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PROJECT PERFORMANCE ASSESSMENT REPORT

PEOPLE'S REPUBLIC OF CHINA

IRRIGATED AGRICULTURE INTENSIFICATION III PROJECT (IBRD-48030, TF-92393)

MAINSTREAMING CLIMATE CHANGE ADAPTATION IN IRRIGATED AGRICULTURE PROJECT (IBRD-48030, TF- 92393)

HAI BASIN INTEGRATED WATER AND ENVIRONMENT MANAGEMENT PROJECT (TF-53183)

June 19, 2015

IEG Public Sector Evaluation
Independent Evaluation Group

Currency Equivalents (annual averages)

Currency Unit = Renminbi (RMB)

2004	US$1.00	RMB8.276801
2005	US$1.00	RMB8.194317
2006	US$1.00	RMB7.973438
2007	US$1.00	RMB7.607533
2008	US$1.00	RMB6.948655
2009	US$1.00	RMB6.831416
2010	US$1.00	RMB6.770269

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Abbreviations and Acronyms

CAD	Comprehensive Agriculture Development
CAS	Country Assistance Strategy
COCAD	County Office for Comprehensive Agriculture Development
CDD	Community Driven Development
COD	Chemical Oxygen Demand
CPMO	Central Project Management Office
CPS	Country Partnership Strategy
ET	Evapotranspiration
ERR	Economic Rate of Return
FA	Farmers' Association
FB	Finance Bureau
FC	Farmers' Cooperative
GEO	Global Environmental Objective
HBC	Hai Basin Commission
HBP	Hai Basin Integrated Water and Environment Management Project
IAIL2	Second Irrigated Agriculture Intensification Project
IAIL3	Third Irrigated Agriculture Intensification Project
ICR	Implementation Completion Report
IEG	Independent Evaluation Group
IEGPS	IEG Public Sector Evaluation
IWEMP	Integrated Water and Environment Management Plan
IPM	Integrated Pest Management
IRSA	Institute of Remote Sensing Applications
KM	Knowledge Management
MEP	Ministry of Environment Protection
MIS	Management Information Systems
MOC	Ministry of Construction
MTR	Mid Term Review
MWR	Ministry of Water Resources
MCCA	Mainstreaming Climate Change Adaptation in Irrigated Agriculture
NDRC	National Development and Reform Commission
O&M	Operations and Maintenance
PAD	Project Appraisal Document
PMO	Project Management Office
PLG	Project Leading Group
POCAD	Provincial Office of Comprehensive Agricultural Development
PPAR	Project Performance Assessment Report
PPMO	Provincial Project Management Office

RS	Remote Sensing
SAP	Strategic Action Plan
SEBAL	Surface Energy Balance Algorithm for Land
SEPA	State Environment Protection Administration
SOCAD	State Office of Comprehensive Agricultural Development
SWAT	Soil and Water Assessment Tool
TUDEPII	Tianjin Urban Development and Environment II Project
WCP	Water Conservation Project
WUA	Water User Association
WRB	Water Resource Bureau
3H Basin	Huang- Hua- Hai River Basin

Fiscal Year

Government: July 1 – June 30

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Contents

This report was prepared by Keith Robert A. Oblitas and Kenneth M. Chomitz, who assessed the project in September 2014. The report was peer reviewed by Scott Douglas Rozelle and panel reviewed by Monika Huppi. Vibhuti Narang Khanna provided administrative support.

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The graphics in this report are best viewed in color.

Principal Ratings

Irrigated Agriculture Intensification III Project (IBRD-48030, TF-92393)

	ICR*	ICR Review*	PPAR
Outcome	Highly Satisfactory	Satisfactory	Highly Satisfactory
Risk to Development Outcome	Negligible to Low	Negligible to Low	Negligible to Low
Bank Performance	Satisfactory	Satisfactory	Highly Satisfactory
Borrower Performance	Highly Satisfactory	Highly Satisfactory	Highly Satisfactory

* The Implementation Completion Report (ICR) is a self-evaluation by the responsible Bank department. The ICR Review is an intermediate IEGWB product that seeks to independently verify the findings of the ICR.

Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (IBRD-48030, TF 92393)

	ICR*	ICR Review*	PPAR
Outcome	Highly Satisfactory	Satisfactory	Highly Satisfactory
Risk to Development Outcome	Negligible to Low	Negligible to Low	Negligible to Low
Bank Performance	Satisfactory	Satisfactory	Highly Satisfactory
Borrower Performance	Highly Satisfactory	Highly Satisfactory	Highly Satisfactory

* The Implementation Completion Report (ICR) is a self-evaluation by the responsible Bank department. The ICR Review is an intermediate IEGWB product that seeks to independently verify the findings of the ICR.

Hai Basin Integrated Water and Environment Management Project (TF-53183)

	ICR*	ICR Review*	PPAR
Outcome	Satisfactory	Moderately Satisfactory	Satisfactory
Risk to Development Outcome	Negligible to Low	Negligible to Low	Significant
Bank Performance	Satisfactory	Satisfactory	Satisfactory
Borrower Performance	Highly Satisfactory	Moderately Satisfactory	Satisfactory

* The Implementation Completion Report (ICR) is a self-evaluation by the responsible Bank department. The ICR Review is an intermediate IEGWB product that seeks to independently verify the findings of the ICR.

Key Staff Responsible

Irrigated Agriculture Intensification III Project (IBRD-48030, TF-92393)

Project	Task Manager/Leader	Division Chief/ Sector Director	Country Director
Appraisal	Qun Li	Mark D. Wilson	David R. Dollar
Completion	Qun Li	Mark R. Lundell	Klaus Rohland

Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (IBRD-48030, TF 92393)

Project	Task Manager/Leader	Division Chief/ Sector Director	Country Director
Appraisal	Qun Li	Rahul Raturi	David R. Dollar
Completion	Qun Li	Mark R. Lundell	Klaus Rohland

Hai Basin Integrated Water and Environment Management Project (TF-53183)

Project	Task Manager/Leader	Division Chief/ Sector Director	Country Director
Appraisal	Douglas Olsson	Mark D. Wilson	Yukon Huang
Completion	Liping Jiang	Paul Kriss	Klaus Rohland

IEG Mission: Improving World Bank Group development results through excellence in evaluation.

About this Report

The Independent Evaluation Group assesses the programs and activities of the World Bank for two purposes: first, to ensure the integrity of the Bank's self-evaluation process and to verify that the Bank's work is producing the expected results, and second, to help develop improved directions, policies, and procedures through the dissemination of lessons drawn from experience. As part of this work, IEG annually assesses 20-25 percent of the Bank's lending operations through field work. In selecting operations for assessment, preference is given to those that are innovative, large, or complex; those that are relevant to upcoming studies or country evaluations; those for which Executive Directors or Bank management have requested assessments; and those that are likely to generate important lessons.

To prepare a Project Performance Assessment Report (PPAR), IEG staff examine project files and other documents, visit the borrowing country to discuss the operation with the government, and other in-country stakeholders, and interview Bank staff and other donor agency staff both at headquarters and in local offices as appropriate.

Each PPAR is subject to internal IEG peer review, Panel review, and management approval. Once cleared internally, the PPAR is commented on by the responsible Bank department. The PPAR is also sent to the borrower for review. IEG incorporates both Bank and borrower comments as appropriate, and the borrowers' comments are attached to the document that is sent to the Bank's Board of Executive Directors. After an assessment report has been sent to the Board, it is disclosed to the public.

About the IEG Rating System for Public Sector Evaluations

IEG's use of multiple evaluation methods offers both rigor and a necessary level of flexibility to adapt to lending instrument, project design, or sectoral approach. IEG evaluators all apply the same basic method to arrive at their project ratings. Following is the definition and rating scale used for each evaluation criterion (additional information is available on the IEG website: http://worldbank.org/ieg).

Outcome: The extent to which the operation's major relevant objectives were achieved, or are expected to be achieved, efficiently. The rating has three dimensions: relevance, efficacy, and efficiency. *Relevance* includes relevance of objectives and relevance of design. Relevance of objectives is the extent to which the project's objectives are consistent with the country's current development priorities and with current Bank country and sectoral assistance strategies and corporate goals (expressed in Poverty Reduction Strategy Papers, Country Assistance Strategies, Sector Strategy Papers, Operational Policies). Relevance of design is the extent to which the project's design is consistent with the stated objectives. *Efficacy* is the extent to which the project's objectives were achieved, or are expected to be achieved, taking into account their relative importance. *Efficiency* is the extent to which the project achieved, or is expected to achieve, a return higher than the opportunity cost of capital and benefits at least cost compared to alternatives. The efficiency dimension generally is not applied to adjustment operations. *Possible ratings for Outcome:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Risk to Development Outcome: The risk, at the time of evaluation, that development outcomes (or expected outcomes) will not be maintained (or realized). *Possible ratings for Risk to Development Outcome:* High, Significant, Moderate, Negligible to Low, Not Evaluable.

Bank Performance: The extent to which services provided by the Bank ensured quality at entry of the operation and supported effective implementation through appropriate supervision (including ensuring adequate transition arrangements for regular operation of supported activities after loan/credit closing, toward the achievement of development outcomes. The rating has two dimensions: quality at entry and quality of supervision. *Possible ratings for Bank Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Borrower Performance: The extent to which the borrower (including the government and implementing agency or agencies) ensured quality of preparation and implementation, and complied with covenants and agreements, toward the achievement of development outcomes. The rating has two dimensions: government performance and implementing agency(ies) performance. *Possible ratings for Borrower Performance:* Highly Satisfactory, Satisfactory, Moderately Satisfactory, Moderately Unsatisfactory, Unsatisfactory, Highly Unsatisfactory.

Preface

This is the Project Performance Assessment Report for three projects in the People's Republic of China: the Third Irrigated Agriculture Intensification (IAIL3) Loan; the Mainstreaming Climate Change Adaptation in Irrigated Agriculture (MCCA) Global Environment Facility Grant; and the Hai Basin Integrated Water and Environment Management Project (HBP). The MCCA was blended with IAIL3.

IAIL3 was approved on October 11, 2005 for a loan of $200 million (IBRD-48030), and closed as scheduled on December 31, 2010, with the Loan fully disbursed. MCCA was approved on April 17, 2008, about 2 ½ years after approval of IAIL3. It received a Grant from the Global Environment Facility of $5 million which was also fully disbursed. The project closed as scheduled on June 30, 2012. HBP was approved on April 15, 2004 for a Global Environment Facility (GEF) Grant of $17 million, of which nearly all ($16.96 million) was disbursed. It closed on June 30, 2010, one year after the original planned date.

Together, the projects tackled many of China's water issues – from the macro and multi-sectoral picture under the HBP to the farm-level actions under IAIL3 and MCCA, providing perspectives of possible relevance to future water management in China, and in other countries.

The report was prepared by Keith Oblitas, Consultant, and Kenneth Chomitz, Senior Advisor and Task Team Leader, Independent Evaluation Group. It was based on a mission to China in September 2014 to visit field sites and discuss the projects with Government officials, academics, World Bank staff and other knowledgeable persons; and review of project documents, research papers and other sources.

The Assessment is a "Learning" PPAR, with the objective of more in-depth review to garner lessons from the assessment.

Following standard IEG procedures, a copy of the draft PPAR was sent to the relevant government officials and agencies for their review and feedback, and comments received from the Government have been included in Annex D.

Summary

This Project Performance Assessment Review assesses three projects which between them have addressed a spectrum of issues facing China's water and agriculture sectors: the Third Irrigated Agriculture Intensification Project ("IAIL3," FY06, IBRD Loan of $200 million); the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project ("MCCA," FY08, GEF Grant of $5 million); and the Hai Basin Integrated Water and Environment Management Project ("HBP,"FY04, GEF Grant of $17 million). All three operations have been innovative, have helped advance China's capability for tackling its increasingly difficult water resource and productivity issues, and have been learning experiences for replication in other water and agriculture projects in China. The impacts of the projects, how these impacts were achieved, and how learning was generated and disseminated from project experience, are germane to future development of the water and agriculture sectors, and to the mainstreaming of changes piloted and found effective through these operations.

China's Water Sector Issues

China faces tremendous challenges in sustainably managing water and agriculture. Precipitation in the north is decreasing and will probably become more variable, so water supply is declining. At the same time, there is increasing demand for food – and therefore for water, since agriculture is the main user. Hence many rivers run seasonally dry and groundwater is unsustainably drawn down. At the same time, overuse of fertilizer and pesticides poses downstream environmental hazards, including eutrophication and red tides. Industrial and domestic pollution exacerbates the problem.

This situation raises the difficult institutional problem of managing finite water resources within a river basin – a problem which requires understanding and dealing with trade-offs among water uses and users. China faced three obstacles in addressing this problem. First, river basin boundaries do not coincide with the established provincial and county level governments. Second the environmental and water authorities have had overlapping and inconsistent mandates, and yet did not coordinate with one another. And third, there has been a lack of integrated knowledge of water use and water quality, and a lack of understanding on how different scenarios would affect water flows and economic conditions.

These problems are particularly severe in the Huang-Huai-Hai rivers basin, where all three projects were situated. The "3H" Basin is China's prime agricultural area - the "breadbasket" of the country, producing about half of national grain output. It is also the source of one-third of the nation's industrial output. Yet the basin is particularly water stressed and polluted.

To confront these challenges, the three projects introduced a set of innovations in irrigated agriculture and water resources management. In IAIL3, it fixed dilapidated irrigation canals, introduced productivity-enhancing and water-saving agricultural practices, and supported farmer organizations to better manage water and to boost profitability. It also supported integrated pest management and reduced fertilizer

application. MCCA reinforced IAIL3 by emphasizing activities that were adaptive to current climate variability and future climate change.

In contrast to the farm and community-level interventions, the HBP addressed the institutional coordination issues at the county, province, and basin level. The project's contribution was in finding a pragmatic way to operate effectively within the government structure and to bring the key agencies involved with water together to work jointly on comprehensive water management. It also introduced technical tools for planning and for monitoring actual consumptive water use.

IAIL3 and MCCA

The objectives of IAIL3 were "to increase water and agricultural productivity in low and medium yield farm land areas; raise farmers' income and strengthen their competitive capacity under post-WTO conditions; and promote sustainable and participatory water resources management and agro-ecological environmental management in the Huang-Huai-Hai Basin Area." MCCA's added objective was to: "enhance adaptation to climate change in agriculture and irrigation water management practices through awareness raising, institutional and capacity strengthening and demonstration activities in the 3-H Basin." The projects are evaluated together as they were blended to be a combined operation.

These objectives were highly relevant. They recognized that improved agricultural productivity was a necessary base for better use of the nation's water, and also recognized that to be sustainable, water and land management needed to help protect the environment. They addressed China's goals of feeding a growing population and boosting rural incomes. The additional climate change adaptation objective responded to increasing concerns about trends toward higher temperatures and more frequent extreme weather events. IAIL3/MCCA was the first comprehensive program in China to introduce climate change adaptation in agricultural development, hence responding to a potentially critical need. These objectives fit well with the Bank's Country Partnership Strategy (2006-2011) and with the Government's 11th Five Year Plan (2006-2010). While agricultural productivity remained a fundamental target, water related environmental issues, climatic impacts and "greener" agricultural growth have assumed greater importance.

IAIL3's design relevance was high, in that it directly addressed the objectives with an effective combination of investments - improving irrigation systems; establishing water user associations as a base for water saving irrigation, and a major intensification of agricultural extension (a doubling in the extension staff/farmer density). MCCA's design relevance was also high. It was well suited to mainstreaming climate change adaptation actions - the measures to be taken were practical and could be expected to have an impact, and nesting within IAIL3's existing institutional structure ensured implementation capacity and an expeditious start.

IAIL3/MCCA's efficacy was high for three objectives and substantial for one. Agricultural productivity (kg/ha) increased by about 24 to 39 percent; the productivity of water increased by 55 percent; and real farm incomes increased substantially. The

efficacy of the productivity and income increase objectives were both high. Amongst the agro-ecological outputs that the project promoted, the largest (with achievements above appraisal targets) were the establishment of 390,000 hectares of water saving irrigation under water user associations; land grading of 155,000 hectares (at appraisal only a pilot exercise had been planned); and achieving near-universal coverage of integrated pest management, which increased from 70 percent to 96 percent of land area. Due to a lack of data on agroecological outcomes, efficacy for this objective is rated as substantial. Under the climate change adaptation program, efficacy was high. A menu of field activities was drawn up and integrated in the IAIL3 program, eventually reaching half of the project area. Adaptation measures – such as shelterbelts of trees, water retention ponds in irrigation schemes, more drought and flood resistant crop varieties and straw mulching - were practical and in general improved productivity, hence were attractive to farmers.

Project efficiency was high. The economic rate of return was high, and project implementation was as scheduled, within projected costs, and with nearly all implementation targets achieved or exceeded. Given the high ratings for relevance, efficacy and efficiency, IAIL3/MCCA's Outcome was Highly Satisfactory. Risk to Development Outcome is rated Negligible to Low.

The Bank's and Borrower's performances were both Highly Satisfactory. For the Bank, quality at entry was strong, both in strategic and innovative qualities; while proactive supervision enabled practically all targets to be met, including the added climate change adaptation program which had little Chinese experience to draw on. Government provided full support to the project, the main implementing agency – the State Office for Comprehensive Agriculture Development – was a highly effective coordinator, and the technical agencies performed to good standard.

HBP

The Objectives of the Hai Basin Integrated Water and Environment Management Project, as stated in the Grant Agreement, were to: "to assist the recipient in reducing pollution in the Bohai Sea by developing an integrated approach to water resource management and pollution control in the Hai Basin". These objectives were highly relevant. Finding ways to manage water and pollution in an integrated way and to reduce pollution to the Bohai Sea were critical needs, yet China had made only limited progress towards holistic water resources management.

The design was substantially relevant. It understood that achieving integrated water-environment management would require significant conceptual, technical and institutional innovation. On the *conceptual* side, the project design recognized the need to restrict agricultural water demand to sustainable levels. It introduced a revolutionary paradigm shift away from traditional views of irrigation efficiency. It focused instead on the need to put a hard cap on the consumptive use of water (evapotranspiration or ET). On the *technical* side, this meant that the project needed to develop a tool for tracking and managing ET. In addition, optimizing the complex interplay of quality and quantity required spatially explicit computer models that could trace flows of water and pollutants, including nonpoint source pollution from agriculture. With respect to *institutions*, it

proposed to create cooperation and data-sharing between the environmental and water authorities, and to sponsor the creation of integrated water-environment management plans (IWEMPs) at the county and basin levels. There was a disconnect, however, between the ambition of the objective to reduce pollution in the Bohai Sea and the project's modest scale.

The HBP had substantial efficacy in each of its two sub-objectives:

First, significant steps were taken towards integration of water and environmental management – the Ministries of Water Resources and Environmental Management planned and implemented the project jointly and shared data on water quality and quantity for the first time; all participating counties and provinces prepared and began implementing multi-sectorial water and environmental management plans; a strategic action plan was prepared for the whole Hai Basin, and a knowledge management center was established for basin-wide hydrological data and basin and sub-basin modeling; and sophisticated technical capacity was fostered in remote sensing measurement of ET and in hydrological-economic modeling. The new paradigm on water conservation gained widespread traction. However, sharing of hydrological and ET data diminished after the project closed, and the successful demonstration of cooperation between the environmental and water authorities, while continuing, did not spark the anticipated replication and scale-up elsewhere.

These institutional achievements had physical impacts on water. Improved management of water pollution was incorporated in the IWEMPs, supplemented by technical support for clean-up of a polluted canal and for operation of two wastewater treatment plants. There were substantial reductions in emissions of COD, inorganic nitrogen and sewage. There was a large project-wide decrease in groundwater over-extraction. However, this was not accompanied by an overall decrease in ET, suggesting that the improvement may largely be due to a fortuitous and temporary increase in precipitation. Water use decreased in some counties.

Second, there was a small but measurable reduction in pollution inflows into the Bohai Sea, exceeding targets. The direct impact was limited by the fact that the Hai accounts for only a small part of the overall pollution inflow. However, the project demonstrated approaches that are replicable throughout the Sea's watershed area.

The project's efficiency was High, based on its accomplishments in introducing integrated water management to more counties than anticipated, effectiveness in reducing pollution, and the high economic returns to even small water savings.

The project's outcome was Satisfactory. This rating balances some exemplary achievements with some shortcomings. On one hand, its signal accomplishments included gaining acceptance for a wholly new paradigm for water management, supporting the development and application of global state-of-the-art remote sensing techniques for water monitoring, setting up integrated water resource management based on sophisticated hydrological monitoring, and breaking institutional silos between the environment and water ministries. On the other hand the faltering of data-sharing, the lack of expansion of environment-water agency cooperation, and the lack of anticipated

replication, are factored into the rating. The same considerations lead to a rating of Significant Risk to Development Outcome. Evapotranspiration maps are still being assembled by the Hai Basin Commission, but this information is no longer being shared with all of the pilot counties, impeding the goal of operationalizing the use of ET for monitoring and water allocation. The Bank's performance is rated Satisfactory, in particular because of the diversely specialized and innovative task teams both at entry and during supervision, and the willingness to take risks introducing new concepts. The borrower's approach was Satisfactory overall. After initial skepticism about the new approaches, Government performance was satisfactory. Performance of the implementing agencies (the two ministries, the Project Management Offices and technical staff from county and provincial governments) was Satisfactory. While it took time initially to adjust to the new concepts, unfamiliar activities were then implemented expeditiously and to high standard. The performance rating for Government and for the implementing agencies was affected by the shortcomings in data-sharing and replication.

Cross-cutting issues

Sustainable management of agriculture and water

The field-level interventions of IAIL3/MCCA were complementary to the Hai Basin support for integrated watershed planning. This combination is generalizable: integrated water planning needs to be able to draw on field-level tools.

However, in China as elsewhere, the 'silos' of sectorial and provincial authority conflict with the logic of integrated water basin management. The HBP showed that it was possible to undertake improved planning and implementation even within existing bureaucratic structures. Further progress may be possible through expanded interim ministerial cooperation and by strengthening the coordinating role of the Hai Basin Commission. The introduction of the concept of ET has succeeded in changing, for the better, perspectives on water management. The technical success in timely and accurate measurements of ET is also noteworthy. Operational application of these measurements is less evident. Partly this is due to the complexity of the task. Separating ET reduction signals from "noise" is harder in the Hai Basin than it is in the arid areas covered by the follow-on Xinjiang Turpan project.

The challenges of ET management are compounded when data are not freely shared, though it could be done over the internet at little or no cost. The joint World Bank-Government of China report, *China 2030,* emphasizes the value of public disclosure of environmental information. Wider distribution of ET and other monitoring data to stakeholders would be consistent with this strategy and with the 'bottom-up' planning orientation of the Hai Basin project, and would complement the strong technical capabilities of Chinese academics and researchers. Further research could help to resolve the inconsistencies between reportedly strong reductions in groundwater exploitation and weak reductions in ET or water use.

Mainstreaming climate change

A challenge in assessing the success of adaptation mainstreaming, in general, is the strong overlap between what is good for adaptation and what is good for development – the domain of 'no-regrets' or 'win-win' options. The success of MCCA stems largely from identifying and implementing practices that already constitute good farming, and will be increasingly important in an uncertain future.

The climate change adaptation measures brought in under the IAIL3/MCCA program were in most cases technologies already known, a number of which were already being practiced under IAIL3 (e.gs. tree shelter belts, increasing water conveyance efficiency, mulching). There were some measures, such as developing seed better able to withstand droughts and floods that required actions specific to the climate change adaptation agenda, but much of the climate change technologies were familiar, in practice or in concept, to agriculture and irrigation extension staff. Nearly all IAIL3/MCCA's climate change adaptation measures increased average farm yields as well as reduced climatic risks, and farmers, once they understood the climate change agenda, and witnessed demonstrations, adopted most of the practices enthusiastically. A particular effort, however, had to be put in to familiarize civil society, the extension staff themselves, and farmers with the concept of climate change and the adaptations feasible to counter such changes. And even before that, Government decision makers and senior and middle-level extension staff from the various agencies involved with the project needed themselves to understand and embrace the climate change agenda. The MCCA project also supported sophisticated climate modeling efforts, but findings often had a generic flavor, a common experience with such exercises, reflecting fundamental scientific uncertainties, especially with regard to precipitation trends and to the effect of increasing carbon dioxide on plant growth.

Learning

Several aspects of learning stand out. A notable feature of all the projects, and a significant factor in the projects' performance, was the substantial use, and integration within the institutions, of academics and consultants in research, training and the work program generally. They included experts from the Chinese Academy of Sciences, from nationally prominent and provincial universities, and international and local expert consultants.

Second, World Bank and project staff played a crucial role in introducing new ideas and technology, particularly the concept and measurement of ET, and developing "water saving" irrigation technology. Bank TTLs brought expert knowledge and evangelistic fervor to promoting these ideas. Their counterparts in the executing agencies also showed dynamism and enthusiasm. They, together with Chinese experts who embraced these ideas, have succeeded in beginning a diffusion of these approaches to follow-on projects in China and internationally. However, these concepts have not spread widely between Bank teams concerned with water.

Finally, IAIL3 missed an opportunity to contribute to better learning about how to improve land and water productivity. The project introduced a diverse range of

approaches and technologies in engineering, agronomy and management. It would be desirable to understand which worked best under which conditions, so as to guide future scale-up. While the project did gather voluminous data and produce reports at province and county levels, rigorous impact evaluation was not undertaken.

Lessons

Generalizable findings and lessons from the projects' experiences include:

- **The concept of evapotranspiration management can underpin sustainable water management.** Three simple but powerful ideas - that water is only used up by evapotranspiration, that allowable evapotranspiration has to be capped at a sustainable level, and that the goal is to minimize non-beneficial evapotranspiration - can transform the way water is managed.

- **Water-saving agricultural projects could in principle provide immense economic benefits.** In water-scarce regions such as north China, there is a substantial economic value to water savings. Savings on the scale envisioned by the projects, if evaluated at conservation shadow prices, would imply extraordinary economic returns to investment. In these projects, unfortunately, data are not adequate to verify whether there was net water saving.

- **It is possible to simultaneously boost water productivity and land productivity.** Usually, more productivity requires more water. Here, intensive agricultural extension, community management of irrigation, environmental improvements, and promotion of higher value crops and commercialization managed to conserve water while boosting crop quantity and quality. This was done in significant part by reducing non-beneficial evapotranspiration.

- **Multi-agency, technically based, integrated water management is possible**. Under the HBP, environment and water authorities worked together, in consultation with stakeholders to develop plans. The plans were informed by hydrological models that helped prioritize ways to meet water quality and quantity goals. They were incorporated in operational county investment plans.

- **Field-level and basin level approaches are complementary.** Holistic management at the basin level depended on the ability to deploy field level techniques for increasing water efficiency. But promoting irrigation efficiency can lead to continued groundwater depletion unless total consumption is capped.

- **Sharing of data is a key to success**. Progress was made when the Environment and Water ministries pooled information from their formerly separate monitoring stations and worked together to solve problems, and when Basin authorities shared information with counties. Coordination was hindered when counties found it hard to share information with upstream or downstream neighbors, and when information flows from the center diminished. Globally, there is a growing realization among public agencies that by making data open – freely accessible,

machine readable and unrestricted in use – both public and private sectors are able to make better and more informed decisions.

- **Climate adaptation interventions are easily assimilated when they bring immediate benefits under current climate conditions and variability**. Measures introduced were resilient to future conditions, but already made good farming sense given current risks. Substantial outreach to farmers and policymakers helped with adoption, as did incorporation of the innovations in a larger project.

- **Climate modeling is best used to test adaptation policies for robustness against different scenarios, rather than to predict 'what will be.'** There are limits to the ability of climate models to predict future cropping conditions, because of fundamental uncertainties about the effect of-more carbon dioxide on crop growth, and inability of the models to accurately predict precipitation.

- **The Bank can be a driving force for technology transfer.** Innovations in integrated water management, and the ET paradigm, were introduced by Bank TTLs who combined expertise with persuasive leadership, supported by international and local experts.

Caroline Heider
Director-General
Evaluation

1. Background and Context

1.1 The three projects evaluated in this Project Performance Assessment Review addressed a central issue facing China's water and agriculture sectors: water scarcity. The projects were: the Third Irrigated Agriculture Intensification Project (IAIL3); the Hai Basin Integrated Water and Environment Management Project (HBP); and the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (MCCA). The projects incorporated innovative approaches to tackling the increasingly difficult resource and productivity issues that China confronts. The projects provide lessons for future design and implementation of the larger programs that have succeeded them, with possible relevance also for other countries facing land and water scarcity.

Land and Water Scarcity

1.2 On a per capita basis, China's land and water resources compare poorly with most other nations. With a population of 1.36 billion, China has over 20 percent of the world's population. Yet it has only 6 percent of the world's land area, 7 percent of farm land area, and 6 percent of renewable water resources. Scarcity is compounded by pollution: in 2009, 43% of rivers were classified as posing health risks from direct use[1] – over half of the country's water is estimated to be "polluted," with rapid growth of industry and urban centers adding pressures both as sources of pollution and as additional demand for water supplies. China's GDP growth rate has slowed somewhat since the 10 percent per annum growth rates of the 1990s, but at about 8 percent per annum (2013) is still a structural driver of greater demand for both food and water.[2]

1.3 Unsustainable water use is of particular concern in the Huang-Huai-Hai rivers basin, China's bread basket and the site of all three projects. The "3H" Basin has a population of over 425 million, and accounts for about one-third of national industrial output, thus making it a hub of China's economy. The Basin is China's prime agricultural area and produces about half of national grain output. Yet the basin is particularly water stressed. It has less than one-third of China's average water availability, overexploitation is causing groundwater tables to decline, and the combination of agricultural, urban and industrial pollution severely degrades most surface water.

1.4 Climate risks to Chinese agriculture have long been known (Smit and Cai, 1996). Rising temperatures, increased rainfall variability, and changing seasonality could imperil farm yields, especially in the already dry north and west. Over the last 30 years, rising temperatures are estimated to have already depressed potential yields of maize, soy and wheat (Lobell, Schlenker and Costa-Roberts. 2011). However, uncertainties about precipitation trends, the degree to which increasing CO_2 levels will benefit crops, and nonlinearities in temperature impact on yield, complicate efforts to forecast climate change impacts (Chavas, Izaurralde et al 2009; Wei, Declan et al. 2009; Piao, Ciais et al. 2010). These impacts add to the stresses posed by growing demand for food and water.

[1] World Bank and Development Research Center of the State Council. 2013. p. 236.

[2] World Development Indicators, World Bank; and PADs and ICRs of IAIL3, HBP, and MCCA.

Government and Bank Water Strategy

1.5 Water scarcity and low productivity have been longstanding concerns in China, but until the 1990s the Chinese Government was primarily oriented to supply-side solutions, such as infrastructure construction. This orientation has changed over time and the water sector has also become more prominent in Government decision making. But it is only quite recently that the concepts of water resources management (to better allocate water between sectors, to make water more productive, and to control overexploitation), and management of water pollution, have received priority attention. Gathering pace in the 11th Five Year Plan (2006-2010), and with heightened emphasis in the 12th Five Year Plan (2011-2015), water resources management, water saving, efficiency of agricultural water, and management of pollution have become policy priorities. In 2012, the State Council established the landmark "Three Red Lines," establishing a national cap on water use, and targets for irrigation efficiency and for water quality. But the broad precedents to the more recent strategies of Government and the Bank go back at least a dozen years. The FY03 to FY05 CAS emphasized in its "Thematic Framework" the goal of an environmentally sustainable development process, another major theme being poverty alleviation for the disadvantaged and China's poorer areas.

1.6 Concern with agricultural adaptation to climate change has progressively gained attention. The Country Partnership Strategy (CPS) for FY 2006 to FY 2010 raised climate change as an issue, and climate change is discussed more specifically in the CPS for FY13 to FY16. Other concerns increasingly referred to by both Government and the Bank are the need to conserve natural resources and reduce pollution. Knowledge transfer and a "knowledge agenda", an interest of both Government and the Bank, is also referred to, going back to the FY03 to FY05 CAS.

1.7 The Bank's strategy supported Government's changing priorities, and the projects themselves provided a means of piloting new technical and institutional approaches. A strong "Green" Agenda is put forward in the FY13 to FY16 CPS, and "Greener Growth" is one of the report's strategic themes. Emphasizing this, the CPS comments that "addressing the Country's environmental deficit is an ongoing challenge,' noting that 300 million of China's population use contaminated water. Climate change is also addressed in the CPS. Raising agricultural productivity is also targeted, with both the Government and the Bank seeing a need to make agriculture more competitive, especially after China joined the World Trade Organization in 2001. To this end, Government is focusing on moving up the values chain to access higher quality markets. Agricultural productivity and food self-sufficiency still remain priority features in the 12th Plan. This necessarily implies a higher productivity of land and water, and the conservation, both in quantity and quality, of both resources

The Projects

1.8 The three projects reviewed in this report, though small relative to the Chinese agriculture sector, tried to pioneer new approaches to water management.

1.9 The Third Irrigated Agriculture Intensification Loan (IAIL3, IBRD Loan of $200 million) addressed the need to substantially increase the agricultural productivity and

environmental sustainability of both land and water. IAIL3 had three main thrusts to introduce water saving and increase agricultural productivity: (i) engineering – by rehabilitating and modernizing, using water saving technology, the lower levels of irrigation schemes (where the greatest water losses occur); (ii) agronomy - by improving agricultural practices both for enhancing yields and conserving water and land; and (iii) organizational improvements - through empowering water user associations. The project also promoted, through farmer associations, higher value crops and commercialized marketing. Throughout implementation, technical assistance to farmers was intensive, through existing government structures supplemented by widespread use of China's academia.

1.10 At around midterm, IAIL3 was blended with a small ($5 million) GEF Grant for a Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (MCCA), reflecting greater attention to this issue by both the Bank and Government. Until then, little had been done by Government to mainstream climate change adaptation activities in the rural sector. Hence, MCCA's agenda was largely the piloting of an array of activities to test technologies for wider implementation.

1.11 The Hai Basin Integrated Water and Environment Management Project HBP, GEF Grant of $17 million) is the third project examined. HBP pilots an innovative approach to multi-sectorial management of water and water-based pollution, including a number of experimental features. The hub of the project was the preparation by counties of Integrated Water and Environment Management Plans (IWEMPs). HBP placed as much emphasis on pollution management as it did on water resources management, the two – water quantity and quality – being managed as an integrated whole. This was an unusual concept for China, which had water resources and environment in different ministries, with little communication between them.

1.12 As an integrated water management effort, the HBP was the broadest in scope of the three operations. A number of river basin projects, including projects financed by the Bank, had been implemented earlier. However, the HBP was the most advanced in several institutional features. It pioneered a number of advanced technologies, including a computerized knowledge management system, and piloting of remote sensing-based evapotranspiration measurement. This could be used for managing water use, with significant potential for boosting China's water savings and improving water resources management.

Three issues of broad interest

1.13 Three themes link these projects and are of broad interest. First and most importantly, all three projects are centrally concerned with sustainable water management. In the past, water savings from irrigation efficiency have often been used to expand cultivation, so that water was not really saved. This leads to continued unsustainable drawdown of surface and groundwater. In response, the projects introduced a paradigm shift from 'irrigation efficiency' to 'real water savings'. That is, they recognize the need to cap total water consumption at sustainable levels, and introduced planning and operational tools to do this. The concept of evapotranspiration (ET) is central to this paradigm shift (Box 1.1).

1.14 Second, the projects are among the first to confront the question: how does explicit consideration of climate change impacts affect land and water management for agriculture?

1.15 Third, these projects are noteworthy for their emphasis on learning, within and between projects, and for their incorporation of academia into planning and operations.

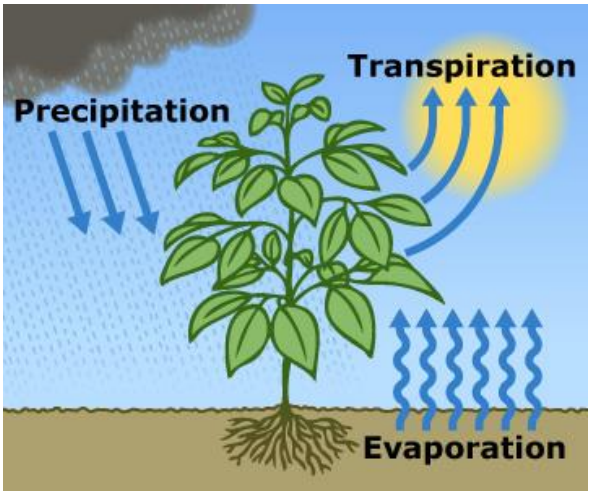
1.16 The reader who is interested primarily in lessons regarding these issues, rather than project details, may focus on Box 1.1 and section 4, which are self-standing.

Report Structure

1.17 This report is structured as follows. Succeeding this chapter there are two chapters providing detailed reviews, including ratings of performance, of the projects. Chapter 2 reviews IAIL3 and its blended MCCA operation. Chapter 3 reviews the Hai Basin IWEMP. A broader discussion, involving all three projects, follows in Chapter 4, focused on general issues that have emerged in the review.

Box 1.1. Evapotranspiration and Water Use Efficiency

Through the Hai Basin and associated projects, the World Bank introduced a paradigm for thinking about water efficiency that is quite different from the way irrigation engineers, in China and elsewhere, have traditionally thought about efficient use of water.



The new paradigm focuses on evapotranspiration (ET) as the focus of water management. ET consists of water that evaporates from the soil or from leaves, plus the water that plants take up from the ground and transpire ('exhale') as water vapor. The ET paradigm has the following elements.

1. ET represents the water that is actually used up and lost to a water basin. So ET=real water consumption. (Of course, flows to the sea are also lost to the basin.)

2. For sustainable water management – to avoid drawing down groundwater – average annual ET should equal average annual precipitation in a basin.

3. ET = beneficial ET + non-beneficial ET. Beneficial ET is the transpiration of crops and of desired natural vegetation such as forests. Non-beneficial ET includes evaporation from the soil and from open canals, and transpiration from weeds and undesirable vegetation.

4. The goal of water management is to minimize non-beneficial ET while capping total basin ET at a level that is less than average precipitation, thus allowing adequate river flows for navigation and aquatic life. So at the basin level, on average:

Average Precipitation = target beneficial ET + non beneficial ET +required river flow to sea.

The idea is to reallocate as much non beneficial ET as possible to beneficial ET or to required river flow (if that is inadequate).

This paradigm has implications that are counterintuitive to many irrigation practitioners and planners. Irrigation specialists think in terms of water withdrawals – how much is going from the river into the canal. The traditional view has two serious flaws in the context of the Hai Basin, or other places where groundwater is being unsustainably drawn down. First the traditional view prizes 'crop per drop' (of water), but pays no attention to total water consumption. So, for instance, introduction of drip irrigation may save water at the plot level, but if the saved water is used to expand cultivation, the Basin as a whole sees no savings. Second, the traditional view mischaracterizes losses. It sees leakages from irrigation as losses, when in fact this water recharges groundwater and can be used by other crops, or can contribute to environmental flows.

So the new and old paradigms lead farmers and planners to favor different actions (see below). Traditional irrigation and water managers may resist the new paradigm because it is counterintuitive, because it is inconsistent with the technical specifications of existing regulations, or because, in overdrawn basins, it highlights the unpopular message that total water consumption needs to be curbed. An important achievement of the HBP was to gain wide acceptance of the new paradigm.

Action	***Does it contribute to ET efficiency?***	***Does it contribute to irrigation efficiency?***
Line an irrigation canal to prevent leakage	No	Yes
Replace lined canals with pipes	Yes	Yes
Land leveling	Partly; reductions in percolation are not truly water-saving, reductions in evaporation are	Yes
Weeding	Yes	Yes
Drip irrigation	To the extent that it reduces evaporation. But gains are lost if water that formerly went to groundwater is now used to expand irrigation	Yes
Surface mulching	Yes	Not for post-harvest mulching with straw residue

Source: draws on Perry and others 2009.

2. Irrigated Agriculture Intensification III Project and Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project

Objectives, Design, and Relevance

2.1 The Irrigated Agriculture Intensification III Project (IAIL3) and the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (MCCA) are evaluated jointly rather than sequentially because MCCA was blended with IAIL3 to adjust the IAIL3 program, during its implementation, to include a climate change adaptation agenda. The two operations are closely interlinked.

2.2 The objectives of the Irrigated Agriculture Intensification III Project (IAIL3) were:

"To increase water and agricultural productivity in low and medium yield farm land areas; raise farmers' income and strengthen their competitive capacity under post-WTO conditions; and promote sustainable and participatory water resources management and agro-ecological environmental management in the Huang-Huai-Hai Basin Area."

Source: Loan Agreement, December 9, 2005 (The PAD version is similar except that it includes the word "demonstrate" before "promote")

2.3 The objectives of the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project (MCCA) (a GEF Special Climate Change Fund) were:

"To enhance adaptation to climate change in agriculture and irrigation water management practices through awareness raising, institutional and capacity strengthening and demonstration activities in the 3-H Basin."

Source: Grant Agreement; Special Climate Change Fund for the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project, February 25, 2008.

Relevance of objectives

2.4 The IAIL3 directly addressed core needs in China's development and environmental conservation strategy. Notwithstanding China's buoyant overall GDP growth rate (10 percent per annum in most of the 2000s, and still 8 percent in 2013), rural income growth has lagged behind the urban sector, partly a result of inefficient use of land and water. Growth faces constraints of land and water availability. Nearly all productive land is already cultivated. Groundwater tables are falling, water is polluted, and overexploited rivers run dry.

2.5 These constraints are an increasing concern for China. First, improving productivity is important for raising the incomes and welfare of the rural population. Second, food security is a perennial issue given the growth in demand due to population growth and increasing incomes. And finally, unsustainable use of land and water threaten agricultural productivity and environmental health. These issues are especially pertinent

to the Huang/Huai/Hai Basin, source of half of national cereal production. To relieve this situation, the productivity of agriculture, both per unit of land and per unit of water, must increase.

2.6 These concerns are reflected in the "World Bank-China Country Partnership Strategy, 2006-2010" and China's 11th (2006-2010) Five Year Plan. The CPS includes a "Supporting Greener Growth" theme, promoting sustainable agricultural practices and natural resources management. The Strategy notes that the Bank has placed increasing attention to environmental issues, but also refers to the need to increase agricultural productivity. The Eleventh Plan emphasized increasing agricultural productivity, improving irrigation efficiency, and protecting the agriculture related environment.

2.7 The 12th Plan (2011-2015) elaborates the focus of the 11th Plan in more detail. The 12th Plan aimed to enhance agricultural productivity via increased mechanization, more advanced agricultural practices, improved irrigation, and commercialized produce markets. Conservation of irrigation water is also emphasized. And agro-ecological farming to protect the quantity and quality of soils and water, including protecting groundwater from overexploitation, brings in the environmental agenda. Lastly, self-sufficiency in foodstuffs remains a perennial objective in China. The Bank's CPS for FY06 to FY10 refers to agricultural growth and management of water and land resources.

2.8 IAIL3's objectives were directly responsive to these concerns. They furthered the Bank's rural and water sector strategy, and addressed the critical challenges of China's rural and water sectors. The additional objective brought in through the GEF Grant to "enhance adaptation to climate change in agricultural practices and irrigation water management" was a strategically positive addition to the relevance of IAIL3's original objectives.[3] There was a need for irrigated agriculture to be more resilient to the more difficult conditions and extreme events such as floods and droughts that were occurring. The Relevance of IAIL3's and MCCA's Objectives was High.

Design

2.9 AIL3 continued the basic approach of its predecessor, the Second Irrigated Agriculture Intensification Project (IAIL2), which had been largely successful in its goals of both increasing agricultural production and increasing farm incomes.[4] Significant adjustments were, however, made. In particular, IAIL3 introduced the concept of "real water-saving." Secondly, a greater focus was placed on upgrading the quality of agricultural advisory services through a major intensification of extension staff and training activities. Third, product quality and value added were promoted as much as the quantity of production. Fourth, it made more rigorous the expansion of the Water User Associations (WUAs). These local groups promote more rational and coordinated use of

[3] The objective was not in IAIL3 originally as climate change was not receiving priority attention from Government. However, when Government policy shifted at mid-point of IAIL3's implementation, the opportunity was taken to add this objective to the program using a GEF Grant – the MCCA.

[4] IAIL2 received a Loan of $300 million, was approved in June 1998 and closed in June 2005 with Outcome rated by IEG as Satisfactory.

water, including through the imposition of water use fees. And fifth, a more comprehensive agro-ecological program was introduced including actions to improve groundwater management.

2.10 IAIL3 was implemented over a large area comprising 107 counties in five "project" provinces engaged in all sponsored activities. In another five "participating" provinces, the only activity was establishment of new WUAs. The project provinces represented varied agricultural conditions – water abundant and tropical in the southern rice-growing provinces of Jiangsu and Anhui, and more water-scarce in the wheat-growing northern provinces.

2.11 IAIL3's two main thrusts were modernization of the lower reaches (secondary and tertiary levels) of irrigation systems coupled with an agricultural research and extension program (Box 2.1). Environmental protection measures related to irrigated agriculture were also included. Water saving and enhancing agricultural productivity were fundamental goals behind most of the irrigation and agricultural actions. Water savings were to be through three integrated and mutually supportive activities: engineering by modernizing conveyance systems and installing water control and measurement devices so as to reduce losses; agronomic through improved seed, better cultivation practices, and crop diversification; and organizational, through establishment of WUAs, better water management practices, and by applying water quotas.

2.12 Enhancement of product quality (and hence increased value added) was primarily pioneered through introducing support to establishment of Farmer Associations or Farmer Cooperatives, for diversifying crop production and establishing standardized brands and market linkages. Additionally, "green" (organic and other low pollution cultivation) crops were to be grown, inspected for quality, and marketed, fetching higher prices.

2.13 The MCCA grant supported climate change mainstreaming by adding studies, planning, and demonstration activities to the IAIL3 program (Box 2.2).

2.14 For the entire IAIL3/MCCA program, a general feature in design was the provision in project costing and in the project's implementation program, for major use of consultants, and national and international study tours[5]. This included extensive use of academics, who proved to be the main source of the project's technical assistance, and played a key role in the project's innovations.

[5] Significant spending on training, demonstrations and consultancies were included in each project component, on top of which was the $54 million (12 percent of project costs) planned for Institutional Strengthening and Project Management Support, which was mostly for domestic and international training, consultancies and academics and study tours.

Box 2.1. Third Irrigated Agriculture Intensification Loan: Project Components and Costs

1. Water-saving Irrigation and Drainage

Improvement and construction of tertiary and on-farm level irrigation and drainage; water conservation using measures from engineering, agronomic and WUA management activities; installation of water measurement devices; and preparation and implementation of groundwater management plans in selected water-short counties.

Estimated cost (base costs without contingencies) at Appraisal - $295.87 million. Actual cost - $316.14 million.

2. Agricultural Modernization and Organization Development

Strengthening and modernizing agricultural services; demonstrations and extension services including for specialist crops; development of farmer organizations; and technology and training for farmers, technicians and farmer organizations.

Estimated cost at Appraisal - $61.61 million. Actual cost - $65.47 million.

3. Agro-ecological Environmental Protection and Management

Establishing shelterbelt forest networks around farm areas; integrated pest management; monitoring, training and demonstrations in environment and soil and water conservation; and groundwater management in selected areas.

Estimated cost at Appraisal - $22.94 million. Actual cost - $24.46 million.

4. Institutional Strengthening and Project Management Support

Domestic and international training, study tours and consultancies; research and demonstrations; office equipment; and management information systems and M&E.

Estimated cost at Appraisal - $54.10 million. Actual cost - $57.11 million

Financing: Financing of the overall actual project costs was by IBRD (USD 200 million) and Government and Beneficiaries (USD 263.5 million).

Source: ICR and PAD.

Box 2.2. Mainstreaming Climate Change Adaptation in Irrigated Agriculture: Project Components and Costs

1. Identification and Prioritization of Adaptation Options

(i) Assessing the impact of climate change in the 3-H basin and project area; (ii) a study to identify needed adaptation measures and help integrate them into IAIL3 and the ongoing national Comprehensive Agriculture Development program; and (iii) prioritizing and selecting adaptation measures and demonstrations, including consultations with farmers and local officials, to help incorporate empirical experiences during project implementation.

Estimated cost (base costs without contingencies) at Appraisal - $0.50 million. Actual cost - $0.49 million.

2. Demonstration and Implementation of Adaptation Measures

(i) Introducing, implementing and demonstrating specific climate change adaptation measures; and (ii) integrating appropriate adaptation measures into implementation of IAIL3 to help reduce vulnerability to climate change, focusing primarily on agricultural practices and irrigation water management.

Estimated cost at Appraisal - $48.43 million. Actual cost - $50.88 million.

3. Mainstreaming Adaptation into National Comprehensive Agriculture Development Program and Institutional Strengthening

(i) Integrating and mainstreaming climate change adaptation into the Comprehensive Agriculture Development Program, through capacity building, technical assistance, knowledge sharing and public awareness activities; and (ii) preparation of a National Climate Change Adaptation Plan for the Program.

Estimated cost at Appraisal - $6.57 million. Actual cost - $6.25 million.

Financing: Contributions to the overall actual project costs of $57.62 million were: GEF $5.00 million; IBRD (estimated share of IAIL3's IBRD Loan that was used for climate change adaptation activities) $20.00 million; and Government $32.62 million.

Source: ICR.

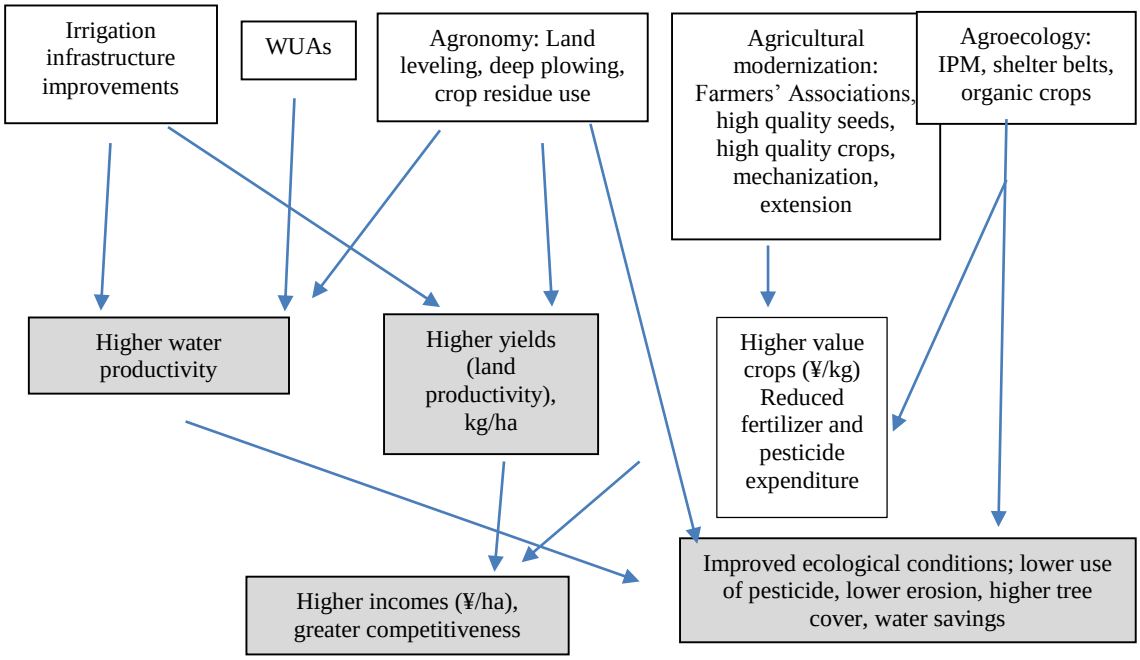
Relevance of Design

2.15 Figure 2.1 shows the implicit logical framework for IAIL3 (excluding the MCCA). Individual activities often contribute to multiple objectives, and functional classifications cut across the components.

2.16 Raising the productivity of land and water required synergistic action to upgrade irrigation systems and improve agricultural practices. Improved irrigation would provide the base for a higher level production function, and improved agricultural practices would enable this potential to be realized. Better water management via Water Users Associations (WUAs) complements efficiency improvements in irrigation and enables higher yields in water-scarce areas. Higher physical yields, combined with shifts to higher value varieties or crops, boosts farmers' income and competitiveness. Thus, irrigation improvement and improvement of agricultural practices formed the core of the project, accounting for over 80 percent of project costs. A notable feature of the project's design was the degree to which the agricultural extension program was intensified, with a

planned reduction in farmers per extension staff from 57 farmers per extension worker at appraisal to 25. IAIL3 was as much an agricultural program as an irrigation program, in contrast to many irrigation projects where the first emphasis is infrastructure.

Figure 2.1. Logical Framework of IAIL3



Source: IEG based on IAIL3 PAD. Note: Objectives shown in gray.

2.17 There were also investments in shelter belts and integrated pest management to improved agro ecology. These typically contributed to productivity as well as ecological balance – shelter belts can be expected to reduce soil erosion, integrated pest management reduced the need for pesticides, increased mulching and, to some degree, increased use of organic fertilizer, reduced farmers' need for chemical fertilizers.

2.18 The added objective under the GEF Grant to enhance adaptability to climate change also provided a clear logical path from the objective to the components. Deliberate adaptations to climate change in the agriculture sector were uncommon and not well understood. Hence, by undertaking research and demonstrations using the IAIL3's field activities as a base for adjustments to enable more resilience to climate change and extreme weather events, MCCA could pilot innovations. In contrast to free-standing demonstration projects, the MCCA provided for the mainstreaming into a larger program of adaptations that were found to be working and practical. This was done largely from scratch, as, until MCCA, there had been no comprehensive program in China's agriculture sector promoting climate adaption measures.

2.19 MCCA's results chain and components (PAD Annex 3) were highly relevant to the Grant's objectives and how they would fit within the IAIL3 objectives and design. First, and supported by MCCA's first component, as climate change adaptation was a largely unknown, and certainly untested, concept, there was need to identify and

prioritize adaptation options through significant research, modeling and development of a menu of options and field activities. Then, these options needed major and widespread demonstrations for farmers and officials to gain interest in applying the options on the farms. Farmer confidence was the key, and this stage included widespread exchanges of experience as the options were put into practice. Finally, MCCA's design culminated in a mainstreaming stage to integrate climate change adaptation more broadly within the IAIL3 program, and ultimately within the national Comprehensive Agriculture Development program. To promote this, it was recognized that major outreach would be needed to farmers, civil society and government officials, including workshops, media, consultations and policy recommendations.

2.20 For IAIL3, innovation was incremental, building on the predecessor IAIL2. IAIL3 was China's main pioneer of the breakthrough water saving irrigation concept. It promoted a major intensification of agricultural extension, and, in contrast to most other irrigation projects which were infrastructure oriented, placed as much weight on agriculture as on the irrigation service. The project also emphasized product quality as well as product quantity, and brought in commercialized marketing through farmer associations and cooperatives (until two years before the project, there was no legislation for cooperatives), and promoted "green" and "organic" crops. The project was also designed to integrate agro-ecological management with agricultural production.

2.21 In summary, IAIL3's design responded closely to the project's objectives, and MCCA's addition further enhanced the utility of the operation by introducing a set of activities that made agricultural intensification more resilient to weather events. There were innovative features in the combined IAIL3/MCCA program that stood the chance of significantly enhancing productivity and climatic resilience; and project design was practical, providing a good base for implementation. The Relevance of Design, both for the original IAIL3 and the subsequently blended operation including MCCA was High.

Implementation

2.22 IAIL3 was approved on October 11, 2005 and closed on schedule on December 31, 2010. It received an IBRD Loan of $200 million which was fully disbursed. MCCA was approved for a GEF Grant of $5.00 million on April 17, 2008, some 2 ½ years after approval of IAIL3, and closed as scheduled on June 30, 2012, 18 months after closure of IAIL3. MCCA's implementation period was 4 years and 3 months, and the Grant was fully disbursed. There were no changes in the objectives of either project. Two minor adjustments to disbursement allocations were made via restructurings.[6] Project costs and financing were essentially identical to Appraisal intentions.[7]

[6] (i) to IAIL3 on December 18, 2008 as part of a downsizing of some components to accommodate an appreciation of the Yuan against the dollar; and (ii) on December 7, 2011, when some of the GEF grant intended for study tours and incremental operating costs was shifted to study tours and climate change activities.

[7] IAIL3's costs at completion were $463.5 million compared with $463.7 million estimated at appraisal, and the $5 million GEF Grant was fully utilized. Financing of IAIL3 was: by the Bank (the $200 million Loan); local governments ($136.8 million planned and $137.4 million actual);

2.23 IAIL3 and MCCA were implemented through a Project Management Office (PMO) in the State Office of Comprehensive Agricultural Development (SOCAD) under the Ministry of Finance. Project activities were highly decentralized, using the existing Government structure in the Provinces and Counties, and giving them substantial independence. At Provincial level there was a POCAD (Provincial Office of Comprehensive Agricultural Development) which coordinated the activities of the various Government Departments entrusted with the function concerned – the provincial Bureaus of water, agriculture, forestry, environment and others. The Ministry of Finance was also represented through the Provincial Finance Bureau. This pattern was repeated at county level, with a COCAD coordinating the activities of the relevant county level bureaus. An additional feature was that each level in the project's structure - the POCADs, COCADs, and SOCAD itself - had a committee of experts – the "Project Leading Groups" – from academia, retired Government staff, and other sources, providing technical and general advice.

2.24 When MCCA commenced, the same administrative structure was used, largely through absorbing the climate change project's activities into the IAIL3 program. Based on the MCCA's outcome, this appears to have worked. As pointed out in IEG interviews with POCAD and COCAD staff, the climate change actions were practical (as were the IAIL3 actions), enabling relatively smooth integration into the IAIL3 program.

Monitoring and Evaluation

2.25 **Design**: Using experience gained through IAIL2, three complementary monitoring systems were established; (i) a Management Information System for monitoring project progress and other data relevant to the project; (ii) an M&E system for monitoring delivery of project outputs and achievement of outcomes, reported at both province and overall project levels (this provided most of the data for the project's monitorable indicators, and for the project's provincial and overall project completion reports); and (iii) a specific M&E system for management and output monitoring of the WUA program. The entire system was computerized, internet based, and interconnected. The MIS system was well set up for routine reports but not for analysis. When MCCA was brought into the IAIL3 program, its M&E program was set up and integrated into this structure. Very little information was collected on the five 'participating' provinces, where activities were limited to setup of water user associations.

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and beneficiaries ($126.9 million planned and 126.1 million actual). For MCCA, the $5 million Grant was used as part of IAIL3's regular program, which was adjusted to incorporate climate change adaptation activities in its technical and development activities. As a means of indicating the degree to which the IAIL3 program was adjusted to reflect the GEF program's promotion of climate change adaptation, project costs for the GEF program were presented in the ICR at about $50 million of IAIL3 project costs. However, such an assessment will involve some subjective judgment and also result in double counting. Hence, for project costing purposes, this PPAR includes only the $5 million GEF Grant. The broader impacts of the Grant are, however, discussed elsewhere in this report.

2.26 Attempts were made to use "controls" (counterfactual comparisons of changes in project areas with changes in non-project areas) for the WUA program and, in some localities, for groundwater drawdown, but controls were not always devoid of project influence, and were not well matched, making interpretation difficult. The very limited use of controls is the weakest part of the M&E design (and implementation), and the efficacy section of this evaluation illustrates the kind of difficulties encountered when evaluating project impacts without non-project comparisons. Monitoring of WUAs was in SOCAD's view excessively time consuming and unnecessary for operational management; yet the data were not utilized to determine the impact of WUAs on water user and productivity. Overall, there was a missed opportunity to use the voluminous monitoring data for rigorous learning about the relative impacts of the project's many interventions.

2.27 The MCCA outcome indicators, as set out in its PAD, redundantly included pre-existing targets for income per capita, water productivity, and ET productivity that had been set for IAIL3. This was inconsistent with the idea that MCCA should enhance IAIL3 by bringing new adaptation-related considerations. In fact, the MCAA income indicator is labeled "increase in per capita income of typical farm households *due to adaptation measures applied"* (emphasis added) – in essence, double counting the original IAIL3 impact. In practice, while the M&E system tracked output and some outcomes of the added component, it did not attempt to track the marginal impact on productivity or income. To do so would require extended monitoring since adaptation benefits would be largest in drought or flood years. However, the M&E framework could have better documented precisely which adaptation innovations were most widely used.

2.28 **Implementation**: The M&E program was managed overall by the Central Project Management office of SOCAD, which reviewed and compiled aggregate data in periodic reports and provided back-up as needed to the provinces. But hands-on supervision and quality control of the counties' M&E programs was primarily handled by the POCADs. Each POCAD and every COCAD had a small M&E unit, and the M&E staff also received specialist inputs from the technical agencies (such as the bureaus of water resources and agriculture). As needed, advice from local universities was obtained. To increase transparency, broad-based county-level committees were also established, typically comprising local government, POCAD and COCAD staff, technical bureau staff, and village committee representatives. A baseline survey was conducted at the beginning of the project, and comprehensive training provided for staff throughout the SOCAD/POCAD/COCAD hierarchy. From the briefing provided to IEG, measurement and data analysis appears to have followed acceptable practices. For measuring yields, random placement sub-plots were used, with harvesting by a village representative and COCAD. Quality control may have been a weakness in some counties and might have been the source of some data discrepancies noted in aggregate figures. But overall, other than its limited use of controls, the M&E/MIS system developed to be both a useful management tool and a means of tracking progress against most of the project's monitorable indicators.

2.29 **Utilization:** The M&E/MIS system was used extensively, at central, province and county levels. The system's multi-dimensional character provided both for management use (mainly the MIS system), and for tracking progress towards project

outputs and outcomes (the main M&E system). M&E for the WUA program was particularly comprehensive, with mixed utility. There was little information on the participating provinces and a missed opportunity to assess program impact.

2.30 Balancing the strengths and weaknesses of the entire M&E/MIS system, the Overall Quality of M&E was Substantial.

Safeguards

2.31 IAIL3 was an Environmental Category B project and triggered the following safeguards: Involuntary Resettlement (OP 4.12); Indigenous Peoples (OP 4.10); Dam Safety (OP 4.37); and Pest Management (OP 4.09). (MCCA fell within the existing scope and safeguards of IAIL3.) An Environmental Management Plan was prepared for each province, and implementation of the Plan was monitored by an independent province-level Environmental Management Team. Most actual monitoring was carried out by institutions specialized in the respective technical field.[8] There were also environmental requirements for larger sub-projects - each feasibility study had an environmental section, and the Provincial Environmental Bureau had to approve the study.[9] A Resettlement Policy Framework was prepared as a guide in case resettlement was needed. Due to the small-scale nature of modernization works, generally following the existing canal alignments, one would not expect relocation impacts. SOCAD reports that there were no "disputes" about land.

Fiduciary

2.32 The Project Management Offices of SOCAD and the POCADs checked for fiduciary compliance during their supervision activities, and through the MIS system. Annual financial reports were prepared by the POCADs and SOCAD. Audits, by independent auditors, were on time and without substantive qualifications. Regular Bank missions also reviewed the project's financial management and fiduciary compliance. The project's last Implementation Status Report (December 15, 2011) rated financial management and procurement as satisfactory.

Achievement of Outputs

2.33 For evaluative purposes, this chapter begins with an assessment of IAIL3/MCCA's achievement of planned outputs. Subsequently, the degree to which the project achieved its Objectives (Efficacy) will be reviewed based on IAIL3/MCCA's sub-objectives. In summary form, these were: (i) increasing water and agricultural productivity; (ii) raising farmers' incomes; (iii) promoting sustainable and participatory rural water resources and agro-ecological environmental management; and (iv) (the

[8] Specializations in, for instance: groundwater management, and measurement of groundwater levels and quality, soil fertility, surface water quality and quantities, pest monitoring, resettlement and indigenous peoples; and dam safety.

[9] For the Dam Safety safeguard, annual inspections were done and a Dam Safety Report submitted to the Bank annually. Integrated Pest Management was a large part of IAIL3's agronomic improvement program, covering most of the project area.

added objective for MCCA) enhancing adaptation to climate change in agriculture and irrigation water management.

2.34 The projects' outputs (implementation achievements) largely met or exceeded appraisal targets, and also any revised targets if changes were made at Mid-Term-Review (Tables 2.1 to 2.6). All revised targets were, like the appraisal targets, exceeded, except for two exceptions. The number of agricultural extension service stations was 64 percent of the appraisal target (111 percent of the revised target). Agricultural demonstrations were increased (116 percent of the appraisal target). The other shortfall was the number of study tours. In response to the financial crisis, Government restricted study tours as part of general policy austerity measures. The number of international study tours fell to 45 percent of the target at appraisal (from 235 tours planned at appraisal to an actual number of 105 tours); and the number of domestic study tours fell to 81 percent of appraisal intentions – from 4445 to 3626 persons. There was a small amount of international training (longer duration studies) which increased by 500 percent - from 8 to 40 courses. Thus, apart from the two exceptions above, all project targets were met, whether original or revised (and revised targets always exceeded appraisal targets). The targets at appraisal will be used in the evaluation of outputs as they represent the goals set at appraisal rather than updates based on project progress, of any revisions made in project targets during implementation.

Irrigation expansion, Improvements, and Management

2.35 Irrigation improvements were the modernization of the lower (mostly tertiary) reaches of the existing irrigation schemes. This primarily comprised the re-sectioning and lining of the existing channels and water courses, and modernization of small diversion and other small structures within the irrigation schemes. These improvements reduced conveyance losses caused by seepage from dilapidated channels and enabled better control of water. The modernization program (Table 2.1)[10] resulted in "water saving irrigated land" (modernized irrigation systems) increasing from 16,000 hectares in 2004 (the year before project approval or "base year"), to 393,000 ha by 2009, the year before project closure (data to 2010, the last year of IAIL3, is not available).[11] This was a large increase on the small area of water saving irrigation before the project, and about three percent above the modernized area targeted at appraisal. A major campaign to promote WUAs resulted in the establishment of 1022 WUAs (compared with an appraisal target of 993 WUAs), covering an area of 225,000 ha – three percent more than the 204,000 ha targeted at appraisal.

[10] Specific data items can vary by source. Where this occurs, and throughout the evaluation, the data from the ICR Monitorable Indicators is used to better enable the consistency of comparisons between actual achievements and targets.

[11] Most monitoring stopped in 2009 meaning that some output data will understate actual achievements.

Table 2.1. Improving Irrigation: Main Implementation Achievements

Action	Baseline	Appraisal Target	Revised Target	Actual Achieved	Achieved as % of baseline	Achieved as % of Appraisal Target	Achieved as % of Revised Target
Area of water saving irrigation (‘000 ha)	16	380	-	393	2450%	103%	-
Number of WUAs (No.)	-	494	1014	1022	-	207%	101%
Area covered by WUAs (‘000 ha)	-	95	-	221	-	110%	-
	Indicators of water productivity						
Improving water use efficiency (canals) (%)	58%	79%	-	79%	136%	100%	-
Water productivity (kg cereal/m^3) (expressed in cereals equivalent)	1.06	1.39	1.45	1.55	146%	112%	107%
Production of cereals/unit of ET (in ‘000 kg cereals/ET)	55	114	-	114	207%	100%	-

Source: SOCAD.

Improving agronomic practices

2.36 A similarly intensive program to improve agronomic practices on the modernized irrigated lands (Table 2.2) was also devised. At the center was a major thrust to create greater capacity of agricultural extension and training. Farmer demonstration areas were established on 158,000 ha (appraisal target 136,000 ha). Farmer training reached 74,000 person months (appraisal target 59,000), and extension services were concentrated to 25 farmers per extension staff, less than half the 57 farmers per extension worker before the project. Use of improved seed was increased from 87 percent of land area before the project to 100%, as planned. And use of integrated pest management was brought up

from 70 percent baseline to 96 percent (the appraisal target was 93%). The use of machinery also increased during the project period: mechanized plowing from 80% of farmed area to 93%, sowing from 56% to 74%, and harvesting from 58% to 77%.

Table 2.2. Improving Agricultural Practices: Achievements

Action	Base-line	Appra-isal Target	Revised Target	Actual Achieved	Achieved as % of baseline	Achieved as % of Appraisal Target	Achieved as % of Revised Target
Main Agricultural Actions							
Demonstrations and extension							
Seed coverage (percentage of project area sown with high quality seed)	87%	100%	-	100%	114%	100%	-
IPM coverage (percentage of project area where integrated pest management is employed)	70%	93%	-	96%	137%	103%	-
Balanced fertilizer use (‘000 Ha)	n.a.	105		106	n.a.	101%	-
Land leveling (‘000 Ha)	n.a.	(pilot)	-	155	n.a.	109%	-
Degree of mechanization (percent of land that uses mechanized equipment for:							
Ploughing	80%	89%	-	93%	116%	104%	-
Sowing	56%	68%	-	74%	132%	132%	-
Harvesting	58%	71%	76%	78%	133%	133%	103%
Other agronomic improvements		(as per extension advice, pamphlets and training - unquantified)					
Agricultural extension and training							
Agricultural extension/service stations (No.)	-	516	296	329	n.a.	64%	111%
Ratio of technicians/extension staff to farmers	57	20	-	20	228%	228%	-
Agricultural demonstrations area (‘000 ha)	-	136	-	158	n.a.	116%	-
Extension training (person months)							
Training of technicians	-	12469	-	14290	n.a.	115%	-

Training of farmer technicians	-	22599	-	22825	n.a.	101%	-
Training of farmers	-	59239	66036	74455	n.a.	116%	113%
Of which women	-	14995	-	24621	n.a.	164%	-
Institutional capacity building and training							
International training (person months)	-	8	27	40	n.a.	500%	148%
International study tours (person months)	-	235	-	105	n.a.	45%	-
Domestic training (person months)	-	17035	13586	13638	n.a.	80%	100%
Domestic study tours (person months)	-	4445	4053	3626	n.a.	81%	89%

Source: SOCAD and ICR.

Promoting sustainable water and agro-ecological management

2.37 A concerted effort was mounted to establish a sustainable water and agro ecological management program, the main elements of which are at Table 2.3. Several activities were at large scale. The area under water-conserving irrigation (through improved management by WUAs, and by applying water use quotas) reached 392,000 ha, near the target set at appraisal of 380,000 ha. Land grading (which increases retention of surface water, increases groundwater recharge and reduces soil erosion) was originally a small piloting activity but was ramped up to a major program, eventually covering 155,000 hectares. Shelterbelt forestry covered 31,000 hectares, 11 percent above the appraisal target. Integrated Pest Management expanded to near universal coverage – from 70 percent of total project area at the beginning of the project to 96 percent coverage at completion. A pilot program to prepare groundwater management plans in 19 counties was carried out as intended. About 18,000 hectares of green crops exceeded the appraisal target of 17,000 ha and while still relatively small (5 percent of the project's water saving irrigated area), is growing rapidly (refer below).

Table 2.3. Main Agro Ecological and Water Resources Management Actions

Action	Baseline	Appraisal Target	Revised Target	Actual Achieved	Achieved as % of baseline	Achieved as % of Appraisal Target	Achieved as % of Revised Target
Water saving irrigated area (‘000 ha)	16	380	-	392	n.a.	103%	-
Land Leveling (‘000 ha)	-	(pilot)	-	155	n.a.	n.a.	-
Integrated pest management (coverage of cropped area in percent)	70%	93%	-	96%	137%	103%	-
Use of Deep plowing (‘000 Ha)	-	177	-	184	n.a.	104%	-
Use of Crop residues (000’ Ha)	-	121	-	125	n.a.	103%	-
Other Agro-ecological agronomic actions		as based on extension advice, training and pamphlets					
Counties prepare groundwater management plans (No.)	-	19	-	19	n.a.	100%	-
Tree shelter belts (‘000 ha)	9	28	-	31	344%	111%	-
Area of green, non-polluting and organic crops (‘000 ha)	-	17	-	18	-	106%	-

Sources: ICR and SOCAD.

Piloting Farmers’ Associations and “Green” Crops

2.38 Two partly interlinked project initiatives piloted higher value agricultural production: first, IAIL3’s introduction of farmer agricultural and marketing organizations; and second, the project’s lead role in piloting “green crops.” Most farmer organizations were “Associations” with statutes that enabled business autonomy, and with by-laws to protect members’ rights and participation. A few “Cooperatives” were also established which undertook the same activities as the Associations under more formal regulations. By project end, 207 Farmer Associations and 20 Cooperatives, both exceeding appraisal targets (Table 2.4) had been established. Virtually all of these organizations were involved in production of a high-demand product or a number of products, and/or in standardization and marketing, with their own brands and logos.

Produce went primarily to markets in small to large cities and, in one case visited by IEG, to international markets. While this was a relatively small program – the area was greater than targeted but was still less than two percent of improved irrigated area – the success of the program is likely to have provided the experience and demonstrations to back-stop future expansion.

2.39 These organizations also contributed to Government's "Green" campaign. This initiative promoted ecological improvements in agricultural production using three grades which had to be earned through an inspection and rating process (Table 2.5). "Pollutant Free" production requires no use of pesticides. "Green" food has more rigorous standards in production and the production environment. And "Organic" food has more stringent definition of what is allowed or prohibited, including no fertilizer, hormones or other synthetic substances. These green products typically command a price premium. With the exception of the area of certified/green label agro-products, for which the appraisal target was 16,800 ha and achievement was 18,000 ha, there were no appraisal or revised targets for green and organic cropping.

Table 2.4. Development of Farmer Associations and Higher Value Crops

Indicator	*Baseline (2004)*	*Appraisal target*	*Revised Target*	*Actual Achievement*	*Achievement as percent baseline*	*Achievement as percent Appraisal Target*	*Achievement as % Revised target*
Farmer Associations (No.)	-	166	193	207	-	125%	107%
Farmers Cooperatives (No.)	-	12	19	20	-	167%	105%
Area of high quality products ('000 ha)	0.7	499	-	563	807%	113%	-
Number of registered brands (No.)	-	86	-	93	n.a.	108%	-
Value of output (million Yuan)	66	918	-	773	1171%	84%	-
Per capita income of Green Crop producers (yuan per annum)	-	1853	-	4418	-	238%	-

Source: SOCAD and ICR.

Table 2.5. Development of Agro ecological Cropping

*"***Non-polluting" agro-products**	
Number of certified agro-products (No.)	250
Area of certified Agro-products ('000 Ha)	59
"Green" Agro-products	
Certifications & green labeling provided (No.)	210
Area covered by certified/green label Agro-products ('000 Ha)	18
"Organic" Agro-products	
Number of certified Agro-products (No.)	18
Area covered by Certified Agro-product (Ha)	3

Source: SOCAD.
Note: with the exception of the area of certified/green label agro-products, for which the appraisal target was 16,800 ha and achievement was 18,000 ha, there were no appraisal or revised targets for agro-cropping.

Introducing an Agricultural Climate Change Adaptation Program

2.40 The final main project activity was the GEF funded MCCA. A broad array of activities (Table 2.6) was implemented, including research and simulations for climate change; development of a menu of climate change adaptation actions for field implementation; preparation of extension material; training and demonstrations; implementation of climate change actions by farmers with guidance from the extension service, and mainstreaming a climate change adaptation agenda into the overall IAIL3 program.

Table 2.6. Main Climate Change Adaptation Actions

Action	Appraisal Target	Actual Achieved	Achieved as % of Appraisal Target
Build climate change scenarios and models	undertake	done	100%
Develop menu of climate change adaptation measures	undertake	done	100%
Number of different documents related to climate change adaptation issued by SOCAD, POCADs and COCADs	326	331	102%
Climate Change Adaptation demonstrations (ha)	32000	35000	112%
Number of IAIL3 sites where CCA measures have been included	154347	172868	112%
WUAs and Farmer Associations incorporating CCA	183	183	100%
Greenhouse area for adaptation to warming (in ha)	-	124	n.a.
Percentage of farmers & technical staff who are aware of climate change adaptation actions	47%	56%	119%

Source: SOCAD.
NB: No revisions to the targets were made.

Achievement of the Objectives

OBJECTIVE 1: INCREASE AGRICULTURAL AND WATER PRODUCTIVITY

Agricultural productivity and income per hectare

2.41 The project sought to increase farmers' incomes via a sustainable increase in agricultural productivity. The increase would be accomplished through a combination of higher physical yields, higher cropping intensity, and shifts to higher-value varieties and crops, leading to higher incomes per hectare[12].

2.42 Over the project period the nominal value of output per hectare increased 81%. Annual price inflation was 13% or higher during 2003-4 and 2006-8. So, adjusting for price inflation, real productivity rose by 19% (Figure 2.2). However, the national price deflator may understate the gains, which were driven by two main factors:

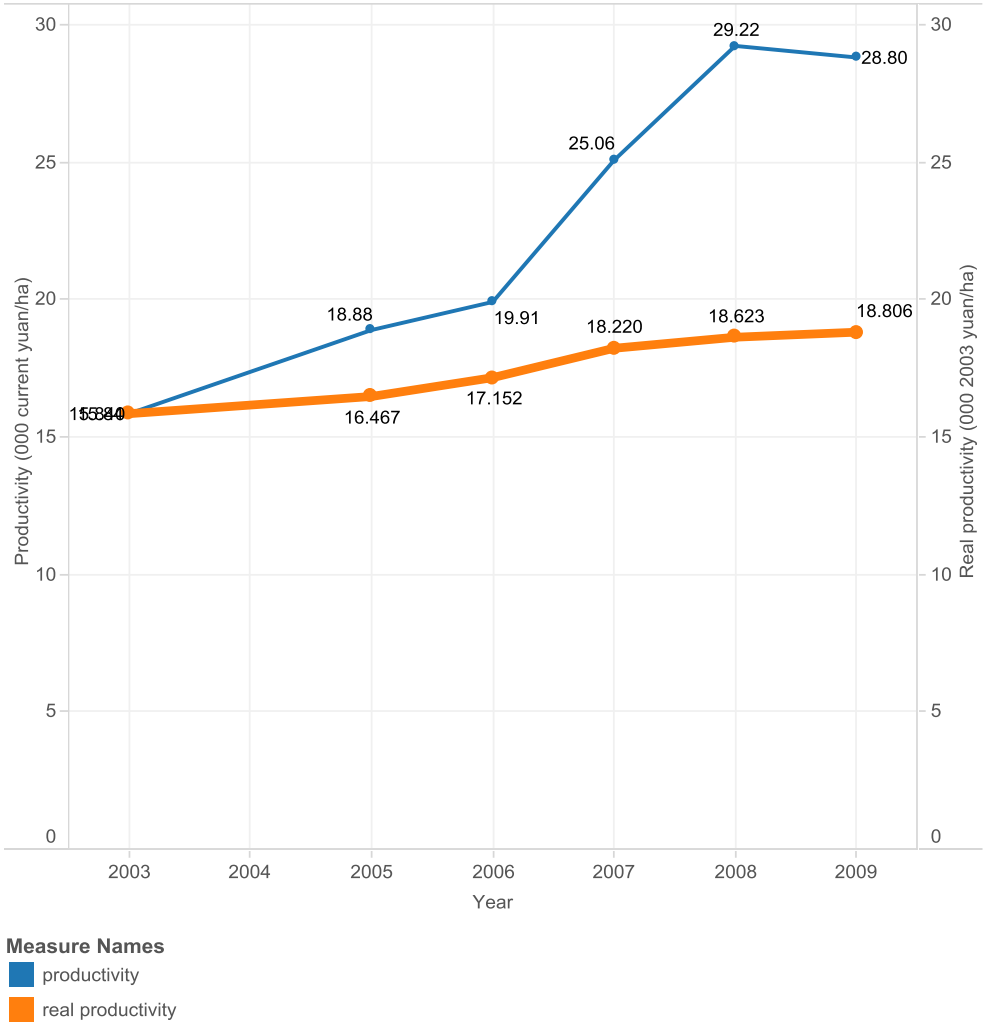
- Increase in physical yields of 22% to 35% among major crops (see below),
- A large shift from low quality to good quality varieties, which fetch premium prices. The proportion of area devoted to good-quality wheat increased from 31% to 76%; for corn, from 43% to 75%; for rice, from 9% to 67%; and for melons and vegetables, from 35% to 65%.

2.43 Smaller factors included:

- A 9% increase in cropping intensity (see below)
- A slight increase in the proportion of area planted to cash crops (up from 26% to 28%).

[12] The total area under cultivation grew by less than 2% from base year to 2009, but there was a large dip in 2005 with recovery thereafter.

Figure 2.2. Nominal and Real Land Value of Production/ha by Year



Source: IEG based on IAIL3 project data and China Statistical Yearbook. Denominator is actual farmed land area, and so does not double count in case of multiple cropping. The price deflator is the national agricultural producer price index.

2.44 Yields. For the three major cereals there has been a distinct increase in yields per hectare over the project period, ranging from a 22 percent increase for rice, a 30 percent increase for maize, and a 35 percent increase for wheat (Table 2.7). For the cash crops listed in the table, yields also increased - typically by between 20 to 30 percent. The yield increases were about the level targeted at Appraisal. Yields increased in all provinces (Figure 2.2). Yield increases in the project significantly outpaced province-wide and national increases.(Table 2.8 and Figure 2.4)[13]

2.45 Cropping intensity also increased, going from 167% to 187% (above the appraisal and revised targets, Table 2.6), reflecting a more prolonged and reliable growing season under irrigation. IAIL3's program to upgrade the irrigation systems enabled a surer base

[13] Over 2004-9, based on the China Statistical Yearbook, cereal yield averages by province increased 3% in Jiangsu, 8% in Anhui and Shandong, 11% in Hebei, and 17% in Henan.

for a second crop during, in particular, the drier months. The increased cropping intensity would approximately add a further 10 percent to crop yields per hectare including multiple cropping, thus giving an effective yield increase of 24 to 39 percent for the cereals.

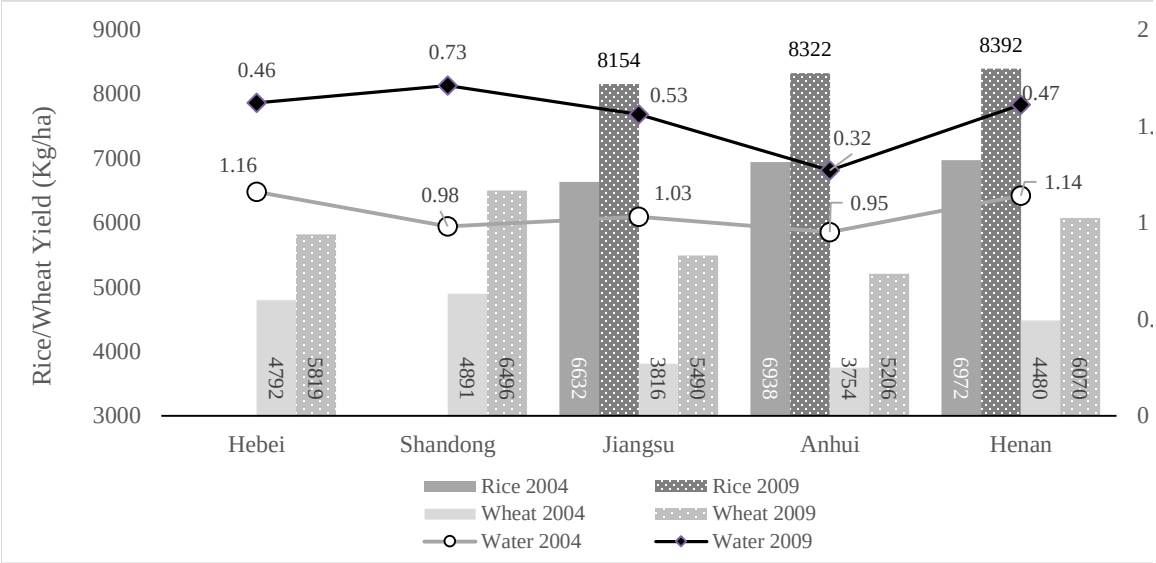
2.46 Crop Diversification and Higher Value Farm Produce. The project's program to establish Farmer Associations and cooperatives (the number of Farmer's Associations and Cooperatives that were established exceeded both appraisal and revised targets, Table 2.4) resulted in the associations/cooperatives choosing to grow higher value crops and develop market channels to more lucrative markets. This was only a pilot program so its impact on the overall value of agricultural production was relatively small, but prospects for the future appear buoyant. Green crop area reached 18,000 ha (Table 2.3), slightly exceeding (by 6 percent) the appraisal target (the target was not revised). Green crop development was from zero at the beginning of the project. The much larger change, however, was the above-mentioned within-crop shift to higher quality varieties, fetching premium prices.

Table 2.7. Yields of Major Crops

Crop	Baseline Yield (Kg/ha) (2004)	Appraisal Target (Kg/ha)	Actual Yield Achieved (2009) (Kg/ha)	Achieved as % of baseline (%)	Achieved as % of Appraisal Target (%)
Cropping Intensity (multiple cropping index)	167	183	187	112%	102%
Major cereals					
Wheat	4362	5540	5900	135%	106%
Maize	5511	6946	7137	130%	103%
Rice	6782	7977	8260	122%	104%
Selected Major cash crops					
Soybean	2081	2531	2565	123%	101%
Potato	5958	7535	7399	124%	98%
Rapeseed	1953	2486	2548	130%	102%
Peanuts	3133	3845	4134	124%	132%
Cotton	965	1183	1194	123%	101%
Melon and vegetables	34770	40643	40551	117%	100%

Source: SOCAD.
NB: No revisions were made to the appraisal targets.

Figure 2.3. Rice Yield, Wheat Yield, and Water Productivity by Province



Source: IAIL3 project data (2004 to 2009).

Table 2.8. Comparison of Changes in Cereal Yields (kg/hectare) under the Project with Overall Province Level Yield Changes

PROVINCE	PROVINCE (GRAIN) (Overall grain yield changes by province. In % increase, 2004 to 2009)	PROJECT RICE (Changes in yields of rice under the project. In % increase from 2004 to 2009)	PROJECT WHEAT (Changes in yields of rice and wheat under the project. In % increase from 2004 to 2009)
Hebei	12%	-	21%
Jiangsu	3%	23%	44%
Anhui	8%	20%	39%
Shandong	8%	-	33%
Henan	17%	20%	35%

Note: Province data includes project areas.
Source: SOCAD and China Statistical Yearbook.

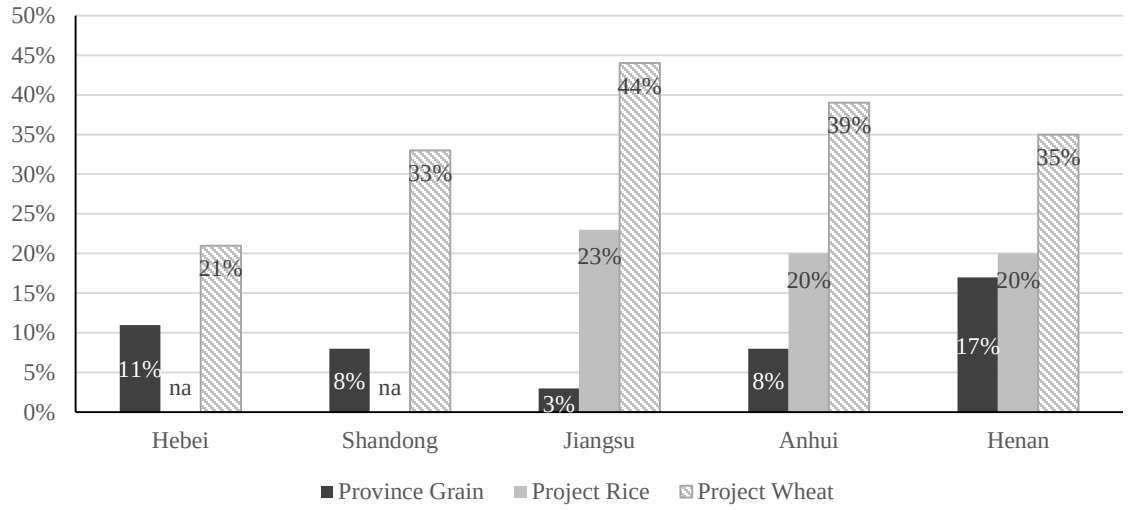
Yield growth compared to a counterfactual

2.47 Table 2.8 shows that cereal yields grew much more rapidly in the project areas than the overall rate in the corresponding province.[14] Average grain yields for the five

[14] It should be noted, however, that this is not a fully "controlled" comparison; project areas were selected because they were low-yielding and thus had more scope for improvement than other lands. But the differences between project and provincial growth rates is large and is consistent with a causal impact on productivity. Provincial data includes data from IAIL3 areas, so that the difference between project and provincial averages understates the difference between project and non-project areas.

provinces (un-weighted averages) grew by 9 percent between 2004 and 2009 spanning most of the IAIL3 project period.[15] By contrast, rice yields in the project area increased by an average of 22 percent, and project wheat yields increased by 35 percent. These comparisons indicate that IAIL3 has substantially outpaced provincial and national yield growth. There are also the other impacts of IAIL3, such as within-crop shifts to higher value products, and, although it is still at small scale, the market commercialization program.

Figure 2.4. Comparing Changes in Project Cereal Yields with Changes in Province Yields (2004 to 2009)



Source: SOCAD and China Statistical Yearbook.

2.48 In the absence of IAIL3, some of its interventions might have diffused, but more slowly. Some of these would have been dependent on support by other projects. For instance, SOCAD considers that, absent IAIL3, farmers would not have received rehabilitated/modernized irrigation, training, extension advice and access to improved seed. But thanks to other initiatives, there was an increase in nationwide irrigated area.[16] WUAs have also been increasing. Other innovations might have developed spontaneously. Mechanization has been increasing rapidly as rural wages have begun to rise. Relatively low-cost innovations, such as straw mulching, might diffuse as farmers emulate neighbors.

2.49 Nevertheless, IAIL3 greatly outpaced provincial gains in yield and crop value (Figure 2.4), which is unlikely to have been achieved without the specific investments in infrastructure, agronomy and management that the project provided.

[15] IAIL3 was approved in October 2005 and closed in December 2010, but data for 2010 was not collected by SOCAD.

[16] China National Statistical Yearbook.

Water Productivity and Water Saving

2.50 The productivity of water increased considerably. As noted, this reflected a combination of 'hardware' – such as improved irrigation infrastructure and land-leveling, and 'software' – improved management practices, including quotas and fees for water use and better timing of irrigation, in part due to the proliferation of WUAs. These had the following effects.

- Water conveyance efficiency increased by over one-third - from a baseline average at time of appraisal of 58 percent, to 79 percent by project completion. This was primarily due to re-sectioning and lining of water channels or replacement with low- pressure pipes. The increase to 79 percent is the same as the appraisal target (there was no revised target).
- Water productivity increased by 46 percent - from its baseline average at appraisal of 1.06 kg equivalent of cereals per cubic meter of irrigation water, to 1.55 kg cereals/m^3 of water by project completion. The achievement in water productivity of 1.55 kg cereals/m^3 exceeds both the original target of 1.39 kg/m^3 and the revised target of 1.45 kg cereals/m^3 of water. (See Table 2.1)
- Estimated in terms of evapotranspiration, cereal production per unit of ET reportedly doubled (Table 2.1) - from a project average of 55,000 kg cereal/unit of ET (baseline), to 114,000 kg/unit of ET by project completion, the same as the targeted increase at appraisal (the target was not revised).[17]

2.51 The increase in water productivity (kg cereals/m^3 of water) of 55 percent accompanied the average increase in agricultural productivity of between 22 to 35 percent.

2.52 Did the project achieve 'real water saving'? The project acted both to reduce and to increase water consumption. Some of its innovations truly reduced evaporation (water loss): straw mulching, deep plowing, and drip irrigation. Canal lining, on the other hand, increases irrigation efficiency but does not really save water to the extent that it reduces groundwater recharge. And the increase in cropping intensity and in productivity increases water demands. In Hebei, for instance, planting of winter wheat is discouraged because it is water-intensive and only marginally profitable. Shifts in crop mix can have major impacts. For instance, cotton has an evapotranspiration rate 200 mm more than maize. So the question is whether increased efficiency of water use was counterbalanced by increased demands for water.

2.53 Evidence on overall impacts is inconsistent. A rough calculation[18] suggests that a 63% increase in crop tonnage at the project level was accompanied by a 9% increase in

[17] However, measurement is difficult, and values are quite variable by location. For instance, measurements in Hebei of actual evapotranspiration in wheat, maize, and cotton fields found reductions of just 2% to 3% against control plots with the same crop.

[18] Based on kg of production in cereal equivalents/m^3 water used, at the aggregate project level. Water use is not exactly equivalent to ET, and may include, for instance, canal leakage that recharged groundwater.

overall water consumption. In other words, increased efficiency allowed water consumption to increase only slightly while crop production increased substantially. On the other hand, there were reported improvements in groundwater depth in Shandong and Hebei (see below). In Hebei, field monitoring showed a reduction of 8, 12, and 21 mm of ET in wheat, maize, and cotton respectively. The bottom line is that the project resulted in a substantial increase in water productivity, without greatly increasing water consumption and possibly while reducing it. A province-wide ET monitoring system of the kind pioneered by the HBP, if perfected and deployed on a large scale, would allow more accurate determination of impacts on real water savings.

2.54 Summarizing, as concerns IAIL3 agricultural productivity, crop yields (kg/hectare) increased by between 25 to 35 percent over the project period and cropping intensity increased from 167 to 187 percent, resulting between them in a 24 to 39 percent increase in productivity. Both yield and cropping intensity increases exceeded appraisal targets (targets were not revised). A relevant counterfactual is the difference between cereal yield increases on project areas of the five participating Provinces, and the average yields of each Province as a whole (Table 2.8). Increases in grain yields in the provinces from 2004 to 2009 ranged from 3 to 17 percent, whereas increases in the project areas ranged from 20 to 23 percent for rice and from 33 to 44 percent for wheat, thus substantially outpacing other areas in the project provinces. A shift to high value crop varieties added to economic impact. Water productivity also improved substantially – irrigation conveyance efficiency increased from 58 to 79 percent, and water productivity (in kg of cereal equivalent/m3 of water) increased by 55 percent. The project also primarily benefitted disadvantaged farmers. As an irrigated agriculture project, with primary focus on rehabilitating and modernizing irrigated areas, the targeted areas were all considered to be "low and medium yield farm land areas" – the systems were too dilapidated for higher yielding farming. An unknown is the degree to which "real water saving" was achieved (see discussion under Objective 3. Nevertheless, in terms of the project objective to "increase water and agricultural productivity in low and medium yield farmland areas" achievements were considerable and above targets, and IAIL3's Efficacy was High.

OBJECTIVE 2: RAISE FARMERS' INCOMES AND COMPETITIVENESS

Farm Incomes and Reaching low income areas and excluded groups

2.55 A little more than a third of the 107 IAIL3 project counties were officially classified as poor: 11 as National Poverty Alleviation and Development Focus counties, and another 27 as Provincial Economic Underdevelopment Counties. About one-third of the person-months of farmer training went to women, who play an important farming role.

2.56 In current terms, average per capita incomes increased from Yuan 1,100 baseline to Yuan 3,290 at project completion. This increase was 119 percent more than the appraisal target of Yuan 1,505, and 50 percent more than the revised target of Yuan 2,207.

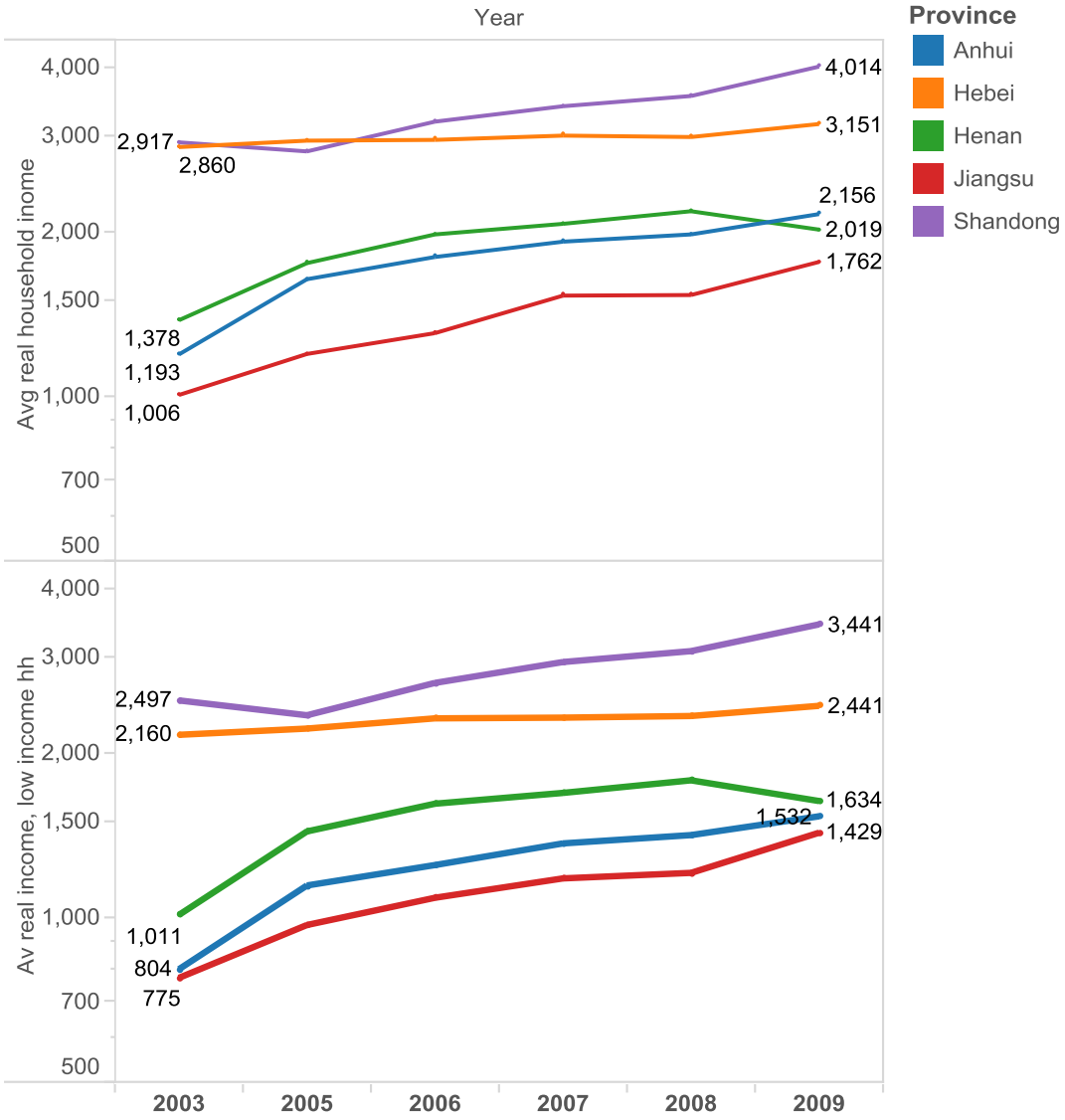
2.57 What matters, though, is real income. Real incomes grew for project households, both on average and for those initially identified as low income. These gains are consistent with the improvements in land productivity, shifts to higher-value varieties of crops, increased value-added from Farmers' Associations and Cooperatives, and off-farm employment of labor freed up by mechanization. Figure 2.4 shows income gains in real terms in net total per capita income (including non-farm income) by Province. Incomes increased in all provinces, with very large gains for poor households in the three provinces with the lowest initial incomes (Jiangsu, Henan, Anhui). In these provinces, poor households gained by 61 to 90 percent, and average households did nearly as well. But, for unidentified reasons, gains were modest in Hebei.

2.58 This was a period of dynamic change in China, with rapid changes in the off-farm economy and growth in wages. To rule out the hypothesis that income gains in the project area were driven largely by national growth, it would be desirable to compare trends in project areas with those in a matched set of control areas. However, no such areas were identified at project outset. As an imperfect alternative approach to constructing a counterfactual, Figure 2.6 shows the ratio, by province, of mean incomes in project areas to mean rural incomes in the counties containing project areas.[19] This comparison was incorporated in the IAIL3 monitoring framework. Figure 2.6 shows that by this measure, low income project households in Anhui, Jiangsu, and Shandong closed the gap with peers, while households in Hebei and Henan fell behind. In making these comparisons it is important to keep in mind that the project areas (except in Shandong) were poorer than the project counties. (Figure 2.4, top panel). It is plausible that the project areas faced more severe constraints to growth – such as lower educational levels or greater distance from employment centers – and therefore would be expected to fall even further behind comparators in the absence of the project. This consideration makes the relative gains in Jiangsu and Anhui more remarkable.

2.59 To sum up, real income gains were substantial and were consistent with a causal impact of the project via improved land and labor productivity and shifts to higher value crops. Incomes of project households gained against local non project households in three of five provinces, with greater relative gains for poorer households. In two provinces, absolute incomes rose but relative incomes declined. This evidence suggests a causal contribution of the project to incomes.

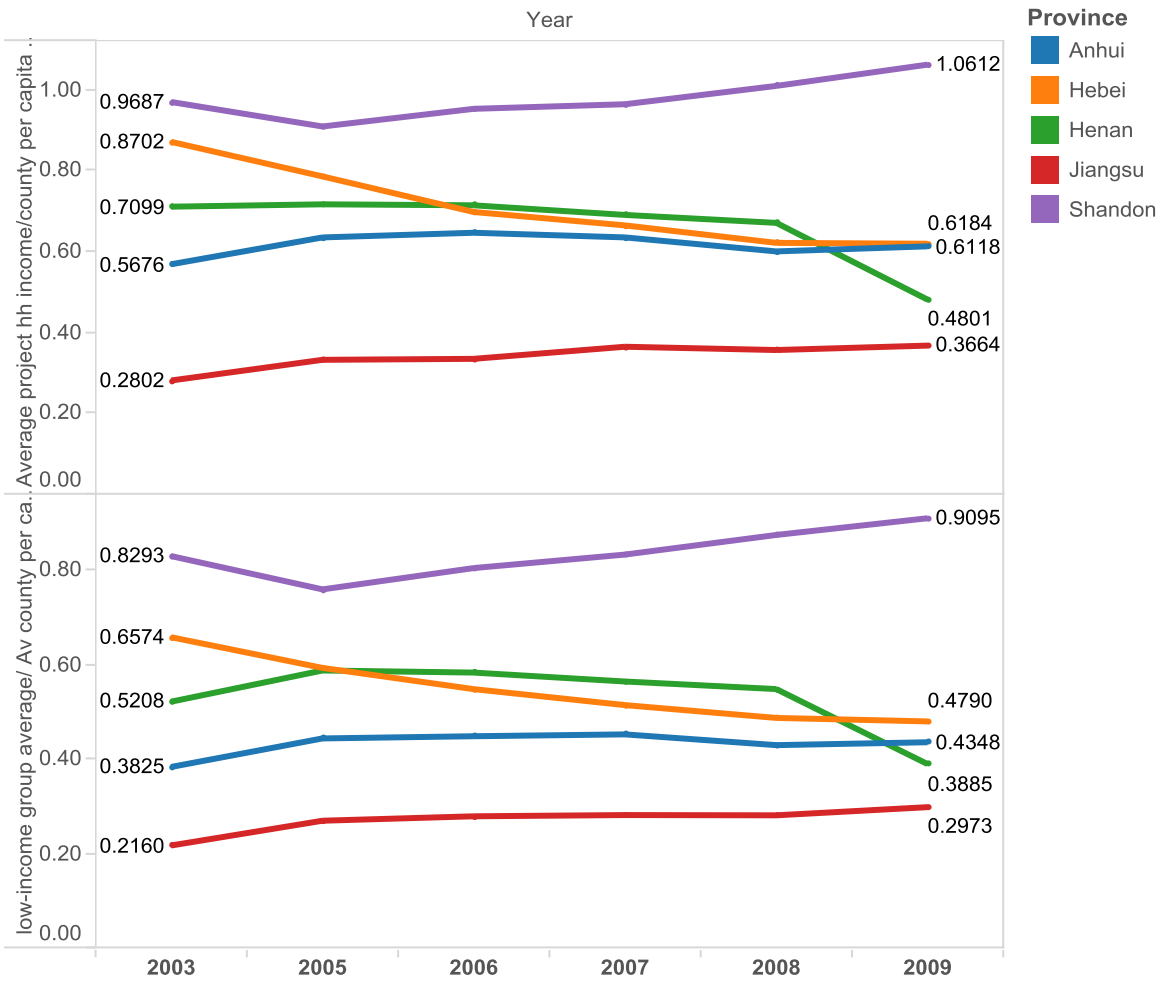
[19] Project areas covered only part of a county. Coverage data were not available, but staff indicated that a typical project area would cover about a third of its county. Thus the difference between average income in the project area and in the county as a whole understates the difference between average income in project vs. non project areas of the county. The method of aggregation from county to province was not documented.

Figure 2.5. Real Income Trends of Project Households by Year and Province



Note: top panel shows average net per capita income in project area. Bottom panel shows corresponding statistic for households initially classified as 'low income' households. Scales are logarithmic.
Source: IEG based on income data from SOCAD; deflated by nationwide rural consumer price index from China Statistical Yearbook.

Figure 2.6. Trends in Project Area per Capita Income Relative to Province Average Incomes



Source: SOCAD.
Note: Top panel shows ratio of average per capita income in project areas to average per capita rural income in project counties. Bottom panel shows ratio of average per capita income of initially-classified low income families in project areas to average per capita income in project counties.

Strengthening Farmers' Competitive Capacity

2.60 The income-enhancing objective also aimed to "strengthen (farmers') competitive capacity under post-WTO conditions." In cereal production, the increase in yields and farm incomes under the project can be expected to be reflected in generally more competitive agricultural production. As concerns diversification to higher value production ("green crops," horticulture and other diversification crops) the main project intervention has been the program to support growth of Farmers Associations and Cooperatives. This program is small relative to the rest of the project, and is in effect a pilot rather than a mainstream program. However, in this role the program was valuable. In launching the farmer associations and participating in the drive to diversify to green crops, IAIL3 encouraged the growth of production of higher quality – higher value crops, and the progressive professionalization of marketing. For green crops, total value of

output grew from 66 million Yuan ($11 million) at the beginning of the project to 773 million Yuan ($127 million) by closure. As noted earlier, there has been rapid expansion in the share of "high quality" cereals, fruits and vegetables. Based on IEG interviews and field visits, potential for medium and high-end marketing of green and higher value crops is substantial. Farmer associations were found expanding their businesses, had developed effective produce grading, standardization, market brands and packaging, and had developed market niches in various urban centers (and in one association visited, internationally).

Summary

2.61 The project boosted annual yield per hectare by 24 to 39 percent. Yield increases were faster in project areas than in the corresponding provinces as a whole. The project also succeeded in piloting viable means of diversifying to more remunerative crops and marketing processes, so as to further enhance incomes and the agriculture sector's competitiveness. These gains plausibly drove the observed gains in income, and would have contributed to increased competitiveness. Thus, the efficacy of the objective to increase farm incomes and competitiveness is rated as High.

OBJECTIVE 3: PROMOTE SUSTAINABLE AND PARTICIPATORY WATER RESOURCES AND AGRO-ECOLOGICAL MANAGEMENT

2.62 The two main productivity-enhancing activities of the project – modernizing irrigation and improving agricultural practices – can be expected in themselves to have had agro-ecological benefits. Improved irrigation efficiency could be used to reduce the drawdown of groundwater. And improved agricultural practices (such as integrated pest management, more straw mulching and other actions) could enable ecological as well as agricultural production benefits.

2.63 An array of other measures were also undertaken which can be expected to have improved the management of water resources and the agro-ecological environment (Table 2.3). All of the activities exceeded appraisal targets (targets were not revised). A number of the activities were at large scale. The land levelling program (initially intended to be a small pilot program) covered 155,000 ha or 39 percent of the water saving irrigated area; use of deep plowing and crop residues covered areas of 47 and 32 percent respectively of irrigated area; and the percentage of project lands under integrated pest management increased from 70 percent to 96 percent. Most of the actions (including integrated pest management, green cropping, land leveling, and the bulk of agronomic improvements) also benefited agricultural productivity. The project also supported planting of 31,000 ha of shelterbelts. These were intended to increase tree cover and protect crops and top soil while improving microclimates. Based on international experience, such impacts are likely. SOCAD also considers that they may promote water retention, although trees can be large consumers of ET so their net impact on groundwater is indeterminate. An achievement that, based on the experience under the HBP, may be an important source of better soil and water management was the preparation by each project county of a Groundwater Management Plan. With several exceptions discussed below, most of these actions do not have empirically based measures of agro-ecological impacts, but all are based on international experience where

impacts have been positive and farmers and environmentalists continue to practice such actions.

2.64 Under IAIL3's Environmental Management Plan a number of key environmental and productivity variables were monitored, including groundwater levels, soil fertility, inorganic fertilizer levels, pesticide content and water and soil pollution levels. Some of these are noted below. Measurement was through an extensive network of monitoring stations, and use of professional monitoring agencies hired by the POCADs. The agencies were adequately qualified and capable of producing technically sound and accurate results.[20]

Groundwater Recharge

2.65 SOCAD reports generally favorable impacts in reducing groundwater extraction, though with considerable variation between regions. In Shandong, groundwater levels improved in five monitoring areas, held steady in 11, and dropped in 10. In some of the latter, a declining water table was considered beneficial because it ameliorated problems with water-logging and salinity. In water-scarce Hebei, the decline in the water table was slower in project areas than in comparison areas, by 0.14 to 0.75 meters/year. Total groundwater extraction in 2009 was reported to be 449 million m^3 lower than 2005. Different sources of project data on water productivity and tons of crop production give inconsistent estimates on the implied total water consumption of crops in the project area, ranging from an increase in consumption of 111 million m^3 to a decrease of 16 million. In Henan, groundwater levels rose by 4 to 73 centimeters over 2005-2009 in three areas where rainfall was approximately constant, declined by 2.3 meters in Luhun, where rainfall during the project averaged 94 mm/year lower than normal; and fell 73 cm in Sanyiza, where rainfall was average. Measurements were not reported for the less water-constrained provinces of Anhui and Jiangsu.

2.66 It is difficult to reconcile and generalize these data. Spot measurements of groundwater depth may not convey a comprehensive picture of water use over a large and heterogeneous area. Comparisons of groundwater levels between project and non-project areas could be problematic if they draw on common groundwater resources. Calculations based on water productivity may not fully account for reflows or leakages back into the system (yielding an upward bias on water use), but on the other hand do not factor in the positive or negative impacts of shelterbelt planting (likely a downward bias).

2.67 This underlines the potential complementarity between the efficiency innovations of IAIL3 and the basin-wide perspective on water conservation of the Hai Basin project. IAIL3 was designed with a small pilot component on evapotranspiration (ET)

[20] As examples, Anhui Province hired the Environmental Monitoring Center in Anhui and the Soil and Fertilizer Station. Hebei hired the China Academy of Geological Sciences, and the Province's Institute of Hydrogeology and Environmental Geology and Fertilizer Association. Henan used the Province's Agricultural Environmental Protection Monitoring Station. Jiangsu employed the Agricultural Environmental Monitoring and Protection Station, and the National Environment Protection Agency. And Shandong hired the Province's Agricultural Environment Protection Station, Fertilizer Testing Station and the Institute of Hydrology and Water Resources.

measurement (**Error! Reference source not found.** and discussion under Hai Basin). This was undertaken independently of the ET component of the HBP, with fewer resources. It measured production/ET at the plot level but did not consider overall consumptive use of water. As noted, the ability to comprehensively measure water consumption over a large area would be helpful in tracking the environmental and economic impacts of programs such as IAIL3.

Soil Organic Matter, and Pesticide and Fertilizer Pollutants

2.68 Other impacts are also reported by SOCAD's monitoring agencies. In Hebei Province, during the project period pesticide residues in soil decreased by 22 percent, and pesticide residues in water diminished by 15 percent. Soil sampling in Jiangsu Province indicates a small increase in soil organic matter (from 19.0 grams/kg of soil in 2005 to 20.3 grams/kg by project completion), and SOCAD asserts that use of chemical fertilizer has declined, quality of both groundwater and surface water has improved, and that the shelterbelt trees have improved water storage capacity, reduced soil erosion, helped create moister air, and attracted bird species. People's participation was integral to water user association management, but also applied to varying degree to other activities such as producing and marketing green crops, pest management, and the training and demonstration program generally.

2.69 Summarizing, a number of interventions were undertaken that might be expected to confer agro-ecological benefits. There are some indications of favorable outcomes – notably reduced pesticide residues in Hebei -- but others are not well documented. With regard to impacts on groundwater, there are measurements suggesting favorable impacts in some regions. However, data on cropping and water efficiency suggest that the project may have slightly increased total water consumption. In view of the presumed favorable but suboptimally documented outcomes, the Efficacy of promoting sustainable and participatory rural water resources management and agro-ecological environmental management was Substantial.

OBJECTIVE 4: ENHANCING AND MAINSTREAMING ADAPTATION TO CLIMATE CHANGE[21]

2.70 This objective, added specifically for the MCCA, had the goal of enhancing adaptation to climate change in agriculture and irrigation management, and had two sub-objectives: (i) enhancing awareness, capacity building and demonstrations; and (ii) assisting the mainstreaming of adaptation measures into the national irrigated agriculture development program.

2.71 The grant supported analyses that would inform adaptation strategy for the IAIL3 and for SOCAD in general; field implementation of adaptation practices in specific pilot areas and the IAIL3 implementation program; and dissemination and awareness-raising activities.

[21] The full wording of this objective was: "to Enhance adaptation to climate change in agricultural practices and irrigation water management through awareness raising, institutional and capacity strengthening and demonstration activities in the project area and to assist in mainstreaming climate change adaptation measures, techniques and activities into the Comprehensive Agriculture Development Program of the recipient."

2.72 The project sponsored, with only a modest budget, a range of scientific analyses to support adaptation planning. These were important in building capacity of Chinese scientists and economists to address climate change issues in a rigorous fashion, and contributed to a stronger empirical and theoretical basis for future work. The work included sophisticated integration of climate, hydrology, water allocation, and economic models; altogether 27 studies were undertaken. Several project-sponsored papers have been published in international journals, and many in Chinese journals. And perhaps the most influential outreach medium towards mainstreaming climate change adaptation was a sizeable group of media modules ranging from webpages, booklets, and radio and TV coverage. 331 of such modules were applied, slightly above the appraisal target of 326 (the target was not revised).

2.73 Due to inherent limitations on climate forecasting (see Section 4), the climate analyses reach useful but rather generic conclusions:

- temperatures will definitely rise;
- precipitation will probably rise, but will become more variable, with more droughts and floods, and less synchrony with traditional planting schedules;
- higher temperature will lead to more demand for water by crops (higher evapotranspiration), exacerbated by increasing nonagricultural demand, leading to water scarcity;
- rain fed areas will be hardest hit;
- market effects will tend to reduce the economic impact of climate change, as farmers and international trade react to changing prices; and
- overall impacts on yields may be modest, but there are many 'wild cards' such as the impacts of pests, floods and droughts.

2.74 Some of the main implications of these studies are fully consistent with the original goals and design of IAIL3. Most important is the focus on irrigation efficiency and real water savings. IAIL3's emphasis on farmer organizations is also consistent with the need for farmers to identify locally relevant adaptive actions.

2.75 SOCAD points to the following as areas where MCCA insights resulted in course corrections or increased emphasis during IAIL3 implementation: rainwater harvesting, low-pressure pipelines, land-leveling, selection of crop varieties that are resilient to drought, waterlogging, pests and temperature; pest-monitoring; greater use of pumps to provide water to marginal irrigated areas, collection ponds for water storage at the ends of irrigation networks; rainwater harvesting, retention of straw, mulching and using dung for reduced evaporation and improved soil fertility, drainage, and pest-monitoring. There was increased emphasis on greenhouses. Bio digesters were introduced, though in some project areas it is still too cold for them to function in the winter.

2.76 The sub-objective to enhance climate change adaptation awareness and capacity was primarily through training and demonstrations for farmers. This was also a base, together with learning by doing and association with specialists, for building capacity of project field staff. Another channel was through pamphlets and other literature. This was on a large scale – some 170 different publications for various audiences – farmers, the general public and academics - were issued with coordination or funding through

IAIL3/MCCA. By the end of the project, 57 percent of project farmers were aware of climate change; 35,000 ha of climate change adaptation demonstrations measures had been established; and the climate change concept had become a standard feature in IAIL3's irrigation modernization program. All of the actions above exceeded project targets at appraisal, which were not revised (Table 2.6).

2.77 For the second sub-objective, mainstreaming, activities included: development of long-term agricultural climate change scenarios; holding consultations and meetings on climate change adaptation; mounting of an awareness campaign; training for scientists and technicians; a comprehensive media campaign including radio, television, newspapers, and a web site; and use of advisory booklets and other documents. Also, MCCA's attachment to IAIL3 enabled a substantial influence on the IAIL3 program as a whole. By the end of IAIL3, adaptation measures were being applied on 173,000 hectares (112% of the MCCA target at appraisal) – about 44 percent of the project's total irrigated area of 393,000 hectares.

2.78 A quantitative assessment of MCCA's impacts on farmers' productivity and welfare, in particular in mitigating extreme events such as droughts and floods, would be difficult to interpret as IAIL3/MCCA was a fully integrated blended program, and reliable statistics on extreme events would require a long time-series. Some inferences can, nevertheless be drawn from several observations. First, farmers were found enthusiastic to take up the adaptation measures –hence the rapid adoption of climate change adaptation noted above. Second, IEG found a virtually uniform view amongst all field staff and managers of the POCADs and COCAD's that integrating MCCA-type actions was beneficial.[22] Most of the adaptation measures, as well as providing greater crop security, are generally recognized by agriculturalists as having potential to increase yields. Third, as indicated below, national decision makers, witnessing what IAIL3/MCCA was achieving, have shown strong interest in further expansion of the program. To provide guidance, SOCAD, and the project POCADs issued in 2012 a "Circulations to Strengthen Climate Change Adaptation in CAD." Finally, over 30 consultation meetings have been held for Government leaders and officials, another mainstreaming activity for the climate change adaptation agenda.

2.79 Thus, an impactful start towards adapting agriculture to climate change was made. Climate change adaptation measures became embedded in the IAIL3 program as an integral part of its development approach. And the IAIL3/MCCA climate adaptation approach was subsequently integrated by SOCAD into China's national Comprehensive

[22] In Huaiyuan County in Anhui Province, IEG was advised of the following climate adaptations. From October 2008 to February 2009 there was a severe (1 in 50 years) drought. Crops in non-project irrigated areas did not survive. In the IAIL3/MCCA irrigated areas, the wheat crop survived. COCAD staff advised of the following MCCA actions. The likely most influential action was the adaptation of the irrigation system to include water retention ponds, increased canal lining and other measures. Another was to introduce new more heat resistant seed, which was also less susceptibility to wind induced lodging. Other agronomic measures had also been promoted by COCAD.

Agriculture Development program, hence providing the prospect of impact on a far larger scale than the IAIL3/MCCA program alone.

Summary

2.80 GEF's MCCA Project, and in particular, the blended IAIL3/MCCA program, leveraged a much larger climate adaptation program than if the MCCA project had been stand-alone. All implementation targets were met or exceeded. Farmers and Government alike are committed to adapting agriculture to climate change and are taking the program forward. The Efficacy of Enhancing adaptation to climate change in agriculture and irrigation water management, and mainstreaming such activities into the national Comprehensive Agriculture Development program was High.

Efficiency

2.81 As concerns IAIL3/MCCA's implementation and costs there was little that could have been improved: the project was implemented as scheduled and without extensions; there were no changes to the project objectives, and no significant changes in the components; both the Bank Loan and GEF Grant were fully disbursed; and actual project costs ($463.5 million) were very close to the appraisal estimate of $463.2 million. With the exception of part of the domestic training and study tours program, the result of a general reduction in training imposed by Government in response to the financial crisis, all physical targets were achieved or exceeded; and for some programs, achievements were considerably above targets. Thus, 1022 WUAs were established compared with a target of 494 WUAs. And 155,000 hectares of land was graded compared with the 667 hectare pilot exercise originally intended.

2.82 The combined IAIL3/MCCA project's Economic Rate of Return estimated in the ICR was 25.3 percent, marginally higher than the PAD estimates. The ICR did not report sensitivity analyses to assumptions. However, the without-project scenario, against which benefits are computed, is based on assumptions that are open to question. The economic analysis represents without-project farming to be loss-making (uneconomic), suggesting that market forces or policy changes would have propelled it to greater profitability over time. And indeed there is dynamism as rising rural wages impel mechanization. If we assume (arbitrarily, as an example) that, without the project, farms would break even from year 6, the ERR drops to 17.8 percent.

2.83 On the other hand, the economic analysis does not attach value to the project's environmental benefits. Its reductions in pesticide application would have health benefits, and reductions in fertilizer would reduce harmful eutrophication of freshwater bodies. Information is lacking to quantify these benefits. The ERR is also conservative in disregarding possible spillover effects to neighboring areas from technology demonstrations. Net reductions in water use have a clear economic benefit, given water scarcity and the costs of unsustainable groundwater extraction. If the reported groundwater savings in Hebei of 446 million m^3 is assumed to carry forward annually, and is valued at the urban household tariff of 5 yuan/m^3 (an underestimate of the shadow price of water), it would dwarf the net benefits from farm production and lead to an

astronomical rate of return. As noted earlier, though, it is hard to make a definitive estimate of the net project impacts on water consumption.

2.84 Because IAIL3/MCCA were unified, their efficiency is assessed jointly. The costs and benefits of counterpart contributions to the MCCA are included in the ERR calculation. However, the $5 million in expenditure supported by the GEF grant are not. Those funds went to studies, training, awareness raising, and demonstration plots that influenced IAIL3 activities, but also may have had nationwide, hard-to-quantify impacts on agriculture, policy, and capacity. These costs were small relative to overall IAIL3/MCCA costs, so their exclusion biases the ERR by only about 0.2% at most. While it would be of interest to assess the efficiency associated with the marginal impact of MCCA on IAIL3, data does not permit this. Nor is it possible to calculate the benefits associated with outside-the-project awareness impacts of MCCA. Diffusion effects into neighboring counties or provinces would boost the overall IAIL3/MCCA ERR.

2.85 Taking these positive and negative biases into account, it is likely that the project's returns are well above the 12% social discount rate applied by SOCAD in the analysis, indicating an efficient use of funds.

2.86 Taking account of the project's economic viability; its efficient implementation; the timely achievement of targets within costs; and the integration of the IAIL3 approach within the national agricultural development program, adding considerably to the longer term economic value of the project; the Efficiency of IAIL3/MCCA is rated High.

OUTCOME

2.87 IAIL3's objectives were highly relevant to China's need to increase agricultural productivity in the face of its limited water and land resources which were confronting an expanding demand for foodstuffs and for a more diversified agricultural output. The project could also contribute to improving rural incomes, and the thrust on productivity needed to be environmentally sustainable. The project's design was also highly relevant, distinguished by a sharp, practical focus on attaining the objectives. The addition of the climate change operation enhanced the relevance of the project to China's increasing concerns with extreme weather events, and its design was responsive to that need.

2.88 The efficacy of three of IAIL3/MCCA's four objectives was high. As concerns the first objective, efficacy was high. Agricultural yields (quantity/hectare) increased by about 22 to 35 percent, which, taking account also of an improved cropping intensity results in an increase in agricultural productivity of about 24 to 39 percent. Areas under high value crops also increased and are likely to take an increasing share of agricultural value added. Water productivity increased by even more than the productivity of land. Starting with a yield of 1.06 kg cereal equivalent per m^3 of water, water productivity became 1.55 kg/m3 of water – a 55 percent increase. What may have happened with non-project (control) farmers is not known precisely, but, for instance, without the modernization of the irrigation systems (which were also specifically designed as "water saving" schemes), water productivity would not be expected to improve. And average

yield increases for project farmers during the project period were much above their provinces' average grain yield increases of 9 percent (Table 2.8).[23]

2.89 Farmer incomes also increased (the second objective), and the efficacy of this objective was also high Adjusting for inflation, real incomes increased by an average across provinces of 50 percent, with larger increases for poorer farmers. And through the farmer association pilots, a model for agricultural diversification to higher value crops and modernized marketing was established.

2.90 There was substantial effort related to the third objective to promote sustainable water and agro-ecological environmental management. Some actions – such as the entire "water saving" irrigation modernization program, land leveling, and shelter belt trees – were at large scale. However, systematic evidence regarding the results of the program is limited, and the objective's efficacy is rated substantial. Finally, concerning the fourth objective – climate change adaptation – efficacy was high. The adaptation program was carried out as planned, and comments from farmers, and the involved Ministries, POCADs and COCADs, indicate a general view that the adaptation measures have provided greater protection from droughts and other events, and have also helped increase yields. EG field visits found that farmers were enthusiastic to adopt the adaptation measures.

2.91 IAIL3's Efficiency was High. Operationally, the project implemented the full intended project program within appraisal estimated costs, met or exceeded implementation targets, and was completed as scheduled without any extensions. While the ERR is difficult to compute, it is well above any reasonable discount rate.

2.92 A more complete consideration of IAIL3/MCCA's value is the influence of the project on China's agricultural development as a whole. This is major. Central Government has taken the IAIL3/MCCA program as a model and is integrating the approach into the irrigated agriculture part of the National Comprehensive Agricultural Development Program which covers all of China's Provinces and which in 2014 received a budget of about 36 billion Yuan (about $6 billion).

2.93 Given that the ratings for relevance and efficiency are high, and three out of four objectives were rated high on efficacy (and the fourth substantial), IAIL3/MCCA's overall Outcome is rated Highly Satisfactory, and the more so given the project's further influence on China's overall agriculture development program.

RISK TO DEVELOPMENT OUTCOME

2.94 Now mainstreamed into China's Comprehensive Agriculture Development, the IAIL3/MCCA program is unlikely to be abandoned. As a central part of Government's agricultural development strategy and budget, and strongly prioritized by policy makers, insufficient ownership is not an issue. Institutionally, the project found an effective way of operating within the Government system and of harnessing the capabilities of the line

[23] Yield growth in the Provinces will have some bias upwards, as the project areas are included in Province-wide averages.

agencies, both centrally and at provincial and county levels. If this continues, and the arrangements have every chance to do so if Government commitment is maintained, sufficient executive capacity to handle the field development activities would be maintained. At the behavioral level, farmers have found ways to boost income and are likely to continue these behaviors. At the physical level, interventions such as land leveling will be enduring. So Risk to Development Outcome is rated Negligible to Low.

BANK PERFORMANCE

Quality at Entry

2.95 The Bank was strategically well focused in recognizing and addressing the critical need to increase the productivity of rural water for greater agricultural output, water saving and higher farmer incomes. The project was innovative in a number of ways, amongst them, promoting the concept of "water savings" rather than irrigation efficiency alone, a new emphasis on diversification to higher value products, new grassroots farmer institutions, and significant integration of Chinese academics to enhance Government expertise. A senior government official described the Bank's most significant role as bringing in "new concepts and specialists."

2.96 Preparation was practical, and the institutional structure of the project enabled timely implementation. The Task Team worked to make the project ready for immediate implementation after signature[24]. The team was not short of ingenuity. Faced with a limited operational budget, it drew on the cooperation established between the Bank and DFID (UK) through the Pro-poor Rural Water Reform Project. The arrangements were informal but enabled DFID financing of specialist consultants for IAIL3 beyond what would have been possible using only the Bank's budget. This proved important to the technical strength of preparation, and ultimately of project implementation. There was a close collegial partnership between the Bank and Borrower throughout the preparation process. Quality at Entry is rated Highly Satisfactory.

Supervision

2.97 The Task Team maintained a close partnership with Government and the implementing agencies, and tackled bottlenecks practically. The team was an effective resolver of implementation issues, enabling an ambitious project to be implemented on schedule and with practically all targets achieved. Two strengths particularly stand out. First, as during project preparation, the team maintained a good balance between implementers and technical specialists, in part through the informal arrangement with DfID noted above.[25] Without proactively searching for outside resources there would have been minimal scope to afford such expertise.[26] Second, the Bank was outstanding in

[24] The flip side of the quality and innovation achieved during project preparation is that preparation to approval took about 2 ½ years, which SOCAD feels was too long.

[25] Between FY06 and FY11 the average Bank budget provided for supervision was $61,000/annum.

[26] For instance, technical specialists were hired for WUAs, water saving techniques, farmer associations, green crops, gender, climate change, and other skill areas.

the design, blending and supervision of the added MCCA GEF Grant. It required initiative and acceptance of the possibility of failure to add a sub-project to IAIL3 when IAIL3's closure was only 2 ½ years away, and an agricultural climate change agenda had hardly been tried in China. But strong performance in design and supervision of MCCA, coupled with similarly strong performance by Government and the project implementing agencies, made this innovation succeed. The Bank's Supervision Performance was Highly Satisfactory.

2.98 Overall Bank Performance: Highly Satisfactory.

BORROWER PERFORMANCE

Government

2.99 Government ownership and commitment for IAIL3 was strong from the start. By IAIL3's Board approval, core leadership staff in SOCAD and other agencies had already been appointed and necessary implementation measures had been established. This enabled the project to get off to a fast start. Provision of counterpart funds was consistently timely and to the amounts required. The decision to have SOCAD under the Ministry of Finance was a considerable help in providing coordination, in a back-up role, of the different technical institutions involved – the Ministries of Water Resources, Agriculture, Environment, and other agencies[27]. Facilitated by this arrangement, SOCAD and these institutions were able to quickly resolve implementation constraints. Finally, Government, providing that key persons were kept informed, was near ideal in its overview support for the project's innovations. Thus, a full package of facilitating institutional arrangements, ready intervention to solve interagency issues, financial support, and willingness to experiment was provided. Government's Performance was Highly Satisfactory.

Implementing Agencies

2.100 The most noteworthy performance was that of SOCAD itself, and more specifically, SOCAD's Central Project Management Office and its regionally based staff – the POCADs and COCADs. They had to cover five project provinces and 107 counties, plus the additional five participating provinces and 16 counties where the project's WUA program was extended. Other key implementers were the provincial and county Bureaus of the Ministries of Water Resources, Agriculture, Environment and Forestry, plus other Bureaus as needed. Academics were significant partners and were particularly valuable in innovatory areas. This extensive administrative structure might seem unwieldy, but it had the merit, especially considering the subsequent scale-up to a national program, of operating, except for SOCAD itself, within the existing Government structure and agencies. In the event, the management system worked, despite the number of agencies

[27] The unusual arrangement whereby SOCAD and the Comprehensive program are housed under the Ministry of Finance has been a significant facilitator between ministries. On several occasions government staff commented to IEG their view that the arrangements had been a key factor enabling efficient project implementation and should stay.

and offices involved. In general, the technical bureaus did a good job – each agency's responsibilities were carried out. But SOCAD's (including provincial and county staff) performance was outstanding. The Performance of the Implementing Agencies was Highly Satisfactory.

2.101 Considering both the performance of Government and the implementing agencies, the Overall Performance of the Borrower was Highly Satisfactory.

3. Hai Basin Integrated Water and Environment Management Project

Objectives, Design, and Relevance

Project Objectives

3.1 The Objectives of the Hai Basin Integrated Water and Environment Management Project (HBP), as defined in the Global Environment Facility Trust Fund Grant Agreement, were:

To assist the recipient in reducing pollution in the Bohai Sea by developing an integrated approach to water resource management and pollution control in the Hai Basin.

(The objectives described in the PAD are broadly consistent with these objectives, although water and pollution management are more prominent.)[28]

3.2 The Project Objectives (Grant Agreement) can be considered as comprising two sub-objectives: (i) developing an integrated approach to water resource management and pollution control in the Hai Basin; and (ii) reducing pollution in the Bohai Sea. These sub-objectives will be used for evaluation purposes in this review, in particular in the Efficacy section.

Relevance of Objectives

3.3 Water is acutely scarce in northern China, and made more so by the high pollution of both land and off-shore water resources. As indicated in Chapter 1, the Nation's annual 305 m^3/person of water is only 14 percent of the world average, and in the Hai Basin, the project's location, water scarcity is even more acute. Pollution is also a major problem

[28] In accordance with standard IEG practices, HBP's objectives as defined in the legal document are taken as the project objectives and the base for evaluating the project. The PAD gives a slightly different emphasis. According to the PAD's Logical Framework (page 35) - the project would: "Improve integrated water and environmental management in terms of water quantity and water quality in the Hai Basin and reduce land-based sources of pollution to the coastal and marine environment of the Bohai Sea."

affecting most waterways, and is particularly high in China's Northern Plains where most of the Hai Basin is situated. Some 68 percent of the total river length in the North China Plains is classified as "polluted" (unsuitable as raw water sources for drinking), and for the Hai River, 80 percent of river length is polluted.

3.4 This situation is made more critical by the Hai Basin's crucial role in China's development. In 2005, the Hai Basin accounted for 10% of China's population, 12% of its grain production, and 15% of its GDP.

3.5 Much of China's coastal and off-shore waters are also under pressure due to land-based pollution. The Bohai Sea – a shallow, mostly enclosed body of water fed by some 40 rivers of which the Hai and Huang (Yellow) rivers are amongst the larger rivers - is one of the most affected. Discharge of wastewater and pollutants into the Bohai Sea may be as high as one third, and a half, respectively, of China's total pollutant discharge. This has put pressure on fish species and fish stock, as well as the livelihoods of fishermen, and has particular significance because of the Bohai Sea's role as a seasonal spawning and nursery ground for fish which then migrate to the Yellow Sea, and to Korean and Japanese waters. The interlinked problems of water scarcity and pollution of water, both inland and coastal, are critical issues confronting China, and are appropriately categorized as relating to international waters under the Global Environmental Facility's financing criteria.

3.6 At the time when the HBP was being prepared, and even in many respects today, the conceptual and technical skills, and the institutional base for better water resources and pollution management, were severely underdeveloped. Water was used rather than managed; there was little knowledge and use of modern water savings technology; water resources and pollution issues were handled by separate institutions; and water planning was limited, seldom multi-sectorial, and top down rather than also including local governments and other stakeholders.

3.7 These issues have not gone unheeded. Water and pollution issues have become more prominent in China's Five Year Plans, and, the Nation's strategy documents have increasingly reflected this. China's 11th Five Year Plan (2006-2010) aimed to achieve higher water savings; to significantly increase water use efficiency, especially for irrigation; to improve monitoring of water use and pollution; to strengthen pollution regulations; and to reduce water pollution, especially of major rivers. A Bank study, "Agenda for Water Sector Strategy for North China" (2001), highlighted the developing problems of water scarcity and pollution. Improving the management of water resources and the environment has been featured in the last several Country Assistance Strategies. Thus, the China Country Partnership Strategy for 2006-2010 (May 23, 2006) - the Strategy current for most of the project period - cites water availability and quality as critical issues under its Pillar Three: "Managing Resource Scarcity and Environmental Challenges." The Strategy notes the increasing difficulty meeting the growing demand for water, and mounting problems with water pollution. It includes recommendations to reduce water use, especially of agriculture, including more productive irrigation and less water using crops; better regulation of industrial water; and expanding waste water treatment for urban areas.

3.8 The current Country Partnership Strategy for China (issued in October 2012) further sharpens understanding of key issues in the water sector. It emphasizes the need to tackle the issues of water scarcity, overexploitation, and water pollution; and calls for implementing integrated water resources management at the river basin level; and addressing multiple uses including: water scarcity, flooding, pollution, water demands, economic instruments and institutional aspects. Thus, from all angles – water quantity and quality, pollution of the Bohai Sea, and the strategies of both Government and the Bank, the Relevance of HBP's Objectives was High.

Project Design

3.9 Box 3.2 shows the HBP's components and costs. The project focused on studies, pilots, and consultants rather than physical infrastructure. Its core was the first component – Integrated Water and Environment Management - which incorporated the central concept in the project's objectives of the inclusion and integration of both the quantity of water resources and the quality of water and the water environment. This was to be implemented through county and province level Integrated Water and Environment Management Plans (IWEMPs). The component also included strategic studies and pilot demonstrations to prepare for future policy and technical initiatives in integrated water and environment management planning.

3.10 Three key innovations were to be piloted under the project's second component, Knowledge Management. First, the component supported the development and application of models used to construct the IWEMPs. A sophisticated "Dualistic Model" combined hydrological and socioeconomic components and was to be applied at the basin level. SWAT (Soil and Water Assessment Tool), a public-domain software package, was adapted to model water flows, evapotranspiration (ET), erosion, and nonpoint source pollution at the county level. Second, a Remote Sensing ET Management System was to be developed to measure ET – actual consumptive water use – at the county and basin level. (Box 3.1). These measurements were to be used for target setting and for allocation and management of water. Third, the component developed hardware and software for sharing data with planners; notably including, for the first time, data sharing between the Ministry of Water Resources (MWR) and the Ministry of Environment Protection (MEP).

Box 3.1. Measuring Evapotranspiration (ET)

In order to operationalize management of the consumptive use of water (ET), it is useful to measure it. This would allow water managers to determine whether a field, county, or province is staying within its water budget, and whether groundwater was being drawn down over the region. It would also allow identification of 'hotspots' of high ET that could be targeted for diagnosis and attention.

Traditional methods of ET measurement have limitations for these purposes. Direct field-based measurement of ET applies only to individual plots, and requires expensive equipment. ET can be derived for large areas using the water balance equation:

ET = Precipitation –runoff – change in groundwater storage

However, direct measurement of each of these quantities is subject to error, and the number of required gauges becomes unmanageable in order to cover small areas such as counties or villages. Moreover, groundwater pumping may be underreported.

Satellite-based remote sensing offers the promise of continuous, detailed monitoring of ET. The principle is simple in concept. Satellite sensors can measure how much energy a plot of land receives from the sun, and what part of that energy goes to heat up the air and ground. The residual energy was absorbed by evaporating and transpiring water. There's a fixed relationship between the amount of water evaporated and the energy taken up. So measurements of energy flux can be used to compute ET.

In practice it is much more complicated. Measurements have to be corrected for haze and dust in the atmosphere, and wind complicates the energy balance calculation. Some satellites have high resolution – they can see fields as small as 30 meters x 30 meters – but low frequency – they return to the same field about every two weeks, and may encounter cloud cover. Other satellites offer daily observations, but at a coarser resolution. These information sources need to be fused. Calculations have to be validated against field-based instruments.

Source: IEG.

3.11 The third component was to pilot, through studies and seed funding, the construction of wastewater plants for two of the cities adjoining the Bohai Sea, and studies for clean-up of Dagu canal, Tianjin city's main waste water drain. Both the canal and the cities had been identified as major pollutants. The final component was for consultants, training, M&E and management.

Box 3.2. HBP Components and Costs

Integrated Water and Environment Management (Appraisal cost US$13.9 million; actual cost US$14.8 million)

Comprising: (i) 8 Strategic Studies covering: institutional, political and legal aspects of water resources management; environmental needs; and management of water quantity and pollution; (ii) Integrated Water and Environment Management Planning: Preparation of Integrated Water and Environment Management Plans at county and provincial levels, and a sub-basin Strategic Action Plan for Zhangweinan sub-basin. Each IWEMP would be prepared over about a two year period, with implementation beginning during the project period. IWEMPs would be multi-sectoral, and concerned with all water resources, uses of water and pollution; and (iii) Demonstration Projects to pilot activities that might be relevant for the IWEMPs in areas such as: control of wastewater discharge, pollution control and environmental improvement; use of evapotranspiration monitoring and remote sensing to improve water allocation and saving; and effective management of water rights and well permits.

2. **Knowledge Management** (Appraisal cost US$5.8 million; actual cost US$6.3 million) Comprising: (i) Knowledge Management by developing the software and communication network to collect, keep, track, provide and analyze data covering the whole Hai Basin as well as counties and provinces. Data collected would progressively be used in a decision support role and planning covering water use, pollution discharges, reservoir management, groundwater, multi-sector allocation and the water environment. Developing and using knowledge management would be a facilitating process for increased collaboration between the Ministries of Water Resources and Environmental Protection (which would jointly manage the Knowledge Management system), between counties and other counties and provinces, and for the basin as a whole; and (ii) Piloting a Remote Sensing Evapotranspiration (ET) Management System. Improving conservation of water through use of evapotranspiration measurement and monitoring by remote sensing, and adjustments in water delivery to achieve a better water balance and more rational allocation. ET measurement would be accompanied by improved water delivery efficiency, administration of water rights and well permits, and administration such as through water user associations.

3. **Tianjin Coastal Wastewater Management** (Appraisal cost US$4.1 million; actual cost US$4.5 million)

Comprising: (i) Studies to improve waste-water management for small cities. Two cities were to be chosen. The project also provided financial incentives for initial operations of the cities' waste-water treatment plants; and (ii) technical assistance and studies for the clean-up of Dagu canal – Tianjin's main waste-water canal which had become severely silted and contaminated.[29]

4. **Project Management, Monitoring and Evaluation, and Training Management** (Appraisal cost US$8.6 million; actual cost US$9.0 million)

Comprising: consultancy services, "expert groups' supporting all Project Management Offices, training and study tours, and management information.

Financing: Financing was by Government and GEF in the following amounts: Government - planned (at appraisal) allocation $16.32 million; actual contribution $17.58 million); and GEF Planned allocation $17.00 million and actual allocation $16.96 million.

Source: PAD and ICR.

[29] For both sub-components, the Hai Basin project's role was provision of technical assistance. The works were implemented under another Bank project the Tianjin Urban Development and Environment II Project.

Relevance of Design

3.12 The HBP's logical framework (Annex 1 of the PAD) presents a clear linkage between the project components and institutional structure and the project Objectives. Design responded well to all four aspects of the objectives: (i) developing an integrated approach to water resources management and pollution control; (ii) better conservation and use of water: (iii) better management and control of water pollution, and (iv) reduced pollution into the water systems and the Bohai Sea.

3.13 Integrated water resources management was at the heart of project design. This addressed the fundamental need to integrate management of both water quality and quantity in order to meet environmental, social and economic goals. Reducing unsustainable water use and harmful pollution required comprehensive planning and management across sectors, and between provinces and counties. And in order to reduce the environmental impact of pollution, it was necessary not only to reduce the pollution load (in tons), but also to decrease its concentration. That is, more water is needed to dilute the pollutants down to acceptable levels. Higher flows are also needed to support freshwater biodiversity and to counteract the increasing salinity of the Bohai Sea. On the other hand, it was recognized that greater flows in the Hai Basin Rivers – which are now often seasonally dry -- could have the perverse effect of delivering more pollutants to the Sea. So close coordination is needed between pollution management and flow management.

3.14 The design understood that achieving integrated water-environment management would require significant conceptual, technical and institutional innovation. On the conceptual side, the project design recognized the need to restrict water demand to sustainable levels, through attention to agriculture, the largest water using sector. It introduced a revolutionary paradigm shift away from traditional views of irrigation efficiency. The project focused instead on the need to put a hard cap on the consumptive use of water (ET), and within that cap to shift from non-beneficial to beneficial uses. On the technical side, this meant that the project needed to develop a tool for tracking and managing ET. In addition, optimizing the complex interplay of quality and quantity required spatially explicit computer models that could trace flows of water and pollutants including nonpoint source pollution from agriculture.

3.15 The PAD frankly described the strong institutional barriers to integrated water management. First, there was no coordination in regulations or enforcement between MWR and the State Environmental Protection Administration (later promoted to Ministry level, becoming the MEP) and other vertical ministries affecting water use and pollution. The lack of coordination between the MWR and MEP was particularly problematic, because they did not share monitoring data and their regulations were sometimes inconsistent. Second, there was little or no coordination across county or province boundaries between upstream and downstream water users. Consequently there are cases of interprovincial disputes about water. Third, the Hai Basin Commission and other river basin commissions engaged in planning have little actual authority and do not bring stakeholders together.

3.16 These institutional barriers are deeply rooted in Chinese law and government structure, so that comprehensively addressing them would be far beyond the scope of a modest GEF grant. The project adopted a pragmatic approach to these issues that focused on piloting better coordination through the creation and implementation of IWEMPs. It proposed to create coordinating mechanisms at the county and basin level, linking the MEP, MWR and other agencies; to incorporate 'bottom-up' and cross-sectorial consultation in the creation of IWEMPs, and to improve the policy framework for controlling groundwater over-extraction. So there would be direct effects through implementation, and demonstration that could lead to replication outside the project and to policy reform.

3.17 Eight "Strategic Studies" were included in the project, and in broad terms were of two kinds. First, the more strategic and policy related studies such as the policy, legal and institutional framework, and water rights and sustainable groundwater exploitation. Second, on specific issues such as wastewater reuse, and Bohai Sea-river linkages

3.18 In addition, there were engineering studies and technical assistance related to two investments that could be expected to reduce pollution into the Bohai Sea (refer Efficacy Section): (i) removal of silt from the Dagu canal, Tianjin city's main conduit of pollution; and (ii) design and operation of two wastewater plants to pilot wastewater management plants, sorely lacking in coastal areas. Both studies underpinned successful investments financed under the Second Tianjin Urban Development and Environment Project (World Bank FY03)

3.19 While the project would be expected to directly and significantly improve water management in the project counties, its immediate direct effect on the Bohai Sea is limited, because the Hai River and its tributaries account for only a small fraction of Bohai's pollution; most comes from the Yellow and Liao Rivers. Greater impact would come over time from replication of this small ($34 million) project's technical and institutional innovations.

3.20 In summary, HBP's design was well aligned to achieving its objectives. Its strikingly innovative conceptual, technical, and institutional interventions dovetailed well with each other and were adapted pragmatically to the existing institutional structures in China. *A priori* this was a risky project given its innovativeness, ambition, and lack of funding for infrastructure. However, these risks were mitigated by a phased structure of implementation and by the practical institutional structure and implementation processes chosen. Nevertheless, the minor degree to which the project could influence pollution load to the Bohai Sea could have been better elaborated at project design stage. However, in other respects design was strong and well aligned to the project's objectives. HBP's Relevance of Design was Substantial.

Implementation

3.21 HBP was approved on April 15, 2004 with intended project closure on June 30, 2010.[30] Actual closure was one year later – on June 30, 2011. There were two project extensions of six months each. The first extension was made after the December 2007 Mid-Term Review. According to the MWR and MEP, progress was delayed by staff unfamiliarity with concepts and technologies. This was a difficulty throughout the first several years of the project. A second extension of six months was made to: (i) put in place incentives for operations and maintenance of the wastewater treatment plant financed under the Tianjin Urban Development and Environment II Project, for which construction had been delayed; and (ii) to provide more time for consolidating actions to better assure the project's sustainability, and to hold workshops to consider extending the project approach beyond the HBP area.

3.22 There were no project restructurings or additional financing. Total project costs at completion ($34.5 million) were close to the appraisal estimate of $33.3 million. The $17.0 million GEF Grant was virtually fully used, with disbursements of $16.96 million. Government financed the increase in project costs.

3.23 There were no revisions in targets in the monitorable indicators. Output targets were met or exceeded. The project components remained virtually unchanged, although the scope of some components was expanded, notably: (i) the knowledge management system was extended to cover Tianjin and Beijing Municipalities; (ii) six additional County Integrated Water and Environment Management Plans were carried out compared with 10 targeted; (iii) the WUA program achieved 407 WUAs against a targeted 65 WUAs.; and (iv) a study on non-point source pollution was added. While these increases substantially expanded the project's achievements, they did not change the project's basic design.

3.24 The project was implemented jointly by the Ministry of Water Resources (MWR) and the Ministry of Environment Protection (MEP). This joint-responsibility extended through the entire implementation chain: from the center, to the provinces, to the counties, and, where relevant, to sub-entities such as the waste-water plants and water user associations. Academics were significantly involved and the impact of their specialist expertise was enhanced by informally integrating them into project work programs. The project also made major recourse to international consultants in areas where domestic experience was limited.

3.25 Other actors included the Ministry of Agriculture, Ministry of Construction, Ministry of Finance, and provincial and county governments. The Hai Basin Commission was made responsible for the basin-wide Knowledge Management System. The primary project coordinating role was through the Project Management Offices. There was a Joint Project Management Office (PMO) at the center, supported by a "Joint Expert Group" of specialists. Joint PMOs and Joint Expert Groups were also established in each province

[30] It was implemented in parallel with two other Bank financed projects which had some activities complementing the Hai Basin Project: The Tianjin Urban Development and Environment II Project, and the Water Conservation Project.

sub-basin or extended municipality, and in each of the 16 counties. The local staff of the Bureaus of water resources and environmental protection, plus other relevant agencies, joined the PMOs in implementing the project. Technical assistance and training was a major thrust under the project. Consultant services were projected at appraisal to be 42 percent of total project costs,[31] and by project completion 164 training sessions and 57 study tours had been conducted.

Safeguards, Fiduciary Performance and M&E

Safeguards

3.26 The HBP was classified an Environmental Category C project (no environmental assessment required). As a project targeted on improving the water environment, without any intended major infrastructure, and with works confined to small structures such as measuring stations; deleterious environmental impact could be expected to be minimal. (The Dagu canal and the wastewater treatment plants, funded under the TUDEP 2 project had individual environmental assessments and management plans). Nevertheless, to provide for any eventuality, two safeguards were considered triggered at appraisal: Environmental Assessment (OP 4.01); and Involuntary Resettlement (OP 4.12). An Environmental Impact Assessment, an Environmental Management Plan and a Resettlement Policy Framework were prepared for the HBP (all issued in January 2004), and a screening process was put in place. These frameworks and screening processes followed Bank guidelines at the time of appraisal. More recently (January 2014) a policy change regarding indirect effects of technical assistance (such as investments stemming from IWEMPs) has been issued.[32] The guidelines are not relevant to HBP as it was appraised before they were issued. However, for the benefit of future, similar, projects the IWEMPs provide an interesting example of the potential for technical assistance to have indirect social impacts. It may be useful to review the ways in which unforeseen indirect effects of technical assistance would be relevant in future projects.[33]

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[31] A cost breakdown at completion is not included in the ICR, but as project components did not significantly change during implementation, the actual consultancy costs would likely be in the same range as the appraisal estimate.

[32] "Interim Guidelines on the Application of Safeguard Policies to Technical Assistance (TA) Activities in Bank-Financed Projects and Trust Funds Administered by the Bank" (Jan 2014). The guidelines specifically refer to 'water resources management/planning studies," "river basin management studies," and "agricultural and rural development planning" as examples.

[33] As an example of such impacts, the Tianjin IWEMP identified a pollution threat to the city's main reservoir and it was decided to relocate 30,000 people in order to reduce domestic and farm runoff. Under the new Guidelines, the welfare of the displaced persons would need to be part of the planning exercise.

Fiduciary Management

3.27 According to the ICR, financial management was of good quality and reporting was regular and timely, and reviewed by Bank staff. Annual auditing was also timely and no substantive fiduciary issues had arisen. The financial and procurement staff of the project received training at the beginning of the project which had provided a good grounding in Bank processes, although it took time for project staff to master procurement, which was initially slow. The financial manager of the former central PMO advised IEG that the project had had no problems with disbursement processes. A real-time management information system tracked procurement and (once staff were familiar with the procurement and tracking system), resulted in efficient and rapid procurement processes, despite the large number (23 in all) of province and county PMOs involved with the project. No cases of misprocurement were reported.

Monitoring and Evaluation

3.28 Design. The activities and outcomes to be monitored were established at the beginning of the HBP, and included the project's Monitorable Indicators. There was a large number of indicators – 12 on outcomes and 17 on outputs. Some covered critical quantitative measures of water quality and quantity impacts, while others were check-offs of institutional or organizational achievements. Given the technical sophistication of the Knowledge Management system, it would have been useful to combine data on ET and groundwater overdraft with statistics on agricultural cropping and production, so as to assess the impacts of tightening water allocations. Monitoring was restricted to the 16 project counties. Each county, prior to commencing its project activities, undertook a baseline survey to serve as the platform for measuring future impacts.

3.29 Implementation. Each province, county and major city had its own M&E team. For coordination, supervision and compilation of overall project data, an M&E unit was established in the Central Project Management Office. Most data was collected first by the county teams, passed on to the provincial teams, and then passed on to the central unit which compiled the data. A report was prepared every year with consolidated results. An issue, however, reviewed under efficacy, was the Government clearances and time required to access some of the data.

3.30 Utilization. Information on project activities was a useful management tool for assessing project progress, both in terms of outputs and outcomes. The M&E work also interacted with a number of project activities, notably: for the Knowledge Management data base, which used part of the M&E data for its data platform and modeling work; and for (ii) data relevant to preparing each county's and province's Integrated Water and Environment Management Plan.[34] In conclusion, the project's M&E system was

[34] Since project closure, the project's Central Project Management Office has been disbanded, disrupting the M&E program. However, a number of functions are continuing under different institutions. Project data for Tianjin City is continuing in the city's Environment Monitoring System; and the Knowledge Management Unit has taken on part of the data collection. Also, some provinces, such as Tianjin, have maintained their M&E program. But since project completion, comprehensive monitoring of key indicators is either not undertaken or not reported widely to stakeholders.

effective at gathering and processing project output and outcome information, and the work of the Knowledge Management unit added further sophistication to the overall M&E capacity. Although data sharing needed improvement, taken overall, M&E performance during the project period is assessed as Substantial.

Achievement of the Sub-Objectives

3.31 This section reviews first the achievement of project outputs and then turns to HBP's efficacy-- the degree to which the project achieved each of its two sub-objectives: (i) Developing an Integrated approach to water management and improving water management and pollution control; and (ii) reducing pollution in the Bohai Sea.

Main Project Actions

3.32 Table 3.1 summarizes the main outputs under the project. All of the Appraisal targets were reached or exceeded. The main actions were related to establishing capacity in the Counties for preparing the County Integrated Water and Environment Management Plans. Ten such IWEMPs were to be created, but in the event, the program was expanded to 16 counties. Backstopping the IWEMPs were a combination of measures: in particular, revision of the current policies and mechanisms to create an enabling institutional environment; establishment of an expert group in each county to provide technical advice; establishment of field-based Project Management Offices for management and technical support; creation of an interagency committee in each county and province; and the agreement between MWR and MEP to work as joint implementers of the program.

3.33 The IWEMP program and broader basin objectives were boosted by development of a Knowledge Management System; an ET management system; and the establishment of WUAs to implement water savings at field level. The 407 WUAs that were established greatly exceeded the original intention of 65 WUAs. HBP also provided technical assistance for two investments financed by another project: removal of contaminated silt from Dagu canal; and creation of two waste-water treatment plants. As intended, two Strategic Action Plans were prepared – for the Hai Basin and the Zhangweinan sub-basin. Twelve studies were also carried out amounting to an array of topics that contributed to the program (for instance, groundwater management, well permits, wastewater reuse, and water and pollution management policy). Together, the actions above provided for achieving the project's objectives.

Table 3.1. HBP – Main Project Outputs

	Baseline (pre-project situation	Appraisal Target	Achievement	Achievement as % Appraisal Target
Create Inter-agency Committees for WRM and Pollution Management	-	10	16	160%
IWEMPs Prepared	-	10	16	160%
Coordination structure for IWEMPs established: High level Expert Groups	-	25	45	180%
Joint Project Management Offices Established	-	13	23	177%
Policies, Mechanisms and Instruments for IWEM developed	-	Prepare	Prepared and findings applied to IWEMPs, SAPs, ET and KM	n.a
Prepare Strategic Action Plans (SAPs) for: Hai Basin Zhangweinan	-	Do	Achieved	100%
Establish Knowledge Management System	-	Do	Achieved	100%
Establish Joint Decision Making Conference System	-	Do	Achieved	100%
Establish ET Management System	-	Do	Achieved	100%
Establish WUAs for water management	-	65	407	626%
Strategic Studies	-	12	12	100%
Disposal of 2.2 million m3 of contaminated silt from Dagu (HBP's role was technical assistance	-	2.2 million m3	6.3 million m3	286%
Technical assistance and studies for developing incentives for establishing and operating waste water plants in 2 small cities	-	Do	achieved	
Training, workshops and study tours	-	-	164 training courses, 57 study tours	

Source: ICR.

OBJECTIVE 1: DEVELOP AN INTEGRATED APPROACH TO WATER RESOURCE MANAGEMENT AND POLLUTION CONTROL IN THE HAI BASIN

3.34 An integrated approach to water and pollution management was sorely lacking when HBP was being prepared. The embodiment of the 'integrated approach' is the creation and implementation of IWEMPS – the integrated plans. The integrated approach is composed of interacting technical, conceptual, institutional, and capacity improvements that are reviewed below. Next, the efficacy of the integrated approach is further evaluated by reference to its impacts on water quality and quantity.

Conceptual achievements

3.35 The project succeeded in introducing the novel and critically useful paradigm of consumptive water use (ET) as the focus of concern for water management and the cornerstone of an integrated approach. After initial early resistance to the paradigm[35], the idea that there should be a cap on ET, and that efforts should focus on reducing non-beneficial or low value ET, has taken strong hold with water managers at the pilot county, pilot province and basin levels. The Hai Basin Master plan 2010-2020, which was endorsed by the State Council, includes a goal of capping Basin ET. This unprecedented provision is most likely attributable to the project. At the national level, the State Council's landmark "Opinions on Implementing the Strictest Water Resources Management System" (12 January 2012) sets forth three Red Lines governing water use, the first of which is to cap water consumption at 700 billion m^3 by 2030. This is consistent in spirit with the idea of capping ET, and it is also likely that the HBP informed the drafting of the Red Line.

Capacity-building for integrated planning

3.36 The project supported successful development of Chinese capacity to undertake remote-sensing based measurement of ET. The starting point was a proprietary model, SEBAL, which dates back at least to 1989. The Institute of Remote Sensing Applications (IRSA) at the Chinese National Academy determined that this was not accurately representing local conditions. So, going back to the basic science, they developed their own algorithms, through a long series of iterative improvements. A validation of the model was published in an international peer-reviewed journal[36], and it is considered to have advanced the global state of the art. IRSA continues to develop the model, and it is being applied in a follow-on Bank project in Turpan, Xinjiang.

3.37 Capacity was also developed in the construction and use of hydrological models. Again this was facilitated by the high level of competence in participating research and academic institutions. The China Institute of Water Resources and Hydropower Research developed the basin-level "Dualistic Model," a highly sophisticated model that combined economics and hydrology. This model could be adapted for use in China's many other

[35] Noted in interviews with project and government staff.

[36] Wu and others (2012).

Basin Management Conservancies. The public-domain SWAT model was adapted for use at the county level and applied by several academic and research units.

Knowledge Management and Data Sharing

3.38 A necessary, and achieved, condition for project success was the formal agreement between the MWR and MEP to share data and cooperate in the implementation of IWEMPs. As noted earlier, historically the ministries had maintained separate water monitoring stations, promulgated mutually inconsistent regulations, and did not share data. The project succeeded, in the pilot provinces, in breaking down the silos that separated these and other concerned ministries. At the Basin level, this was manifest in the creation of Strategic Action Plans for the Hai Basin and Zhangweinan sub-basin. As an example of how cooperation made a difference at the county level, Pinggu district personnel cited permitting for new local development projects. Before cooperation, the petitioner would have to visit each department sequentially. Currently, a joint meeting of the water, environment, planning, local DRC, agriculture, and land resources agencies considers the proposal together.

3.39 While the project significantly advanced the sharing of data within counties, bottlenecks remain and there has been some backsliding. Obtaining data from outside a county would need to pass through the provincial government and could take weeks or months. In some counties visited, IEG found that they had ceased to receive ET maps via the Knowledge Management system after the project closed. Some interviewees suggested that this was because the financial or staffing requirements for ET data distribution and use were not mainstreamed. ET maps are not published on the HBC website. The 2014 concept note (PID) for a follow-on project notes the continued lack of data-sharing between MEP and MWR as an issue.

Implementation of the IWEMPs

3.40 Based on IEG's field visits, IWEMPs appear to have been successfully implemented. While the PAD only planned for ten, 16 were undertaken. Modelling was not an academic, desk-based exercise. Modelers spent a month in the field interacting with stakeholders and tuning the model. Model recommendations were specific and were incorporated in the counties' five year plans. Thus they were not mere studies, but guided investments and policies. For instance, Tianjin Municipality created an integrated Water Resource Bureau, promulgated stricter pollution and groundwater regulations, and launched a program to renew and construct sewage plants. In practice, though, adjustments were necessary. For instance, in Pinggu County, a plan to eliminate high-ET fishponds ran afoul of long leases and had to be deferred.

3.41 The project also supported the completion of Strategic Action Plans for the Hai Basin as a whole and for the Zhangweinan sub-basin. These are indicative rather than prescriptive. However, drafting of the more prescriptive Basin Master Plan is likely to have incorporated ideas from the Hai Basin SAP.

ET planning, monitoring and allocation

3.42 ET measurements were important to the formulation of the IWEMPs. Allocation of ET, at the county level, was set at average precipitation. (So wet years would recharge groundwater, to be drawn down in dry years.) Measuring average ET therefore gives counties an idea of how much work needs to be done in order to reduce water consumption to sustainable levels. ET maps also provide information on ET requirements of different land uses.

3.43 The sustained contribution of ET monitoring to water management and allocation is less clear. The Hai Basin Commission, using technology developed by the IRSA, continued to produce monthly maps of ET in pilot counties. This was available to the counties during the project's term. IEG did not find examples of this information's use for management. ET is very variable from year to year (see Figure 3.1), complicating its use as a monitoring tool. In Guantao County, under the pilot for plot-level allocation of ET, each farming household was assigned an ET quota (translated into a water withdrawal right). But remote sensing was not used to monitor actual ET at the field level. Officials of water user associations said that they would be reluctant to enforce hard quotas. It is worth noting, however, that county level managers can and did take many actions to reduce ET without directly applying quotas at the household level. These included expanding the scope of volumetric charges for water, encouraging shifts to cropping patterns with lower ET demands, and setting and monitoring limits on water usage by industries and towns.

Strategic Studies

3.44 The eight strategic studies,[37] all of which were completed, appear to have had significant impact. Although quantification of benefits is not possible, in the combined view of MWR and MEP, each has served a purpose. As examples: the Review of How to Apply Water Rights and Well Permits for Sustainable Groundwater Management was directly relevant to water and pollution planning and management by IWEMPs, as was the Review of Water Savings and Efficient Water Utilization. The Study of Water and Pollution Planning and Management was also useful. The Study of Wastewater Reuse had direct bearing on urban water planning. And there was a more policy related Study on Water Policy, the Legal Framework and Institutional Arrangements. The ICR comments (page 26) that the studies also informed: National policy and water laws; the State Council's "Number One Document for 2011;" and the "Three Red Lines" water policy. The Studies also provided background for the Hai Basin Master Plan, and the 12th Plan proposals at basin, provincial and county levels.

[37] The Strategic Studies were: (i) Policy and Legal Framework and Institutional Arrangements; (ii) Bohai Sea Linkage; (iii) Countermeasures for the Protection and Measurement of the Water Ecological System; (iv) Water Savings and High Efficiency Water Utilization; (v) Administration of Water Rights and Well Permits, and Sustainable Groundwater Exploitation; (vi) Wastewater Reuse; (vii) Water Pollution Planning and Management; and (viii) Rationalization of Beijing Water Resources.

Impact on water management

3.45 Although the outcome relates to the development of an integrated approach – as manifested in the creation of processes that resulted in IWEMPs – it is possible to go further and look at the impacts of that approach. The project reported impacts on water management and on pollution. These impacts are the result of the project-sponsored planning process together with the physical investments and policy changes sparked by those plans.

3.46 The key water management need was to reduce the unsustainable consumption of water and to improve its effectiveness. The former would reduce the rate of drawdown of groundwater resources which had depleted water tables in the Hai Basin at an alarming rate over the last two decades. The IWEMPs were the basis for most water-saving activities attributable to the project, and their impact would primarily have been from a combination of measures decided on in the planning process and as the IWEMPs were put into implementation. Typical measures taken under the IWEMPs which could be expected to have had impact included:

- Establishment of Water User Associations (some including community driven development features), including imposition of volumetric water charges, sometimes together with remote metering of pumps and prepaid card access to pumped water.
- Reducing irrigation conveyance losses by changing from channel to piped conveyance.
- Conserving domestic water use through encouraging households to install new water conserving taps, toilets and washing machines.
- Conserving industrial water use through setting targets for large companies to reduce water consumption.
- Preparation of groundwater allocation plans.
- Tariffs reform for water savings.
- Crop shifting, including shifts away from winter wheat, from open-field vegetables to greenhouses, and from wheat/maize to cotton.

3.47 In addition, a study and a demonstration on administration of water rights, well permits and sustainable groundwater exploitation contributed to the knowledge base for reducing overexploitation, and another study focused on water savings and high efficiency water utilization

3.48 Reported overexploitation of groundwater dropped dramatically. The PAD had targeted a reduction in the overdraft of 10%. The reported reductions were much steeper: a 63% reduction in overexploitation of shallow groundwater and a 46% reduction for deep groundwater, for an overall reduction of 390 million cubic meters (see Figure 3.1.) The biggest reductions were for shallow groundwater in Beijing and Hebei, and deep groundwater in Tianjin.

Figure 3.1. Groundwater Overexploitation by Area and Year

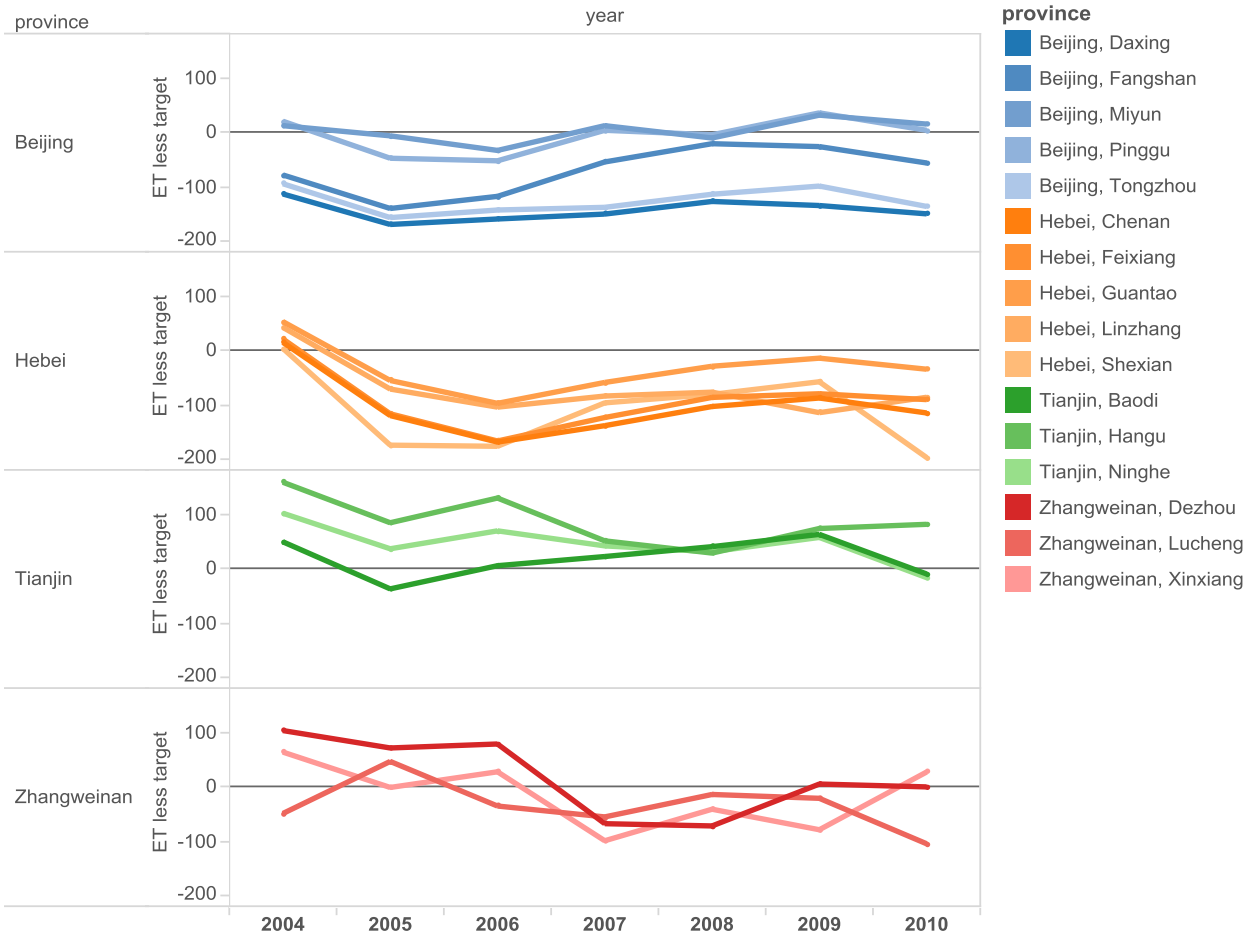
Note: water exploitation in units of 10^4 cubic meters; Zhangweinan is not a province but a sub basin under which some counties are grouped.
Source: IEG based on project M&E data.

3.49 There is inconsistency between data on groundwater exploitation and ET data. According to the project's logical framework, the reduction in groundwater extraction should have been accompanied by a reduction in ET. While there was a drop in overall ET from 2004 (the baseline year) to 2005, there was no subsequent trend in ET (measured either by remote sensing or via traditional water balance calculations.)[38] Figure 3.2 shows the evolution of ET over time by county. It shows, for each year, the difference between that year's ET and the target ET level set for 2010. Positive numbers indicate water consumption above the target. In Beijing, Hebei, and Tianjin there was a drop in ET from 2004 to 2005. Because the IWEMPs were not yet formulated and implemented, it is difficult to attribute this drop to the project. However, the picture is not entirely uniform. In Dezhou County, there was a substantial drop in ET over the whole period.

[38] A linear regression of county ET on time, with dummies for counties, did not find a statistically significant relationship after 2005 either with project M&E data for 2004-2010 or for an extended ET data series covering 2002-2012. Nor was there a time trend for agricultural ET.

3.50 In part, the overall reduction in groundwater over extraction may be explained by a trend over the period 2006-10 for increased rainfall. A regression of county-level precipitation on time, with county-level dummies, showed an increase of 24.6 mm/year, a substantial amount. Given a lack of trend in ET, this would generate a favorable water balance and would permit a reduction in groundwater overdraft. Conceivably, constant ET and reduced groundwater extraction could be consistent with reduced outflows to the sea, or increased water transfers from other basins. Finally, each source of water information – groundwater pumping, remote-sensing ET, and water-balance ET -- is subject to measurement errors of different kinds. Some groundwater use may be unreported. Remote-sensing ET is novel and depends on complex assumptions and interpolations. Water-balance ET is derived from possibly inaccurate stream and rainfall measurement. The bottom line is that while it is plausible that the project reduced groundwater over extraction, the inconsistency with ET data makes it impossible to confirm this impact.

Figure 3.2. Trends in Actual Minus Target ET by County



Note: Graphed quantity is actual ET (year) – target ET (2010) based on remote sensing measure of ET. Positive values represent excess consumption, negative values represent reduction of water consumption below the target. Zhangweinan is not a province. Target is for 2010.
Source: IEG calculations based on M&E data.

Impact on county-level pollution

3.51 Pollution control was one of the "three red lines" established by Government in 2012, and received significant attention. The IWEMPs and preparation of the Hai and Zhangweinan Basin SAPs prioritized control of pollution as well as better management and allocation of the overall water resources. The IWEMP approach was essential because the type, source and mix of pollutants varied greatly between counties.

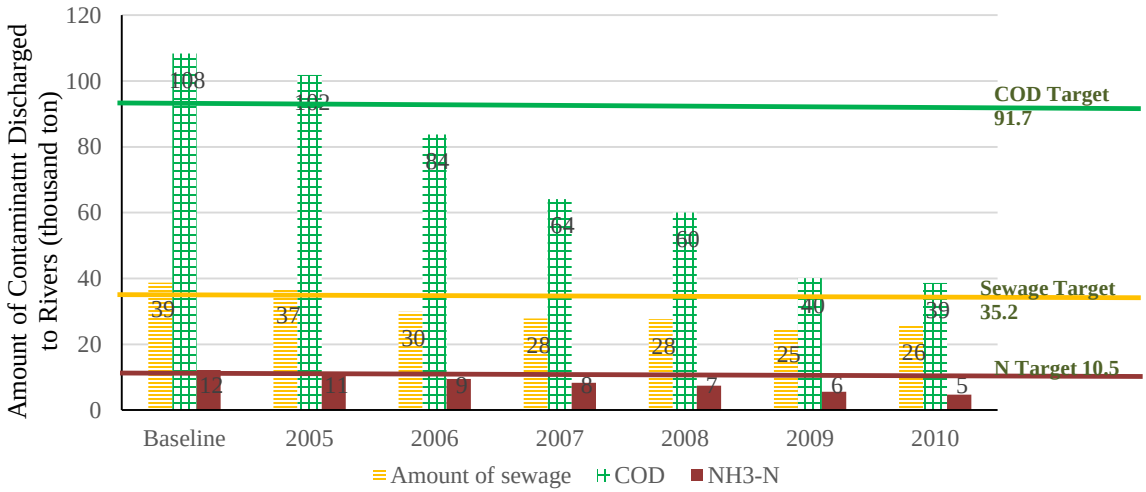
3.52 Project-wide there were large reductions, in absolute and relative terms. (Table 3.2.) The reductions greatly exceeded targets, and there was a progressive decline over the project period of all three commonly measured contaminants: sewage, COD and NH3-N. Figure 3.3 presents the data for contaminants discharged to rivers. Sewage discharge in 2010 was 70 percent of discharge in 2005; COD discharge was 38 percent of 2005 discharge; and NH3-N discharge was 41 percent of the 2005 level.

Table 3.2. Pollution Loads to Rivers and to Bohai Sea

Baseline	Amount of Contaminant Discharged to Rivers			Amount of Contaminant Discharged to Bohai Sea		
	AMOUNT OF SEWAGE (10^4 TON)	COD (TON)	NH_3-N (TON)	AMOUNT OF SEWAGE (10^4 TON)	COD (TON)	NH_3-N (TON)
	38701.4	108372.7	12152.9	6244.1	18661.4	1821.6
2005	36829.8	101790.3	11196.6	6634.8	20096.0	1399.6
2006	29902.1	83728.3	9453.1	3595.1	8523.0	913.2
2007	27792.2	64143.5	8256.2	3379.4	8927.6	923.8
2008	27623.5	59998.7	7380.5	3343.8	7968.6	855.0
2009	24960.9	40133.1	5562.9	2676.7	6613.4	750.0
2010	25767.3	38614.8	4665.3	5531.0	6951.0	804.7
Reduction	12934.0	69757.9	7487.6	713.1	11710.4	1016.9
2010 target	35229.1	91727.3	10508.0	5143.5	8468.3	820.5

Source: Project M&E data.

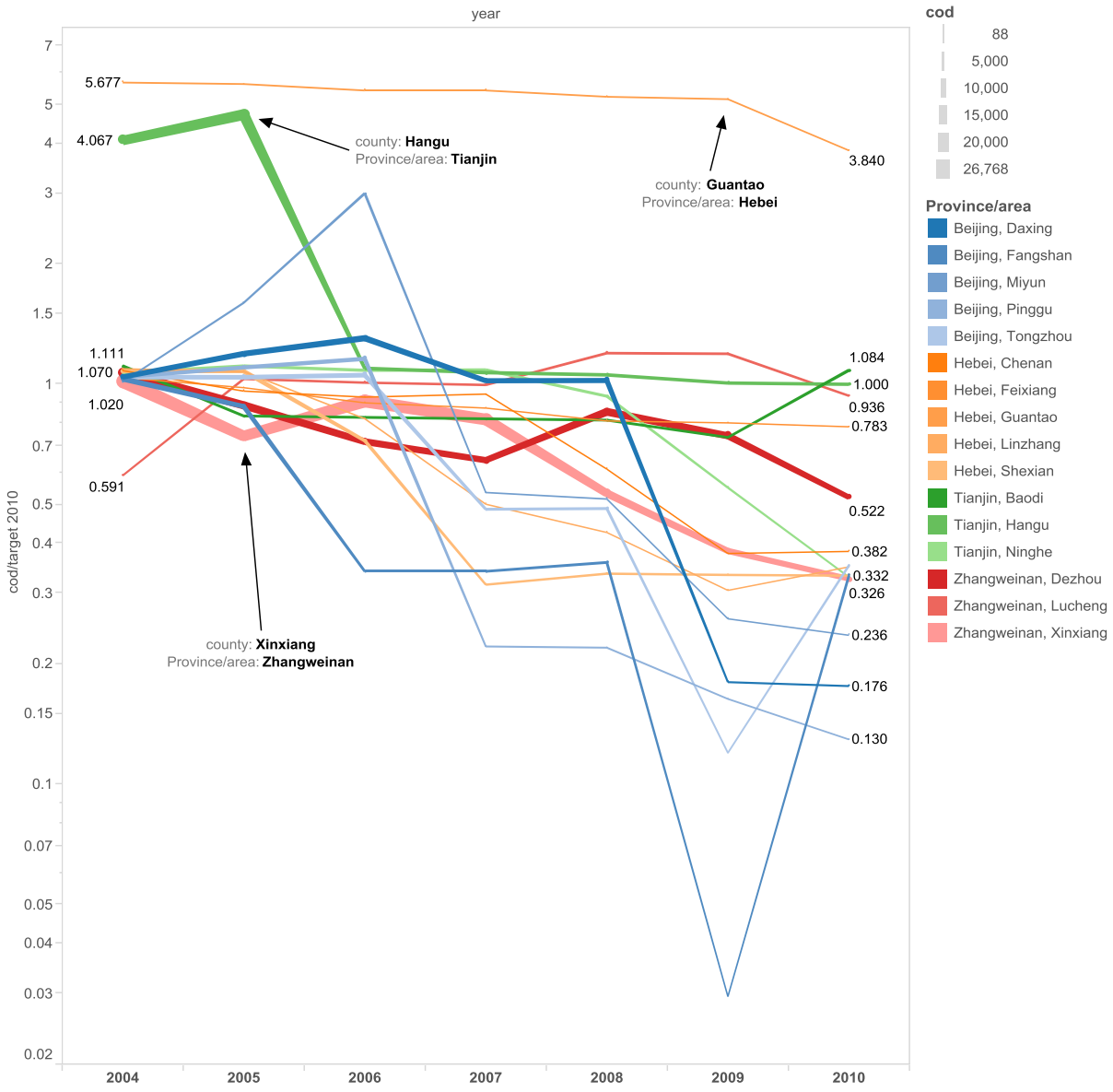
Figure 3.3. Amount of Contaminant Discharged to Rivers – 2004 to 2010



Source: HBP M&E data.

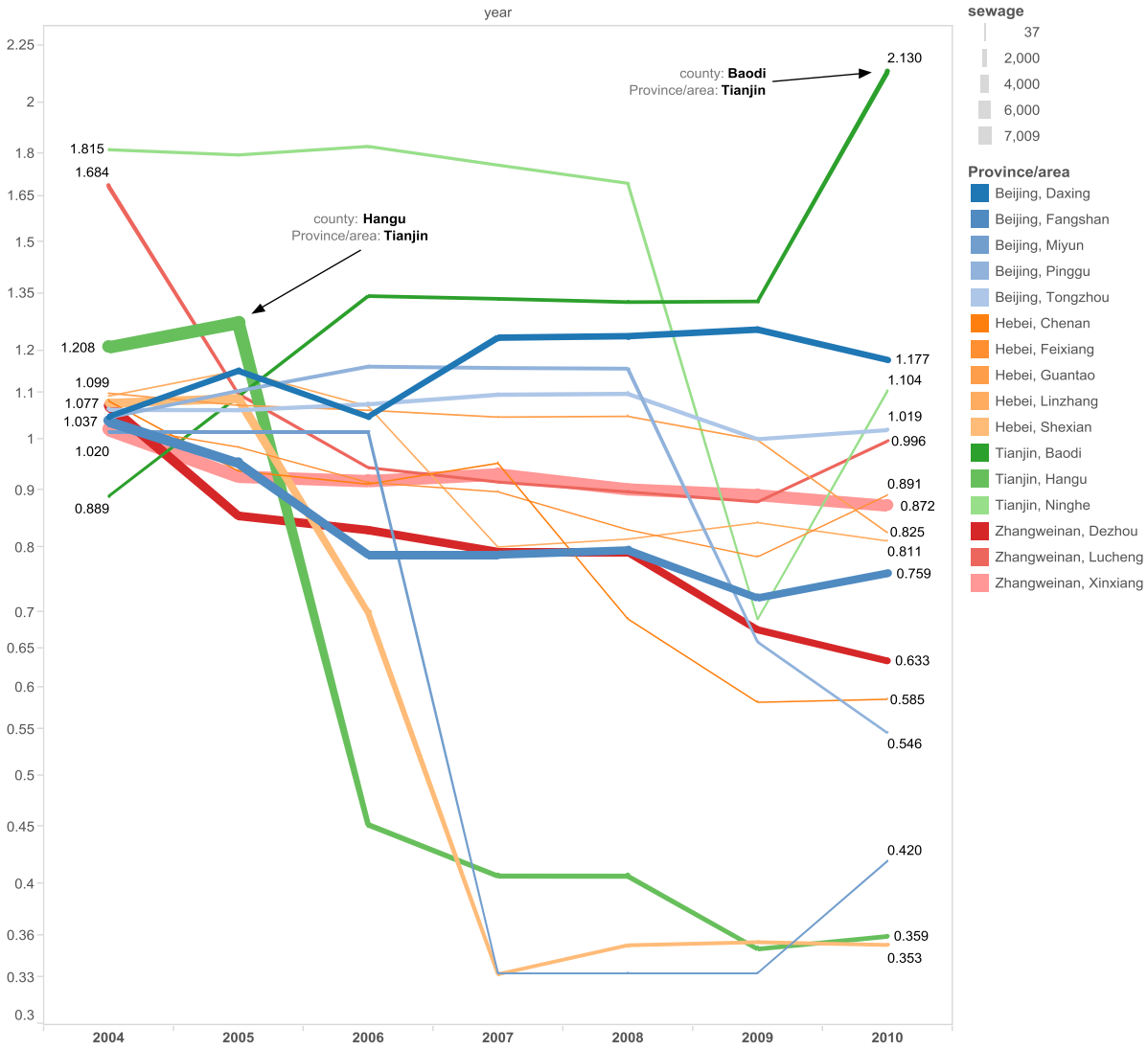
3.53 This success was widely shared among the counties. (Figures 3.4-3.6) The graphs show the ratio of the pollution in each year to the target level for 2010. For most counties, targets were set about 10% below the initial level, so that ratio for 2004 was 1.1 By 2010, most counties were polluting at levels well below their target (a ratio less than 1), indicating a successful reduction. For instance, Xinxiang's nitrogen ratio for 2010 was .209, indicating a reduction of 80.1% below the target. A few counties, such as Hangu, stand out for achieving large absolute and relative reductions. Unfortunately comparison data are not available for counties outside the project area, so it is not possible to rule out the possibility that reductions are due in part to some contemporaneous national policy.

Figure 3.4. Trends in COD Pollution, by County (normalized by target level of discharge)



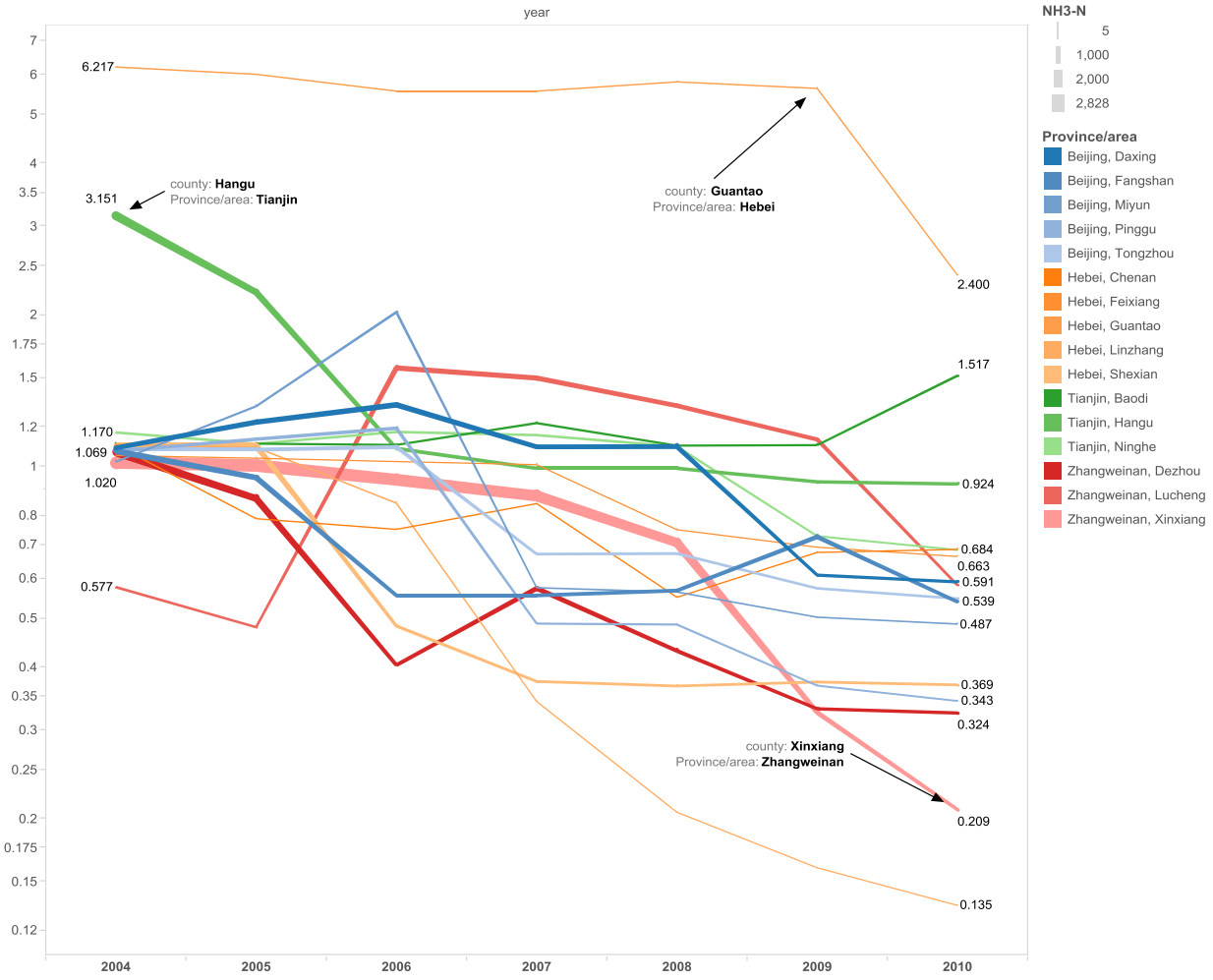
Note: logarithmic scale. Graphed quantity for each year is pollution (year)/pollution target (2010). E.g. a ratio of 1.1 indicates pollution discharge 10% above target levels; a ratio of 1.0 indicates achievement of target; a ratio of 0.9 indicates a reduction of pollution by10% below target. Thickness of line proportional to absolute quantity.
Source: IEG based on project M&E data.

Figure 3.5. Trends in Sewage, by County (normalized by target level of discharge)



Note: logarithmic scale. Graphed quantity for each year is sewage (year)/sewage target (2010). E.g. a ratio of 1.1 indicates pollution discharge 10% above target levels; a ratio of 1.0 indicates achievement of target; a ratio of 0.9 indicates a reduction of pollution by10% below target. Thickness of line proportional to absolute quantity.
Source: IEG based on project M&E data.

Figure 3.6. Trends in Inorganic Nitrogen Pollution, by County (normalized by target level of discharge)



Note: logarithmic scale. Graphed quantity for each year is pollution (year)/pollution target (2010). E.g. a ratio of 1.1 indicates pollution discharge 10% above target levels; a ratio of 1.0 indicates achievement of target; a ratio of 0.9 indicates a reduction of pollution by10% below target. Thickness of line proportional to absolute quantity.
Source: IEG based on project M&E.

3.54 The planned wastewater treatment plants for two small coastal cities - for which HBP provided technical assistance in design, implementation and early operations, and financial support on operating costs during the start-up period - were completed, and are operating as planned. According to the MEP, these were the only urban or industrial treatment plants constructed during the project term in the 16 pilot counties. The targeted reduced pollution loading was achieved. COD loading per plant reduced on average by nearly 10,000 tons per annum; and nitrogen loading reduced by 620 tons per annum (Table 3.3).[39] But the plants'

[39] Yingcheng Waste Water Treatment Plant in Tianjin New District is treating about 50,000 tons of wastewater per day.

significance goes beyond their direct impact. Their main utility may be in piloting, as intended, the introduction of incentives for investors to build, operate and maintain such plants. Towns had found a lack of interest from investors as charges for wastewater removal were too low. Under the project, subsidies on O&M were provided to investors until treatment charges had increased. Initial experience appears positive. According to government officials, the treatment plants are serving as demonstrations for other cities, many of which do not have such facilities.

Achieving Integrated Water and Pollution Management

3.55 HBP set in place and guided initial implementation of an entirely different form of water and pollution management based on close and synergistic interaction both at central level and in the counties. This was accompanied by innovations in key technical areas, a number of which were state-of-the-art. Pollution control appears to have benefitted considerably, although results for water savings are complicated by conflicting data. Performance in modelling, and knowledge management was excellent, but ease of access to data is variable, and needs improvement. The data problems bring an otherwise high performance to Substantial Efficacy.

OBJECTIVE 2: REDUCE POLLUTION IN THE BOHAI SEA

Actions

3.56 The project reduced inflows to the Bohai via actions under the county and city based IWEMPs and via technical assistance for constructing the two waste water plants and de-silting the Dagu canal (see below), both of which were successfully completed. The main impacts on Bohai Sea inflows are assumed to follow from the overall pollution reductions stemming from the IWEMPs.

3.57 The excavation of Dagu canal got rid of three times more contaminated silt than anticipated. The operation removed a major source of pollution - based on comparing nitrogen levels, the contaminated sediment removed from Dagu canal on a one-time basis was equivalent to about 27 times the target annual contaminant removal rate of a small-city waste water treatment plant).[40] However, there is no information on the extent to which the cleanup affected ongoing flows of pollution from the Dagu into the Sea. Impacts of the wastewater plants and the Dagu canal cleanup cannot be fully attributed to the HBP, which provided only technical assistance.

Impacts

[40] From the "Outcomes and Applications of Hai River Basin Integrated Water and Environment Management Project, 2012, China Government: Foreign Economic Cooperation Office, Ministry of Environmental Protection; Irrigation and Drainage Development Center; and Hai Water Conservancy Commission, Ministry of Water Resources.

3.58 The project substantially exceeded the targets set out at appraisal as shown for the monitorable indicators in Table 3.3. The reduction of COD and nitrogen pollution loads into the Bohai Sea was 240 percent more than appraisal targets. The reduction in nitrogen inflows of about 1000 tons/year is a reduction of about 3% in annual flows into the Bohai, and represents a reduction of about 9% in the excess of flows over assimilative capacity.[41] The COD reduction represents about 3% of the total assimilative capacity for this pollutant. Table 3.3 shows reduction of contaminants discharged to the Bohai Sea over time.

3.59 Of the total reductions in pollution inflows, about a quarter of the COD reductions and an eighth of the nitrogen reductions are associated with the two small wastewater plants. Since the plants were financed outside the HBP, this portion of the reduction cannot be fully attributed to the HBP.

Table 3.3. Output and outcome Indicators Related to Reduced Pollution of the Bohai Sea

Indicator	Appraisal Target	Achievement /Percent of Target
Reduce discharge pollution load to Bohai sea from pilot counties by 10% (in '000 tons/annum) (As measured by chemical oxygen demand (COD) and all nitrogen (Baseline: NH3-N.) COD 164 NH3-N 19)	By 10% i.e. COD reduced by 16,400 tons/annum NH3-N by 1,900 tons per annum	Achieved: COD: 38,615 tons/annum (reduction 235 % greater than target reduction) NH3-N: 4665 tons/annum (reduction 245% greater than target reduction)
Reduced annual pollution loading to Bohai Sea from two Tianjin small wastewater plants	Reduction of COD 10,000 tons/annum per city NH3-N 500 tons/annum per city	Achieved: Waste water treatment plants were established in two small cities and average pollutant discharge was: COD 9,855 tons (98% of target); and NH3-N 620 tons (124% of target)
Disposal of 2.2 million m^3 of contaminated sediment in Dagu canal, and achieve a one-time reduction of 10,000 tons of oil, 2,000 tons of Zinc, and 5,000 tons of total nitrogen.	As indicated	Achieved: Removal of: Sediment 6.3 million m3 (286% greater than target; oil 28,670 t (186% more than target); Zinc 1,822 tons (91% more than target); and total nitrogen 13,379 tons (168% more than target)

Note: HBP provided technical assistance during design and implementation of both the wastewater plants and Dagu canal desilting and provided TA to the two wastewater plants at their completion to devise financing and operating plans. HBP also provided some financial support to the wastewater plants during early operations. Civil works for both the Dagu canal and wastewater plants was financed under the TUDEP II Project.
Source: ICR.

3.60 The project's direct impact on the overall condition of the Bohai Sea itself is necessarily limited. First, a declining portion of river pollutants - between 18 and 31

[41] Based on Special Study 2, as cited in the *Outcomes and Applications*.

percent depending on contaminant – actually reach the sea. This is because increasing water demands have reduced the flows of the rivers leading to the Bohai Sea.[42] Of seven major rivers leading to the Sea most are dry or seasonal. As noted earlier, flows into the Sea have drastically declined since the 1950s. With reduced flow, pollutants tend to be trapped as contaminated silt on river banks or shallows. Thus, ironically, long-term success in capping water demand in the Hai Basin, which is essential for sustainability of supply, will tend to increase pollutant flows into the Sea unless there is further mitigatory action. Second, as noted earlier, most of the pollution entering the Bohai Sea comes from rivers other than the Hai.[43]

3.61 In summary, the HBP effected a small but measurable relative reduction in pollutants entering the Bohai Sea, surpassing its reduction targets several fold. As a pilot project working on just one of the rivers entering the sea, it could not be expected to have a large direct impact. The main value of the project is that it demonstrated practical and replicable ways to incorporate pollution management as a key part of an integrated water and environment management project. However, no significant scale-up has yet taken place. A follow-on GEF project, currently in the planning stage, seeks to upscale the approaches demonstrated in HBP. Based on achievements so far, the efficacy of HBP's objective of reducing pollution in the Bohai Sea was Substantial.

Efficiency

3.62 An economic rate of return for the HBP was not calculated in the ICR (or PAD) on the grounds that benefits could not be quantified. In principle it would be possible to attach economic value to the pollution reductions, based either on alternative abatement costs or on marginal values of health or other damages, but such parameters are debatable and were not found. It is slightly easier to assign shadow values to water. The value of water in northern China is evidenced by the huge investments in the South-to-North water transfer scheme. Since water is fungible between sectors, it is reasonable to take the value of urban water as a shadow price. The urban household tariff of 5 yuan/m^3 is subsidized, and can be taken as a lower bound to the shadow price. China introduced in 2004 a tariff for large commercial users of 160 yuan/cubic meter, which might be taken as an upper bound to the marginal value of water.

3.63 As an illustrative calculation, let us suppose that the only water savings attributable to the project were in Dezhou County, where ET declined 100 mm during the course of the project. If this decline is entirely attributed to the project, it means that 53.9 million m^3 were saved annually. Valued conservatively at the subsidized household tariff rate, this represents an annual benefit of more than $43.1 million. The commercial tariff

[42] In the Hai basin, discharge from the river to the Bohai Sea dwindled from an annual average of 24 m^3 in the 1950s to 1 billion m^3 in 2001 Y Jiang (2009). China's Water Scarcity. April 2009.

[43] Source, all data: Outcomes and Applications of Hai River Basin Integrated Water and Environment Management Project, 2012, China Government: Foreign Economic Cooperation Office, Ministry of Environmental Protection; Irrigation and Drainage Development Center; and Hai Water Conservancy Commission, Ministry of Water Resources.

implies a valuation of $1.4 billion/year –the amount is not credible, but emphasizes the value attached to the marginal consumption of water and underlines that the true value would be much higher than $43 million. Against these benefits would be set the cost of the HBP ($34.5 million) together with the costs of implementing the actions, such as improving irrigation or abandoning fishponds that caused ET to decline. This illustrative calculation suggests that even modest water savings, together with modest values attached to pollution reduction, would imply a very high economic rate of return to the project. This would especially be true if benefits were achieved at low economic cost (or with net benefits), for instance by closing uneconomic polluting businesses or by instituting volumetric water charges that reduced wasted water.

3.64 Another indicator of project efficiency was the overachievement of key targets. Most importantly, IWEMPS were conducted for 16 rather than 10 counties, representing a greater than planned uptake of the 'integrated approach'. In addition, the projects established 407 WUAs against the planned 65.

3.65 It is also possible to comment on the efficiency of management and implementation.

- Costs. The total project costs at project completion of $34.5 million were only 3 percent above the costs estimated at appraisal. Costs by component were also close to original estimates.[44]
- Management. Financial management and procurement were effective (Procurement involved 23 Project Management Offices requiring a close overall management).
- Implementation. The project was implemented largely as planned; with no changes in objectives, components and monitorable indicators.
- Outputs. All planned activities were implemented, and monitorable indicators were achieved (the number of participating communities and WUAs greatly exceeded targets).
- Implementation period. Half of the one-year extension was due to factors outside the control of the project: technical assistance for operationalizing the wastewater plants was delayed because plant construction was behind schedule.

3.66 In summary: The HBP was implemented as planned with no changes in objectives and no substantive changes in components. It achieved or exceeded all implementation targets, including overachievement of IWEMP implementation. Costs were only marginally above appraisal estimates, and financial management and procurement were tightly managed. While it is not possible to compute a precise economic rate of return to tangible gains in water quality and quantity, under plausible assumptions the return is high. The project introduced significant institutional changes that would improve overall efficiency, including a paradigm shift on water management. HBP's efficiency is assessed High.

[44] The implied efficiency of expenditures assumes that project costs themselves were efficient at time of appraisal.

OUTCOME

3.67 HBP's objectives were highly relevant to China's critical need to better manage and conserve its water and protect the water environment. Water availability per capita was well below other countries, demand for water was growing rapidly, and pollution of groundwater, rivers and other sources for domestic and agricultural needs was increasing apace. The objectives were also relevant to ensuring the health of the Bohai Sea, a shared international resource on which fishers depend.

3.68 The project was not sized to meet the ambitious goal of reducing pollution in the Bohai Sea. Rather, it was tailored towards the goal of demonstrating approaches, which, if replicated, could meet that objective. The design was appropriate for the goal of developing an integrated approach to water/environment management. At the core was a change in the concept of water management, to water savings rather than water supply; and the planning and management of water and pollution together in an integrated approach. The various measures to manage water at county and community levels were more responsive than the traditional centralized system. And, as a pilot project, there were significant studies, demonstrations and pilot activities, including state-of-the-art innovations such as the project's knowledge management and evapotranspiration initiatives.

3.69 With regard to the first objective, an integrated approach to water and pollution management was adopted and institutionalized via county Integrated Water and Environment Management Plans and basin level Strategic Action Plans. Important strides were made in inter-ministerial cooperation and in knowledge management. However, advances in knowledge management were partially reversed after project closure and inter-ministerial cooperation has not continued to expand. In terms of impacts of the integrated process, pollution discharges declined dramatically and groundwater over-extraction reportedly declined. The latter report is however inconsistent with a lack of reduction in ET, and a counterfactual is not available for the former. The mostly high quality of HBP's performance with integrated water and pollution management is reduced by the project's uneven performance in sustained sharing of data. Based on HBP's performance overall, the project's Efficacy in developing an integrated approach to water and pollution management was Substantial.

3.70 Concerning the second objective, Efficacy was also Substantial. The absolute reduction in pollutant discharge to rivers and to the Bohai Sea exceeded plans, in most cases by a large degree. However, the relative impact on the Sea is small – to be expected from a small project compared with a large body of water such as the Bohai Sea. The more important benefit of the project is in demonstrating approaches that could be scaled up throughout the area that drains in to the Sea. A planned follow-on project proposes to do this.

3.71 The broader worth of HBP is its developing impact on Chinese water policy and investments – and its potential impact beyond China. The new paradigms introduced by the project -- in water savings rather than water supply; the integrated, model-based approach to water and pollution management; and knowledge-based planning -- are significant changes from the past, with potential to substantially improve water

conservation, control groundwater exploitation, and reduce pollution. And the introduction of remote-sensing based monitoring of ET has the potential to facilitate sustainable management of water resources.

3.72 The Ministries of Water Resources and Environmental Management advised the IEG mission that these practices, or variants of these practices, are being integrated in a number of projects including the government-financed Wei River Rehabilitation Project. Management of ET is central to three newer Bank projects in China: the planned follow-on Phase II of the HBP (Mainstreaming Integrated Water and Environment Management), the $160 million Water Conservation Project II (FY12-17), and the $204 million Xinjiang Turpan Water Conservation Project (FY11-17). The ET management and monitoring concept has also been introduced by the Bank to projects in the Middle East and North Africa. Moreover, the Ministries also advised IEG that they are working to include the Hai Basin Project's approach in China's 13th Plan (2016-2020). And, in the view of a senior manager in the Ministry of Environment Management, out of 30 internationally financed water projects covering all of China's major basins, the Hai Basin Project has "had the greatest learning impact."

3.73 Summarizing, HBP's ratings are: Relevance of Objectives – High; Relevance of Design-Substantial; Efficacy in developing an integrated approach to water resources management in the Hai Basin-Substantial; Efficacy in reducing pollution in the Bohai Sea-Substantial; and Efficiency-High.

3.74 On the basis of the ratings for relevance, efficacy and efficiency, the Outcome of the HBP was Satisfactory.

RISK TO DEVELOPMENT OUTCOME

3.75 The project has had a number of impacts that are likely to be enduring.

- It has contributed to building high-level capacity in remote sensing of ET and in hydrological-economic modeling of river basins. Organizations with these capacities are able to seek funds for continued elaboration and application of this work.
- It has set up MEP-MWR cooperation in the pilot counties.
- It has introduced the concept of 'real water savings' and ET management, changing the way that water management is regarded at least in the Hai Basin and probably to a wider set of practitioners.

3.76 However, as noted, some operational aspects of the program have deteriorated since project closure. Evapotranspiration maps are still being assembled by the Hai Basin Commission, but this information is no longer being shared with all of the pilot counties, let alone expanded to others. This is inconsistent with the goal of operationalizing the use of ET for monitoring and water allocation.

3.77 The issue appears to reflect a lack of mainstreaming and operational financing of the project's innovations. Some operations were undertaken by project management staff or funded by the project. With the close of the project, functions and staffing have not

always been continued. Likewise, it is not clear that there are resources to revise IWEMPs as conditions change and new planning horizons kick in.

3.78 Finally, while MEP and MWR continue to cooperate in the pilot areas, the gulf between them persists elsewhere. Demonstration of real benefits to cooperation in the pilot counties was not sufficient to spark replication.

3.79 At this writing, a follow on project on "Mainstreaming Integrated Water and Environment Management" is under preparation. Nevertheless, based on the current situation, the Hai Basin Project Risk to Development Outcome is rated Significant.

BANK PERFORMANCE

Quality at Entry

3.80 The Bank conceived a project of major strategic significance to China's critical need for more productive and environmentally sustainable water management. The Bank brought to China a new "water saving" concept and technologies, starting a fundamental change in how water was managed. A variety of innovations were brought in, with support from a strong task team and recourse to specialists as needed. Preparation was thorough and marked by a close engagement with Government on the new concepts, technologies and institutional arrangements. In difficult aspects such as the joint-responsibilities of two agencies, and government through administrative rather than hydrological boundaries, practical alternatives were found. Quality at Entry was strong in conceptual, technical and innovatory features. However, the design of the project was not consonant with the ambitious stated goal of reducing pollution into the Bohai Sea, given that the Hai Basin is a small contributor to the overall pollution load. Quality at Entry was Satisfactory overall.

Supervision

3.81 Regular supervision activities were fully satisfactory: implementation difficulties were handled expeditiously and practically; supervision missions were regular and about twice a year; and reporting was thorough, including of fiduciary, safeguards and other matters.

3.82 The Task Team contained a good balance between project administration experience and technical specialists, supplemented with consultants as needed. The team was thereby able to provide the detailed guidance required to get the project's new approaches and technologies underway. Learning for government, implementation staff and visitors from other countries was encouraged and is continuing. This includes organization of study tours for delegations from Morocco and Latin America, and follow-on projects in Egypt. Data sharing issues were brought up with Government and the implementing agencies, but structural disincentives limited sharing achievements. Nevertheless, the team established a good partnership with Government, promoting cooperation between agencies, joint reporting by MWR and MEP, and building "ownership" in the project. A particularly difficult area was to change mind-sets amongst engineers and others about the new approaches to water and environmental management. Through workshops, arrangement of study tours and other means, the team effectively

helped Government to change such attitudes. In particular, the team excelled in promoting an ambitious and innovative program to ultimate success, despite the challenges that this entailed. For the Bank, the project provides an example of "Learning through Lending." Recognizing that the Bank had limited leverage on data sharing shortfalls that were interlinked with governance, the Quality of Supervision was Highly Satisfactory.

3.83 Taking account of both Quality at Entry and Supervision, the overall Performance of the Bank was Satisfactory.

BORROWER PERFORMANCE

Government

3.84 Although there was some initial skepticism about the new concepts for water resources and pollution management that the project would introduce, the Central Government was an active participant during project preparation despite a relatively long project preparation process and the uncertainties regarding project results. Confidence grew over time including at provincial and county levels, and commitment grew and became strong as implementation proceeded. The uncertainties at the outset of the project were to be expected, and overcoming them – through intensive training and technical assistance both for regional Government staff and for the regional representatives of the involved technical ministries – was a difficult but ultimately successful endeavor. Interestingly, both Government and the Bank Task Team advised IEG that convincing the regional staff who would be the hands-on project implementers of the new paradigms, was possibly the project's most significant achievement.

3.85 Government commitment was strong throughout the project and a close working relationship was established with the Bank. Provision of counterpart funds was timely from the center. It was delayed in the first six months of the project at provincial government levels and this was one of the reasons for the slow project start-up. MWR and MEP, which were effective managers and were jointly responsible for the project, worked together closely, an important break from the past when the two ministries had little contact with each other. However there is still need for more effective data sharing between the counties and provinces, and ultimately, the central, provincial and county governments have the means to make this happen. The Ministry of Finance provided an important bridging role between the agencies.

3.86 In summary, although counterpart funding from the provinces was initially delayed, and data sharing difficulties were not resolved, the larger picture is Government's achievement in driving a complex project forward, to become by completion a new approach and national policy for one of China's most essential resources. Nevertheless, more have been done to resolve data sharing constraints and Government's Performance is rated Satisfactory.

Implementing Agencies

3.87 The two Joint Directorate teams from MWR and MEP who jointly managed the project, and the Central Project Management Office (CPMO), were highly effective in

coordinating and motivating the regional governments and the field staff of the entities involved. This included setting up and training the provincial and county Project Management Offices, and bringing, with associated training, staff of the technical agencies into the work programs, in particular for preparing the IWEMPs. Partnership with the Bank team and consultants was strong.

3.88 Building confidence in the new approaches was particularly needed at the provincial and county levels, requiring significant outreach by the CPMO at both political and field implementer levels. The CPMO, the provincial and county PMOs, the province and county based agencies (MWR, MEP, urban and others), and stakeholders such as the cities, did well in achieving this transformation, and in completing a particularly ambitious project, mostly within the intended time-frame. However, the MWR and MEP as implementing agencies could have done better in ensuring sustained and expanded data-sharing, an important element of the Knowledge Management program. The Performance of the Implementing Agencies was Satisfactory.

3.89 The overall rating for Borrower Performance is Satisfactory.

4. Lessons on Three Themes

4.1 This chapter reviews three cross-cutting aspects of the projects: (i) promoting sustainable management of water and agriculture; (ii) climate change adaptation, and (iii) learning through lending. It discusses what worked well, what could have been improved, and lessons for the future. It concludes with a summary of lessons.

PROMOTING SUSTAINABLE MANAGEMENT OF WATER AND AGRICULTURE

Challenges

4.2 China faces tremendous challenges in sustainably managing water and agriculture. Precipitation in the north is decreasing and will probably become more variable, so water supply is declining. At the same time, there is increasing demand for food – and therefore for water, since agriculture is the main user. Many rivers are running dry to the sea and groundwater is being unsustainably drawn down. Overuse of fertilizer and pesticides poses downstream environmental hazards, including eutrophication and red tides and Industrial and domestic pollution exacerbate these problems.

4.3 This situation raises the difficult institutional challenge of managing finite water resources within a river basin – a problem which requires understanding and dealing with trade-offs among water uses and users. There were three severe obstacles to solving this problem. First, river basin boundaries do not coincide with the established provincial and county level governments. Moreover, efforts to establish river basin commissions in most of the other major river basins in China had run up against the classic difficulty of limited recognition of the commission as an authoritative body.[45] Second the environmental and

[45] For instance, comments such as this: "Although China has established basin commissions for major rivers and lakes to promote integrated basin management, these

water authorities had overlapping and inconsistent mandates, and yet did not coordinate with one another. Third, there was a lack of integrated knowledge of water use and water quality, and a lack of understanding on how different scenarios would affect water flows and economic conditions

Interventions

4.4 To confront these challenges, the three projects introduced a set of complementary innovations. IAIL3 fixed dilapidated irrigation canals, introduced productivity-enhancing and water-saving agricultural practices, and supported farmer organizations to better manage water and to boost profitability. It also supported integrated pest management and reduced fertilizer application. MCCA reinforced IAIL3 by emphasizing activities that not only saved water, but were more resilient to temperature changes and extreme events such as drought and floods to changes in precipitation timing.

4.5 In contrast to the farm and community-level interventions of IAIL3/MCCA, the Hai Basin IWEMP addressed the institutional coordination issues at the county, province, and basin level. The project's contribution was in finding a pragmatic way to operate effectively within the government structure and to bring the key agencies involved with water together to work jointly on comprehensive water management. It also introduced technical tools for planning and for monitoring actual consumptive water use.

What worked well

4.6 The IAIL3 interventions succeeded in boosting physical yield, water productivity, crop value/kg, and irrigation efficiency, with the result that farmer incomes increased substantially without significantly boosting total water demand. There was success in implementing purely technical improvements, such as irrigation repair and land-leveling, as well as changes in farm practice and community organization, such as WUA management of water (via rationing or fees) and farmer association/cooperative efforts to commercialized agriculture. MCCA smoothly integrated a number of climate change adaptation practices, including greater resilience to floods and droughts.

4.7 At the institutional level, HBP succeeded in introducing meaningful, technically rigorous and integrated planning, informed by consultation. These were not mere paper plans, but documents that informed policy and implementation. A key element of this success was the initiation of cooperation and data-sharing between environmental and water authorities. The Hai Basin Commission's capacity was improved with respect to modeling and data collection and management.

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basin commissions have limited power to allocate water resource, coordinate water resource exploitation and conservation, and enforce water resource planning at the basin level." (Yong Jiang, April 2009. "China's Water Scarcity." In Journal of Environmental Management).

4.8 Together the projects succeeded in introducing a new paradigm for thinking about water management. It focuses managers' attention on actual, rather than apparent water consumption, and on the need to restrict total consumption to sustainable levels. This paradigm is an essential tool for water-scarce regions such as the 3H Basin.

Areas for further attention

4.9 To achieve sustainability of land and water use, it is necessary to combine the field-level interventions of IAIL3/MCCA with the watershed level interventions of HBP. Most of the water savings from irrigation efficiency under IAIL3 were used to support increased output, so that absolute water savings may have been small. On the other hand, the IWEMPs developed under the HBP were often predicated on the kinds of actions undertaken by IAIL3, so further coordination is desirable.

4.10 At the watershed level, there remain obstacles to cooperation among administrative units and between ministries. While data-sharing between MEP and MWR has been institutionalized within pilot counties, it does not always occur smoothly elsewhere. ET data is not always transmitted to counties. Downstream counties and provinces may not have easy access to data from upstream neighbors. It may be useful to explore ways of boosting incentives for wider data sharing at the Hai Basin Commission, MEP and MWR.

4.11 The technical success in timely and accurate measurements of ET is noteworthy. Operational application of these measurements is less evident. Partly this is due to the complexity of the task. In many ways the application of ET measurement in the ongoing Xinjiang Turpan project is easier because of the simpler hydrology. In Turpan, there is essentially no precipitation, with water coming from runoff from distant mountains, and fields are larger and thus more easily monitorable. In the Hai Basin, in contrast, it is much more difficult to separate the signal of ET management from the noise of changing weather conditions. In these conditions it may not be realistic to aim for operational use of ET for monitoring water use at the WUA or plot level.

4.12 ET measurement could play a critical role however at larger scales. One of the important lessons of this evaluation is that, if reasonable shadow prices are applied to water savings, the benefit/cost ratio of successfully executed water conservation projects could be astronomical. Existing monitoring techniques are not adequate to provide comprehensive, reliable measures of net water savings. Better ET measurement, combined with ground-based data, could solve this problem.

4.13 The challenges are compounded when data are not freely shared. The joint World Bank-Government of China report, *China 2030,* emphasizes the value of public disclosure of environmental information. Wider distribution of ET and other monitoring data would be consistent with the 'bottom-up' planning orientation of the HBP and would complement the strong technical capabilities of Chinese academics and researchers. Further research could help to resolve the inconsistencies between reportedly strong reductions in groundwater exploitation (or rises in groundwater level) with weak reductions in ET or water use.

CLIMATE CHANGE ADAPTATION

Challenges

4.14 Climate change adaptation presents challenges. First is promoting awareness of climate change and motivating action. Second is determining what actions, in fact, are indicated. While the broad direction of climate change is clear, the precise evolution of climate at any locality is subject to uncertainty. The third is mainstreaming. If adaptive actions are already beneficial or 'win-win', why are they not already part of practice? If they promote long-term resilience but are currently costly, why should farmers adopt them?

Awareness

4.15 China had gone through a conceptual journey before espousing a climate change adaptation program. Until the 2000's, interest in climate change adaptation was primarily in China's research community rather than in the political domain. At the time of approval of IAIL3 in October 2005, Government's climate change concerns were not prominent.

4.16 Interest in climate change adaptation gradually increased in the early to mid-2000s, with several policy papers likely to have helped stimulate this. Interest mounted as a series of poor harvests drew attention to the need to mitigate the effects of climatic extremes: droughts, floods, and high temperatures. In 2007, Government issued a National Plan for Coping with Climate Change, which included an emphasis on developing capability in measuring and dealing with climate change, with increased scientific research to support this. By mid-term Review of IAIL3 (September 2008) the adjustment to include a targeted climate change adaptation agenda through the addition of MCCA (approved in September 2008), was made. The Chinese Academy of Agricultural Science, and World Bank sponsored specialists, were brought in to help conceptualize and design a climate change adaptation agenda. This was important to MCCA's subsequent success as the project was the first comprehensive agricultural climate change adaptation project in China, requiring a high level of expertise in its formulation.

4.17 A particular effort, however, had to be put in to familiarize civil society, the extension staff themselves, and farmers with the concept of climate change and the adaptations feasible to counter such changes. And even before that, Government decision makers and senior and middle-level extension staff from the various agencies involved with the project needed themselves to understand and embrace the climate change agenda.[46] [47]

Planning

[46] For instance, as commented in the MCCA PAD (page 34) "The need for climate change adaptation has been widely recognized only recently."

[47] As advised to IEG, climate change adaptation had not received much policy attention before the early 2000s, and it was not surprising, therefore, that IAIL3 did not contain a specific climate change focus at its conception.

4.18 The project supported sophisticated climate modeling efforts. These were important for boosting Chinese capacity to model and understand climate processes. However, these efforts tended to yield only generic implications for specific, localized agronomic interventions. This experience is common to such exercises[48] and reflects fundamental scientific uncertainties. First, there is no consensus on the degree to which higher CO_2 levels in the atmosphere will fertilize plant growth, counteracting negative impacts from temperature rise. Chinese grain yields could go up or down, depending on the strength of this effect. Second, while climate models yield confident projections of temperature change, they are much less consistent on precipitation trends for smaller geographic areas, and on quantifying flood and drought trends. Third, it is very plausible that pests will increase with temperature, but it is difficult to project their impact.

4.19 For this reason, scientists and policy analysts are increasingly skeptical of a 'predict and prescribe' approach to adaptation (Schindler and Hilborn 2015).[49] Given the uncertainties, they advocate designing policies that are robust to a wide range of possible futures. This would apply also to further on-the-ground adaptation activities under the National Comprehensive Agriculture Development Program.

Mainstreaming

4.20 MCCA mostly supported interventions that already made sense under current conditions of climate vulnerability, and would be resilient to further changes. These include, for instance, the development and diffusion of drought and flood resistant seeds, and techniques for water conservation. Some – for instance, tree shelter belts - were already being practiced under IAIL3 but were expanded. Many of the climate change technologies were familiar, in practice or in concept, to agriculture and irrigation extension staff. Technical feasibility was, thus, not a major constraint. Nor, after initial concern as to whether it would work, were farmers' incentives. Nearly all IAIL3/MCCA's climate change adaptation measures increased farm yields as well as reduced climatic risks, and farmers, once they understood the climate change agenda, and witnessed demonstrations, adopted most of the practices enthusiastically.

LEARNING: KNOWLEDGE CREATION AND DISSEMINATION

4.21 Both IAIL3/MCCA and the Hai Basin Project brought in substantial innovation, as described earlier in this chapter. In both projects, policy makers, implementers and householders had much to learn in order to implement the projects. In turn, these participants would potentially become resources for possible replication of project approaches, although the degree of such outreach varied.

Accomplishments

4.22 In terms of knowledge creation, HBP was exemplary in boosting the global state-of-the-art in remote sensing of evapotranspiration and the national state-of-the-art in

[48] See IEG's Climate Adaptation Evaluation (2012) for a review.
[49] Schindler, Daniel E., and Ray Hilborn. "Prediction, precaution, and policy under global change." Science 347, no. 6225 (2015): 953-954.

integrated economic-hydrological modeling of water resources. As noted above, MCCA supported advances in climate modeling and in development of climate-resilient agricultural technologies.

4.23 Under both IAIL3/MCCA and HBP, the training programs and related activities such as demonstrations and study tours were large. IAIL3/MCCA undertook 37,000 person months of training for extension staff, 74,000 months for farmers, 158 demonstration sites, 145 international and 3,600 domestic study tours, and 330 extension or public outreach publications. HBP included 9 international and 155 domestic training sessions, and 43 domestic and 14 international study tours. For both projects, "Joint Expert Groups" were also formed at all institutional levels, to provide higher level advice.

4.24 Particularly for the MCCA climate change adaptation program and, though probably to a lesser extent, HBP, public outreach is reported to have been a major effort. Public outreach was part of the mainstreaming climate change adaptation objective of MCCA, and appears to have been significant – some 330 outreach media (booklets, webpages, newspapers, and TV presentations) were undertaken under the MCCA, and, while no numbers are available, HBP staff advised IEG that they had also had a significant outreach effort.

4.25 Dissemination of project results grew in the last years of the projects as project impacts began to be apparent, attracting increasing interest. The projects responded in various ways including distribution of brochures, some workshops at local and national levels, farmer events, and organizing field visits for Government officials. Study visits from other provinces have also been facilitated. SOCAD has also advised that informal visits of technicians from neighboring counties was another form of dissemination. Presentations at conferences, and international exchanges, provided a forum for international contact.

4.26 One of the most noteworthy aspects of the projects is the way in which Bank staff and local experts have supported the diffusion of ET as a concept and as a monitoring technology. There are follow-on Bank projects in China and the Middle East. Study tours from Morocco and from Latin America have further disseminated the approach.

What worked – the role of innovators

4.27 *World Bank Task Team Leaders and other Bank specialist staff* were key catalysts of innovation during project preparation and implementation, according to government staff. They were critical to the introduction of the new paradigm of focusing on ET. There were three commonly shared qualities of these TTLs. First, all had extensive experience in Bank operations and were able to take on a Bank team leadership role. Second, they had expertise in innovations related to the projects, in particular for the HBP which introduced several state-of-the-art technologies. Third, they combined expertise with a passionate championship of new ideas. During preparation, HBP involved multiple missions by an experienced and relevantly specialized Task Team Leader, and was then supervised by a locally based Task Team leader, also highly experienced and qualified. The first TTL continued to be involved with the project as a technical specialist during

project implementation. IAIL3/MCCA was both appraised and supervised, with hands-on involvement, from a Task Team Leader with extensive field experience who brought in consultants to bring particular expertise for specific needs.

4.28 There is substantial consistency between these observations and the findings of a survey about the Bank undertaken in 2011-2012 in preparation for the 2013-2016 Country Partnership Strategy.[50] The CPS comments that "Respondents indicated that the Bank's greatest value to China was in bringing new concepts and innovation, transferring international best practices, and piloting innovations to be scaled up." and: "The Bank must offer innovative knowledge products."

4.29 The second group of innovators were *academics and consultants*. They were engaged in research and training and were a significant factor in the projects' performance. They ranged in expertise from the National Academy of Sciences and China's top universities and specialist international consultants advising on new technologies, to more junior consultants to extend staff capacities in specific implementation areas.

4.30 In IAIL3, academics were used extensively by the counties, provinces, and at the center. The academics' roles were diverse ranging from advice or actual implementation of the new activities that the projects were taking on; to training; and even to "staff type" roles to provide extra persons in standard project implementation. Academics hired by counties were mostly from local universities or research institutes.[51] At province level, local institutions were also used but higher level specialists, such as from China's elite Chinese Academy of Agricultural Science, were also engaged. International consultants were also hired in some specialized areas, although hiring of academics and consultants at this level was more often at central level – SOCAD itself.

4.31 Whether at county, province or central levels, persons interviewed by the IEG mission were unanimously positive on the value that the academics and consultants had brought to the operations. "Hiring experts" had greatly enhanced the ability to take on new technologies; "they helped a lot;" and they were "needed" … "to show us" how to do the new activities, were typical remarks.

4.32 Part of the reason why the three projects had largely successful experiences with academics was that a common practice was to integrate them within the work programs and staffing. Many became, in effect, staff, visiting frequently, and had ready access to data and the field. Thus, trust and teamwork made the consultants skills' more effective.

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[50] Survey of Ministries, local governments, local project management officers, academics, the media, and NGOs.

[51] For instance, in Sihhong and Huaiyuan counties in Anhui, the IAIL3 project team had hired professors from the County Agricultural Institute and Anhui Agricultural University, and had also been visited by a more specialized consultant hired by Anhui Province. The generally positive views from the counties on training and academia also show in decision making since the project. Thus, the level of training in both counties has increased since project closure, and government funding of the training budgets has also continued.

4.33 Notwithstanding the mostly positive appreciation of the help that had been provided by the academic community, there were some weaknesses in how well the highest-level academics and international consultants were able to relate to local conditions. A complaint to IEG was that some of these needed better familiarization with local agricultural conditions and governance practices. Advice was sometimes generic – one size fits all – and insufficiently adapted to China's quite variable socio-agricultural conditions. Similar comments were made about some consultants and academics hired directly by the Bank.

4.34 Nevertheless, the overall benefit from the academics has been high, and, based on IEG's observations, it is likely that, without the academics, the projects would have been significantly less successful in the rapid transformation of the technologies that they all promoted.

4.35 Innovation was facilitated by a receptive culture. In the course of the projects, national participants showed an appreciation of potential new technologies, and the capacity and propensity to rapidly disseminate and implement such knowledge if seen to be successful. Perseverance is also evident. Project preparation of the HBP, for example, was a detailed and lengthy process in unknown terrain for activities such as ET, the institutional structure, and the knowledge management system. The IEG mission was informed that there was some frustration with the length of the process, but the Chinese preparation team and policy makers persevered, with no indication that the innovations would succeed. Government was also prepared to rapidly mainstream the projects' approaches, as evidenced by the integration of the IAIL3/MCCA into the national Comprehensive Agricultural Development program, and use of the HBP as a model for successor water resources management projects.

4.36 However, resistance to change was present in some quarters. For instance, HBP's holistic water resources management approach was initially resisted by the engineering community, who were used to construction of irrigation infrastructure, and considerable effort was needed to change this mind-set. Indeed, according to some involved senior staff from the Ministries of Water and Environmental Management, achieving the change in culture was possibly the project's most difficult achievement.

Areas for further attention

4.37 IAIL3 missed an opportunity to contribute to better learning about how to improve land and water productivity. The project introduced a diverse range of approaches and technologies in engineering, agronomy and management. It would be desirable to understand which worked best under which conditions. This is especially true for actions with water conservation benefits, given the potential size of those benefits. While the project did gather voluminous data and produce reports at province and county levels, rigorous impact evaluation was not undertaken. The cost of doing so would have been relatively small, and this could have provided guidance that would increase the effectiveness of efforts to replicate and scale-up IAIL3.

4.38 The Bank has been more of a transmitter of knowledge than itself a significant learner. As noted above, involved staff have played a proactive role in disseminating the

concept of ET-based water management, including through follow-on Bank projects. However, this has been driven largely by the individuals involved, rather than being institutionalized in strategy or approach to water-scarce regions.

5. Summary of main observations and lessons

5.1 Concluding this report, following are some lessons and observations which may be of general relevance in China and beyond:

- **The concept of evapotranspiration management can underpin sustainable water management.** Three simple but powerful ideas - that water is only used up by evapotranspiration, that allowable evapotranspiration has to be capped at a sustainable level, and that the goal is to minimize non-beneficial evapotranspiration -- can transform the way water is managed.

- **Water-saving agricultural projects could in principle provide immense economic benefits**. In water-scarce regions such as north China, there is a substantial economic value to water savings. Savings on the scale envisioned by the projects, if evaluated at conservation shadow prices, would imply extraordinary economic returns to investment. In these projects, unfortunately, data are not adequate to verify whether there was net water saving.

- **It is possible to simultaneously boost water productivity and land productivity.** Usually, more productivity requires more water. Here, intensive agricultural extension, community management of irrigation, environmental improvements, and promotion of higher value crops and commercialization managed to conserve water while boosting crop quantity and quality. This was done in significant part by reducing non beneficial evapotranspiration.

- **Multi-agency, technically based, integrated water management is possible.** Under the HBP, environment and water authorities worked together, in consultation with stakeholders to develop plans. The plans were informed by hydrological models that helped prioritize ways to meet water quality and quantity goals. They were incorporated in operational county investment plans.

- **Field-level and basin level approaches are complementary.** Holistic management at the basin level depended on the ability to deploy field level techniques for increasing water efficiency. But promoting irrigation efficiency can lead to continued groundwater depletion unless total consumption is capped.

- **Sharing of data is a key to success.** Progress was made when the Environment and Water ministries pooled information from their formerly separate monitoring stations and worked together to solve problems, and when Basin authorities shared information with counties. Coordination was hindered when counties found it hard to share information with upstream or downstream neighbors, and when information flows from the center diminished. Globally, there is a growing realization among public agencies that by making data open – freely accessible, machine readable, and unrestricted in use – both public and private sectors are able to make better and more informed decisions.

- **Climate adaptation interventions are easily assimilated when they bring immediate benefits under current climate conditions and variability.** Measures introduced were resilient to future conditions, but already made good farming sense given current risks. Substantial outreach to farmers and policymakers helped with adoption, as did incorporation of the innovations in a larger project.

- **Climate modeling is best used to test adaptation policies for robustness against different scenarios, rather than to predict 'what will be'**. There are limits to the ability of climate models to predict future cropping conditions, because of fundamental uncertainties about the effect of-more carbon dioxide on crop growth, and inability of the models to accurately predict precipitation.

- **The Bank can be a driving force for technology transfer.** Innovations in integrated water management, and the ET paradigm, were introduced by a Bank TTL who combined state of the art, agriculture with irrigation expertise with persuasive leadership, supported by international and local experts, and by dynamic successor TTLs.

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Annex A. Basic Data Sheet for the Irrigated Agriculture Intensification III Project and the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project

Key Project Data (amounts in US$ million)

	Appraisal estimate	Actual or current estimate	Actual as % of appraisal estimate
Total project costs	463.18	463.00	99.96
Loan amount	200.00	200.00	100.00
Cofinancing (GEF)	5.00	5.00	100.00
Borrower	136.79	137.40	100.00
Beneficiaries	126.89	126.10	99.38

Cumulative Estimated and Actual Disbursements

	FY06	*FY07*	*FY08*	*FY09*	*FY10*	*FY11*	*FY12*
Appraisal estimate (US$M)	30.19	73.86	118.07	160.55	189.55	199.55	200.00
Actual (US$M)	20.50	57.12	130.18	170.66	200.00	200.00	200.00
Actual as % of appraisal	67.90	77.33	110.25	106.29	105.51	100.22	100.00
Date of final disbursement: 10/16/2009							

Project Dates for the Irrigated Agriculture Intensification III Project

	Original	Actual
Initiating memorandum	12/15/2003	03/16/2004
Negotiations	09/01/2005	09/01/2005
Board approval	04/27/2005	10/11/2005
Signing	12/12/2005	12/09/2005
Effectiveness	02/17/2006	02/17/2006
Closing date	12/31/2010	12/31/2010

Project Dates for the Mainstreaming Climate Change Adaptation in Irrigated Agriculture Project

	Original	Actual
Initiating memorandum	03/06/2007	03/29/2007
Negotiations	02/25/2008	02/20/2008
Board approval	01/22/2008	04/17/2008
Signing	08/22/2008	08/15/2008
Effectiveness	10/15/2008	1/13/2008
Closing date	06/29/2012	06/30/2012

Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
Lending	**No. of staff weeks**	**US$ Thousands (including travel and consultants costs)**
FY04	25.82	184.91
FY05	52.01	520.37
FY06	8.72	42.96
Total:	**86.55**	**748.24**
Supervision/ICR		
FY06	8.39	37.48
FY07	16.64	82.46
FY08	14.44	68.25
FY09	6.33	49.69
FY10	5.47	68.91
FY11	7.89	58.94
Total:	**59.16**	**365.73**

Task Team Members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Qun Li	Team Leader Sr. Operations Officer	EASER	Team Leader
Arlene D. Reyes	Sr. Program Assistant	GSDPR	Administrative
Chongwu Sun	Sr. Environmental Spec.	EASCS	Environment
Hongwei Zhao	Program Assistant	EACSQ	Administrative
Houbin Liu	Consultant	EASCS	Water Resources Management
Jinan Shi Sr.	Procurement Specialist	EAPPR	Procurement
Lang Seng Tay	Consultant	EASRE	HIS Irrigation Engineer
Li Ouyang	Program Assistant	EACCF	Administrative
Margaret Png	Lead Counsel	LEGEM	Legal
Marie Claire M. Li Tin Yue	Sr. Program Assistant	AFTUW	Administrative
Minhnguyet Le Khorami	Program Assistant	EASER	Administrative
Patria Consuelo M. Morente	Program Assistant	MDM	Administrative
Qingtao Xie	Consultant	EASCS	Environment
R. Cynthia Dharmajaya	Program Assistant	EASER	Administrative
Richard B. Reidinger	Consultant	EASER	Water Users'
Robert Leonard O'Leary	Sr. Finance Officer	CTRFC	Financial Management
Shaojun Li	Project Coordinator	EASCS	DFID Project Coordinator
Wen Poh Ting	Consultant	EASRE – HIS	Agronomist
Xiuzhen Zhang	Interpreter/ Translator	GSDTI	Translator
Yi Dong	Sr. Financial Management Specialist	EAPFM	Financial Management
Zong-Cheng Lin	Sr. Social Development Specialist	EASCS	Social Aspects
Supervision/ICR			
Qun Li	Sr. Operations Officer/Task Team Leader for both supervision and ICR missions	EASER	Team Leader
Chongwu Sun	Sr. Environmental Spec.	EASCS	Environment
Chunxiang Zhang Sr.	Program Assistant	EACCF	Administrative

Names	Title	Unit	Responsibility/ Specialty
Geoffrey Spencer	Consultant	EASCS	Irrigation Engineer
Jinan Shi	Sr. Procurement Specialist	EAPPR	Procurement
Harideep Singh	Senior Rural Development Specialist	EASER	ICR Author
M. Salah Darghouth	Consultant	AFTWR	Agriculture and Water Resources
Minhnguyet Le Khorami	Program Assistant	EASER	Administrative
Patria Consuelo M. Morente	Program Assistant	MDM	Administrative
Richard B. Reidenger	Consultant	EASER	Water Users Associations Specialist
Sukanya Venkataraman	Program Assistant	HDNDE	Administrative
Usaid I. El-Hanbali	Consultant	AFTWR	Irrigation Engineer
Yi Dong	Sr. Financial Management Specialist	EAPFM	Financial Management
Yuan Wang Procurement	Analyst	EAPPR	Procurement
Yunqing Tian	Team Assistant	EACCF	Administrative
Zong-Cheng Lin	Sr. Social Development Specialist	EASCS	Social Aspects

Annex B. Basic Data Sheet for the Hai Basin Integrated Water and Environment Project

Key Project Data (amounts in US$ million)

	Appraisal estimate	Actual or current estimate	Actual as % of appraisal estimate
Total project costs	33.32	34.53	103.60
Loan amount	17.00	16.96	99.76
Cancellation	0.00	0.40	0.00

Cumulative Estimated and Actual Disbursements

	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12
Appraisal estimate (US$M)	2.88	6.20	9.77	13.04	15.57	17.00	17.00	17.00
Actual (US$M)	1.47	3.42	5.48	7.61	8.79	11.34	13.97	16.96
Actual as % of appraisal	51.04	51.16	56.09	58.35	56.45	66.70	82.17	99.76
Date of final disbursement: 10/27/2011								

Project Dates

	Original	Actual
Initiating memorandum	11/21/2003	11/17/2003
Negotiations	2/16/2004	2/17/2004
Board approval	4/15/2004	4/15/2004
Signing	7/30/2004	2/17/2004
Effectiveness	9/29/2004	9/22/2004
Closing date	6/30/2010	6/30/2011

Staff Inputs (staff weeks)

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
Lending	**No. of staff weeks**	**US$ Thousands (including travel and consultants costs)**
FY02	20	33.33
FY3	35	102.05
FY04	40	189.88
FY 05	10	1.78
Total:	**105**	**327.04**
Supervision/ICR		
FY04	2	0.13
FY05	35	100.50
FY06	20	64.67
FY07	20	64.84
FY08	22	78.88
FY09	15	35.00
FY10	15	30.00
FY11	20	42.00
Total:	**149**	**416.02**

Task Team Members

Names	Title
Lending	
Olson, Douglas	Task Team Leader, Principal Water, Resources Engineer
Jiang, Liping	Task Team Leader, Sr. Irrigation Engineer
Braedt, Oliver	Natural Resource Management Specialist
Broadfield, Robin	Sr. Regional Coordinator
Browder, Greg	Sr. Water Resources Specialist
Dong, Yi	Financial Management Specialist
Lin, Zong-Cheng	Social Development Specialist
Nguyen, Hoi-Chan	Sr. Counsel
Jostein, Nygard	Sr. Environmental Specialist
O'Leary, Robert	Sr. Finance Officer
Png, Margaret	Sr. Counsel
Reyes, Arlene	Program Assistant
Sun, Chongwu	Sr. Environmental Specialist
Yang, Dawei	Procurement Specialist

Zhou, Weiguo	Operations Officer
Supervision/ICR	
Jiang, Liping	Task Team Leader, Sr. Irrigation Engineer
Lyle, Clive	Consultant, Water Resources
Zhang, Kaiping	Consultant, Project Management
Liu, Xueming	Economist, FAO
Su, Yibing	Consultant, Environment
Li, Ou	Consultant, Social Assessment
Olson, Douglas	Principal Water Resource Engineer
Browder, Greg	Lead Water and Sanitation Specialist
Dong, Yi	Sr. Finance Management Specialist
Guo, Xiaowei	Sr. Procurement Specialist
Lin, Zong- Cheng	Sr. Social Development Specialist
Wang, Yuan	Procurement Specialist
Zhou, Weiguo	Operations Officer
Chen, Xin	Sr. Program Assistant
Chen, Jianxin	Interpreter

Annex C. List of Persons Met or Contacted

Tianjin City - September 12, 2014

Name	*Organization*	*Title*
BAI Xiaohong	Tianjin City Construction Commission	Consultant
HE Yunya	Tianjin City Water Affairs Bureau	Deputy Director
HOU Xiaomin	Tianjin Academy of Environmental Sciences	Staff
JIA Liquan	Tianjin City Environmental Protection Bureau	Director
LI Haoting	GEF Hai Basin IWEM Project Office, Ministry of Environmental Protection	Staff
LI Li	Tianjin Academy of Environmental Sciences	Staff
LI Wanqin	Tianjin City Environmental Protection Bureau	Consultant
LIU Bin	GEF Hai Basin IWEM Project Office, Ministry of Water Resources	Deputy Director
LU Xueqiang	Tianjin Academy of Environmental Sciences	Vice President
MA Fengju	Tianjin City Finance Bureau	Staff
SHAO Xiaolong	Tianjin Academy of Environmental Sciences	Staff
SUN Yanqing	Tianjin Environmental Assessment Center	Staff
XING Rong	Tianjin City Water Affairs Bureau	Staff
YAN Li	Tianjin City Construction Commission	Deputy Director
YAN Yeduan	Tianjin City Water Affairs Bureau	Consultant
YUE Lin	Tianjin City Construction Commission	Staff
ZHANG Xiaolan	GEF Hai Basin IWEM Project Office, Ministry of Environmental Protection	Deputy Director

Pinggu County - September 16, 2014

Name	*Organization*	*Title*
DONG Chunyu	Pinggu GEF Hai Basin IWEM PMO	Staff
GUO Jianhua	Pinggu GEF Hai Basin IWEM PMO	Director
HE Hao	Beijing GEF Hai Basin IWEM PMO	Deputy Director
LI Chunmei	Pinggu GEF Hai Basin IWEM PMO	Staff
LI Qianxiang	Beijing GEF Hai Basin IWEM PMO	Staff
MA Ming	China Institute of Water Resources and Hydropower Research	IWEMP Writer
WANG Guoquan	Pinggu Water Affairs Bureau	Deputy Director
WANG Jianzhong	Dahua Town, Dahuashang Village WUA	Chairman
WANG Youcai	Pinggu GEF Hai Basin IWEM PMO	Staff
XU Wei	Pinggu GEF Hai Basin IWEM PMO	Staff
ZHANG Guangming	Pinggu Environmental Protection Bureau	Director

ZHOU Haibin	Shandongzhuang Town, Shandongzhuang Village	Water Manager

Guantao County - September 14, 2014

Name	*Organization*	*Title*
GU Junfang	Handan City Water Resources Bureau	Department Head
LI Huichang	Expert Group	Consultant
LI Nan	Handan City Water Resources Bureau	Staff
LIU Wengang	Handan City Water Resources Bureau	Deputy Director
PENG Junling	Hebei Provincial Water Resources Department	
WANG Yinhu	Hebei Provincial Water Resources Department	Deputy Director
ZHANG Yanhong	Handan City Water Resources Bureau	Section Chief

Cangzhou County- September 18 2014

Name	*Organization*	*Title*
JIN Shulin	Hebei Provincial IAIL3 PMO	Deputy Director
FAN Guofeng	Hebei Provincial IAIL3 PMO	Section Chief
BEN Yu	Provincial Office of Comprehensive Agriculture Development	Section Chief
GUO Yongchen		Water resources expert
LIN Wenjing		Water resources expert
XU Zhiyong	Cangzhou City IAIL3 PMO	Director
JI Jianyong	Cangzhou City IAIL3 PMO	Deputy Director
WANG Jigui		Agriculture expert
LIU Wengang	Cangxian County Office	Vice Mayor
YU Guodong	Cangxian County Office	Director
YANG Shide	Cangxian Finance Bureau	Deputy Director

Jiangsu and Anhui

Name	*Title*	*Sihong*	*Suqian*	*Jiangsu*
Haifeng Zhao	Deputy ombudsman at POCAD			Jiangsu
Shijun Sun	Deputy director at the Foreign Capital Utilization Division of POCAD			Jiangsu
Xilin Wang	deputy division chief at POCAD			Jiangsu
Linzhi Bao	MOCAD deputy director		Suqian	Jiangsu
Guangjun He	COCAD director	Sihong	Suqian	Jiangsu
Cunshan Liu	MOCAD director		Xuzhou	Jiangsu
Xuelun Wang	COCAD director	Xinyi	Xuzhou	Jiangsu
Bin Lu	COCAD staff	Xinyi	Xuzhou	Jiangsu

Wenyi Xu	COCAD staff	Xinyi	Xuzhou	Jiangsu
Ke Xu	COCAD staff	Xinyi	Xuzhou	Jiangsu
Jun Chen	POCAD deputy director			Anhui
Wenjian Guan	division chief at POCAD			Anhui
Jun Zheng	deputy division chief at POCAD			Anhui
Meng Wang	POCAD cadre			Anhui
Ping Yan	POCAD professor			Anhui
Bo Zhou	Deputy director at city finance bureau		Bengbu	Anhui
Wei Yang	MOCAD director		Bengbu	Anhui
Changkui Xu	County Governor	Huaiyuan	Bengbu	Anhui
Shouben Wang	Director of County Finance Bureau	Huaiyuan	Bengbu	Anhui
Guifang Shi	Deputy Director at County Finance Bureau	Huaiyuan	Bengbu	Anhui
Yi Shang	COCAD staff	Huaiyuan	Bengbu	Anhui
Bin Gu	COCAD staff	Huaiyuan	Bengbu	Anhui
Laibin Zhong	Deputy Director of City Finance Bureau		Chuzhou	Anhui
Ning Hu	MOCAD director		Chuzhou	Anhui
Zhihua Cao	Deputy County Governor	Quanjiao	Chuzhou	Anhui
Zhishan Jiang	Director of County Finance Bureau	Quanjiao	Chuzhou	Anhui
Heping Zhao	Deputy Director of County Finance Bureau	Quanjiao	Chuzhou	Anhui
Yong Gao	COCAD Director	Quanjiao	Chuzhou	Anhui
Maohua Wang	COCAD Deputy Director	Quanjiao	Chuzhou	Anhui
ZHONG Laibin	Deputy Director, Finance Bureau		Chuzhou	Anhui
HE Guangjun	Director COCAD	Sihong		Jiangsu
WANG Xuelun	Director COCAD	Xinyi		Jiangsu

Others

Name	***Organization***	***Title***
Ahmed el Bouari	Association of Rural Engineers, Rabat	President
Bastiaanssen, Wim	HBP Global Expert Group; Chair, Global Water Accounting, Unesco	Chair
Din Ping	SOCAD	Senior Monitoring Officer
Droogers, Peter	HBP Global Expert Group; Futurewater	
DONG Chunyu	Pinggu GEF Hai Basin IWEM PMO	Staff
Guo Bao Li	Baodi Water Authority	Deputy Director

GUO Jianhua GUO Yongchen	Pinggu GEF Hai Basin IWEM PMO Hebei Provincial Academy of Water Resources	Director
HE Hao	Beijing GEF Hai Basin IWEM PMO	Deputy Director
Huang, Jikun	Centre for Chinese Agriculture Policy	Director
Hadani El Driss	Royal Center for Remote Sensing	Director
Jun Jin You	Department of Water Resources China Institute of Water Resources & Hydro Power Research	Senior Engineer
LI Chunmei	Pinggu GEF Hai Basin IWEM PMO	Staff
Li Haoting	Foreign Economic Cooperation Office, Ministry of Environment Protection	Program Officer
Li Jian Xin	Hai Water Conservation Committee	Deputy Director
Li Jian Xin	Hai Basin Water Conservation Commission	Deputy Director
Li Pei	Ministry of Environment and Protection	Deputy Director General
LI Qianxiang	Beijing GEF Hai Basin IWEM PMO	Staff
Liping Jiang	Beijing Office, World Bank	Senior Water Specialist
Liu Cunshan	Municipal Office of Comprehensive Agricultural Development, Xuzhou City	Deputy Director
Liu Hanfu	Water Resources Department, Baodi District	Director
Liu Harfu	Water Resources Department, Baodi District	Director
Liu Suxia	Hydrology and Water Resources	Professor
Lou Xiao Hui	SOCAD	Deputy Director
MA Ming	China Institute of Water Resources and Hydropower Research	IWEMP Writer
Ongley, Ed	HBP Global Expert Group	
WANG Guoquan	Pinggu Water Affairs Bureau	Deputy Director
WANG Jianzhong	Dahua Town, Dahuashang Village WUA	Chairman
Wang Xilin	Provincial Office of Comprehensive Agricultural Development, Jiangsu Province	Deputy Chief
Wang Xue Lun	Office for Comprehensive Agriculture Development, Xinyi County	Director
Wang Xue Lun	Xinyi COCAD	Director
Wang Youcai	Pinggu GEF Hai Basin IWEM PMO	Staff
Wang Jinxia	Center for Chinese Agricultural Policy Chinese Academy Sciences	Professor
Wu Bingfang	Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences	Professor
Wu Xiaopu	Oceanic Department for Bohai Sea, Tianjin	Research Fellow And M&E specialist

Xiaopu Wu	Institute of Environmental Ecology, Chinese Research Academy of Environmental Science	Researcher
Xin Wenli	Production Department, Baodi District Agricultural Committee	Director
XU Wei	Pinggu GEF Hai Basin IWEM PMO	Staff
Xueqiang Lu	Tianjin Academy of Environmental Sciences	Professor
Yan Ping	Anhui University of Agriculture Resources and Environment	Professor
Yang Yuchuan	Foreign Economic Cooperation Office, Ministry of Environmental Protection	Team Leader
Yuan Xin	Atmospheric Physics Research Institute, Chinese Academy of Science	Research Fellow
Yangwen Jia	China Institute of Water Resources and Hydro Power Research	Professor
Zhang Guangming	Pinggu Environmental Protection Bureau	Director
Zhou Haibin	Shandongzhuang Town, Shandongzhuang Village	Water Manager
Zhou Zuhao	State Key Laboratory of Simulation and Regulation of Water Cycle in River Basin	Professor

Annex D. Borrower Comment

Comments received from the Ministry of Finance

From: socad_wly [mailto:socad_wly@126.com]

Sent: Wednesday, June 03, 2015 9:25 AM

To: Dan Xie

Subject: Re: For your attention and comments on draft PPAR for CHINA - Third Irrigated Agric. Intensification Project, Mainstreaming Climate Change Adaptation in Irrigated Agric. Project , and Hai Basin Integrated Water and Envir. Management Project.

Dear Ms. Xie,

Thanks for sending us the draft PPAR. What we implemented are Irrigated Agriculture Intensification III Project and Mainstreaming Climate Change Project. We roughly go through the draft report and found in Page ix "principal ratings," the PPAR rating for Risk to Development Outcome is Moderate, but in the text of Page 41, the risk to development outcome is rated Negligible to Low. Except the above doubt, we have no other comments. Thanks!

Best Regards,
Lanying Wang from SOCAD, MOF