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Evaluation of national irrigation systems in the Philippines

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The government, through the National Irrigation Administration (NIA), undertakes the planning, construction, operation and maintenance (O&M), and rehabilitation of national irrigation systems (NIS). These NIS are large gravity systems, typically more than 1,000 hectares in size.

Today, there are 242 NIS spread across the country, covering 46 percent of the total irrigated area of the country in 2018 (NIA 2019). NIS account to about half of the area that supply rice in the country, making its O&M critical in the food sufficiency program of the government. Despite the huge budget allocated to NIA, however, many NIS are underperforming based on selected indicators.

This Policy Note highlights the results and recommendations of a case study on the technical and institutional evaluation of 39 selected NIS in the Philippines (Table 1). It evaluates the policy and institutional framework governing irrigation development and management for the purpose of improving irrigation performance and productivity of irrigated lands.

The methodological approach in this study consisted of data collection through site visits, field measurements, key informant interviews, and focus group discussions. Meanwhile, the primary and secondary data mainly revolved around water supply and quality, conditions of irrigation structures and canals, profile of irrigators' associations (IAs), degree of satisfaction on water delivery, irrigation service fee (ISF) collection, and mapping of service areas, erosion, and ground water potential, among others.

Principal Component Analysis (PCA) was also used to assess the performance of the NIS cases considered at the IA level using four major categories, namely, technical/physical, institutional/organizational, economic, and environmental. PCA is a multivariate analysis of the numerous factors representing major indicators that affect irrigation performance.

Technical and institutional issues of NIS

This study identified several issues related to NIS, namely, siltation issues in canals, flooding problems, deterioration of canal and canal structures, and water quality issues, among others.

Table 1. National irrigation systems included in the study and their location

Location	Name of the irrigation system	
Luzon	Visitacion Irrigation System	Bonga Pump No. 2 Irrigation System
	Nueva Era River Irrigation System	Magapit Pump Irrigation System
	Banaoang Pump Irrigation System	Solana-Tuguegarao Pump Irrigation System
	Magat River Integrated Irrigation System	Ambayoan-Dipalo River Irrigation System
	Tarlac Groundwater Pump Irrigation System	Upper Pampanga River Integrated Irrigation System
	Tarlac-San Miguel-O'Donnell River Irrigation System	Pampanga Delta River Irrigation System
	Angat-Maasim River Irrigation System	Balayungan River Irrigation System
	Dumacaa River Irrigation System	Libmanan-Cabusao Pump Irrigation System
	Caguray River Irrigation System	
Visayas	Mambusao River Irrigation System	Binahaan-Tibak River Irrigation System
	Barotac Viejo River Irrigation System	Jalaur-Suague River Irrigation System
	Daguitan-Guinarona-Marabong River Irrigation System	Sibalom-Tigbauan River Irrigation System
	Capayas River Irrigation System	Bayongan River Irrigation System
	Malinao River Irrigation System	
Mindanao	Manupali River Irrigation System	Roxas-Kuya River Irrigation System
	Pulangui River Irrigation System	M'lang River Irrigation System
	Padada River Irrigation System	Banga River Irrigation System
	Marbel No. 1 River irrigation System	Malitubog-Maridagao River Irrigation System

Source: Author's compilation

Siltation in canals

Siltation arose due to lack of land-use planning and poor watershed management and maintenance, such as in the case of the five irrigation systems in Luzon, namely, Division 4 of Upper Pampanga River Integrated Irrigation System (UPRIIS), Solana Pump Irrigation System (PIS), Magapit PIS, Ambayoan-Dipalo River Irrigation Systems (RIS), and Caguray RIS. In Visayas and Mindanao, similar concerns were observed in Manupali RIS, Jalaur-Suague RIS, and Sibalom-Tigbauan RIS.

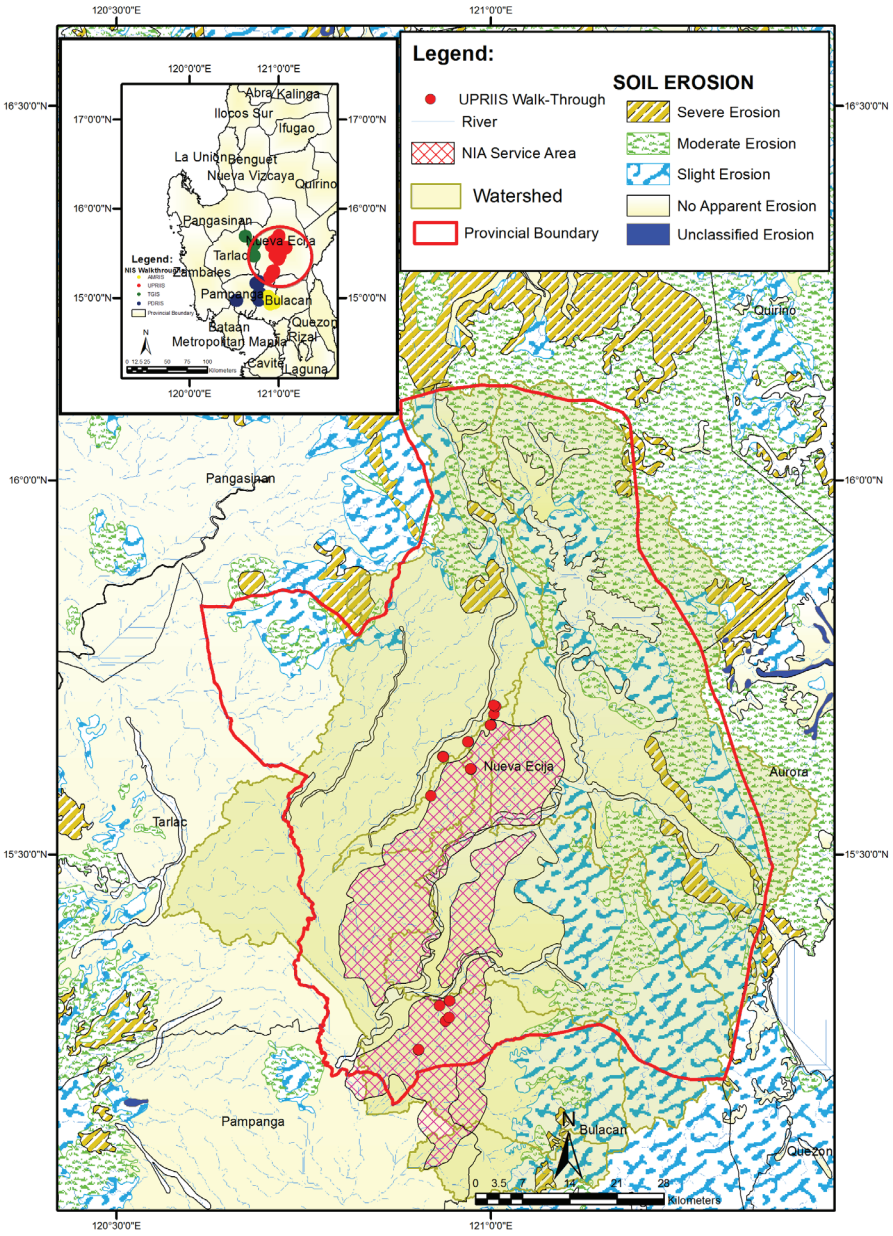
Siltation was moderately high across NIS cases, wherein >25 percent to <75 percent of each canal section was filled with silt. Figures 1 and 2 are representative soil erosion maps of UPRIIS in Nueva Ecija and Jalaur-Suage RIS and Sibalom-Tigbauan RIS in Iloilo, respectively, which show that erosion of upland watershed could be the major cause of siltation of irrigation canals in the downstream part of watershed.

Flooding in some NIS

In some cases, drainage canals are lower than the river, such as in Lal-lo IA in Magapit PIS and TG 86 in Tarlac Groundwater Irrigation System (TGIS). This causes flooding problems during the wet season because these canals cannot drain out the excess water. However, this kind of flooding problem was not widespread across the NIS cases visited in Luzon. It only existed in North Cotabato due to its location near the Liguasan Marsh.

Moreover, the downstream section of M'lang RIS and a section of Malitubog RIS were flooded only during wet season. Meanwhile, this problem was experienced in Bukidnon due to lack of proper drainage systems.

Figure 1. Erosion map for Upper Pampanga River Integrated Irrigation System



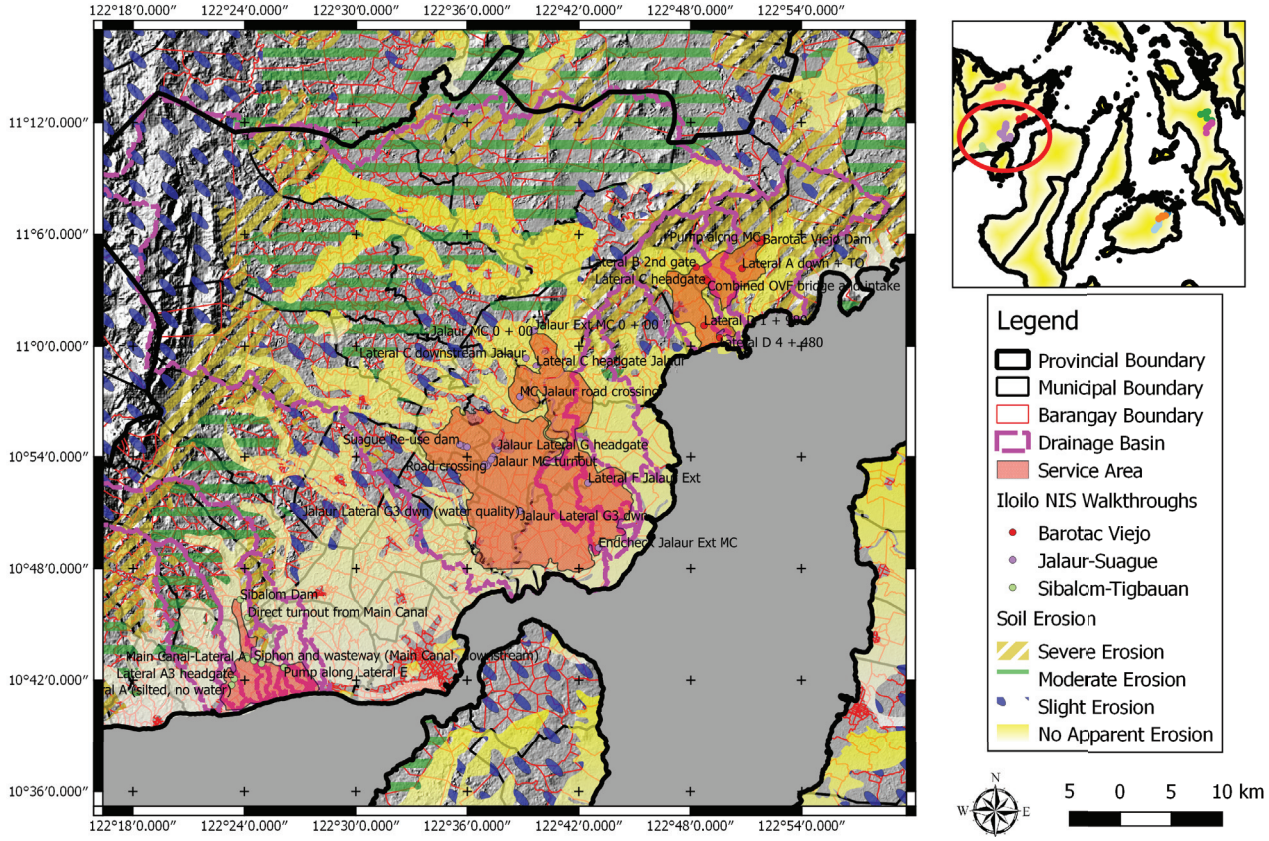
Source: Author's own based on shapefile data from the Department of Agriculture-Bureau of Agricultural Research (2002)

Deterioration of canal and canal structures

The efficiency of water distribution is a function of the condition of the main canals and laterals, especially in terms of the lining coverage and degree of siltation. As such, conveyance efficiency is low especially in earth canals, or the unlined ones.

More than 85 percent of the main canals and laterals in Pampanga Delta RIS, Bonga Pump #2 PIS, and Libmanan-Cabusao PIS were lined. Meanwhile, more than 80 percent of the main canals and laterals in Angat-Maasim RIS and Magapit PIS were unlined. Although most NIS canals were lined in Bohol and

Figure 2. Erosion map for Iloilo (Jalaur-Suague and Sibalom-Tigbauan River Irrigation Systems)



Source: Author's own based on shapefile data from the Department of Agriculture-Bureau of Agricultural Research (2002)

Marbel 1 RIS, many unlined canal existed in the other sites visited in Visayas and Mindanao, such as Jalaur-Suague RIS, Mambusao RIS, and Binahaan-Tibak RIS.

Staff gauges for determination of canal water discharges were also lacking in most NIS cases, such as Libmanan-Cabusao PIS, Ambayoan-Dipalo RIS, Caguray RIS, Balayungan RIS, Banaoang PIS, Bonga Pump 2 PIS, Nueva Era RIS, and TGIS. This limits information on available flows.

Institutional and policy issues

NIS currently face at least two institutional problems. First is regarding the water delivery scheduling and distribution. This is particularly true in the case of TGIS, Nueva Era RIS, Banaoang PIS, Magat River Integrated Irrigation System (MARIIS) Division 2, and Ambayoan RIS.

Second is regarding conflicts among users, especially when upstream members block the path of water, which reduces the water supply in the downstream area. Some farmers were hesitant to pay ISF because of poor water service, especially in the downstream area. Many farmers were still traditional and did not follow a cropping calendar, such as in Banaoang PIS and Manupali RIS.

In Division 4 of UPRIIS, informal settlers along the canals posed solid waste problems. These concerns may reach the other systems, especially if NIA policies are

Poor water service is one of the issues concerning national irrigaton systems (NIS) in the Philippines. According to the authors, informal settlers living along the canals of NIS pose solid waste problems, which can further worsen the situation. Photo: Roberto Clemente

not properly enforced. Institutionally weak AIS can also be vulnerable to this concern in the future.

ISF collection was rated as poor in the upstream area of Division 3 of UPRIIS. In some IAs, farm-to-market roads were also in poor condition, such as in New Life IA in MARIIS, Dagupan IA in Visitacion RIS, Ambayoan-Dipalo RIS, Balayungan RIS, Binahaan-Tibak RIS, and Pulangui RIS. They were also not passable, especially during the wet season.

The enforcement of policies was also weak in the NIS sites in Visayas and Mindanao, where the problem of illegal settlers and garbage dumping also exist in Binahaan-Tibak RIS, Padada RIS, Pulangui RIS, and Maridagao RIS. Although the concern on ISF collection was not an issue during the survey in Visayas and Mindanao, some related problems on lack of budget for maintaining and cleaning canals were raised by some IAs, such as in Jalaur-Suague RIS.

Water quality issues in a few systems

On water quality, most NIS cases showed pH levels on the alkaline side (>7), which can lead to sodicity problem. In TGIS and Magapit PIS, salinity problems can pose serious effects on crop development and

yield. Another important water quality indicator that affects photosynthesis and biomass production is dissolved oxygen (DO), found to be low in UPRIIS and Pampanga Delta RIS. Low DO was also reported in most NIS in Bohol, Davao del Sur, North and South Cotabato, and Bukidnon.

Mapping unsuitable service areas using GIS

By using geographic information system (GIS) map overlay, this study was able to show the unsuitability of significant proportions of NIS service areas to irrigated rice farming. In one of the cases assessed, the study found a reduction in firmed-up service area (FUSA) by 16 percent because of soil erodibility alone. Meanwhile, the overlaid maps indicated that only 54 percent of the total FUSA in MARIIS is most suitable to irrigated rice agriculture.

Similar diagnostics were performed for the other systems, with varying estimates of irrigated rice suitability. GIS maps also documented the degraded state of some NIS watersheds, which also accounted for the heavy siltation in these systems. Groundwater potential map also showed areas with high potential for groundwater resources to supplement inadequate water supplies from surface water.

Poor irrigation performance

On the performance assessment, many IAs in Luzon had shown low performance levels (47%) because of inadequate water supply, especially in downstream areas. Only 12 percent, usually those in upstream areas, showed high performance. Even with data limitations in the analysis of indicators, water delivery remained one major factor that caused low performance among IAs. In Visayas and Mindanao, 32 percent exhibited low performance, while 45 percent performed moderately. The level of performance for the 87 IAs is broken down as follows: 28/87 (32%), 39/87 (45%), and 20/87 (23%) were showing low, moderate, and high performance, respectively.

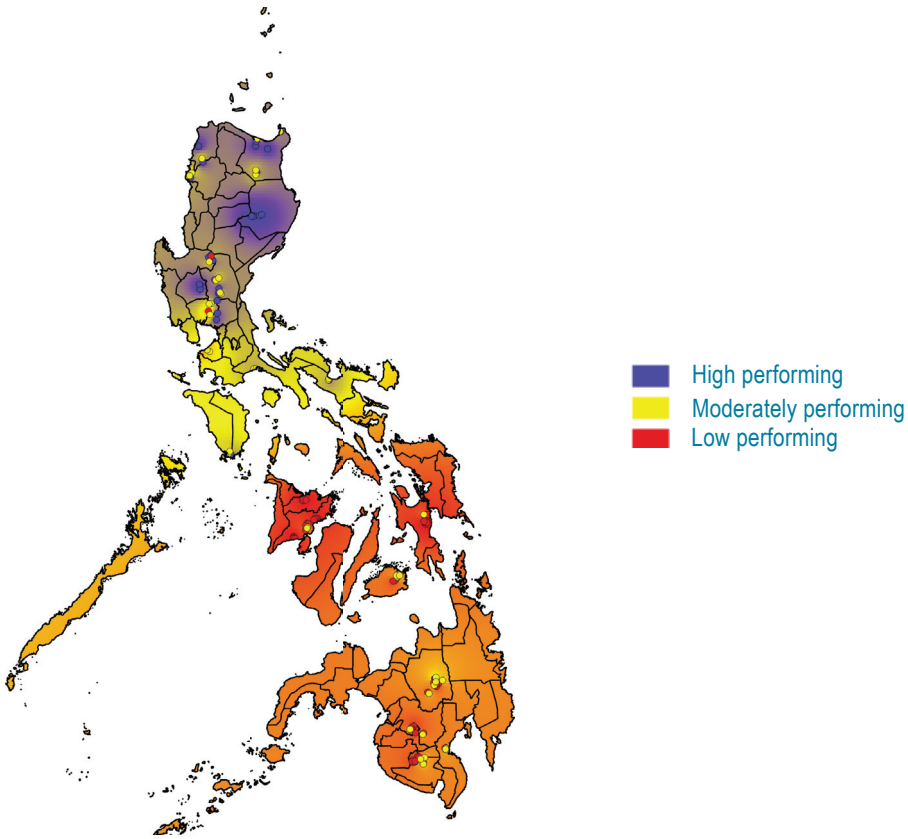
Since the determinants of localized PCA model for Luzon, Visayas, and Mindanao were different, PCA results only apply within their respective groups. However, anecdotal evidences revealed that free ISF has improved the satisfaction of IAs. This is despite complaints from few associations, especially in Jalaur RIS, which claimed that free ISF has reduced their funds for maintenance of canals related to siltation.

However, in the development of Irrigation Performance Index (IPI), a mutually exclusive PCA model integrating common observable data from Luzon, Visayas, and Mindanao with a total sample size of 151 IAs throughout the Philippines was used. Its results showed that only 23 percent of the samples had high level of irrigation performance, while 33 percent and 45 percent showed moderate to low performance, respectively (Figure 3). Almost one in every two low performing IAs was also in Visayas and Mindanao.

To further determine the effect of ISF on the performance of IAs, a regression model was used in the integrated analysis of all NIS in Luzon, Visayas, and Mindanao. Instead of using the actual amount of ISF collected, the study used a dummy variable to indicate whether the IAs were collecting ISF or not.

The results showed that the presence of ISF was a highly significant factor affecting the performance index of AIs. Furthermore, the model result indicated that IAs with ISF were likely to increase the performance by 0.30 score point. This was particularly substantial in terms of increasing their performance. Intuitively, this also followed theories pertaining to resource maximization given that the presence of ISF showed a resource constraint that needs to be maximized. The presence of this resource constraint

Figure 3. Distribution map of the performance of irrigators' associations in Luzon, Visayas, and Mindanao



Source: Author's own based on the gathered field data

represents opportunity cost for farmers hence, they need to make the most out of the resource given that it is scarce and has cost implication.

Recommendations

Adopt a good watershed management

Watershed management is under the jurisdiction of the Department of Environment and Natural Resources. The full control of the watershed of irrigation systems should be transferred first to the NIA to allow the latter to conduct a better assessment of the state of the watersheds for each NIS project and properly factor the results in the system design and operation and management. A more comprehensive approach called integrated watershed management can be adopted.

Invest in pipe network

The government should explore investing in pipe network given its low maintenance cost, high distribution efficiency, and low evaporation loss especially during summer. Such network can also support land consolidation and facilitate farm operations, especially mechanization activities. Nonetheless, the return to investment can be obtained after several years of operation. A detailed cost analysis is, thus, needed to estimate the required investment. A pilot project is recommended to establish its feasibility with respect to economic, technical, and social implications.

Enhance maintenance of facilities

NIA should allocate realistic resources for O&M and formulate effective policies and incentive systems. This

is so as not to defer O&M until the problem becomes a major rehabilitation project. The target is to establish the system condition near its design condition. As discussed earlier, the poor water distribution in most NIS cases was mainly due to water losses, especially in unlined canals.

The IPI also showed that the technical aspect of irrigation management is a major indicator of performance. This implies that O&M should be given high priority by NIA, especially focusing on reduction of siltation, reduction of water losses via pipe use or canal lining, and proper monitoring of water flows. With these measures, adequate and equitable water distribution and allocation will be enhanced.

Initiate timely repair of devices

Water flow is a basic indicator critical to system management. However, this information could not be obtained due to the nonoperational canal structures and check gauges. NIA should have a regular monitoring of structures so timely repair or replacement of damaged or nonfunctional devices can be done. Water quality should also be checked seasonally to avoid water quality deterioration in the future that could have an effect on yield.

Utilize GIS analysis

The use of GIS analysis was useful in mapping the location of structures, measurements, and spatial analysis of erosion, groundwater potential, flooding, and distribution of the performance of IAs. GIS applications can be further enhanced in targeting interventions and in determining suitable areas for irrigation. It can also be used as a tool for project identification, selection, design, and implementation based on suitability of lands for irrigation development as reflected in slope, soil erosion, and ground water potential maps.

Undertake projects on water availability

The government should undertake a research project focusing on detailed hydrologic data gathering and modeling of ground water balance. The decline in surface water availability can lead to the utilization of ground water on a conjunctive use scheme.

Monitor the implementation of policies

Regular monitoring and proper implementation of policies related to illegal activities that affect irrigation system functionality, such as those relating to illegal settlers, pumping, and waste disposal, should be enforced and ensure that penalties are meted out to violators.

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