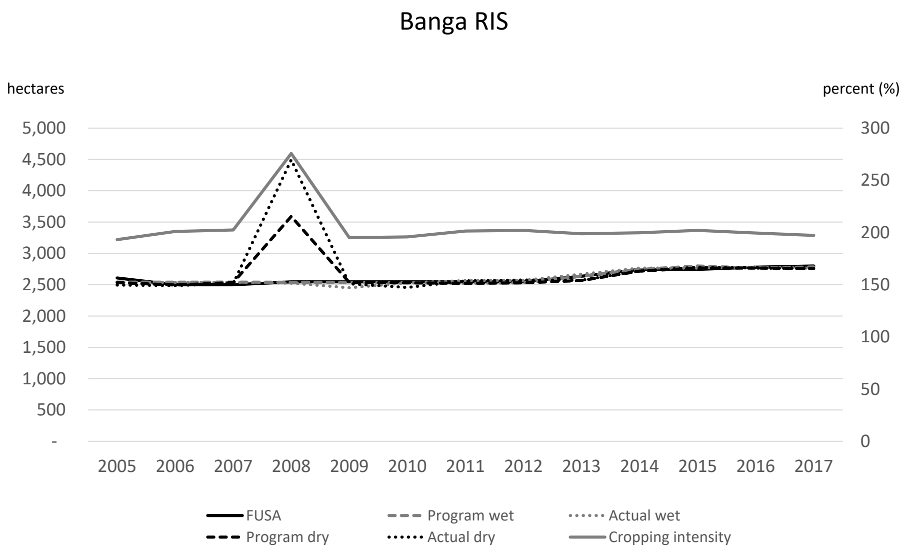




PIS = pump irrigation system; RIS = river irrigation system; MRIIS = Magat River Integrated Irrigation System; UPRIIS = Upper Pampanga River Integrated Irrigation Systems; IS = irrigation system; FUSA = firmed-up service area

Source: National irrigation system performance data of NIA (Various years)

Table 2 presents a summary of farmers' perceptions derived from KIIs and FGDs regarding the problems encountered with irrigation. The most common problem is shortage of water for various reasons, whether institutional, technical (engineering), or environmental. Also mentioned often is siltation, which may be related to canal repair and concrete lining of earth canals. Repairs are also mentioned in the case of various facilities (farm-to-market road, gates, dam). The problems encountered can be grouped into clusters of issues, discussed below.

Table 2. Problems with irrigation encountered by farmers

Problems	Luzon	Visayas	Mindanao	Total
Number of respondents	65	48	39	152
Shortage of water due to internal reasons (e.g., theft)	20	64	53	137
Shortage of water due to due to NIA (e.g., scheduling)	12	12	40	64
Canal repair	10	15	6	31
Shortage of water due to engineering limitation	9	5	16	30
Siltation	9	4	16	29
Farm-to-market road	10	9	9	28
Shortage of water due to environmental limitation	6	18	3	27
Earth canal to be lined	7	3	12	22
Gates for repair	2	3	12	17
Solid waste	6	3	5	14
Dam repair	1	0	0	1

NIA = National Irrigation Administration
Source: Authors' compilation

Water supply

The most common water supply problem is water shortage during the dry season. During the wet season, some major systems suffer from flooding, which also reduces cropping intensity.

The lack of water supply can be inferred from the difference between the FUSA and actual irrigated area during the dry season. The magnitude of the problem can be seen in the deployment of remedial measures, such as the construction of re-use dam, intake dam, installation of open source pumps (re-pump), and installation of shallow tubewells (STW). Sources of water for pumping are irrigation and drainage canals, tubewells, lakes, and nearby creeks and streams.

Re-use dams could be observed in UPRIIS, MARIIS, Balayungan RIS, Dumacaa RIS, Binahaan-Tibak RIS, Daguitan-Guinarona-Marabong RIS, Jalaur-Suague RIS, Barotac Viejo RIS, Padada RIS, M'lang RIS, Marbel #1 RIS, Banga RIS, and Pulangui RIS. Magapit PIS, PDRIS, UPRIIS, and MARIIS have re-pump stations. Pumping from irrigation and drainage canals could be observed in BPIS, Solana and Magapit PIS, UPRIIS, MARIIS, Libmanan-Cabusao PIS, Malinao IS, Binahaan-Tibak RIS, Sibalom-Tigbauan RIS, Padada RIS, MalMar 2, and M'lang RIS.

Lastly, STWs were still being utilized in some NIS cases (though few examples were encountered in the walk-throughs). Based on the groundwater potential maps, service areas of PDRIS, BPIS, Bonga Pump #2 PIS, TASMORIS, some areas of UPRIIS and MARIIS, and Solana and Magapit PIS, Binahaan-Tibak RIS, Jalaur-Suague RIS, Barotac Viejo RIS, Padada RIS, M'lang RIS, and Pulangui RIS are within areas of shallow-well potential.

Another practice for dealing with water shortage is alternate wetting and drying (AWD), wherein water delivery is reduced to a level lower than discharge capacity or design discharge. AWD is being practiced in most irrigation systems in the study to deal with prolonged water shortage, especially during the dry season.

Flooding problems also exist in most NIS (i.e., PDRIS, Magapit PIS, AMRIS, M'lang RIS, MalMar 2, and Pulangui RIS), especially during the wet season, which limit cropping to dry season only. This, in turn, reduces the cropping intensity of the said NIS. Likewise, this problem is being experienced in Bukidnon due to lack of proper drainage systems.

Siltation

Siltation decreases the available water in the system and increases the efficiency losses of the canal.

The primary source of siltation is the rivers that supply water for the irrigation systems. Excessive siltation of the dams and canals was observed in Ambayoan-Dipalo RIS (Figure 2), Nueva Era RIS, TASMORIS, Caguray RIS, Jalaur-Suague RIS, Padada RIS, M'lang RIS, and Manupali RIS. In the case of the Jalaur RIS, the 8-meter wide main canal has been reduced to 1-meter width due to siltation.

Figure 2. Silted diversion dam of Dipalo River Irrigation System

Source: Authors' documentation

Dam siltation can be controlled to some extent by opening the sluice gates during high river flow; however, in some of the systems, sluice gates are nonfunctional. Canal siltation, meanwhile, can be controlled by regular maintenance. Silt can be cleared out of the canals through dredging or use of structures (e.g., silt ejector of PDRIS and Marbel #1 RIS, by-pass canals). The lack of canal maintenance as a reason for canal siltation was mentioned during the FGDs by Mapamasa IA in Division 4 of UPRIIS, Muhara IA in Solana PIS, Zigiran IA in Magapit PIS, Carsan IA in Ambayoan-Dipalo RIS, and Gamot Bolo Nicolas IA in Caguray RIS, among others.

Siltation is also part of the headwork problems of all pump irrigation systems (PIS) covered in the study, including the Bonga Pump #2, Banaoang, Libmanan-Cabusao, Solana, and Magapit. Siltation could not be minimized in these systems because all of them were drawing water from major rivers (e.g., Cagayan River for Solana and Magapit PIS, and Libmanan River for Libmanan-Cabusao PIS), which were already heavily silted.

Canal lining

Earthen canals—the most common type of canal in NIS—are vulnerable to damage and disrepair.

Few of the NIS are completely lined (Table 3). The systems that are mostly lined (more than 80% of main canals and laterals) are PDRIS, Bonga Pump #2, Libmanan-Cabusao PIS, Malinao IS, Capayas IS, Bayongan IS, Manupali RIS, and Marbel #1 RIS. In contrast, more than 80 percent of the main canals and laterals in AMRIS, Magapit PIS, Jalaur-Suague RIS, Barotac Viejo RIS, and Mambusao RIS are unlined or earth canals.

The efficiency of water distribution depends on the condition of the main canals and laterals, which depends on the concrete lining. Canal damage may also be attributable to lack of lining due to carabaos and other animals that frequent earth canals, causing damage and collapse of the canal-side slopes. In system designs, canal lining is assumed; hence, lack of canal lining can explain in part the discrepancy between the design area/FUSA and the actual irrigated area.

State of irrigation structures

Irrigation structures were mostly nonfunctional, missing, damaged, or in a deteriorated condition.

Walkthroughs of the NIS arrived at the following observations:

- Various canals/structures were damaged, affecting water delivery service, as in the case of Victoria IA in MARIIS, MalMar 2 (Figure 3), and Manupali RIS.
- Staff gauges, which are part of the flow-measuring structure, are lacking or missing in most of the NIS cases visited. These include the Libmanan-Cabusao PIS, Ambayoan-Dipalo RIS, Caguray RIS, Balayungan RIS, BPIS, Bonga Pump #2 PIS, Nueva Era RIS, and TGIS. Without flow measurement, the delivery performance ratio, equal to the ratio of actual over design discharge, cannot be assessed.
- Roadways from the farm to the market are also in poor condition in some IAs (New Life IA in MARIIS, Dagupan IA in Visitacion IS, Ambayoan-Dipalo RIS, and Balayungan RIS). They are not passable, especially during the wet season.

Table 3. Proportion of lined canals, Luzon and Mindanao systems (%)

	Main	Lateral
Luzon systems		
PDRIS	100.0	79.8
AMRIS	20.5	13.0
Nueva Era RIS	100	6.6
Bonga Pump #2 RIS	100.0	90.6
Magapit PIS	60.9	0.0
Libmanan-Cabusao PIS	94.3	83.4
Visitacion RIS	36.5	47.1
Caguray RIS	85.1	42.8
BALAYUNGAN RIS	53.9	39.1
DUMACAA RIS	30.3	47.5
Mindanao systems		
Mambusao RIS	29.8	19.2
Jalaur-Suage RIS	5.7	7.5
Sibalom-Tigbauan RIS	37.9	1.6
Barotac Viejo RIS	2.9	11.4
Malinao IS	100.0	100.0
Capayas IS	100.0	100.0
Bayongan IS	100.0	100.0
Daguitan-Guinarona-Marabong RIS	89.6	66.1
Manupali RIS	100.0	100.0
Pulangui RIS	57.4	33.7
Roxas-Kuya RIS	59.3	46.6
Marbel #1 RIS	100.0	100.0

Note: The following systems show only the aggregate share for main and lateral canals: Binahaan-Tibak RIS (35.8); Padada RIS (30.5); M'lang RIS (23.5); Malmar2 (32.4); and Banga RIS (80.8).
PDRIS = Pampanga Delta River irrigation system; AMRIS = Angat-Maasim River Irrigation System; RIS = river irrigation system; IS = irrigation system
Source: Inventory of irrigation systems, NIA (Various years)

Figure 3. Missing gates in MalMar 2 River Irrigation System

Source: Authors’ documentation

Water quality

Most of the NIS main canal and laterals exhibited reasonably good water quality.

Measurements for the various NIS showed that most reached the EC and DO cutoffs. However, most NIS cases showed pH levels on the alkaline side (> 7). This was also seen in most NIS cases in the Visayas and Mindanao. In Iloilo, 14 of 22 samples showed pH > 7, including 9 locations in Jalaur RIS. High alkalinity can be attributed to excess sodium. Another source of alkalinity is sodium bicarbonates (Oosterbaan 2003).

Salinity (EC is > 300uS/cm) was also detected in some NIS cases, especially those pumping groundwater like TGIS. This is due to seawater intrusion, as in the case of Magapit PIS, or leaching of salts from irrigated lands. The highest measured salinity was for TGIS Tarlac, where EC was around 700 uS/cm. Soil salinity can pose serious effects on crop development and yield, if not adequately addressed.

The DO was also low (6 < ppm) in some NIS cases, including the downstream of the Vaca dam and PDRIS end of downstream. This can be attributed to the thick aquatic vegetation upstream of the Vaca dam, which has caused the reduction of DO downstream (Figure 4). DO was likewise found to be low (6 < ppm) in the Capayas and Bayongan IS, Binahaan-Tibak, and Daguitan-Guinarona-Marabong RIS. Seven sites in Capayas and Bayongan IS have low DO (around 4.5 ppm); all 12 sites in the Leyte NIS have shown very low DO (about 1.5 ppm).

Typically, the DO increases as it goes upstream since water in the source has less pollution. Some cases have different findings, such as measurements in re-use dams, which exhibited more pollution. DO was likewise found to be low (6 < ppm) in other NIS cases, such as 6 out of the 14 sites in Bukidnon, 8 out of the 12 sites in South Cotabato, and 3 out of the 6 sites in M'lang and Padada RIS.

Figure 4. Vaca Dam of Division 2, UPRIIS

UPRIIS = Upper Pampanga River Integrated Irrigation System
Source: Authors' documentation

Institutional assessment

Problems with irrigation service and water quality can partly be attributed to governance issues, both inside and outside the NIS.

The KIIs and FGDs revealed numerous problems in the governance of the NIS. Downstream users can experience water shortage owing to the diversion of water for unauthorized use. Some IAs encountered illegal opening and closing of gates, compelling them to installed locks and security gates (Figure 5). The ability of an IA to prevent water theft reflects the effectiveness and efficiency of IA management.

Majority of the IAs practice scheduling or rotational irrigation. The usually preferred irrigation flow practiced by the IAs is upstream to downstream, which would flow through different irrigation zones. IAs are generally satisfied with the rotation schedule, though the satisfaction rating tends to decline from upstream to downstream. In some cases, poor scheduling is cited as a governance issue (secondary to water theft).

Figure 5. Check gate with padlocks in Libmanan-Cabusao PIS

PIS = pump irrigation system
Source: Authors' documentation

On a positive note, farmers value the services provided by NIA. Majority of the IAs affirmed that they receive regular support of different types. The most common form is technical assistance, e.g., training, seminars, and other consultation and advisory services, to enhance the capability of the farmers in the efficient management of their system. Less common is physical and structural support, which NIA is less capable of providing owing to budget constraints.

Meanwhile, outside the IS, NIS with urban areas within its service area have to contend with illegal settlers and garbage dumping (Figure 6). Some illegal settlers dump their waste directly into the canals that pass near their homes. Solid wastes were commonly observed, clogging the headgates going to the laterals and tertiary canals. This affects the water flow during operation. Removal of these wastes increases the O&M cost of the NIS. Moreover, structures constructed by illegal settlers along the canal damage the lining and canal hydraulic shape.

Figure 6. Garbage near the gates of one section of Lateral B NMC, AMRIS

NMC = north main canal; AMRIS = Angat-Maasim River Irrigation System
Source: Authors' documentation

Other analytical findings

GIS applications

Analysis of siltation

Mapping of erosion maps of NIS watersheds reveals that most of the uplands from the downstream service areas have moderate to severe erosion.

Runoff and flooding of lowland/irrigated areas depend on the typology and characteristics of the watershed that surrounds the irrigation service areas. The upland watershed can be prone to erosion depending on the combined effects of vegetative cover (land use), soil characteristics (erodibility), slope (topography), and rainfall patterns (erosivity). Poor watershed management results in upland erosion and river siltation. Although watershed management is being considered during the design stage, problems occur during the operation of the system after construction. Watershed management and control is under the jurisdiction of DENR, not NIA.

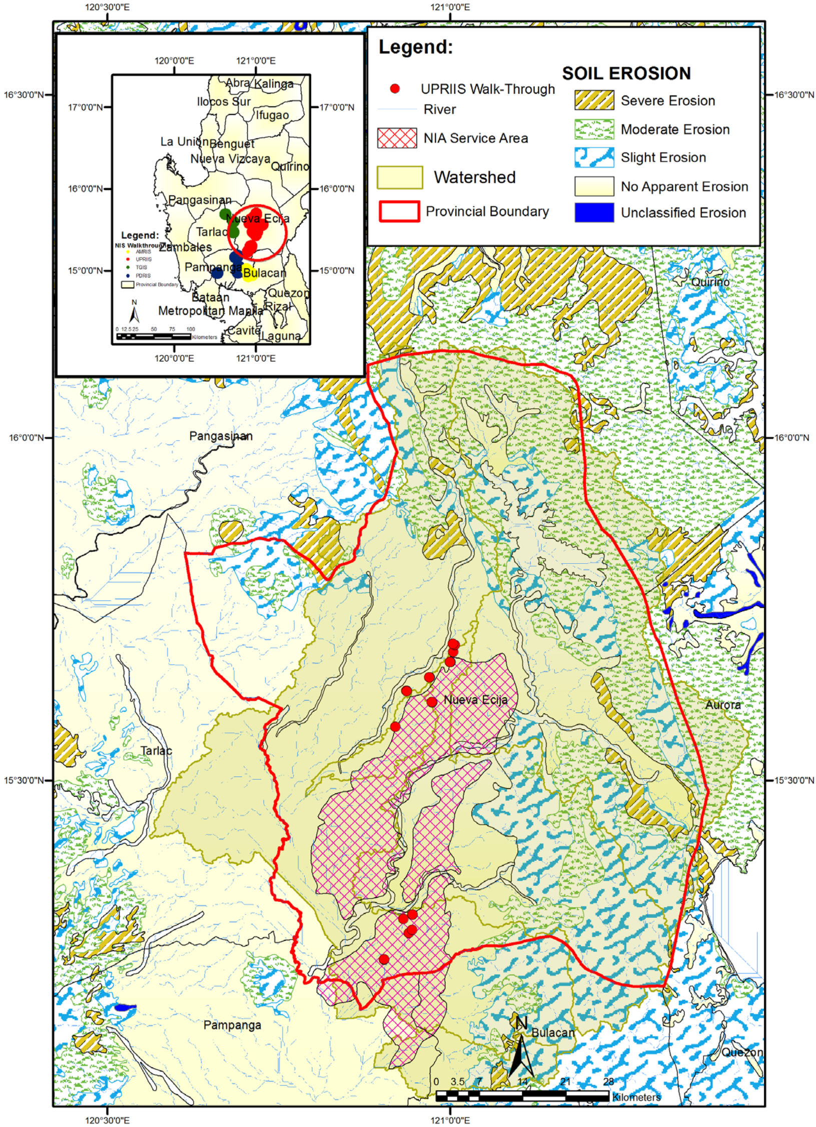
Figure 7 shows an erosion map for UPRIIS: moderate to severe erosion could be observed in the watershed area of UPRIIS. The watershed area is the upper and right side part of the figure. This accounts for the heavy siltation observed within the UPRIIS, especially in the middle and downstream areas.

Other GIS applications for irrigation management

GIS can also be used to analyze land suitability, groundwater resources, water user parcellary layout, and others.

Regarding land suitability, digital map overlays show the unsuitability of significant proportions of NIS service areas to irrigated rice farming. A representative case is the Magat River Integrated Irrigation System (MARIIS), an extensive system with about 80,000 ha of the service area. The overlaid GIS map indicated only 54 percent of the total FUSA in MARIIS as most suitable to irrigated rice agriculture. Conversely, 46 percent is unsuitable, which may be why sub-optimal yields were obtained within the system. Similarly, diagnostics are performed for the other systems, with varying estimates of irrigated rice suitability. On the other hand, GIS maps document the degraded state of some NIS watersheds, which partly accounts for the heavy siltation in these systems.

Figure 7. Erosion map for UPRIIS



UPRIIS = Upper Pampanga River Integrated Irrigation System
Source: Authors' processed/developed map

Meanwhile, groundwater maps (Figure 8) show areas with high potential for groundwater resources to supplement the inadequate water supplies from surface water.

Another useful application of GIS mapping is the three-dimensional (3D) map (Figure 9). The 3D map revealed the location of the service area of NIS and its watershed. Merging this with other maps will be an excellent tool for policy and planning. For example, an input of an updated built-up area or land-use plan may show areas for expansion or limits for the irrigated area.

Padada RIS, which is part of the Japan International Cooperation Agency project entitled “Improving Operations & Maintenance of National Irrigation Systems”, actively uses GIS in irrigation management. The RIS created a new parcellary map through satellite imagery and farmland database/GIS in 10 pilot sites. Other NIS that apply GIS were the PDRIS, as well as Caguray, Mambusao, Barotac Viejo, and Malinao RIS.

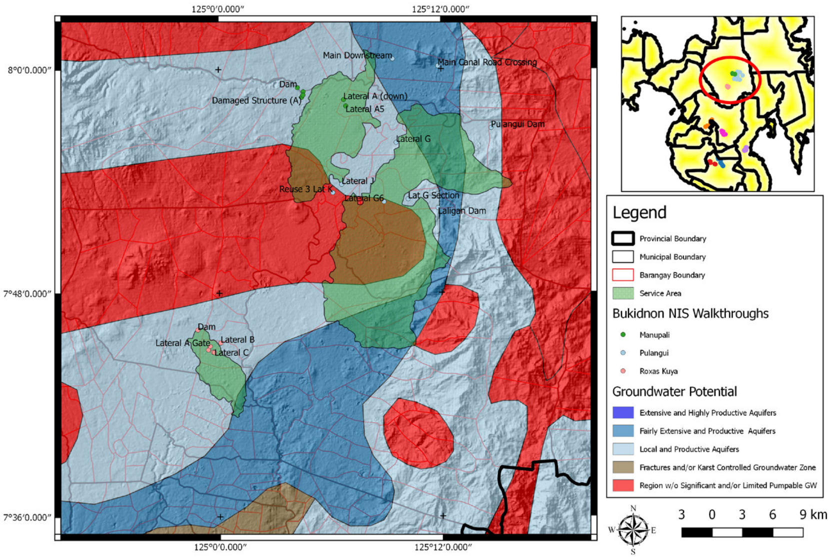
Summary index of irrigation performance using PCA

Due to the difference in the nature of data collection between cycles, the PCA model was specified for the IAs covered in the study, with a separate analysis for each island group (Luzon, Visayas, and Mindanao). Using a set of variables common to the two cycles, an integrated PCA for all the IAs (151) was also estimated.

Based on the PCA model, 70 percent of the IPI is explained by 10 contributing factors, which, in turn, are classified into four principal components (Table 4). The mean irrigation performance index of Luzon (= 0.79) was higher than that of Visayas-Mindanao (= 0.49), which implies that systems in the former perform better than those in the latter. Economic and financial factors are the major indicators of the IA’s performance.

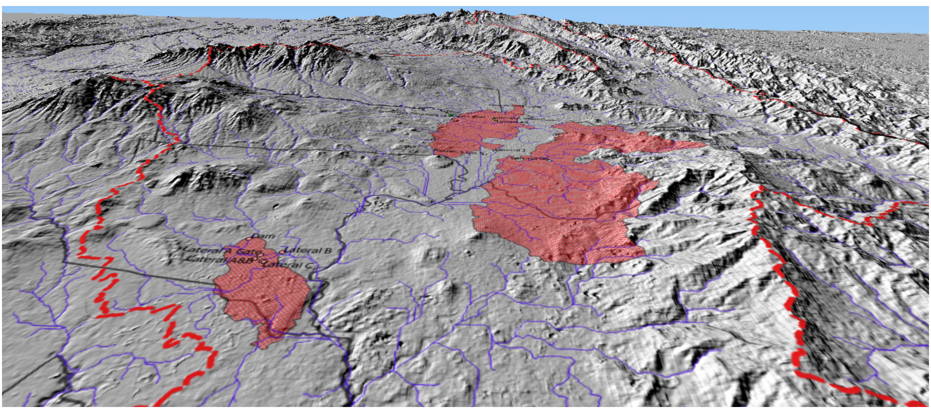
Applying the model to all IAs resulted in a classification of Low-, Moderate-, and High- performing IAs. Results showed that, under this rating scale, 22 percent of the IAs are rated as high performing, while 33 percent are moderate, and 45 percent are low performing. For Cycle 2, the performance of the 87 IAs covered shows that the low-performing IAs are mostly located in the downstream part of the main canal. This confirms that water distribution and availability is a major factor that affects irrigation performance at the IA level.

Figure 8. Groundwater map of Bukidnon and service areas of Manupali, Roxas-Kuya, and Pulangui RIS



Source: Authors' processed/developed map

Figure 9. 3D map showing the relative elevation of the service area and terrain of the whole watershed of the NIS covered in Bukidnon



Source: Authors' processed/developed map

Table 4. PCA results for the integrated irrigation performance index

Variables	Component weights			
	Economic	Technical	Environmental	Institutional
Number of cropping per year	0.4938			
Annual gross profit	0.6094			
Annual net profit	0.5966			
Performance rate on distribution of water		0.5776		
Performance rate on the maintenance of canals		0.6324		
Rate on technical advice to farmers		0.5117		
Dissolved oxygen			0.6969	
Acidity (pH)			0.7086	
Ability to seek outside help				0.7490
Meeting participation rate for board of directors				0.6397
Weights (%)	22.90	19.67	14.18	12.75

PCA = principal component analysis
Source: Authors' computation

Conclusion

Summary

The ocular inspection, walkthroughs, and measurements of water flows and quality and siltation conducted in this study reveal numerous technical, institutional, and environmental issues confronting the NIS studied. On the technical side, results showed that siltation prevails in most NIS cases. This causes flow capacity reduction and poor water delivery, especially in downstream areas. Some NIS cases have nonfunctional, missing, or damaged structures (e.g., check gates, staff gauges, turnout gates, etc.), which affect flow control and measurement.

On the institutional side, it was found that there is weak enforcement of the policy on canal maintenance, illegal settlers, and pumping/dumping of garbage/turnouts. Some NIS sites manifested flooding problems since drainage canals are higher than irrigation canals in some cases. Low water quality as per DO, EC, and pH standards, on the other hand, was observed and may have affected yield in some sites.

The analysis also showed that GIS is an essential tool for determining suitable areas for irrigation project design and development. By using GIS map overlay, the study was able to show the unsuitability of significant proportions of NIS service areas to irrigated rice farming. Diagnostics were also performed for the other systems, with varying estimates of irrigated rice suitability. GIS maps also documented the degraded state of some NIS watersheds, which accounted for the heavy siltation in these systems.

This study found that the performance of NIS is influenced both by factors beyond its control and governance issues internal to the systems. External problems include (i) constriction of waterways, which causes the worsening flooding problems; (ii) rapid denudation of the water source (watershed), which accelerates the rate of flooding and canal siltation within the irrigation system and reduces available irrigation water supply; and (iii) political pressures impinging on the choice of irrigation projects and contractors, the proper operation and maintenance of irrigation systems, and the quality of personnel appointments in the bureaucracy.

Recommendations

Watershed management

Watershed management is a key strategy to prevent siltation problems.

Watershed management is a function of the DENR and local governments. Watershed management activities are not being coordinated with NIA, which accounts for the deterioration of watersheds and erosion of uplands near NIS. Hence, a requisite institutional reform is to transfer the mandate of NIS watershed management to NIA. A Watershed Unit (Office) in NIA should be created for the full control of the watersheds covering all irrigation systems, absorbing the current mandate and function under the DENR. Watershed management is already part of the NIA's charter; nonetheless, implementing this recommendation will require allocating substantial resources and not just "coordination" with the DENR and local governments.

Use of science-based methods

GIS analysis was useful in mapping the location of structures, measurements, and spatial analysis of erosion, groundwater potential, flooding, and distribution of IA performance.

GIS applications can be further enhanced in targeting interventions (i.e., helping NIA and DA improve land productivity) and determining suitable areas for irrigation. In addition, there is a need to re-evaluate the definition of potential irrigable areas. This includes the assessment of water supply sources and comprehensive land use plans of the local government units. In estimating the potential irrigable areas, improved data collection and management is required. In all feasibility studies on all NIS in the country, data adequacy and quality have always been the constraints to correctly estimating irrigable areas.

O&M and system upgrade

The canal and its appurtenant structures require considerable rehabilitation work and consistent maintenance.

A critical upgrade to many of the NIS assessed in this study is the concrete lining of main and lateral canals. This is to improve efficiency in water allocation and distribution from upstream to downstream users. The poor water distribution in most NIS cases is mainly due to water losses, especially in earth (unlined) canals. A feasibility study should be conducted to determine whether the investment cost of canal lining is smaller than the present value from the stream of future benefits from improved irrigation service.

Moreover, NIA should allocate sufficient resources for O&M and formulate effective policies and incentive systems. The current O&M regime is characterized by inadequate O&M, leading to worsening problems with the systems, until a major rehabilitation project becomes necessary. A better administration will be to consistently maintain the system to near its original design condition, i.e., keeping conveyance losses to the minimum, and ensure that control structures are working properly.

Chapter 3

Communal Irrigation Systems

Roger A. Luyun Jr. and Dulce D. Elazegui

Introduction

Communal irrigation systems (CIS) are irrigation systems constructed by the National Irrigation Administration (NIA) with inputs from farmer-beneficiaries in various phases of the project. These farmers are organized into irrigators' associations (IAs) that operate and maintain the irrigation system. CIS have service areas of less than 1,000 hectares (ha). They operate through either gravity system, where water level is raised by a dam or a weir and water flow by gravity, or through a pump system, where water is raised by mechanical action.

By virtue of the Agriculture and Fisheries Modernization Act of 1997, Local Government Code (LGC), and Executive Order 718, series of 2008, IAs took over the management of the completed CIS subject to a cost-recovery arrangement and repayment scheme.

Most recently, however, the Free Irrigation Service Act heralded a new policy milieu for CIS beneficiaries and managers. Currently, IAs are receiving a subsidy from NIA for their operations and maintenance (O&M).

While most CIS are constructed by NIA, several others started as private initiatives and have received some government funding support for the cost of rehabilitation and new construction. At least 95 percent of CIS are run-of-the-river type gravity systems obtaining water from rivers or streams, though a few have been given funding support for medium-sized pumps to also distribute water from a river.

Yields in CIS were lower by 30–40 percent than in the national irrigation systems (NIS) because of the uncertainty in water supply in the small catchment areas where CIS are located (FAO 2011). Unreliable water supply is a fundamental problem for CIS tapping water from less dependable small rivers and creeks or relying on springs and runoff.

The government has made huge investments in CIS, particularly around 1995-2010, because more areas can be developed for CIS compared to NIS. Many CIS were found to have service areas with slopes greater than 3 percent.

To expand the irrigation base, new irrigable areas may be served by small-scale irrigation systems, including CIS (David 2003). As such, there is a need to assess the status of CIS development in the country.

Background and Method

Issues raised in previous studies

While O&M problems affect individual users, the persistent problem in water distribution is due not only to technical aspects but also institutional factors governing water allocation. These relate to availability, reliability, predictability, manageability, and equality of the allocation. The first three relate to water rights. Manageability refers to the combined control of users over the quantity and timing of water deliveries. Equality refers to the sharing of benefits commensurate to fees paid and services rendered. The tail-end syndrome indicates the positional advantage of upstream versus downstream due to topographic and conveyance conditions. The unequal tenurial, social, and political status leads to differential access to water (Cruz 1983).

The involvement of farmers in planning the irrigation system is one important factor in the existence of more functional canals and structures. Effective leadership is crucial in addressing water distribution conflicts between upstream and downstream farms. A decentralized leadership solves coordination problems in CIS with widely dispersed farms (de los Reyes and Jopillo 1986).

The management structure of CIS becomes more formal as system size increases. More successfully managed systems divide their areas into smaller units or sectors for broader involvement of farmers in managing the system and more organized distribution of water. The interventions of NIA in the IAs, such as in areas of organizational structure, leadership, and systems management, yielded positive impacts. These include higher productivity, stronger associations, improved water distribution, and better compliance with government policy (de los Reyes and Jopillo 1986).

Government investments in irrigation also suffer from political pressures, rent-seeking, and corruption perpetuating technical and economic inefficiencies in the irrigation and water sector (Wade 1982; Repetto 1986; Araral 2005a; Huppert 2013).

Problems of sustainability of irrigation infrastructure include overestimation of benefits during the planning stage of the project. The area estimated to be served by the irrigation system is generally much larger than what is served. Projected yields are also overestimated although water use efficiency declines over the years. Another cause is the lack of investments in recurrent costs associated with O&M activities once construction is completed (Ostrom 1990). Donors normally restrict their involvement in the design and construction and view O&M as the responsibility of the recipient of the system. Routine maintenance is delayed until the deterioration of the system is large enough to require rehabilitation.

A wide range of factors causes the poor performance of irrigation systems, spanning from technical aspects to institution-related issues. Constraints may be rooted in the inadequacy of relevant data during the planning stage, errors in design, poor quality of construction, and lack of institutional capacity for system development. Moreover, the complex operation and socioeconomic and institutional management of an irrigation system, and the inadequate support services for irrigated agriculture make it difficult to fully achieve potential performance (David 2003). Design shortcomings of CIS include errors in estimating design floods and sediment loads of rivers, lack of head control structures, ungated intake structures, and faulty design of farm ditches. The rate of deterioration at 140,000 ha per year of both NIS and CIS between 1996 and 2004 casts doubt on the sustainability of irrigation systems in the country (UPLBFI 2007).

Development of CIS in the Philippines

CIS covered approximately 663,000 ha, accounting for 35 percent of the total area served by irrigation systems in the country in 2017 (Table 1). The development of irrigation system lags in Mindanao, considering the large irrigable area, relative to Luzon and Visayas.

Construction of simple irrigation systems dates to the Spanish era when mountain tribes built the Ifugao rice terraces and Spanish friars installed systems in areas bordering Manila. Farmer associations were building, operating, and maintaining irrigation systems (World Bank 1990). A set of practices referred to as the *Zanjera* system ensured that farmer-beneficiaries participate in the maintenance of the system (de los Reyes and Jopillo 1986). Zanjeras are known for their capacity to manage gravity-fed CIS and for their rules and regulations, water allocation and distribution, system O&M, and conflict resolution (Yabes 1990).

Under the American regime, an Irrigation Division was created in the Bureau of Public Works (BPW) in 1908. The legislature provided for the regulation of water rights and conceptualization of IAs for managing CIS. With the destruction brought by World War II, BPW provided assistance to both NIS and CIS.

Foreign financing of CIS projects came in the 1970s as a component of rural development projects. The first foreign-assisted project in the Philippines focusing mainly on CIS and beneficiary participation was the Communal Irrigation Development Project (CIDP) in 1982. By 1983, all NIA-assisted communal irrigation projects were adopting the participatory approach. The involvement of farmers in the planning of CIS project and the incorporation of their suggestions in the design contributed to more functional canals and structures (de los Reyes and Jopillo 1986).

The second CIDP project was implemented in 1990 (World Bank 1992a). NIA obtained loans from the International Bank for Reconstruction and Development and International Fund for Agriculture and Development. The four components of the project were construction and rehabilitation of CIS, development of communal IAs, institutional development of NIA on communal irrigation, and agricultural development planning.

By virtue of the LGC of 1991, CIS were devolved to local government units (LGUs), including similar projects funded by municipalities, provinces, and cities. Prior to the enactment of the Code, NIA implemented locally funded CIS with a budget allocation of PHP 518 million under the General Appropriations Act. In 1992, the fund for CIS implementation was transferred to the internal revenue allotment of the LGUs. As

Table 1. Status of irrigation development in the Philippines*

	Estimated Total Irrigable Area[a/]	Service Area (hectares)					Share in Total (%)	Total Remaining Area to be Developed
		National Irrigation System	Communal Irrigation System	Private Irrigation System	Other Government Agency Assisted	Total		
CAR	111,295.65	15,936.64	55,293.89	23,376.34	3,606.82	98,213.69	88.25	13,081.96
Region 1	264,491.00	61,499.44	57,519.40	20,788.45	50,575.83	190,383.12	71.98	74,107.88
Region 2	457,246.76	176,273.28	54,734.49	44,501.34	21,021.12	296,530.23	64.85	160,716.53
Region 3	483,830.18	219,165.30	75,964.06	9,343.65	19,481.79	323,954.80	66.96	159,875.38
Region 4A	85,929.00	29,034.00	22,778.00	7,288.00	2,553.00	61,653.00	71.75	24,276.00
Region 4B	143,558.95	29,130.59	39,372.92	14,973.91	12,596.00	96,073.42	66.92	47,485.53
Region 5	239,440.00	24,016.05	74,613.04	25,059.00	15,966.30	139,654.39	58.33	99,785.61
Region 6	191,253.16	53,935.08	39,035.13	15,309.81	15,012.30	123,292.32	64.47	67,960.84
Region 7	53,674.35	12,210.99	31,510.00	4,068.00	1,496.00	49,284.99	91.82	4,389.36
Region 8	91,982.90	25,877.00	38,573.90	5,915.75	2,765.00	73,131.65	79.51	18,851.25
Region 9	93,706.00	19,049.59	25,826.15	1,957.00	3,481.00	50,313.74	53.69	43,392.26
Region 10	121,122.69	32,164.82	29,072.05	4,930.54	4,784.25	70,951.66	58.58	50,171.03
Region 11	177,546.92	38,567.98	29,267.33	1,291.00	1,675.27	70,801.58	39.88	106,745.34
Region 12	293,226.24	71,299.41	39,756.18	2,840.00	10,256.00	124,151.59	42.34	169,074.65
Region 13	160,176.75	32,029.70	28,672.00	3,137.00	6,418.00	70,256.70	43.86	89,920.05
ARMM	160,150.45	27,712.86	21,241.75	90.00	295.00	49,339.61	30.81	110,810.84
Total	3,128,631.00	867,902.74	663,230.28	184,869.79	171,983.68	1,887,986.49	60.35	1,240,644.51

* as of December 31, 2017

For provinces with service areas greater than the estimated total irrigable area, it means that more areas are now irrigated beyond the estimated total irrigable area.

Note: CAR. Region 7, Region 8, Region 9, Region 10, Region 13, and ARMM generated 13,963 ha. of new areas but not yet operational. CAR = Cordillera Administrative Region; ARMM = Autonomous Region in Muslim Mindanao

Source: NIA (2017b)

a result, the construction and rehabilitation of CIS by NIA in areas where concerned LGUs had no capacity to undertake CIS projects had been stalled. Since 1992, NIA has implemented CIS in partnership with farmer-beneficiaries through their IAs, which contributed a portion of the direct cost during construction.

Data collection

The performance of CIS was examined at two levels: (1) NIA irrigation management offices (IMOs) and(2) IA level. The analysis was based on secondary data, mainly from NIA, provincial IMOs, and key informant interviews (KIIs) with staff, and primary data from field investigation of selected CIS and focus group discussions with IAs.

Technical data included physical state, service area, irrigation efficiency, source of water, access to and availability of water, year constructed, and start of operations, cropping calendar, and cropping intensity. Field investigation included walk-throughs and actual measurements for a subset of sample CIS to gauge the physical conditions of the systems.

Institutional data included the status of IAs, such as profile/institutional report of IAs, their source of funding, financial status and viability, program of works for all available years, and CIS performance.

The assessment was done in two cycles. Cycle 1 covered Luzon while Cycle 2 covered Visayas and Mindanao. The system-level analysis covered 66 sample CIS and IAs in 11 selected IMOs in Luzon (six each from Laguna, Ilocos Norte, Cagayan, Isabela, Nueva Vizcaya, Benguet, Pangasinan, Nueva Ecija, Pampanga, Camarines Sur, and Occidental Mindoro); 12 sample CIS and IAs in four IMOs in the Visayas (three each from Leyte, Iloilo, Capiz, and Bohol); and 12 sample CIS and IAs in four IMOs in Mindanao (three each from North Cotabato, South Cotabato, Davao del Sur, and Bukidnon).

To capture possible differences in characteristics, selection of CIS per province was based on size of firmed-up service areas (FUSA) in hectares: (1) small (50 ha and below), (2) medium (between 50 and 100 ha), and (3) large (above 100 ha)—considering one for each size category. Depending on groundwater potential, at least one pump irrigation system (PIS) was also selected for the provinces considered.

Findings from IMO data

Firmed-up service area

Based on FUSA, most CIS were small (below 50 ha) gravity systems. A fifth were only partly operational.

Table 2 shows the frequency distribution of CIS based on the size of FUSA, type of technology (gravity or pump), and operational status in the sample IMOs for Luzon, Visayas, and Mindanao. Over 40 percent of 1,606 CIS under the 11 sample IMOs in Luzon and 464 CIS in four sample IMOs in the Visayas had FUSA below 50 ha (small) while over 50 percent had 50 ha and above (medium to large). In contrast, 85 percent of the 176 CIS in the four sample IMOs in Mindanao had medium to large FUSA.

Majority of CIS had run-of-the-river type gravity irrigation systems, except in Cagayan, Isabela, and Camarines Sur, where more than 50 percent of the systems were PIS. There were no PIS selected in Leyte and no actual CIS using pumps in the selected provinces in Mindanao. Farmers with shallow tube wells (STWs) sourcing water from shallow aquifer systems acquired them through their own initiatives or from other government agencies. Some CIS were also in rice areas with slopes greater than 3 percent, particularly in areas outside NIS, such as the Upper Pampanga River Integrated Irrigation System (UPRIIS) and Magat River Integrated Irrigation System (MARIIS). Just over 10 percent in Luzon and Visayas used pumps.

Table 2. Frequency distribution of CIS by the size of FUSA and technology type (%)

Island Group	FUSA (ha)			Technology			Extent of Operation (%)		
	Small <50	Medium 50-100	Large >100	Gravity	Pump	Others[1]	≤50%	> 50	Others[2]
Luzon	41.10	25.59	33.31	79.64	17.81	2.55	4.73	74.84	20.42
Visayas	46.55	31.90	21.55	86.42	12.5	1.08	11.64	78.45	9.91
Mindanao	14.77	36.36	48.86	100	0	0	11.36	87.5	1.14

[1] not classified
[2] partially operational/ongoing/deferred/not yet operational
CIS = communal irrigation system; FUSA = firmed-up service areas; ha = hectare
Source: Authors' data obtained from respective IMOs (Luzon data as of 2013 and 2014; Visayas and Mindanao data as of 2017)

Over 70 percent of all CIS in Luzon and Visayas and 87 percent in Mindanao were above 50 percent operational. In Luzon, around 20 percent were partially operational, or ongoing, deferred, or not yet operational systems. Meanwhile, around 5 percent were below 50 percent operational due to defective/inadequate facilities. Partially operational, ongoing, deferred, or not yet operational CIS were more notable in Ilocos Norte, Bulacan-Neva Ecija, and Cagayan-Batanes. Nonoperational CIS were reported higher in Occidental Mindoro and Isabela. The causes of these conditions were discussed in the technical review based on the walkthroughs of the sample systems.

Cropping intensity

CIS maintained an average cropping intensity above 130 percent, though a significant proportion (especially in Visayas and Mindanao) fell below this threshold.

Cropping intensity is the ratio of area irrigated to the FUSA (or design area in some cases) of CIS. Annual cropping intensity could also be the ratio of area irrigated during the dry and wet seasons to the area irrigated during the wet season expressed in percentage. According to NIA Camarines Sur IMO, cropping intensity should be at least 130 percent, i.e., 100 percent for wet and 30 percent for the dry season. The national average cropping intensity dropped from 133 percent in 2013 to 129 percent in 2014. In 2017, the national average cropping intensity based on FUSA was 144.5 percent (NIA 2017).

The average cropping intensity of all CIS in all IMOs visited are shown in Table 3. In the selected 11 IMOs in Luzon, the average annual cropping intensity of CIS was 158 percent, higher than the national average.

Of the total 1,151 CIS reported by IMOs, 81 percent had cropping intensity higher than 130 percent, indicating they were better than the national average. The average cropping intensity was slightly higher in Mindanao (160%) than in Luzon (157%) and the Visayas (158%). Among the sample IMOs in the three regions, Visayas had the least percentage of CIS with cropping intensity above 130 percent.

Functionality of CIS IAs

Majority of CIS IAs achieved at least a satisfactory rating in terms of functionality.

NIA conducts functionality assessment of CIS IAs based on parameters related to O&M performance, financial performance, and organization and organizational discipline.

Table 3. Average cropping intensity of the CIS from the different IMOs visited

Average Cropping Intensity	Value (in %)
Luzon	158
Visayas	157
Mindanao	160
Percentage of systems:	
Luzon	
Below 130 percent cropping intensity	12
Above 130 percent cropping intensity	81
Data not available	7
Visayas	
Below 130 percent cropping intensity	22.6
Above 130 percent cropping intensity	64.0
Data not available	13.4
Mindanao	
Below 130 percent cropping intensity	24.4
Above 130 percent cropping intensity	73.3
Data not available	2.3

CIS = communal irrigation systems; IMO = irrigation management office
Source: Authors' data obtained from Seasonal Operational and Maintenance Report of respective IMOs (Luzon data as of 2013, 2014; Visayas and Mindanao data as of 2017).

Results of the annual or seasonal functionality surveys are used in the search for outstanding IAs at the provincial, regional, and national levels. This is a good motivation for IAs and their members. It also helps NIA in identifying appropriate strategies to enhance IA's capabilities. The rating is done through discussions and consultation with IAs and relies heavily on reports provided by irrigators development officers (IDOs), who are NIA staff focused on community organizing.

Currently, indicators and the percentage weight used in rating functionality of IAs include:

• O&M	35
• Financial performance	26
• Organization and organizational discipline	29
• Assistance program/agri-support services/linkages	6
• Special features	4

O&M indicators include O&M planning, implementation, and performance, such as annual cropping intensity, irrigated area vis-à-vis programmed area, status of irrigation facilities and structures, yield, and collection efficiency. Financial performance includes income generation and fund utilization, and viability index. Organization and organizational discipline cover information on membership, meetings, recording/filing system, attendance in meetings and group work, holding of regular elections, conflict resolution, and the imposition of discipline. The overall score indicates the following functionality rating:

- Outstanding (O): 95–100 percent
- Very satisfactory (VS): 85–94 percent
- Satisfactory (S): 75–84 percent
- Fair (F): 65–74 percent
- Poor (P): below 65 percent

Table 4 shows the distribution of CIS IAs in all sample IMOs based on functionality rating. A majority (around 76%) of IAs in 11 sample IMOs in Luzon, as well as in the Visayas, had satisfactory to very satisfactory ratings. Around 19 percent of IAs in sample IMOs in both regions had fair to poor ratings. In Mindanao, over 16 percent of IAs in the sample IMOs were outstanding and over 14 percent had fair to poor rating.

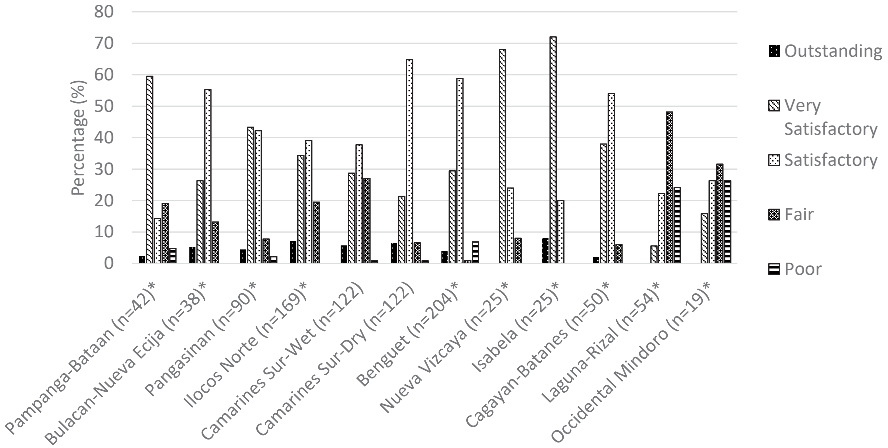
Table 4. Distribution of CIS IAs by category of functionality rating (%)

Area	Outstanding	Very Satisfactory	Satisfactory	Fair	Poor
Luzon	4.30	34.25	42.12	15.04	4.30
Visayas	4.86	45.14	29.86	17.36	2.78
Mindanao	16.47	47.65	21.18	7.65	7.06

CIS = communal irrigation systems; IAs = irrigators' associations
Source: Authors' data obtained from respective IMOs

On a per IMO basis, IAs in Isabela, Nueva Vizcaya, and Pampanga-Bataan had very satisfactory ratings. Fair to poor ratings, on the other hand, characterized IAs in Laguna-Rizal, Occidental Mindoro, and Camarines Sur during the wet season (the province had seasonal functionality survey during the period (Figure 1).

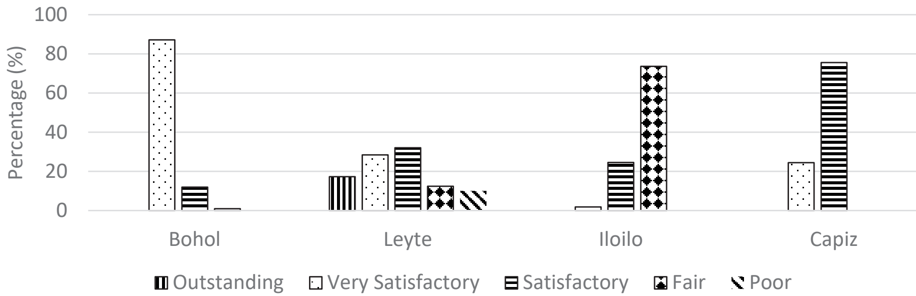
Figure 1. Percentage distribution of communal IAs by functionality rating and province in 11 sample IMOs in Luzon: 2014



*Functionality survey is done only once a year except in Camarines Sur where it is done every wet and dry season.
IAs = irrigators' associations; IMO = irrigation management office
Source: Authors' data obtained from functionality survey reports of respective provincial IMOs (as of 2013 and 2014)

In the Visayas, 80 percent of Bohol IAs had very satisfactory ratings. In contrast, majority of IAs in Iloilo and Capiz were rated as fair and satisfactory, respectively. Only Leyte had IAs with poor ratings (Figure 2).

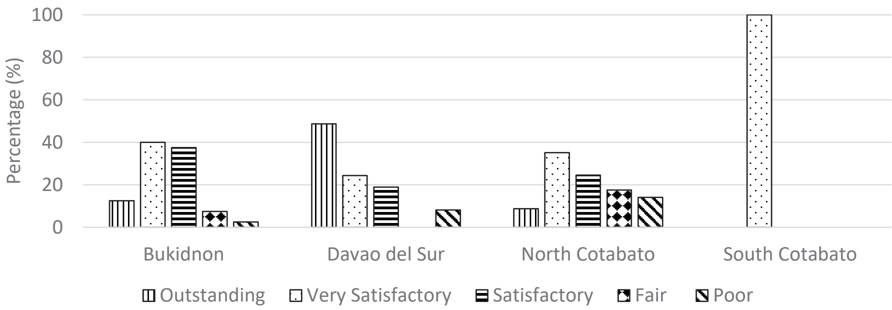
Figure 2. Percentage distribution of communal IAs by functionality rating and province in four sample IMOs in the Visayas: 2017



IAs = irrigators' associations; IMO = irrigation management office
Source: Authors' data obtained from functionality survey reports of respective provincial IMOs (as of 2017)

In Mindanao, all IAs in South Cotabato had very satisfactory ratings, with over 40 percent of them rated as outstanding. Poor IAs were noted in North and South Cotabato, and Bukidnon (Figure 3).

Figure 3. Percentage distribution of communal IAs by functionality rating and province in four sample IMOs in Mindanao: 2017



IAs = irrigators' associations; IMO = irrigation management office
Source: Authors' data obtained from functionality survey reports of respective provincial IMOs (as of 2017)

Deployment of irrigators development officers (IDOs)

NIA's ability to coordinate with and support IAs was limited by inadequate staffing of IDOs.

Table 5 shows the number and deployment of IDOs to CIS in each of the selected IMOs. The role of an IDO is very crucial to IAs' institutional development. Based on KIIs with IDOs and Institutional Development Division (IDD) officials, the IDOs' workload was quite heavy. For instance, most of the IMOs in Luzon had fewer than 10 IDOs with some assigned to both CIS and NIS projects. There were 68 gravity CIS and 28 pump CIS in Pampanga, and four were under preconstruction. There was one senior IDO for CIS and one community relations assistant. In Pangasinan, the supervising IDO was the overall supervisor for both NIS and CIS IDOs. There were IDOs assigned to CIS in six districts.

As of writing, IDOs still had heavy loads but were not getting adequate incentives, such as security of tenure and other benefits. In the Visayas, one IDO was assigned 14 to 20 CIS. IDOs in Mindanao had a lighter load with one IDO in charge of three to eight CIS.

Table 5. Deployment of IDOs to CIS in all the sample IMOs

IMO	No. of CIS/IAs	No. of IDOs
Luzon		
Pampanga	68	1 Senior IDO for CIS and 1 Community Relation Assistant (CRA)
Nueva Ecija	60	7 IDOs with CRAs helping
Pangasinan	120	8 IDOs are assigned to CIS in 6 districts
Ilocos Norte	116	4 IDOs assigned to CIS; 5 IDOs to both CIS/ NIS; 2 farmer/irrigator organizers
Benguet	431	3 IDOs
Camarines Sur	152	2 IDOs for CARP and SRIP; 6 Research Assistant B position covering 5 districts
Nueva Vizcaya	217	4 IDOs are assigned CIS/IAs
Isabela	45	1 assigned to CIS project but there are many radiation projects
Cagayan	673	3 IDOs
Laguna	13	3 IDOs in 3 districts
Occidental Mindoro	32	5 IDOs
Visayas		
Bohol	213	14
Leyte	186	13
Iloilo	123	7
Capiz	62	3
Mindanao		
Davao del Sur	77	10
South Cotabato	35	10
North Cotabato	68	12
Bukidnon	40	14

IDOs = irrigators development officer; CIS = communal irrigation systems; NIS = national irrigation systems; IAs = irrigators' associations; IMO = irrigation management office; CARP = Comprehensive Agrarian Reform Program; SRIP = Small Reservoir Irrigation Project
Source: Authors' data obtained from respective IMOs

Findings from system-level and IA-level data

This section presents results of the survey of 66 sample IAs in 11 selected provinces in Luzon in Cycle 1 and 12 sample IAs each in both Visayas and Mindanao. Information include the technical assessment of CIS and institutional assessment of IAs.

Technical assessment of CIS

Location

The scope of irrigable area in the country was probably wider than current estimates.

The slope maps showed that some CIS were irrigating rice areas with slopes greater than 3 percent, particularly in areas outside large NIS like UPRIIS and MARIIS. In some cases, CIS were irrigating small patches of areas under a 3-percent slope. The 3.1-million hectare-potential irrigable areas as defined by NIA based on the 0-3 percent slope were quite low. There is a vast potential for small-scale irrigation development if a good surface water source is present or if it is underlain by a good aquifer. This lends credence to a World Bank study, which included areas up to 8-percent slope increasing the irrigable areas to more than 6.1 million ha. These show that the basis for the delineation of potential irrigable areas should be revisited.

Water sources and availability

The lack of surface water during dry season was a key constraint in CIS performance.

In the feasibility study stage of a typical CIS, historical records of river discharge are subjected to hydrologic frequency analysis using the 80-percent dependable flow in the design. In the absence of data, engineers usually rely on empirical equations, such as rational equation and other site-specific case studies, water balance methods, or synthetic data generated using hydrologic models, such as the Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS) and the Soil and Water Assessment Tool (SWAT). The reliability of these methods should always be tested and the results calibrated with actual data.

The water sources for the surveyed CIS included lakes, rivers, creeks, springs, groundwater, and runoff or a combination of one or more sources. Rivers, creeks, and springs were the major sources of irrigation water in Luzon. Groundwater was particularly used in Pampanga, Isabela, and Laguna. In the Visayas, only one sample CIS in Bohol used groundwater as an additional source. In the Mindanao sample CIS, rivers were the only water source in Davao del Sur while other provinces had either springs or creeks as other sources. Except for some large rivers, there were no historical records of the discharges of the river and creek sources for CIS.

Only 29 out of the 90 (30%) CIS visited had river sources deemed capable of providing irrigation even during dry seasons. Seven of these rivers are very large and provided water for large NIS as well. If the CIS is sourced from these rivers, dry season crops are assured of irrigation 80 percent of the time, and only siltation and hardware problems are left to deal with. However, the majority of CIS were sourced from less dependable small rivers and creeks, as well as springs and runoff (rainfall excess), which did not even have historical records of flows that can serve as a basis for sensible engineering designs. In these cases, the source of water is a major problem. This was compounded by environmental problems, such as denuded watershed cover due to logging and *kaingin* and land use conversion, among others. Moreover, the flow records showed that even during the 1970s, the minimum measured flows were way below the mean daily discharge. This indicates that even larger rivers, in some cases, may not be able to supply irrigation during the dry season.

Many parts of the country had extensive and productive aquifers which can be tapped as supplementary sources of irrigation water.

Adequate groundwater was found in parts of Isabela, Pampanga, Pangasinan, Ilocos Norte, Laguna, Leyte, Iloilo, Davao del Sur, and North and South Cotabato. Meanwhile, localized productive aquifers were present in Cagayan and other parts of Isabela, Camarines Sur, Benguet, and Occidental Mindoro, Bohol, Leyte, Iloilo, Capiz, Davao del Sur, and North and South Cotabato. For Benguet, localized perched aquifers were the sources of springs. Bohol, on the other hand, has many springs due to the karst formations underlying the province. On the other hand, Nueva Vizcaya and Nueva Ecija were without significant or limited pumpable groundwater, particularly since the visited CIS were located on the outskirts of the Pampanga River Basin.

Water delivery program

Based on IA self-assessment, the implementation of the CIS water delivery program was satisfactory.

Water delivery performance indicators include flexibility, reliability, and equitability (Table 6). Flexibility refers to the ability of CIS to deviate from an established irrigation schedule. Based on farmers' perception, the average flexibility index was computed at 3.3 in Luzon and 3.7 in both Visayas and Mindanao. This indicates that the flexibility was quite high. The highest was 4 in Benguet, Bohol, Capiz, Davao del Sur, and North and South Cotabato, and the lowest was 1.5 in Nueva Ecija. The lowest in Mindanao was in Bukidnon at 2.7. Most of the interviewed IAs had defined schedules for water releases, especially during the dry season when water is limiting, but is rather flexible during the wet season when water is more than sufficient. Some IAs had strict rules and penalties for noncompliance or water stealing. Flexibility in larger irrigation systems may be limited by the lack of control structures to divide or divert flows between zones.

Table 6. Water delivery performance indices in all the IMOs visited

IMO	Flexibility Index	Reliability Index	Equitability Index
Luzon (average)	3.3	3.5	3.7
Pampanga	3.8	3.2	3.7
Nueva Ecija	1.5	3.2	3
Pangasinan	3.7	3.5	3.8
Ilocos Norte	3.3	3.2	3.8
Benguet	4.0	3.8	3.8
Camarines Sur	3.2	3.8	3.7
Nueva Vizcaya	4.0	3.8	4.0
Isabela	3.0	3.6	3.8
Cagayan	3.0	2.8	3.3
Occidental Mindoro	2.7	3.8	3.8
Laguna	3.7	3.3	4.0
Visayas (average)	3.7	3.7	3.7
Bohol	4.0	4.0	4.0.
Leyte	3.7	3.7	3.7
Iloilo	3.0	3.0	3.0
Capiz	4.0	4.0	4.0
Mindanao (average)	3.7	3.7	3.5
Davao del Sur	4.0	4.0	4.0
South Cotabato	4.0	4.0	4.0
North Cotabato	4.0	4.0	4.0
Bukidnon	2.7	2.7	2.0

IMO = irrigation management office
Source: KII with officers/members of irrigators' associations (IAs)

Reliability is an expression of confidence by the irrigation system to deliver water as promised (Murray-Rust and Snellen 1993). It is also the degree to which the irrigation system conforms to prior expectations of its users (Rao 1993). The average score for Luzon based on the KIIs was a high 3.5. However, it was higher at 3.7 in both Visayas and Mindanao, indicating reliable water delivery. Some farmers were resigned to the fact that water is scarce during a certain dry period to the point they would not receive water. As such, they usually find other water sources, such as

STWs or low-lift pump. The almost uniform rainfall distribution in Mindanao and the reliable water sources in both Visayas and Mindanao were plus factors.

Equitability, referred to as equity in some literature, is the spatial uniformity of the ratio of the delivered amount to the required amount (Molden and Gates 1990). It is also an expression of the share for each individual or group considered fair by all system members (Murray-Rust and Snellen 1993). Based on KIIs, the average equitability index score in Luzon and Visayas was also high at 3.7 and a bit lower in Mindanao at 3.5. This means that the members considered the distribution of water among members per IA as equitable. Most IAs interviewed practiced downstream first irrigation scheduling during the dry season. Flexibility, reliability, and equitability of water delivery was not a problem in Benguet because all CIS were sourced from springs and mountain rivers. Water is also stored on a series of storage tanks and distributed to individual patches of lands with the use of high-density polyethylene hoses. The reliability of water source was the main reason for the high index ratings of CIS in Bohol, Capiz, Davao del Sur, North Cotabato, and South Cotabato.

Water management practices

Water management practices, such as alternate wet-and-dry and reuse of drainage water, were adopted in majority of CIS.

The lack of proper water management practices, both by the farmers and the related agencies, has been identified as one of the reasons for the low irrigation efficiency. To enhance such low irrigation efficiency, it is suggested that capacity development and the introduction of new water-saving technologies be required. IAs were also asked how they conserve water or cope with expected water deficits. Specifically, they were asked if they practice alternate wetting and drying (AWD) or if they reuse drainage water for irrigation. In Luzon, 27 out of 64 (42%) IAs said they practiced AWD. Meanwhile, 6 out of 12 (50%) IAs in the Visayas and 9 out of 12 IAs (75%) in Mindanao practiced AWD. IAs learned the technology by attending training conducted by the Philippine Rice Research Institute or the International Rice Research Institute and sponsored by NIA. In Benguet, AWD was not applicable because the crops planted were not rice. Only 10 percent of IAs in Luzon reused drainage water for irrigation. Meanwhile, this was again higher in the Visayas and Mindanao, at 50 percent and 83 percent, respectively. Other IAs had no idea whether they practice AWD or drainage reuse or not. Table 7 shows the result of the KII.

Table 7. Water management practices in all the IMOs visited

IMO	Practicing AWD		Reusing Drainage Water	
	Yes	No	Yes	No
Luzon	27	37	6	56
Pampanga	5	1	2	2
Nueva Ecija	1	5	0	6
Pangasinan	2	4	0	6
Ilocos Norte	2	4	0	6
Benguet	3	3	3	3
Camarines Sur	4	2	0	6
Nueva Vizcaya	0	5	0	5
Isabela	2	3	0	5
Cagayan	3	3	0	6
Occidental Mindoro	2	4	0	6
Laguna	3	3	1	5
Visayas	6	6	6	6
Leyte	2	1	0	3
Iloilo	3	0	3	0
Capiz	1	2	0	3
Mindanao	9	3	10	2
Davao del Sur	3	0	3	0
South Cotabato	3	0	3	0
North Cotabato	3	0	3	0
Bukidnon	0	3	1	2

IMO = irrigation management offices; AWD = alternate wetting and drying
Source: KII with officers/members of IAs

Sedimentation and silt control

Many CIS were rated by their IAs as being heavily silted.

The IAs from Pangasinan, Camarines Sur, Bohol, North Cotabato, South Cotabato, and Bukidnon rated their silt level as high, which verified the observations from the walkthroughs (Table 8). Silt levels in canals were also high in Nueva Vizcaya, but the values assigned by IAs were relatively low. Members in these areas conducted regular cleaning of canals since CIS canals were small and did not require renting a backhoe, unlike that in NIS. Heavy siltation was mostly observed in the dams of most systems during the walkthroughs. IAs also reported relatively high undesired seepage, primarily because most them still wanted all their canals to be concrete-lined.

The provision of silt control devices was not included in the CIS design manual of NIA. However, several silt control devices were encountered during the field visits, all of which were observed in Mindanao. This is quite understandable given that the catchment management program of the Water Resources Development Project (1998) was piloted in Mindanao.

Table 8. Silt and seepage levels in the canals of CIS for each IMO

IMO	Silt Level Grade	Undesired Seepage Grade
Luzon (average)	1.7	2.7
Pampanga	1.5	2.8
Nueva Ecija	1.8	3.8
Pangasinan	3.0	2.7
Ilocos Norte	1.3	2.5
Benguet	0.8	3.7
Camarines Sur	3.3	2.0
Nueva Vizcaya	0.7	2.0
Isabela	1.5	2.8
Cagayan	1.7	2.5
Occidental Mindoro	2.7	0.5
Laguna	0.6	4.0
Visayas (average)	1.3	3.6
Bohol	3.3	3.3
Leyte	0.0	4.0
Iloilo	2.0	3.0
Capiz	0.0	4.0
Mindanao (average)	2.8	2.7
Davao del Sur	0.0	0.0
South Cotabato	4.0	4.0
North Cotabato	4.0	4.0
Bukidnon	3.3	2.7

Note: For silt level grade, the ratings go from 0 = low to 4 = high. For Undesired seepage grade, the ratings go from 0 = high to 4 = very low seepage
CIS = communal irrigation systems; IMO = irrigation management office
Source: KII with officers/members of IAs

Design considerations

Shortcomings in system design complicated subsequent O&M.

The CIS dams are mostly run-of-the-river types with simple designs, such as ogee-type or glacis spillways, gated weirs, and gabions. Some dams are quite old, with exposed rock cores, damaged spillways, or silted storage area. Most of the dams visited had sediments almost at the crest level. These would require dredging to increase the storage capacity and increase water available for irrigation. Large-scale silt problems that will require the use of backhoe need the assistance of NIA.

The sluice gates are used to control the water level at the dam and flush out sediments preventing it from entering the intake gates, which control the amount of water entering the system. Most of the sluice gates and intake gates usually made of steel were replaced with flashboards, sandbags, or stones. In one CIS, the steel sluice gates were not even installed. In some relatively larger CIS, the lifting mechanisms were defective or rather slow. IAs in Visayas and Mindanao resorted to using second-hand or rented chain blocks to facilitate lifting and closing the gates. These gates should be repaired or replaced to ensure proper control of the water and sediment intake.

Since CIS have small FUSA, infrastructure costs are more for canal linings and control structures. Most of the CIS visited had lined main canals while some have lined canals up to the laterals. The conditions of the lined and unlined canals depend primarily on whether the IA have good O&M and cleanup activities. Siltation was a major problem but usually, the IA can manage to clean the canals themselves

Since the discharge capacity was small, only simple structures were found in most CIS. While some were well maintained, others have deteriorated and the control structures were not functioning well as originally intended. These included cross regulators, check gates, drop structures, division boxes, and farm turnouts. Cross regulators were found only in the main canals of some large CIS while check gates were more common on small main canals and laterals. In most new CIS, the steel gates were still in good condition and the screws and turning wheels were still operating. In older and improperly managed CIS, the gates were already damaged and replaced by wooden slabs or, in some cases, none.

Drop structures are ubiquitous in all systems and are lined to prevent channel scouring and erosion. They are often combined with check gates and division boxes to minimize costs. Division boxes are also usually made of concrete with slots for wooden slabs, which serve as control gates. The control of flow direction is done by the water master based on agreed upon irrigation schedules. The density of farm turnouts depends on the FUSA of CIS. Together with the check gates, it influences the flexibility and efficiency of water delivery within the system. Only four CIS had digitized maps of their system and some of the maps did not indicate the kind of structures present in the system. Some CIS had inverted siphons channeling water under roads or rivers. Most of these structures have been rehabilitated or desilted already. Still, some were under request for repair. Elevated flumes can also be found in some CIS.

There were no flow measuring structures. Any form of flow measurement was done at the headworks, but these were only based on staff gauge readings and rating curves, most of which have not been recalibrated since the CIS construction. Other miscellaneous or appurtenant structures commonly found in all CIS included road and thresher crossings, end checks, and service roads. IAs generally regarded poorly the availability of roads along canals. Most service roads were rough roads with most dams accessible only by walking or by motorcycle, which added more cost to the farmers to deliver their harvest to rice mills and storage facilities. One of the main requests of IAs was the provision of farm-to-market roads to ease this burden.

There were no specific drainage canals at CIS. Normally, the downstream farm ditches receive the excess water from paddies, sometimes used to irrigate downstream areas. In most systems, water distribution downstream was from paddy to paddy, without individual farm ditch for each paddy. Again, the downstream canal serves as the drainage canal. These are done to maximize areas devoted to planting. However, the absence of drainage canals more often contributes to flooding or a longer time for flood recession.

Maintenance

Based on IA self-assessment, maintenance of CIS was rated as mostly satisfactory.

As shown in Table 9, most IAs regarded the water distribution as more than satisfactory with an average rating of 3.2 in Luzon, 3.5 in Visayas, and 3.4 in Mindanao. The results also showed that the canals and control structures were deemed well maintained, indicating the management and policy implementation of the individual IAs themselves. A major contributing factor was the small size of CIS, which makes them easier to manage and maintain, even with the occurrence of high siltation in the canals.

Table 9. Performance rating on water distribution, maintenance of canals, and maintenance of control structures in all the IMOs visited

Province	Water Distribution	Maintenance of Canals	Maintenance of Control Structures
Luzon (average)	3.2	3.1	2.9
Ilocos Norte	2.7	3.0	2.0
Pangasinan	3.0	2.8	3.0
Cagayan	2.7	2.8	3.0
Isabela	3.2	3.5	2.8
Nueva Viscaya	2.7	2.8	2.8
Pampanga	3.7	3.3	3.5
Nueva Ecija	3.5	3.7	3.2
Camarines Sur	3.3	3.2	3.2
Laguna	4.0	3.4	3.6
Occ. Mindoro	3.2	2.7	2.5
Benguet	3.0	2.8	2.8
Visayas (average)	3.5	3.3	3.4
Bohol	4.0	3.0	3.0
Leyte	4.0	4.0	4.0
Iloilo	3.0	3.0	3.0
Capiz	3.0	3.0	3.3
Mindanao (average)	3.4	3.4	3.3
Davao del Sur	4.0	4.0	4.0
South Cotabato	3.7	3.7	3.7
North Cotabato	3.0	3.0	3.0
Bukidnon	2.7	2.7	2.3

Note: 0 - Very Poor; 1 – Poor; 2 – Average; 3 – Satisfactory; 4 - Excellent
IMOs = irrigation management offices
Source: KII with officers/members of IAs

Institutional assessment of IAs

Performance indicators

Based on specific indicators of functionality, IAs in Luzon were getting relatively lower ratings on O&M and financial indicators, compared to organization and organizational discipline.

On average, majority of the provinces had IAs far from the 40-percent score in O&M and 30 percent in financial performance. IAs had scores closer to organization-related indicators (Table 10). In the Visayas, only Iloilo got an overall fair rating. Its IAs had the lowest average score in the different indicators, except in organizational discipline where it was highest. Leyte had the highest rating in O&M, Capiz in financial performance, and Bohol in assistance program and linkages (Table 11). In Mindanao, only Davao del Sur got an overall rating of outstanding, securing the highest score in O&M and financial. Other provinces' IAs also did well with a very satisfactory rating. Bukidnon was the highest in linkages (Table 12).

Table 10. Average rating of the individual indicators for IAs' functionality rating in 11 selected provinces in Luzon

Province (Rating)	O&M (40%)	Organization (15%)	Financial (30%)	Organizational Discipline (15%)	Average Scores in additional indicators	Final Rating (Total)
Pampanga (S)	30.88	12.67	24.69	12.89	2.58	83.71
Nueva Ecija (S)	30.90	12.75	20.91	12.24	3.79	80.62
Pangasinan (S)	32.58	12.25	18.40	12.48	6.16	81.87
Ilocos Norte (S)	32.87	14.21	20.58	14.69	7.72	82.95
Camarines Sur (S)	29.45	13.37	19.67	13.71	3.25	79.42
Nueva Vizcaya (VS)	34.60	12.85	22.10	12.39	3.76	85.69
Isabela (VS)	35.47	13.03	21.09	12.67	2.79	87.83
Cagayan (S)	32.51	12.43	19.35	13.26	5.50	83.05
Laguna (F)	27.96	11.05	17.49	11.48	4.12	72.10
Occidental Mindoro (F)	23.18	11.54	21.38	11.40	4.50	72.00
ALL (S)	31.04	12.62	20.57	12.72	4.42	81.16

IA = irrigators' association; O&M = operations and maintenance
Source: Authors' data obtained from functionality survey reports of respective provincial IMOs (as of 2013 and 2014)

Coping strategies and assistance received

The IAs have adjusted to the limited water access through various coping strategies with support from NIA.

Over 48 percent of IAs in Luzon reported problems related to water access in terms of quantity and timeliness of delivery. This was related to the operation and

Table 11. Average rating of the individual indicators for IAs' functionality rating in four selected provinces in the Visayas

Province (Rating)	O&M (35%)	Financial (26%)	Organi-zational Discipline (25%)	Assistance Program/ Linkages (10%)	Special Features (4%)	Final Rating (Total)
Bohol (VS)	31.33	22.00	22.67	9.00	2.33	88.33
Leyte (VS)	35.07	23.50	22.76	8.67	2.37	91.58
Iloilo (F)	28.40	17.12	23.53	4.40	0.35	73.80
Capiz (S)	31.20	24.50	22.77	4.67	1.67	84.80
ALL (S)	31.50	21.78	22.93	6.68	1.68	84.63

IA = irrigators' association; O&M = operations and maintenance; VS = very satisfactory; F = fair; S= satisfactory
Source: Authors' data obtained from functionality survey reports of four IMOs (as of 2017)

Table 12. Average rating of the individual indicators for IAs' functionality rating in four selected provinces in Mindanao

Province (Rating)	O&M (35%)	Financial (26%)	Organiza-tional Discipline (25%)	Assistance Program/ Linkages (10%)	Special Features (4%)	Final Rating (Total)
Davao del Sur (O)	34.50	24.00	28.55	6.00	3.50	96.55
North Cotabato (VS)	33.53	18.43	27.07	5.50	3.75	88.27
South Cotabato (VS)	32.05	21.25	24.35	4.90	2.63	85.18
Bukidnon (VS)	32.07	22.33	22.90	7.50	2.28	87.08
ALL (VS)	32.99	21.28	25.57	6.10	3.04	88.95

IA = irrigators' association; O&M = operations and maintenance; O = outstanding; VS = very satisfactory;
Source: Authors' data obtained from functionality survey reports of four IMOs (as of 2017)

management of the system, as well as access to funds needed for rehabilitation. Similarly, access to funds needed for rehabilitation, followed by O&M, was raised by the majority of IAs in the Visayas. In Mindanao, access to water and access to funds were equally important issues to IAs. O&M and access to credit were likewise cited by majority of IAs.

To supplement irrigation water supply particularly during dry spells, 34 percent of IAs in Luzon used STWs, low lift pumps, or deep wells, but the members did this individually. The other 25 percent adjusted water scheduling or practice rotational irrigation, while another 18 percent planted alternative crops, such as corn, mung bean, or watermelon. The rest of IAs did nothing to cope with a dry spell. In the Visayas, majority planted alternative crops but 33 percent did nothing. In Mindanao, majority resorted to pumps, STWs, deep wells; adjusted water scheduling or practiced water rotation; or practiced AWD. Other IAs also planted alternate crops.

IAs that rated high performance cited the following good practices:

- resourcefulness of IA president in generating funds, such as through *Balik Tangkilik* (patronage refund) from selling to the National Food Authority and assistance from government programs, such as the Comprehensive Agrarian Reform Program (CARP), and international projects;
- coordination of IA with the barangay council to adopt the IA policy, such as water distribution, for enforcement of policies through a barangay resolution;
- strong cooperation of IA members in the strict implementation of the provisions of by-laws, such as payment of IA fees, imposition of penalties for absence in meetings and violation in water scheduling, no receipt, no water, and first-come, first-served basis in water delivery;
- effective financial management to ensure funds for O&M and loan repayment, incentives for early payment of fees, and income-generating activities, such as equipment rental, selling farm inputs, and crop diversification; and
- regular cleaning of dam and main canals, including trimming of the grasses, before the start of the rainy season. They also avoided using herbicide which they fear could contaminate irrigation.

Of 66 IAs interviewed in Luzon, 51 reported getting continuous support from NIA. By province, Ilocos Norte, Cagayan, and Laguna had the least number of IAs with support from NIA. Assistance from NIA included the use of equipment and other services, such as desilting. All IAs in the Visayas and Mindanao reported that NIA provided them continuous support.

Majority (80%) of IAs in Luzon, Visayas, and Mindanao rated NIA assistance as excellent in terms of technical, financial, and institutional aspects, among others. Technical assistance included rehabilitation of the system, concreting of canal and construction of irrigation facilities. Meanwhile, financial assistance primarily came from LGUs and politicians. Institutional assistance included training and capacity-building activities. Other services included lending of heavy equipment. Other agencies providing assistance as cited by IAs in Luzon, Visayas, and Mindanao included the Department of Agriculture (DA) and its attached agencies, such as the Bureau of Soils and Water Management (BSWM).

Recommendations

Irrigation planning and feasibility

The scope of potential irrigable areas for CIS needs to be widened. However, other key data must be obtained to properly delimit areas suitable for irrigation.

Three criteria are proposed for identification of potential areas for CIS. The first is to consider all areas with up to 8-percent slope, minus the built-up and other protected areas. This will serve to widen the scope of potential irrigable areas for CIS. The second criteria should be the presence of a dependable surface water source and a good shallow aquifer, which may be used as a supplemental water supply. Hydrologic data acquisition and monitoring should be improved and expanded to smaller rivers, creeks, and groundwater. Empirically derived flows should also be reviewed, with special consideration on the effect of climate change. There should be a concerted effort among concerned government agencies, such as the National Water Resources Board, NIA, BSWM, and the academe to identify potential sites for diversion dams and storage reservoirs. The third criteria should be soil texture and its suitability to different types of crops, which would support crop diversification.

Addressing low water availability

The practice of supplementing irrigation from surface sources with groundwater from STWs should be encouraged, especially in areas where surface water sources, such as creeks, have very low dependable discharges during the dry season and for areas underlain by good shallow aquifers.

While using STW pumps and engines incurs additional fuel costs, they do provide a reliable water source during intense drought periods or El Niño episodes. Moreover, farmers have control of irrigation schedules and flows, enabling some of them to increase cropping intensity or diversify into other crops. Some NIA IMOs have already installed standby STWs, which they only use during periods of prolonged droughts.

Farmers' initiatives in deployment of STWs should receive stronger support from DA and NIA.

To address low irrigation efficiency, IA capacity development and the introduction of new water saving technologies and cropping practices should be promoted and/or sustained.

In CIS where the dry season flow cannot support anymore the dry season irrigation requirements, various options are still available to IAs. These include reliance on water-saving technologies like AWD and adjustment of cropping practices for rice, such as direct seeding to minimize water use from land soaking and land preparation. IA may also consider crop diversification like planting nonrice crops or crops requiring less water, particularly in areas at the tail-end of the system.

Another option that needs to be given greater consideration is the adoption of piped irrigation systems.

Common suggestions raised by IAs to address problems in their systems usually refer to physical measures, including lining of canals and rehabilitation of irrigation systems or structures. Generally, rehabilitation connotes lining of canals. However, the concreting of canals is impractical if the soil is clayey. With the availability of low-cost, high-density polyethylene pipes, it is about time to look into the feasibility of using these materials for subsurface canals, instead of concreting open channels to convey irrigation to the fields.

Currently, such piped systems are seldom considered in system design owing to high investment costs. A more sophisticated trash rack or sediment control at the intake is also needed to prevent clogging. Drain holes and repair vents are also needed at key locations in the systems, which again increase the investment cost. Other problems may be rat infestation, which may cause further clogging of the system and destruction of rice crops.

Nonetheless, the high initial cost and other disadvantages may be offset by several benefits, including:

- lower O&M cost due to reduced rubbish and sediments in the system;
- increased areas for planting as the canal is buried underground and risers are used to distribute water to farm ditches;
- lower costs for right-of-way acquisitions;
- reduced seepage and percolation losses; and
- easier water control in terms of command and flow.

Lastly, piped systems are easier to modify to install sprinkler systems, thereby facilitating crop diversification should IAs seek to move out of rice monoculture.

Addressing siltation and other technical issues

Design modifications of CIS are needed to anticipate water shortages and siltation.

Provision for rotational irrigation should also be incorporated in the design of canal system, with more checks or control gates for more efficient water distribution. Drainage should be taken into consideration in the design criteria to avoid gross underestimation of on-farm water losses.

In the case of rehabilitation work, existing systems must be checked for design shortcomings, such as underestimation of flood flows and sediment loads, inadequate provisions for sediment control, and underestimation of reservoir inflow and outflow hydrographs.

Generally, the dams and control structures should be properly maintained and repaired to ensure proper water control and distribution. The dam storage area should be regularly cleared of sediments to increase storage capacity and extend irrigation even with diminished river flows. This should be part of regular O&M activities of the IAs. If heavy equipment is necessary, NIA should extend help to IAs.

Chapter 4

Water Resources Component

Guillermo Q. Tabios III and Tomas Paolo Z. De Leon

Introduction

In the Pampanga River Basin (excluding O'Donnell, Camiling, and west of Agno River Basins), there are five major national irrigation systems (NIS), namely, Upper Pampanga River Integrated Irrigation System (UPRIIS), Casecnan, Balog-Balog, Pampanga Delta River Irrigation System (PDRIS), and Angat-Maasim River Irrigation System (AMRIS). Two of these NIS—AMRIS and PDRIS—were constructed with design service areas of 31,400 hectares (ha) and 11,540 ha, respectively. However, since the completion of the AMRIS irrigation canal (conveyance) system in the mid-1970s, its actual irrigated area has only reached as much as 27,000 ha during the dry season and as much as 18,000 ha during the wet season. Farmers often do not risk planting in flood-prone areas (Tabios and David 2014). In the case of PDRIS, which was completed in 2002, it has irrigated only as much as 6,900 ha during the dry season and 1,000 ha during the wet season. Same as AMRIS, farmers plant less during the wet season due to risk of flooding (Tabios and David 2014). In both AMRIS and PDRIS, physical features like slope, geology, soil, and topography may have led to overestimation of design service areas. However, other major factors, such as water availability, land-use change, underdeveloped irrigation facilities, and frequent flood inundation of the area contributed in actual, historical irrigated areas annually to be below their design irrigation areas as shown by Tabios and David (2014).

This study assessed the design of irrigation service areas according to its original plan compared to the actual service areas in relation to water availability, land use (including flood vulnerability), and status of irrigation facilities. The approach here is to evaluate the ability (how much) of the water resources (water source), land resources (slope, soils, and land use), as well as irrigation facilities to irrigate so much area through watershed and irrigation modeling and simulation.

The background material presented here on the AMRIS and PDRIS were mostly taken from Tabios and David (2014).

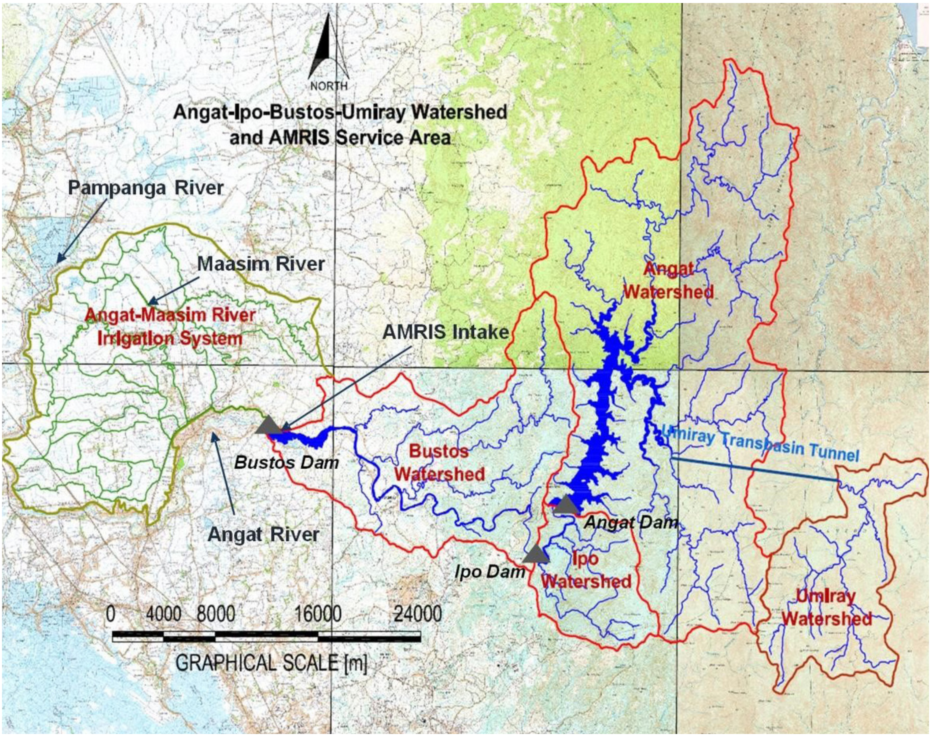
Angat-Maasim River Irrigation System

As shown in Figure 1, the Angat Reservoir inflows come from the Angat watershed, as well as from the Umiray watershed through the Umiray transbasin tunnel. The bulk of irrigation water supply of AMRIS comes from the Angat Reservoir releases to Bustos Dam. The local inflows from Bustos watershed (i.e., inflows between Angat Reservoir and Bustos Dam) also contribute to Bustos Dam and thus become part of the AMRIS irrigation water supply. The Angat Reservoir also supplies domestic water for Metro Manila's Metropolitan Waterworks and Sewerage System (MWSS) through the Ipo Dam, which is viewed as competing with AMRIS for water supply intended for irrigation. Likewise, local inflows from Ipo watershed (i.e., inflows between Angat Dam and Ipo Dam) become part of the domestic water supply for Metro Manila.

The watershed areas associated with each watershed in Figure 1 are as follows: (1) Angat watershed with 546.2 square kilometers (sq. km); (2) Umiray watershed with 124.4 sq. km; (3) Ipo watershed with 72.3 sq. km; and (4) Bustos watershed with 233.3 sq. km. As shown in Figure 1, AMRIS has watershed area of 314.8 sq. km.

Data of historical irrigated service areas from NIA Office in Quezon City showed that during the wet cropping season (window between June and October), the irrigated area declined from 22,000 ha to 17,500 ha in the last 10 years. Likewise, during the dry cropping season (window between December and April), the irrigated area declined

Figure 1. Angat Reservoir water resource system, including the Angat-Maasim River Irrigation System (AMRIS)



Source: Tabios and David (2014)

from 27,500 ha to 24,000 ha. The original design service area of about 31,400 ha was never attained.

Given these historical irrigated areas, Tabios and David (2014) showed, using simple water balance computation for AMRIS planted with paddy rice, that the average daily paddy rice water requirement without wasted water is 1.12 liters/second/ha (lps/ha) or 0.00112 cubic meters/second/ha (CMS/ha) and 1.67 lps/ha or 0.00167 CMS/ha with wasted water. During the four-month cropping season, irrigation water requirement ranges from 19.6 to 29.2 CMS (without and with wasted water, respectively) during the wet season for a 17,500 ha planted area. For a 24,000 ha area, irrigation water requirement ranges from 26.88 to 40.1 CMS during the dry season.

Table 1 shows the historical releases (in CMS) of Angat Reservoir to AMRIS, as well as MWSS. Also shown are the monthly water allocations by NWRB based on daily data from 1996 to 2013. Data are used by NWRB in allocating or scheduling monthly releases to AMRIS. Note that the target water allocation for MWSS is fixed at 46 CMS but the average historical releases is only 36.28 CMS as shown in Table 1. On the other hand, the average annual historical releases (on daily basis) for AMRIS are 27.46 CMS, which is around the midpoint of the range of paddy rice water requirement of 19.6 CMS (minimum if without wasted water) and 40.1 CMS (maximum if with wasted water).

Table 1. Monthly average releases to MWSS and AMRIS from Angat Reservoir (1996–2013) and NWRB allocation for NIA-AMRIS (in CMS)

Month	Historical Releases to MWSS	Historical Releases to NIA-AMRIS	NWRB Allocation for NIA-AMRIS
January	37.97	38.50	36.00
February	39.30	35.80	39.86
March	38.74	27.94	31.00
April	40.01	14.12	15.50
May	41.09	7.94	0.00
June	43.88	15.58	27.90
July	33.17	20.97	28.00
August	29.01	21.51	25.00
September	29.99	24.87	22.73
October	34.21	28.56	13.00
November	32.82	39.80	17.57
December	35.19	53.88	34.00
Annual average	36.28	27.46	24.21

MWSS = Metropolitan Waterworks and Sewerage System; AMRIS = Angat-Maasim River Irrigation System; NWRB = National Water Resources Board; NIA = National Irrigation Administration; CMS = cubic meters/second.
Source: Tabios (2017)

Table 2 shows the flow duration analysis of historical and computed daily flows using the Sacramento-based watershed model of Angat Reservoir inflows, Ipo Dam local inflows, Bustos Dam local inflows, and Umiray River flow diversions to Angat. As seen in this table, the range of dependable Bustos Dam local inflow at 80 percent (about 290 days a year) and 60 percent (about 220 days a year) are 2.97 and 8.66 CMS, respectively, which cover the deficit of about 6 CMS mentioned above. The Angat Reservoir monthly releases as allocated by NWRB with an average daily flow of 24.21 CMS were adequate for AMRIS despite the higher NWRB allocation for MWSS at 46 CMS. However, it should be noted that the actual historical releases from Angat Reservoir to AMRIS is 27.46 CMS while the actual releases to MWSS are only about 36.28 CMS, although the latter may be augmented by Ipo Dam local inflows, which has a daily average of 8.72 CMS.

The big question here is why the historical, actual irrigated area of AMRIS is less than the designed irrigated area of 31,400 ha. During the dry season, the actual irrigated area of AMRIS is about 23,000 ha (or about 73% of the design area) while during the wet season, it is about 17,500 ha (or about 56% of the design area). Tabios and David (2014) and recent estimates by authors of this chapter showed that during the dry season, out of 31,400 ha design service area, the effective area is about 23,000 ha because 3,400 ha is above the 18-m elevation, which cannot be served by Bustos Dam since its operational crest elevation is only 17.5 m, and 5,000 ha is already urbanized. During the wet season, an additional 5,500 ha (mostly below 7-m elevation) is a flood-prone area. Farmers do not risk planting in this area, leaving only a total of 17,500 ha that is normally planted.

Table 2. Historical and watershed model computed daily flows of Angat Reservoir inflows, Ipo Dam local inflows, Bustos Dam local inflows, and Umiray River flow diversions to Angat Reservoir (in CMS)

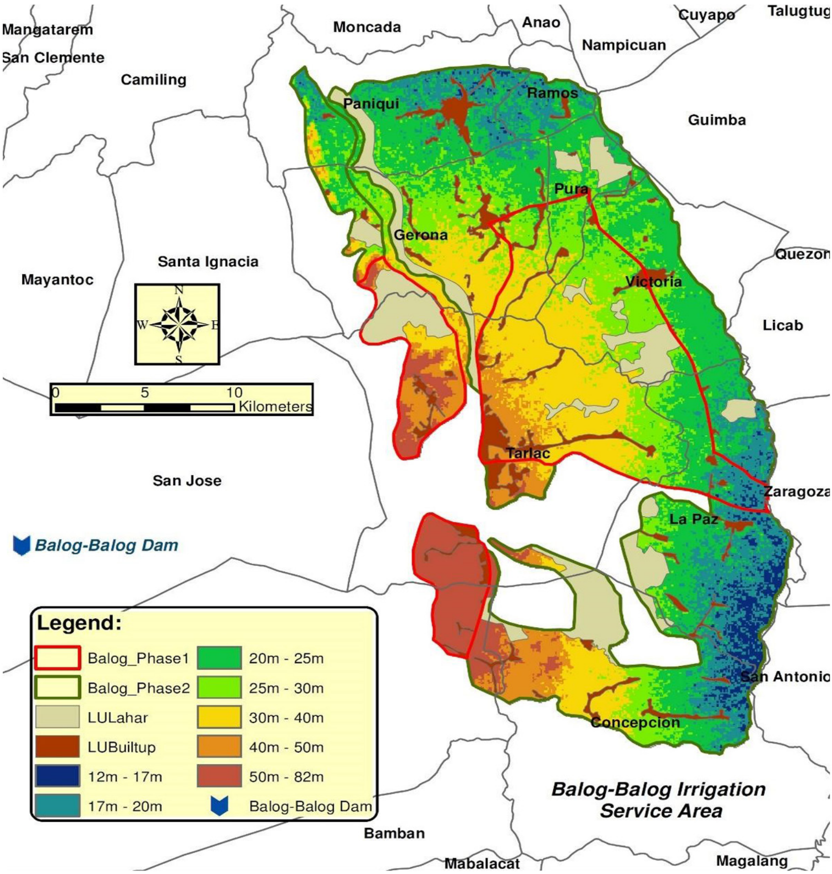
	Angat Reservoir Inflows			Ipo Dam Local Inflows	Bustos Dam Local Inflows	Umiray River Flow Diversions to Angat Reservoir
	Historical Data (1996–2012)	Model Computed (1996–2012)	Model Computed (1974–2013)			
Average	63.01	63.30	65.98	8.72	28.18	15.02
Minimum	0.00	1.68	0.71	0.09	0.31	0.16
Maximum	1526	2309	2988	398	1278	684
Q90%*	4.64	4.78	3.56	0.47	1.52	0.80
Q80%	12.68	8.79	6.97	0.91	2.97	1.58
Q60%	27.99	23.25	20.33	2.66	8.66	4.59
Q40%	46.50	47.11	45.80	6.02	19.53	10.40
Q20%	80.11	89.94	91.91	12.23	39.66	21.08

CMS = cubic meters/second
*Q90% is referred to as the 90-percent dependable flow, which is the amount being equal to or exceeded 90 percent-of-the-time
Source: Tabios (2017)

Pampanga Delta River Irrigation System

The PDRIS was completed around 2002. It has a design service area of 11,540 ha. As shown in Figure 2, the system is divided into four distinct areas: (1) West Area (upper west part) at about 2,980 ha; (2) San Mateo Area (lower west part) at 1,380 ha; (3) Upper East Area at 2,943 ha; and (4) Lower East Area at 4,677 ha.

Figure 2. Pampanga Delta Irrigation System and its physical features

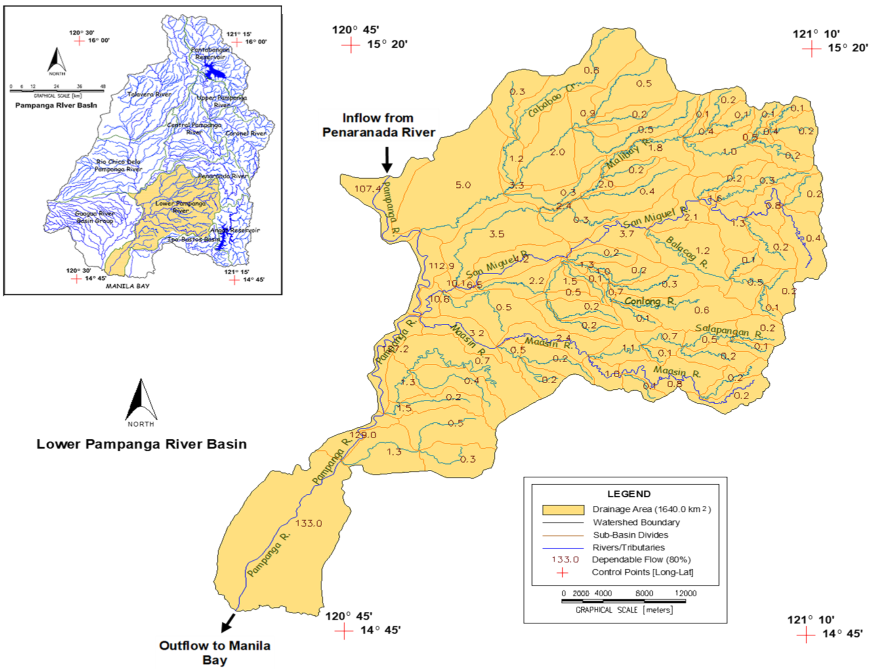


LU = Land use/cover; Balog = Balog-Balog irrigation service areas for Phases 1 and 2 of the project; color codes associated to ground elevations in meters (m).
Source: Tabios and David (2014)

The water source of the PDRIS is the Pampanga River, which is diverted through the Cong Dadong Dam diversion structure. The physical features of Cong Dadong Dam are as follows: (1) the dam elevation is 8.6 meters (m) with a height of 1.3 m; (2) the length is fixed at 850 m plus a movable length of 150 m; (3) a sediment flushing sluice gate with a width of 36.5 m; and (4) the irrigation water intake water level is at 8.5 m with a maximum discharge of 20.18 CMS.

For the design service area of 11,540 ha, the irrigation water supply from the Pampanga River is fairly adequate. It has been computed in this study that the 80-percent dependable flow (Pampanga River flow over 300 days a year) as shown in Figure 3 is 108 CMS; thus, the only constrain is the intake structure of the diversion dam, which has a maximum intake discharge of 20.18 CMS. Similar to AMRIS, for a high end of 0.00167 CMS (1.67 liters/sec) per ha water requirement for paddy rice, the average daily water requirement is about 19.3 CMS for the design area of 11,540 ha.

Figure 3. Long-term dependable (80%) daily flows over the Lower Pampanga River (in m^3/s)



Source: NHRC (2011)

The historical irrigated service areas of PDRIS from 2003 to 2014 during the wet season is about 5,000 ha (about 35% of the design service area of 11,540 ha) and 6,900 ha at maximum during the dry season (about 60% of the design area) (Inocencio 2016).

Based on a geographic information system map of this area, estimates of areas covered according to physical features or land use are as follows: (1) the built-up or urbanized area is about 1,050 ha; (2) areas with fish ponds is about 1,650 ha; (3) areas with an elevation of 8.5 m or higher, which is above intake level at Cong Dadong Dam, is about 2,000 ha; and (4) flood-prone areas during the wet season, which are normally below 3-m elevation, are about 950 ha.

With the above information, the sum of the first three land areas is 4,700 ha while the remaining area that can be irrigated out of 11,540 ha is 6,840 ha. During the wet season, the additional 950 ha that are flood-prone reduce the irrigated area to 5,890 ha. Discussions with NIA personnel during field visits (see next section) yielded further explanations, such as: (1) there are locally elevated paddy areas that cannot be reached by water (by gravity) and therefore require land grading or cutting and (2) downstream water users may not be able to get water due to overallocation or extraction upstream.

Hydraulic modeling of irrigation canal network

Hydraulic model used and the AMRIS and PDRIS canal network

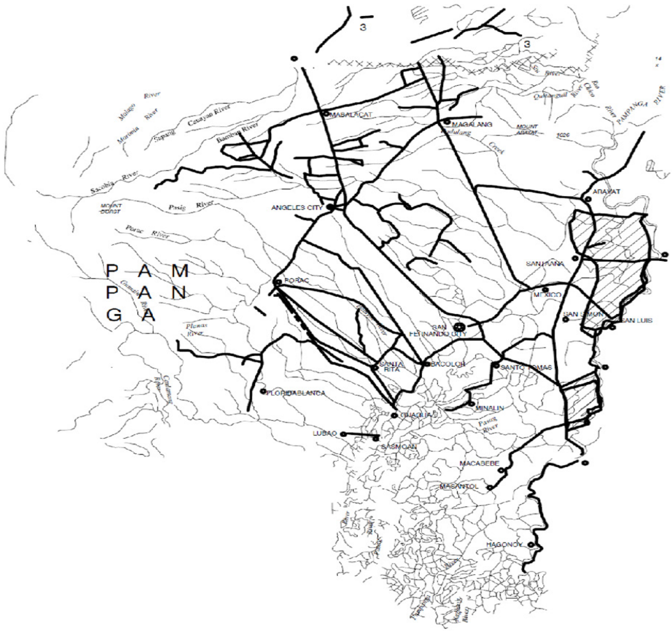
For this study, the unsteady flow model component of the Hydrologic Engineering Center-River Analysis System (HEC-RAS) of the United States (US) Army Corps of Engineers (1995) was utilized to simulate the canal hydraulics of AMRIS with reservoir releases from the Angat Reservoir. The hydraulic model is used to conduct a simulation of the AMRIS operations for different irrigation water inflows as basis for evaluating the ability and reliability of AMRIS to provide irrigation water in the service area. Figure 4 shows the details of the AMRIS irrigation canal layout.

To evaluate the ability and reliability of PDRIS to provide irrigation water in its irrigation area, the unsteady flow model component of the HEC-RAS of the US Army Corps of Engineers (1995) was used. Meanwhile, the Sacramento watershed model was utilized to calculate the inflows of Pampanga River Basin and the water diverted through Cong Dadong Dam. Figure 5 shows the details of the PDRIS irrigation system and the coverage of the Pampanga River Basin watershed model in which the inflow to PDRIS is extracted from the Pampanga River at Cong Dadong Dam diversion structure.

Figure 4. Details of the Angat-Maasim River Irrigation System

Source: NIA Office, San Rafael, Bulacan

Figure 5. Details of the Pampanga Delta Irrigation System (PDRIS) canal layout

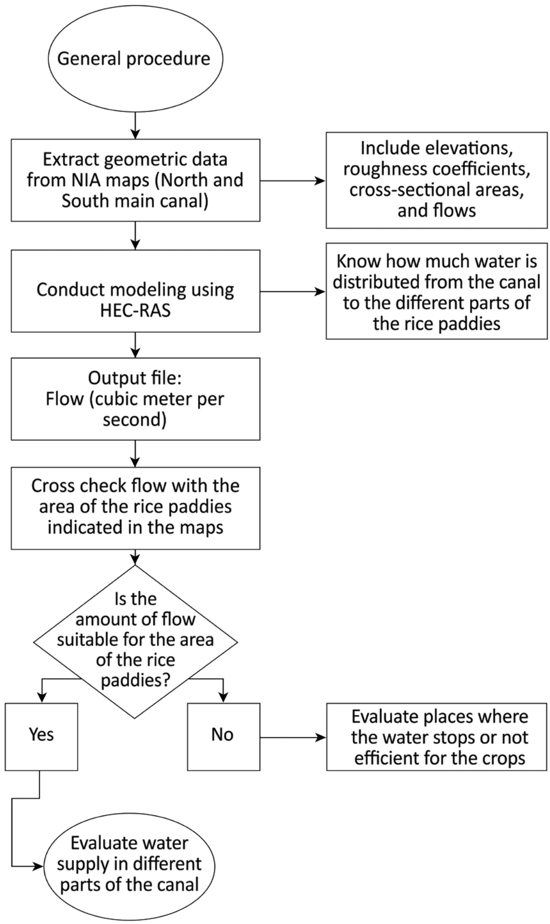


Source: NIA Office, San Rafael, Bulacan

Procedure for hydraulic modeling of irrigation canal network

The steps in the hydraulic modeling of the irrigation canal network are summarized in Figure 6. It starts with the preparation of model geometry data from maps of the canal network provided by NIA. For AMRIS, Figure 7 shows the plan view of the main canal and associated irrigation service sub-areas together with the profile of the

Figure 6. Steps in hydraulic modeling of irrigation canal network

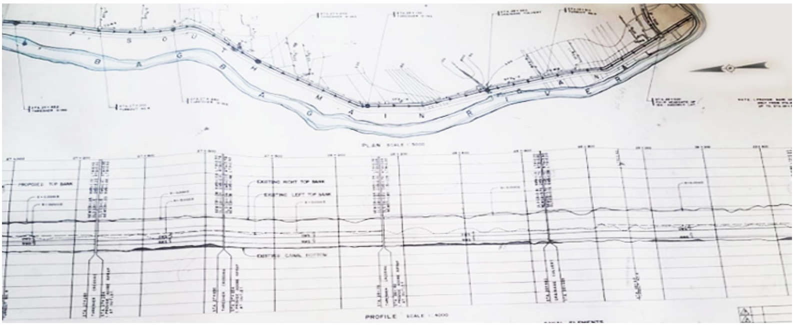


NIA = National Irrigation Administration; HEC-RAS = Hydrologic Engineering Center-River Analysis System
Source: Authors' illustration

canal. These data are needed to create the model geometry of the HEC-RAS model. Figure 7b shows the actual elevations that were recorded by NIA for their plans when they surveyed the area in the 1990s. All data were based on NIA plans, which contain both "actual bottom elevations" and "proposed bottom elevations". The actual bottom elevations were erroneous, as HEC-RAS showed, while the "proposed bottom elevations" were uniform. The actual bottom elevations recorded by NIA at that time

Figure 7. View of irrigation canal network plan and profile data of main canal, including irrigation service sub-areas at pertinent lateral outlets

a. Profile data of main canal



b. Plan view of irrigation canal network

Source: NIA Office, San Rafael, Bulacan

were used, although these elevations were not confirmed in the field. It was assumed that NIA did not perform further maintenance and improvement on the irrigation canals, which would supposedly result in the uniform elevations.

The major boundary conditions in the model are the irrigation water supply from Bustos Dam (upstream inflow) and the water demands calculated based on the irrigation rates according to the wet and dry cropping seasons, which are imposed at pertinent locations along the main canal. In the hydraulic model simulations, it is necessary to check whether the flow demand at each of the irrigation delivery points can be satisfied or not according to the crop water requirements and whether there are areas that can become flooded depending on flow conditions.

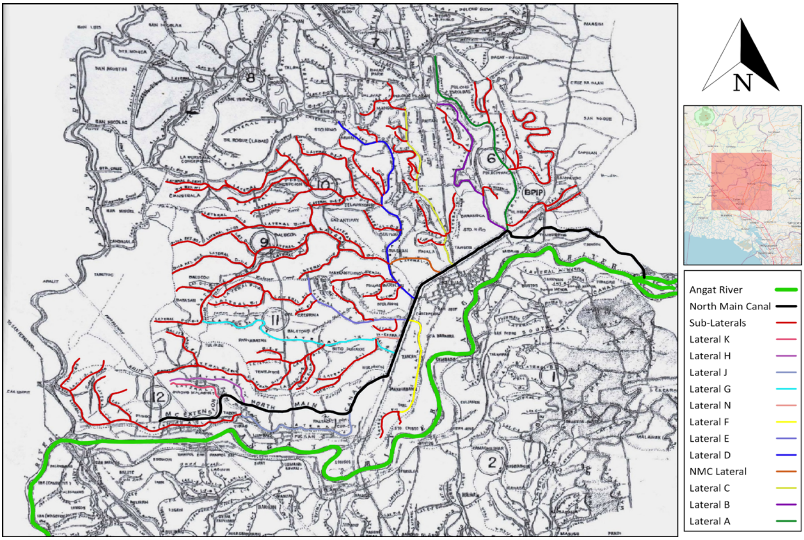
Since there was difficulty (or perhaps unavailability) of channel network geometry data for PDRIS, it was decided that only the AMRIS and, in particular, its north main canal (NMC) be subjected to hydraulic modeling and simulation. The irrigation service area associated with the NMC portion of AMRIS is about 12,200 ha, which is about half of the irrigated area normally covered during the dry season.

Discussion of results of hydraulic simulation of AMRIS canal network

The hydraulic simulation was only conducted for the irrigation service area of AMRIS associated with the NMC covering an area of 12,200 ha (Figure 8). The assumptions are as follows: (1) flow comes only from the upstream section at the north outlet of Bustos Dam, which is equal to 14.6, 18.0, and 26.65 CMS (m^3/s); (2) the upstream boundary condition is subcritical flow and downstream boundary condition is critical flow; and (3) the actual bottom and top river elevations were considered so that the planned elevations varied with the actual elevations due to erosion and parts of the river that need to be scoured. Concerning the three sets of inflows, the 18.0 CMS inflow is based on a typical design irrigation water requirement of 1.5 lps/ha (0.0015 CMS/ha). Meanwhile, 14.6 and 26.65 CMS represent the water requirements at the low end of 1.2 lps/ha (0.0012 CMS/ha) and the high end of 2.2 lps/ha (0.0022 CMS/ha), respectively. A sample graphical display of the HEC-RAS computer model results in a particular lateral canal of AMRIS is shown in Figure 9.

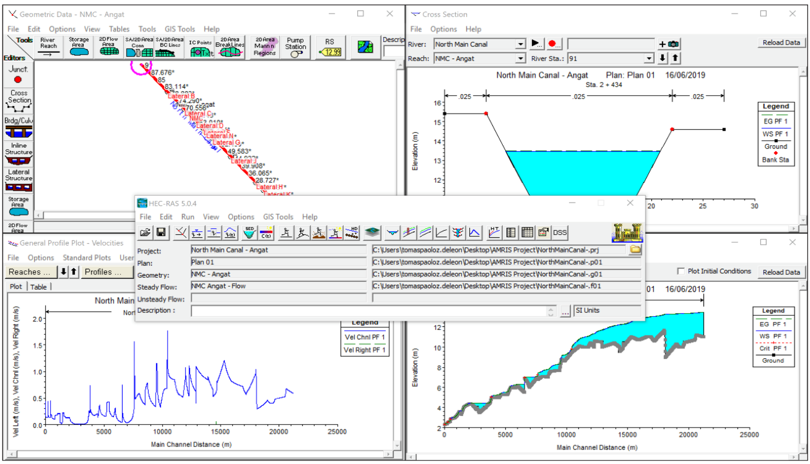
Tables 3, 4, and 5 show the simulation results for inflows to NMC at 14.6, 18.0, and 26.65 CMS, respectively. Figures 10 and 11, 12 and 13, as well as 14 and 15, are the resulting water elevations and water depths at take-off to the laterals along the NMC, respectively, for the three sets of inflows. In the three tables, the major results shown are the differences of bank elevation and water surface at NMC highlighted in green if positive and red if negative. Negative differences indicate that the water at these take-off

Figure 8. North main canal (NMC) and lateral canals of AMRIS



AMRIS = Angat-Maasim River Irrigation System
Note: Inflow point is at Bustos Dam along Angat River (located on middle, left portion of the figure)
Source: Authors' processed/developed map

Figure 9. Sample graphical display of HEC-RAS computer model results in a particular lateral canal of the of AMRIS canal network



HEC-RAS = Hydrologic Engineering Center-River Analysis System; AMRIS = Angat-Maasim River Irrigation System
Source: Authors' documentation

points (from main canal to lateral canal) is overflowing and perhaps simply passed through wasted downstream of the irrigation service area. Also shown are the water depths at NMC (main canal) highlighted in green if above 2.5 m, yellow if between 1.0 m and 2.5 m, and red if below 1.0 m. The lower the water depth relative to the lateral depth, the higher lift is required to move from the main canal to the lateral canal.

From these results, one may ask how much water is required to sufficiently and uniformly irrigate the target service area, which is 12,200 ha in this case. NIA typically sets its design irrigation requirements between 1.2 and 1.8 lps/ha (or 0.0012 and 0.0018 CMS/ha) and at an average of 1.5 lps/ha. As shown in the results

Table 3. Results of hydraulic simulation for AMRIS north main canal with inflow of 14.6 CMS[1]

Lateral	Stations	14.6 CMS				
		Water Surface	Bank Elevation	Difference	Lateral Depth	Water Depth
Grand total A	Sta. 6 + 480	12.81	14.3	1.49	3.7	2.21
Grand total B	Sta. 6 + 480	12.81	14.3	1.49	3.7	2.21
Grand total C	Sta. 8 + 987	11.95	12.7	0.75	2.6	1.85
Grand total NMC	Sta. 9 + 770	11.78	12.9	1.12	2.5	1.38
Grand total D	Sta. 10 + 780	11.22	13.0	1.78	3.0	1.22
Grand total E	Sta. 11 + 715	10.61	12.6	1.99	2.2	0.21
Grand total F	Sta. 11 + 890	10.37	12.5	2.13	2.5	0.37
Grand total N	Sta. 12 + 264	10.33	12.4	2.07	2.4	0.33
Grand total G	Sta. 13 + 240	9.52	12.0	2.48	2.5	0.02
Grand total J	Sta. 16 + 048	7.03	9.0	1.97	2.0	0.03
Grand total H	Sta. 20 + 080	4.92	6.1	1.18	1.2	0.02
Grand total K	Sta. 21 + 248	4.46	5.0	0.54	1.0	0.46

AMRIS = Angat - Maasim River Irrigation System; NMC = north main canal; CMS = cubic meters per second
Source: Authors' computation

[1] In Tables 3, 4, and 5, the difference of bank elevation and water surface at NMC is green if positive while red if negative, thus overflowing. For the water depth at NMC (main canal): green if above 2.5 m, yellow if between 1 m to 2.5 m, and red if below 1 m. The lower the water depth relative to the lateral depth, the higher lift is required to move from main canal to lateral canal.

here, for inflow cases (delivered to the NMC) of 14.6 CMS and 18 CMS (associated with 1.2 and 1.5 lps/ha deliveries, respectively, for a 12,2000-ha area), both Tables 3 and 4 show that the water depths (last column) in the main canal relative to the laterals are relatively low that it will require some pumping to transfer water from the main canal to the lateral canal. On the other hand, the inflow of 26.65 CMS required to sufficiently and uniformly supply the target irrigation service area, which is equivalent to a requirement of 2.2 lps/ha for 12,200 ha, is quite wasteful and excessive. The result here shows that not all of the 12,200 ha of AMRIS can be sufficiently and uniformly irrigated unless there is excessive water applied at 2.2 lps/ha. This can be attributed to several factors. The major factor is that certain channel sections have reduced capacities (i.e., shallowing canal) due to sedimentation.

Table 4. Results of hydraulic simulation for AMRIS north main canal with inflow of 18.0 CMS

Lateral	Stations	18 CMS				
		Water Surface	Bank Elevation	Difference	Lateral Depth	Water Depth
Grand total A	Sta. 6 + 480	13.05	14.3	1.25	3.7	2.45
Grand total B	Sta. 6 + 480	13.05	14.3	1.25	3.7	2.45
Grand total C	Sta. 8 + 987	12.26	12.7	0.44	2.6	2.16
Grand total NMC	Sta. 9 + 770	12.09	12.9	0.81	2.5	1.69
Grand total D	Sta. 10 + 780	11.68	13.0	1.32	3.0	1.68
Grand total E	Sta. 11 + 715	11.12	12.6	1.48	2.2	0.72
Grand total F	Sta. 11 + 890	11.05	12.5	1.45	2.5	1.05
Grand total N	Sta. 12 + 264	10.95	12.4	1.45	2.4	0.95
Grand total G	Sta. 13 + 240	9.83	12.0	2.17	2.5	0.33
Grand total J	Sta. 16 + 048	7.12	9.0	1.88	2.0	0.12
Grand total H	Sta. 20 + 080	4.93	6.1	1.17	1.2	0.03
Grand total K	Sta. 21 + 248	4.47	5.0	0.53	1.0	0.47

AMRIS = Angat - Maasim River Irrigation System; NMC = north main canal; CMS = cubic meters per second
Source: Authors' computation

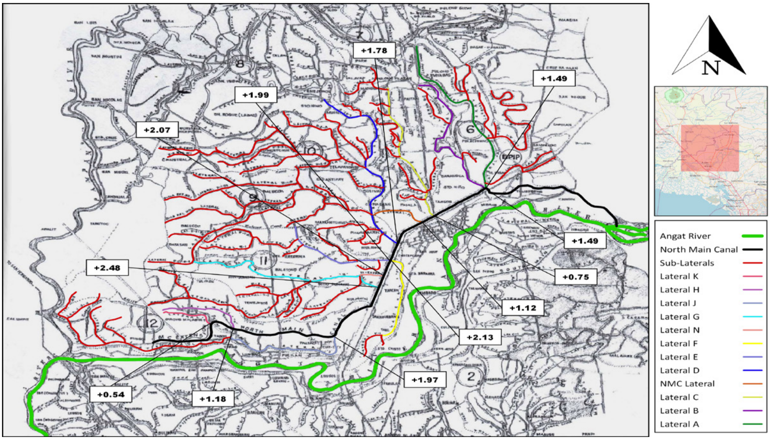
Consequently, channel gradients or slopes of the channel network are reduced, resulting in the inability to effectively deliver water over the entire area. Thus, the inability to efficiently move water from the main canal to the lateral canal even at certain take-off points in the channel network leads to difficulty in proper allocation and uniformity of water delivery to the target irrigation service areas. Periodic appraisal or assessment—every three years or as deemed necessary—of the efficiency of irrigation water delivery operations as illustrated here through hydraulic model simulations must be conducted for proper maintenance and upgrade of irrigation facility if needed.

Table 5. Results of hydraulic simulation for AMRIS north main canal with inflow of 26.65 CMS

Lateral	Stations	26.648 CMS (Original)				
		Water Surface	Bank Elevation	Difference	Lateral Depth	Water Depth
Grand total A	Sta. 6 + 480	13.61	14.3	0.69	3.7	3.01
Grand total B	Sta. 6 + 480	13.61	14.3	0.69	3.7	3.01
Grand total C	Sta. 8 + 987	12.91	12.7	-0.21	2.6	2.81
Grand total NMC	Sta. 9 + 770	12.77	12.9	0.13	2.5	2.37
Grand total D	Sta. 10 + 780	12.44	13.0	0.56	3.0	2.44
Grand total E	Sta. 11 + 715	11.91	12.6	0.69	2.2	1.51
Grand total F	Sta. 11 + 890	11.84	12.5	0.66	2.5	1.84
Grand total N	Sta. 12 + 264	11.68	12.4	0.72	2.4	1.68
Grand total G	Sta. 13 + 240	10.59	12.0	1.41	2.5	1.09
Grand total J	Sta. 16 + 048	8.71	9.0	0.29	2.0	1.71
Grand total H	Sta. 20 + 080	6.40	6.1	-0.30	1.2	1.50
Grand total K	Sta. 21 + 248	6.12	5.0	-1.12	1.0	2.12

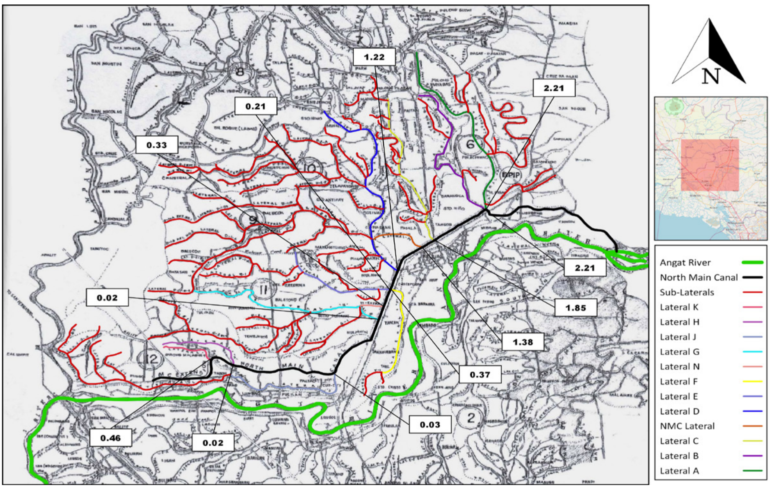
AMRIS = Angat - Maasim River Irrigation System; NMC = north main canal; CMS = cubic meters per second
Source: Authors' computation

Figure 10. Differences of simulated water elevations and bank elevations at AMRIS north main canal with inflow of 14.6 CMS



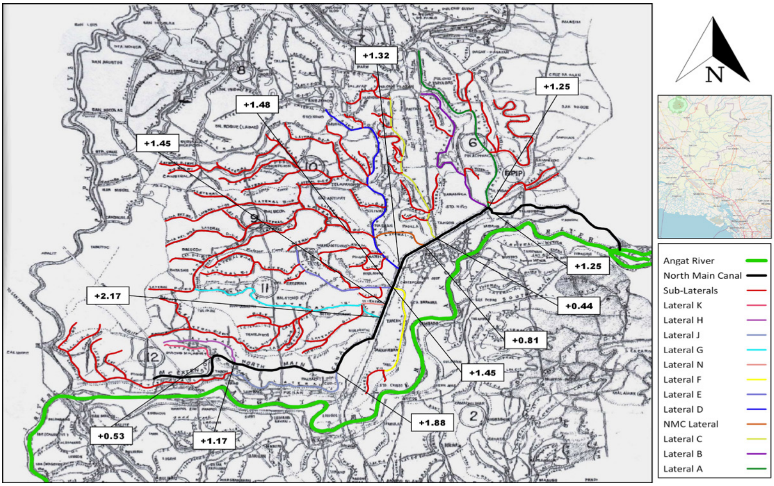
AMRIS = Angat-Maasim River Irrigation System; CMS = cubic meters/second
Source: Authors' processed/developed map

Figure 11. Simulated water depths at AMRIS north main canal with inflow of 14.6 CMS



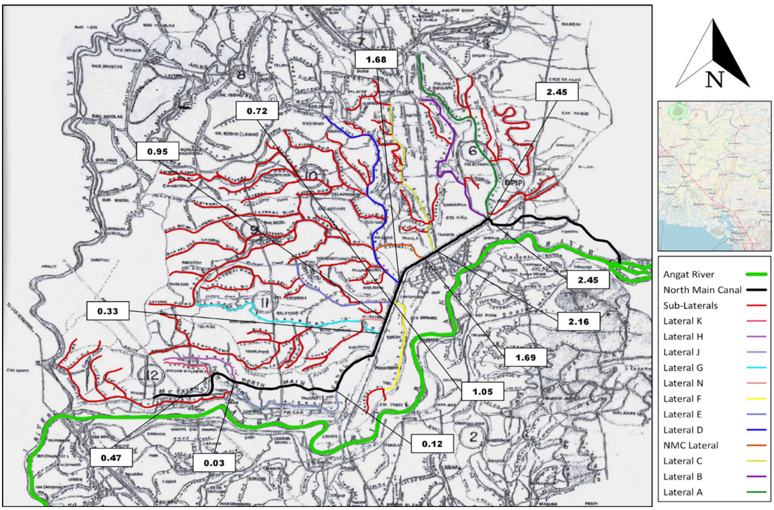
AMRIS = Angat-Maasim River Irrigation System; CMS = cubic meters/second
Source: Authors' processed/developed map

Figure 12. Differences of simulated water elevations and bank elevations at AMRIS north main canal with inflow of 18.0 CMS



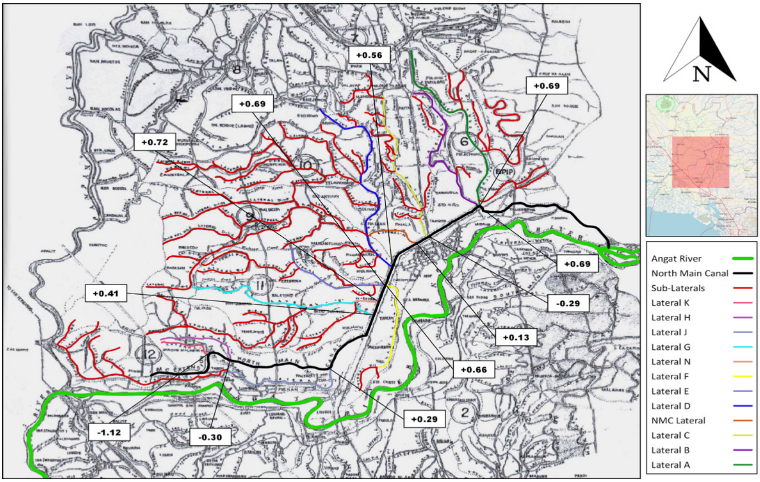
AMRIS = Angat-Maasim River Irrigation System; CMS = cubic meters/second
Source: Authors' processed/developed map

Figure 13. Simulated water depths at AMRIS North main canal with inflow of 18.0 CMS



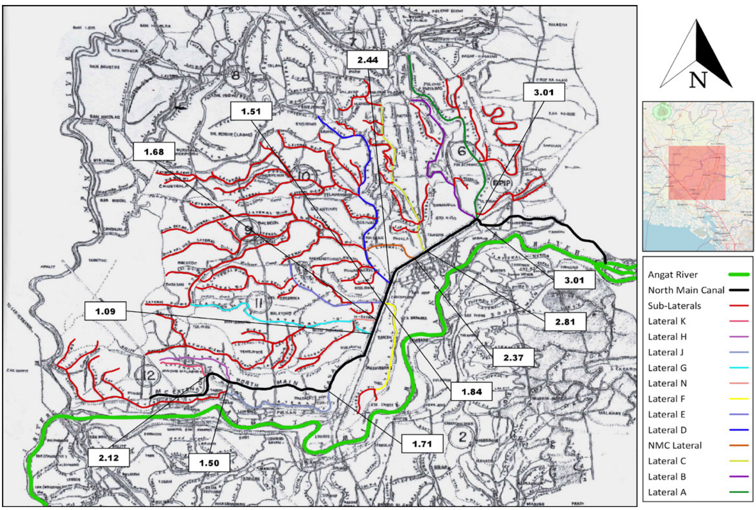
AMRIS = Angat-Maasim River Irrigation System; CMS = cubic meters/second
Source: Authors' processed/developed map

Figure 14. Differences of simulated water elevations and bank elevations at AMRIS north main canal with inflow of 26.65 CMS



AMRIS = Angat-Maasim River Irrigation System; CMS = cubic meters/second
Source: Authors' processed/developed map

Figure 15. Simulated water depths at North main canal with inflow of 26.65 CMS



AMRIS = Angat-Maasim River Irrigation System; CMS = cubic meters/second
Source: Authors' processed/developed map

Summary and recommendations

Findings

1. The original design irrigation area of 31,400 ha of NIA-AMRIS has now reduced to about 17,500 ha during the wet cropping season and 24,000 ha during the dry cropping season. This reduction is due to urbanization, lowered height of Bustos Dam that renders certain areas unfeasible to be irrigated, and flooding in some areas during the wet season. This study urged the NWRB to reduce the Angat water allocation to irrigation from 22 to 36 CMS, wherein the difference of 15 CMS is unused water of NIA-AMRIS and was re-allocated to MWSS for domestic water supply (referred conditional water right of MWSS since 1988).
2. With the above changes in physical conditions that limit the irrigation service area of AMRIS and together with the reduced Angat water allocation to irrigation, it should be recognized and accepted that this is the current status of AMRIS as an irrigation system. However, there is still the complicating issue of competing water use with hydropower generation since the 200-megawatt (MW) plant of the San Miguel Corporation and Korean Water joint venture (SMC/K-Water JV) is through the irrigation water release gates to NIA-AMRIS versus the 18-MW hydropower plant (also owned by SMW/K-Water JV). With the 28-MW hydropower plant owned by MWSS, a total only of 46 MW is through the domestic water release gates to MWSS (Metro Manila water supply).
3. The PDRIS system has likewise only realized half of the target irrigation service area from the originally planned service area of 11,540 ha due to urbanization and flooding problems, as well as operational issues with Cong Dadong Dam as described below. In the last few years, PDRIS only irrigated about 7,000 ha during the dry cropping season and 5,000 ha during the wet cropping season. While the irrigation water available from Pampanga River through the Cong Dadong Dam (diversion structure) is not limiting, the diversion dam height of 8.6 m is not high enough, so it is unable to irrigate over 2,000 ha of the target irrigation service area.
4. Both AMRIS and PDRIS have reduced irrigation service area from their original plan due to urbanization and flooding problems, as well as technical issues. In the case of urbanization in the AMRIS area, a significant portion of the agricultural land was converted for industrial and/or residential

uses being near to Metro Manila. Urbanization has also taken a toll on the agricultural areas in PDRIS being adjacent to the growing metropolis development of New Clark City and San Fernando City of Pampanga. Concerning flooding problems, both AMRIS and PDRIS have low-lying areas in their lower ends being in the vicinity of the Pampanga Delta. There is not much that can be done to encourage the rice farmers to plant rice during the wet season.

5. In this study, the AMRIS irrigation canal network was thoroughly investigated through hydraulic modeling and simulation. The simulation showed that there are areas that may not be irrigated at all. Since most canals had reduced capacities due to sedimentation, consequently, the channel slopes or gradients needed for gravity flow are no longer efficient. Thus, there is a need to develop an effective canal maintenance scheme of the AMRIS and also to reassess the operation schemes for efficient canal operations.

Recommendations

First, the dry and wet cropping season schedules should be revisited to maximize the conjunctive use of the Angat watershed streamflow (through the reservoir) with the seasonality of rainfall to minimize its competing use with Metro Manila's water supply demand, which is fixed and uniform all year round. The irrigation water supply to AMRIS from Angat Reservoir (including the contribution from Bustos watershed) may be curtailed due to episodic occurrences of critical dry years associated with Pacific Equatorial anomalies such as El Niño. It can also be constrained due to competing water uses with domestic water supply, which has a higher release policy during low Angat Reservoir water levels or equivalently, water shortage conditions. Although the AMRIS irrigation water demand has reduced in the last 20 years or so, the irrigation water requirement of AMRIS is still significant, particularly during the dry cropping season from December to March, which coincides with the onset of the dry season when the Angat Reservoir should be filling up or saving water for the dry months of April and May.

Second, consider raising the height of the diversion structure of PDRIS. Water supply to PDRIS is not at all limiting since there is more than enough water flowing from the Pampanga River at the point of diversion. The only constraint is that the diversion dam elevation is not high enough to cover the entire design service area of PDRIS. As such, over 2,000 ha cannot be irrigated. The economics of this recommendation should be carefully studied.

Third, for AMRIS, it is worthwhile to properly mitigate the sedimentation problem and also design the canal maintenance with dredging or rehabilitation optimally, satisfying both the slope and canal width/depth, including alignment requirements. Canal network simulation shows that there are areas in AMRIS that may not at all be irrigated because of canal shallowing due to sedimentation. Consequently, the channel slopes needed for gravity flow are no longer efficient.

Fourth, conduct periodic operational studies once the system is already built. Such studies are crucial to make adjustments based on actual observations and experiences. Likewise, periodic assessment of the efficiency of irrigation water delivery operations should also be made for proper maintenance and upgrade of irrigation facilities, if needed. Hydraulic model simulations should be conducted for proper maintenance and upgrade of irrigation facility, as this type of analysis and operations studies can only be done through canal network model simulation.

Fifth, reassess the details of operations under extreme conditions. A review of the feasibility studies (reports) of these irrigation systems showed the absence of detailed technical assessment of performance of the irrigation systems with regard to reliability of water sources (in time and space), such as simulation of the hydraulic performance of canal system under “dry year” or under “flooding” conditions. Hence, should such conditions arise, there is limited time to prepare and apply countermeasures. Detailed simulation analysis, on the other hand, can support planning toward improved resilience of irrigation systems.

Chapter 5

Irrigation Water Governance

Agnes C. Rola, Therese R. Olviga, Francis John F. Faderogao, and Chrislyn Joanna P. Faulmino

Introduction

Agriculture is the highest consumer of water, accounting for 84 percent of total water use in Asia and 72 percent globally (David 2003). Ironically, agriculture generates the lowest economic return per unit of water (Turral et al. 2011). The Comprehensive Assessment of Water Management in Agriculture asserted that improvement in water use in agriculture is crucial to meet the challenges of increasing pressure on water resources due to rising water demand. A looming water crisis may be averted if reforms in the ways water is managed and governed are put in place (FAO 2012).

In the Philippines, accelerated irrigation development significantly contributed to rice self-sufficiency/rice surplus in 1968 and 1977. However, over the years, irrigation development has faced many technical and institutional constraints. The poor performance of irrigation systems has been attributed to several factors including inadequate database for planning, inadequate institutional capacity and mechanisms for development, design mistakes, poor quality of construction, inadequate and fragmented support services for irrigated agriculture, and complexity of operation, such as socioeconomic and institutional management (David 2003). All of these factors relate to water governance.

An emerging lesson is the need for a governance regime that connects various actors and decisionmakers in setting rules for managing water resources to sustain the desired state. Irrigation can no longer be addressed in isolation, implying coordinated and integrated water resource planning and management among institutions. Implementation of policies (e.g., devolution to local government units [LGUs] and irrigators' associations [IAs], free irrigation versus cost recovery-schemes) at the national irrigation system (NIS) and communal irrigation system (CIS) levels has to be evaluated to see what works and what does not work so that appropriate policy reforms can be formulated.

This chapter discusses the institutional arrangements in irrigation water governance in the Philippines. Institutional evaluation is conducted on the stages of the project cycle, namely, project identification; project preparation, appraisal, and selection; project implementation, operations and maintenance; and monitoring and evaluation.

1. For the planning and design stage, the chapter analyzes the institutional capacity of the project proponent (selected NIS or CIS) in arriving at an appropriate, science-based, and economically viable design of an irrigation project; describes the institutional capacity of the project decision-making system in conducting an independent and competent appraisal of proposed irrigation projects; and recommends strategies for addressing institutional capacity gaps and delineation of roles of the Department of Environment and Natural Resources (DENR), Department of Agriculture (DA), National Irrigation Administration (NIA), IAs, and LGUs, and in ensuring proper coordination across agencies and meaningful consultations with end-users.
2. For the implementation stage, the chapter assesses the institutional capacity of NIA, LGUs, and Bureau of Soils and Water Management (BSWM) in implementing irrigation projects, including timeliness and transparency in procurement, and delineates the proper role, if any, of farmers in project implementation, including right-of-way (ROW) issues.

3. For the operations and maintenance (O&M) stage, the discussions focus on assessing the capacity of IAs, NIA, and LGUs in terms of O&M, particularly in coming up with recommendations for the O&M strategy to address capacity gaps of IAs, cost recovery, and the perennial problems of siltation and inadequate water supply.
4. For the monitoring and evaluation (M&E) stage, the chapter discusses ways to institutionalize an efficient M&E system covering NIS and CIS, ensuring the timely collection of proper information that can be used for operations and planning.

Irrigation water governance in the Philippines

Institutional arrangements

At least 13 national agencies play a part in irrigation water governance (Table 1). The agencies are grouped into four: (i) irrigation implementation, (ii) other agriculture and natural resources agencies, (iii) oversight agencies, and (iv) other agencies competing in the use of water.

Aside from implementing large-scale irrigation projects, NIA is also concerned with water use and watershed management. Ideally, NIA should coordinate with the DENR in watershed management. Currently, however, no personnel is assigned to tasks related to this function due to rationalization. Moreover, no clear institutional link exists between NIA and DENR with respect to watershed management (Rola and Elazegui 2016), a noncompliance to the Agriculture and Fisheries Modernization Act (AFMA).

Water governance in NIA

The project cycle

The project cycle starts with project identification. Potential irrigation project identification is recommended by technical specialists or farmers/irrigators' associations or local politicians. Preliminary assessments on irrigation potential are conducted before detailed planning of the project is undertaken. This assessment is done at the regional irrigation office (RIO) level for smaller projects and at the RDC level for big-ticket projects. For small CIS projects, irrigation project proposals emanate from the LGU while the IAs prepare the proposal for endorsement by the

Table 1. Institutions involved in irrigation water governance in the Philippines

Group	Agency	Responsibilities
Offices involved in Irrigation implementation	National Irrigation Administration (NIA)	Administers irrigation development in the Philippines
	Bureau of Soils and Water Management	Builds small-scale irrigation projects
Agriculture and natural resources agencies involved in irrigation	Department of Agrarian Reform	Invests in irrigation systems located in agrarian reform communities
	National Water Resources Board	Issues water permits for all irrigation systems
	Forest Management Bureau	Implements joint memorandum of agreement with NIA for watershed-level activities.
	Department of Environment and Natural Resources-River Basin Control Office	Monitors river basin management plans from which irrigation systems obtain water
	National Power Corporation	Sits as a member of the NIA board; comanages with the NIA the Pantabangan and Magat watersheds and water releases
	Department of the Interior and Local Government	Supervises and does capacity building for small impounding systems. It also ensures that local government units connect with the provincial development plans (PDP) and that the comprehensive land-use plan and PDP central plans are linked.
Oversight agencies	National Economic and Development Authority (NEDA)	Approves big-ticket projects through its Investment Coordination Committee. Its regional development council reviews and endorses smaller projects to the NIA Central Office.
	Governance Commission for Government-Owned and Controlled Corporations	Coordinates and monitors the operations of government-owned and controlled corporations
	Department of Budget and Management	Oversees the budget together with the Department of Finance, Land Bank of the Philippines, and NEDA
Agencies competing in the use of water	Local Water Utilities Administration	Connects with NIA for domestic water supply needs when the water source permit is owned by NIA
	Metropolitan Waterworks and Sewerage System	Coordinates with NIA during water crises, when irrigation water use is second only to domestic water use

Source: Rola et al. (2019)

Provincial Development Council to the RDC. On the other hand, the regional offices of NEDA provide technical support to the Investment Coordination Committee (ICC) and the NEDA Board in project planning and design of big-ticket NIS projects.

Project planning includes environmental and social assessments. Once accepted, the technical aspects, such as structural design and water management, are investigated through feasibility studies, which are usually conducted by NIA or as contracted by NIA. Some projects bundle appraisal of feasibility with the design stage while others treat this as an independent phase. In either case, a critical review is undertaken before large investments are poured into a project.

The RDC endorses the acceptance of projects below PHP 200 million while projects above this threshold are submitted to the ICC of the NEDA for approval. The implementation of approved projects entails procurement and construction of facilities, usually supervised by NIA with oversight from DBM and the NEDA regional office where the project is to be undertaken. Ideally, this has high coordination and participation of farmers and, when applicable, other stakeholders at the provincial level. Although not explicitly identified in many basic project cycles, irrigation development includes system management and O&M following the formation of irrigation facilities. NIS is managed by NIA and turned over to the IAs once the irrigation management transfer (IMT) is successful. In cases of CIS, IMT takes place with IAs at the forefront. Lastly, M&E should also be done as part of the irrigation process.

For big-ticket projects, NEDA, together with DILG and DBM, monitors project implementation through the Regional Project Monitoring Committee (RPMC), a special committee under the RDC that monitors expenditures vis-à-vis the progress in construction. The monitoring is carried out by the RPMC quarterly, with a threshold for monitoring set at PHP 10 million. For appraisal purposes, the RIO conducts the evaluation, then sends its irrigation reports to the Public Investment Staff of NEDA. These reports contain progress of indicators and impacts of the projects. Local monitoring teams at the provincial and municipal levels are also established, with NEDA providing training for them.

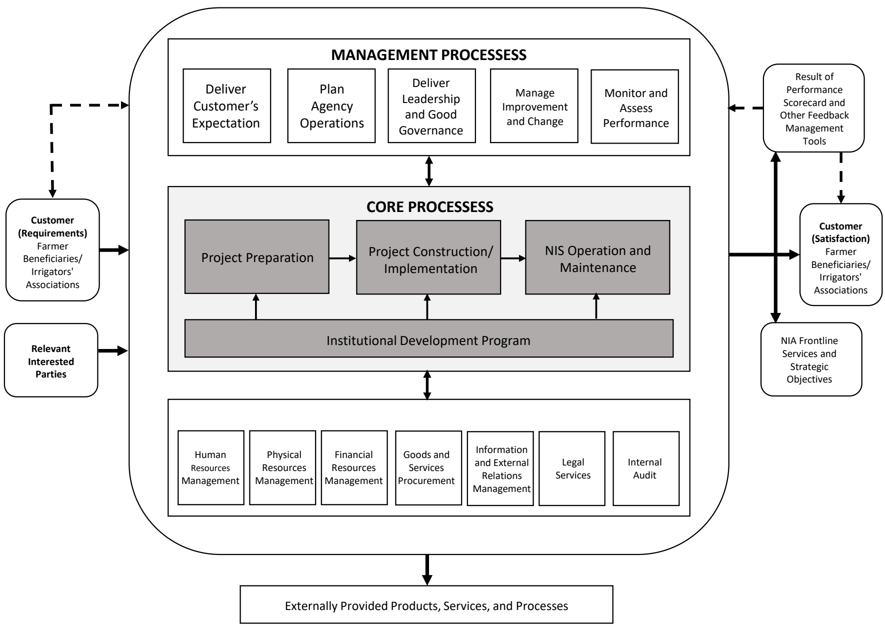
Monitoring and evaluation of the projects reveal areas for improvement that may be specific for the project or applicable to managing irrigation projects in general. Crucial to this stage is the sufficiency and quality of data collected for a comprehensive review of the project cycle processes (Inocencio et al. 2013; Rai et al. 2017).

The responsibilities of other national agencies also affect the development cycle management of the irrigation systems. For instance, delays in the decision of

NEDA and delays in fund release by DBM will potentially affect the performance of NIA, in general.

NIA's Service Process Model (Figure 1) shows irrigation project management as the core process of the institution and is broadly subdivided into three major processes: project preparation, project construction/implementation, and NIS operation and maintenance. There is no provision for M&E, except in the management processes that monitor and assess performance mostly of the IAs. System performance is monitored at the region and irrigation management office (IMO) levels, but not indicated in the Service Process Model. All core processes are supplemented by NIA's Institutional Development Program (IDP) geared toward organizing IAs and building their capacity to partially or fully manage irrigation systems under the irrigation management transfer program for NIS or system turnover program for CIS. The service processes cover the central, regional, and IMOs of NIA.

Figure 1. Service process model of the National Irrigation Administration



Source: NIA (2018)

Activities

The activities and corresponding responsible units per core process of the NIA are summarized in Table 2. Responsible units for project preparation are the Central Office Engineering Department, RIO Engineering and Operations Division, and IMO Engineering Section. The same offices are responsible for the construction of irrigation systems. However, several departments within the CO are responsible for the O&M of NIS. The IMO has a dedicated O&M Section for NIS. The Institutional Development Division (IDD) takes care of the institutional development programs, mostly on the organization and capacity building of the NIS IAs. The CIS IAs are, by law, to be supervised by the LGUs. Thus, NIA does not reflect this function. In reality, NIA IDD renders technical support to the CIS IAs.

Table 2. Irrigation project management activities of NIA and responsible units

Phase	Activity	Responsible Units
Project preparation	Project Planning • Project identification • Project investigation/validation • Project design studies • Plan formulation • Feasibility report • Project authorization Project Detailed Engineering Design • Preparation of conceptual designs • Determination of project feasibility Considering: - Surveys and mapping - Hydrology - Geology - Agronomy - Irrigation - Drainage - Economic - Watershed management and environmental study Project Procurement • Program of works • Project procurement management plan • Annual procurement plan	• CO-Engineering Department • RIO-Engineering and Operations Division • IMO-Engineering Section

Table 2. Continued

Phase	Activity	Responsible Units
Construction	• Construction planning and scheduling • Contract administration • Project evaluation and monitoring (Construction Management Division follows the Implementing Rules and Regulations of Republic Act 9184, Commission on Audit, and office policies and foreign financing procurement guidelines)	• CO-Engineering Department • RIO-Engineering and Operations Division • IMO-Engineering Section
O&M	• Water delivery • Irrigation service fees collection • Repair and improvement - Irrigation facilities - Drainage facilities - O&M equipment	• CO-System Management Division under the Operations Department • CO-Irrigation Engineering Center under the Operations Department • CO-Equipment Management Division under the Operations Department • RIO-Engineering and Operations Division • IMO-Operation and Maintenance Section
Institutional Development Program	• Organization of irrigators' associations (IAs) • Capacity building of IAs	• Institutional Development Division under the Operations Department but with supervision from the Engineering office on oversight functions on irrigation projects.

NIA = National Irrigation Administration; O&M = operations and maitenance; CO = central office; RIO = regional irrigation office; IMO = irrigation management office
Source: NIA (2018)

In a more detailed work plan, NIA presents its activities per phase for NIS and CIS (Table 3). It can be observed that because farmers are involved, CIS projects also entail more activities and actors, particularly in the preconstruction and construction phases. The project cycle is not complete in the absence of an M&E function within the core activities. It should also be noted that CIS IAs are organized during the preconstruction phase while NIS IAs are organized after the construction phase. Meanwhile, monitoring after the O&M, which refers to the performance of the irrigation system, is not listed within the core activity of NIA.

Table 3. Project management activities of NIA in NIS and CIS

NIS	Duration (NIS)	CIS	Duration (CIS)
Phase 1 – Identification, Investigation, and Selection Phase			
Project identification Selection and evaluation		**Project identification Selection and evaluation**	
• Pre-engineering study -Gathering of climatic data -Topographic survey -Date gathering for project profile	1 month	• Pre-engineering study -Gathering of climatic data -Topographic survey -Date gathering for project profile	
• Feasibility study and detailed engineering design -Planning and design -Surveys and mapping -Hydrology -Geology -Agronomy -Irrigation -Drainage -Economic -Watershed management and environmental study	6–8 months	• Feasibility study -Hydrology -Geology -Agriculture and land resources -Economic and financial analysis -Environmental impact assessment • Detailed engineering design -Contract document and technical specifications -Derivation of unit cost estimates -Design plans and computations -Survey mapping	6 weeks
Phase 2 – Preconstruction Phase			
• Preconstruction works -Row requisition and acquisition -Preconstruction survey -Construction of project facilities and access road to the dam site		• Preconstruction activities -Right-of-way -Survey works -Dam and project facilities investigation -Detailed design -Project development presentation -Plans and estimates preparation -Detailed survey -Paddy mapping parcellary survey -Working committee formation -Farmers mobilization -Planning and formal reflection sessions -By-laws (By-Laws Committee) dissemination and ratification -Regional and provincial orientations -Community IAs integration -SEC registration of IAs (IA Registration Committee)	

Table 3. Continued

NIS	Duration (NIS)	CIS	Duration (CIS)
		-Water application preparation and submission of (Water Permit Committee) -POW preparation -POW presentation to IA - POW submission for approval -Legal requirements completion -Right-of-way negotiation (ROW Committee) -Construction working committee mobilization	
• Detailed engineering design		• Dissemination and signing of MOA -Construction reconciliation workshop	
• Environmental compliance certificate • Geologic exploration • Procurement		• Preparation and submission of certification for project construction -IA viability evaluation	
Phase 3 – Construction Phase			
• Construction of diversion works		• Procurement and delivery of construction materials -Receiving and recording delivered materials	
• Construction of irrigation facilities -Canalization -Canal structures -Drainage canal -Drainage structures -Service road -On-farm activities		• Moving in of manpower and equipment -Condition of equipment checking by IAs -Bodega and bunkhouse construction -Manpower and locally available materials provision by IAs	
• Construction of project facilities -IA office -Gatekeepers' quarter		• Construction of other major structures -Diversion works construction -Canal structures construction	
		• Preparation of FFCC -System turnover -Physical and financial reconciliation review -Repayment scheme approval	

Table 3. Continued

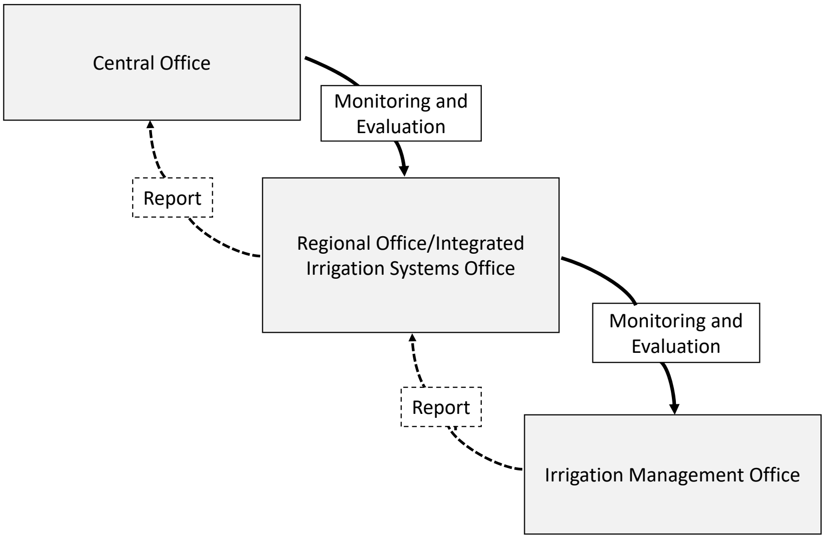
NIS	Duration (NIS)	CIS	Duration (CIS)
Phase 4 – Operations and Maintenance Phase			
• Conduct of training once the IAs are organized and when the IAs need training		• Assessment, evaluation, and planning of operations and maintenance activities -Calendar of farming activities formulation/implementation/ updating • Water distribution and system maintenance • Continuous education and training from management • Issuance of water service invoice -Water service bill	

NIA = National Irrigation Administration; NIS = national irrigation systems; CIS = communal irrigation systems; POW = program of work; IA = irrigators' association; SEC = Securities and Exchange Commission; FFCC = final financial construction cost; ROW = right-of-way
Source: NIA (2013)

Project Management Structure

The NIA irrigation project management structure consists of three distinct offices: the central office, the RIO/integrated irrigation systems office (for two big irrigation systems Pantabangan and Magat), and the IMO (Figure 2). NIA central office's performance is very much dependent on the reporting activity of the RIO and the IMO. The IMOs are responsible for the construction and rehabilitation of irrigation projects and systems in one or a cluster of provinces. They also implement the O&M plans of irrigation systems in collaboration with the farmer-beneficiaries (NIA-MIMAROPA n.d.). On the other hand, RIOs prepare regional irrigation development, implement irrigation projects, manage O&M of NIS and IA development and assistance, and render technical assistance to LGUs on CIS development.

Figure 2. Management structure and flow of activities between NIA offices



NIA = National Irrigation Administration
Source: NIA (2017)

Other irrigation institutions

Before the passage of the Local Government Code (LGC) in 1991, NIA had been the sole provider of irrigation services. Currently, there are three government entities concerned with irrigation: NIA, LGUs, and DA-BSWM, each of them having its own legal frameworks and mandates for irrigation.

The LGC provides that CIS should be under the supervision of the LGU. Thus, LGUs have the mandate to construct inter-barangay irrigation infrastructure, which is part of the basic services they provide so that their communities can be self-reliant. But recognizing the lack of expertise at the local level, the AFMA mandated NIA to provide technical and financial support to LGUs.

The third player, as provided by AFMA, is the DA through BSWM, which is charged with the promotion of the small-scale irrigation projects under the Small Water Impounding Project (SWIP), Small Diversion Dam (SDD), Shallow Tube Well (STW), and Small Farm Reservoir (SFR) for organized farmer associations. It provides supplemental irrigation and incidental function such as flood control structure and other economic uses of irrigation (e.g., fishery and livestock production). The Small Water Impounding System Association (SWISA) was established because of these programs.[1]

Other institutions involved in irrigation include the Department of Agrarian Reform (DAR), which funds irrigation projects in agrarian reform communities with technical support from NIA and in close partnership with LGUs, especially in right-of-way issues.

Method of the Study

In the Luzon phase of the study, respondents were NIA officers from the 7 RIOs and 14 IMOs (Table 4). These areas have a high firmed-up service area (FUSA) served by CIS relative to other provinces in the country, with Camarines Sur (43,729 ha) and Pangasinan (29,783 ha) topping the list (NIA 2013). The Visayas and Mindanao phase covers NIS and CIS in 8 IMOs and 6 RIOs in the Visayas and Mindanao regions.

Table 4. Study sites

Luzon		Visayas and Mindanao	
Region	**Province**	**Region**	**Province**
1	Ilocos Norte	6	Capiz
1	Pangasinan	6	Iloilo
2	Isabela	7	Bohol
2	Nueva Vizcaya	8	Leyte
2	Cagayan	10	Bukidnon
CAR	Benguet	11	Davao del Sur
3	Nueva Ecija	12	North Cotabato
3	Pampanga	12	South Cotabato
4-A	Laguna		
4-B	Occidental Mindoro		
5	Camarines Sur		

CAR = Cordillera Administrative Region
Source: Authors' compilation

Primary data collection was done through key informant interviews (KIIs) in the national government agencies with irrigation functions such as DA-BSWM, DILG, DAR, National Water Resources Board (NWRB), National Power Corporation (NPC), and DENR-River Basin Control Office (RBCO). For the national agencies, data generated

[1] http://www.bswm.da.gov.ph/successstory/002/small-scale-irrigation-systems (accessed on October 25, 2018)

included legal mandates in irrigation, compliance to the mandates, and activities related to these mandates. Data on irrigation budget source, amount, and allocation were also generated, as well as information on staffing sufficiency. Linkages with other agencies such as DAR, DENR, and BSWM were also identified. Guide questions on the roles and responsibilities of the various institutional participants across the irrigation development and project cycle were likewise formulated.

The RIO and IMO officials were interviewed about the institutional arrangements and project cycle management. During Cycle 1, key informants included all RIOs and IMOs in the study sites. During Cycle 2, the RIOs interviewed were from Regions 6, 11, 12, and 8. The IMOs from all provinces listed in the scope of the study were also interviewed.

Interview questions for RIOs consisted of irrigation water governance indicators and their role in the irrigation project cycle. For the irrigation project cycle, data gathered included representation/participation in the planning and design of systems of stakeholders, implementation details, information on the operations and maintenance stage, monitoring and evaluation information, irrigation water governance arrangements, and incentive mechanism provided for by the Free Irrigation Service Act (FISA). Data collected from IMO included information on the IMO budget, personnel matters, governance/organizational structure/administration, project cycle governance, and incentive mechanisms.

Questions asked during the focus group discussions (FGDs) conducted for NIS IAs included awareness of policy changes particularly those under the FISA, changes due to new policy, incentives for sustaining Model 2/3, details on the planning and design stage, as well as implementation and O&M stage, monitoring and evaluation, and incentive mechanisms for NIS IAs. Information gathered from CIS IAs included profile of the IA they belong to, irrigation system profile, operational aspects, cropping information, and organizational aspects.

Analysis relied mostly on qualitative techniques. Institutional landscape analysis is used to identify the various actors in irrigation water governance and their roles and responsibilities, especially in the implementation of irrigation projects and the whole project cycle. The descriptive analysis of governance mechanisms in the RIO and IMO levels is also discussed, integrating both the Cycle 1 and 2 results. Data and data analysis on project management cycle are only for the Visayas and Mindanao. Descriptive analyses were used in processing data for the NIS and CIS IAs.

Results of the assessment

Macro level

Current planning framework

Coordination of multiple national agencies is a major challenge in irrigation sector planning.

Aside from NIA, both BSWM and DENR-RBCO also have their master plans for irrigation and river basin management, respectively, that indicate potential sites for irrigation development (Table 5). Respondents from BSWM, DAR, and DILG felt that double-counting of beneficiaries and service areas could be avoided through close collaboration with NIA. Also, it was suggested that it would be more efficient to have one comprehensive irrigation plan agreed upon by all stakeholders with NIA as the lead.

Table 5. Irrigation water-related agencies and their roles in the irrigation development cycle at the national level

	Project Identification, Planning, and Design	Implementation	Operation and Management	Monitoring and Evaluation
NIA[a]	*	*	*	*
DA-BSWM	*	*		*
DAR	*			
NEDA	*			
NWRB	*			
DENR-FMB	*			
DENR-RBCO	*			
DILG	*			

[a] NIA's role in irrigation service is limited to NIS.
NIA =National Irrigation Administration; DA-BSWM = Department of Agriculture-Bureau of Soils and Water Management; DAR = Department of Agrarian Reform; NEDA = National Economic and Development Authority; NWRB = National Water Resources Board; DENR = Department of Environment and Natural Resources; FMB = Forest Management Bureau; RBCO = River Basin Control Office; DILG = Department of the Interior and Local Government
Source: Rola et al. (2019)

Following a set of criteria, NIA's Project Management Office decides on whether to do new construction or rehabilitation. But right now, the budget is allocated more for construction (70%) than rehabilitation. Location of the sites for rehabilitation depends on the proposal of the IAs, with NIA evaluating and suggesting if these are feasible. Modern techniques, such as geographic information system (GIS) mapping that can inform about sites needing rehabilitation, are not being used. Government funds through the General Appropriations Act are the sources of funds for rehabilitation.

NEDA plays an important role in the review and approval of new irrigation projects. According to NEDA memorandum dated June 27, 2017, the ICC must review and approve national projects amounting to PHP 2.5 billion and above. Meanwhile, national and LGU/local projects amounting from PHP 200 million to PHP 2.5 billion must be submitted to the ICC for review and notation only. LGU projects costing PHP 50 million to PHP 200 million require an endorsement by the RDC and/or Provincial Development Council (PDC). For projects that require approval by the ICC, the NEDA regional office is the lead evaluating unit and can request inputs from NEDA central office staff (i.e., Infrastructure Staff, Agriculture, Natural Resources, and Environment Staff, etc.).

In deciding the location of big-ticket NIA projects, NEDA requires the conduct of Value Engineering/Value Analysis/Assessment (VEVA), which is an environmental and social assessment that requires all sector reports/assessment before NIA submits the engineering design. With the VEVA method, sector studies are done first before the engineering design.

NIA and BSWM implement the construction of irrigation systems. The DA regional offices implement the BSWM projects and set these projects up for bidding or memorandum of agreement (MOA) with the LGU. On the construction part, the LGU provides the engineer while the DA monitors the progress of the implementation. For DAR projects, the municipal agricultural office (MAO) identifies the recipients of the irrigation project while the DAR engineer monitors the implementation of the construction.

At present, service areas of 200 ha and above are served by NIA while the smaller ones are managed by DA-BSWM. However, in the field, it seems to respondents that the new service areas of 200 ha and above are hard to find. Thus, NIA may have difficulties in identifying contiguous areas. Meanwhile, BSWM is also concerned with developing these contiguous areas individually. So, where will NIA get its future new areas?

While it has a set of personnel monitoring the construction, DAR solicits the technical support of NIA. It also seeks help from LGUs in the settlement of right-of-way. But LGU's equity is limited to the resolution of right-of-way and not as co-implementer. For example, if the source of irrigation water for a proposed project is a spring, DAR collaborates with the LGU or NIA or whoever has the right to the source of water to secure permits from the owners.

The M&E of the irrigation system performance is mainly done by the regional offices of NIA and BSWM through the regional field offices of DA. Despite the availability of modern technologies, M&E still depends on reports from the field.

Problems in the planning process

The planning process is spread out across too many agencies with insufficient integration at the basin level.

The preceding discussion makes it clear that the various agencies involved in irrigation governance have mandated lines of collaboration. In practice, however, data reporting problems are common, requiring further convergence from the national to local levels. There are also insufficient organizational links among the various agencies. For instance, DENR has the mandate to protect the watershed, thereby protecting the source of water supply for irrigation. There is a MOA between DENR-FMB and NIA to the effect that DENR-FMB should ensure the protection of the water sources of NIA. However, the implementation of this agreement leaves much to be desired.

While it is agreed that NIA builds the larger systems and DA-BSWM together with LGUs and DAR builds the smaller systems, planning for these systems are currently done in parallel. A better planning approach for a given river basin would be to integrate physical planning of LGUs, flood control plans, intersectoral plans, and the Agrarian Reform Community Development Plan so that they are all harmonized. A single irrigation development plan will compel coherent data reporting and analysis and avoid duplication. Moreover, service areas of 200 hectares and above are served by NIA while the smaller ones are served by DA-BSWM. Contiguous areas for new irrigation projects spanning at least 200 ha are already difficult to find. DA-BSWM is increasingly taking over the niche of small irrigation systems in the country.

Integrated planning for irrigation requires a close connection between DENR-RBCO and NIA and the involvement of LGUs to ensure that it is linked with the local development plan. The DENR-RBCO plan can be a guide for LGUs in the development of their local development plans and other plans needed by national agencies.

At the regional level, there is a need to push for the characterization of the critical watersheds. NIA, LGUs, and DA-BSWM may use the RBCO plan as a guide in deciding where to place the irrigation facility and which facility to rehabilitate. RBCO believes that water issues are more local and should be viewed at the watershed level.

The absence of coordination by NIA and DENR at the local level can create conflict in the choice of project sites. Meanwhile, the LGUs are tasked to help in the right-of-way issues, especially for small projects, and mandated to supervise the CIS. The IAs, which are the beneficiaries of the irrigation projects, were also engaged in the project planning.

Data compilation, gathering, analysis, and research are functions spread out across various agencies to the detriment of integrated, science-based planning.

There is a need for a reliable database that various agencies can use for their planning activities. Data for planning are available but these are located in various agencies, such as those from the National Mapping and Resource Information Authority; Philippine Atmospheric, Geophysical, and Astronomical Services Administration; NWRB; BSWM; Project Nationwide Operational Assessment of Hazards (NOAH); and Department of Public Works and Highways. There is currently no mechanism for consolidating these various data sources to arrive at a coherent database that is useful for integrated planning. This is discussed further in the final section of this chapter.

Allocation of water rights

The system of water rights is failing to keep pace with demands from various irrigation development plans and other water systems.

NWRB's procedure in issuing water permits to NIS IAs is done government-to-government. First, technical evaluation is conducted by computing standards per hectare to determine the water demand for areas to be irrigated. Second, if there is available water supply to be allocated, water permits are then evaluated and recommendation for approval is issued. Meanwhile, CIS IAs are treated as private entities in their water permit application.

According to NWRB, NIA has already applied for permits to use most rivers for irrigation. Thus, LGUs, which are demanding to use the water from the rivers for domestic needs, have to seek the approval of NIA to access the water. In issuing water permits, NWRB thus needs to assess whether the water source can still supply the water needed by LGUs for domestic purposes after irrigation needs are met. However, NWRB lacks the data needed to make this assessment.

Meso level

Meso-level planning process

Responsibility for meso-level planning is largely borne by NIA RIOs in coordination with IAs and LGUs.

At the meso level, the NIA RIOs, together with the LGUs and the IAs, craft the irrigation development plan (Table 6). Meanwhile, the IMOs, in coordination with the IAs, implements the construction of irrigation projects. DAR solicits LGU participation, especially in right-of-way issues. Other actors include NEDA, which solicit input from the Regional Land Use Committee, which it also chaired; Mines and Geosciences Bureau of the DENR, which produces the Engineering Geological and Geohazard Assessment Report concerning data on faults and other geological issues; and Project NOAH, which generates data on geologic faults.

Table 6. Irrigation water-related agencies and their roles in the irrigation development cycle at the meso level

	Project Identification, Planning and Design	Implementation	Operation and Management	Monitoring and Evaluation
Regional irrigation offices of the NIA	*			*
NIA IMOs		*	*	*
Regional field offices of the DA		*	*	*
LGUs	*			
RDC-NEDA	*			
Regional officers of NCIP	*			
NGOs	*			

NIA = National Irrigation Administration; IMOs = irrigation management offices; DA = Department of Agriculture; LGUs = local government units; RDC-NEDA = Regional Development Council-National Economic and Development Authority; NCIP = National Commission on Indigenous Peoples; NGOs = nongovernment organizations
Source: Rola et al. (2019)

During the project planning, the civil society and nongovernment organizations (NGOs) at the barangay level are consulted for the social acceptability of the project. NGOs usually work with indigenous people and the National Commission on Indigenous Peoples. The RDC endorses big-ticket projects (above PHP 10 million) and approves the smaller ones.

Other agencies are also part of irrigation development at the meso level but divergent priorities compromise their functions.

NEDA, together with DILG and DBM, supports irrigation development planning and M&E through the Regional Project Monitoring Committee (RPMC), a special committee under the RDC. The RPMC monitors expenditures relative to the progress in construction quarterly. Provincial and municipal counterparts of these monitoring teams are also in place, with NEDA providing training for them. For appraisal purposes, the Regional Investment Office under NEDA evaluates and then sends irrigation reports to NEDA's Public Investment Staff. These reports contain progress of indicators and impacts.

As mandated by AFMA, CIS are supposedly devolved to LGUs. However, field data show that there is only one LGU that has successfully managed a CIS (Elazegui 2015) from a total of 6,000 CIS in the country. The devolution of CIS to LGUs is rarely implemented because of LGUs' low priority for irrigation concerns or lack of capacity to operate and manage CIS (Celestino et al. 2016). By default, the rehabilitation and restoration of existing irrigation systems, whether national or communal, are continuously being conducted by NIA.

The sorry state of watersheds critical to major irrigation systems in the country is another manifestation of the divergent priorities of national agencies. DENR-FMB provides technical guidance to the DENR central and field offices for the effective protection, development, and conservation of forest lands and watersheds. Ideally, NIA must work with DENR-FMB to ensure sustainable water supply for the irrigation systems. While NIA does have a joint MOA with DENR-FMB for watershed-level activities, such MOA is yet to be finalized and implemented.

Effects of the RatPlan

The ability of NIA to develop and manage irrigation systems has been severely depleted by the rationalization implemented in 2011–2012.

The rationalization plan (RatPlan), which took effect in 2011–2012, was aimed at creating a "lean and mean" organization that is more suitable to a farmer-centric system. However, because of the RatPlan, NIA's technical personnel are now in short supply relative to the needs of its clients. This is validated in Laguna, where CIS IAs said that they did not receive any technical support from NIA even if their system needs technical diagnosis.

In general, the implementation of the RatPlan has reduced NIA's manpower by 50 percent and created an imbalance between the number of technical and administrative staff. In one case, the provincial CIS officer is also the irrigation superintendent of an NIS. Thus, in almost all regions, a lot of activities are being outsourced. The insecurity of tenure is also affecting NIA's work negatively. For instance, there is less time to monitor the staff gauges resulting in theft. Because staff are overloaded, the time for monitoring collection of fees, for instance, has also been reduced. In short, the RatPlan resulted in decreased personnel to implement project activities.

NIA personnel also have to devote time for meetings convened by other agencies and preparing reports in various formats requested by different offices (such as NEDA, Office of the Presidential Assistant on Food Security and Agricultural Modernization, and DA) and NIA central office. Too much office work has therefore reduced the time for farmer interaction and monitoring among NIA staff.

In one RIO, there were 400 personnel with only 100 permanent staff. Of the 400 employees, only 30 percent are technical staff. In Region 3, the RatPlan eliminated such positions as hydrologists, environmental engineers, and other engineers. As a result, no one is in charge of water supply data. There is also no link between NIA and DENR for watershed management, considering that the main problem of siltation in irrigation canals is caused mostly by soil erosion upstream. If left unmonitored because of the lack of personnel from NIA, the siltation problem is likely to aggravate. One respondent emphasized the need for an environmental management unit that will check the availability of water in an area and a hydrologist who will help in the design. In addition, NIA has stopped generating data on streamflow of rivers after the RatPlan.

The RatPlan has forced NIA staff to do considerable multitasking. From four divisions, regional operations now just have two—Engineering and Operations Division and Administrative and Finance Division. One regional official said that because of the rationalization, many employees retired early as permanent positions were reduced.

In reality, the main challenge in watershed protection is the dynamics and the level of collaboration among the various agencies that deal with the environment and land use. Interagency collaboration involves various national government agencies, such as DENR (for forest management) and DA (for agricultural land use). In contrast, multisectoral collaboration involves national government agencies, LGUs and local communities, youth, among others.

System level

Governance within NIS

NIA is primarily responsible for planning, construction, and operation of NIS, with varying degrees of farmer participation.

As NIS are mostly big projects, the participation of farmers in the planning and design stage is not significant. Almost all of them do not participate in the decisionmaking during the planning stage. A small percentage of the respondents said that social acceptability by the community is part of the assessment. Most farmers are also not involved in the implementation phase of the project. Concerning the O&M, Luzon respondents mentioned that funds come from NIA. NIS IAs respondents felt that they are not capable of O&M activities and their technical background is nearly adequate.

In Visayas and Mindanao, NIS IAs were active in the O&M phase of the project cycle. Most of them are aware of the payment rate by NIA for the O&M of the system and that these payments are not enough for their needs.

There are four models of IMT or the transfer of O&M responsibilities for NIS from NIA to NIS IAs (Table 7). O&M of turnouts and farm-level facilities is the inherent responsibility of IAs. As of 2014, IMT accomplishments involved models 1 and 2 (95% of IAs) and very minimal involving models 3 and 4 (Table 7). This rate raises concern on whether the devolution of management of NIS has reached sufficient depth given that model 1 is limited only to maintenance of canals and model 2 to the management of lateral canals—far from a complete turnover of the system.

For monitoring and evaluation of the system, the participation of the NIS IAs is high. Monitoring is done manually by staff gauge or through ocular inspection by NIA. Almost all NIS IAs have an existing monitoring system for flow rates. Both NIA and IAs monitor the flow rates. Defects in the system can be reported directly to NIA. There is also a system of reporting concerning problems in flow rates and other issues to NIA or NIS IA management. Monitoring of service areas is also done daily and monthly by IA members. The information contained in the monitoring report by IAs, which is submitted to the IMOs, serves as the basis for future decisions, especially on water allocation.

The NIS systems management committee meeting is conducted with the IAs, LGUs, and national government agencies to propose a crop calendar and pattern of planting to be approved by the provincial governor. The municipal office decides on the issuance of the *patalastas* (bulletin), which informs both NIA and the IAs of the irrigation schedule for the next season.

Table 7. Status of irrigation management transfer of NIS to IAs*

IMT Model	Description	Number of IAs	Share of Total (%)
Model 1	Maintenance of canals delegated to IAs; IAs are compensated based on canal area maintained and existing labor rate	1,192	49.7
Model 2	Turnover of management of lateral canals to IAs; IAs get a share of ISF collected; typical ISF sharing—NIA: 70%; IA:30%	1,103	46.0
Model 3	Turnover of management of main and lateral canals to IA Federation (headworks/dam not included); IAs get a share of ISF collected; typical ISF sharing—NIA: 70%; IA:30%	77	3.2
Model 4	Complete turnover of irrigation system to IAs; IAs pay NIA rental fee at a rate of 75–100 kg of dry *palay* per hectare per year	27	1.1
Total IMTs		2,399	83.0
Total systems		2,891	100.0

*as of October 31, 2014
NIS = national irrigation systems; IMT =irrigation management transfer; IAs = irrigators' associations; NIA =National Irrigation Administration; ISF = irrigation service fee; kg = kilogram
Source: NIA (2016b)

Governance within CIS

IAs in CIS participate actively in all phases of irrigation development and take over the system at the O&M stage, with occasional technical and other support from NIA.

Governance of CIS is less formal and uses more customary rules. The AFMA provides for LGUs to oversee CIS operations and investments. However, CIS irrigation project development remains dependent on national government's (i.e., NIA) assistance. CIS projects were often in response to requests/proposals/resolutions submitted by IAs, farmer organizations, and LGUs to NIA (IMO), which, in turn, taps sources for funding. IAs' awareness/knowledge and institutional network are crucial in enhancing CIS programs (Luyun and Elazegui 2019).

Respondents noted high participation in drafting resolutions when planning for new CIS irrigation systems (Table 8). NIA, with some participation from IAs, still decides on the location of new systems, particularly if water availability is a criterion in the site selection. IAs participate in writing the proposal, with NIA deciding mainly on the size of the structure. Since social acceptability by the community is part of the assessment, farmers, in general, are consulted on the location of the irrigation structure. Meanwhile, it is the role of IA officers to validate the list of the beneficiaries and their tenure.

Table 8. Participation of CIS IAs in the planning and design stage of the project cycle

Item		Frequency	Percent
Participation of IAs in drafting a resolution when planning for new CIS	Yes	20	83
	No	4	17
	Total (n)	24	100
Decisionmaker on the location of the new systems	IA	2	8
	NIA	14	58
	Both IA and NIA	3	13
	Driller and IA member	1	4
	Don't know	2	8
Participation of IAs in the selection of location of new irrigation	Yes	13	54
	No	9	38
	No response	2	8
	Total (n)	24	100
Whether water availability is a criterion in the site selection	Yes	24	100
	No	0	0
	Total (n)	24	100
Participation in writing the proposal	IA	14	58
	NIA	8	33
	IA with LGU assistance	1	4
	No response	1	4
	Total (n)	24	100
On whether social acceptability by the community is part of the assessment	Yes	23	96
	No	1	4
	Total (n)	24	100
On whether farmers, in general, are consulted on the location of the irrigation structure	Yes	22	92
	No	2	8
	Total (n)	24	100
Person in charge of validating list of farmer-beneficiaries	IDO	1	4
	IA/ IA Officers	15	62
	IMO	2	8
	No response	6	25
	Total (n)	24	100
Person in charge of validating the tenure of farmers	IDO	1	4
	IA/ IA Officers	15	62
	IMO	2	8
	No response	6	25
	Total (n)	24	100

CIS = communal irrigation system; IA = irrigators' association; NIA = National Irrigation Administration; IDO = irrigators development officer; IMO =irrigation management office; n = number of samples
Source: Authors' calculations

IAs are formed before the project construction. Unlike the NIS IAs, the CIS IAs participate actively in project implementation, mostly to provide labor equity (Table 9). NIA involves farmers in the construction of projects. IAs perceive that CIS projects are done on time.

Table 9. Participation of CIS IAs in project construction

Item		Frequencies	Percent
Participation in project implementation	Yes	22	92
	No	1	4
	No response	1	4
	Total (n)	24	100
On whether construction schedules are followed (Timeliness of construction)	Yes	14	58
	No	5	20
	No idea	1	4
	No response	4	17
	Total (n)	24	100
Roles of farmers in general in the project implementation*	Labor	17	71
	Monitoring/supervision	6	25
	No response	2	8
Persons who involve farmers in the construction	NIA/IDOs	21	88
	No response	3	12
	Total (n)	24	100
Periods when IAs are formally formed	Before construction	24	100
	Total (n)	24	100

*Multiple responses
CIS = communal irrigation system; NIA = National Irrigation Administration; IAs = irrigators' association; IDOs = irrigators development officers; n = number of samples
Source: Authors' calculations

NIA supports CIS projects by funding diversion and conveyance facilities, with CIS IAs funding the rest of the O&M, mostly for canal cleaning, repairs, and routine maintenance. Farmers develop other farm-level facilities such as the turnouts (Elazegui 2015).

As provided for by the AFMA, LGUs must be provided capacity-building programs for them to sustainably manage CIS. Technical and financial assistance, training, and other logistical support are part of the capacity-building needs of LGUs. DA is expected to lead this activity.

Table 10. Participation of CIS IAs in the M&E of system performance

	Item	Frequency	Percent
On whether the results of the monitoring of the flow rates are reported to the IA management	Yes	21	88
	No	1	4
	No response	2	8
	Total (n)	24	100
Follow-up actions done by the IA management in such incidents	Rotation or water scheduling	3	13
	Reported to NIA, LGU to seek	3	13
	assistance	2	8
	Requested water pump from DA	2	8
	Created proposal/resolution for system rehab, canal lining		
Timeliness of system repairs needed	Always		
	Sometimes	17	71
	Never	5	21
	No repair yet since newly	1	4
	constructed	1	4
	Total (n)	24	100
On whether a monitoring system for service area of the CIS exists	Yes		
	Total (n)	24	100
		24	100
Strategies used in the monitoring system for service area of the CIS	By sector, BOT	13	54
	Water Tender/Master	5	21
	Barangay, IDO, NIA	2	8
	No response	4	17
Decisionmaker on water allocation for the following season	Decided during the general	6	25
	assembly	11	46
	IA officers and BOT	7	29
	No response		
Role of IAs in the water allocation decision	Decided during the general assembly meeting regarding the	15	63
	water allocation plan	1	4
		8	33
	Scheduling of water delivery		
	No response		
On whether CIS IAs perceive that personnel within the IAs are adequate to monitor the structures of the system for maintenance and operations	Yes	19	79
	No	2	8
	No response	3	13
	Total (n)	24	100

CIS = communal irrigation system; IA = irrigator's association; M&E = monitoring and evaluation; NIA = National Irrigation Administration; BOT = Board of Trustees; IDO = irrigators development officer; n = number of samples

Source: Authors' calculations

Due to uncoordinated efforts by agencies concerned, only a few capacity-building programs for LGUs and IAs had been accomplished. Despite the shortage in the provision of capacity-building programs, it was observed that 80 percent of the 5,322 CIS IAs organized had achieved complete turnover of irrigation systems.

Monitoring of the flow rates is reported to the IA management, which, in turn, does rotation or water scheduling with the assistance of NIA and the LGU (Table 10). Mostly, the MAO of the LGUs offers some technologies from DA as part of its institutional links with the IMO. Timeliness of the repairs is always observed. There is also a monitoring system for service area of the CIS involving the board of trustees (BOT) of the IA, water tender/master of the IAs, barangay officials, and irrigators development officer of NIA. Decisionmaking on water allocation for the following season is done by IA officers and BOT of IAs during the general assembly. CIS IAs perceive that there is enough personnel within the IAs to monitor the structures of the system for maintenance and operations.

Conclusions and recommendations

Summary

Decisionmaking in the Philippine irrigation sector, which involves multiple institutions that are not necessarily linked to one another, is fragmented at the various phases of the irrigation development cycle. Before the devolution, NIA had been the sole provider of irrigation services in the country. Currently, there are three government entities concerned with irrigation governance: NIA, DA-BSWM, and LGUs, each of them having its own legal frameworks and mandates for irrigation. These institutions plan and implement irrigation projects, and therefore, no integrated irrigation plan is being followed. This results in double-counting of areas and even of beneficiaries. Activities are also disjointed due to many plans.

According to the AFMA, the LGU has the responsibility to manage the CIS or the small systems. This is not happening because of LGUs' low priority for irrigation concerns, limited funds for project implementation, and lack of capacities to do planning, implementation, and monitoring and evaluation. LGUs also lack enough personnel to operate and manage irrigation systems.

The various government regional offices that are members of the RDC participate in the identification of sites, planning, and endorsement of projects to the national level. The regional DA monitors the CIS project implementation. The RIO and the IMO both participate in the planning, implementation, and monitoring and evaluation (M&E) of the systems' performance and report these back to the NIA central office. The meso-level agencies are deemed effective in what they do.

NIS IAs do mainly ISF collection. They are also involved in the planning, and depending on the level of the IMT they are in, they are also involved in the O&M. NIA and the IAs are in charge of monitoring the flow rates.

CIS IAs, on the other hand, have more autonomy. Once the project is turned over to them, they do the full O&M of the system. They also claim to be engaged from the planning to implementation of the project, as well as in the O&M, and even in the monitoring of water flows. Over 48 percent of the CIS IAs reported problems related to access to water, particularly in terms of quantity and the timeliness of delivery. They also raised concerns related to the O&M of the system as well as access to funds needed for rehabilitation. O&M involves different activities such as minor repair, routine maintenance, emergency, and annual repairs, which are not adequately covered in their collection targets.

Recommendations

Craft an integrated irrigation development plan that includes a national master plan at the macro level, a river basin plan at the meso level, and a comprehensive land-use plan at the micro level.

An integrated irrigation development plan for the country implies coordination among agencies in terms of projects, sites, and IAs. At the national level, there is a need for an integrated and rolling irrigation development master plan led by NIA. At the meso level, plans should be harmonized with the river basin plans of DENR- RBCO, together with the flood control plan of Project NOAH, and other intersectoral plans. Lastly, at the micro level, the local irrigation development plan should be harmonized with the ARC and LGU plans.

Incorporate watershed protection and restoration as part of integrated planning at the basin level to ensure sustained availability of water resources.

Watershed management is very important for irrigation water security as watersheds protect the freshwater supply. Key to reversing the trend of watershed deterioration is to build high levels of trust and commitment among the various government agencies, a measure that can make collaboration more effective. Other important measures that can promote successful collaboration include clear guidelines for sharing knowledge, information, and other resources; distributing leadership; and sharing accountability (Cruz 2018).

Establish water resource research centers (WRRCs) at the macro and meso levels.

To address the need for an integrated database and analysis, the study proposes a network of water resource research centers at the macro and meso levels. The proposed WRRCs are centralized units specializing in water-related concerns. WRRCs can provide science-based and technical support to water-related government agencies. They can assist in the planning and design of irrigation systems, managing M&E of projects, and assessing the performance of facilities and operations. Intensive data gathering is also necessary, especially if recharge rates of groundwater as a function of rainfall, runoff, evapotranspiration, inflows/outflows, and percolation and upward flux need to be checked (Clemente et al. 2018). Databases for such local data can be housed at the state universities and colleges that can store time-series data from a watershed or a cluster of watersheds in the locality. Researchers can analyze these data for policy while students can use the data for academic purposes. The end goal is to have a systematic database for watershed-based water information to support policy and foresight exercise for water allocation decisions. WRRCs can also assist NEDA in evaluating foreign and large locally funded water projects and preparing medium-term development plans for the water sector. The first step in moving forward is to pilot such a structure with the full support of the NWRB and other water-governing bodies.

Water rights allocation should be kept consistent with assessed levels of water resources.

The assignment of water permits by NWRB can benefit greatly from the creation of WRRCs. These resource centers can consolidate technical expertise currently scattered across multiple agencies as well as funding for water resource assessment initiatives. A reliable and updated database on water supply and demand will enable more precise water rights allocation.

Institutionalize M&E system at the macro, meso, and system levels.

Although the M&E system is not part of NIA's core activities, information from this activity is needed for foresight and planning activities at all governance levels. Thus, M&E must be institutionalized as one of the agency's core activities. At the national level, GIS applications can be further enhanced in targeting interventions (i.e., in helping the NIA and the DA improve land productivity) and in programming areas for irrigation (e.g., construction, rehabilitation, etc.). Checking of water quality should also be done seasonally and should be part of M&E programs of NIA as information from this activity can be used as a basis for policy formulation. Evaluating water quality is important to avoid water quality deterioration in the future, which could affect yield (Clemente et al. 2018). At the meso level, NIA has a system called System Management Committee, where NIA, IAs, and even LGUs meet days or weeks before the start of planting, especially during dry spells, to discuss water allocation and schedules/water flow. In addition, simulation models to forecast rainfall during the wet season can guide water allocation in a particular region or province. There are also new technologies for monitoring physical targets, such as irrigated areas and water supply. More training for NIA staff may be needed for them to be conversant with these tools.

Boost the technical capacity of NIA. The IMT, which was a major component of the RatPlan, resulted in the downsizing of NIA, and eventually, an exodus of technical expertise.

There is a need to restore the technical capacity of NIA to be able to address the demand by other agencies. NIA needs more operations personnel (rather than financial personnel) as IAs have lamented the inadequacy of NIA staff complement to monitor the system structure.

Create an apex body for water that can harmonize policies and plans for the whole water sector.

An apex body is defined as a national organization that guides the water sector in reforms for both water services and resource management. Its focus is interdepartmental/intersectoral or interministry coordination. It can take on a variety of forms, such as a national water resource council, committee, commission, board, or authority, together with its supporting offices or secretariats (ADB 2006). Establishing a national apex body is a complex task, requiring the participation of all national partner agencies. To avoid conflict of authority, clear distinctions between the apex body and existing water agencies must be made. Creating a water sector apex body is a proactive step a country can take to manage its reform process and to ensure reforms reach the target beneficiaries (Birch 2004). While the creation of this possibly new institution is necessary, the mandates of existing water agencies and sectors should also be reviewed. Their existing roles and responsibilities would have to be reoriented for them to be synchronized with the regulatory and policymaking role of the proposed water apex body of the Philippines.

Chapter 6

An Assessment of the Free Irrigation Service Act

Roehlano M. Briones, Roberto S. Clemente, Arlene B. Inocencio, Roger A. Luyun, and Agnes C. Rola

Introduction

The Philippines used to implement a policy of cost recovery for the operations and maintenance (O&M) of its irrigation facilities. In national irrigation systems (NIS) managed by the National Irrigation Administration (NIA), farmers using irrigation service were charged an irrigation service fee (ISF). Meanwhile, in communal irrigation systems (CIS), associations of water users or irrigators' associations (IAs) would typically collect an ISF among themselves to pay for O&M of CIS. NIA also collected fees from IAs to amortize the capital cost of CIS.

The cost-recovery policy was repealed in February 2018, when the President signed into law the Free Irrigation Service Act (FISA). The law exempts most members of IAs in NIS from paying the ISFs. It also provides a subsidy for O&M of CIS. Only farmers cultivating more than 8 hectares (ha) are required to pay ISF. Moreover, for farmers cultivating 8 ha or lower, all unpaid ISF and corresponding penalties owed to NIA are condoned. For IAs, all loans, past due accounts, and corresponding interests and penalties owed to NIA are likewise condoned. By 2019, the budget for funding free irrigation for farmers reached PHP 2.6 billion (DBM 2019).

In 2015, the income of NIA from ISF was about PHP 1.8 billion, representing significant cost recovery on irrigation maintenance. The waiver of ISF effectively transferred income to farmers equivalent to the amount of ISF with associated interest and penalties for past due payments. On the other hand, there was a real cost for irrigation maintenance. FISA shifts the burden of paying irrigation O&M from direct users, namely, farmers, to the public treasury funded by taxpayers, effectively establishing an in-kind transfer scheme.

This study evaluated the policy of making irrigation service free for farmers. Specifically, it described the implementation of the free irrigation policy at the level of budget, NIA, and IAs. It also evaluated the free irrigation policy in terms of its impact on farmers, the irrigation sector, and public finances and advanced recommendations for irrigation service pricing in the Philippines.

Implementation of free irrigation policy

Cost recovery before FISA

Before the implementation of FISA, NIA actively collected ISF from IAs in NIS to defray the cost of O&M in these systems. In contrast, ISF was not collected from IAs in CIS, which had taken over system O&M. Instead, collections went to amortize the investment cost of NIA in constructing CIS. ISF was denominated in *palay* and set on a system-by-system basis in consultation with the IAs. The factors considered include type of system (diversion, reservoir, pump), crops planted, and season.

Nor was O&M solely the function of NIA. Before FISA, NIA implemented an irrigation management transfer (IMT) program, where both O&M responsibilities and ISF fees were shared between NIA and IAs, following a scheme summarized in Table 1.

Before the implementation of FISA, several issues had arisen in O&M among NIS, most notable of which was the lack of funds for proper O&M and rehabilitation. The internally generated funds of NIA, mostly composed of ISF, were insufficient such that the national government had to subsidize O&M of national systems (Figure 1). The collection rate was way below 100 percent. However, farmers had little incentive to clear their arrears, as NIA could not exclude delinquent farmers from its service.

Table 1. Basic responsibilities of NIA and IAs under various models of IMT contracts

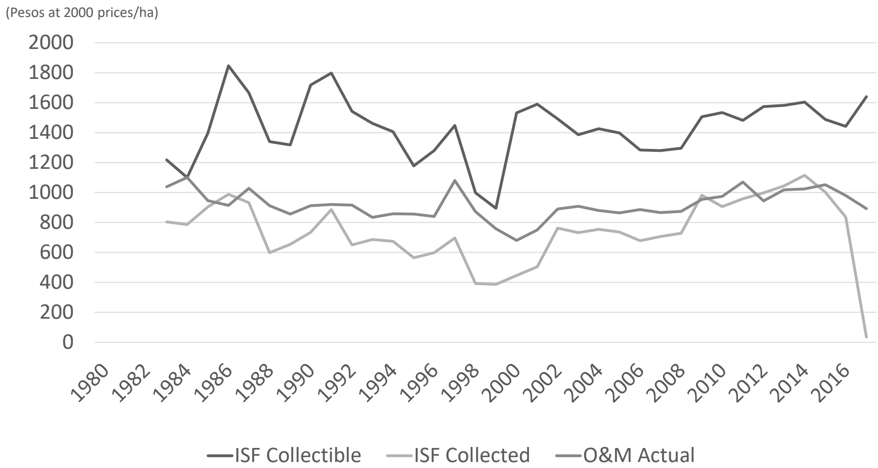
IMT Contract	NIA's Responsibility	IAs' Responsibility
Model 1	Management of the entire system but transferred specific operations and maintenance (O&M) responsibilities to the IAs	(a) Maintenance of canals (portion of main canals, laterals, and other irrigation facilities and structures within the coverage of the IA service area); (b) Operation activities, such as discharge monitoring and preparation of list of irrigated and planted area; and (c) Distribution of irrigation service fee (ISF) bills and campaign for payment. Depending on the capacity and willingness of the IA, ISF collection was an added responsibility of the IA, especially in NIS that had minimal NIA staff under the NIA rationalized structure.
Model 2	Management of the main system, from the headworks to the head gates of lateral canals	Management, O&M of the laterals, sublaterals, and terminal facilities. ISF collection.
Model 3	Management of the headworks and portion of the main canal up to the junction of the first lateral canal headgate	Management, O&M of the rest of the system from the junction of the first lateral canal headgate down to the farm-level facilities. This was an expanded form of Model 2.
Model 4	Monitoring, evaluation, and technical assistance of the IAs	Full management, O&M of the entire system, including the headworks.

Note: The share of the IA in ISF collection is negotiated on a system basis; however, the share of the IA typically increases from Model 1 to 3. In Model 4, only a system rental fee is paid by the IA.
NIA = National Irrigation Administration; IAs = irrigators' associations; IMT = irrigation management transfer
Source: NIA (2012)

Preparatory phase of FISA implementation

The NIA Board of Directors through Resolution 8396-17 series of 2017 has approved the Guidelines on Free Irrigation Service provided in NIA Memorandum Circular 13, series of 2017. According to the guidelines, IAs in NIA will be compensated based on the length of canal section transferred to them by NIA for maintenance. The equivalent of one canal section shall be: lined canal = 3.5 kilometers (km) of earth main or lateral canal; lined canal = 7 km of concrete main or lateral canal. For each canal section, the IA, after satisfactorily complying with its maintenance obligations stated in the contract, shall be paid PHP 1,750 per month for a maximum of six months in a year.

Figure 1. Trends in the actual cost of O&M of firmed-up service areas, ISF collected of NIS: 1983–2016



O&M = operations and maintenance; ISF = irrigation service fee; NIS = national irrigation systems; PHP = Philippine peso; ha = hectare
Source: Inocencio and Barker (2018)

For operations-related responsibilities, the IAs/federation will be paid PHP 150 per ha per cropping of irrigated and planted areas.

For CIS, NIA will stop collecting amortization and equity payments from farmers and/or IAs. This policy also applies to small irrigation systems, pump irrigation systems, including shallow tube wells, and small reservoir irrigation systems. For projects with participation of local government units (LGUs), the equity requirement from the concerned LGU will be maintained.

IAs, as part of their internal policies, may collect an additional amount from members on top of the regular dues (membership fees, annual dues, capital buildup, among others) to cover or augment their O&M budget. Their respective general assemblies must approve such collection. A subsequent amendment repealed this provision to allow the IA to decide freely whether to pursue internal cost-recovery schemes.

Implementation after the passage of FISA

The Implementing Rules and Regulations (IRR) of FISA cover the scope of free irrigation, condonation, O&M of both NIS and CIS, collection and use of ISF, technical assistance to IAs and irrigators service cooperatives (ISCs), and appropriations.

- **Scope:** All farmers with landholdings 8 ha and below are exempted from paying ISF in NIS, CIS, and other systems developed by NIA or other government agencies. This covers reservoir systems, diversion systems, and pump systems. It also covers natural persons. Corporate farms and plantations, regardless of size, are not covered.
- **Condonation**: All past due ISF, amortization of CIS, interest due, and penalties assessed owed by exempted persons are condoned and written off from NIA's books.
- **O&M of NIS:** NIA will be responsible for developing, operating, and maintaining NIS. In particular, the main facilities of an NIS, such as dams, reservoirs, intakes, headworks, diversion works, pumping stations, main canals, and large lateral canals, shall be managed by NIA.

Secondary facilities and structures of NIS, namely, medium-size laterals, sublaterals, turnouts, farm ditches, farm drains, and other terminal facilities, will be transferred to IAs, ISCs, or federations of the same. The delegation will be done under the IMT program of NIA and formalized by an IMT contract.

For areas covered by IMT, NIA will provide the following subsidies:

1. Operations subsidy – PHP 150 per ha per season
2. Maintenance subsidy – PHP 1,750 per canal section every 45 days (maximum of six times per year). A canal section is equivalent to a 3.5 km length of canal for earth canals and a 7 km of canal for concrete-lined canals.

IAs/ISCs are free to formulate policies to generate funds for their O&M, subject to the approval of their respective general assemblies.

The scope of an IMT contract will be determined by a functionality survey, to be conducted annually and administered by senior water resources development technicians, water resources development technicians, or irrigators development officers (IDOs) of NIA. Every IMT contract will be subject to a seasonal performance evaluation.

Based on a sample contract found in Attachment 2 of the IRR, an IMT contract may be suspended in case of noncompliance and poor performance of the IA/ISC as determined through the performance evaluation. Upon suspension of the contract, NIA takes over the management of NIS. The sample provisions state that "When the IMT Contract is suspended, the NIA through the irrigation management office (IMO) under the direction and supervision of the regional irrigation office (RIO) shall take over the management of irrigation O&M of the area covered by the IMT contract and the NIA shall have the option to hire 'contract of services' to complement its manpower in the management of the area covered by the contract."

- *O&M of CIS:* The IMT policy governing NIS is adopted as well for CIS, according to Rule 7.2. Implicitly, IMT for CIS goes even further than in NIS. In these smaller systems, the management of primary structures is also delegated to IA.
- *Collection and use of ISF:* NIA shall collect ISF and other payments due from nonexempt farmers and corporations. NIA may also enter into ISF collection agreements with relevant IA/ISC to be covered by an IMT contract. Such collections shall be used to augment the O&M subsidy received from NIA.
- *Technical assistance to IAs:* NIA shall continue to be responsible for organizing IAs/ISCs, as well as federations of IAs at the system level, develop their technical and institutional capacity, and facilitate delivery of support services from other agencies.
- *Appropriations:* The funding for O&M will be obtained from the annual General Appropriations Act (GAA). The GAA will also fund the irrigation systems development program, irrigation systems restoration, repair and rehabilitation program, and support to operations.

Related literature

Options for water pricing

Postwar agricultural development in many developing countries involved massive investments, often funded by official development assistance, primacy of political over economic criteria, and low-cost recovery, if any. In the 1970s, the World Bank and other agencies began to introduce cost-recovery schemes in its irrigation financing. One of the primary motivations was the generation of public savings, thereby increasing public resources for agricultural development. However, governments failed to implement the various schemes thoroughly, owing to political clout of farmers and the lack of credibility of water providers given the unreliable irrigation service. Various partial cost-recovery schemes were instead implemented A typology of water-pricing schemes is described in Molle and Berkoff (2007):

- *Area-based charge:* ISF is charged per unit area served. This is often combined with adjustment for type of crop and other factors, such as season and location, among others. Countries practicing this include Nigeria, Kazakhstan, Indonesia, Pakistan, Philippines, Viet Nam, and Japan.
- *Volumetric charge*: ISF is charged per unit volume of water delivered. This is practiced in several Middle East and North African countries, Southern European countries, Australia, and the United States.
- *Mix of area-based and volumetric price*: This is practiced in Spain, Colombia, Lebanon, and Morocco.
- *Quota and fixed charge*: The user is charged a fixed rate up to a certain amount or quota. This is often implemented as a mix of quota, fixed charge, and volumetric price above-quota.
- *Market-based pricing*: Unlike the aforementioned schemes, where prices are set by the irrigation service provider, prices are set by supply and demand in market-based pricing, such as by auctioning off water access.

Viet Nam presents a valuable case study of a policy shift from water pricing to free water (Cook et al. 2013). In 2008, the government waived water charges for irrigation under Decree 115. The policy was intended to provide relief from high production costs to farmers and raise productivity. However, the government expected a farmer's counterpart that is self-reliance for the management of tertiary canals and farm ditches. Favorable impacts of the policy include the following:

- Farm net income increased by an average of about USD 20 per household per year as a result of reduced payments for irrigation O&M.
- Irrigated areas increased by 3–5 percent in some areas. These increases were because the government provided a steady flow of income to irrigation and drainage management companies (IDMCs), allowing them to overcome the problem of undercollection of ISF.

However, there were some negative outcomes:

- The government is slow to update cost norms of IDMCs, leading to underfunding and erosion of O&M.
- Making irrigation free effectively severs the link between water user organizations and IDMCs.

In the case of the Philippines, Fullon et al. (2018) gave a highly positive evaluation of FISA. NIA has shouldered a large share of O&M activities, leaving IAs free to undertake maintenance activities using their own funds. This is contrary to the notion that incentives toward O&M will be weakened by free irrigation. Moreover, the subsidy is conditional on IA effectiveness, incentivizing effort and coinvestment in maintenance and repairs.

NIA (2016c) prepared a position paper on free irrigation. The paper cited the following advantages of collecting ISFs:

1. The funding of O&M is better ensured.
2. Partnerships with IAs are better sustained.
3. Self-reliance of IAs is strengthened.
4. Management of the irrigation system is incentivized.

On the other hand, the removal of the ISF has its advantages:

1. Cost of production of farmers is estimated to decline by 3.4 to 6.1 percent.
2. NIA can better focus on planning, design, construction, restoration/rehabilitation, and O&M of NIS.
3. NIA can better focus on strengthening and capacity building of IAs.

Scope of cost recovery and categories of maintenance

The scope of cost recovery through water pricing is distinguished by the type of cost to be covered. At a lower range of values for cost recovery, the aim is **partial to full recovery of O&M cost**. At an upper range of values for cost recovery, the aim is **partial to full recovery of capital cost**.

The maintenance level is another variable to be selected depending on the desired benefit stream from the asset. Alternative strategies for asset management are the *cyclical* approach and the *regular maintenance* approach. The former is characterized by little to no maintenance input over time, rapid deterioration of the irrigation system, and sporadic rehabilitation to bring the system back to full functionality.

The latter is characterized by regular maintenance inputs precisely to avoid rapid system deterioration. Rehabilitation, if any, is done only after prolonged enjoyment of irrigation services. The latter approach is likely to be a better approximation of an optimal asset management schedule than the former (Skutch and Evans 1999).

Distinctions within the regular maintenance approach can be made according to the following categories (Svendsen and Huppert 2003):

- *Minimum maintenance:* This refers to a fixed and low level of funding. After a short period of maximum performance, the irrigation service declines, first rapidly, then at a decreasing rate.
- *Pragmatic maintenance:* Successively higher levels of funding are provided for upkeep. This lengthens the period during which maximum service is delivered.
- *Maximum or gold-plated maintenance:* A very high level of maintenance funding is sustained period after period. Irrigation service is delivered at a maximum level at virtually all times.

Under cost recovery of O&M, governments and users do not only agree on cost-sharing. They will need to also agree on the objectives and standards of maintenance. Securing users' agreement on these and other matters is part of participatory management, discussed in the following.

Participatory management schemes and free irrigation

Most gravity irrigation systems worldwide have relied on public investment for their initial construction. Their management, however, can remain under government auspices, or it can be turned over to water users. The decision to turn over management is separate from the decision to charge for irrigation service, which leads to various options for pricing and management (Table 2).

The upper left (GG) and lower right (UU) quadrants are the opposites among the options. In the former, the government is responsible for both management and funding of O&M. In the latter, users are entirely responsible for management and O&M. Other combinations are found in the upper right (GU) and lower left (UG) quadrants. In the former, the government manages the system but users contribute to O&M. In the latter, the government contributes to O&M while the users are responsible for managing the system.

This schema, while useful, is a gross simplification of reality. There are gradations in terms of management responsibility, such as the division of tasks between the government and users, and cost-sharing between government and users.

The column on the right (GU and UU) represents the pre-FISA policy of cost recovery, with GU mapping to NIS and UU mapping to CIS. Users in NIS pre-FISA may not pay for O&M completely, such that the government shoulders the balance of O&M cost.

Meanwhile, the column on the left (GG and UG) represents the free irrigation policy. Clearly, UG maps to CIS. However, free irrigation in NIS may map to either GG or UG depending on the following:

- GG prevails when the NIS is not covered by an IMT program
- UG prevails when the NIS is covered by an IMT program.

Table 2. Options for management and O&M payment

Who pays? / Who Manages?	Government (G)	Users (U)
Government (G)	(GG) Government manages system Government shoulders O&M	(GU) Government manages system Users contribute to O&M
Users (U)	(UG) Users manage the irrigation system Governments contribute to O&M	(UU) Users manage system Users shoulder O&M

O&M = operations and maintenance
Source: Authors' own

This uncovers a critical problem in the current schema involving IMT under FISA. NIA's takeover of the management of irrigation O&M and hiring of a contract of services will merely free the IAs/ISCs of the responsibility and financial burden of topping up the inadequate O&M subsidy. The irrigation service will not be necessarily suspended and the erring IAs/ISCs can still benefit from the free irrigation service. In this sense, this supposed disincentive can potentially serve as an incentive for IAs/ISCs to perform poorly.

There are gradations in the degree of user participation and government contribution in UG. UG in CIS involves greater user participation than UG in NIS as the former exercises full management over the irrigation system, whereas the latter covers only secondary facilities and structures.

IMT remains the main institutional solution for irrigation management problems and poor system performance in the developing world. Earlier studies by the World Bank (1992a) indicated some favorable results from IMT. The literature on IMT and participatory management is far from a consensus on whether such policy generally succeeds or fails (Garces-Restrepo et al. 2007). The impacts of management transfer are rarely uniform across the various social, technical, and financial indicators the process is theoretically intended to effect.

A more prudent approach is for research to focus on knowledge gaps about how IMT works and what factors contribute to IMT success (Rap 2006 as cited by Senanayake et al. 2015). For instance, Araral (2011) found that in NIS, IA-managed turnout service areas (TSA) are better-managed than NIA-managed TSAs, owing in part to the perception of legitimacy. In the former, an offense is committed against peers while it is committed against an impersonal bureaucracy in the latter.

Method of the study

As mentioned previously, FISA embraces equitable access to opportunities as one of its key strategies to raise the quality of life of rural areas. To this end, it provides for the reduction of farm production cost by waiving recovery of irrigation cost from farmers. Implicitly, it deems it more **equitable** to transfer resources from taxpayers to provide cost-savings for farmers.

However, it is also an **efficiency** issue. First, the budget for irrigation may be more efficient as an instrument for promoting equity. This can be done by targeting it to a group more disadvantaged than the main beneficiaries of FISA, particularly farmers cultivating less than 8 ha.

Second, any incentive effect from water-pricing schemes is problematic under free irrigation. Water-saving must be a voluntary act on the part of farmers. Given that agriculture is the main user of the country’s freshwater supply, which faces threats from climate change, the effectiveness of the policy for future water resource management needs to be carefully reviewed (Cabangon et al. 2016).

Third, as an operational matter, free irrigation may complicate the management of irrigation systems. Operational concerns include issues, such as underfunding of O&M by the government and weakening of incentives to cooperate and actively participate in irrigation management on the part of users.

To address the issues, the study adopted the following strategies:

1. Equity was analyzed by examining the poverty and income profile of rice farmers, drawing on secondary data.
2. Efficiency in terms of operations and incentive effects was explored based on field investigation and primary information.

Data gathering was part of a broader evaluation study implemented by the Philippine Institute for Development Studies. Its respondents and study sites were

- NIA officers from the seven RIOs and 14 IMOs in the following provinces covering all regions of Luzon: Laguna, Ilocos Norte, Cagayan, Isabela, Nueva Vizcaya, Benguet, Pangasinan, Nueva Ecija, Pampanga, Camarines Sur, and Occidental Mindoro;
- NIA officers in 8 IMOs and 6 RIOs in the following regions and provinces of Visayas and Mindanao: Regions VI, VII, VIII, X, XI, XII, and Capiz, Iloilo, Bohol, Leyte, Bukidnon, Davao del Sur, North Cotabato, and South Cotabato; and
- other government agencies found in the National Capital Region, namely, the central offices of NIA and the Department of Environment and Natural Resources.

Focus group discussions (FGDs) were also conducted among IA officers in NIS and CIS in the provinces. During these FGDs, a structured questionnaire was administered, with some questions related to the implementation and impacts of free irrigation.

The reference period of the study was 2017. During that year, free irrigation law had yet to be enacted, though the policy of waiving ISF in NIS and amortization in CIS was already in place. The feedback from IA officers and government staff was therefore based only on preliminary versions of the law and mostly based on opinions and subjective impressions. Moreover, the sample was very small and not based on random selection. Inferences made should be seen as hypotheses for further validation.

Results and discussion

Analysis of equity

Free irrigation has the potential to benefit millions of individuals and households.

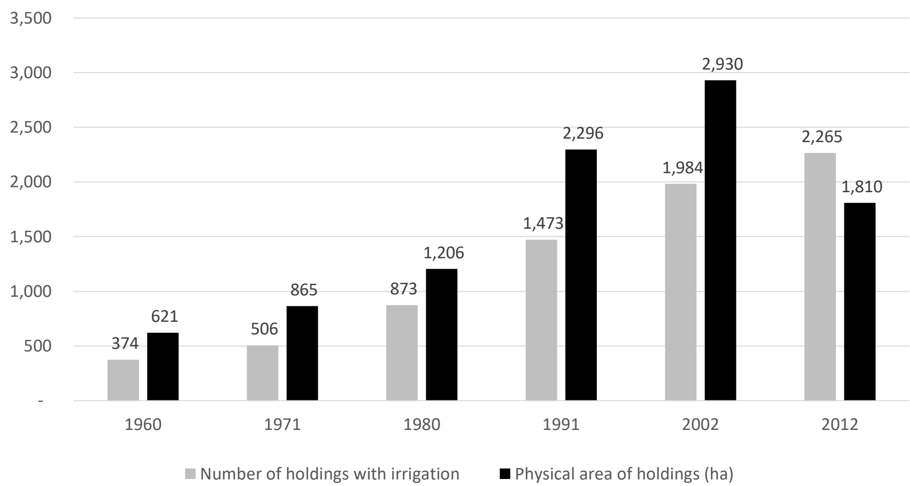
Based on the Census of Agriculture (PSA 2015), the number of irrigated farm holdings had been consistently increasing, from just 374,000 in 1960 to nearly 2.3 million holdings in 2012, spanning 1.81 million ha (Figure 2).

The number of farmers cultivating these holdings was less than 2.3 million, as some farmers may cultivate multiple parcels. However, the actual number was likely to be close to 2 million. A vast majority of them planted palay and fell under the 8-ha cutoff. In 2012, holdings of 7 ha or below accounted for 77.8 percent of all holdings by area, and 98.2 percent of all holdings by number (PSA 2015).

Free irrigation led to only small savings in palay production cost.

In an earlier cited position paper, NIA (2016c) estimated 3.4 to 6.1 percent as the share of ISF in the production cost of palay. It turns out that estimate refers to

Figure 2. Number and area of irrigated farms/holdings: Philippines, 1960–2012



Source: PSA (2015)

cash cost. Table 3 shows the relative size of ISF (paid both in cash and in kind) in 2017. The 2013 estimates were compared to show that cost shares remained largely the same, despite the implementation of free irrigation in 2017. Nationwide, ISF accounted for as little as 1.5 to 1.6 percent of cash cost (Region VIII) to as much as 6.8 to 7.3 percent in Region XII.

Table 3. Share of irrigation service fee in the cost of palay production by region, 2013 and 2017 (%)

	Share in Cash Cost		Share in Total Cost	
	2013	2017	2013	2017
Philippines	4.0	4.2	1.9	1.9
CAR	2.4	3.0	1.2	1.3
Region I	3.1	3.1	1.5	1.4
Region II	4.0	3.8	1.9	1.8
Region III	3.7	4.0	1.9	1.8
Region IV-A	4.1	4.4	1.9	2.0
Region IV-B	3.1	3.2	1.6	1.6
Region V	3.3	3.3	1.7	1.6
Region VI	5.4	5.6	2.3	2.2
Region VII	4.0	4.2	2.0	1.9
Region VIII	1.6	1.5	0.8	0.7
Region IX	3.6	3.6	1.8	1.7
Region X	5.5	5.7	3.0	2.9
Region XI	6.5	6.7	2.6	2.6
Region XII	6.8	7.3	2.6	2.6
Region XIII	6.9	6.2	3.2	2.9
ARMM	5.4	5.2	2.9	2.6

CAR = Cordillera Administrative Region; ARRM = Autonomous Region in Muslim Mindanao
Source: PSA (2020)

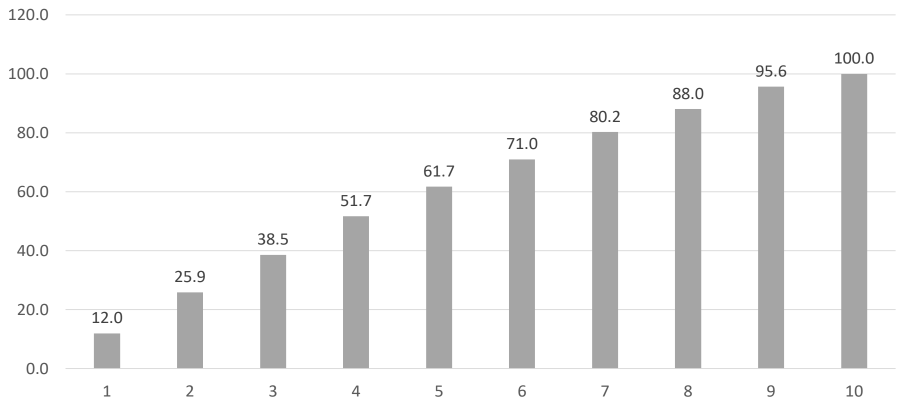
As a share in total cost, ISF averaged under 2 percent for the entire country. The share was lowest in the Cordillera Administrative Region at 1.2 to 1.3 percent and highest in Region XI at 2.9 to 3.0 percent. Making irrigation free conferred only small savings in cost for palay farmers. Based on 2017 estimates of cost of production and total production of irrigated palay, removal of the ISF will save palay farmers the equivalent of PHP 3.4 billion.

Palay farmers were poorer than the average household, but most were not poor. Based on a merging of the Family Income and Expenditure Survey and the Labor Force Survey in 2015, about 4.1 percent of all households were identified as net rice producers, i.e., households whose heads identified their primary occupation as growing of paddy rice and whose household crop income exceeded household rice expenditure (Figure 3). If farmers (i.e., net rice producers) were poorer than most of the population, then they would account for a disproportionate share of the number of poor households. Palay farmers accounted for 4.8 percent of poor households, that is, poverty incidence among rice-farming households was higher than average by about 17-percentage points. This implies, on the other hand, that the share of palay farmers among nonpoor households was 4 percent, almost identical to the share of palay farmers in all households.

Alternatively, Figure 3 shows the cumulative distribution of palay-farming households by per capita income decile. As the poverty incidence of families in 2015 was only 16.5 percent, the poor fell only among the first and second deciles. The first two deciles accounted for about 28 percent of rice-farming households.

However, this implies that 72 percent of rice-farming households were in the third to top deciles, among the nonpoor. When combined with the fact that most palay farmers were below the 8-ha cutoff, an income transfer to palay farmers had a chance of 3 in 4 of benefiting a nonpoor household. In short, free irrigation performed better at targeting the poor than a general transfer to the population, but not by much. Far better are means-tested schemes for transferring incomes, such as the *Pantawid Pamilyang Pilipino* Program.

Figure 3. Cumulative distribution of net rice-producing households, 2015 (%)



Source of basic data: PSA (2015)

Results of FGDs and key informant interviews

National systems

In NIS, cost recovery was associated with distorted incentives, failures in ISF collection, and inadequate level of O&M.

As discussed in previous sections, the cost-recovery scheme was fraught with problems. Area irrigated was often underdeclared to reduce payment, as ISF was charged on a per hectare basis. Another was that the collection of ISF was typically below 100 percent. As explained earlier, cost recovery is difficult when access to the service is not tied to the payment. According to IAs, the top reasons for nonpayment were (1) personal difficulties of the IA member, (2) insufficient water, and (3) damaged state of irrigation systems. The second and third reasons imply that members were reluctant to pay ISF if they believe they are not receiving value for their money.

IAs in NIS viewed the level of O&M as being generally inadequate, consistent with the literature on the subject. Given the political unwillingness to raise ISF rates, the government was also complicit, given its failure to raise budgetary outlays for O&M. The main benefit to farmers from free irrigation was the savings from paying ISF.

The repeal of ISF provided some cost savings on the part of farmers. An overwhelming majority (87%) of IA respondents in NIS found the free irrigation policy to be more beneficial than the cost-recovery policy. Views on the specific benefits of free irrigation are summarized in Figure 4.

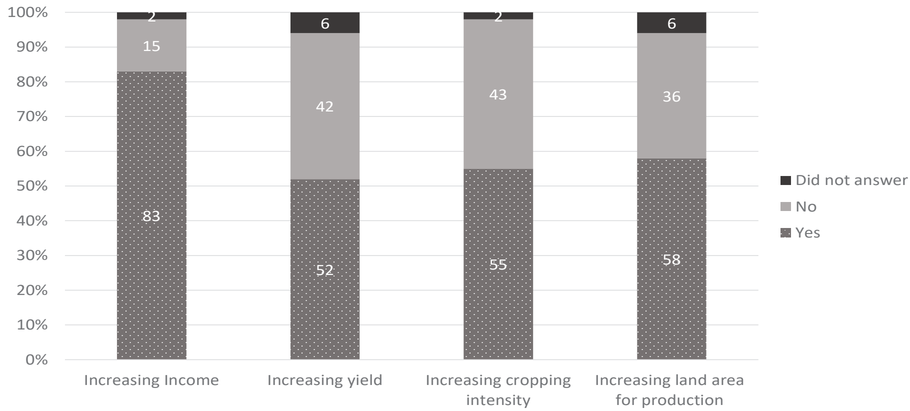
The cost savings translated to higher incomes. There were also supposedly other effects, such as increased yield and cropping intensity, due to the extra income enjoyed by farmers from the waiving of ISF.

The shift to free irrigation in NIS addressed some distortions, though with unclear implications for IMT.

Under free irrigation, the incentive to underdeclare the area irrigated was removed. However, with the costing of O&M subsidy dependent on area planted, there might be a tendency to overstate in the opposite direction. Moreover, resources expended in collecting ISF can be saved and diverted elsewhere. Nonetheless, IAs mentioned that miscellaneous contributions from members were still being collected, but under a different label, such as irrigation maintenance fee, association fee, water maintenance, among others.

The idea of giving farmers or IAs bigger roles and more responsibilities in the operation and management of national systems was meant to address the

Figure 4. Benefits from free irrigation based on NIS IAs FGDs (% of respondents)



NIS = national irrigation systems; IAs = irrigators' associations; FGDs = focus group discussions
Source: Authors' data

sustainability concerns given limited funds for O&M. However, NIA can no longer incentivize management transfer by sharing its ISF collection with the IA. Under its current IRR, the free irrigation policy may have therefore diminished the incentive for IAs to participate and contribute more toward managing and sustaining the NIS.

Funding for O&M has declined under the initial stage of free irrigation.

It is too early to assess whether the shift to free irrigation has led to a net improvement of O&M outcomes. According to NIA informants, O&M subsidy under cost recovery was about **PHP 650 per ha per season**. This corresponds to 30 percent of the average value of the ISF per hectare (about 2.5 cavans of palay at the government support price of PHP 17 per kg). Compare this to the current subsidy provision consisting of an operating subsidy of PHP 150 per ha per season, together with a maintenance subsidy per kilometer of lined canal. Using the figure of 34.5 meters of canal per hectare of irrigated service area, of which 84 percent consisted of earth canals, the maintenance subsidy is another PHP 95 per ha for a total of **PHP 245 per ha per season.** This is equivalent to a 62.3 percent decline in the O&M subsidy.

Likewise, in no case has an IA expressed satisfaction at the level of O&M provided, whether before or after free irrigation. The impression of IA respondents was that its subsidy levels were too low. IAs had to keep collecting from their members to generate enough funds to properly cover O&M. The subsidy provided by NIA cannot fully cover the maintenance costs, especially those involving major repairs or rehabilitation. In some NIS, IAs reported no improvement in system performance when free irrigation has been introduced.

A minority of IAs expressed overall dissatisfaction with the shift to free irrigation. These NIS were those located in Jalaur, Iloilo, as well as along the Mambusao River in Roxas City. Their objections are illustrative of the difficulties associated with free irrigation.

- In the Jalaur system, the main canal from the source suffered water shortage due to siltation. The subsidy was insufficient, as laterals became nonfunctional and the main canal was almost fully silted. These NIS reported that there was no improvement in system performance when free irrigation was introduced in 2017.
- In Roxas City, some IAs were complaining that laterals were only partially operational. Management and association fees provided by NIA cannot fully cover the maintenance costs, especially those involving major repairs or rehabilitation.

Communal systems

Free irrigation was seen to be beneficial in communal systems due to subsidies for O&M and added incentives to undertake new projects.

Under the cost-recovery policy, IAs in CIS were left to fend for themselves in terms of funding O&M. Under free irrigation, they became entitled to a subsidy equivalent to what is received by IAs in NIS. During the period of fieldwork, CIS IAs had not yet received the O&M subsidy but were expecting to receive it. With this expectation, an overwhelming majority (75%) assessed the free irrigation policy to be beneficial to them.

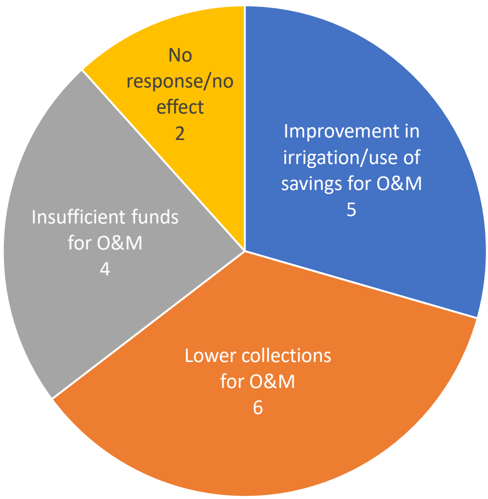
The removal of CIS amortization minimized conflicts between NIA and IAs and increased funds for the association. Free irrigation not only provided a recurrent subsidy for O&M but also a capital subsidy for new irrigation projects, as the NIA no longer required IAs to pay for amortization. Hence, the confirmation of small irrigation projects and rehabilitation of existing systems became easier as farmers were no longer hesitant to implement such projects.

The level of O&M in CIS was constrained by the low level of subsidy and increased difficulty in collecting O&M contributions from IA members.

Of the 24 responses obtained from CIS IAs, 17 stated that free irrigation would affect the level of O&M. Reasons given for the effect are broken down in Figure 5. Five of them (29%) said that the level of O&M would improve, mainly due to additional funding from the government that can be used for O&M. The savings in amortization can also be used for this activity.

However, some IA respondents pointed to potential difficulties, the most serious of which was the inability to collect from their members. Even before IAs had received a budget for O&M, some members already stopped paying for ISFs. In general, free irrigation was expected to lead to lower collections (35% of respondents) in the face of insufficient O&M subsidy from the government (24%).

Figure 5. Reasons given for the change in O&M level, CIS IA respondents (n = 17)



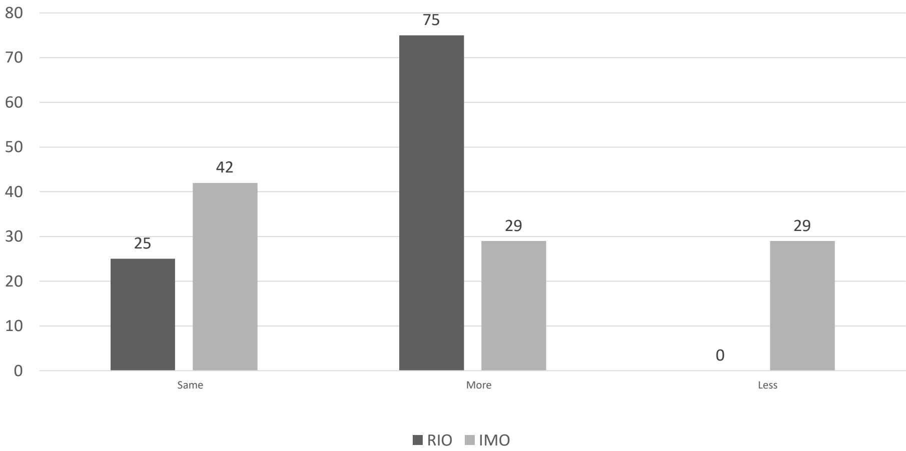
n = number of respondents; O&M = operations and maintenance
Source: Authors' data

Operational and institutional issues: Perspectives from NIA

Overall, free irrigation was expected to increase the level of O&M in irrigation.

NIA staff in regional and field offices generally held that the level of O&M would increase or remain the same. In RIOs, the share of those expecting an increase in O&M was as high as 75 percent (Figure 6). Given the low level of O&M subsidy in NIS, this increase must therefore be due to (a) allocation for O&M of CIS where there was none before, (b) elevation of maintenance inputs from NIA itself over its management responsibilities, and (c) continued internal fund generation of IAs for O&M. Still, there was the dissenting opinion of an NIA Central Office staff, who remained skeptical about the benefits of free irrigation policy in terms of managing IAs, since the new policy has discouraged resource mobilization from IA members.

Figure 6. Share of NIA respondents by expectation of change in O&M with FISA (%)



NIA = National Irrigation Administration; O&M = operations and maintenance; FISA = Free Irrigation Service Act; RIO = regional irrigation office; IMO = irrigation management office
Source: Authors' data

The shift to free irrigation has altered the incentive structure of NIA for both staff and NIA as an institution while facilitating some administrative processes.

Under cost recovery, various incentive schemes staff tied to ISF collections were in place for NIA. The Variable Incentive Grant (VIG) was given at year-end to fund personnel incentives. VIG was given to offices based on physical performance and financial self-sufficiency indicators. With free irrigation, VIG will need to be replaced with a different incentive scheme.

As an institution, NIA should become aware of the tendency for IAs to be more complacent about project viability. IAs perceived that they would still be receiving some level of service, however poorly, without paying any of the cost. Unless corrected, project selectiveness within NIA itself may be compromised under free irrigation.

Under the cost-recovery policy, the interests of NIA and IAs would often be in conflict. NIA sought to collect fees and the latter to avoid paying, often disputing the value of the service being provided by NIA. Moreover, disbursement of salaries tended to be tied to the flow of ISF collections, leading to occasional delays in the release of staff salaries. Under FISA, the conflict of interest issue was mooted, facilitating coordination with IAs. Furthermore, the funding for O&M is remitted directly by the Department of Budget and Management to NIA from the General Fund, with no delays in release.

Under free irrigation, NIA would need to reconfigure its functions and staff complement.

NIA had previously expended considerable resources and human resource collecting ISF from NIS and amortization from CIS under the cost-recovery policy. This function is now removed under free irrigation. NIA must now intensively monitor the IMT program in both NIS and CIS and allocate more resources for O&M and technical assistance. IMOs will now need to be considerably strengthened. Under this setup, IDOs believed that free irrigation could reinforce partnership between NIA and IAs.

Analysis of findings

A simplistic view of FISA suggests that the government both supplies and pays for O&M in NIS (GG option) while contributing to the cost of O&M in CIS (UG option). However, a closer assessment based on the IRR suggests a more nuanced framework. The IMT strategy provided in the IRR implies that NIA also prefers the UG option even in NIS. However, the scope of user responsibility is certainly less than that in CIS. The IMT scheme convinces IAs in NIS to accept at least some management responsibility, in exchange for a subsidy. NIA is continuing to assign full management responsibility of CIS to the IAs. In return, they pay a subsidy on equal terms as in the NIS. This likewise suggests that IAs also have the incentive to continue their management responsibility.

The incentive for IAs to absorb management responsibility does not always work. For instance, resource mobilization within the IA may fail if enough members opt out of making maintenance contributions. This has been observed on the part of several IAs in the study sites. The failure of an IMT scheme in NIS implies defaulting to the GG option, as discussed earlier.

In the case of a CIS, NIA does not have the authority to take over the management in case of poor maintenance by the IA. The suspension of an IMT contract implies that the O&M subsidy will also be suspended. However, the IA continues to be responsible for CIS.

What might be the incentive for participatory management? And what might make such incentives fail?

For CIS, the first question is easy to answer. The O&M subsidy provides additional incentive to continue to manage the system effectively, as poor management will likely entail a loss of the subsidy. For NIS, the question of incentives is trickier. Suppose for publicly managed and publicly funded systems, the government only provides the minimum maintenance. There is strong evidence to suggest that the government provides even a lower level of maintenance, i.e., low enough to fall into a deterioration-rehabilitation-deterioration cycle (Araral 2005b). Suppose further that with pragmatic maintenance, the discounted value of the benefit stream of irrigation service outweighs the discounted value of the cost stream of O&M. The IA members have an incentive to raise the maintenance level from minimum to at least pragmatic, especially for assets for which user maintenance is affordable (i.e., secondary irrigation structures). This maintenance level is made even more affordable with additional public subsidy for O&M. Improved system operations and the move up from minimum to pragmatic maintenance levels offer a two-fold answer to the first question.

As to the second question, the answer for both systems is the prospect of free-riding in the presence of nonexcludability. As discussed earlier, it is difficult to deny water to irrigation system users. Some users therefore may opt to shirk and let others pay for asset maintenance, while benefiting from irrigation service. This is precisely the problem around which IAs are organized, an issue which not all are successful in solving. The presence of O&M subsidy from NIA may perversely embolden some IA members to shirk their responsibility to contribute to O&M.

This interpretation of FISA IRR is summarized as follows: NIA offers to provide a minimum level of functionality of irrigation systems. It offers an IMT scheme to IAs, through which it assigns management responsibilities and a subsidy for O&M for those who assume management responsibility. The abolition of ISF implies that NIA is transitioning away from a fee-collecting agency toward one specialized in technical assistance, contract design, and performance monitoring. Similarly, IAs are in an adjustment phase, learning that voluntarily absorbing management responsibilities and costs is in their own best interest even under a policy of free irrigation service.

Conclusion

Summary

Before 2017, the country's irrigation systems had a long history of cost recovery, interrupted only briefly in 1998. In the late 1990s, it also encouraged water users' participation in irrigation management, with complete turnover being a standard practice in communal systems and partial turnover in national systems. In the latter, turnover was incentivized by the sharing of ISF collections.

All this changed with FISA. The Act provides for free irrigation for farmers with landholdings of 8 ha or lower. Such landholdings account for over 98 percent of all farms/holdings. Free irrigation covers both O&M cost and capital cost. For NIS, this entails repeal of the ISF. For CIS, the IRR of the law provide for a subsidy for O&M.

Based on key informant interviews and FGDs, the study found that cost recovery in NIS was associated with distorted incentives, failures in ISF collection, and inadequate level of O&M. Meanwhile, the main benefit to farmers of free irrigation was the savings from paying ISF in the case of NIS and the subsidy for O&M in the case of CIS.

Despite a likely decline in O&M subsidy for IMT areas, overall O&M funding was expected to increase. Although the free irrigation policy was implemented unilaterally, with minimal consultation with IAs, many IA members demonstrated willingness to continue to contribute toward the delivery of water services. Lastly, the shift to free irrigation altered the incentive structure of NIA, for both staff and NIA as an institution. Under free irrigation, NIA will need to reconfigure its functions and staff complement.

These findings from field investigation narrowly examined irrigation sector outcomes. More broadly, equity and efficiency analysis relating expenditures to expected impacts raised serious concerns. Despite a significant budgetary allocation to free irrigation, the analysis showed that the benefits received on a per hectare or per farmer basis were relatively small. Moreover, while beneficiaries of free irrigation were poorer than average, a large majority of potential beneficiaries were nonpoor. To achieve equity objectives, targeted transfers are probably superior to in-kind transfers, such as free irrigation.

Recommendations

Continue to pursue IMT within the context of free irrigation for both NIS and CIS based on minimum maintenance for NIA and transparent maintenance standards for both NIA and IA to be stipulated in the IMT contract.

The provision for IMT in the IRR of FISA may be contested by advocates who back a policy of completely free irrigation with zero contribution from farmers. However, the IMT strategy is probably sound and relieves some of the cost of O&M on the public treasury. To incentivize management transfer, users must realize they can do maintenance better and more efficiently than NIA. Hence, NIA should adopt a minimum maintenance strategy, with transparent maintenance standards for itself, under the default case of government-managed and government-funded O&M.

Provide for sustained and increasing O&M subsidy but only on a performance basis.

The funding for free irrigation service is vulnerable to the vagaries of the budgeting and approval process. To maintain the credibility of the policy, the executive department must continue to include O&M subsidy in the annual budget and Congress must vet and approve the proposal for as long as FISA is in place. Beyond the financial sustainability, the government should heed the clamor of farmers and irrigation sector advocates to increase funding for O&M. However, rather than providing this on an all-or-nothing basis as in the current IRR, incentives should be built in by tying a larger subsidy allocation to the IA to better O&M outcomes achieved by the IA under IMT.

Explore water-saving as a performance criterion in O&M subsidy.

The current set of performance indicators provided in IRR relate only to irrigation service, rather than longer-term issues of sustainability and water resource management. Currently, there is no management-oriented measurement of water delivery, as is done under volumetric pricing, to calibrate payments based on economizing on water. In the subsidy-based regime under FISA, similar incentive effects can be obtained by penalties for higher water usage. The penalty can be collected by subtracting the penalty value from the O&M subsidy.

Transform NIA into a service-providing agency specializing in technical assistance to IAs, contract design, and performance monitoring.

Under free irrigation, NIA is no longer expected to generate income to develop and maintain irrigation systems. In this setup, its current charter as a government-owned and controlled corporation makes little sense. It might need to be rechartered along the lines of a line agency providing a public service. In doing so, it can focus on its core mandates concerning O&M, namely, technical assistance, contract design, and performance management. As pointed out by NIA staff and accepted by many farmers, IAs are badly in need of training in system management, technologies (e.g, alternate wet and dry irrigation), and institutional capacities in terms of leadership, financial management, and value formation.

Introduce a mandatory review comparing FISA with other social assistance and social protection schemes.

This recommendation flows from the logic of accepting FISA as a state policy. Given the newness of the legislation, it is prudent to keep the law intact and ensure its proper implementation along the lines recommended above. However, this approach should not obscure the broader implications of a policy of deploying public funds for what is essentially a private good, which is the irrigation service. This warrants a thorough review of the policy, say after five years of implementation. It must be compared with other social assistance schemes, such as subsidized agricultural insurance and targeted cash transfers, among others. The aim is to evaluate whether FISA is an effective instrument for delivering benefits for the poorest and most marginalized, relative to other social protection schemes.

Chapter 7

Benefit-Cost Analysis of the Resurgent Irrigation System Program of the Philippines

Roehlano M. Briones

Introduction

It is undeniable that irrigation investments have benefited farmers and society at large. Such benefits have been used to justify the massive investments in irrigation, beginning in 2009, following the rice price crisis (see Chapter 1). The current *Philippine Development Plan* (PDP) *2017–2022* targets 65.07 percent of potential area to be covered by irrigated systems by end of period, higher than the 57.33-percent target in 2015. The General Appropriations Act for 2019 allocated PHP 36 billion for irrigation development while appropriations for 2020 are programmed to reach PHP 32.27 billion. Irrigation development will continue to loom large in the national budget into the foreseeable future.

The previous chapters have highlighted the myriad difficulties encountered in the design, performance, and maintenance of irrigation systems in the Philippines.

These problems highlight the gap between the actual and expected benefits from these systems, with the latter determined as early as the planning and feasibility/project identification stage.

In addition to a more realistic evaluation of the effectiveness of irrigation investments, a comprehensive assessment should also examine the issue of efficiency. This entails comparison of expected benefits of irrigation with the cost of irrigation development and maintenance. This chapter primarily aims to make this comparison to assess the net returns to society of the resurgent irrigation program. The assessment will be used as a basis for drawing policy implications for future public investments in irrigation.

Background

Irrigation expenditures

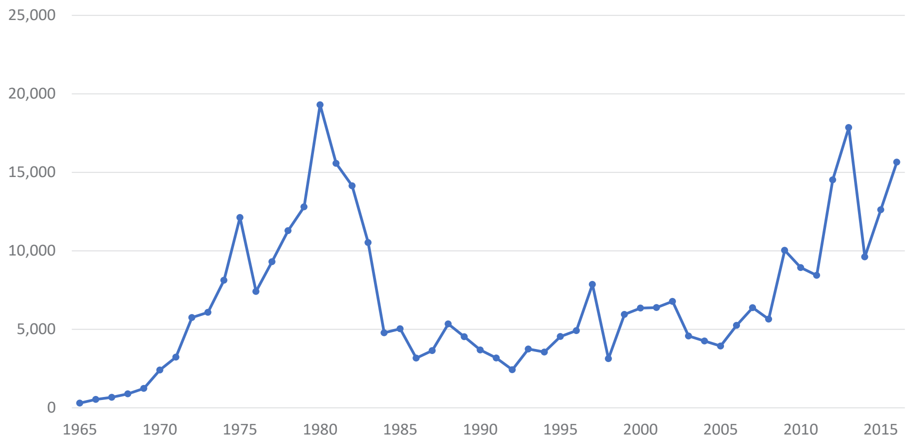
Spending on irrigation reached a peak in the late 1970s when expenditures approached PHP 20 billion in 1979 (Figure 1). With the economic crisis in the early 1980s, expenditures plummeted to below PHP 5 billion in 1984. Since that time until 2008, irrigation expenditures stayed within the PHP 5- to PHP 8-billion range. However, the rice price crisis of 2008—when world price of rice breached USD 1,000 per ton—reinvigorated the policy of rice self-sufficiency. In 2009 expenditure breached the PHP 10-billion mark and continued to trend steeply upward in the subsequent years until it again approached the PHP 20-billion high-water mark in 2013.

Production and area trends

The area of irrigated systems has been growing; expansion has accelerated recently, particularly for communal irrigation systems.

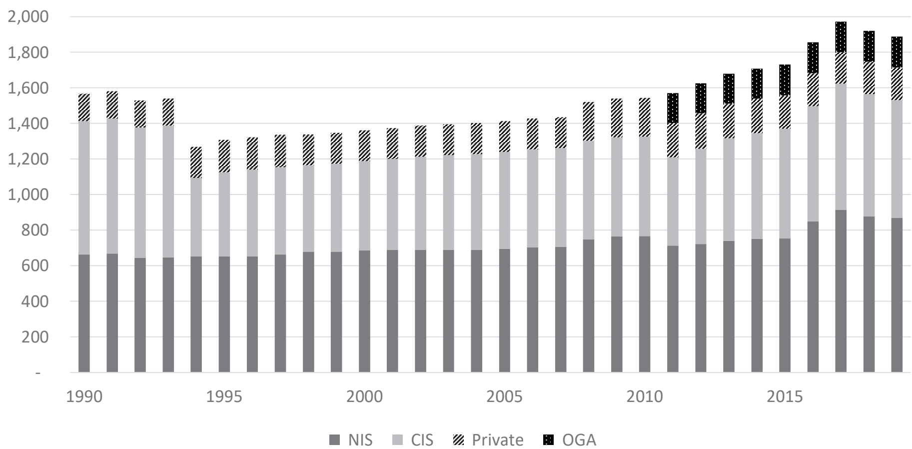
Total irrigated area of the country in 2016 was about 1.86 million hectares (ha), of which about 46 percent are national irrigation systems (NIS) and 35 percent are communal irrigation systems (CIS)(Figure 2). The remainder (19%) is composed of other government systems, plus private irrigation systems. The NIS correspond to government irrigation systems from 1,000 ha and higher, administered by the National Irrigation Administration (NIA). CIS consist of systems below 1,000 ha, which are administered by local government units (LGUs) and fully managed by irrigators' associations (IAs) (NIA 2020).

Figure 1. Expenditures on irrigation in 2000 prices: Philippines, 1965–2016 (PHP millions)



PHP = Philippine peso
Source: Inocencio and Inocencio (2020)

Figure 2. Irrigated area by system: Philippines, 1990–2019, (in '000 ha)



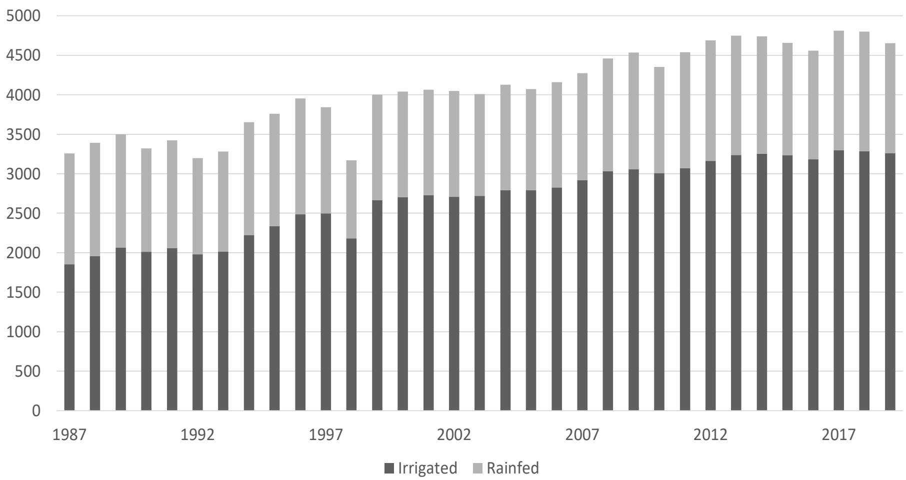
ha = hectare; NIS = national irrigation systems; CIS = communal irrigation systems; OGA = other government agencies
Source: Inocencio and Inocencio (2020)

There was a huge revision in the estimated area of CIS as a result of a validation exercise by NIA in 1994. In 2011–2012, some NIS and CIS areas were converted to other government systems, hence the decrease in area for both. Nonetheless, compared to the baseline figures in 1994, the country's irrigated area in 2016 was 46 percent larger. In particular, growth rate of irrigated area was fastest in 2011–2016 at an annual rate of 3.4 percent, compared to an annual rate of 1.15 percent in 1996–2011, consistent with the rise in irrigation investment discussed previously. In 1996–2000, growth rate of CIS was even faster, reaching an annual rate of 5.5 percent.

Over the long term, area harvested for all palay and irrigated palay have been increasing, but the pace of growth has slowed since 2011.

As expected, the expansion in irrigated area has led to an increase in area harvested both for all palay and irrigated palay (Figure 3). However, the acceleration in the growth of area from 2011 onward has been accompanied by a deceleration in growth of area harvested of irrigated palay and total palay. The reason for this is the contraction in irrigated area in 2015–2016 and rainfed area in 2014–2016. The former, in turn, was attributed to a severe El Niño phenomenon in 2015–2016; the area harvested recovered immediately after the event, but fell again in 2018–2019.

Figure 3. Area harvested for palay by system: Philippines, 1987–2019 (in '000 ha)

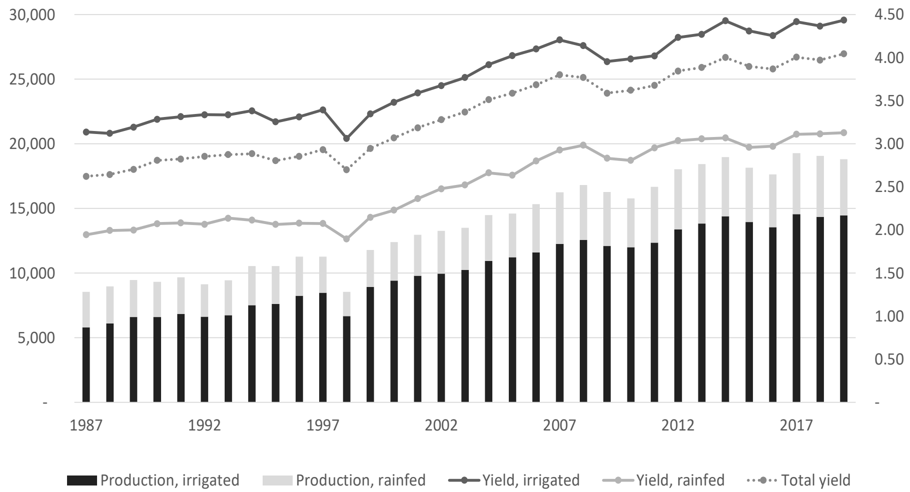


ha = hectare
Source: PSA (2020)

Compared to rainfed palay, irrigated palay is produced with higher yield and at lower cost; however, yield and cropping intensity of irrigated palay has recently been falling.

Palay production has been increasing from just 8.5 million tons in 1987 up to an all-time high of 19.3 million tons in 2017 (Figure 4). However, output has seen intermittent dips, most recently in 2015–2016 owing to an El Niño episode.

Figure 4. Production ('000 tons) and yield (tons per hectare) by system: Philippines, 1987-2017



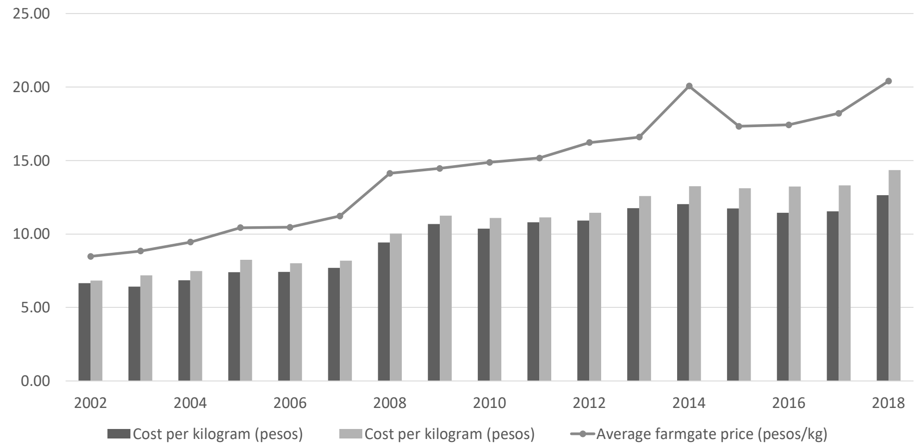
Source: PSA (2020)

Previously, similar bouts of El Niño caused output to fall in 2009–2010, as well as in 1997–1998. Yield of palay has likewise been in an upward trend, though an erratic one, reaching a peak of 4.0 tons per ha in 2014, after which, it declined. In 2017, though, it recovered to the same level of 4.0 tons per ha. While both irrigated and rainfed palay follow an upward trend, irrigated palay retained a consistent yield advantage over rainfed palay (40–50%).

Irrigated palay has a significant cost advantage over rainfed palay and realized a sizable margin over production cost at farmgate price.

Production cost per hectare for irrigated palay has exceeded PHP 50,000 since 2013, compared to PHP 40,000 per ha for rainfed palay. However, owing to higher yield, irrigated palay has a significant cost advantage (Figure 5). Production cost of irrigated palay ranges from PHP 11 to PHP 12 per kilogram (kg) since 2011, compared to rainfed palay, which ranges from PHP 11 to PHP 13 per kg. The average cost advantage is about 8 percent. Production of irrigated palay realized a sizable margin of farmgate price over production cost, averaging 50 percent since 2011; as rainfed palay is priced nearly the same, the margin over production cost for rainfed palay is somewhat lower.

Figure 5. Cost and returns by system: Philippines, 2002–2018 (in PHP per kg)



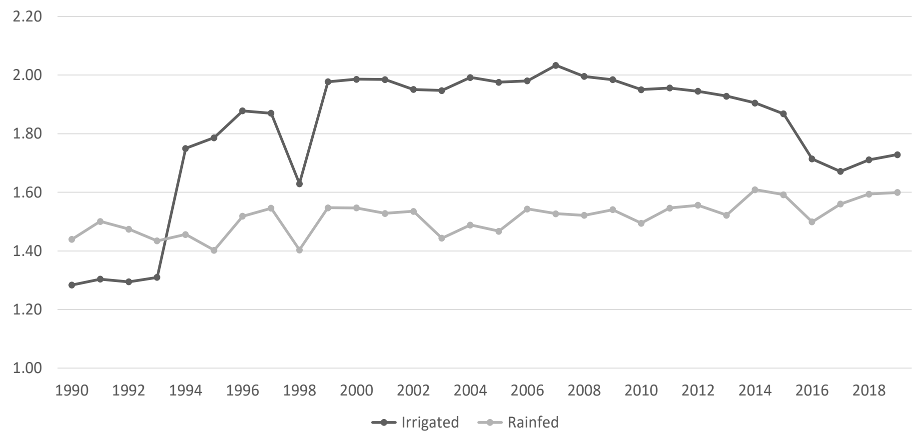
PHP = Philippine peso; kg = kilogram
Source: PSA (2020)

Cropping intensity of rainfed systems exceeds unity and has been relatively stable, whereas that of irrigated systems rose to more than 2 and then declined.

In the following, cropping intensity in irrigated systems is defined as the ratio of annual area harvested for irrigated palay to total irrigated system area. Meanwhile, cropping intensity for rainfed systems is the ratio of total area harvested per year for rainfed palay to area harvested in the second semester (the rainy season). The ideal is cropping intensity of 2 or more for irrigated systems, while the expectation is cropping intensity of 1 for rainfed systems.

In fact, cropping intensity for irrigated systems approximated 2 only in 2000–2007 (Figure 6). During the period of resurgent irrigation investment, cropping intensity began to decline, reaching a low point in 2016. This is consistent with expansion in irrigation investment discussed previously, together with area under irrigation, but the weak growth in area harvested since 2010.

Figure 6. Cropping intensity estimates by system: Philippines, 1990–2019



Source of basic data: PSA (2020)

Past studies on benefits and costs of irrigation

Early evaluations of irrigation systems noted large discrepancy between expected and actual performance.

The first wave of irrigation investments in the 1970s and early 1980s was followed by several evaluations in the 1990s. David (1990) observed that gains in CI and yield were low, owing to poor performance of the country's irrigation systems. For the nation's flagship irrigation project—the Upper Pampanga River Integrated Irrigation System (UPRIIS)—David (1990) noted the following technical problems:

- Assumptions on water availability, efficiency, water requirement, and sediment inflow were systematically over/understated to raise the economic internal rate of return (EIRR). For example, at feasibility study stage, the UPRIIS was appraised at EIRR of 13 percent, but at ex post was reappraised at 8.9 percent, which falls below the 12-percent cutoff.
- Design philosophy tends to be highly unrealistic. For instance, UPRIIS design engineers introduced double-gated water control structures that are too sophisticated for farmers and watermasters to operate. There is

no interaction between design engineers and farmers about proper design and operations.

- Irrigation-related agencies fail to coordinate with one another. Design engineers do not communicate with operations and maintenance (O&M) engineers for feedback and advice. Agencies in charge of watershed management are unable to control sedimentation rates, which reached up to 375 percent above appraisal estimate. The Pantabangan Watershed Management and Erosion Control was poorly conceived and unable to control the flow of sediment into the Pantabangan Dam.

Similar findings were broached in by the World Bank (WB 1992a). Design improvements are warranted, such as

- greater attention to siltation, erosion, and related problems, and
- a more realistic approach to water control toward staggered and rotational rather than continuous supply.

There is also potential for improving O&M in the following areas:

- minimizing silt inflows;
- optimizing reservoir rules;
- more effective utilization of rainfall and return flows; and
- systematized rotational distribution and/or staggered transplanting.

Meanwhile, the following principles are propounded as guidelines for future investment:

- Large multipurpose projects are likely to prove justified only if the costs of headworks and other joint facilities can be attributed primarily to purposes such as electric generation.
- New run-of-the-river national projects will continue to be important but many are high cost with a limited dry season water supply and/or difficult physical conditions.
- Communal irrigation remains a relatively high priority, subject to rigorous application of agreed selection criteria to ensure that high-cost and economically low-return projects are avoided.

The WB report noted with concern the policy thrust of rice self-sufficiency, which is driving large investments in irrigation. The important role of rice self-sufficiency was reiterated in a study of investments in irrigation from 1953 to 1988. Kikuchi et al. (2003)

showed that public investments in irrigation can be explained by an indicator of rice self-sufficiency, as well as short-run changes in world rice prices (which affect rates of return to investments).

A review of the literature by David (1995) confirms these findings, with some additional observations:

- On average, actual irrigated area is only 75 percent of design service area; large systems have a smaller ratio than small systems; and new irrigation projects (after 1972) tend to have much lower ratios (56%) compared to older systems (94% for projects before 1965).
- Selected foreign-assisted projects exhibit overruns in terms of time (60% on average) and cost (50% on average), with EIRR at completion dates generally lower than at appraisal dates, across a wide range of irrigation systems.
- Overestimates of EIRR are not only results of overestimates of service area, but also due to failure to anticipate declining world prices of rice, which are the basis for imputing the shadow price of domestic rice.

Wider policy context

Chapter 1 has demonstrated the tight link between irrigation and policies and programs in relation to rice. Rice policy in the Philippines has been undergoing dramatic shifts in recent years. In trade policy, the state has reversed decades of self-sufficiency targeting to accede to its international trade obligations by converting nontariff barriers into equivalent tariffs. In rice industry development, the latest draft of the *Rice Industry Roadmap* (DA 2019) continues to target import substitution, but subject to a cost-plus margin, i.e., 35-percent tariff protection but free trade otherwise. Income of rice farmers is targeted to increase by 50 percent by 2022. The roadmap adopts a strategy of irrigation development focusing on priority medium-yield provinces (Table 1), with percent irrigated area harvested below the national average.

Despite these recent shifts, budget allocation for irrigation appears to follow a different set of priorities, i.e., as if the previous regime of production targeting and self-sufficiency remain intact. This leads to expenditure allocations sustaining the levels observed since around 2011, i.e., PHP 30 billion or greater. Such allocations are justified in terms of the benefits, although a proper evaluation of these investments is to systematically compare benefits to costs.

Table 1. Priority medium-yield provinces in the Philippines

Low Cost	Medium Cost
Agusan del Norte	Bohol
Aklan	Compostella Valley
Albay	Ifugao
Antique	Negros Oriental
Camarines Sur	Occidental Mindoro
Capiz	Quezon
Cavite	
Iloilo	
Lanao del Sur	
Leyte	
Maguindanao	
Masbate	
Negros Occidental	
Palawan	
Sorsogon	
South Cotabato	
Surigao del Sur	
Western Samar	

Note: In the Philippines, medium-yield provinces have an average yield of 3–4 tons per hectare. Priority medium-yield provinces are those with low cost (below PHP 12 per kg) and medium cost (PHP 12 to PHP 17 per kg).
PHP = Philippine peso
Source: Department of Agriculture (2019)

Methodology

Valuation of benefits and costs

Benefit-cost analysis applies the **with-and-without** comparison: the **with** or baseline is the actual situation with irrigation investments; the **without** or counterfactual is the hypothetical situation without irrigation investments. The **increment** or change in benefit and cost is the difference in benefits and costs of irrigation investments between the two cases.

The cost of an irrigation project involves the following:

- value of resources associated with the irrigation system itself, mainly construction cost (but also sundries, such as foregone output from land occupied by canal system); and
- value of resources associated with increased cropping intensity and increased yield.

Meanwhile, benefits from an irrigation arise from a more controlled delivery of water to a farmer's field, as an alternative to rainfall. Benefits from an irrigation project are therefore measured by the incremental value of crop output. In the Philippines, the crop that captures nearly all the benefits from irrigation is rice, i.e., irrigation programming is designed primarily to boost rice production. Incremental rice production is obtained through the following channels:

- Irrigation enables the farmer to plant during the dry season, thereby increasing cropping intensity, i.e., frequency of harvest per unit of physical land area.
- Irrigation leads to an increase in yield, through greater exposure of palay to sunlight during the dry season and controlled timing of water delivery in the wet season.

Note that water generates multiple types of benefits, hence, construction of an irrigation system generates ancillary benefits. Depending on its design, an irrigation system can be instrumental to production of potable water, electricity, and even fish. Moreover, it can provide drainage services and flood management. In this chapter, though, the valuation of benefits is limited only to that related to incremental crop production; the issue of valuing ancillary benefits is revisited in the concluding section.

Benefit-cost analysis is best done at the level of an actual irrigation project. However, the thrust of this assessment is to assess the policy of catching-up with the estimated backlog in irrigation investment over the past decade, hence, will be implemented at a highly aggregated scale.

Note that at the level of individual systems, benefit-cost analysis uses the same sets of prices used to value with-project and without-project situations. Such an assumption is questionable when analysis is done at the sector level where incremental output is large enough to affect market prices. We shall return to this issue later.

Project lifespan and measures of project worth

For an irrigation project, costs are typically incurred upfront, i.e., during the first several years as the system is being established. Meanwhile, benefits are realized over an extended time horizon, equal to the duration of irrigation services provided by the system; by convention, thirty years. To render the two streams comparable, the suitable method is discounting to present value, using a social rate of discount. The difference between total discounted benefits and total discounted costs is called *NPV* (net present value). Denoting *t* as time periods; B_t, C_t the benefits and costs, respectively, for each period; *N* the total number of periods in the lifespan of the irrigation project(s); and *r* the social discount rate; then *NPV* is calculated as

$$NPV = \sum_{t=0}^{N} \frac{B_t - C_t}{(1+r)^t}$$

The official social discount rate for evaluating projects is 10 percent, following the latest National Economic and Development Authority guidelines (NEDA 2016). Meanwhile, the ratio of total discounted benefits to total discounted costs is the benefit-cost ratio (BCR). Lastly, the discount rate needed to equate NPV = 0 is the internal rate of return (IROR). The project merits social investment when NPV > 0; BCR > 1; or IROR hurdles the social discount rate.

Time horizon

The time interval over which irrigation investment was implemented is 2008–2016. Assessment done only over the past horizon is called **ex-post** assessment. The advantage of evaluating over a past period is that actual prices and quantities are known. If the evaluation interval ends in 2016, then incremental benefits can be estimated from differences in yield and cropping intensity between irrigated systems (with investment) and rainfed systems (without investment). However, the estimate of cost cannot be the entire development cost, as that cost was incurred to generate a stream of benefits into the future. Rather, the past benefits must be made comparable to some measure of past costs. This can be most readily implemented by converting the total irrigation investments into a stream of annuity values over the relevant past interval. Letting *PV* to denote present value of the asset, then annuity payments *P* over *N* periods are given by the formula

$$P = \frac{PV \cdot r}{1-(1+r)^{-N}}.$$

Alternatively, the interval can extend up to the future period wherein the benefit stream from irrigation accrues. In this case, the entire development cost of the investment can be used, dispensing with annuity value. However, there is no data about future prices by which to value the incremental output. To generate estimates of future prices, a multimarket equilibrium model, the Agricultural Market Model for Policy Evaluation (AMPLE) is applied. A complete description of AMPLE is found in Briones (2013).

Using AMPLE to generate baseline and counterfactual scenarios

Note that each year in AMPLE is a three-year average to smooth out vagaries of agricultural production (a standard practice in multimarket agricultural policy models). That is, AMPLE year 2015 is a three-year average for 2014–2016. Hence, 2016 (interpreted as the average for 2015–2017) is a suitable starting point for the projection.

The AMPLE will be used to generate a baseline scenario, which incorporates the with-irrigation case. The baseline will incorporate a key policy reform to be implemented in 2019, specifically, the repeal of the quantitative restriction (QR) on importing rice. The QR has hitherto been implemented under the import monopoly of the National Food Authority conferred by Presidential Decree 4. The QR prevents the domestic price of rice at wholesale level from converging with the world price in terms of milled rice. Consequently, palay price is also elevated compared to the no-QR scenario. In 2018, Republic Act 11203 was passed by Congress. The law converts QRs into tariffs, equivalent to bound rates of 35 percent for imports coming from countries in the Association of Southeast Asian Nations; 40 percent for most-favored-nation (MFN) imports in-quota; and 180 percent for imports out-quota where "quota" or minimum market access is set at 350,000 tons. Its implementing rules and regulations were released in March 2019.

Implementing the counterfactual scenario involves shocking an area share parameter in AMPLE that leads to endogenous area harvested for each crop, including irrigated rice. Relevant equations of the AMPLE model are given in Equations 1 to 7 where *i* denotes index the crops of AMPLE and *j* the nonland inputs. Crop output, QSS_i is obtained by multiplying area harvested () A_i) by the yield per hectare () Y_i) (Equation 1). Yield itself is obtained from a Cobb-Douglas production function; at the profit optimum, per hectare supply is a function of producer prices (PP_i), input prices (W_j), and various parameters (Equation 2). The net revenue function $NREV_i$ is given by total revenue, net of the factor share of nonland inputs equal to αY_i (Equation 3).

$$QSS_i = A_i * Y_i \tag{1}$$

$$Y_i = \left[\left(PP_i^{\alpha Y_i} \right) * \left(\alpha 0 Y_i \right) * \prod_j \left(\alpha 1 Y_{ij} / w_j \right)^{\alpha 1 Y_j} \right]^{\frac{1}{1-\alpha Y_i}} \tag{2}$$

$$NREV_i = \left(1 - \alpha Y_i\right) * PP_i * Y_i \tag{3}$$

$$A = \left(\sum_i \beta_i A_i^{\rho} \right)^{\frac{1}{\rho}} \tag{4}$$

$$atot = \sum_i A_i \tag{5}$$

$$LAM * ATRAN * atot = \sum_i NREV_i A_i \tag{6}$$

$$A_i = ATRAN * atot * \left(LAM * \beta_i / NREV_i \right)^{\sigma A} \tag{7}$$

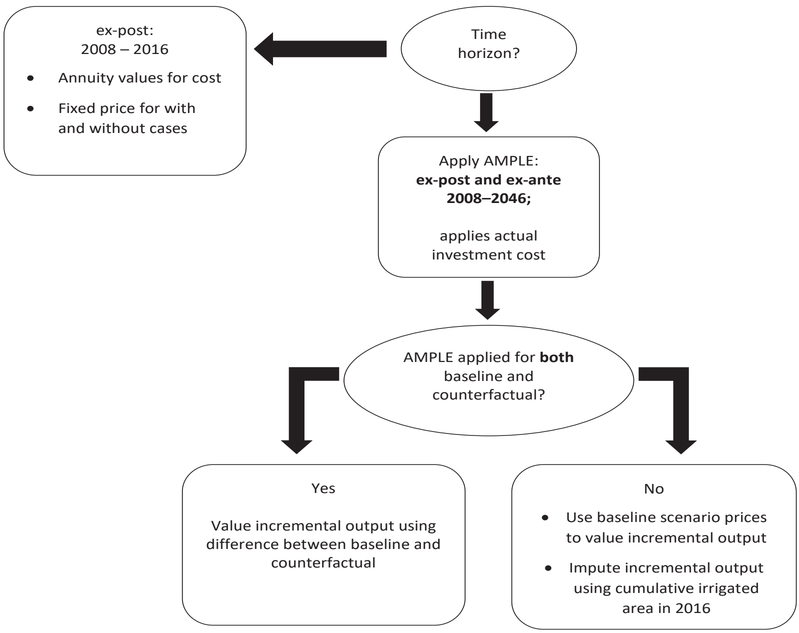
The interesting part of the framework is Equation (4), which expresses total area harvested as a constant elasticity of substitution function of the area harvested of each of the crops, together with a share parameter β_i . Further imposing the constraint that total area *atot* is the sum of area harvested by crop (Equation 5) gives rise to an adjustment variable *ATRAN;* in conjunction with minimizing cost by choice of area harvested, subject to an overall area harvested constraint, then total net revenue across all crops is a product of the Lagrange multiplier *LAM*, the adjustment variable *ATRAN*, and *atot.* The same factors, together with the share parameter in Equation (4), and $NREV_i$, determine area allocation under minimum cost (Equation 7). It is this share parameter that can be shocked to calibrate the difference in irrigated area due to investment.

Summary of assessment frames

To synthesize the foregoing discussion, benefit-cost analysis (BCA) will be conducted under several assessment frames, summarized in a flow chart (Figure 7). The first decision point for the BCA is the time horizon of the assessment. If the horizon is limited to the past, then the assessment frame is **ex-post assessment**. Incremental benefits are compared to annuity value of development costs over the period 2008–2016. On the other hand, if the horizon includes the future, then the assessment frame is **ex post and ex ante**. The ex-ante projection applies the AMPLE. The baseline incorporates projections of future price and output, together with policy reform in 2019 as rice import quotas are converted to tariffs set at 35 percent.

The next decision point is generating the counterfactual scenario. One option is to apply AMPLE itself, representing the counterfactual by an appropriate shock affecting the size of irrigated area in 2016. NPV and other measures of project worth are obtained by comparing the baseline with the counterfactual scenario. Alternatively, AMPLE is only used to generate projections for baseline scenario for prices; incremental output is obtained from the cumulative irrigated area, multiplied by difference in cropping intensity and average yield between irrigated and rainfed systems.

Figure 7. Assessment frames for benefit-cost analysis



AMPLE = Agricultural Market Model for Policy Evaluation
Source: Author's illustration

Findings

Ex-post 2008–2016

Table 2 presents a summary of investment costs for the past horizon for 2008–2015 while the impact of irrigation is shown in Table 3. For Table 2, the investments summarized in the Total, market prices and Total, 2006 prices both involve projects under the following classification, with intervals for completion of construction:

- totally new construction: 3 years
- more than 50 percent new construction: 2 years
- less than 50 percent new construction: 1 year
- total rehabilitation: 1 year
- other: 1 year

Table 2. Investment costs of irrigation projects: Philippines, 2008–2015 (PHP millions)

	Total	2008	2009	2010	2011	2012	2013	2014	2015
Total, market prices		8,327	15,201	14,107	13,858	24,326	30,530	16,969	22,115
Total, 2006 prices		1,423	13,093	11,707	10,990	18,698	22,784	12,164	15,629
Annuity value		7,632	7,632	7,632	7,632	7,632	7,632	7,632	7,632
NPV, annuity value	44,788	7,632	6,938	6,307	5,734	5,213	4,739	4,308	3,916

NPV = net present value; PHP = Philippine peso
Source: Author's calculations

The horizon is truncated at 2015 as the projects with the shortest duration to realizing benefit is one year. Based on market prices, irrigation investments in nominal terms rose from PHP 8.4 billion in 2008 to PHP 22.1 billion in 2015. Deflated to 2006 prices, the corresponding amounts were PHP 1.4 to PHP 15.6 billion. The estimated annuity value was PHP 7.63 billion every year, for which the discounted value, in turn, was PHP 44.8 billion.

As for impact, benefits from investments are felt from 2009 onward as irrigation investment takes at least one year to generate incremental output. The change in

Table 3. Estimated impact of irrigation: Philippines, 2008–2016 (PHP millions)

	2009	2010	2011	2012	2013	2014	2015	2016
Change in irrigated area (ha)	19,995	22,726	74,499	122,253	181,900	211,089	235,730	362,301
Palay price (PHP per ton)	14,760	14,870	15,170	16,220	16,760	20,070	17,330	17,430
Difference in yield	1.1	1.2	1.1	1.2	1.2	1.4	1.4	1.3
Difference in CI	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.7
Incremental returns	326	378	1,154	2,246	3,433	5,210	4,789	5,787
Difference in cost (PHP per ton)	-580	-730	-330	-540	-840	-1,210	-1,390	-1,270
Incremental cost	-46	-66	-99	-280	-653	-1,131	-1,413	-1,958
Total benefit, 2006 prices	320	369	993	1,941	3,049	4,545	4,383	5,379
Discounted value of benefit	291	305	746	1,326	1,893	2,566	2,249	2,509

ha = hectare; CI = cropping intensity; PHP = Philippine peso
Source: Author's calculations using PSA (2018) data

irrigated area is computed from a base year 2008, i.e., it is the **cumulative** change in irrigated area from 2008 onward. The value of incremental output is computed from the change in irrigated area, multiplied by the palay price, difference in yield, and difference in cropping intensity. The latter is computed not based on actual difference in cropping intensity of irrigated areas and nonirrigated areas, but rather as cropping intensity of irrigated areas less unity. This tends to bias the calculation of incremental output upwards. The resulting incremental output begins from just PHP 326 million in 2009 and rising to PHP 5.8 billion by 2016.

An additional source of benefit is the reduction in incremental cost, computed as the difference in cost per ton multiplied by the change in irrigated area and the total yield in irrigated areas. The resulting incremental cost was PHP 46 million in 2009, rising to about PHP 2 billion in 2016. The total benefit in real terms is the sum of incremental output and cost savings. The sum of discounted benefits from 2009 to 2016 was **PHP 11,885 million.**

The measures of project worth based on Tables 1 and 2 are shown in Figure 8. The NPV (discounted benefits less discounted costs) was PHP 32.9 billion, as costs greatly exceed benefits. This is reflected in the BCR, which shows discounted benefits are only 26.5 percent as large as discounted costs. No amount of positive discount rate can alter this outcome. In fact, the discount rate has to fall to -42.2 percent to achieve a zero NPV.

Figure 8. Measures of project worth, irrigation investments, ex post: Philippines, 2008–2016

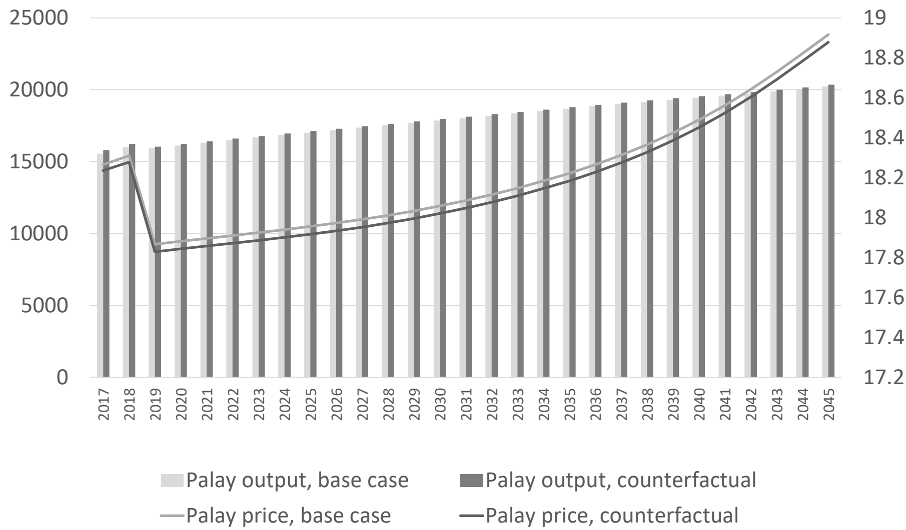
BCR = benefit-cost ratio; IRR = internal rate of return; NPV = net present value
Source: Author's calculations

Ex post and ex ante, 2008–2045

Next, the author examined the assessment frame involving the combination of ex-ante and ex-post horizon. The baseline scenario incorporated projected population and income growth to 2045 to account for changes in demand to 2045. For the counterfactual scenario, a change in share parameter by 4.2 percent was set. From the ex-post analysis, the cumulative area harvested by 2016 was computed, adjusted by difference in cropping intensity (rainfed vs. irrigated), as 258,673 ha. The aforementioned shock to β_i led to a decline in area harvested for irrigated rice approximately equal to 259,905 ha. The results of the baseline and counterfactual scenarios are shown in Figure 9.

In the baseline scenario, output rises from 15.8 to 20.4 million tons, whereas in the counterfactual, output rises from 15.5 to 20.2 million tons (Table 4). In both cases, rounding off reduces annual growth to just 0.9 percent. Trends in palay price are also very similar; under the base case, palay price goes from PHP 18.24 per kg in 2017, up to PHP 18.88 (in 2015 prices) in 2045. Compare this to an actual 2017 price (for "other paddy varieties") equal to PHP 18.21 per kg. Meanwhile, in the counterfactual scenario, 2017 palay price is very similar at PHP 18.26 per kg, rising to PHP 18.92 in 2045.

Figure 9. Palay output ('000 tons) and palay price (PHP per kg), base and counterfactual case: Philippines, 2017–2045



PHP = Philippine peso; kg = kilogram
Source: Author's calculations

Table 4. Irrigated palay output (in ‘000 tons) and price (in PHP per kg), projections for 2017–2045: Philippines

	2017	2027	2037	2045
Palay output, base case	15,813	17,465	19,107	20,357
Palay price, base case	18.24	17.95	18.27	18.88
Palay output, counterfactual	15,551	17,364	19,001	20,244
Palay price, counterfactual	18.26	17.99	18.31	18.92

PHP = Philippine peso; kg = kilogram
Source: Author’s calculations

Note that palay prices experience a relatively big drop in 2019 whether in the baseline or the counterfactual scenario. This is attributed to the policy reform of tariffication envisaged to be adopted in 2019. The implicit tariff rate for milled rice (84.3% in 2014–2016) falls by assumption to a 35-percent explicit tariff rate from 2019 onward.

The figures shown in Table 5 imply incremental returns starting at PHP 4.3 billion in 2017. However, the incremental returns decline to just over PHP 1 billion per year over the subsequent decades, as the difference between with and without case narrows over time. Together with the incremental cost savings, total benefit deflated to 2006 prices reaches PHP 3.1 billion in 2017, down to just PHP 1 billion or below in subsequent years. With discounting, benefits accruing in later years decline to single-digit levels (Table 5).

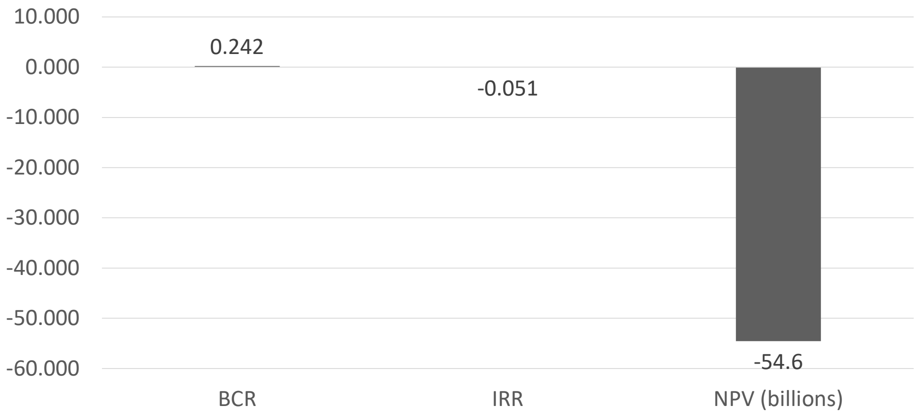
Table 5. Palay output and price, projections for 2017–2045, in PHP millions

	2017	2027	2037	2045
Incremental returns	4,320.22	1,127.70	1,210.78	1,351.72
Difference in cost (PHP per ton)	-861	-861	-861	-861
Incremental cost	-225.49	-86.42	-90.91	-97.04
Total benefit, 2006 prices	3,157	843	904	1,006
Discounted value of total benefit	1,339	138	57	30

PHP = Philippine peso
Source: Author’s calculations

Across the measures of project worth, expanding the time horizon improves the evaluation of irrigation investment only for the IROR, which increases to -5.1 percent (Figure 10), from -42 percent (Figure 8). The reason is that extending the time horizon allows for a more extended period in which positive returns are accruing to the project. However, the ratio of benefits to costs falls slightly down to 24 percent, from 26 percent under ex-post assessment. Lastly, the NPV falls further to PHP -55 billion, as extending the benefit horizon is simply unable to balance the full investment cost incurred in 2008–2016.

Figure 10. Measures of project worth, irrigation investments, ex ante and ex post: Philippines, 2008–2045



BCR = benefit-cost ratio; IRR = internal rate of return; NPV = net present value
Source: Author's calculations

Ex post and ex ante, 2008–2045, fixed loss in irrigated area

A sensitivity analysis was conducted wherein AMPLE is only applied to generate baseline prices; incremental output uses a fixed estimate of the change in irrigated area in the counterfactual, equal to the cumulative irrigated area for 2008–2016 (Table 6). Incremental returns are now much higher than in the previous ex-post and ex-ante analysis, as it rules out endogenous adjustment of the agricultural market to a shock in irrigated area. Incremental output ranges from PHP 8 billion to PHP 8.4 billion by 2045. In 2006 prices and discounted to present value, the total benefits range from PHP 2.5 billion in 2017 to just PHP 0.2 billion by 2045.

Measures of project worth for the fixed irrigated area counterfactual are shown in Figure 11. With higher benefit estimates from 2017 onward, the IROR rises to positive values, reaching 4 percent. However, it remains far below the hurdle rate of 10 percent. Likewise, the BCR rises to 51.8 percent, but remains far below the cutoff of 100 percent. Finally, the NPV rises to negative PHP 35 billion, compared to negative PHP 55 billion in the previous analysis. However, society continues to incur significant loss by overinvestment in irrigation.

Table 6. Palay output and price, projections for 2017 to 2045: Philippines (in PHP millions)

	2017	2027	2037	2045
Incremental returns	8,071	7,946	8,089	8,356
Difference in cost (PHP per ton)	-861	-861	-861	-861
Incremental cost	-381	-381	-381	-381
Total benefit, 2006 prices	5,870	5,783	5,882	6,068
Discounted value of total benefit	2,489	946	371	178

PHP = Philippine peso
Source: Author's calculations

Figure 11. Measures of project worth, irrigation investments, ex ante and ex post: fixed change in irrigated area, Philippines, 2008–2045

BCR = benefit-cost ratio; IRR = internal rate of return; NPV = net present value
Source: Author's calculations

Conclusion

This study conducted a systematic comparison of irrigation investments undertaken in 2008–2016. The analysis adopted various assessment frames to arrive at a more robust set of conclusions about the resurgent irrigation program. Across all frames, the findings converge around this conclusion: the **costs of irrigation investment are too large compared with the expected benefits**. None of the project worth indicators reached threshold levels. Rather, the BCR tends to fall below unity; IROR estimates tend to fall below the hurdle rate of 10 percent; and estimated NPV tends to fall below zero.

These findings are far from original. They simply continue a strand of researches on irrigation programs in the past decades, which also found that IROR at the feasibility study stage tends to overestimate actual returns. This is, moreover, consistent with the findings of other studies conducted by the Philippine Institute for Development Studies under this research program, which saw considerable gaps between potential and actual benefits of irrigation.

This begs the question of how irrigation projects gain approval at the feasibility stage. Key informants from NIA have pointed out that actual feasibility studies incorporate noncrop benefits from irrigation, as mentioned in the section on irrigation expenditures. This highlights a key limitation of this study's BCA, which only incorporates benefits from incremental rice output.

This paper does not deny wholesale the validity of the government's policy on investment programming for irrigation. Certainly, there will be any number of irrigation projects making appropriate assumptions about future crop and noncrop benefits, which will validly reach favorable findings about IROR, BCR, and NPV. This paper argues rather that policy reform abandoning production and self-sufficiency targeting, already underway, be adopted more consistently. The justification for investment planning in terms of reaching some target level of potential irrigation area should be treated with greater skepticism. And finally, project evaluation at the feasibility stage must be stricter about making credible projections concerning future crop and noncrop benefits of proposed irrigation projects.

Chapter 8

Assessing the Resurgent Irrigation Development Program of the Philippines: Synthesis Report

Arlene B. Inocencio, Albert Dale B. Inocencio, and Roehlano M. Briones

Introduction

Irrigation sector development is a key policy instrument in the pursuit of improved agricultural production and crop productivity. It supports the "*Ani at Kita*" program of the Department of Agriculture (DA), as well as the food security objectives of the nation. The rice crisis, threats to food security, and the need to assist smallholder farmers have been the main drivers of the irrigation program resurgence being implemented by the government since 2009 (David and Inocencio 2012).

Given the importance of irrigation in terms of national budget allocation and its expected contributions to agriculture and in addressing food concerns, this chapter examines the effectiveness and efficiency of the government's irrigation program. It synthesizes the findings and recommendations of the previous chapters while incorporating broader issues of irrigation, with a focus on governance, particularly higher-level issues cutting across national irrigation systems (NIS) and communal irrigation systems (CIS), and across other water sector agencies.

Specifically, this chapter focuses on the performance of both NIS and CIS in terms of technical, physical, and institutional aspects. As a means to structure the discussion, the synthesis is organized around the research issues clustered under the various stages of a typical project/program cycle, namely, project identification, design and appraisal, implementation and procurement, operations and maintenance (O&M), and monitoring and evaluation (M&E). It is hoped that breaking down the analysis by stage allows a substantive, comprehensive, and systematic analysis of program status, assessment findings, and recommendations for improvement.

Project identification

Current status

Identifying and scoping potential projects is the first stage in the cycle. The key starting point for project identification is the concept of **potential irrigable area**, which provides an initial basis of scoping, both at the macro level (in terms of national targets and budgeting) and the micro level (in terms of possible irrigation projects on the ground).

For the National Irrigation Administration (NIA), project identification is part of a set of activities called **project preparation,** which is a continuing function to ensure a wider base for the selection of projects. Sources of information for potential projects are technical specialists at the national, regional, irrigation management and system offices, and local leaders.

The next stage after project identification is project preparation and analysis. The conduct of feasibility studies is included in this stage. The feasibility study (FS) addresses the question of whether alternative projects are a better way of achieving the project objectives. In this way, the FS enables planners to redesign the project and determines whether the project is worth its investment cost. For complex projects, a succession of increasingly more specific and well-defined projects may be undertaken as part of project preparation. The methodology of NIA's selection and prioritization of projects is summarized in Table 1. The methodology adheres to the Agriculture and Fisheries Modernization Act (AFMA) classifications of project types, while the criteria reflect NIA's design philosophies.

Table 1. Criteria for selection and prioritization of NIA irrigation projects under AFMA (%)

Categories (Main/Sub)	NIP/ NIS New	NIS Rehab	CIP/ CIS New	CIS Rehab	Multi-purpose
(1) Technical feasibility	**33**	**25**	**25**	**25**	**28**
Project components	0	0	0	0	20
Extent of area for rehabilitation	0	0	0	25	0
Cropping intensity	0	0	20	0	8
Water supply	0	15	0	0	0
Availability of hydrologic data	0	10	0	0	0
Water resources	15	0	0	0	0
Land resources	10	0	0	0	0
Type of project	8	0	5	0	0
(2) Agro-institutional feasibility	**0**	**50**	**40**	**45**	**0**
Status of farmers/ Status of IAs	0	0	15	10	0
Right of way	0	0	10	0	0
Landholdings	0	0	5	0	0
Type of soil	0	0	5	0	0
Status amortization	0	0	0	10	0
Willingness to amortize additional cost	0	0	0	10	0
Willingness to render equity	0	0	0	10	0
Local government acceptance	0	0	5	5	0
Ratio of present over target no. of beneficiaries	0	5	0	0	0
With existing IAs	0	10	0	0	0
Present performance level of IAs (1-10)	0	10	0	0	0
Commitment of IAs to O&M	0	25	0	0	0
(3) Socioeconomic and financial feasibility	**38**	**10**	**20**	**20**	**42**
Economic internal rate of return	10	10	10	10	15
Level of irrigation development in the region	10	0	5	0	9
Development cost per hectare	8	0	5	10	8
Per capita income in the project area	5	0	0	0	5
Population density	0	0	0	0	5
Average farm size	5	0	0	0	0
(4) Environmental and other factors	**29**	**15**	**15**	**10**	**30**
Watershed conditions	9	10	10	10	10
Environmental impact	5	5	5	0	5

Table 1. Continued

Categories (Main/Sub)	NIP/ NIS New	NIS Rehab	CIP/ CIS New	CIS Rehab	Multi-purpose
Reservoir resettlement	0	0	0	0	10
Endorsement/acceptability of beneficiaries	5	0	0	0	5
Availability of hydrologic data	5	0	0	0	0
Availability of maps	5	0	0	0	0
Total	**100**	**100**	**100**	**100**	**100**

NIA = National Irrigation Administration; AFMA = Agriculture and Fisheries Modernization Act; NIP = national irrigation project; NIS = national irrigation systems; CIP = communal irrigation projects; CIS = communal irrigation systems; IAs = irrigators' associations; O&M = operations and maintenance; rehab = rehabilitation
Source: Schema Konsult Inc. and Eptisa (2016)

Currently, decision criteria for selection and prioritization cover technical, economic, environmental/social, and institutional considerations. NIA provides detailed guidance in assessing identified projects according to type. Note that some of the subcriteria appear to belong to other categories, such as type of soil, availability of hydrologic data, and maps, which are technical factors while endorsement by project beneficiaries would fit better under institutional feasibility.

Assessment issues and findings

Problems

Micro level: The aforementioned methodology promises to place project identification on an objective footing. However, critics have charged that, in practice, politicians interfere in project selection. Further, they co-opt for their own interests project decisions regarding construction, rehabilitation, distribution of water, and even staff appointments and promotions (Rola et al. 2019). Political pressures, rent-seeking, and corruption perpetuate technical and economic inefficiencies in the irrigation and water sector (Wade 1982; Repetto 1986; Araral 2005a; Huppert 2013). Project identification and selection seem to be the starting point of this interference. In the Philippine context, interference may be motivated by advocacy over voter constituencies, as well as naked self-interest given that many of these politicians are landowners and contractors themselves.

Macro level*:* On a broader macro perspective, it is clear that, on the demand side, rice self-sufficiency has been driving the demand for more irrigation projects; whereas, on the supply side, the notion of potential irrigable area has been enabling this demand to muster the funding needed by the resurgent irrigation program. However, inaccuracies in delimiting this potential area could both overestimate the need for irrigation (i.e., unjustified projects being approved) or underestimate it (i.e., omission of actually feasible projects). Questions considered in this assessment include the following: How can the present irrigation potential estimate/estimation process for the whole country be improved? What is the correct methodology for estimating the service area of an identified project, considering both engineering and economic constraints?

Methodology for estimating irrigation potential

Unfortunately, local land-use plans are not often updated. As such, designed service areas of NIA appear not to properly consider actual land uses. Estimates of potential irrigable area by NIA have failed to account for the expansion of residential, commercial, and industrial uses of land.

The NIS and CIS studies found that to improve the present irrigation potential estimation process, use and updating of certain data would be required. In national systems, irrigation potential of the available agricultural lands is already low, owing to limitations due to slope and soil productivity. Moreover, degradation of the watersheds due to human activities and other factors contribute to unstable water supply for irrigation, which, in turn, reduces irrigation potential.

These findings seem to imply that developing new areas will increasingly become more difficult. On the other hand, a key criterion adopted for delimiting potential irrigable area is the 0–3-percent slope requirement. In fact, the CIS study shows that many irrigated systems are already in the 8-percent slope. Relaxing the criteria to an 8-percent slope may substantially expand the potential irrigable area.

Lastly, the following additional considerations, mainly drawn from UPLBFI (2019), are also needed in scoping of potential irrigable area:

- administrative boundary from the National Mapping and Resource Information Authority, which provides land cover data (latest available is for 2015) together with the slopes (usually for 0-3% and 3-8%) from its interferometric synthetic aperture radar (IfSAR);
- soil suitability from the Bureau of Soils and Water Management (BSWM);

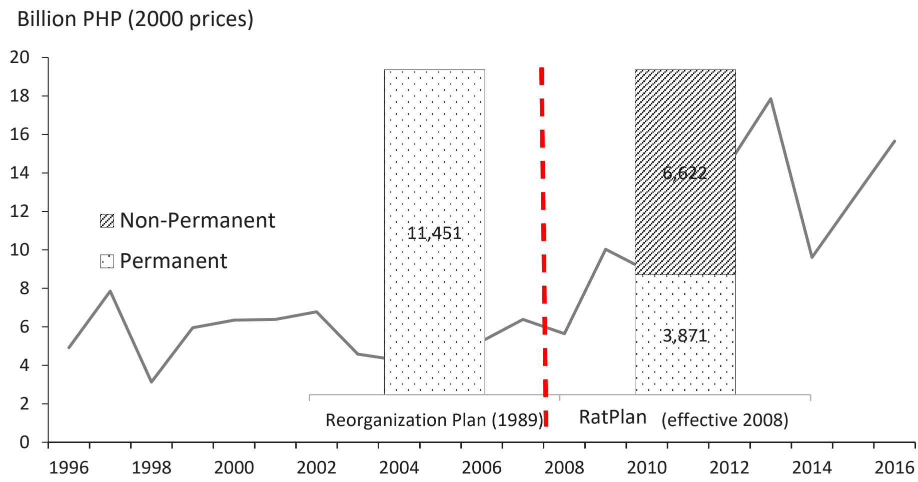
- data on existing land uses and water bodies, such as the road network from OpenStreetMap;
- delineation of ancestral domains from the National Commission on Indigenous Peoples;
- delineation of protected areas from the Biodiversity Management Bureau;
- delineation of inland water bodies, including rivers, streams, and lakes, from OpenStreetMap and land cover data;
- delineation of built-up areas, also from the land cover data, which can be updated through Google Earth;
- delineation of forest and mangrove areas from land cover data;
- fault line maps from the Philippine Institute of Volcanology and Seismology;
- projected land uses, in anticipation of land conversions, especially in rapidly urbanizing provinces;
- existing demands on water as shown in the water permits already approved by the National Water Resources Board (NWRB); and
- future status of water resources in view of climate change.

Institutional capacity for project design and appraising proposed projects

The government Rationalization Plan (RatPlan) implemented in 2008 and completed in 2012 resulted in the reduction in NIA's staff from 11,451 authorized plantilla positions (1,021 in NIA Central Office and 10,430 in the field offices) to just 3,819 plantilla positions (392 in Central Office and 3,427 in field offices). Many senior technical staff took advantage of the RataPlan to retire from service. NIA's budget, however, continued to increase even if the number of authorized positions remained the same following the RatPlan (Figure 1).

From merely PHP 12.8 billion in 2011, NIA's budget increased to PHP 32.7 billion in 2016, PHP 38 billion in 2017, and PHP 41.7 billion in 2018. NIA had to rely even more on job order personnel and consultants and contracted out some of its work. Currently, over 50 percent of NIA personnel have no security of tenure because they consist of casuals and job order personnel. Out of the 12,455 NIA employees as of November 2018, about 35 percent are casual and 21 percent are job order positions. Permanent positions only represent one-third of the total. The RatPlan reduced the capacity of NIA, particularly the Central Office, to prepare prefeasibility studies and other project development activities (Cablayan et al. 2014; NIA 2018; Ponce et al. 2019).

Figure 1. Public expenditures for irrigation, 1996–2016 (2000 prices) and number of NIA positions before and during the RatPlan



RatPlan = rationalization plan; PHP = Philippine peso; NIA = National Irrigation Administration
Source: Ponce et al. (2019)

Given this gap between expectations and capacities, NIA has been proposing for a reorganization or organizational strengthening to address the dire staff shortage resulting from the RatPlan. This is evidenced by the organization strengthening proposal formulated by NIA, which is yet to be approved by the Board. The NIA Board, on the other hand, wants the National Irrigation Master Plan (NIMP) completed before approving the reorganization proposal.

Coordination with the Department of Agriculture and local government units

Identification of irrigation projects had largely been an internal process within NIA. The NIA central office obtains inputs from its regional offices, but seldom from other agencies. The transfer of NIA from DA to the Office of the President (OP) severed its connection with DA programs. This is a missed opportunity, as DA has been facilitating the identification of priority commodities and infrastructure for all the provinces covered in the World Bank (WB)-funded Philippine Rural Development Program (PRDP). The process of identification under this project appeared to be very consultative and made use of all available data, including suitability and vulnerability assessments. Coordination with DA will also facilitate crop diversification in irrigated areas given that DA has lately been promoting higher value crop mixes in view of the Rice Industry Road Map and the New Thinking on Agriculture.

Recommendations

Build capacity for developing new projects

If NIA is to improve its performance in identifying and developing projects, it has to rebuild its capacity, which has been largely diminished by the RatPlan and early retirement of many senior technical staff. As pointed out in the Trends paper, the significant gaps between planned versus actual new areas irrigated could partly be attributed to the slower generation of prefeasibility studies required in programming projects (UPLBFI 2019).

Increase coordination with the DA and LGUs

NIA should increase its collaboration with DA and the local government units (LGUs). The priority commodities and infrastructure identified by DA, together with the LGUs and other government and nongovernment agencies through the PRDP project, can guide in identifying potential irrigation projects that are relevant to the provinces, particularly in terms of commodities and locations to support.

Consider land conversion trends in the estimation of irrigation potential

NIA should consider projected changes in land use and land conversions, especially in larger projects. Trends in converting agricultural lands for industrial and residential applications must be considered in land suitability assessment and classification. Adjusting estimates of irrigation potential to anticipate land conversion will save the government millions or billions of pesos in public funds invested in irrigation only to be converted for nonagriculture uses. Where irrigated lands are converted, the government should at least put in place a policy of recovering its investments.

Include the assessment of water supply sources in defining irrigation potential

The NIS and CIS reports recommended that planning for the annual increase in irrigated areas should be based on the dependable water supply of the rivers in the basin. The water balance analysis in the river basin master plans would be a good starting point in the estimation of water duties for new areas for irrigation development. Improved data collection and management is required, given that data adequacy and quality were always found to be the constraints to proper estimation of irrigable areas. The formula to compute for water supply through time should be calibrated to account for climate change. Thus, the database to be generated can also be used by NWRB as basis for issuance of water permits, which shall, in any case, be required by any planned irrigation project.

Project design and appraisal

Overview

Formal appraisal of proposed irrigation projects is mostly done for big projects, as stated in the governance report. The funding agency, like the WB or the Asian Development Bank, creates an appraisal team composed mostly of hydrologists and engineers while NIA usually assists in the field. The appraisal is mostly technical.

Project design ideally should be sufficiently well developed to allow for immediate and straightforward project implementation but flexible enough to allow for adaptation without causing undue delay, wasted expenditures, or cost increases (WB 1981). After project preparation, an appraisal should be conducted. Project appraisal is the opportunity to review all project aspects and as a final check before committing funding for the project (Gittinger 1981).

Project appraisal builds on the project plan, but may also rely on new information should project specialists deem it warranted. Shortcomings in design appear to have been a result of projects being approved without sufficient preparation or sufficient detail to permit implementation. Issues encountered in the assessment studies and previous literature are summarized in the next section.

Findings

Insufficient resources and time for project preparation

As shown in Table 2, project preparation activities within NIA appeared to have been given little attention even before the RatPlan implementation. One sign of improvement, however, can be seen in the 2018 figures with much-increased allocation and relatively higher percentages of completed FS and detailed engineering. But relative to the magnitudes of projects, even a 2-percent allocation may seem small if the critical role of getting the designs right is considered as among the first few steps in successfully implementing projects.

Related to this concern, there is the issue of time lag between FS and implementation with FS that are already 10 years old by the time the project gets funded (Moya 2014). Also noted by Moya was that engineers know how to design well but seemingly not why, thus the need for peer-reviewers or third-party reviewers. According to Moya, engineers usually veer toward traditional design approaches rather than adapting to actual field conditions.

Table 2. Status of project preparation activities

	2018	2017	2013	2012	2008	2007
FSDE obligation (PHP million)	927	415	283	336	31	32
Total obligation (PHP million)	41,160	48,710	31,309	24,218	8,327	8,745
As % of total	2.25	0.85	0.90	1.39	0.37	0.37
Completed FS*	191	172	91	3	2	8
Completed DE*	164	111		0	3	0
Completed as % of target FS	70	74	31	11	13	53
Completed as % of target DE	54	47		0	21	0

* Figures in 2013 are combined FS and DE.
** FS for 2007–2008, 2012 includes pre-FS/project identification
FSDE = feasibility study detailed engineering; FS = feasibility study; DE = detailed engineering; PHP = Philippine peso
Sources: NIA inventory of irrigation systems (Various years)

Lack of consultative process in project design

A key aspect of the design is achieving operational flexibility by anticipating the needs of O&M in system design. There is little interaction happening between the design and implementation, and the operations units of NIA (Moya 2014). Ideally, in constructing farm water facilities, the main and lateral canal water elevations (hydraulic working head) are determined and firmed up first. Then, the microtopography of the area is carefully considered by involving the farmers as they have intimate knowledge of their areas. In fact, upon project completion, the irrigation systems are turned over to the operations staff, with little or no design inputs from O&M engineers, let alone farmers.

Capability for science-based project design and appraisal

In the implementation of less viable projects, design mistakes in irrigation projects could partly be attributed to weak capacities for design and appraisal. NIA is now more dependent on consultants for FS. There appears to be reliance on proponent and donor design and assessment and insufficient independent checks in the project planning and appraisal. The National Economic and Development Authority (NEDA) has been funding more FS in the last few years and commissioning consulting firms, many of which are tapping experts from the academe.

Absence of geo-referenced data and other science-based information

A key concern on project design has been the systematically smaller service area found in various studies, relative to the original design area. This suggests that the potential irrigable area has been consistently overestimated, owing to failure to account for urbanization, flooding, and so on.

The NIS report points to the benefits of high-resolution data using geographic information system (GIS) and science-based information at the level of the basin and at the irrigation system, which includes mapping the location of structures, measurements, and spatial analysis of erosion, groundwater potential, and identification of flooded and elevated areas. These high-resolution data and information can also enhance the targeting of interventions and programming areas for irrigation. However, this type of database will require intensive data gathering that will not only establish the land-based potential but will also take into account both surface and groundwater potential. The latter includes determining recharge rates of groundwater as a function of rainfall, runoff, evapotranspiration, inflows/outflows and percolation, and upward flux, among others.

Using GIS analysis, the NIS component found that significant proportions of NIS service areas are unsuitable to irrigated rice farming. The analysis points to the degraded states of the NIS watersheds, accounting in part for the heavy siltation in the systems. On the other hand, the groundwater maps show areas with high potential for groundwater resources to supplement inadequate water supplies from surface water. These applications illustrate the enormous potential of applying geo-referenced data in planning and appraisal of irrigation projects.

Delineation and coordination of roles with other agencies and LGUs

Chapter 5 of this book identified at least 13 agencies involved in irrigation project planning, design, and appraisal. Interagency committees have been created to orchestrate the participation of all the concerned agencies, often including representatives from nongovernment and people's organizations.

While roles and functions are clearly spelled out on paper, coordination problems persist. With the transfer of NIA to OP, DA has now broadened the scope of DA-BWSM. Small farm reservoirs, small diversion dams with a height of below 3 meters, small water impounding projects, small water irrigation systems associations (SWISAs), and distribution systems traditionally under NIA are now covered by DA-BWSM. On the other hand, when El Niño occurs, NIA distributes pumps to farmers, which has historically been the function of DA.

Per the Local Government Code and the AFMA, the municipal and provincial LGUs are responsible for the development and funding of inter-barangay and inter-municipal irrigation systems. However, LGUs have largely sidestepped these responsibilities owing to limited resources and technical capacities. The IAs or SWISAs continue to coordinate with national agencies rather than LGUs, save for a few exceptions (e.g., the Southern Philippines Irrigation Sector Project).

Recommendations

Strictly adhere to rigorous benefit-cost analysis in project identification, even if this will require adjustment of physical targets.

The benefit-cost analysis (BCA) in Chapter 7 suggests that, on the aggregate, the resurgent irrigation program has suffered a shortfall of benefits compared to costs (if benefits are confined only to rice production impacts). Favorable assessments of viability for irrigation projects may be driven by physical targets for irrigation rather than the actual merits of the project. Instead, rigor must be maintained in the implementation of BCA.

Improve irrigation system designs

Luyun (2016) suggests that irrigation system design should consider the ability to irrigate small patches of lands (including flatlands on higher elevations) with limited sources of water; farmer empowerment or farmers getting a higher degree of control over the management of irrigation water (or operational flexibility); higher water use efficiency (lower conveyance losses because the farm is near the source); and possibly, flexibility for crop diversification. Additional emerging irrigation design philosophies include environment-friendly; participatory (stakeholder), particularly for communal and small NIS; and resilient irrigation systems (Moya 2014).

Opt for multipurpose projects

The governance study recommends that NIA should pursue multipurpose projects with hydropower and/or domestic water supply to increase the benefits and make projects (more) viable. Giving a percentage of income to the host communities of the dams and structures will engage the local people to protect these structures and extend the economic viability of the irrigation system.

Such multipurpose projects must engage experts who can do sectoral assessments. Optimizing incomes from the projects benefits NIA by providing revenues from generating power and addressing long-term water supply concerns in municipalities and cities downstream through the bulk water supply.

Define/delineate clearly roles and responsibilities

The governance study recommends a memorandum of agreement (MOA) specifying the roles and responsibilities of each agency and mechanics to improve the coordination among the agencies involved. NIA, together with local and national agencies, can converge on specific projects where a single, integrated rolling plan that would account for the dynamic nature of human, physical, and institutional players can be implemented.

Aside from linking with DENR's Forest Management Bureau (FMB), NIA should engage with DENR's River Basin Control Office to validate irrigation plans. Characterization of the critical watersheds should be an input in the design of irrigation systems, particularly at the regional level. Also, NIA can actively engage with LGUs and other provincial stakeholders through the PRDP platform, where provincial development councils generate priority projects to which NIA can validate and align its identified and designed projects.

Project implementation and procurement

Overview

Project implementation is the most important phase of the project cycle. Rather than mechanically following the project design, revisions may be undertaken during project implementation, given that some information are not available during the project design stage.

Gittinger (1981), citing Olivares (1978) on his review of agricultural projects, indicated that the most common reasons projects run into problems of implementation can be grouped into five categories: (1) inappropriate technology; (2) inadequate support systems and infrastructure; (3) failure to appreciate the social environment; (4) administrative problems, including those of the project itself, and of the overall administration within the country; and (5) policy environment, of which the most important aspect is producer price policy. Furthermore, administrative effectiveness during implementation can be affected by constraints from various fronts—from bidding failures for lack of qualified contractors/consultants/firms or absence of bidders, to right-of-way acquisitions, to the timing of releases of funding, and to seeking approvals and resistance by affected communities.

Findings

Roles and capacities of NIA, BSWM, LGUs, and farmers

The implementation of irrigation projects is done mainly by NIA and DA-BSWM. NIA has the technical capacity to implement projects while the Department of Agrarian Reform (DAR) and the LGUs rely on the technical expertise of NIA and BSWM.

For small-scale irrigation projects, BSWM is supposed to provide technical assistance, which includes capability building to regional field offices, LGUs, and SWISAs. The DA regional offices that implement BSWM projects set them up for bidding, or they enter into MOA with LGUs. The LGUs provide engineers and DA monitors the progress of the implementation. For DAR projects, the MOA identifies the recipients of the irrigation project. DAR engineers monitor the implementation of the construction of DAR projects. Again, owing to rationalization, technical staff of NIA for project implementation are usually hired under nonplantilla positions. IAs do benefit from support from NIA and other agencies, though there remains much room for upgrading of capacity through training and networking.

The role of farmers in project implementation is limited to the clearance of the right of way, participation and membership in IAs, provision of workforce, and other relevant forms of assistance. They actively participate in the implementation of new projects, in part due to NIA and the contractors drawing them in as project labor workers and for their indigenous/local knowledge, especially on the construction and rehabilitation locations.

Procurement process transparency and timeliness

NIA oversees procurement through the necessary bidding process, which is delegated, depending on the size of the projects, to the regional irrigation offices (RIOs) or the irrigation management offices (IMOs). Standard bids and awards committee procedure is followed in the procurement. The reports identified failure in the bidding as the cause of implementation delays. The governance study finds that delays in budget releases and the legal requirements for procurement tend to delay construction. Despite these, more than half of the respondent-farmers who have been active in the implementation of new projects reported timely implementation (from the formation of their respective IAs to construction).

Recommendations

Increase capacities to implement projects

As NIA is the organization that regularly implements irrigation projects, the governance report recommends to beef up its technical capacities to ensure that it would be able to address the demands of the collaborating agencies on technical assistance. With the formulation of a national irrigation master plan with even higher targets for new irrigated and rehabilitated areas, plantilla technical positions need to be created.

Improve procurement and understand better the bottlenecks in implementation

The governance component recommends revisiting the procurement law because, instead of facilitating, it is impeding efficient processes and causing delays in project implementation. Other than this, there is no systematic study that clearly establishes the most common problems in implementation and causes of delays. While some projects may have mentioned the weather, politics/corruption, and right-of-way problems, a better understanding of the bottlenecks will help in formulating effective solutions.

System management and operations and maintenance

Overview

After construction and turnover of the irrigation system, continuous irrigation service (conveyance of water to farmers' fields) entails management and O&M of the irrigation system. A set of issues arise in this stage of the project, particularly, addressing key technical issues in management and O&M (e.g., water scheduling and water diversion, siltation problem, avoiding system deterioration, cost recovery versus free irrigation, and participatory versus top-down management).

Findings

Increasing degradation and poor system performance

The studies highlighted the relatively poor states of existing irrigation systems due to inadequate O&M and rehabilitation. They cited increasing degradation of irrigation infrastructure, control structures in need of rehabilitation/improvement, canals needing de-silting, or reshaping or heightening of embankments. A good part of the service roads also need rehabilitation.

A key concern is the lack of funds to do proper O&M and rehabilitation to arrest, if not slow down, the deterioration even before the Free Irrigation Service Act (FISA). Pre-FISA, the internally generated funds of NIA, mostly composed of irrigation service fees (ISF), were insufficient such that the national government had to subsidize O&M of national systems. The collection rate was way below 100 percent, and yet, NIA could not exclude from its service farmers who did not pay the ISF.

Aside from inadequate funds, Moya (2014) raised an equally important concern—how is the O&M/rehabilitation fund spent? Moya noted that despite the varied rehabilitation and maintenance works needed, NIA's rehabilitation projects in the cases documented by de los Reyes (2017) were largely spent on canal lining at about 80 percent of the total project cost. Moya also raised the need to modernize systems and strengthen system resilience. Irrigation modernization entails upgrading of both technical and social components of existing systems. This direction will require higher investments in the updating and upgrading of both hardware/technical and software/social components of irrigation systems (Moya 2014).

Governance within irrigation systems

Governance problems within irrigation systems include compliance with water delivery scheduling and distribution, illegal diversion of water, and conflicts among users. Another issue is the resistance of farmers to change and adopt new technologies. Many farmers prefer traditional methods and refuse to follow the crop calendar.

To some extent, participatory irrigation management is a mechanism for farmers themselves to resolve intra-system conflicts and excess withdrawal while mobilizing resources from among themselves to undertake management and O&M. Cablayan et al. (2014) indicated that while the IAs have been organized in almost the entirety of existing NIS, at the time of the study, less than 80 percent had contracts under the "new" irrigation management transfer (IMT) policy: 40 percent with Model 1, 30 percent with Model 2, 2 percent with Model 3, and 1 percent with Model 4 contracts. With fewer NIA personnel at the system level, IAs had to be strengthened to accept more responsibilities in the O&M of systems. But IAs with Model 1 or Type 1/Type 2 contracts were reluctant to convert to Model 2 contract for fear of not being able to achieve the higher ISF collection targets set by NIA and ending up with zero shares in the collection. In Model 1 contract, IAs had guaranteed compensation for clearing canals and possible share from ISF collection if the base collection efficiency is surpassed. There were also officers of IAs who simply did not want to accept responsibility for collecting irrigation fees, which was an IA responsibility in Model 2 or higher-level contract. Moreover, some IAs were dissatisfied with their contracts due to NIA's failure to honor its commitment to complete repair and maintenance of facilities agreed upon during contract negotiation and inadequate support to improve O&M during water shortage and calamities.

Implementation and implications of FISA

With the passage of FISA, all farmers with landholdings of below 8 ha are exempted from paying ISF for water derived from NIS, as well as making amortization payments in the case of CIS. The FISA threatens to reverse the IMT process of devolving more responsibilities to IAs and reducing those of NIA in operating, managing, and maintaining systems.

NIA, however, came up with a "modified" IMT, which essentially collapses the four IMT models into a single contract. The incentive mechanism imbedded in the original IMT program, with the four different models taking into account capacity and performance, is gone as all IAs/ISCs are offered the same O&M subsidy per hectare and per 3.5 kilometers (km) (unlined) or 7 km of (lined) canal. While the annual functionality survey is still done in the "modified" IMT, the results are meant to determine what interventions and assistance are to be provided to the IAs and ISCs (irrigation service cooperatives).[1] In addition, the modified contract includes a provision for IMT performance evaluation to be conducted by both NIA and the IA/ISC. At first glance, this part provides some "disincentive" for extremely poor performance, which can lead to suspension of contract and provision of subsidy. However, if we note that NIA's takeover of the management of irrigation O&M and hiring of "contract of services" will, in fact, just free the IAs/ISCs of the responsibility and financial burden of topping up the inadequate O&M subsidy, the irrigation service will not be necessarily suspended and the erring IAs/ISCs can still benefit from the free irrigation service. In this sense, this supposed disincentive can potentially serve as an incentive for the IAs/ISCs to perform poorly.

The need for baseline geo-referenced data

To address O&M issues in NIS, a 4-year project was implemented from 2013 to 2017 through the NIA-Japan International Cooperation Agency (JICA) Technical Cooperation Project 3 (TCP3) to adopt an improved O&M system in NIS (NIA 2017c). This project involved reviewing existing O&M management methods, practices, and monitoring systems, and proposing methods and strategic plans for an improved O&M system. In addition, this project included piloting an O&M system with baseline data collection to initially populate the system. During the baseline survey in the project, some of

[1] The annual functionality survey also serves as basis for awards and incentives for annual search for regional and national outstanding IAs/ISCs in NIS and CIS systems.

the common issues found were (1) outdated basic information on farmers and their farmlands; (2) discrepancies in data of NIA and the actual farms; (3) lost data due to flood, fire, and other reasons; (4) unrepaired damages of irrigation facilities; (5) many illegal turnouts; (6) inequitable water distribution and downstream farms not getting water; and (7) several canals not constructed according to design, resulting in operational difficulties.

Under the NIA-JICA TCP3, the Farmland GIS (FGIS) with an integrated database of farmland information using satellite images was generated for a total of 10 pilot NIS. The basic problem encountered in this project was the collection of data and submission by the regional offices. Prompt and correct data submission holds the key to the success of FGIS. Among the Phase 2 project sites, only 3 out of 8 completed data validation in two years. Of the Phase 3 project sites, there were turnout service area groups that did not submit the needed data to the FGIS consultant. With all the failures and shortcomings in gathering information, TCP3 recommended that data collection for the NIS systems be continued and that NIA should do some validation even after the completion of the JICA project. One suspected cause of delay in the submission of parcellary data was the large number of farmers to get information from or the numerous parcellary data to be collected. Given the shortage of workforce in each NIA regional office, the collection of data for FGIS was not a priority.

This represents a key missed opportunity as geo-referenced data has the potential to make a meaningful contribution to system management and O&M. The GIS generated maps from the NIS report (Chapter 2) show the location of field walkthroughs and measurements, erosion sites, and groundwater potential. The significance of mapping erosion potential in NIS sites lies in the fact that runoff and flooding of lowland/irrigated areas depend on the typology and characteristics of the watershed surrounding the irrigation service areas. The upland watershed can be prone to erosion depending on the combined effects of vegetative cover (land use), soil characteristics (erodibility), slope (topography), and rainfall patterns (erosivity). These factors are used as inputs to the universal soil loss equation (USLE) to estimate soil loss and erosion potential of a watershed.[2] Many studies, validated by actual observations, have shown that eroded particles from upland areas are carried downstream and commonly cause siltation of watercourses, irrigation canals, and surface water systems. By mapping erosion potential, it is possible to assess which part of the watershed is prone to erosion and propose appropriate land use planning and

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[2] USLE is a widely used mathematical model that describes soil erosion processes. It predicts the long-term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, crop system, and management practices (Hudson 1993).

watershed management measures to protect the lowland areas from sedimentation and siltation that are believed to cause reduced flow capacity of canals and poor water distribution. This consideration appears to be missing in the identification of projects.

Recommendations

Adoption of asset management method

The adoption of the asset management method (AMM), which considers financial, economic, social, and engineering conditions to maintain the function of irrigation in a most cost-effective manner, is recommended. AMM combines the entire lifecycle (design, construction, operation, maintenance, repair, modification, replacement, and disposal) of respective irrigation facilities. This management method will be advantageous as it will reduce the life cycle cost of irrigation systems and the risks of suspension of water supply or damages caused by sudden and unexpected accidents.

JICA's and WB's earlier studies have already been pushing for this. Given the problem of performance and sustainability, it is imperative to implement a sustainable and cost-effective asset management plan (AMP). This AMP will enable NIA to utilize and maintain the condition of its assets in the best possible way—keeping the systems at good operating standards and providing levels of services that are consistent with cost-effectiveness and sustainability objectives.

The asset management activities will include the conduct of soundness diagnosis of irrigation followed by the formulation of long term maintenance plans for each irrigation system based on the results of the diagnosis. For the AMM to work, baseline data on the state of the systems will have to be established and then regularly updated. The AMM module in FGIS will provide information on the soundness of each facility visually and will make it possible to easily view detailed diagnosis results.

Continuous capacity building

To institutionalize the first recommendation, more NIA staff will have to be capacitated. In addition to the TCP3 pilot sites, the key NIA personnel for facility maintenance at each of the irrigation systems will have to be trained on AMM for the maintenance of irrigation facilities. Under TCP3, some NIA staff in the 10 pilot NIS have already been trained on irrigation system maintenance and management. The participants studied the methodology of soundness diagnosis of irrigation facilities and crafting of long-term maintenance plan. This initiative can use the TCP3 Maintenance Manual for irrigation systems, which includes the methods for carrying out the diagnosis and planning for the long-term maintenance of irrigation facilities. Resources will need to be allocated for this to be institutionalized at NIA and scaled up to include the rest of the NIS, and over time, can also be adopted for CIS.

Determination of appropriate O&M funds

Given the findings on poor states of many systems, NIA will need to allocate realistic resources for O&M and formulate effective policies and incentive systems so as not to defer O&M until the problem becomes a major rehabilitation project. Additionally, canal lining, while effective in reducing water losses, should be evaluated to confirm its long-term efficiency in comparison to unlined canals. With the use of the AMM, it is possible to come up with the appropriate estimates of fund requirements for appropriate O&M of systems.

Integration of watershed management with irrigation system management

The issue of erosion highlights not only the need for proper maintenance within an irrigation system but also to undertake proper watershed management and environmental protection outside the irrigation system. Whereas DENR-FMB is supposed to ensure the protection of the water sources for NIA, major watershed areas continue to deteriorate. This contributes to widespread siltation and the shortfall between actual and design service areas of irrigation systems.

Adoption of an integrated watershed management (IWM) is also suggested to control damaging runoff and degradation. IWM seeks to protect and conserve the watershed and control soil erosion and sedimentation in downstream areas. Additional benefits are moderation of floods peaks in downstream areas and increase infiltration of rainwater to hasten soil and groundwater recharge.

Project monitoring and evaluation

Overview

The final phase in the project cycle is **evaluation**. The idea is to systematically look at the elements of success and failure in the project experience to learn how to plan better for the future. A formalized evaluation may take place several times in the life of a project. It may be appropriate when a major capital investment, such as a dam, is in place and operating, even though the full implementation of the plan to utilize the water and power is still underway. Ideally, careful evaluation should precede any effort to plan follow-up projects.

Monitoring consists of tracking inputs, activities, outputs, outcomes, and other aspects of the project on an ongoing basis during the implementation period, as an integral part of the project management function. **Evaluation**, on the other hand, is a process by which project results, impacts, and implementation performance are assessed. Projects are evaluated at discrete points in time (usually at the project's midpoint and completion) along some key dimensions (i.e., relevance, efficiency, efficacy, impact, performance). Evaluations often seek an outside perspective from relevant experts.

For M&E, the study components were supposed to carry out the following: (1) identify the types of information to be regularly collected from the NIS and CIS for proper monitoring and evaluation; (2) develop the means to institutionalize an appropriate monitoring and evaluation system covering both NIS and CIS; and (3) demonstrate how information can be used for operations and planning of future projects.

Findings

Types of information to be regularly collected

Water flow is a basic measure critical to system management. However, in the cases cited in the NIS report, it was found that this information could not be obtained due to the nonoperational check gauges. Water quality, on the other hand, is characterized by indicators under the environmental aspect that include dissolved oxygen, pH, and electrical conductivity, which is related to salinity level.

On the environmental aspect focusing on water quality, pH levels on the alkaline side (>7) can be attributed to excess sodium that can lead to a sodicity problem in the future and pose a serious problem in water quality, especially if combined with high salinity levels. Another water quality indicator that affects photosynthesis and biomass production is dissolved oxygen (Clemente et al. 2018). Aside from saltwater intrusion, water quality has been adversely affected by illegal dumping of solid wastes by community residents.

Slow annual growth and focus on new investment

The annual growth of newly irrigated areas seems to go at a slow pace despite the huge investments, supposedly for development projects. The preference for focusing on new projects instead of rehabilitating inefficient systems is another concern. In fact, for 2010–2016, only 33 percent of irrigation expenditures were directed to new or mostly new projects. The emphasis on rehabilitation/restoration or mostly rehabilitation/restoration projects in recent years has been a remedial action given years of underspending on irrigation management and repair.

Institutionalizing an M&E system for NIS and CIS

According to the governance report, the participation of NIS IAs in M&E is high. Monitoring is done manually by ocular inspection of staff gauges by NIA with support from IAs. Most NIS IAs have an existing monitoring system for flow rates. Water flow is a basic measure critical to system management. However, for many irrigation systems, water flow data are unavailable due to nonfunctional check gauges. The IAs oversee the flow rates and report problems to NIA. Follow-up actions and interventions are sometimes done on time.

IA members are supposed to monitor the service area regularly, with the data collected being reported to the IMO to form the basis for next season's decisions on water allocation. However, beyond the basic water flow data, no other information are gathered and used for systems management.

Recommendations

Data collection and use of information technologies

There is considerable potential for more analytical approaches, such as reliance on GIS, mapping of structures and measurements, spatial analysis of erosion, resource assessment of water potential (including groundwater), and mathematical modeling and simulations. The NIS report recommends regular monitoring and collection of data on water flow and water quality in the irrigated areas and regular monitoring of structures, such that repair or replacement of damaged or nonfunctional devices is done on time. This recommendation is part of the AMM mentioned earlier. NIA and IAs can perform monitoring of flow rates while the IAs can do the monitoring of irrigated areas. Modern methodologies of analysis and design should be used, given the increased technical capacity of NIA. The GIS maps, for instance, should be used to show the performance of the IAs and the different irrigation systems throughout the country.

Use of modeling in the system for water allocation management

The water resources component proposes to develop, at the river basin level or large irrigation systems, a hydrologic/hydraulic-based model of the watershed, reservoir operations, and irrigation distribution associated with the systems. Model simulations can then be conducted to determine the actual irrigated areas according to the existing and other what-if scenarios of the water and land resources, as well as the configuration and dimension of the irrigation facilities. Simulation analysis can also be used to assess the design service areas concerning actual service areas based on water availability, land use (including flood vulnerability), status of irrigation facilities, available water resources, and available land resources (slope, soils, and land use).

Concluding remarks

After years of relative neglect, irrigation has again emerged as the single largest budgetary outlay in government-funded agricultural programs after the world rice price crisis of 2008. Since then, priority for irrigation and rice agriculture has been sustained over three administrations. Never has the goal of closing the gap between actual and potential irrigable area been nearer than today.

NIA had initially formulated a *2014–2028 Irrigation Master Plan*, which was revised in the *2017–2026 Irrigation Master Plan*. Most recently, NEDA has commissioned the preparation of a 10-year NIMP covering 2020–2030. The new master plan (which is yet to be formally adopted) sets forth a medium- and long-term investment program for the sector. The long-term program must culminate in the completion of the asset build-up for the sector. Once complete, public spending on irrigation thereafter shifts to O&M expenditure. Despite the tens of billions already invested, it appears the country remains far off from the end-goal of completion of asset build-up.

This volume has evaluated the resurgent irrigation development program to date, covering national systems, communal systems, and various program considerations, such as water resource assessment, governance issues, recent policy shifts (e.g., FISA), and benefit-cost comparison. The analysis will hopefully serve as input to the continued implementation of the irrigation development program, which, as argued earlier, has yet a long way to go. The assessment has sought to combine both field-based qualitative and ocular assessment, with state-of-the-art quantitative assessment (including hydraulic and economic modeling). Based on this assessment, the authors offer a set of practical and hopefully useful recommendations, primarily for NIA as well as for the broad set of stakeholders in the national irrigation development agenda.

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The Authors

Vicente G. Ballaran Jr. is an assistant professor at the Institute of Agricultural and Biosystems Engineering, University of the Philippines (UP) Los Baños, and an agricultural engineer by profession. He holds an MA in Agrometeorology from UP Los Baños. His areas of specialization are agricultural structures, field hydrology, and GIS/remote sensing.

Roehlano M. Briones is a senior research fellow at PIDS, where he conducts policy research for the Philippine government, with specialization in agriculture, CGE modeling, and rural development. He is a board member of the consultancy group Brain Trust Inc., a past board member of the Philippine Economic Society, and a fellow of the Foundation for Economic Freedom. He has a PhD in Economics from UP Diliman.

Roberto S. Clemente had been a professor at Asian Institute of Technology (Thailand) until 2012 and at UP Los Baños until 2018. He was also a *Balik Scientist* of the Department of Science and Technology (DOST). He is currently a consultant at the National Research Council of the Philippines and Philippine Council for Agriculture and Resources Research and Development of the DOST. He obtained his PhD in AgroEnvironmental Engineering from McGill University in Montreal, Canada. He specializes in environmental hydrology and land and water resource management.

Tomas Paolo Z. De Leon is an assistant civil engineer at AMH Philippines Inc. He obtained his BS in Civil Engineering degree from UP Diliman. He specializes in water resources engineering and civil works projects, such as design of water supply, storm drainage, and sewage systems for both commercial and residential developments.

Dulce D. Elazegui was a university researcher at the Center for Strategic Planning and Policy Studies, College of Public Affairs and Development, UP Los Baños. She obtained her master's degrees in Technology Policy and Innovation Management from the University of Limburg (renamed Maastricht University) in the Netherlands and Agricultural Development Economics from the Australian National University. She also took a summer certificate course on Sustainable Environmental Management at the University of California-Berkeley under the Beahrs Environmental Leadership Program. Her research work focuses on policy and governance in water and agriculture, climate change, natural resources and environment, and science and technology.

Francis John F. Faderogao is a university researcher at UP Los Baños where he obtained his bachelor's degree in Statistics. His research interests include integration of climate information into crop/hydrological simulation models for decision support in agriculture and water management.

Arthur L. Fajardo is a professor at the Institute of Agricultural and Biosystems Engineering, UP Los Baños where he obtained his PhD in Agricultural Engineering. His areas of specialization are in irrigation design and development, machine design and testing, soil tillage, mechanization, and renewable energy (microhydro and biomass).

Chrislyn Joanna P. Faulmino is a project research fellow at UP Diliman. She graduated from UP Los Baños with a bachelor's degree in Human Ecology. Her research interests revolve around water governance in the agricultural and domestic sectors.

Albert Dale B. Inocencio was a project research associate in the Assessment of the Resurgent Irrigation Program. He obtained his AB in Public Administration from UP Diliman. He is an MA candidate in the same program at UP Diliman.

Arlene B. Inocencio is a full professor and department chair at the School of Economics, De La Salle University (DLSU)-Manila. She teaches business economics, agricultural economics, environmental valuation, and public finance at DLSU. Her research areas cover irrigation and agriculture, provincial product accounts, domestic water, and poverty.

Roger A. Luyun Jr. is a professor at the Land and Water Resources Division of the Institute of Agricultural Engineering, College of Engineering and Agro-industrial Technology, UP Los Baños. He has a PhD in Agricultural Engineering from Kagoshima University, Japan. His areas of specialization include groundwater hydrology, irrigation engineering, water resources assessment, hydrologic modeling, hydraulic structures, and soil engineering.

Therese R. Olviga is a university research associate at UP Los Baños. She has a BS degree in Agribusiness Management from UP Los Baños. Her research interests include food security, natural resource economics, climate change, and governance.

Agnes C. Rola is a professor emeritus at UP Los Baños and a member of the National Academy of Science and Technology, Philippines. She obtained her PhD in Agricultural Economics from the University of Wisconsin-Madison, USA. Her research interests are in the fields of sustainable agriculture and natural resources management, water governance, gender and agriculture, and policy analysis of the convergence of water, food security, and climate risk management.

Guillermo Q. Tabios III is a professor emeritus of Civil Engineering at UP Diliman. He has a PhD in Civil Engineering from Colorado State University. He specializes in stochastic and computational hydrology and hydraulics as well as water resources systems engineering.

Julie Carl P. Ureta is a PhD Candidate in Forest Resources at Clemson University, South Carolina, USA. He was an assistant professor at the Department of Economics, UP Los Baños. His areas of specialization are in ecological and natural resource economics, agriculture and applied economics, spatial analysis and econometric modeling, and landscape sustainability.

After years of relative neglect, irrigation has again emerged as the single largest budgetary outlay in government-funded agricultural programs after the world rice price crisis of 2008. Since then, priority for irrigation and rice agriculture has been sustained over three administrations. Never has the goal of closing the gap between actual and potential irrigable area been nearer than today.

This volume has evaluated the resurgent irrigation development program to date, covering national systems, communal systems, and various program considerations, such as water resource assessment, governance issues, recent policy shifts (e.g., Free Irrigation Service Act), and benefit-cost comparison. The analysis will hopefully serve as input to the continued implementation of the irrigation development program, which, as argued earlier, has yet a long way to go. The assessment has sought to combine both field-based qualitative and ocular assessment, with state-of-the-art quantitative assessment (including hydraulic and economic modeling). Based on this assessment, the authors offer a set of practical and hopefully useful recommendations, primarily for National Irrigation Administration, as well as for the broad set of stakeholders in the national irrigation development agenda.

Philippine Institute for Development Studies
Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas

18th Floor, Three Cyberpod Centris–North Tower
EDSA corner Quezon Avenue, 1100 Quezon City, Philippines
Telephone Number: (632) 8877-4000
Email: publications@mail.pids.gov.ph
Website: https://www.pids.gov.ph
facebook.com/PIDS.PH twitter.com/PIDS_PH