World Bank Support for Irrigation Service Delivery

Responding to Emergent Challenges and Opportunities

IEG MESO EVALUATION

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Abbreviations

FY	fiscal year
GP	Global Practice
GSG	Global Solutions Group
I&D	irrigation and drainage
IEG	Independent Evaluation Group
IWRM	integrated water resources management
KPI	key performance indicator
O&M	operations and maintenance
WRM	water resources management

All dollar amounts are U.S. dollars unless otherwise indicated.

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Overview

This evaluation seeks to inform the World Bank's efforts to support client countries to deliver sustainable irrigation and drainage services and achieve development impacts.

The evaluation traces the emergent factors affecting irrigation service delivery, including those that cut across other sectors. The results of this evaluation can help the World Bank improve strategic approaches in an evolving context.

Irrigation service delivery is increasingly challenged by multiple factors that are driving demand for agricultural production, water scarcity, and variability in water precipitation. These factors include population growth and urbanization leading to increasing demand for agricultural products, and greater competition for water resources from domestic and industrial users. Untreated urban wastewater released into water bodies affects irrigation water quality. Water availability is increasingly variable because of the effects of climate change.

Based on this evolving context and these challenges, this evaluation develops a theory of change for the irrigation sector that incorporates both traditional and emergent issues. The theory of change is used to assess the extent to which the World Bank addresses traditional and emergent issues in its project portfolio at both the individual project and country levels.

An analysis of key performance indicators (KPIs) for projects approved or closed from fiscal year (FY)09 to FY19 shows a markedly low emphasis on emergent factors, especially water service delivery, water resources management (WRM), and climate resilience. KPIs for outputs, outcomes, and impacts relating to emergent factors regarding water service delivery, WRM, climate resilience, and market links occur far less frequently compared with the traditional elements of infrastructure, institution and capacity building, and agricultural inputs.

Country case analysis reveals the scope for improving the sequencing and complementarity of the World Bank's projects, potentially with those of other multilateral and bilateral lenders and donors, to address the theory of change in a country context. The analysis shows two patterns in the World Bank's country-level project portfolios: (i) a proclivity for repeat projects with a marginally expanding set of objectives and components but with the focus still on infrastructure rehabilitation; and (ii) irrigation projects complemented by other climate change, WRM, or agriculture marketing and livelihood projects but without apparent coordination among them to achieve development impacts in the irrigation sector.

Based on the findings of the project KPIs and country-level analyses, this evaluation proposes an expanded results framework for the irrigation sector that can guide the transition from a predominantly infrastructure-oriented design focus to a multisectoral effort to achieve sustainable and outcome-oriented irrigation service delivery and impacts. The proposed expanded results framework emphasizes the various dimensions of water service delivery, integrated WRM, water accounting, marketing links, accountability, and increasing climate resilience.

The expanded results framework also places a premium on measuring outcomes from planning and implementing WRM by adopting appropriate institutional arrangements and widely available instruments. Measuring this is increasingly feasible owing to advances in information and communication technology and more affordable means of acquiring and sharing digital information (for example, from sensors and water flow measurement devices, satellite data, and drones linked to cell phones and the internet of things).

Four areas related to WRM and sustainable service delivery need to be tracked to assess the response to new and emerging external factors in individual projects and a country's irrigation sector as a whole: (i) accounting for water productivity (to manage competing demands for limited water quantity), (ii) reliability (for on-demand or continuous flow necessary for high-value crops), (iii) water quality (necessary to meet phytosanitary regulations and to reduce downstream nonpoint pollution), and (iv) value for money leading toward financial security (to avoid the cycle of build-neglect-rebuild in large-scale irrigation systems). It is necessary to assess and monitor the financial viability of operating different parts of the irrigation system, in addition to assessing financial returns at the farm level.

Fostering awareness and promoting behavior change among actors at all levels—decision makers, technical staff, irrigators, potential investors, and the wider community—are key but underemphasized areas, which can become obstacles to adopting the expanded results framework. Although several irrigation project activities may implicitly drive behavior change, this evaluation did not find significant incidence of KPIs designed to track behavior change at the administrative or farm level. Encouraging the adoption of higher-level WRM, on-farm water management, and agricultural practices remains a challenge to address.

1. Motivation

This evaluation exercise responds to a request of the Water Global Practice (GP) to inform its efforts in supporting client countries to deliver sustainable irrigation services for agriculture.

The Water GP acquired the irrigation portfolio in 2015 as part of the reorganization of the World Bank operational structure. Under the former structure, irrigation was under the domain of the Agriculture and Rural Development Sector. In conjunction with the reorganization, the Water in Agriculture Global Solutions Group (GSG) was formed, co-led by technical leads from the Water in Agriculture GPs to facilitate attention to the cross-cutting nature of the topic. The Water in Agriculture GSG is the technical counterpart for this evaluation.

This evaluation seeks to complement a practitioner's resource book on governance in the irrigation and drainage (I&D) sector that the Water in Agriculture GSG is developing. This evaluation is a building block of the environment and climate change work stream of the Independent Evaluation Group (IEG), which includes a future thematic evaluation on water resources management (WRM).

2. Irrigation Service Delivery: The Evolving Context and the World Bank's Response

Irrigation is the artificial management of water to increase crop production. Formal irrigation involves controlled and scheduled delivery of water to match the times when crops need more water than is available from precipitation. Over time, the factors driving and affecting the delivery of irrigation services have evolved.

Over the past six decades, the world's irrigated area has doubled, contributing to food security and a reduction in rural poverty. The enhanced availability of water from irrigation systems was an important building block in operationalizing the green revolution in many farming systems. The result was a significantly enhanced capability to feed rapidly growing populations while simultaneously reducing rural poverty levels in many parts of the world.

Unregulated irrigation development has resulted in the overexploitation of aquifers in many parts of the world. Groundwater-based irrigation has experienced explosive growth over the past two decades because of the availability of cheap electric or diesel-operated pump sets and subsidized energy prices. Groundwater investments were often a work-around strategy for farmers when irrigation organizations functioned inefficiently. But, in some places, groundwater-based irrigation became not just a supplement, but the primary source of water for a progressive farmer. Although this trend reduced the demand-side pressures on poorly functioning irrigation bureaucracies, it simultaneously increased risks to overexploited aquifers that were not recharged at a rate sufficient to compensate for extraction. In some locations, overextraction has reached a point that groundwater pumping is no longer sustainable.[1]

Competition for available and renewable water resources among different water uses (domestic, industrial, power, and environmental) has further increased water scarcity pressures in many countries. Interference in surface systems, and especially the construction of large dams, has led to upstream-downstream tensions and disputes. Surface water and groundwater pollution have affected overall water quality because of contamination by agrochemicals, particularly where there has been an intensification of farming without adequate environmental regulations. Agricultural water management dialogues have consequently transitioned from just supplying more water to farms to tracking water productivity for overall environmental sustainability.

Changing dietary preferences and a global shift to market-oriented irrigated farming is increasing farmers' demands for improved irrigation service delivery. Urbanization and rising incomes are shifting preferences away from food staples (such as wheat and rice) and toward higher-value production of fruits, vegetables, meat, and dairy products. Moreover, farmers around the world are increasingly seeking to produce commercial crops and integrate with global markets. Meeting the often-exacting water requirements for high-value crops and phytosanitary regulations of exported produce requires greater control and flexibility of the irrigated water supply and maintenance of water quality.[2]

Opportunities for horizontal expansion of the irrigated area are limited in most regions. Except for Sub-Saharan Africa and parts of South America, there is little or no suitable land remaining for development and little or no water remaining for further expansion. The focus has shifted to improving system performance and agricultural water productivity in existing irrigation schemes. The design and mode of operation of some irrigation schemes are outdated. Traditional top-down, supply-driven service delivery is no longer appropriate where farmers are looking to have irrigation water on demand to increase productivity or diversify cropping. Increasingly, in some I&D schemes, demand may comprise a nearly continuous supply to serve farmers' drip irrigation systems. In some cases, the failure to provide more user-focused service delivery tailored to increasing agricultural production lies with well-established change-resistant irrigation agencies (World Bank 2018b). This situation has implications for greater inclusiveness and transparency toward beneficiaries and accountability in provision of irrigation services.

Irrigation schemes vary worldwide by several characteristics, such as size, hydrology, form of irrigation service delivery, technology, and institutional arrangements at the administrative and farm levels. The World Bank's I&D practitioner's resource book identifies four types of irrigation schemes based on mode of governance: large-scale public schemes, small- and medium-scale community schemes, individually managed schemes, and corporate irrigation farms for cash crops (World Bank 2018a). Diverse forms of organization of irrigation service delivery are present within each irrigation scheme, responding to local priorities of farmers and specific hydrology characteristics. Table 2.1 provides a summary of the key features and management challenges of these schemes.

Table 2.1. Irrigation Scheme Types

Type	Description	Key Management Challenges
Type 1. Large-scale public schemes	Government-sponsored irrigation organizations responsible for water distribution systems and provision of a water delivery service to farmers or groups of farmers and irrigators. Usually over 1,000 hectares.	Economic and financial viability and technical and managerial upgrading is needed to allow schemes to respond to the new needs of farmers.
Type 2. Small- and medium-scale community schemes	Built, owned, and maintained by farmers and their local communities. Public sector involvement is limited, focusing on improvement, rehabilitation, or consolidation.	Schemes are rooted in communal knowledge and tradition that may not be equipped to deal with water variability through climate change.
Type 3. Individually managed schemes	Self-provision by individual farmers through groundwater from borewells on their property or a surface water source. Developed around cities to take advantage of local markets for high-value crops. Farms are 0.5 to 2 hectares typically.	Reliance on groundwater or wastewater makes schemes vulnerable to environmental and health-related problems, for both consumers and on-field workers.
Type 4. Corporate irrigation farms for cash crops	Owned and operated by a single entity or company. Various partnership arrangements are possible between corporate agribusiness and community-farmed dimensions.	Such arrangements require support to develop fair and transparent contracts and a regulator to ensure a balance of power between the private sector partners and community groups.

Source: Adapted from World Bank 2018a.

Policy reforms to promote financial sustainability and ensure adequate operations and maintenance (O&M) and a service delivery perspective are lacking. Past assessments have highlighted the urgency of policy reforms to promote financial sustainability, but to no avail. Neglect of system O&M for large-scale public irrigation schemes has led to what is appropriately described by the practice as "design, neglect, and rebuild" (Briscoe and Malik 2006). In most countries, the build-neglect-rebuild cycle has become so deeply engrained that large-scale surface irrigation systems are dependent on the public budget, through direct allocations or indirectly through subsidies for energy consumption (or both) (World Bank 2018b).

Water-saving technologies and policies for the dual objectives of increased agriculture productivity and water conservation need to be undertaken within broader WRM planning and policy making. The most widely promoted approach for adapting water management in agriculture to increasing water scarcity is to focus on improving agricultural water productivity and efficiency, and thus achieve more "crop per drop." The implicit assumption is that such improvements in water productivity and efficiency would help address the trade-off between increased agricultural production and agricultural water conservation and reallocation. Previous assessments did not adequately explore the water-related effects of capital investments and water-saving technologies. This was in part owing to a lack of data on key measures, such as water withdrawls, water applied, and water consumed (Scheierling and Treguer 2018). Moreover, assessments of the impacts of such interventions typically have not considered those beyond the scale of the individual farm or irrigation scheme. A growing body of evidence shows that these interventions have mixed results in conditions of water scarcity and may be counterproductive. A recent study by the Food and Agriculture Organization found that the introduction of water-saving technology in many arid countries has encouraged farmers to increase water consumption by expanding irrigated areas (Perry and Steduto 2017). Generating true water savings requires assessing basinwide impacts of irrigation interventions and better integrating management of water in agriculture with broader WRM planning and policy making.

Climate change will exacerbate the previously mentioned interlinked challenges, so a new approach to manage water in agriculture is urgent. Rainfall variability, one of the predictions from various climate change models, affects the rural sector in several damaging ways. Excessive heat during prolonged droughts will stress plants, although farmers could mine aquifers wherever feasible. These challenges highlight the importance of implementing water resources planning and regulations to safeguard sustainability. Intensive rainfall for fewer days will increase runoff and damage surface infrastructure unless it is anticipated by investing in climate-resilient infrastructure. The overall effects of these factors will be increased pressure on available water resources and greater uncertainty about the timing and availability of water supplies for many existing irrigation systems.

World Bank Response

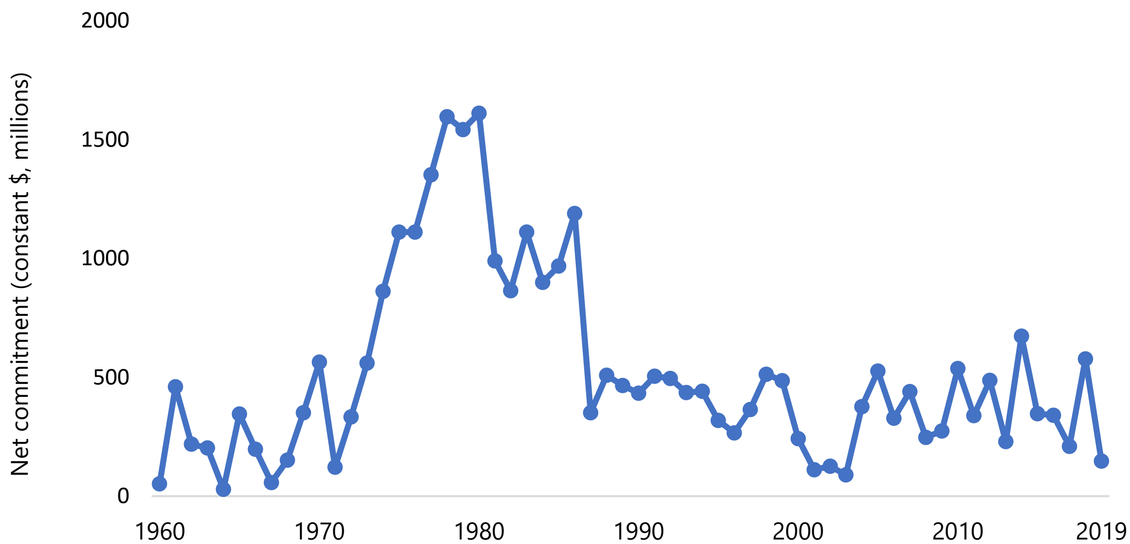
The World Bank has responded to the changing context in the irrigation sector by adjusting its lending and strategic focus over the years. The evolution of the World Bank's strategic response and lending for I&D projects is summarized in box 2.1 and displayed in figure 2.1.

Box 2.1. Irrigation Sector Evolution: Driving Factors and World Bank Response

- The **1960s and 1970s** were marked by food security concerns in many World Bank client countries. The World Bank and other donors responded with high levels of investment in large-scale public surface irrigation schemes to support staple crops (wheat, maize, rice), resulting in a steady increase in lending during these decades. The relative abundance of land, water, and labor during this period, along with improved seeds and fertilizer, allowed global food production to outpace population growth, leading to declines in the real price of food.
- By the early **1980s**, investments in large-scale public irrigation schemes slowed down, and the cycle of build-neglect-rebuild in these irrigation schemes began. The rapid growth of largely unregulated groundwater extraction partly compensated the unreliable service provision from large public irrigation schemes. Rural electrification, private financing, easy access to drilling technology, and inexpensive small pumps enabled such rapid growth. This reduced the demand placed on ineffective public sector irrigation schemes but also led to overextraction and long-term depletion of aquifers, and the need to monitor and regulate groundwater use.
- The period between the **1990s and early 2000s** was marked by the adoption of the Dublin Principles,[a] which recognized water as an economic good and placed the focus on cost recovery while advocating the subsidiarity principle of decentralizing management responsibilities for water to the lowest appropriate level of administration. Environmental concerns also emerged during this period, while competition for water grew as a result of increasing urbanization and industrialization. The slow growth in World Bank lending of the 1980s continued through to the early 2000s owing to the perceived underperformance of large-scale schemes and concerns over their negative social and environmental effects on farmers' livelihoods and water consumption. The World Bank's strategic focus shifted from engineering solutions to institutional solutions, such as delegating on-farm and lower-level canals in surface systems to community organizations and farmer groups.
- In the last two decades, from the **2000s onward**, shifting demographics, competing uses for water, and increasing variability in the availability of water attributed to climate change have been driving the response of the World Bank and other donors to the irrigation sector. The World Bank's 2003 Water Resources Strategy called for integrated water resources management and building of appropriate skills in the World Bank to address those challenges.[b] Overall, the World Bank's lending increased during this period, including large projects in India and China.

Note: a. The Dublin Principles were developed at the International Conference on Water and the Environment in Dublin, Ireland, in January 1992. These principles were highlighted by the World Bank's 1993 water resources management policy paper, which stated (i) that water development and management should be based on a participatory approach, involving users, planners, and policy makers at all levels; and (ii) that water has an economic value in all its competing uses, and urbanization and industrial growth have driven up competition for water.
b. Integrated water resources management refers to a process that promotes the coordinated development and management of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Figure 2.1. World Bank Net Commitments for Irrigation and Drainage Projects, FY1960–2019

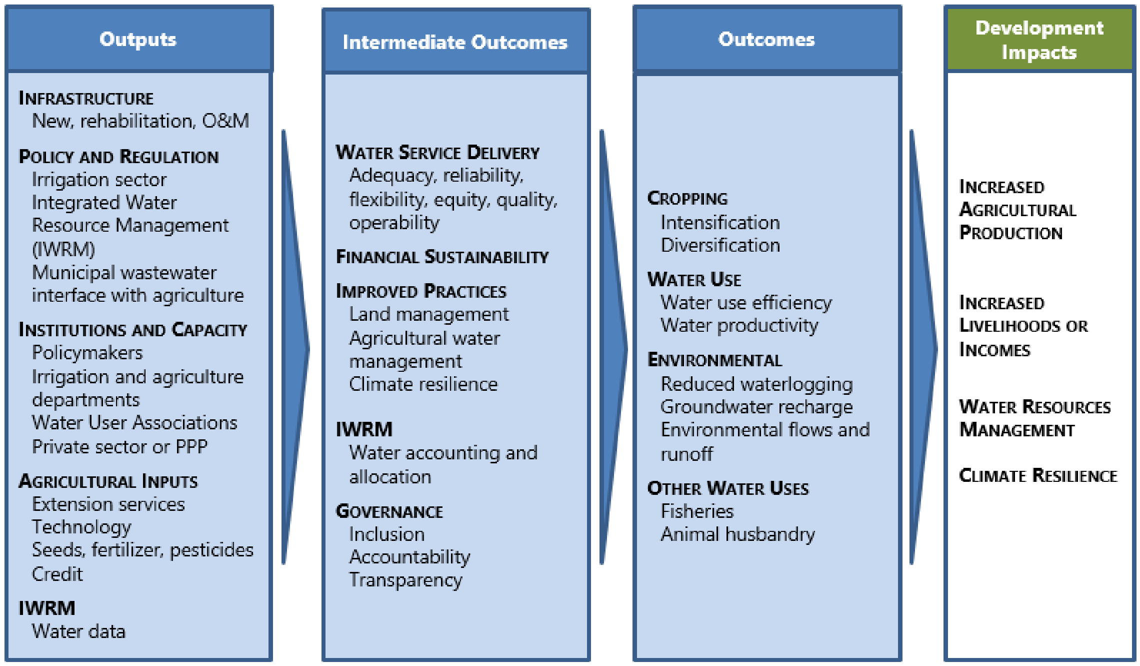


Source: World Bank Business Intelligence data.

Theory of Change

To test the adequacy of the World Bank's response to past experience and the evolving context for I&D, this evaluation uses the theory of change as presented in figure 2.2. The theory of change combines both traditional and emergent factors that affect the sector and provide an analytical basis for a backward- and forward-looking assessment of World Bank operations. Traditional inputs and outputs cover infrastructure development and rehabilitation and policy and regulation for the irrigation sector. Emergent factors include policy and regulation for the urban municipal interface, land tenure, and integrated water resources management (IWRM), in addition to related policy changes aimed at promoting climate-resilient agricultural production and resilient livelihoods. In other words, the traditional elements focus on the production of the service, whereas the emergent elements focus on the outcome of the service for clients and the wider enabling environment (markets, WRM, land, service articulation, and so on). A detailed description of the elements of the theory of change is presented in table A.1 in appendix A.

Figure 2.2. Irrigation Sector: Theory of Change Reflecting Its Evolving Context



Note: O&M = operations and maintenance; IWRM = integrated water resources management; PPP = public-private partnership.

This evaluation used the theory of change as a basis to assess the extent to which the World Bank's operations in the I&D sector address these traditional and emergent elements. The findings are presented in chapter 4 of this report, which contains an analysis of the World Bank's I&D portfolio, at both the project and country levels.

All elements of the theory of change can apply to each of the four types of irrigation schemes introduced in table 2.1, but different elements may be more present in one scheme type than in others. For example, capacity building for irrigation departments and water user associations is an important output for improving the delivery of irrigation services across type 1 schemes (large and public), but it is less relevant to type 3 schemes (individually managed), in which farmers extract water directly from the source through individual pumps. Box 2.2 describes the prevalence of each type of irrigation scheme within the World Bank's I&D portfolio.

Box 2.2. World Bank Irrigation and Drainage Portfolio, by Irrigation Type

Over the evaluation period, the World Bank's irrigation and drainage portfolio is dominated by type 1 (large public) schemes covering 64 percent of the total number of projects in the portfolio, followed by type 2 (small and medium community-based) schemes with 20 percent, and type 3 (individually managed) schemes with 16 percent. Type 4 (corporate irrigation farm) schemes account for only 1 percent of the portfolio. This pattern holds broadly for both closed projects and projects currently active in the evaluation portfolio.

Type 1 and type 2 irrigation schemes are likely to remain a substantial proportion of the World Bank's portfolio in the foreseeable future. Type 1 schemes were designed to meet the demands for irrigation between the 1960s and 1980s. Overall, these large infrastructure schemes need rehabilitation and modernization to enable better water service delivery, integration with systems that support higher-value agriculture, and to make them more climate relisent.

Type 3 and type 4 schemes will be an increasing share of the World Bank's future portfolio. Type 3 schemes are the fastest-growing segment in Sub-Saharan Africa. If left unregulated, this area is likely to experience similar groundwater overextraction issues to those faced in South and East Asian countries in the past two to three decades. Type 4 schemes are also likely to grow in importance as a response to growing urban migration, lower availability of farm labor, and growing demand for high-value and exportable produce, which requires sophisticated production and marketing practices.

3. Evaluation Approach and Methodology

With the objective of informing the ongoing efforts of the World Bank's Water GP to improve the delivery and management of sustainable I&D services, the following questions have guided this evaluation:

1. How can we better conceptualize service delivery within irrigation management models?

2. To what extent have the service delivery components identified in (1) been integrated into the World Bank's irrigation projects?

3. What works, under what circumstances, to shift the institutions involved in the management of irrigation systems toward a service delivery outcome-oriented mind-set?

This evaluation covered I&D projects approved or closed from fiscal year (FY)09 to FY19. The portfolio consists of 293 projects, amounting to $13.4 billion in net commitments for irrigation. Of these, 213 (73 percent) are core projects in which at least 20 percent of the project commitments relate to irrigation components. Among core projects, 135 are closed, and 78 are active. The average commitment for irrigation components in core projects ($58 million) is nearly five times that of noncore irrigation projects. Appendix B contains further details on the breakdown of the I&D portfolio.

The evaluation methodology consists of a targeted literature review, a portfolio review, an analysis of key performance indicators (KPIs) in all projects, and interviews of key experts in the World Bank's Water in Agriculture GSG. The evaluation carried out detailed country analyses for 10 countries: Bangladesh, China, the Arab Republic of Egypt, Ethiopia, India, Madagascar, Morocco, Uzbekistan, Vietnam, and the Republic of Yemen. This set of countries was selected purposefully based on the following criteria: (i) water scarcity issues, (ii) regional representation, and (iii) World Bank lending portfolio size. Four countries—Egypt, India, Uzbekistan, and Vietnam—had targeted site-based project performance assessments. Appendix A contains further details on the methodology used in this evaluation.

The evaluation also conducted semistructured interviews of key stakeholders to obtain contextual information and insights to complement the project portfolio, country assessments, and literature reviews. Internal stakeholders included World Bank task team leaders, staff, and management of the Water GP and Water in Agriculture GSG. On May 16, 2019, the evaluation team held a workshop on prelminiary findings with counteprarts from both the Water and the Agriculture GPs. The study team also participated in an interactive session on irrigation issues during Water Week in April 2019. The discussions from the workshop and Water Week session helped triangulate findings from the portfolio review and the field-based project assessments in Egypt, India, and Uzbekistan.

External stakeholders included government counterparts, irrigation agencies, and donor community representatives in the case study countries covered. Insights were gathered from the California Irrigation Institute's 2019 Conference "Manage Our Land to Manage Our Water," which took place February 4–5, 2019.

4. How the World Bank's I&D Portfolio Addresses the Theory of Change

This section examines the extent to which the World Bank's I&D portfolio addresses the contents of the theory of change, at both the project and country levels. An individual I&D project would be expected to contain a subset of theory of change inputs that can be traced to desired outcomes and impacts. The number of theory of change elements reflected in the KPIs of a given project will vary by project design and context. Not all aspects are relevant to the same extent in all cases; and objectives, means, and demands will differ in different contexts. Several projects in a country—either sequentially or in parallel—would contain a larger set of inputs and collectively cover a larger set of effects.

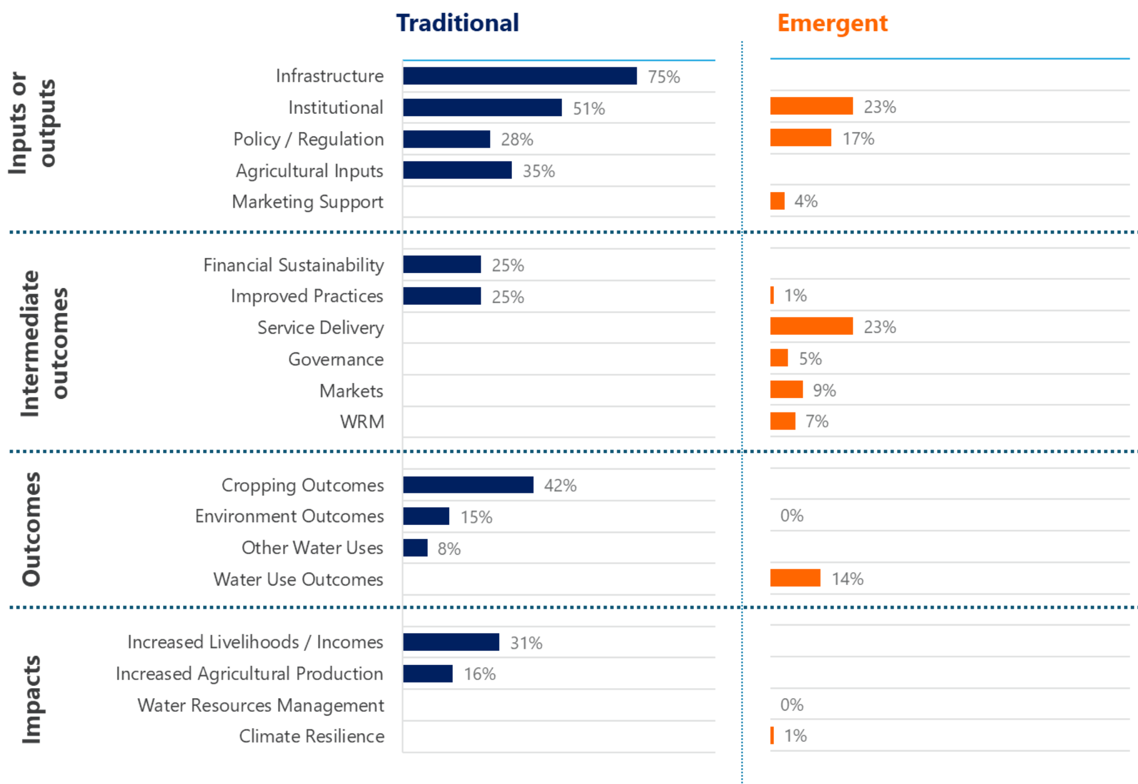
Project-Level Key Performance Indicator Analysis

The evaluation conducted an analysis of KPIs for all I&D projects that were approved or had closed during FY09–19, to assess the extent to which both the traditional and emergent elements of the theory of change are reflected in the project design. In total, 293 projects were identified (119 active and 174 closed). From these, 106 closed core projects (projects that committed more than 20 percent of commitment amount for I&D) were included in the KPI analysis. Figure 4.1 shows the results of this analysis. The evaluation also conducted a review of the objectives statements and descriptions of component activities in 74 projects in 10 purposively selected case study countries to assess the projects' intent to address various elements of the theory of change, compared with the KPIs used to track project results. Figure 4.2 summarizes the results of this analysis. (See appendixes A and B for further details on the evaluation methodology and portfolio.)

The development outcome ratings of closed I&D projects compare favorably with those of all World Bank projects (across all sectors) during that period. The proportion of I&D projects rated moderately satisfactory or better was 76 percent compared with 78 percent for all World Bank projects. Core and noncore I&D projects performed equally well: 75 percent of core projects and 77 percent of noncore projects were rated moderately satisfactory or better. It is important to note that these ratings do not reflect development outcome information in the fullest sense (real outcomes for real people) but project-level outcomes that cover a wide range of outputs and intermediate-level changes.

Despite the favorable picture of the overall development outcome ratings, the KPI analysis found that the monitoring and evaluation within the World Bank's I&D portfolio has been slow to reflect the multisector effort that is required to address the complex set of factors impacting the irrigation sector today. The analysis of all core I&D projects (figure 4.1) shows the World Bank's KPIs are oriented toward the traditional elements of irrigation infrastructure, institutional capacity building at the government agency level, participatory irrigation management, and basic agricultural extension services and inputs. They underemphasize emergent areas of IWRM, such as managing groundwater overdraft through voluntary self-regulation as a means of building climate resilience. Moreover,even when projects include activities to address these elements, they do not always measure results. For example, the analysis in figure 4.2 shows that 20 projects included IWRM-based decision-making in their objective statement or description of component activities, but only 25 percent had KPIs to measure results of this support.

Figure 4.1. Share of Projects That Reflect Traditional and Emergent Elements of the Theory of Change in Their Key Performance Indicators, Closed Projects FY09–19

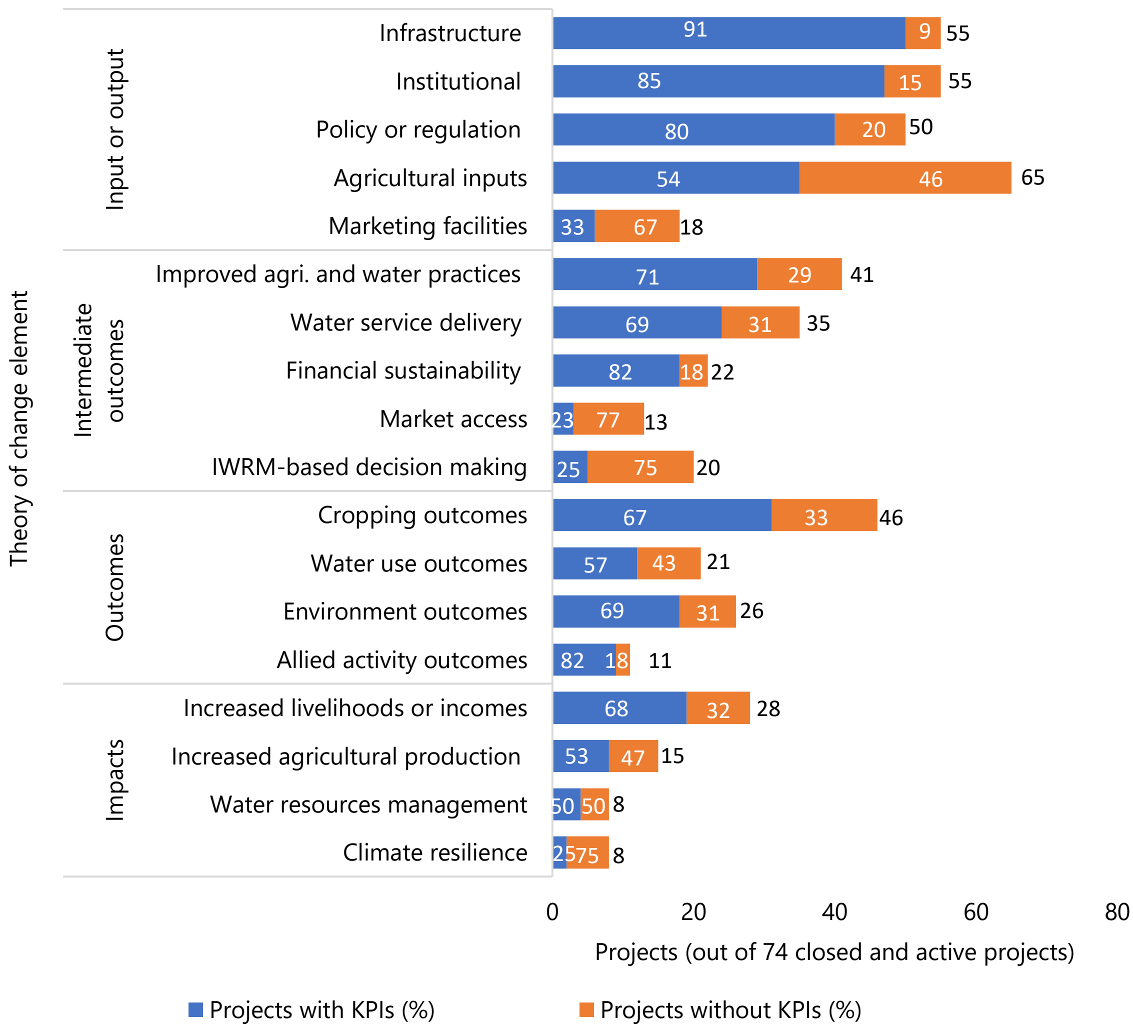


Source: Independent Evaluation Group analysis of World Bank Business Intelligence data.
Note: WRM = water resources management.

KPIs across the I&D portfolio, for both traditional and emergent factors, are more oriented toward output-level results than actual changes in performance of the system or other outcome-level results. The requirement for projects to include core sector indicators, which are meant to be universal and thus pitched at a broad output level, may be a factor contributing to the predominance of output-level KPIs. At the same time, when KPIs do measure intermediate-level changes or impacts, attribution to the project is not always clear due lack of an adequate counterfactual and time lags involved in realizing some of the broader desired outcomes. There is much scope for improving the identification and measurement of KPIs that measure intermediate outcomes that can be achieved within a project time frame.

KPIs for outputs such as irrigation infrastructure and traditional institutional and policy actions, are often clearly specified and measured. These elements also show consistently high performance and drive the overall project outcomes. Figure 4.2 shows the number of projects that address the various outputs, outcomes, and impacts in the theory of change, and the share that specify KPIs for these elements for a sample of 74 projects in 10 purposively selected case study countries. The analysis, which reviewed project objectives and the description of activities, shows that KPIs for infrastructure and traditional institutional and policy outputs were measured in approximately 68 percent of the projects reviewed, and 84 percent of the projects that measured these elements show moderately satisfactory or better performance. In contrast, most emergent elements relating to service delivery, WRM, and climate resilience were measured in less than 20 percent of the projects reviewed, with moderately satisfactory or better performance in less than 32 percent of these cases.

Figure 4.2. Ten-Country Sample: Number and Percentage of Projects That Address a Theory of Change Element in Their Key Performance Indicators, Closed and Active Projects FY09–19



Source: Independent Evaluation Group analysis of World Bank Business Intelligence data.
Note: Agri = agriculture; IWRM = integrated water resources management; KPI = key performance indicator; TOC = theory of change.

The pattern of KPI coverage is similar in closed and active projects. This pattern indicates that attention to the KPIs that capture the emergent elements of the theory of change has not increased in recent years.

Overall, four key findings emerge from the KPI analysis carried out by the evaluation:

- **Definition of water service delivery at the appraisal stage is poor**. The low incidence of indicators in the portfolio that track water service delivery relates in part to the poor definition of the concept in project appraisal documents. However, good practices are seen in some recent interventions, such as the ongoing Morocco Large-Scale Irrigation Modernization Project, where the concept of water service delivery is well defined, and specific dimensions are articulated and measured. Rather than merely stating that the irrigation services will be improved in an unspecified manner, the project appraisal document (World Bank 2015b, 5) articulates that "improved water service entails individual access to water (rather than collective), on-demand (rather than on rotation), reliable (with faster re-establishment of the service in case of shut-downs), and equitable (in terms of flow and pressure across the irrigation network)." This has clear implications for incorporating elements of water service delivery into project design, results frameworks, and KPIs, thus instituting the process and means for measuring the relevant parameters.

- **No line of sight exists between infrastructure and institutional inputs and outcomes and impacts on beneficiaries.** Although most projects include activities to build or improve irrigation infrastructure, much less attention is paid to tracking (i) whether the improved availability of irrigation water reaches the intended beneficiaries in an adequate, reliable, and flexible manner; and (ii) whether the supplied water is used efficiently for its intended purpose. Fifty-five projects in the sample addressed infrastructure activities, and 50 (91 percent) of these projects specified KPIs to measure the infrastructure output, usually the number of kilometers constructed or hectares covered. In contrast, water service delivery was addressed in 35 projects, but only 24 (67 percent) measured at least one service delivery attribute (such as adequacy or reliability).

- **When projects provide training and technical assistance to improve institutions or capacity, few trace how those inputs impact the quality of planning and decision-making processes to bring about behavior changes in policy makers, administrators, and beneficiaries, and ultimately to improve service delivery**. Similarly, farmer extension services are often monitored based on the number of people trained without measuring the adoption of improved water management practices by the intended beneficiaries. These findings call for greater diligence in tracing the causal relationships between institutional inputs and outcomes at project design and for innovating to extend qualitative and quantitative measures at least to the level of intermediate outcomes.

- **Coverage of water use outcomes is weak**. Only a small proportion of irrigation projects that express the intent to improve water use outcomes in their objectives statement or description of component activities (12 of 21 or 57 percent) have clearly defined KPIs regarding water use outcomes because of the consumptive use of agricultural water—namely, water productivity (that is, yield or crop value per unit of water supplied) and water use efficiency (that is, increased savings during conveyance and application). This is so even though improved water use outcomes are a fundamental goal of I&D projects, especially in water-scarce environments. Projects with such KPIs do not always clearly define what or how they are measuring. Recent analytical work produced by the Water GP highlights the need for greater attention to the distinction between water use efficiency and water productivity because these concepts and their measurement are not uniformly understood by project teams (Scheierling and Treguer 2018). With increasing water scarcity, it will be critical for all investments to track water use outcomes appropriately. Factoring in evapotranspiration rates could enable tracking of beneficial and nonbeneficial use of water in I&D projects.[1] Several projects in China define, monitor, and report on water use outcomes; two typical cases are described in box 4.1.

Box 4.1. Measuring and Promoting Water Use Efficiency and Productivity: Project Experiences from China

Two projects in China have demonstrated advancements in the definition, monitoring, and reporting of water use outcomes: Irrigated Agricultural Intensification III (P084742, fiscal year [FY]06–10) and Xinjiang Water Conservation (P111163, FY10–17) Projects.

Both projects measured water productivity based on the actual amount of water consumed by crops. The projects used remote sensing technology to monitor evapotranspiration (water loss from plant transpiration and evaporation from water and land surfaces).

The projects included incentive mechanisms (via policy and regulation, institutional, and data technologies) for adequate water delivery and use. Behavior change to encourage water saving was achieved through the use of remote sensing technology for measuring water levels and controlling water allocations among users.

Appropriate policy framework elements (that is, water rights and consumption caps), institutional capacity building for water user associations for better service delivery, and enforced regulations were employed to achieve water use outcomes. The Irrigated Agricultural Intensification III project also included climate change adaptation measures, including crop diversification and the use of appropriate irrigation technologies.

Country-Level Irrigation Portfolio Analysis

From a World Bank client country's perspective, all elements identified in the theory of change would need to be addressed over time to transform and modernize the sector. Support from the World Bank and other multilateral banks and bilateral donors, combined with the country government's efforts, could achieve this. The contribution of other multilateral banks, bilateral donors, and the government's own efforts are not covered by this evaluation.

The evaluation reviewed the I&D portfolio of a purposive sample of 10 client countries over the last 10 years. The purpose of the analysis was to assess the extent to which the World Bank is supporting client countries to address the elements of the theory of change over an extended period and whether there is increasing attention to new and emergent elements, such as WRM and climate resilience. The analysis also examines how irrigation projects are sequenced and complement each other. The country analysis for Uzbekistan is presented in appendix C as an illustration of the country-level irrigation portfolio analysis carried out. Table 4.1 presents the aggregate project results of the portfolios for all 10 countries reviewed.

Table 4.1. World Bank Country Portfolio of Irrigation Projects with an Emphasis on Outputs and Outcomes in the Theory of Change, Approved and Closed FY09–19

	Outputs							Outcomes						
		Policy and regulation		Institutions		Improved practices		Trad.	Emergent				Trad.	Emer-gent
Country (no. of projects)	Infrastructure	Traditional	New and emergent	Traditional	New and emergent	Traditional	New and emergent	Other water uses	Water service delivery	Markets	WRM	Governance	Environment	Environment
India (20)														
China (18)														
Egypt, Arab Rep. (6)														
Morocco (6)														
Uzbekistan (6)														
Vietnam (6)														
Yemen, Rep. (4)														
Ethiopia (3)														
Madagascar (3)														
Bangladesh (2)														
Countries with high emphasis on result area (percent)	100	20	30	80	0	50	0	0	30	10	20	0	20	0

Source: Independent Evaluation Group analysis based on World Bank project data.
Note: WRM = water resources management. Share of projects in country that address the theory of change element: ☐ = high (66 percent or higher); ☐ = medium (>33 percent and <66 percent); ☐ = low (33 percent or lower).

Overall, the country portfolio sample significantly favors traditional elements over the emergent elements of the theory of change. Infrastructure coverage is high (two-thirds of projects or more in each country) in all 10 countries, and attention to the traditional elements of institutional development (government and participatory irrigation management) is high in 8 countries. Improved practices in agricultural and water management are covered to a high extent in 5 of the 10 countries. Traditional policy and regulation (relating to agriculture and irrigation) and traditional environmental issues (reduced waterlogging and salinization) are addressed to a high extent in only 2 countries each.

Policy and regulation regarding WRM and municipal wastewater interface are addressed to a high extent only in 3 of 10 countries in the sample. Service delivery is covered to a high extent in 3 countries, WRM in 2 countries, and marketing outcomes in

1 country. None of the sample countries address to a high extent the emergent elements of improved practices (climate resilience), governance, or environment (environmental flows and runoff).

Over time, there is no significant growing trend in addressing WRM, climate resilience, and market links in the country sample. Between the first and second half of projects (when arranged in order of approval dates) in each country, there are no distinct trends in attention to WRM, climate change, and market links, suggesting there may not be a conscious attempt to sequence and coordinate them with attention on sectorwide impacts. There is a relatively wide incidence of on-farm water practices in irrigation projects, but their efficacy varies significantly.

Some examples of both active and closed World Bank projects illustrate how new and emergent factors relating to water resource management, market support, and climate resilience are introduced into their results frameworks and designs:

- **Water resource management:** Vietnam's Mekong Delta Water Management for Rural Development project (P113949; FY11–17) sought to strengthen the capacity for WRM at the regional and provincial levels in the Mekong Delta and develop a regional water management framework for data collection, analysis, and forecasting, thus improving provincial coordination on WRM. In Madagascar, the Global Environment Facility Sustainable Landscape Management Project (P154698; FY17–22) sought to improve intersector coordination on IWRM, address WRM capacity building at both the national and local levels, and complete an inventory of water resources.

- **Market support:** Four countries significantly increased market support in the form of facilities for agroprocessing, storage, market information, and links with consumers and traders. Ethiopia's Irrigation and Drainage Project (P092353; FY07–17) promoted the sustainable commercialization of agriculture and increased household incomes by helping to establish forward and backward links between irrigated agriculture and markets. Likewise, in China's Jiangxi Integrated Agricultural Modernization Project (P065463; FY04–13), there was a market system development component that aimed to increase farmers' incomes by supporting value addition to produce and ensuring its efficient delivery to consumers through market-related investments such as postharvest equipment, packaging, transport, and storage.

- **Climate resilience:** Climate resilience has been addressed to a significant extent in only two projects: one in Vietnam and the other in Madagascar. Vietnam's

Irrigated Agriculture Improvement Project (P130014; FY14–21) incorporated climate-smart agriculture, including support for (i) measures to reduce the water and environmental footprints of cropping systems, (ii) promotion of sprinkler and drip irrigation systems, (iii) application of remote sensing imagery for monitoring crop performance, and (iv) the dissemination of information on climate-smart agriculture.

Addressing the complex and multisectoral elements (agriculture, irrigation, water management) in the theory of change requires multiple projects that operate sequentially or in parallel. The country analysis found such a programmatic approach to the irrigation sector must be tailored to the country context with greater attention to targeting, both geographically and over time. As noted previously, a single project can contain only a subset of theory of change inputs. The number of theory of change elements in a given project will vary by project design and context. Experience shows that simple projects typically outperform more complex ones. However, complex projects, such as the Tamil Nadu examples discussed subsequently, can be successful in certain contexts when implementing capacity and political commitment are high.

Broadly, two project deployment patterns emerge from the country-level irrigation portfolio analysis:

- **Repeat projects** with similar project design and with gradually increasing complexity of objectives and components under the same implementing agency and ministry. India presents several examples of this first pattern, with multiple sequential projects in several states, with similarly evolving project designs. For instance, in Tamil Nadu state, the Water Resources Consolidation Project, Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project, and Tamil Nadu Irrigated Agriculture Modernization Project (TNIAMP; approved FY95, FY07, and FY18, respectively), with project costs totaling $1.512 billion, have been supporting irrigation in the state for 24 years.[2] The Water Resources Consolidation Project focused primarily on infrastructure rehabilitation and pioneering of institutional development for WRM and on-farm water management practices, and the Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project added elements of agricultural practices and marketing support, and pursued behavior change for line agencies and farmers. The ongoing TNIAMP has further added elements of climate resilience. The generally satisfactory irrigation infrastructure improvements from these projects have provided the base for introducing better agricultural practices and market links aided by attention to incentivizing collaborative behavior among various line departments. However, significant progress on WRM at the state, basin, and farm levels has yet to be made, and arrangements for O&M and overall financial sustainability continue to be weak. Persistence with this sequential pattern of projects may lengthen the build-neglect-rebuild syndrome of the past and delay the transition to an expanded results framework. The financial viability of operating different parts of the irrigation system needs to be assessed and monitored along with assessing financial returns at the farm level.

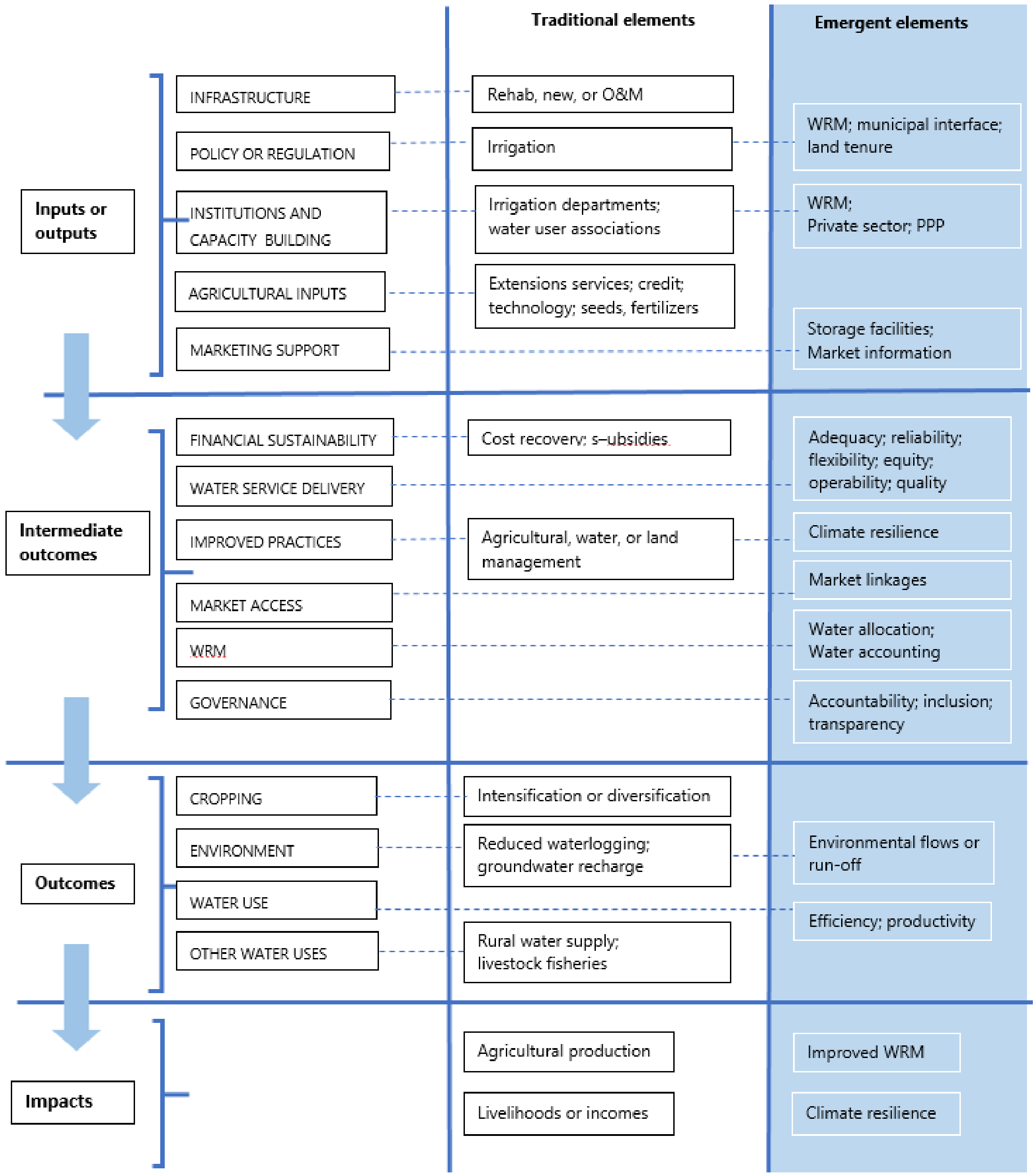
- **Separate and overlapping projects,** which address different aspects of the theory of change separately (for example, intersectoral WRM), under different executing ministries and departments. This second pattern is seen in other sample countries, such as Vietnam and Bangladesh. In Vietnam, intersectoral WRM issues that impinge on irrigation, for example, have been addressed through the Climate Change Development Policy Loan II and III with overall satisfactory project outcomes. These operations complemented three irrigation infrastructure-oriented projects that also include policy and regulation, institutional capacity building, and agricultural practices.[3] In Bangladesh, the National Agricultural Technology Project concentrated on agricultural extension and marketing links and, together with the Modern Grain Storage Facilities project,[4] complemented two irrigation infrastructure-oriented projects.[5]

However, complementarities and synergies are not always maximized from multiple projects in the same country. The country-level portfolio analysis found that repeat or overlapping projects often are not targeted geographically or over time to allow them to realize potential synergies in their development outcomes. Greater use of the multiphase programmatic approach could be instrumental in improving sequencing and targeting in future World Bank interventions. For example, recent economic and sector work carried out by the Water in Agriculture GSG (World Bank 2018b) illustrates how the multiphase programmatic approach might package two sequential projects, over a horizon of 15 years, with multiple interrelated objectives regarding (i) water resources planning and management, (ii) I&D, and (iii) agriculture.

5. Operationalizing an Expanded Results Framework for the Irrigation Sector

Considering the complex context for delivery of I&D services today, and analyzing the gaps in the coverage of the theory of change within the I&D portfolio, the evaluation suggests an expanded results framework as a basis to guide the relevance and content of the World Bank's I&D support to a client country (figure 5.1).

Figure 5.1. Proposed Expanded Results Framework for the Irrigation Sector



Note: O&M = operations and maintenance; WRM = water resources management; PPP = public-private partnership.

The expanded results framework emphasizes the increasing importance of water service delivery, marketing links, IWRM, and building improved resilience to climate change through rigorous analysis of water outcomes utilizing water accounting concepts. Water service delivery as an intermediate outcome was underemphasized in the traditional supply-driven irrigation service delivery model.[1] The World Bank (2018a) I&D practitioner's resource book defines service delivery as ensuring the scheduling and delivery of irrigation water of agreed quality, quantity, reliability, flexibility, and equity to enable specific uses in an agricultural scheme, and for drainage to ensure the evacuation of excess water to avoid salinization and production losses after extreme events. The expanded results framework can leverage water accounting concepts that track how far beneficial water consumption and recoverable water flows sustain an outcomes focus in the emergent elements (and thus track the extent to which consumptive use for agriculture mirrors beneficial use of water).

Analysis of the World Bank's I&D portfolio using the expanded results framework, especially at the country level, can provide a systematic basis for adjusting priorities and for informing project design. Such analysis highlights the gaps in the World Bank's coverage of the theory of change as it applies to the country's irrigation sector needs. Such analysis also has implications for examining institutional arrangements, providing for interministerial and interagency coordination as needed, and making provision for measuring sector impacts that go beyond an individual project. Portfolio analysis at the country level can also provide a basis for identifying areas where the World Bank's efforts complement those of the government and other bilateral or multilateral lenders.

All elements of the expanded results framework can apply to each of the four types of irrigation schemes introduced in table 2.1, but different elements may be more important in one scheme type than another. For example, capacity building for irrigation departments and water user associations is an important output for improving delivery of irrigation services across type 1 schemes (large and public), but it is not relevant to type 3 schemes (individually managed) in which farmers extract water directly from the source through individual pumps. Box 2.2 describes the prevalence of each type of irrigation scheme within the World Bank's I&D portfolio.

Cross-Cutting Issues

The literature review, operational experience, and feedback gathered from stakeholders in this evaluation conclude that designing and monitoring the performance of any modern I&D scheme requires careful attention to the following issues that cut across the expanded results framework and apply to all irrigation scheme types (see also appendix D):

- **Accounting for water productivity:** Ever-growing concerns with climate and weather risks require paying more attention to water accounting methodologies that distinguish between four types of water uses identified by the International Commission on Irrigation and Drainage.[2] All four types of irrigation schemes will need to improve accounting of beneficial water consumption to improve the analysis of water productivity so they can reconcile competing demands for freshwater from agriculture, household use, and the natural ecosystem.

- **On-demand water supply:** Adequacy and reliability of water are important for all types of irrigation schemes, but they are critical for schemes that deliver water to farmers who produce high-value crops that have exacting water requirements and for the adoption of drip irrigation and other water-saving technologies. In type 3 and type 4 irrigation schemes, water is supplied on demand (through individual pumping of groundwater) or through continuous flow (in surface irrigation).[3] Type 1 and type 2 irrigation schemes have often supported capacity building among water user associations or other traditional water management institutions to ensure that the water reaches the farmers' fields in a predictable manner and at adequate quantities. Monitoring water flow to ensure that water is provided as intended is key under all four systems.

- **Water quality:** As an input, high-quality water is largely a concern for type 3 and type 4 schemes that typically produce for the commercial market and need to meet stringent phytosanitary standards. Equally important for farms under type 1 and type 2 schemes is the pollution of downstream water bodies that results from pesticides and chemical fertilizers in irrigation drainage water. As the competition for limited freshwater becomes more intense, poor downstream water quality leads to significant costs of environmental degradation for other farmers, urban residents, and the natural ecosystem. Accounting of the quality of the nonconsumed recoverable fraction of water, water discharged into drains, and other water bodies after irrigation is key.

- **Good value for money leading toward financial sustainability:** Irrigation systems are capital-intensive and are justified for their large public good element. Securing financial sustainability by increased value for money of the system through O&M arrangements is important for all types of irrigation, but particularly for types 1 and 2 to avoid the costly build-neglect-rebuild culture in large-scale irrigation schemes. Ensuring good value for money calls for monitoring the financial sustainability of operating different parts of the irrigation system, not only financial returns at the farm level.

6. Implications for Future World Bank Support to Irrigation

This evaluation has attempted to better conceptualize irrigation service delivery across various irrigation management models in the evolving context driven by population growth, competition for water use, and variability in water availability that can be attributed to climate change. By examining the evidence from the World Bank's irrigation sector portfolio over the past decade, the gaps in addressing the new and emergent factors affecting the sector are seen in relief. However, some significant features of recent projects collectively point the way to an irrigation service delivery mind-set that focuses firmly on desired outcomes and impacts, especially those underemphasized so far. Several implications can be derived from the analysis and findings of this evaluation to enhance the World Bank's future support to the I&D sector in its client countries:

- **The proposed expanded results framework can serve as a basis for enhancing the World Bank's approach and strategy for the irrigation sector at the country level**. The 10-country case analysis illustrates the extent to which the World Bank's support covers the expanded results framework in each country. Such analysis can further inform the World Bank's approach to a country's irrigation sector and better align it to the needs of the country, thereby enhancing the relevance of the World Bank's support.

- **The scope for better sequencing of World Bank projects and complementary efforts (with government and potentially other multilateral and bilateral lenders and donors) should be explored systematically.** The evaluation shows two patterns in the World Bank's country project portfolios: (i) a proclivity for repeat projects with a marginally expanding set of objectives and components but with the focus continuing to be on infrastructure rehabilitation; and (ii) irrigation projects complemented by other climate change, WRM, or rural marketing and livelihood projects but without apparent coordination among them or adequate geographic targeting to achieve development impacts in the irrigation sector.

- **Analysis of KPIs highlights critical gaps to fill in project results frameworks regarding the measurement of relevant intermediate outcomes and the use of outcome-level indicators.** Several outputs (infrastructure, institutional development, capacity building) are not adequately traced to logical outcomes, specifically water service delivery, water productivity, improved planning and decision-making, and physical and financial sustainability of the irrigation services. There is much scope for enhancing KPIs to track broader service delivery, governance and conflict management, and organizational dimensions. That said, development of adequate project-level KPIs requires taking into account the specific context of each individual project and identifying results that can be achieved within the project time frame. Some dimensions of improved service delivery may also be captured better outside of the project results framework, for example, by setting service standards in service agreements or in performance contracts.

- Within the expanded results framework, there are four areas that relate to WRM and sustainable service delivery that require well-defined KPIs and the institutional and technical means for measurement:

  - **Accounting for water productivity**, to manage competing demands on limited water availability

  - **Reliability**, to provide water on demand or by continuous flow necessary for high-value crops

  - **Water quality**, to meet phytosanitary regulations and to reduce downstream nonpoint pollution

  - **Value for money leading toward financial security**, to avoid the cycle of build-neglect-rebuild of large-scale irrigation schemes

  These four elements are pertinent to all types of irrigation schemes and management models, although they may manifest themselves differently across them. Tracking these parameters allows decision makers to assess the extent to which the consequences of new and emerging external factors—water scarcity and variability, and cross-sectoral environmental impacts—are being addressed at the project and sector levels.

- **With the emergence of new and affordable technologies, tracking outcomes for emergent elements in the expanded results framework is becoming increasingly feasible and cost-effective.** In the past, it was difficult or costly to measure these factors, which may account for their low prevalence among KPIs. Today, several technical advances, such as the digitization of data, substantial reduction in costs of installing electronic sensors and other water measuring devices, availability of open-source satellite data, use of drones, widespread adoption of smartphones, big data analytics, and so on, are making the tracking of outcomes in the expanded results framework increasingly feasible and cost-effective.

- Fostering awareness of the expanded results framework and promoting associated behavior change is a key step at all levels—for policy makers, administrators, technical staff, and irrigators—and likely to be a challenging task. This evaluation highlights some efforts at change management in World Bank projects that can guide the way forward. This study did not find any significant incidence of KPIs designed to track behavior change at the policy-making, administrative, technical, or farm levels, although many projects implicitly drive behavior change. There is at least one consciously designed effort at fostering change management among multiple line departments (engineering, agriculture, marketing, animal husbandry, and water) to converge their efforts toward the farmer beneficiary (TNIAMP in India). Other experiences relate to behavior change for measuring water use in China (box 4.1). The experience from these and other similar efforts can provide a basis for more systematic approaches toward behavior change.

Addressing these issues will provide a draft blueprint to review and expand the design of the result frameworks of World Bank I&D projects to (i) better reflect relevant performance dimensions across irrigation schemes, and (ii) identify robust KPIs to monitor the achievement of their relevant development outcomes.

Chapter 2

[1] Until the 1970s, most groundwater development was through shallow wells with pumps capable of lifting water only about 10 meters. Groundwater use was thus self-regulating—once the water table was below 10 meters, exploitation stopped until recharge from rainfall restored the aquifer. However, from the 1970s onward, the availability of cheap submersible pumps, capable of lifting water hundreds of meters, meant that aquifer exploitation had no immediate natural limits. Therefore, aquifers are in retreat today, from the Ogallala in the western United States, through the Middle East, to India and the North China Plain (Perry 2018 citing Rodell, Velicogna, and Famiglietti 2009; Wada, van Beek, and Bierkens 2012).

[2] *Phytosanitary* refers to the basic rules for food safety and plant health standards affiliated with international trade, as in "a point-of-origin phytosanitary certificate."

Chapter 4

[1] The International Commission on Irrigation and Drainage distinguishes between beneficial consumption and nonbeneficial consumption; the former refers to water evaporated or transpired for the intended agricultural purpose, while the latter includes water evaporated or transpired for other purposes. Another important distinction is between recoverable fraction, which refers to water that can be captured and reused, and nonrecoverable fraction, describing water lost to further use. These water accounting concepts enable a focus on outcomes. See SAI Platform 2012.

[2] Tamil Nadu Water Resources Consolidation Project (P010476; FY95–05; project cost: $491 million); Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project (P158522; FY07–15; project cost: $566 million); Tamil Nadu Irrigated Agriculture Modernization Project (P158522; FY18–ongoing; project cost: $456 million).

[3] Vietnam Water Resources Assistance Project (P065898; FY04–13; project cost: $176 million); Vietnam Mekong Delta Water Management for Rural Development (P113949; FY11–18; project cost: $207 million); Vietnam Irrigated Agriculture Improvement (P130014; FY15–21; project cost: $210 million).

[4] Bangladesh National Agricultural Technology Project (P084078; FY08–15; project cost: $74 million); Modern Grain Storage Facilities Project (P120583; FY14–ongoing; project cost: $240 million).

[5] Bangladesh Water Management Improvement Project (P040712; FY08–16; project cost: $136.70 million); Bangladesh Integrated Agricultural Productivity Project (P123457; FY12–17; project cost: $63.55 million).

Chapter 5

[1] Water service delivery is distinct from the broader concept of "service delivery," which meets multiple and increasing demands on the sector. This broader concept is the one used in the analytical framework of this report.

[2] These are (i) beneficial consumption, consisting of water evaporated or transpired for the intended purposes from the irrigation system; (ii) nonbeneficial consumption, consisting of water evaporated or transpired for purposes other than the intended uses, such as evaporation from water surfaces, growth of weeds, and so on; (iii) nonconsumed recoverable fraction that can be captured and reused, such as water discharged into drains and other water bodies after irrigation; and (iv) nonconsumed nonrecoverable fraction, which consists of water that is lost for further use.

[3] Continuous flow refers to a system of irrigation water delivery in which irrigators receive their allotted quantity of water at a continuous rate, as opposed to receiving water periodically on a rotational basis. Continuous flow is meant to provide a more reliable and flexible supply of water at the point of abstraction by farmers.

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Appendix A. Methodology

The design element of the evaluation focuses on the theory of change, evaluative questions, the evaluation components, and a brief statement on limitations. The portfolio element of the evaluation details the key performance indicator (KPI) methodology, including the list of parameters used by the Independent Evaluation Group (IEG), and explanations of the typologies used.

Evaluation Questions

The following questions guided this evaluation:

1. How can we better conceptualize service delivery within irrigation management models?
2. To what extent have the service delivery components identified in (1) been integrated into the World Bank's irrigation projects?
3. What works, under what circumstances, to shift toward a service delivery outcome-oriented model of agriculture water management that meets multiple demands (production, livelihoods, water security, and sustainability)?

Scope and Limitations

The evaluation focused only on World Bank projects in line with the portfolio covered by the Water in Agriculture Global Solutions Group (GSG). The portfolio covered the World Bank projects approved and closed between fiscal year (FY)09 and FY19. It was planned that operations supported by the International Finance Corporation and Multilateral Investment Guarantee Agency would be covered only to the extent that they were relevant in the context of assessing World Bank operations, although no such operations were encountered. The analysis of causal explanations of success was limited by the available evaluative evidence and breadth of analysis that could be achieved within the time and resources available to the evaluation.

Approach and Data Collection Methods

- **Targeted literature review:** Review of select research papers, reports, publications, and other economic sector work of the World Bank, United Nations organizations, other multilateral banks, and academic journals. The review especially focused on the available literature about the state of the irrigation sector and service delivery.

- **Project portfolio review:** Portfolio review of all World Bank projects approved or closed from FY09 to FY19.

- **Key performance indicators analysis:** An analysis of all KPIs for World Bank irrigation and drainage (I&D) projects closed between FY09 and FY19.

- **Key informant interviews:** Semistructured interviews of key stakeholders conducted to obtain contextual information and other information that could not be extracted from the project portfolio and literature. Stakeholders included World Bank task team leaders, staff, and management of the Water in Agriculture GSG, Water Global Practice; government counterparts, irrigation agencies, and donor community (in the case study countries); and participants in California Irrigation Institute's 2019 Conference "Manage Our Land to Manage Our Water," which took place February 4–5, 2019.

- **Reconstruction of theory of change:** An iterative process of reconstruction of the theory of change adapted to I&D activities of the World Bank Group.

- **Country case study (desk-based analysis):** Study of 10 countries selected for deep desk-based research and analysis: Bangladesh, China, the Arab Republic of Egypt, Ethiopia, India, Madagascar, Morocco, Uzbekistan, Vietnam, and the Republic of Yemen. The case study countries were selected purposefully based on the following criteria: (i) existing water scarcity issues, (ii) regional representation, and (iii) World Bank lending portfolio size. This analysis included both active and closed projects (74 total; 51 closed and 23 active). The limitation is that this is not representative of the total population of countries in which the World Bank is active. Thus, direct attribution of commitments to I&D activities was based on assumptions and approximation.

- **Country case study (field based)**: Missions, including site visits and focus group discussions, carried out by IEG in four countries: Egypt, India, Uzbekistan, and Vietnam.

Portfolio Methodology

Data identification. IEG constructed the I&D evaluation portfolio through a multistage process using the Business Intelligence Database and applying sector code "AI" (Irrigation and Drainage). IEG then identified the projects approved or closed during the period FY09–19. In total, 293 projects were identified (119 active and 174 closed). (Note that this total number of projects comprised all types of projects, including small projects of less than $5 million that do not have project completion reports.)

Next, IEG disaggregated these into core (projects that contributed at least 20 percent of their respective World Bank commitments for I&D) and noncore (projects with less than 20 percent of commitments for I&D). There were 213 core projects and 80 noncore projects in the portfolio. Of the 213 core projects, 78 were active and 135 were closed.

Data coding for case study countries. For the 10 case study countries, 74 country case projects (51 closed and 23 active) were assessed in detail by reviewing various project-level documents—project appraisal documents, Implementation Completion and Results Reports, and Implementation Completion and Results Report Reviews—to understand their objectives, components, commitment amounts, and results frameworks. The "intent" was identified and coded for all projects, based on the project development objective, project description, and components in the project appraisal documents, using the variables presented in table A.1.

Table A.1. Descriptions of Elements in the Theory of Change for the Irrigation Sector

Element	Subelements with Indicative Description
I. Inputs and outputs	
Infrastructure	• **Infrastructure**: Irrigation system construction, rehabilitation, or modernization (for example, canals, tanks, reservoirs, dams, channels, pipelines, pumps, pumping stations, drainage, wells) measured by number of works, length, number of beneficiaries, or area with improved services. Land leveling completed. • **Operations and maintenance (O&M)**: Plans for O&M are prepared and operational, project investments are properly operated and maintained, people are trained in O&M, and users are satisfied with the O&M service.
Policy and regulation: Irrigation and drainage (I&D)	• **Planning**: Completion, adoption, or implementation of master plans, action or management plans, strategies and strategic plans, investment frameworks, and roadmaps related to I&D. • **Policy**: Adoption or implementation of policies on irrigation-related issues. • **Regulation**: Adoption or implementation of I&D regulations.
Policy and regulation: Water resources management (WRM) and cross-sectoral	• **Planning**: WRM, asset management, and river basin and watershed management. • **Policy**: Adoption or implementation of policies on irrigation-related WRM (for example, water law or code), groundwater management, water subsidies, and water user association (WUA) establishment. • **Regulation**: Adoption or implementation of regulations relating to governing of river basin committees, managing of transboundary shared resources. • **Water data**: Establishment of Hydrological Information System and Water Information System Platform tools, water data portals, and other information services and decision support systems. Establishment of groundwater monitoring systems.

Element	Subelements with Indicative Description
	• **Municipal regulation**: Regulations on local environmental issues, such as the development of a requirement that beneficiaries of state assistance for drip irrigation install water-metering systems.
Institutions and capacity building	• **Government**: Effective institutional arrangements (for example, national agencies or departments; basin water councils or commissions; local, state, provincial, district agencies or departments), and coordination capacities among local governments. • **Users and WUAs:** Establishing or strengthening of WUAs (or similar groups, such as tank user groups), and user satisfaction with performance; promotion of the duties and rights of users participating in community-based water management. • **Private sector and public-private partnerships:** Private sector participation in irrigation investments, service delivery, or O&M. • **Land tenure**: Land parcels and area(s) with use or ownership rights recorded by the project.
Agricultural inputs	• **Equipment**: Water metering, on-farm water monitoring, pumping, or irrigation maintenance equipment; on-farm water management equipment, such as drip irrigation, sprinklers, and so on, and spare parts and equipment for laser land leveling. • **Extension services and technologies**: Demonstrations and trainings conducted on improved water management practices and technologies, or the construction or rehabilitation of agricultural training centers or farmer field schools. • **Seeds, fertilizers, and pesticides**: Distribution or subsidization of improved seeds, fertilizers, or pesticides for farmers. • **Credit**: Improved access to finance measured by, for example, number of loans provided by financial institutions or percentage of farmers able to afford loan rates.
Marketing support	• **Market facilities and advice**: Construction of collection centers, warehouses, and storage facilities; processing and grading facilities; and procurement of cold chain equipment. Support for advisory services to improve farm-level marketing capacities, and training of farmers' organizations and groups on management, processing, and marketing techniques, including on how to obtain certifications (for example, organic, fair trade) and how to adapt production to market demand and standards.
Water accounting	• Systematic study of current status and trends in water supply, demand, accessibility, and use in a given domain.
II. Intermediate outcomes	
Improved practices	• **Water management practices**: Adoption of water-efficient technologies, such as drip irrigation, improved water management techniques, and sustainable water use planning. • **Agricultural practices**: Adoption of improved agricultural practices or technologies, such as the application of adequate amounts of

Element	Subelements with Indicative Description
	fertilizer, cultivation with improved seeds, use of crop residues or plastic membrane coverings for soil moisture preservation. • **Land management practices**: Percentage of area under sustainable land management practices; percentage of arable land sustainably managed against soil erosion. • **Climate-resilient practices**: Adoption of climate mitigation measures or climate-smart agriculture practices.
Financial sustainability	• Cost recovery rate of O&M expenses; irrigation fees to cover O&M expenditures; percentage of O&M costs covered by local government budget or WUAs; collection of billed water fees by WUAs; number of schemes with volumetric charging, reduced water pumping costs.
Service delivery	• **Adequacy**: Improved access for farmers to adequate irrigation services as measured by, for example, the following: the water supplied matches or is close to crops' irrigation water demands, water supplied is at or close to agreed or contracted volumes, water supplied to WUAs is at or close to the requested level in each period of delivery each year. • **Reliability**: Reliable access among water users in a designated irrigation service area in a given period (weekly, monthly, yearly) to sufficient water resources to meet their demands; farmers' receipt of water according to an agreed schedule. • **Equity**: The fair distribution of water for all competing uses and needs as measured by, for example, the ratio of water availability at tail and head ends (cubic meters per hour), or the delivery performance ratio, which measures water distribution equity. Either the provision of services is of a comparable standard across all users, or any variations in service are fairly reflected in the pricing policy. • **Flexibility**: The ability of irrigation systems or services to respond to variations in demand for water resources owing to changes in farms' needs (for example, during different seasons or crop cycles); the ability of farmers to make decisions on cropping and irrigation methods independent of others in the same system, or choices on services that are reflected in the price they pay (for example, increased flow rates at a higher price, water trading between irrigators). • **Quality**: Safety of the biological and chemical quality of irrigation water supplied for users, crops, the environment, and livestock. • **Operability**: Sufficiency of the water conveyance efficiency and overall operational efficiency of the irrigation systems. • **Governance**: Service delivery operator acting in an accountable and transparent fashion, representing members in an inclusive manner, addressing conflicts and various demands from the beneficiaries. • **Undefined service delivery**: Broad service delivery not categorized under any subelement.

Element	Subelements with Indicative Description
Market access	• Establishment of farmer marketing groups to enhance farmers' value addition activities and postharvest links with both local and export markets (for example, by organizing business roundtables and developing marketing alliances with buyers).
WRM decision-making	• Increased use of outputs from Hydrological Information System and Water Information System Platform tools by implementing agencies for planning and decision-making; and improved forecast accuracy for available reservoir storage and inflow and outflow volumes.
III. Outcomes	
Cropping outcomes	• **Yields and crop intensification**: Increased yields of specific crops (for example, rice, maize, mango), or the adoption of multiple cropping. • **Crop diversification**: Area under high-value crops, increased diversification of productive activities.
Water use outcomes	• **Water use efficiency**: Increased water savings during conveyance and application, reduced water withdrawal for irrigated agriculture, or improved efficiency of the irrigation system. • **Water productivity**: Increased water productivity (kilograms per cubic meter) for crops (that is, yields per unit of irrigation water), or increased value of crop output per unit of water (cubic meters).
Environmental outcomes	• **Groundwater recharge**: Reduced volume of groundwater abstracted or consumed, or increased recharge of groundwater. • **Waterlogging**: Reduced waterlogged land areas, or reduced farm production costs as a result of reduced waterlogging. • **Ecosystems**: Improved downstream water quality, or increased area or population protected from flooding.
Allied activity outcomes linked to irrigation water supply	• **Fisheries:** For example, percentage of tanks or reservoirs used for fisheries, average fish productivity in reservoirs. • **Livestock:** For example, number of farmers whose livestock productivity has increased.
IV. Impacts	
Increased agricultural production	• For example, increased agricultural production in terms of tons or value.
Increased livelihoods and incomes	• Increased farmer household incomes in irrigated areas, production value or farm sales, or permanent agricultural jobs created. Reduced farmers' labor time in irrigated areas.
Water resources management	• Improved overall management of water resources to ensure that sufficient quantity and quality is available for all uses: food production (that is, irrigation), drinking water and sanitation, energy generation, water transport, water-based tourism and recreation, and watersheds and water-based ecosystems, while also mitigating water-related risks, such as floods, droughts, and pollution.

Element	Subelements with Indicative Description
Climate resilience	• Increased farmers' resilience to climate change to mitigate potential future impacts on crop yields and values from climate events (for example, higher evapotranspiration rates, more variable rainfall, changing seasonal river flows, saline intrusion, and snow and glacial melt), which increase pressure on available water resources and bring greater uncertainty regarding the timing and availability of water for irrigation. Improved climate resilience could result from various activities and investments, such as developing and applying climate-proof design standards to irrigation infrastructure investments (outputs) or promoting the adoption of climate-smart agricultural practices and technologies (intermediate outcomes).

Key Performance Indicator Analysis

The analysis examined all KPIs listed in the results frameworks of World Bank projects in the portfolio that were approved and closed from FY09 to FY19, and that also had Implementation Completion and Results Report Reviews with development outcome ratings. Development outcome ratings were available for 137 projects (106 core, 31 noncore). IEG carried out the analysis using the core projects only. IEG classified these KPIs by type—outputs, intermediate outcomes, outcomes, and impacts—and by major elements and subelements (table A.2).

Table A.2. Key Performance Indicator Categories Based on Independent Evaluation Group's Expanded Results Framework

Type	Main Element	Subelement
Outputs	Infrastructure	• Infrastructure • Operations and maintenance
	Institutional	• Government: Irrigation and drainage water resources management (WRM) • Users and water user associations • Private sector and public-private partnerships
	Policy and regulation	• Policy • Plan • Regulation • Water data • Municipal regulation • Land tenure
	Agricultural inputs	• Equipment • Extension services and technology • Seeds, fertilizers, and pesticides
	Marketing	• Market facilities and advice

Type	Main Element	Subelement
Intermediate outcomes	Improved practices	• Agricultural practices • Water management practices • Climate-resilient practices • Land management practices
	Service delivery	• Adequacy • Reliability • Flexibility • Equity • Quality • Undefined service delivery • Operability • Governance
	Financial sustainability	• Financial sustainability
	Market access	• Market access
	WRM decision-making	• Improved planning decisions on WRM
Outcomes	Cropping outcomes	• Crop diversification • Yield and crop intensification
	Water use outcomes	• Water use efficiency • Water productivity
	Environment outcomes	• Groundwater recharge • Waterlogging • Other ecosystem
	Allied activity outcomes	• Fisheries • Livestock
Impacts	Increased livelihoods and incomes	• Increased livelihoods and incomes
	Increased agricultural production	• Increased agricultural production
	Water resources management	• Water resources management
	Climate resilience	• Climate resilience

IEG KPI rating. After mapping the KPIs, IEG rated them according to the following: 1 = target achieved by 70 percent or above; 0 = target achievement below 70 percent. IEG assigned ratings when a baseline, a target, and an achieved target were available, or at least a target and the achieved value.

KPI mapping to features highlighted in the World Bank governance in irrigation and drainage resource book. At the request of the Water in Agriculture GSG, IEG also mapped the KPIs for themes of interest identified by the World Bank's governance in irrigation and drainage resource book (World Bank 2018a), which provides practical insights on **governance in I&D.** The dimensions used to map KPIs are explained in table A.3. IEG is providing the GSG with these results separately from this report.

Table A.3. Key Performance Indicator Categories Based on the Governance in Irrigation and Drainage Resource Book

Element	Description
Governance and conflict management	
Transparency (and customer orientation)	• Is management accountable to users, owners, or stakeholders, and are there performance assessment mechanisms? • Does management include staff and users in institutional improvement processes, and is there an effective communication strategy? • Is information on scheme operation and service delivery routinely and effectively measured (metered) and documented? • Is there an effective and responsive information management system to provide agency-related information on structure, people, and processes? • Are conflict management mechanisms in place to enable debate and resolve conflict regarding the service (either between users or between service providers and users)? • Is there adequate tracking of conflicts, and analysis to overcome structural problems?
Policy and legal	• Are there adequate policy and legal frameworks (including suitable legal instruments in place) to strengthen performance of irrigation service delivery? • Do water and other relevant sectors demonstrate compatibility between policies?
Institutional	• Does the irrigation and drainage (I&D) agency have organizational autonomy (financial, political, and so on)? • Are there suitable mechanisms defined for inter- and intra-agency coordination? • Is there clarification of tasks and responsibilities (spatially, functionally, hierarchically, and hydraulically) of the various agencies regarding delivery of I&D services? • Is the I&D service provider considered credible by the people it serves, by financiers, and by other stakeholders?
Accountability	• Is provision of irrigation water regulated and licensed, and are regulation and licensing suitably enforced? • Are there (formal or informal) service agreements between parties for the provision of services, and are these agreements enforced? • Are there process management and performance monitoring systems within the organization that ensure adequate accountability to the management, and to users? • Are farmers and users of I&D services engaged in the accountability of the I&D agency and other stakeholders responsible for service delivery? • Is there effective communication within the organization and with its clients on the formulation, execution, and evaluation of service delivery activities?
Inclusive	• Is there transparency, equity, and inclusiveness (including women, youth, and other groups) in the stakeholders associated with services delivery, including the I&D agency?

Element	Description
	• Is the level of representation of various stakeholders (for example, women, youth, and marginalized groups) suitably reflected in the composition of water user groups and the I&D agency? • Are stakeholders, including women, youth, and marginalized groups, suitably empowered, included in dialogue, and involved in decision-making, including setting their agenda?
Service delivery	
Adequacy	• Do the farmers receive enough flow, pressure (if applicable), and total quantity, to meet their crop water requirements and timelines? • Is excess irrigation water suitably drained from farmers' plots without causing damage to soil and crops? • Is the biological and chemical quality of irrigation water supplied safe for users, crops, the environment, and livestock?
Reliability	• For irrigation services based on irrigation scheduling: does the farmer receive water according to the agreed schedule and with predictability? • For on-demand service: does the service provider ensure continuity of service at the delivery point (for example, hydrants or other)? • For proportional distribution or spate irrigation: does the farmer receive water according to agreement? • For flood protection: are the fields and other conveyance infrastructure protected against the design flood (of relevant return period, such as 1 in 50 years)?
Equity	• Is irrigation water distributed fairly across all users of the system? • Are drainage and flood protection services of comparable standard across all users? • Are irrigation service parameters (adequacy, reliability, flexibility, quality) built into infrastructure that enables equitable distribution to all users? • If service varies within the scheme, are these variations reflected in the pricing policy?
Flexibility	• Does the system allow farmers to vary their demand in response to changing needs at farm level, during the cropping cycle, and over the seasons? • To what extent can farm decisions on cropping and irrigation methods be made independently from others in the same system, within the overall service agreement? • Can farmers make choices in relation to the services, which are then reflected in the price they pay (for example, increased flow rates at a higher price, formal and informal water trading)?
Multiple-use services	• Are the needs of other groups of water users, or services, recognized by I&D and other agencies (for example, watershed management, flood protection, environment, ecological flow, hygiene, livestock, fisheries, domestic water, washing, tourism, recreation, groundwater)? • Is there a pricing policy for other users adapted to their use?
Productivity	• Is the irrigation service attuned to enabling sustainably maximized and diversified production (in terms of yield or return per unit of water, labor, inputs, and so on)? • Is the cost of service affordable compared with productivity gains, and is the invoicing done in relation to farmers' expected cash flow?
Operability	• Is the physical design of the infrastructure (density of network, type of control structure, measurement capability) fit to deliver the required level of service required by farmers?

Element	Description
	• How sensitive is the service to flow fluctuations, breakdowns, and other variations or anomalies, and can service be maintained without high deployment of water, energy, and personal resources?
Organizational resources	
Financial sustainability	• Are sufficient resources budgeted for and mobilized to manage, operate, maintain, and replace irrigation infrastructure to deliver quality I&D services now and in the future? • Do water users pay for irrigation services? (Is there effective fee setting, and are fee collection mechanisms enforced?) • Is there access to finance for scheme management from commercial sources, such as private financial institutions (for example, banks), technology suppliers, and so on?
Asset management and technical	• Is there an asset management plan to maintain the condition of I&D assets and an optimum operating standard, and to provide a level of service to farmers that is consistent with cost-effectiveness and sustainability objectives?
Operations management	• Is there an appropriate operation plan that rationalizes the type and costs of various operational requirements (to provide a suitable level of service to farmers consistent with cost-effectiveness and sustainability objectives)? • Is the organizational structure and decision-making clear and functional in terms of inclusiveness, hierarchy, functions, and reporting? • Is there a suitable inventory on main system and service parameters (users, land owners, irrigation network, irrigation rights, geography, crops) to support decisions? • Are there internal service standards and process workflows for common operations and maintenance functions, and are records on service levels maintained?
Organizational management and human resources	• Is the staffing composition adequate to fulfill the mission in terms of technical, financial, social, and management positions, skills, and capacities? • Is there an effective staffing plan, including training and development, performance management, adequate compensation, and learning opportunities? • Is there a transparent and merit-based staff performance and reward system in place? • Are there outsourcing policies and practices for specific functions?
Fiduciary management	• Is there effective expense control and cash flow management of I&D agency based on accurate forecasting? • Are there performance standards for I&D services that are used as the basis for fund allocations, prioritization of activities, and monitoring improvements in service delivery?
Strategy and processes	• Is the institutional vision, mission, and sector road map to support change management and improved service delivery performance by the I&D agency aligned to water and agricultural policy? • Is there an appropriate investment strategy for development and sustainability of I&D infrastructure and services? • Is there appropriate due diligence on decision-making, including attention to issues of inclusiveness, and to "decision meetings" with due process and record keeping?

Analysis by Project Typology

Finally, owing to divergent needs for different types of irrigation systems—of different sizes, management styles, hydrology characteristics, and forms of irrigation service delivery in response to local farmers' priorities—IEG disaggregated the analyzed projects into four types (table 2.1). These types have been adapted from the governance in irrigation and drainage resource book (World Bank 2018a). This additional level of analysis and mapping was conducted for the 106 closed core projects with development outcome ratings identified for the KPI analysis.

Appendix B. Portfolio Tables

Portfolio Overview

The portfolio includes 293 projects, amounting to $13.4 billion in commitments (table B.1). Of these 293 projects, there are 213 core projects, totaling $12.4 billion, of which 135 projects are closed and 78 are active. The average commitment for core irrigation projects is nearly five times that of noncore projects.

Of the 135 closed projects in the portfolio, 76 percent received a moderately satisfactory (MS) outcome rating or above. Overall project outcome ratings are similar for core and noncore projects.

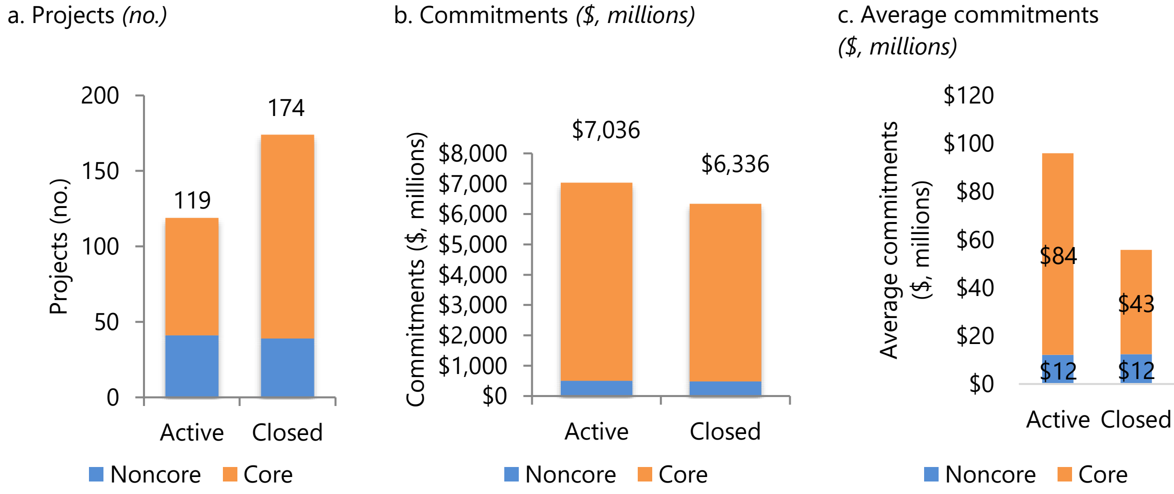
Table B.1. Portfolio Overview: Number of Projects, Net and Average Commitments, and Outcome Ratings of MS+

	Projects		Net World Bank Commitments			Average Project Commitment		Outcome Rating MS+	
	Active *(no.)*	Closed *(no.)*	Active *(no.)*	Closed *(no.)*	Total *($, millions)*[a]	*(percent)*	*($, millions)*	*(no.)*	*(percent)*
Core[b]	78	135	6,536	5,852	12,389	92	58	82	76
Noncore	41	39	500	484	984	8	12	24	77
Total	119	174	7,036	6,336	13,372	100	46	106	76

Source: World Bank Business Intelligence data.
Note: MS+ = moderately satisfactory or above.
a. The calculation of net commitments includes additional finance and Global Environment Facility projects attached to the 293 parent projects, resulting in 387 project information documents.
b. Core projects are defined as those that contribute at least 20 percent of World Bank commitments to irrigation.

Regionally, Africa has the most projects, but South Asia has the highest commitments, with large programs in India and Pakistan that rank among the top 10 countries with the largest commitments (figure B.2). Overall, the top 10 recipient countries account for 66 percent of the portfolio's total commitments and 35 percent of its projects (figure B.2).

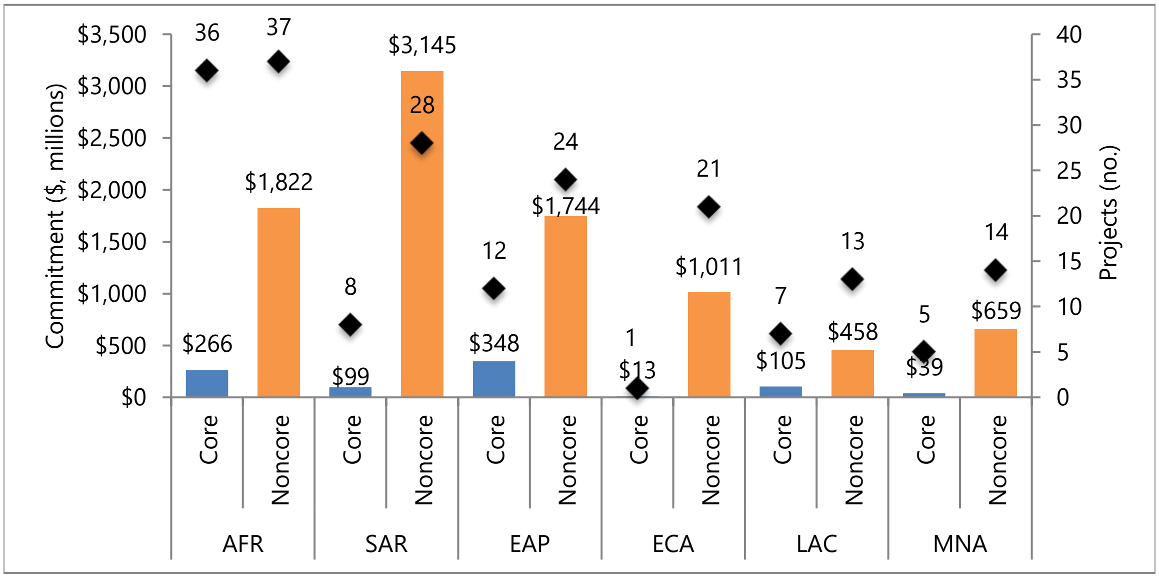
Figure B.1. World Bank Irrigation and Drainage Portfolio



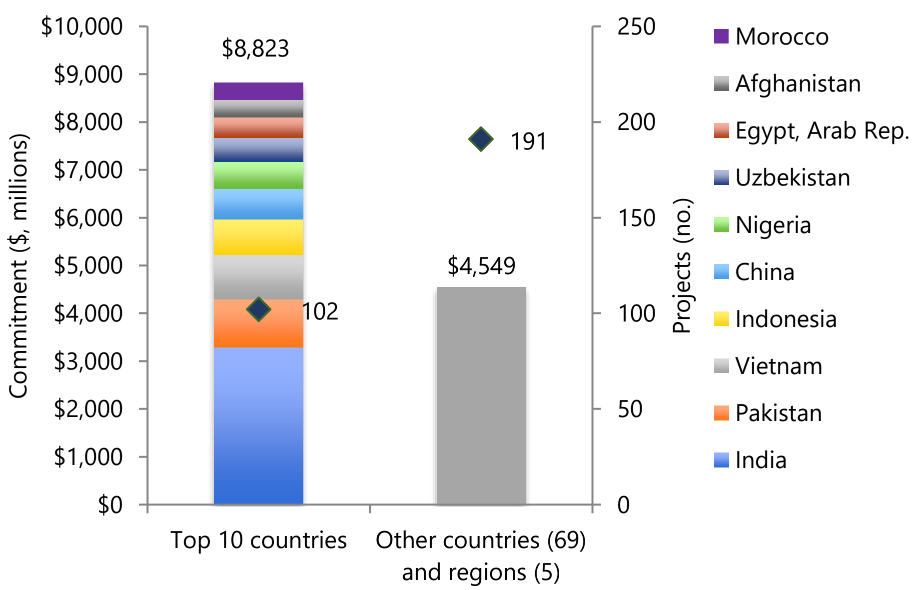
Source: World Bank Business Intelligence data.

Figure B.2. Commitments and Projects, by Region and by Top 10 Recipient Countries

a. Commitments and projects, by Region[a]



b. Commitments and projects, by top 10 recipient countries[b]

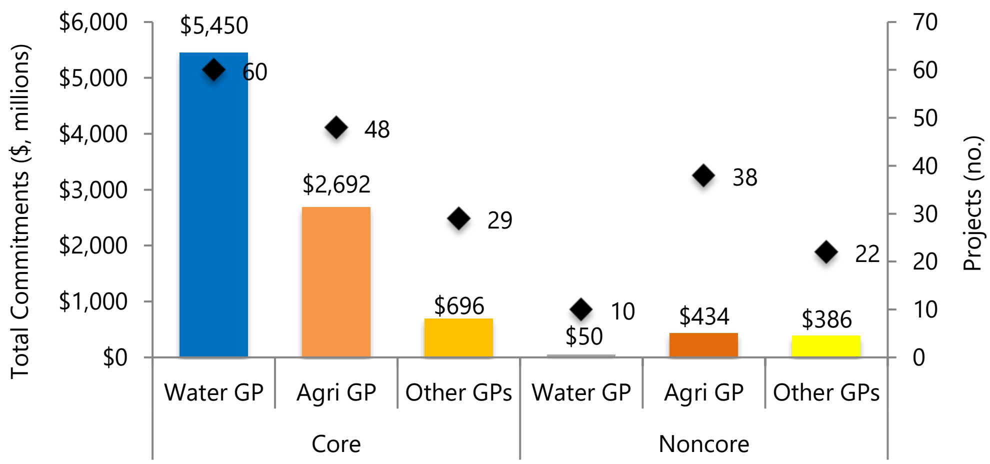


Source: World Bank Business Intelligence data.
Note: Black diamonds represent the number of projects. AFR = Africa or Sub-Saharan Africa; EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MNA = Middle East and North Africa; SAR = South Asia.
a. To illustrate more recent trends in commitments, only projects approved from FY09 to FY19 were included in this figure.
b. This figure includes all 293 of the core and noncore projects in the portfolio, along with their additional finance and trust fund commitments (387 project identification codes totaling $13,372 million).

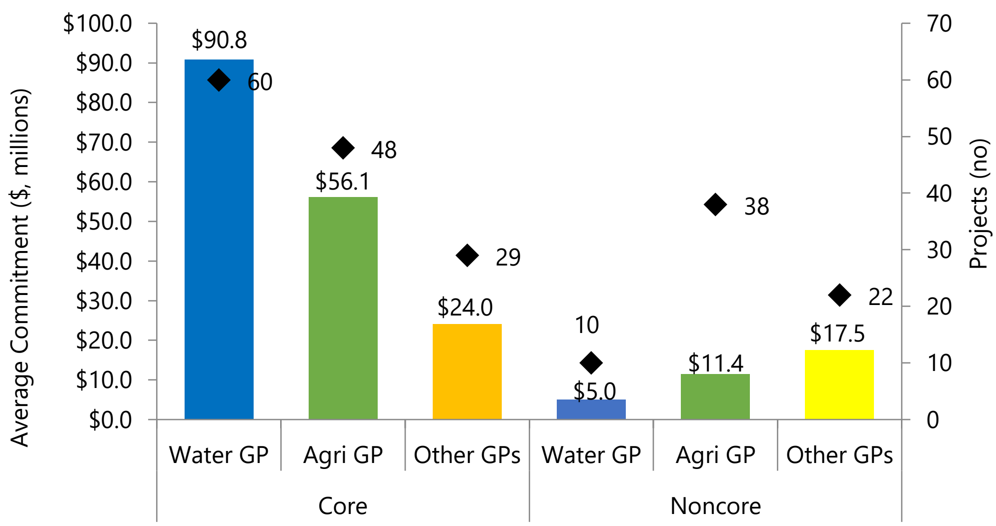
Water GP commitments are twice those of other GPs, and the majority are core projects (figure B.3). In addition, the average commitment per project is highest for the Water GP ($91 million) compared with Agriculture GP ($56 million) and other GPs ($24 million).

Figure B.3. Total and Average Commitments and Projects, by Global Practicea

a. Total commitments and projects, by GP



b. Average commitments and projects, by GP



Source: World Bank Business Intelligence data.
Note: Black diamonds represent the number of projects. Agri = Agriculture; GP = Global Practice.
a. To illustrate more recent trends in commitments, only projects approved from FY09 to FY19 were included in these figures.

An analysis of trends in the range of activities among country case study projects shows that infrastructure and institutional activities were the most common, with an increased focus among active projects on agricultural inputs and practices, marketing support, and climate change (table B.2). In addition, there has been a decrease in focus on water resources management to a significant extent (45 percent among closed projects compared with 22 percent among active projects).

Table B.2. Trends in Range of Project Activities, Country Case Study Projects

	Policy Planning	Infrastructure	Institutional and Capacity Building	On-Farm Water Practices	Agriculture Inputs and Practices	Marketing Support	Water Resources Management	Climate Change	Behavior Change
Closed *(no.)*	29	40	40	26	29	11	23	9	6
Closed *(percent)*	57	78	78	51	57	22	45	18	12
Active *(no.)*	10	21	18	12	17	9	5	10	—
Active *(percent)*	43	91	78	52	74	39	22	43	—

Source: Independent Evaluation Group analysis based on World Bank Business Intelligence data.
Note: — = not available.

Furthermore, an analysis of selected interactions of project activities shows that although infrastructure is often accompanied by agricultural inputs and practices, agricultural practices are not sufficiently supported by marketing support activities (table B.3).

Table B.3. Trends in Interactions of Project Activities, by Country Case Study Projects

	Infrastructure Plus On-Farm Water Practices	Infrastructure Plus Agricultural Inputs and Practices	Agricultural Practices Plus Marketing Support
Closed *(no.)*	22	26	9
Closed *(percent)*	55	65	23
Active *(no.)*	12	17	7
Active *(percent)*	57	81	37

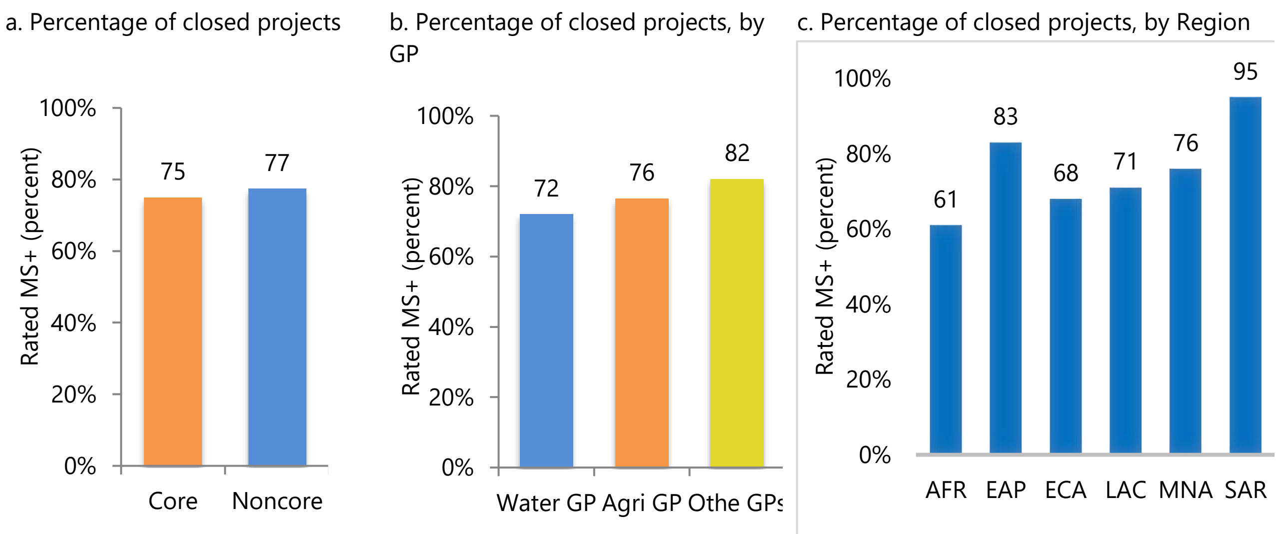
Source: Independent Evaluation Group analysis based on World Bank Business Intelligence data.

Project Performance

Of the closed projects in the portfolio, most (76 percent) have an MS outcome rating or above, representing 83 percent of net commitment amounts (figures B.4 and B.5). Of these, core and noncore projects have the same overall development outcome ratings. Among GPs, the Water GP has a lower average rating than the Agriculture GP or other

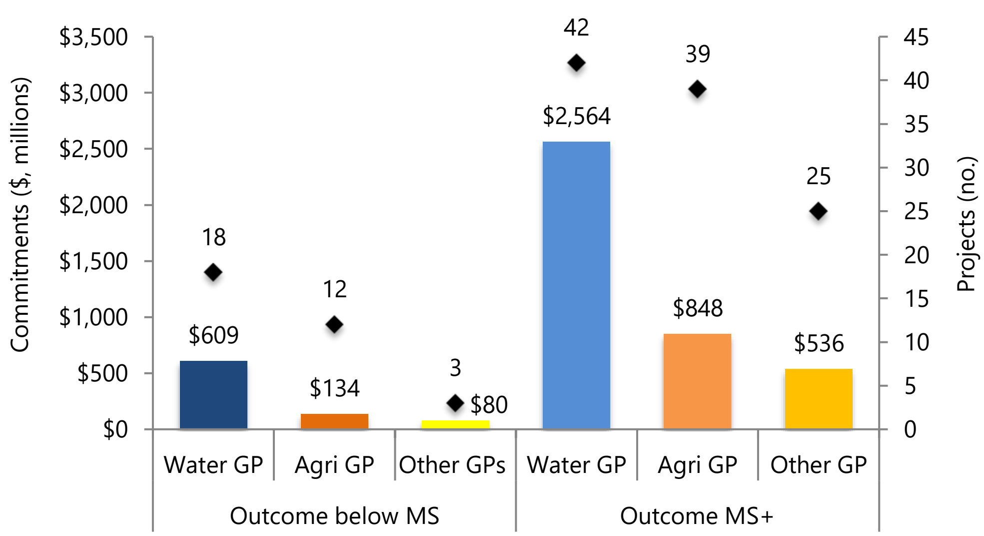
GPs. Regionally, the South Asia and East Asia and Pacific regions have the highest percentage of projects with an outcome rating of MS or above (figure B.4c).

Figure B.4. Irrigation Projects with Development Outcome Ratings of MS+, by Percentage of Closed Projects and Global Practice and Region



Source: World Bank Business Intelligence data.
Note: AFR = Africa or Sub-Saharan Africa; AGRI = Agriculture; EAP = East Asia and Pacific; ECA = Europe and Central Asia; GP = Global Practice; LAC = Latin America and the Caribbean; MNA = Middle East and North Africa; MS+ = Moderately satisfactory or above; SAR = South Asia.

Figure B.5. Commitments for Global Practices with Development Outcome Ratings Below MS versus MS+



Source: World Bank Business Intelligence data.
Note: Black diamonds represent the number of projects. AGRI = Agriculture; MS = moderately satisfactory; MS+ = moderately satisfactory or above.

Among country case study countries, intended outputs were measured more often than intended outcomes or impacts.

At an aggregate level, project outcome ratings are strongly correlated with both borrower performance and bank performance (table B.4). However, the difference in risk to development outcome between projects that perform well and those that do not is not statistically significant.

Table B.4. Link between Project Outcome Ratings and Borrower Performance, Bank Performance, and Risk to the Development Outcomea

	Project Outcome Rated MS+ *(n = 104)*			Project Outcome Rated MU− *(n = 32)*		
	MS+ ***(no.)***	**MU−** ***(no.)***	**MS+** ***(percent)***	**MS+** ***(no.)***	**MU−** ***(no.)***	**MS+** ***(percent)***
Borrower performance	83	5	94	5	25	17
Bank performance	94	27	78	19	29	40
Risk to development outcome	87	39	69	30	25	55

Source: World Bank Business Intelligence data.
Note: MS+ = moderately satisfactory or above; MU− = moderately unsatisfactory or below.
a. Not all projects are rated on all parameters. One project’s development outcome was marked as N/A, so there are 136 projects reviewed in this table.

Appendix C. Illustrative Country Case Example: Uzbekistan

PROJECT INFORMATION							SERVICE DELIVERY MODELS									
PROJECT ID	NAME	WB Net Commitment Million US$	Duration	CORE? (Y/N)	GP	ICRR Outcome Rating	Policy Plan	Infra	Inst & Cap Bldg	Water Mngm Prcts	Inputs & Agri Prcts	Marktg Support	WRM	Climt. Chang.	Behav. Change	Measurement
P009127	Drainage Irrigtn and Wetlands	57.6	2003-2013	y	Water	MU										Rating
P109126	Rural Enterprise Support II	28.5	2008-2017	y	Agri	MS										Rating
P110538	Ferghana Valley WRM I	58.3	2010-2017	y	Water	MS										Rating
P127486	Sust Agr & Cl Ch Mitig GEF	3.7	2013-2018	y	Agri	MS										Rating
P127764	S Karakalpakstan Water Res Mgmt	208.6	2014-2022	y	Water	-										Rating
P149610	Fergana Valley WRM - Phase II	131.9	2017-2025	y	Water	-										Rating

PROJECT ID	INPUTS / OUTPUTS: Policy/Reg						Infra		Institutions & Capacity Building			Agri Inputs				Mktg
	Policy	Plan	Regulation	Water Data	Municipal regulation	Land Tenure	Infrastructure	O &M	Government-I&D WRM	Users / WUAs	Private Sector/ ppp	Equipment	Extension Services / Technology	Seed /Fertilizers /Pesticides	Credit	Market facilities / Advice
P009127							1	-	1	0			1			
P109126				-			1	1	1	1			1		1	
P110538			-	-			1	-	1	1			1			
P127486							1					-	1			
P127764		-		-			*	-	*	*		-	*		-	
P149610				-			*	-	*	*			*			

PROJECT ID	INTERMEDIATE OUTCOMES: Service Delivery								Fincl Sust	WRM Decision	Mrktg	Improved Practices			
	Adequacy	Reliability	Flexibility	Equity	Quality	Undefined Service Delivery	Operability	Governance	Financial Sustainability	Improved Planning Decision WRM	Market Access	Agricultural Practices	Water Mngt Practices	Climate Resilint Practices	Land Mngt Practices
P009127	0	0			-	-	-	-	-			-	-		
P109126	1			-			-	-	-			-	-		
P110538	-			-			-	-				0	0		
P127486													-		-
P127764						*			*		-	*	-		
P149610	*			-	*	*	-		*			*	-	-	*

PROJECT ID	OUTCOMES: Cropping Outcome		Water Use Outcome		Allied Activity Outcome		Environment Outcome			IMPACTS			
	Crop Diversification	Yields/ Crop Intensification	Water Use Efficiency	Water Productivity	Fisheries	Livestock	Ground Water Recharge	Water Logging	Other Ecosystem	Increased Agricultural Production	Increased Livelihoods / Incomes	Water Resources Management	Climate Resilience
P009127		0						-	1		0		
P109126		0							-		0		
P110538		0	-					1	1				
P127486													
P127764	*	-	-										
P149610	-	-	*				-		-				-

ADDITIONAL AGRICULTURE AND HYDRO PROJECTS

PROJECT ID	NAME	WB Net Commitment Million US$	Duration	CORE? (Y/N)	GP		Policy Plan	Infra	Inst & Cap Bldg	Water Mngm Prcts	Inputs & Agri Prcts	Marktg Support	WRM	Climt. Chang.	Behav. Change
P133703	Horticulture Development	150	2014	na	Agri										
P153613	Livestock Sector Development	150	2017	na	Agri										

ADDITIONAL WRM PROJECTS

There are no WRM projects .

1	Measured and above the line
0	Measured and below the line
-	Intended but not measured
*	Planned to be measured (for active projects)
na	KPI was designed but not reported

Source: Independent Evaluation Group analysis based on World Bank project data.

Note: GP = Global Practice; ICRR = Implementation Completion and Results Report Review; WRM = water resources management.

Appendix D. Project Examples Incorporating Theory of Change Elements of Significance

Type 1 projects: The China Xinjiang Water Conservation Project, as an example of a large public scheme, provides important lessons on the use of remote sensing technology to monitor evapotranspiration to monitor total water use and water productivity and the development of and experimentation with an evapotranspiration-based water allocation and permitting system. The project included right incentive mechanisms (via policy and regulation, institutional, and data technologies) to achieve water delivery, water productivity, and financial sustainability. Behavior change—water saving by farmers—was achieved through consumption caps, use of remote sensing technology for measuring water levels, and controlling water, accompanied by a policy framework (that is, water rights), institutional capacity building of water user associations (WUAs), and enforced regulations (penalty fees for overuse). Financial sustainability was achieved via preparation of operations and maintenance (O&M) plans and government's willingness to increase water fees or subsidies. The project adequately monitored reliability of water service, water productivity, and financial sustainability.

Type 2 projects: The Yemen Sana'a Basin Water Resources Management Project is a good example of a type 2 model. The basin is one of the most water-scarce areas of the world, and irrigation systems are groundwater resources managed by farmers. The project included demand-side management of water by introducing water-saving technologies, and supply-side activities for improving irrigation water delivery from village wells and constructing or improving dams for groundwater recharge. Institutional components included development and application of registration and permits of well users and drillers, and basin water management for basin-level coordination and overview of water resources. The WUAs were responsible for the monitoring and O&M of irrigation schemes. The project had weaknesses in the implementation of these institutional and regulatory measures. The shortcomings of the monitoring and evaluation framework also echoed this problem; that is, no measurement was included on management of the water resources (decision-making and planning) at the basin level. Also, financial sustainability of irrigation schemes managed by WUAs were not considered and monitored.

Type 3 projects: The Sahel Irrigation Initiative Support Project, an active project covering Burkina Faso, Chad, Mali, Mauritania, Niger, and Senegal, presents an example of an individually managed irrigation type. Individually managed systems do not include a service provider because individual farmers operate the irrigation system on their own, mostly with small private wells. However, these individual systems need organizational support in managing the aquifers or shared watersheds. Enforced regulations may need to be implemented for licensing and data collection, and monitoring frameworks may need to be established to measure and control groundwater levels.

Type 4 projects: These projects involve commercial farms supplying the domestic and international markets through the production of high-value crops. Therefore, these projects should include activities and monitor indicators for on-demand supply, continuous flow, and water quality. Two active projects in Africa, the Malawi Shire Valley Transformation Program and Zambia Irrigation Development Support Project, present lessons on the corporate irrigation type of projects. Both projects include establishing smallholder-owned commercial farm enterprises transitioning into commercial agriculture. The Malawi project includes a two-tier water management system, with the main system managed by a private bulk water operator and the tertiary level consisting of large blocks managed by smallholder farmer enterprises. Neither of the projects established service delivery–type indicators. The Zambia project had a grievance mechanism to ensure that the newly established commercial farmer enterprises reflected the needs of the member farmers; it also had land and water rights and contractual rights between service providers and beneficiaries, which stakeholders were clearly informed of. When the irrigation water service is up and running, service delivery indicators (adequacy, reliability, flexibility, equity between different types of farms) and quality of the irrigation water may need to be included and monitored. Although water resources are still abundant in these countries, systems to measure productivity of water are still important to better allocate water resources among different stakeholders.

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