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

Policy Notes

ISSN 1656-5266

No. 2014-20 (October 2014)

Measuring irrigation performance: Lessons from national systems

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Introduction

The rapid expansion of irrigated land in Asia since the 1960s and the introduction of modern cereal seed and fertilizer technology have undoubtedly been key factors to the achievement of food security in the region. For more than a decade, however, there has been a growing recognition that large-scale gravity irrigation systems funded by public investments have performed poorly, and have not shown significant improvements with further investments for rehabilitation (Mukherji et al. 2009). Moreover, attempts to devolve operation and maintenance (O&M) to irrigators' associations through Participatory Irrigation Management (PIM) or Irrigation Management Transfer (IMT) programs have not generally led to improved productivity nor O&M.

The disappointing performance of public investments in large-scale irrigation in the Philippines has been documented as early as the late 1980s and early 1990s by David (1986), Ferguson (1987), and the World Bank (1992) mainly in terms of the significant gap between actual irrigated area and design area of selected national irrigation systems. This *Policy Note* examines three measures of performance of all national irrigation systems from the mid-1960s to 2012.

The government through the National Irrigation Administration (NIA) undertakes the planning, construction, O&M, and rehabilitation of national irrigation systems. These are mostly run-of-the-river gravity systems, though a few systems use large pumps to extract water from major river systems. The national irrigation systems are typically more than 1,000 hectares in size, with the largest three systems with water

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reservoirs for dry season cropping having service areas ranging from about 30,000 to 110,000 hectares. They presently number close to 220 systems with a total firmed-up service area of 723,000 hectares, and accounted for approximately 78 percent of government capital outlays for irrigation from 1966 to 2012. However, the national irrigation systems accounted for only 47 percent of government's capital outlays for irrigation from 2008 to 2012, much lower than the overall average as greater budgets were allocated for communal and other smaller irrigation systems in recent years. Also, while irrigation service fees are collected from farmers, these do not cover any of the capital cost nor the full cost of O&M.

Performance indicators

The first set of performance indicators compares the reported actual irrigated area in the wet and dry seasons to the design area, service area, and firmed-up service area. The second indicator is the cropping intensity as officially defined by NIA to be the sum of wet and dry seasons' irrigated area expressed as a ratio to the service area or to the firmed-up service area. The third indicator is the irrigation service fee collection rate (ISFR) on current account as this is associated with the effective irrigated area. These performance indicators were chosen because these have been regularly monitored by NIA since the mid-1960s for each of the national irrigation systems and are freely available for analysis. While appearing quite simple, their values, trends over time, and patterns by vintage have important implications on the estimates of ex-ante and ex-post economic rates of returns of public investments in national irrigation systems, and thus efficiency in the governance of the irrigation sector.

The estimate of the design area of an irrigation system is based on the estimates of water supply from rainfall and surface or ground water sources, the water requirements of growing one or more crops in a season or year, and the percolation and seepage losses of water along the conveyance facilities and within the farm. The service area, which is the number of hectares provided with irrigation distribution facilities, may be lower than the design area for a number of reasons. Built-up areas (residences; industrial, commercial, and recreational areas; roads and other market and irrigation infrastructure) have not been deducted from design areas. Crop areas grown to coconut and other tree crops, sugar, banana, and other crops that landowners may not want to be converted to rice farms to which gravity irrigation systems are most suited may have been included. Landowners may not be willing to provide right of way for building irrigation facilities even among rice farms if land prices are high, farm sizes are quite small, and alternative individual pump systems may be available for irrigation. Thus, farmers are not willing to give up land as encountered in the construction of the Banaoang Pump Irrigation Systems in Ilocos Sur and in certain areas for the Casecnan Phase I Irrigation Project in Nueva Ecija. Over time, the service area may decline as built-up areas expand with increasing population and growing urbanization. The later estimate is called the firmed-up service area.

The actual irrigated area is the estimate of hectarage that can be provided with irrigation water in the wet and dry seasons according to plans. Whether and to what extent the irrigated area differs from the service area depend on water supply and the quality of the O&M of the irrigation systems. In turn, the available water supply is determined largely by the state of the watershed as this affects both the stream flows of the river systems and the rate of siltation in irrigation facilities.

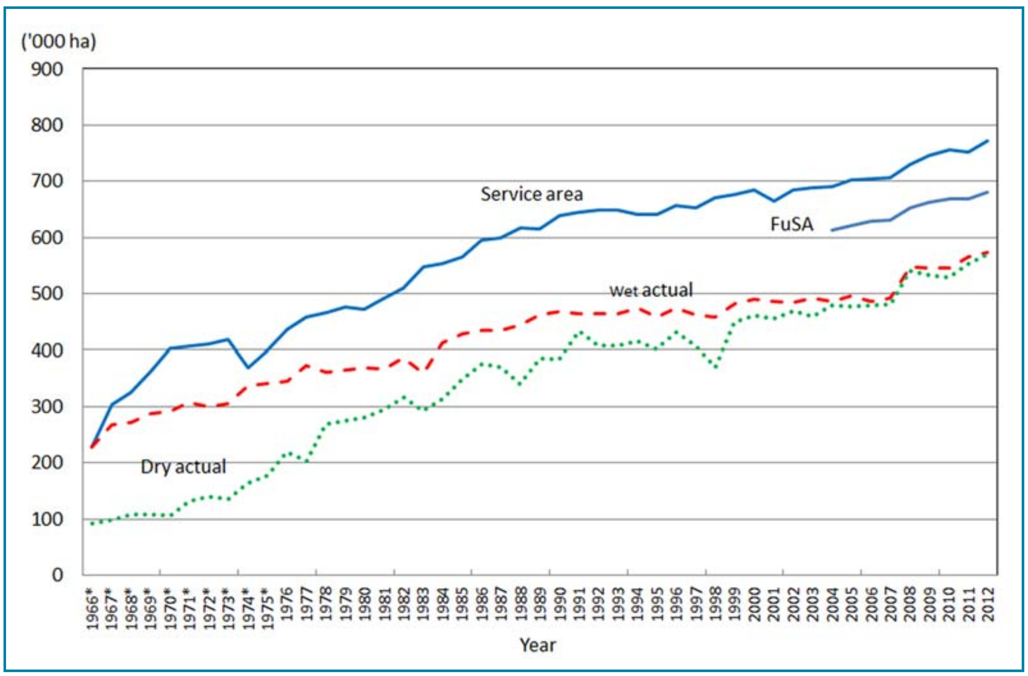
irrigation investments (Hayami and Kikuchi 1978; Azarcon 1990). With the drop in the world price of rice and the stagnation of potential rice yields since the 1980s, growth in service area slowed down until recently when some acceleration can be observed. Estimates of the firmed-up service area based on updated estimates of the built-up area, which became available only since 2004, showed an approximately 10 percent reduction of the service area.

Not surprisingly, the irrigated area has been lower than the service area in both the wet and dry seasons as available water supply was not sufficient to provide irrigation throughout the service area. And since most of the

Trends in performance indicators

Figure 1 illustrates the trends in the service area, firmed-up service area, and irrigated area in the wet and dry seasons from 1966 to 2012. Service area increased most rapidly between the mid-1960s and the mid-1980s as induced by high world rice prices of the 1970s and the introduction of the modern rice seed-fertilizer technology that raised the profitability of

Figure 1. Trends in service area, firmed-up service area (FuSA), and actual irrigated area for wet and dry seasonss of national irrigation systems, 1966–2012 (000 ha)



* Fiscal year

Source of basic data: System Management Division (SMD), National Irrigation Administration (NIA), various years national irrigation systems are run-of-the-river type of gravity systems, the dry season irrigated area was smaller than in the wet season especially from the 1960s up to the mid-1970s.

It is interesting to note that the gap between the wet season irrigated area and the service area widened over time, suggesting a deterioration of the watersheds and/or problems with the O&M of irrigation systems. Faster growth in the dry season irrigated area compared with the wet season irrigated area between the mid-1960s and the mid-1980s was due primarily to the construction of large reservoirs in the Upper Pampanga and Magat River Irrigation Systems that stored water for a second crop of rice, rehabilitation of the Angat-Maasim Irrigation System that also have a reservoir, and the expansion of irrigation in Mindanao which, together with the more even rainfall pattern in that region, also assured the growing of rice in the dry season.

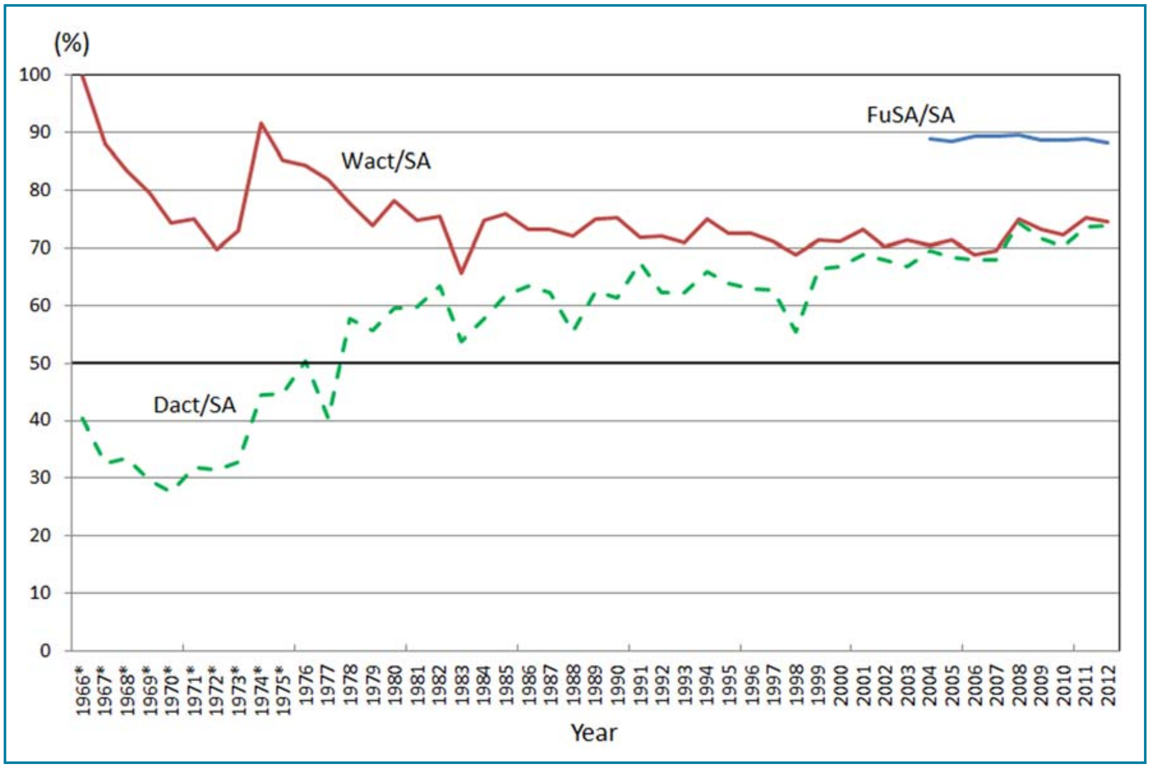
The slower growth of the service area and wet season irrigated area in the late 1980s was due in part to the slowdown in irrigation investments and also to flooding problems in existing and even new irrigation systems such as in Angat-Maasim and Pampanga Delta Irrigation Systems in Bulacan and Pampanga (Tabios and David 2014). Meanwhile, the continued increase in the dry season irrigated area in this period has been due mainly to the more widespread adoption of small individual pump systems within the national irrigation systems that allowed a second rice crop to be grown in the dry season, as irrigation systems contributed to the faster recharge of aquifers. As a consequence of the different trends of irrigated area between the two seasons, the ratio of wet season irrigated area to service area declined over time, as that of the dry season increased (Figure 2).

Irrigation projects generally aim to have a cropping intensity of 200 percent. However, Figure 3, which portrays its trends, shows cropping intensity to have been at about 140 percent for most of the period under study when computed as a ratio to service area and about 160 percent as a ratio to firmed-up service area in more recent years. The slight increase in the cropping intensity despite the relatively fast growth in the dry season irrigated area was due to the growing gap between the wet season irrigated area and service area.

In practice, the irrigation water supply is not uniformly distributed across all irrigated areas. Farmers downstream usually do not receive sufficient water, if any, either because farmers upstream get more water than planned for and/or conveyance losses are higher than expected. One indicator of the severity of that problem is the rate of irrigation service fee (ISF) collection.

Figure 4 shows that the ratio of current ISF collections to current collectibles rose to about 62 percent in recent years from a little less than 50 percent in the late 1980s to the mid-1990s, while collections of back accounts

Figure 2. Trends in the ratios of actual irrigated area to service area in the wet (Wact/SA) and dry (Dact/SA) seasons, and firmed-up to validated service area (FuSA/SA) of national irrigation systems, 1966–2012 (%)



* Fiscal year
Source of basic data: SMD-NIA, various years

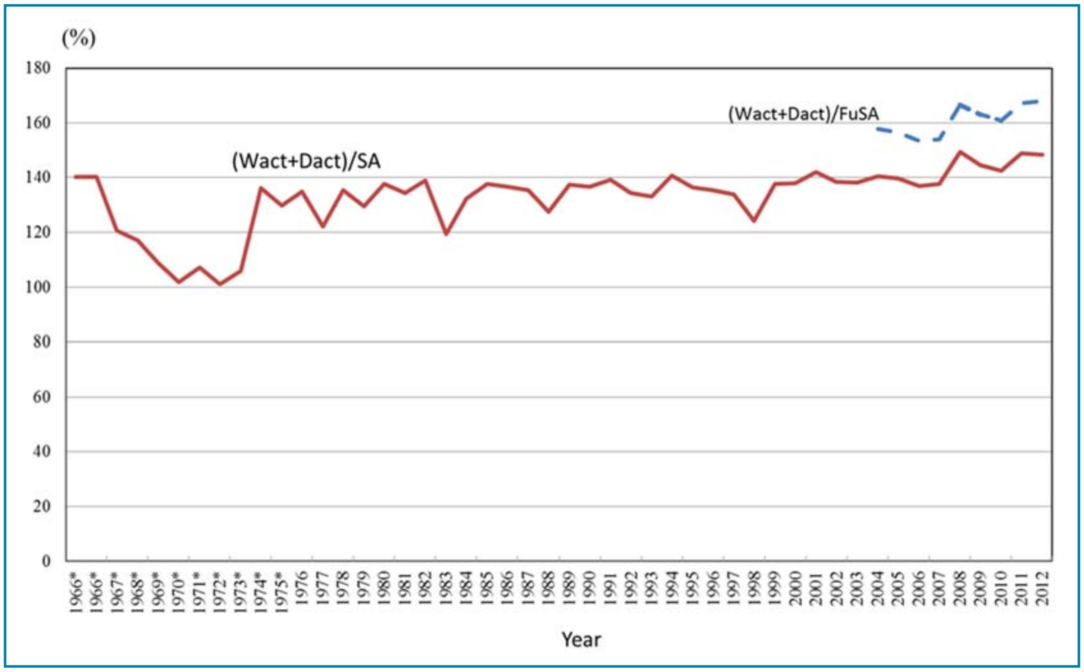
were a minuscule 2 percent.[1] The lowest rates observed in the late 1990s were temporary, due only to President Estrada's policy abolishing the ISF, which was rescinded in 2000 by the succeeding administration.

The slight positive trend in the rate of ISF collection indicates more effective collection efforts rather than improved quality of irrigation service (Cablayan et al. 2014). It appears that the viability incentive grant (VIG) scheme strengthened collection efforts, but to the detriment of the quality of irrigation service as indicated by more complaints from the field.[2]

We argue that of the one-third of uncollected irrigation service fees, much was due mainly to the low quality of irrigation service received by farmers mostly located in downstream canals. Some farmers who have to

[1] The collectible ISF is computed based on benefited area that is, on the average, about 10 percent less than irrigated area as farms obtaining yields lower than two tons per hectare are exempted from paying ISF.
[2] The VIG is given to field offices that attain viability (total revenues divided by total operating costs exceeding 1.0) equivalent to 10 percent of its net income (Memorandum Circular 20 issued on April 4, 2007). The VIG program is similar to the profit-sharing system in progressive private companies where workers are rewarded with bonuses or dividends.

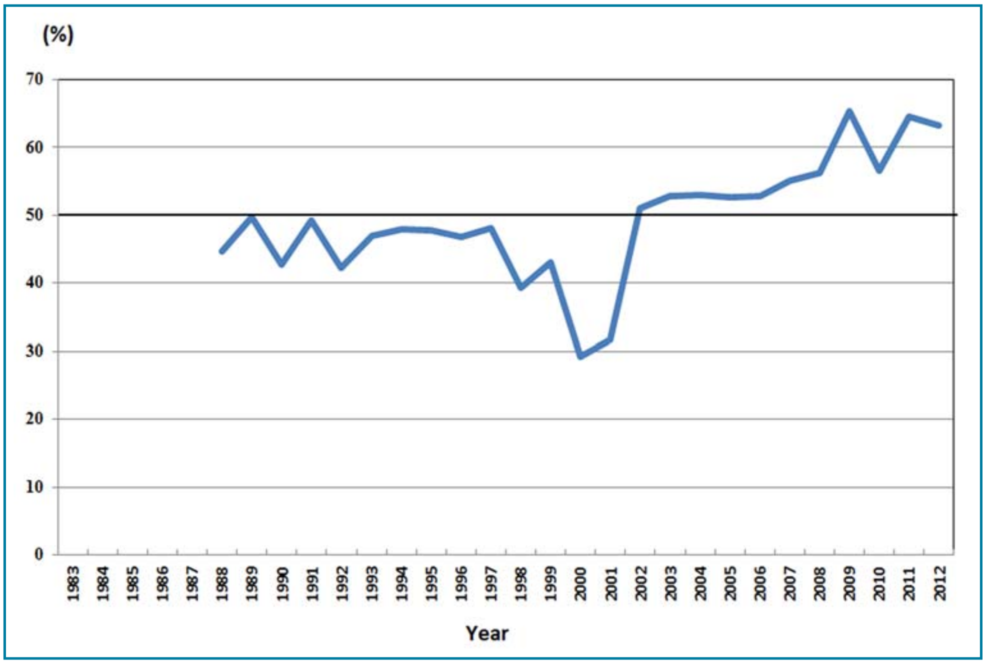
Figure 3. Trends in two measures of cropping intensities of national irrigation systems, 1966–2012 (%)



* Fiscal year

Source of basic data: SMD-NIA, various years

Figure 4. Trends in irrigation service fee collection rate (current account collected/ current collectible) for national irrigation systems, 1983–2012 (%)



Source of basic data: SMD-NIA, various years use pumps to lift irrigation water from canals located lower or across their farms, or to start planting early before the scheduled arrival, or due to the late arrival of irrigation water were allowed informally to pay a reduced amount of the ISF, typically by 50 percent. Others who did not receive or use irrigation water refused to pay the ISF at all.

The fact is irrigation water is valuable to the farmer. ISF rates of national irrigation systems with gravity systems that average about 3 percent of gross production is generally affordable. Even the higher ISF rates for large-pump national irrigation systems of up to 5–6 percent of gross production have been collected from farmers, but not at rates higher than that.

Given the low collection rates of only about 66 percent of current account collectible, we can surmise that the effective irrigated area (i.e., effectively receiving water) is conservatively at least 10–15 percent lower than the NIA's estimated irrigated area.

Performance indicators by vintage

Table 1 presents the average performance indicators for the aggregate national irrigation systems and by vintage (or groups of national irrigation systems that started operating before 1965, 1965–1980, 1981–1995, and 1996–2012) as of 2012. Based on data for all national irrigation systems, the ratio of the service area to design area was close to 80 percent; but with increasing built-up areas over time, the ratio of the firmed-up service area to the design area was just about 70 percent. The ratio of the actual irrigated area to the service area in both wet and dry seasons was similarly around 70 percent. In comparison to the design area, the irrigated area was only about 55 percent. Considering the low ISF collection rate that largely reflects the poor quality of irrigation service particularly for farmers located downstream of irrigation canals, the ratio of the effective irrigated area to the design area may likely just be in the order of 40 percent.

A very disturbing pattern in the performance of national irrigation systems is the generally declining trends in all indicators, i.e., the ratios of service area, firmed-up service area, and irrigated area to design area, irrigated area to service area, cropping intensity, and ISF collection rate across the different vintages. Whereas service and irrigated areas as ratios to design area were about 80 percent and 60 percent in the earlier vintages, these were only 70 percent and less than 40 percent for national irrigation systems that were built after the mid-1990s. The difference in cropping intensity is even wider with early vintages averaging 160 percent, while the most recent vintage was only slightly above 100 percent. With the lower ISF collection rates for the most recent vintage, the reduction in effective irrigated areas for this set of national irrigation systems would even be proportionately greater and ratio to design area can be as low as 25–30 percent. Among the national irrigation systems of recent vintage are the Banaoang Pump Irrigation System in Ilocos Sur, the Pampanga Delta

Table 1. Service area and ratios between pairs of design area (DA), service area (SA), firmed-up service area (FuSA), actual irrigated area in wet (Wact) and dry (Dact) seasons, measures of cropping intensity, and rate of irrigation service fee collection rate, total NIS and by vintage, 2012

Indicators	Measure	Total	Before 1965	1965–1980	1981–1995	1996–2012
Service area	hectares	750,186	255,972	134,716	298,807	60,691
	% to total SA	100	34	18	40	8
% to design or service area	SA/DA	78	81	76	79	72
	FuSA/DA	69	75	71	66	56
	Wact/DA	57	63	62	52	38
	Dact/DA	54	55	59	53	38
	FuSA/SA	89	92	93	85	86
	Wact/SA	71	76	81	68	49
	Dact/SA	68	67	77	68	51
% cropping intensity	(Act W+ Act D)/SA	139	143	158	136	99
	(Act W+ Act D)/FuSA	148	153	164	159	103
% ISF collection rate	Collections/collectibles of current account	54	50	57	61	44

Source of basic data: National Irrigation Administration

Irrigation Component of the Pampanga, Tarlac Groundwater Project, the Lower Agusan Development Project, and a few others.

Why are all the performance indicators generally falling over time across the different vintages of national irrigation systems, a pattern already observed by Ferguson (1987) for the period up to 1983? The obvious explanation is that the best options for irrigation development have been developed earlier, and later public investments have been allocated to marginal projects with higher cost of construction and low and uncertain benefits. The question is to what extent that pattern was caused by failures in the planning and appraisal of irrigation projects, or in the execution of new construction or rehabilitation, or in O&M.

Conclusions

More than two decades ago, the large gap between the actual irrigated area and the design area in national irrigation systems was already pointed out in several studies and summarized in the policy-oriented World Bank irrigation sector review of 1992. Overly optimistic technical and economic assumptions, inadequate water supply, inappropriate designs of irrigation systems, and difficulties in O&M have been listed as the main reasons for the disappointing performance of the national irrigation systems.

Yet in 2012, the national irrigation systems that started operating since the 1990s showed even poorer performance indicators than before, which should lead us to question the budgetary allocations for those irrigation projects. Evidently, there was little effort to adopt more reasonable assumptions in estimating design areas; estimates of available water supply continued to be overstated; designs of irrigation systems have not adequately addressed drainage problems, location-specific physical characteristics, rapid urbanization, and so forth; and O&M have not significantly improved.

The incentive structure to do more accurate ex-ante and ex-post evaluations of both new construction and rehabilitation of irrigation projects, more efficient engineering designs, and more effective O&M had been apparently too weak both within the bureaucracy and the lending agencies, despite presumably rigorous evaluations, particularly of foreign-funded projects.

It should be emphasized that the opportunities to do better planning, construction, O&M, and rehabilitation are now much better. Greater and more accessible technical data can be collected through remote sensing and field-level measurements. The technical capacity to undertake more modern and rigorous methodologies of analysis and design, e.g., geographic information system (GIS) analysis, mathematical modelling, simulations, and so forth, is now available in the country. Of course, the long-researched lessons of involving farmers in the governance of the sector, from planning to rehabilitation, continue to be highly relevant. The constraint appears to be the limited effective demand for improving governance of the sector.

Undoubtedly, the performance of irrigation systems is influenced not just by the quality of governance of the sector itself, but also importantly by factors outside its control. These are the worsening flooding problems caused by constriction of waterways; the rapid denudation of the watersheds that accelerate the rate of flooding and siltation within the irrigation system and reduce available water supply; and the political pressures impinging on the choice of irrigation projects and contractors, proper operations of irrigation systems, as well as the quality of appointments to the bureaucracy.

Recommendations

From the above findings, here are a few key points for further research related to irrigation sector performance:

1) A better understanding of the slowdown in the rate of growth of irrigated area in the wet season should be worth the effort given indications of increasing effects of flooding and watershed degradation through siltation of dams and canals. Scaling up of the GIS-based analysis of national irrigation systems began in the Irrigation Rapid Assessment will address this gap. GIS modelling can also be used to show the impacts of inadequate water supply on the firmed-up service area (FuSA).

2) The just offsetting rate of growth in the actual dry season irrigated area should serve

as a signal to the government that investing in reservoirs alone to increase irrigated areas is no longer enough, and that it is time to also examine investment needs for drainage and flood control in national irrigation systems. Here, GIS-based modelling can also help better target government interventions.

3) The almost flat cropping intensities point to the need for government attention on investments in repair, rehabilitation, and restoration, which are funded under the national budget, instead of corporate operations and maintenance. A better understanding of how the money has been spent and the accomplishments of these investments should shed light to this puzzle—why the government continues to spend billions on irrigation and still ends up with about the same size of functional areas. Scaling up the review of rehabilitation projects will help address this concern.

4) Given the reduced capacity of NIA at the field level, the VIG system needs to be examined. The agency can develop less distorting options balancing the key mandate of providing irrigation service support and collecting payments.

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