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IMPLEMENTATION COMPLETION AND RESULTS REPORT

ON A

GRANT FROM THE GLOBAL ENVIRONMENT FACILITY (GEF) TRUST FUND

IN THE AMOUNT OF USD 6.6 MILLION

TO THE

ARAB REPUBLIC OF EGYPT

FOR THE

ENHANCED WATER RESOURCES MANAGEMENT PROJECT

May 30, 2017

Water Global Practice
Republic of Egypt
Middle East and North Africa Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective November 1, 2011)

Currency Unit = Egyptian Pound (EGP)
EGP 5.97 = US$ 1.00

FISCAL YEAR
July 1 – June 31

ABBREVIATIONS AND ACRONYMS

BCWUA	Branch Canal Water User Association
BOD	Biochemical Oxygen Demand
CAS	Country Assistance Strategy
CD	Controlled Drainage
CDIAS	Central Directorate for Irrigation Advisory Service
CF	Continuous Flow
CPD	Central Procurement Department
CPF	Country Partnership Framework
DO	Dissolved Oxygen
DRI	Drainage Research Institute
DSS	Decision Support System
DWB	District Water Board
EA	Environmental Assessment
EEAA	Egyptian Environmental Affairs Authority
ECRI	Environment and Climate Research Institute
EFA	Economic and financial analysis
EPADP	Egyptian Public Authority for Drainage
EWRMP	Enhanced Water Resources Management Project
GIS	Geographical Information System
GEO	Global Environmental Objective
GOE	Government of Egypt
HAD	High Aswan Dam
HADA	High Aswan Dam Authority
IIIMP	Integrated Irrigation Improvement Project
ISSIP	Integrated Sanitation and Sewerage Infrastructure Project
IWMD	Integrated Water Management District
IWRM	Integrated Water Resources Management

M&E	Monitoring and Evaluation
MALR	Ministry of Agriculture and Land Reclamation
MWRI	Ministry of Water Resources and Irrigation
NDP2	Second National Drainage Project
NFS	Nile Forecasting System
NGO	Non-Governmental Organizations
NRI	Nile Research Institute
NWRC	National Water Research Center
NWQM	National Water Quality Monitoring
PAD	Project Appraisal Document
PCU	Project Coordination Unit
PDO	Project Development Objective
SRI	System of Rice Intensification
SWM	Solid Waste Management
TDS	Total Dissolved Solids

Senior Global Practice Director:	Guang Zhe Chen
Practice Manager:	Steven Schonberger
Project Team Leader:	Abdulhamid Azad, Heba Yaken
ICR Team Leader:	Dambudzo Muzenda

EGYPT

Enhanced Water Resources Management Project

Contents

DATA SHEET

A. Basic Information			
Country:	Egypt, Arab Republic of	Project Name:	EG-Enhanced Water Resources Management
Project ID:	P118090	L/C/TF Number(s):	TF-12952
ICR Date:	05/30/2017	ICR Type:	Core ICR
Lending Instrument:	SIL	Borrower:	GOVERNMENT OF EGYPT
Original Total Commitment:	USD 6.68M	Disbursed Amount:	USD 6.68M
Revised Amount:	USD 6.68M		
Environmental Category: B		**Global Focal Area: I**	
Implementing Agencies: Ministry of Water Resources and Irrigation			
Cofinanciers and Other External Partners: N/A			

B. Key Dates				
Process	**Date**	**Process**	**Original Date**	**Revised / Actual Date(s)**
Concept Review:	12/22/2010	Effectiveness:	02/01/2013	02/01/2013
Appraisal:	11/10/2011	Restructuring(s):		03/17/2015
Approval:	07/05/2012	Mid-term Review:	07/01/2014	11/09/2014
		Closing:	06/30/2015	12/31/2016

C. Ratings Summary	
C.1 Performance Rating by ICR	
Outcomes:	Satisfactory
Risk to Global Environment Outcome	Substantial
Bank Performance:	Moderately Satisfactory
Borrower Performance:	Moderately Satisfactory

C.2 Detailed Ratings of Bank and Borrower Performance			
Bank	**Ratings**	**Borrower**	**Ratings**
Quality at Entry:	Moderately Satisfactory	Government:	Satisfactory
Quality of Supervision:	Moderately Satisfactory	Implementing Agency/Agencies:	Moderately Satisfactory
Overall Bank Performance:	Moderately Satisfactory	**Overall Borrower Performance:**	Moderately Satisfactory

C.3 Quality at Entry and Implementation Performance Indicators			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA):	None
Problem Project at any time (Yes/No):	Yes	Quality of Supervision (QSA):	None
GEO rating before Closing/Inactive status	Moderately Satisfactory		

D. Sector and Theme Codes		
	Original	**Actual**
Sector Code (as % of total Bank financing)		
Irrigation and Drainage	20%	20%
Public administration – water, sanitation and flood protection	70%	70%
Solid waste management	10%	10%
Theme Code (as % of total Bank financing)		
Water resources management	80%	80%
Pollution management and environmental health	10%	10%
Climate change	10%	10%

E. Bank Staff		
Positions	**At ICR**	**At Approval**
Vice President	Hafez Ghanem	Inger Andersen
Country Director	Asad Alam	A. David Craig
Practice Manager	Steven N. Schonberger	Francis Ato Brown
Project Team Leader	Abdulhamid Azad. Heba Yaken	Yoshiharu Kobayashi
ICR Team Leader	Dambudzo Muzenda	N/A
ICR Primary Author:	Dambudzo Muzenda	N/A

F. Results Framework Analysis
Global Environment Objectives (GEO) and Key Indicators (as approved)

The Global Environment Objective of this project, as set out in the project appraisal document (PAD), was to establish the basis for scaling up investments through the GoE's IWRM Plan and contribute more significantly to pollution control and improved ecosystem health of the Mediterranean Sea and its biodiversity resources.

The Project Development Objective (PDO) was to pilot integrated water resources management (IWRM) in the Nile Delta and to enhance the knowledge and capacity of water sector institutions for IWRM in the Recipient's territory.

Revised Global Environment Objectives (as approved by original approving authority) and Key Indicators and reasons/justifications(a) PDO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1:	**Technical and institutional capacity building training**			
Value (quantitative or qualitative)	3 persons/ 1 day	3,167persons/ 3,269 days	-	4,436 persons / 3,515 days
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target exceeded (140% and 107%). Capacity building refers to training on pilot scheme topics. The indicator refers to the number of persons trained and the number of training days.			
Indicator 2:	**Water saving volume used per feddan**			
Value (quantitative or qualitative)	11,000M3/feddan/year (consumed water per year)	9,500 m3/ feddan/ year	-	8,500 m3/feddan/year
Date achieved	Nov. 30, 2011	July 6, 2012		Dec. 31, 2016
Comments	Target exceeded (167%). The baseline (11,000 m3/feddan/ year) refers to the annual amount of fresh irrigation water used per feddan (1 feddan = 0.42 hectares). The target assumed a reduction of water used by applying the system of rice intensification (SRI) method. The target set was to reduce the volume of water used from 11,000m3/feddan to 9,500m3/ feddan, representing about 1,500m3/feddan/year in water savings. By the end of the project, water used went down to 8,500 m3/feddan/ year, saving 2,500 m3/feddan/year, much higher than the target set.			
Indicator 3:	**Increased percentage of reliability of water supply**			
Value (quantitative or qualitative)	55	85	-	85
Date achieved	Nov. 30, 2011	July 6, 2012	-	85
Comments	Target achieved (100%). % of time that sufficient quantity of irrigation water is available in pilot schemes			
Indicator 4:	**Government documents issued for IWRM policies/ procedures/ implementation**			
Value (quantitative or qualitative)	0	8	-	9
Date achieved	Nov. 30, 2011	July 6, 2012		Dec. 31, 2016
Comments	Target exceeded (112%). Government documents issued for IWRM policies/procedures/ implementation as follows: 1. Evaporation Losses Analysis in Lake Nasser 2. Climate Change Scenarios 3. Climate Change Adaptation Strategy 4. Development of a Decision Support System for the Nile Delta 5. Groundwater Modeling Analysis in the Nile Delta 6. Groundwater Water Quality Monitoring Capacity Enhancement in the Nile System 7. EWRMP Sustainability 8. EWRMP Lesson Learned 9. NDP2			
Indicator	**Baseline value**	**Original target**	**Formally revised**	**Actual value achieved**

		values	target values	at completion or target years
Indicator 5:	**Demonstration activities developed and implemented in the pilot areas**			
Value (quantitative or qualitative)	0 feddan	93,200 feddan	-	112,660 feddan
Date achieved	Nov. 30, 2011	July 6, 2012		Dec. 31, 2016
Comments	Target exceeded (121%). The actual area calculated covers the areas for SRI, CD, CF and SWM under EWRMP activities (direct or synergy). EWRMP 26,000 feddans (Direct) ISSIP 12,460 feddans (Synergy) NDP2 14,200 feddans (Synergy) IIIMP 60,000 feddans (Synergy)			
Indicator 6:	**Increased monitoring stations and water samplings**			
Original Value (quantitative or qualitative)	358	404	-	250
Revised value				
Date achieved	Nov. 30, 2011	July 6, 2012		Dec. 31, 2016
Comments	Target not achieved (62%). The indicator refers to the number of water quality monitoring stations (for surface water only).			
Indicator 7:	**Increased IWRM awareness and effective roles of local WUAs, farmers and stakeholders**			
Value (quantitative or qualitative)	0	97	-	319
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target exceeded (329%). Numbers of Organizations: 1. Number of DWB* 1 2. Number of BCWUOs 24 3. Numbers of WUOs 276 4. Numbers of Non WU – NGOs 18 Total 319 *DWB = district water boards, located a step above branch canal water user associations (BCWUAs), were a platform for stakeholder participation as their membership included representatives of all local authorities directly or indirectly involved in water use management.			

b) Intermediate Outcome Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1	**Legal/institutional procedures and regulations related to protection of GW quality**			
Value (quantitative or qualitative)	No	Yes	-	Yes
Date achieved	Nov. 20, 2011	July 6, 2012	-	-
Comments	Target achieved (100%). A draft report was prepared under the project on legal/institutional procedures and regulations related to the protection of GW quality.			
Indicator 2	**M&E system and database established and implemented effectively in the project areas**			
Value (quantitative or qualitative)	No	Yes	-	Yes
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (100%). The M&E system has been established and operational since end of 2012			
Indicator 3	**Sustainable water resources management study report completed and submitted**			
Value (quantitative or qualitative)	No	Yes	-	Yes
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (100%). 1 report was delivered			
Indicator 4	**Stakeholder analysis and policy formulation completed**			
Value (quantitative or qualitative)	No	Yes	-	Yes
Date achieved	Nov. 30, 2011	July 6, 2012		Dec. 31, 2016
Comments	Target achieved (100%). 1 report was prepared for the 3 pilot schemes			
Indicator 5	**Number of government documents issued for IWRM policies, procedures, measures and activities through policy briefs, government reports, implementation/ replication plans.**			
Value (quantitative or qualitative)	0	8	-	9
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (112%). 1. Evaporation Losses Analysis in Lake Nasser 2. Climate Change Scenarios 3. Climate Change Adaptation Strategy 4. Development of a Decision Support System for the Nile Delta 5. Groundwater Modeling Analysis in the Nile Delta 6. Groundwater Water Quality Monitoring Capacity Enhancement in the Nile System 7. EWRMP Sustainability 8. EWRMP Lesson Learned 9. NDP2			

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 6	**Increased sampling parameters for groundwater quality monitoring**			
Value (quantitative or qualitative)	3500	4100	-	4,305
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (105%). This indicator measures improvements in groundwater monitoring.			
Indicator 7	**Consultation/coordination/dissemination workshops conducted by PCU in the field and international conference**			
Value (quantitative or qualitative)	0	4	-	4
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (100%). Consultation workshops were held in the areas of the pilot schemes.			
Indicator 8	**The water saved by the application of evaporation losses reduction methods**			
Value (quantitative or qualitative)	0	1	-	1
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (100%). While the indicator mentions “water saved”, in reality it refers to the study on monitoring evaporation water losses in Lake Nasser. There were no other project activities on evaporation water losses, and no physical activities aimed at reducing these losses.			
Indicator 9	**Biochemical Oxygen Demand (BOD)**			
Value (quantitative or qualitative)	216 mg/liter	30 mg/liter	-	30 mg/liter
Date achieved	Nov. 30, 2011	July 6, 2012	-	31 Dec. 2016
Comments	Target achieved (100%). The indicator is a measure of water quality.			
Indicator 10	**Dissolved Oxygen (DO)**			
Value (quantitative or qualitative)	1mg/liter	4mg/liter	-	3.3mg/liter
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target partially achieved (82%). This indicator is a measure of water quality.			
Indicator	**Baseline Value**	**Original Target Values (from approval documents)**	**Formally Revised Target Values**	**Actual Value Achieved at Completion or Target Years**
Indicator 11	**Solid waste management (collected volume)**			
Value (quantitative or qualitative)	0	5,000 tons	-	4,200 tons
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target partially achieved (84%). Behaira and Sharkiya stations are operational			
Indicator 12	**SRI adopted area**			
Value (quantitative or qualitative)	0	500 feddans	-	348 feddans

Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target partially achieved (70%). It should be noted that while 348 feddan of SRI area was implemented under EWRMP, farmers voluntarily implemented 80 feddans in areas influenced by the SRI experience in the pilot areas. In addition, IIIMP implemented an additional 80 feddans. However, only the EWRMP areas are reported in the final achievement value.			
Indicator 13	**Surface and groundwater quality monitoring report**			
Value (quantitative or qualitative)	0	3 reports	-	1 report
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target not achieved (33%).			
Indicator 14	**Establishment of climate change information database**			
Value (quantitative or qualitative)	No	Yes	-	Yes
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (100%).			
Indicator 15	**Formulation of groundwater development strategy and action plan completed and submitted to MWRI**			
Value (quantitative or qualitative)	No	Yes	-	Yes
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target achieved (100%).			
Indicator 16	**Volumetric water supply measured in no. of branch and mesqa canals**			
Value (quantitative or qualitative)	0	256	-	263
Date achieved	Nov. 30, 2011	July 6, 2012	-	Dec. 31, 2016
Comments	Target exceeded (103%). The number of mesqas where irrigation water supply is provided is measured as follows: IIIMP Hamed Menesi 159 Nekla 54 Sub-total 213 EWRMP 50 Total 263			
Indicator	**Baseline Value**	**Original Target Values (from approval documents)**	**Formally Revised Target Values**	**Actual Value Achieved at Completion or Target Years**
Indicator 16	**Increased new real-time monitoring stations**			
Value (quantitative or qualitative)	7.00	12.00	-	N/A
Date achieved	Nov. 30, 2011	July 6, 2012	-	N/A
Comments	The indicator on “increased new real-time monitoring stations”, which was originally an intermediate indicator in the PAD, was not measured as poor security conditions in the country limited data gathering.			

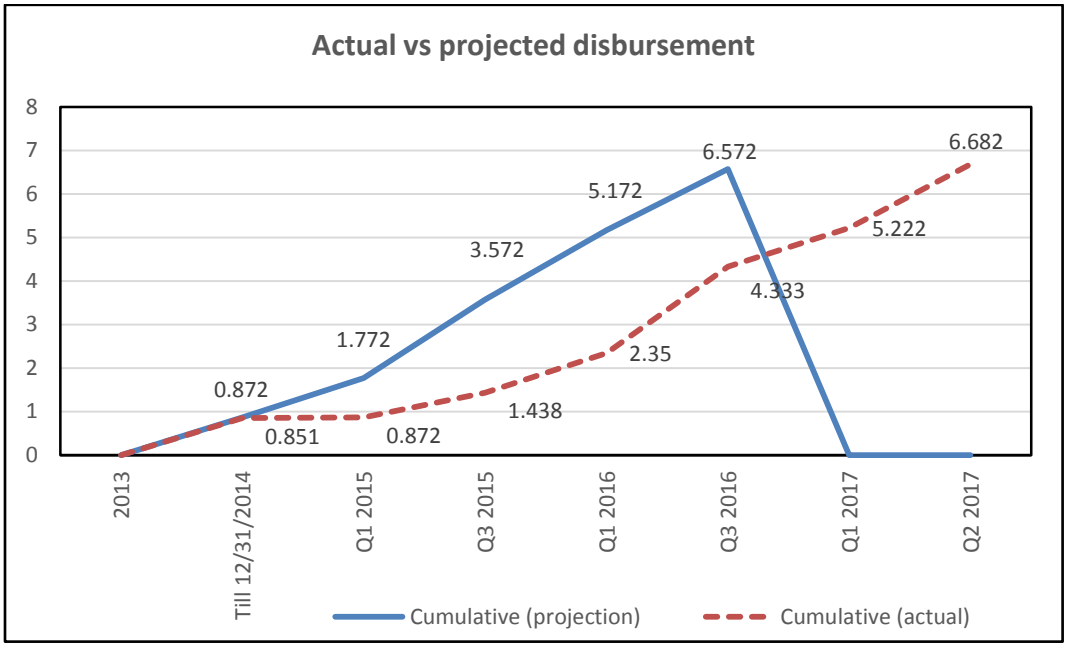
G. Ratings of Project Performance in ISRs

No.	Date ISR Archived	GEO	IP	Actual Disbursements (USD millions)
1	12/31/2012	Satisfactory	Satisfactory	0.00
2	07/08/2013	Satisfactory	Satisfactory	0.40
3	12/28/2013	Satisfactory	Satisfactory	0.40
4	04/20/2014	Satisfactory	Satisfactory	0.45
5	10/11/2014	Satisfactory	Moderately Satisfactory	0.87
6	04/22/2015	Satisfactory	Moderately Satisfactory	1.52
7	12/08/2015	Moderately Unsatisfactory	Moderately Unsatisfactory	3.19
8	06/27/2016	Moderately Unsatisfactory	Moderately Satisfactory	4.98
9	12/30/2016	Moderately Satisfactory	Moderately Satisfactory	6.68

H. Restructuring (if any)

Restructuring Date(s)	Board Approved GEO Change	ISR Ratings at Restructuring		Amount Disbursed at Restructuring in USD millions	Reason for Restructuring & Key Changes Made
		GEO	IP		
03/17/2015		S	MS	0.91	The restructuring extended the grant closing date by 1.5 years from June 30, 2015 to December 31, 2016. The reason was to help the Government finalize the remaining works considering the start-up delay in recruitment of consultants and security problem in the country due to civil unrest.

Disbursement Profile



NB: the projections are based on the revised projections done at restructuring. The PAD Data Sheet shows expected cumulative disbursements of: $4.142 million (2013), $5.828 million (2014) and $6.682 million (2015).

1. Project Context, Global Environment Objectives and Design

1.1 Context at Appraisal

1. **Sector Context**: Egypt is a water stressed country with less than 700 m^3/year of per capita freshwater availability. Population growth, estimated at 2% a year at appraisal, is expected to reduce the per capita share of renewable freshwater resources to less than 300 m^3/year by 2050. The country relies on the Nile River, which provides 98% of the annual renewable water resources. As the Nile is a transboundary resource shared among ten riparian states[1], there is ongoing cooperation between Egypt and the other riparians, particularly in the context of the Nile Basin Initiative. Another important transboundary resource is the Mediterranean Sea, into which the Nile Delta's extensive drains discharge their water. The quality of this water therefore has important ecological impacts on the Mediterranean.

2. In addition to scarcity and transboundary waters, the other issues affecting the water sector then, as now, were related to climate change and growing demand from socioeconomic sectors. Various studies anticipate that climate change could significantly reduce precipitation, increase temperatures and change the flow of the Nile. On the socioeconomic front, Egypt has been expanding its industrial base, while rising living standards and food security needs have been adding to the increasing and competing demands for limited water resources. Recognizing the complexity of these challenges, the Government of Egypt had recognized by appraisal that an integrated approach was needed, rather than the "business-as-usual" siloed approach.

3. Any action to improve water resources management in Egypt requires a focus on agriculture. At appraisal, agriculture used about 85% of freshwater resources and most of the agricultural land was intensely irrigated. However, irrigation suffered from significant inefficiencies that became increasingly unacceptable, as water availability was becoming less assured, particularly for rice cultivation and during peak demand in summer time. A number of projects to improve irrigation management had been implemented in the past, notably the Irrigation Improvement Project (IIP, 1994 – 2006), which focused on improving irrigation efficiency and distribution at the mesqa (tertiary) level, and the Integrated Irrigation Improvement and Management Project (IIIMP, 2006 - 2016), which broadened to scope to include irrigation and drainage and covered the primary, branch and mesqa levels. However, the focus of IIP and IIIMP remained narrow, hardly considering the socioeconomic changes or other relevant sectoral issues such as the need to shift to demand control.

4. As with irrigation, water quality and drainage were essential aspects of water resources management. At the time of appraisal, the extensive drainage system was heavily polluted by industrial effluent and untreated sewerage, which was usually dumped into open drains. The National Drainage Project (NDP) 1 (1992 - 2000) and NDP 2 (2001 – 2015) had promoted improvements to sub-surface drainage in order to evacuate excess water and reduce salinization. However, these projects' main objective was to boost agricultural productivity rather than address other water resource issues such as water quality or water savings. In addition, the Integrated Sanitation and Sewerage Infrastructure Project (ISSIP) provided sanitation systems (ISSIP I, 2008 - 2015) and constructed wastewater treatment facilities (ISSIP II, 2011 - 2017), in order to improve rural sanitation and enhance water quality in

[1] The 10 Nile riparian states are Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania and Uganda.

selected rural areas and drainage basins respectively. However, ISSIP I and II did not tackle solid waste management (SWM), which was also important for water quality.

5. There was a consensus at appraisal that it was important to build on the previous irrigation, drainage and rural sanitation projects while innovating on the approaches taken in the past. There was also increasing awareness among the Government of Egypt (GoE) and its development partners, including the World Bank, that water resources could not be managed in isolation to other interrelated issues, particularly pollution, growing demand, climate change, inefficient agricultural water use and socioeconomic pressures. Moreover, the Government's knowledge of how water resources are aligned with inter-sectoral interests was rather limited and there was not enough of an evidence base to inform decision-making on an integrated approach to water resources management. The Enhanced Water Resources Management Project (EWRMP) was developed precisely to fill these gaps.

6. **Government priorities**: While water management in Egypt had historically focused on supply-side options, at the time of appraisal there was growing recognition that a shift was needed to control demand and improve water quality. At the time the project was prepared, GOE had already acknowledged the importance of adopting an integrated approach to tackling water scarcity, water use efficiency and water quality issues. The 2005 National Water Resources Plan had officially adopted the integrated water resources management (IWRM) concept, which was internationally accepted and widely applied. It combined all aspects of Egypt's water resources, including all water user sectors, as well as a socio-economic perspective. The Integrated Water Resources Management Plan (2005), a companion to the National Water Resources Plan, provided a concrete roadmap for implementing IWRM but at the time it was developed, the Government had not yet implemented IWRM at project level.[2] There was strong Government appetite to pilot IWRM through the EWRMP. There was no change in the project's importance for the Government even when the country faced significant political upheaval starting in February 2011.

7. The aforementioned Plans explicitly identified awareness raising for IWRM, water quality and institutional reform and strengthening as priority action areas. GOE also emphasized the greater role that governorates and local stakeholders could play in future WRM interventions. In addition, the Sustainable Agriculture to 2030 strategy – developed in 2009 by the Ministry of Agriculture and Land Reclamation (MALR) - highlighted the importance of improved WRM to boost agricultural productivity.

8. **Rationale for the Bank's assistance**: The World Bank's 2006-2009 Country Assistance Strategy (CAS), which the Bank extended to cover the period up to 2011, echoed GoE's focus on improved management of water resources. One of the pillars of the Bank's strategy was improved public service provision, including the quality of water resources. The CAS included a goal on improving air and water quality and reducing water losses. The successor to the CAS, the World Bank's Interim Strategy Note, covered the period June 2012 to December 2013, and identified water quality and water availability in the Delta area as critical issues. As with the CAS, the Note identified the need to promote equity in water service provision as a priority of the Bank's support to Egypt and underscored the greater role that governorates and local stakeholders could play in future interventions.

[2] A 2008 Status Report by UN Water on IWRM practices surveyed 104 countries on how far they had adopted IWRM. Adoption was defined as the inclusion of IWRM as a pivotal concept in government documents, national plans or policies. By this measure, Egypt was considered to have adopted IWRM. The Status Report offers 3 classifications: i) IWRM plan in place; ii) IWRM plans in preparation and iii) IWRM implementation (initial steps taken – partial or full). On this basis, Egypt was considered to be at the second stage, i.e. IWRM plans in preparation but not yet under implementation. *Source: http://www.unwater.org/downloads/UNW_Status_Report_IWRM.pdf*

9. **The role of the GEF project**: The EWRMP was developed at a crucial juncture in Egypt's WRM strategy. On the one hand, there was a growing recognition by Egyptian experts that the traditional approach to addressing water scarcity, irrigation, drainage and water quality in isolation was not effective, and that WRM had to address a range of complex issues resulting from rapid population growth, climate change and greater demand on relatively fixed water resources. On the other hand, the Government was stymied by its limited skills and knowledge on how to tackle these inter-related challenges in a holistic way. The development of the WRM Plans was a good first step. However, the Government did not allow Technical Assistance (TA) funding under loans, which limited the possibility for building these skills and knowledge base for informed policymaking. The GEF grant provided the opportunity to support a TA approach and for the Government to pilot and build skills in IWRM.

1.2 Original Global Environment Objectives (GEO) and Key Indicators (*as approved*)

10. The global objective of this project – as reported in the PAD - was to establish the basis for scaling up investments through the GOE's IWRM plan and to contribute more significantly to pollution control and the improved ecosystem health of the Mediterranean Sea and its biodiversity resources.

11. The PDO – as reported in the Grant Agreement and in the PAD - was to pilot integrated water resources management (IWRM) in the Nile Delta and to enhance the knowledge and capacity of water sector institutions for IWRM in the Recipient's territory.

12. **Key PDO Indicators (from the PAD)[3] were**:

- Increased IWRM awareness and effective roles of local authorities, WUAs and other stakeholders in IWRM (Number of farmers, WUA members, and stakeholders involved in pilot schemes);
- Practical water quality and pollution control measures developed and implemented in the demonstration pilot schemes (number of feddan) by participating stakeholders to promote the integrated water quality and water resources availability management (increased percentage of reliability of water supply);
- Strengthened water quality monitoring network through training of government agency staff concerned (number of staff trained) and provision of monitoring equipment to upgrade the national surface water and groundwater monitoring networks (increased number of monitoring stations and water samplings); and
- Established procedures for integrated water quality and water availability management taking into consideration the climate change impacts (number of government documents issued by project implementation and coordination offices for IWRM policies, procedures, measures and activities through policy briefs, government reports, implementation and/or replication plans).

1.3 Revised GEO and Key Indicators, and reasons/justification

13. There were no formal revisions of the PDO, GEO or of the intermediary indicators.

[3] The PAD (Annex 1) also included a results framework with 7 PDO indicators. These indicators were the basis of project monitoring and evaluation and are reflected in the ICR datasheet.

1.4 Main Beneficiaries

14. Rural communities in the Nile Delta, who were largely dependent on irrigated agriculture, were expected to benefit from project pilot schemes on IWRM. Expected benefits included improved water quality and better health outcomes from project interventions. As poverty levels were quite high in the Delta, the project was also expected to increase farmer incomes due to improved equity in water allocation and enhanced water productivity.

15. In addition, water sector institutions were targeted beneficiaries of knowledge and capacity building activities. These institutions included project management units (PMUs), Government agencies and their staff, local authorities and water user associations (WUAs). Non-governmental organizations (NGOs) also received training. These institutions all played a role in various aspects of water sector management – from high-level decision-making to service provision, awareness raising and public sector engagement.

1.5 Original Components

16. The EWRMP comprised the following three components:

Component 1 - Pilot Schemes (USD3.659 million)

17. Develop synergy between on-going water sector projects through demonstration activities in pilot areas, consisting of:

- **Nekla/Menesi Pilot Scheme**: (i) enhancement of surface water management including by application of the continuous flow principle, adoption of controlled drainage techniques, and pilot-testing of the System of Rice Intensification (SRI) approach; (ii) carrying out of a feasibility study on Solid Waste Management (SWM) in the irrigation and drainage canal system of the pilot area and provision of technical assistance and training related to implementation of SWM practices, including preparation of an Environmental Impact Assessment (EIA) and an Environment Management Plan (EMP) of this scheme; and (iii) provision of a Geographical Information System (GIS) and GIS computer equipment to monitor IWRM, and related training.

- **Okda/Tellin Pilot Scheme**: (i) carrying out of an EIA of the pilot scheme and development of an EMP to mitigate against identified pollution sources; (ii) improvement of the capacity of key government agencies to maintain drainage systems and establishment of a district water board; (iii) carrying out of a feasibility study on SWM in the irrigation and drainage canal system of the pilot area and provision of technical assistance and training related to implementation of SWM practices; (iv) identification of small-scale, cost-effective interventions to reduce pollution in the pilot area, and related training; and (v) carrying out of a public awareness campaign on waste avoidance, recycling and environmental health.

- **Khadrawia Pilot Scheme**: (i) carrying out of a stakeholder analysis to facilitate discussions between potential polluters and those affected by pollution; (ii) carrying out of an EIA of the pilot scheme and development of an EMP to mitigate against identified sources of drainage pollution; (iii) carrying out of a study to identify options for resolving drainage pollution; (iv) improvement of the capacity of key government agencies to maintain drainage systems and establish a district water board; and (v) carrying out of a public awareness campaign on waste avoidance, recycling and environmental health.

Component 2 - Capacity Building for Surface Water and Groundwater Management and Monitoring (USD 4.144 million)

18. Technical assistance and capacity building activities to support efficient and effective management of surface water and groundwater across sectors, consisting of:
   i) Carrying out of an evaporation loss analysis in Lake Nasser.
   ii) Carrying out of a climate change impact assessment in water and agriculture in the Nile delta.
   iii) Carrying out of a surface water modeling analysis in the Nile delta.
   iv) Carrying out of a groundwater modeling analysis in the Nile delta.
   v) Provision of surface water monitoring equipment in strategic locations and building the capacity of relevant government staff to effectively monitor surface water.
   vi) Provision of groundwater monitoring equipment in strategic locations and building the capacity of relevant government staff to effectively monitor groundwater quality.

Component 3 - Project Management (USD0.564 million)

19. Activities consisted of:

   i) Support to the Project Coordination Unit (PCU) in Project implementation, monitoring and evaluation and management.
   ii) Establishment of a results-based monitoring and evaluation system.
   iii) Provision of a tracking tool (IW Learn) for reporting and disseminating lessons learned on IWRM.

1.6 Revised Components

20. There were no revisions of the project components.

1.7 Other significant changes

21. Beginning in early 2011, Egypt faced significant political turnover and civic unrest, which slowed down project implementation and disbursement. Following a request from GoE in August 2014, a restructuring of the project took place in 2015 to extend the Grant closing date by 18 months, from June 30, 2015 to December 31, 2016 and to change the implementation schedule accordingly.

2. Key Factors Affecting Implementation and Outcomes

2.1 Project Preparation, Design and Quality at Entry

2.1.1 Project Preparation

22. The Bank undertook two missions in June and August 2011 to work with Government agencies on project preparation. The missions held discussions on selection criteria for pilot schemes, undertook stakeholder consultations in the project areas and advised on practical measures for procurement, M&E, financial management and other implementation arrangements. However, the Technical Assistance Consultant, who was meant to help the PCU with project preparation, did not come on board until well into project implementation.

2.1.2 Design

23. i) **Applying IWRM and enhancing the participation of local stakeholders:** IWRM is inherently complex, not only because of the intersection of multiple water-related sectors but also because it involves the participation of local actors (sub-national authorities and end users) in decision-making.

The project design reflected the multi-sectoral nature of IWRM by identifying roles for various institutions and stakeholders. For instance, in the continuous flow activity, the Mahmoudia District Water Management Board and the Nekla Branch Canal Water Users' Association (BCWUA) planned and controlled the flow rates entering the canal, which was essential for ensuring the optimal level of water used. As another example, farmers were responsible for opening and closing drainage valves in the controlled drainage activity. Virtually all of the pilots had differentiated roles for locally-based MWRI units, research institutes, water users, farmers, NGOs and private companies.

24. ii) **Multiple Government agencies involved in implementing EWRMP**: MWRI was the main implementing agency. Its Planning Sector was designated as the agency in charge of preparing and implementing the GEF proposal. Six agencies within MWRI were involved in implementing the EWRMP.[4] The involvement of the MWRI agencies included both their central units as well as governorate level offices in some cases. Most of the agencies had relatively strong institutional and technical capacity as well as long familiarity with the Bank's procedures and requirements. In addition to its specialized agencies, MWRI carried out the project in collaboration with the Holding Company for Water and Wastewater (HCWW) - the implementing agency for the ISSIP under the Ministry of Housing, Utilities and Urban Development (MHUUD) - as well as with the Egyptian Environmental Affairs Authority (EEAA) under the State Ministry of Environment. Several other Government entities– at least ten at national and sub-national levels – also played a role in implementing the EWRMP.[5] The idea of involving so many agencies was to ensure that the key water sector institutions were well represented in IWRM implementation.

25. iii) **Linkages to other Bank projects**: Another design feature of the EWRMP was its linkage to other ongoing projects aimed at improved water management in the Nile Delta. These projects, also funded by the World Bank and other donors (KfW, AfD, Islamic Development Bank and the OPEC Fund), included the Integrated Sanitation and Sewerage Infrastructure Project (ISSIP), the Second National Drainage Project (NDP2) and the Integrated Irrigation Improvement Project (IIIMP). These projects shared budgets and technical specialists with EWRMP as well as common stakeholders and project areas. For instance, the Nekla/ Menesi pilot in Behaira was implemented in the same areas where the IIIMP was also implemented. While the synergy built into the design was good in theory, it necessitated a high level of coordination among the PCU and the PMUs of the IIIMP, NDP2 and ISSIP.

26. iv) **Piloting of the System of Rice Intensification (SRI) approach**. The main added-value of SRI is to increase rice production by introducing improved seeds and innovative agricultural practices. Rather than flooding rice fields, which is the traditional practice, SRI alternates between irrigating and drying out the rice field, thus effectively reducing water use. GoE wanted to pilot SRI to see if it could be replicated more broadly across Egypt, in order to boost crop productivity, mitigate the effects of water scarcity and contribute to the sustainability of Egypt's water resources.

27. v) **Inclusion of solid waste management (SWM) and industrial water pollution under IWRM**. While SWM is not part of MWRI's mandate – but that of EEAA and local governments – the discharge of solid waste into drains became a pressing issue for water resources management. MWRI had to spend limited financial and institutional resources on dredging polluted drains in order to preserve their

[4] The six agencies were: i) the PS ii) the National Water Resources Center (NWRC) iii) the Groundwater Sector (GWS) iv) the High Aswan Dam Authority (HADA) v) the Irrigation Improvement Sector (IIS), and vi) the Egyptian Public Authority for Drainage Projects (EPADP).

[5] These government entities included: the Ministry of International Cooperation, the Ministry of Agriculture and Land Reclamation (MALR), the Ministry of Trade and Industry, the Governorates of Behaira, Sharkiya, and El-Monofia, and district administrations of Mahmoudia, Minia El-Kamh, and Quesna.

hydraulic and transportation functions. Similarly, industrial wastewater is not part of MWRI's remit but the discharge of untreated wastewater into rivers and drains limited the amount of water available for irrigation and drinking purposes. There was therefore a consensus that pollution from solid waste and industrial sources had to be tackled if IWRM was to make a meaningful contribution to the sustainability of Egypt's water resources. The project brought SWM and industrial wastewater management to the forefront of IWRM, together with improved irrigation and drainage, an innovative combination for the country.

28. vi) **Assessment of Risks**. The overall project risk was rated "moderate". The most important identified risk was the delay in project implementation due to the unstable political situation in Egypt, which did indeed materialize. The risk of weak capacity of the implementation agency was rated "substantial" because the Planning Sector of the MWRI (the designated PCU) did not have previous experience in implementing Bank projects. The PCU did face some capacity constraints during implementation but because it was able to mobilize the right staff, external experts and a Technical Consultant, it managed to minimize its capacity challenges. Design risk was also rated as "substantial", possibly because of the piloting nature of the schemes under Component 1, but no specific mitigation measures were mentioned in project documents. All the other risks (governance, social and environmental, program/ donor and delivery monitoring and sustainability) were rated as "moderate" and did not materialize in a meaningful way.

2.2 Implementation

2.2.1 Institutional and Implementation Arrangements.

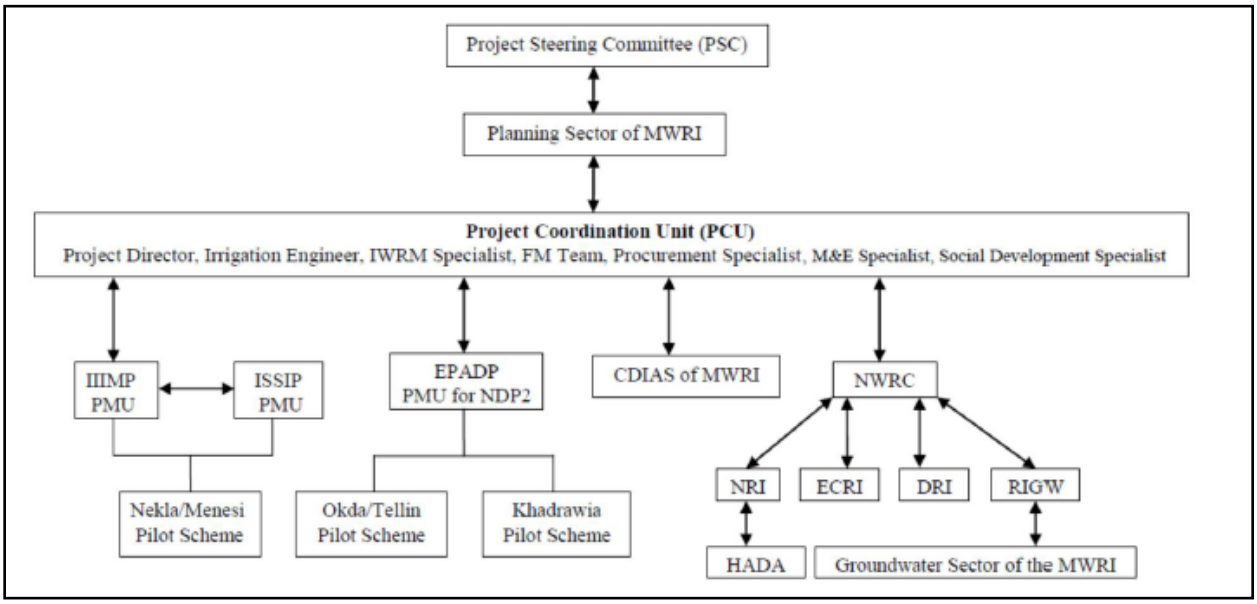
29. To manage the project and coordinate among different agencies, a PCU was established within the Planning Sector of MWRI. The establishment of the PCU was formalized through Ministerial decree after the Grant Agreement was signed. Figure 1 illustrates the implementation arrangement put in place for the project. The Project Steering Committee, established in MWRI with members from concerned ministries and implementing agencies, was meant to coordinate and facilitate project implementation but in reality, played a marginal role. The Planning Sector hosted the PCU, and provided overall guidance and budget management, but the PCU was the central implementing unit that managed the daily operations of the project. It coordinated with the PMUs of IIIMP, ISSIP and NDP 2 for the pilot schemes in shared areas; with the Central Directorate for Irrigation Advisory Service (CDIAS) of the MWRI for irrigation related projects; and with the National Water Resources Center (NWRC) and its constituent bodies, which undertook the technical studies in Component 2 and collaborated on pilot schemes related to their technical areas. The NWRC's bodies focused on specific issues: surface water for the Nile Research Institute (NRI); climate change for the Environment and Climate Change Research Institute (ECRI); drainage for the Drainage Research Institute (DRI); and groundwater for the Research Institute for Groundwater (RIGW).

2.2.2 Initial delays in implementation.

30. The World Bank approved the project on July 5, 2012 but it only became effective on February 1, 2013. There were delays in the start of project activities due to the long time spent in recruiting the TA consultant. The procurement process took almost a year, from the initial request for expressions of interest in April 2013 to the signature of the contract in January 2014. In hindsight, since the consultancy was key to the project activities, measures should have been taken to ensure the timely recruitment of the Consultant.

31. In addition, political changes created significant uncertainty. Security conditions deteriorated in some parts of the country during the initial stages of project implementation, further adding to the delays. The Government declared a state of emergency in mid-2013, thereby limiting working hours and movement in project areas. Moreover, the Dutch government withdrew promised grant funding meant to prepare the environmental assessment (EA) and environmental management plan (EMP) for the Nekla/ Menesi scheme, leading to delays in the start of this pilot. The problem was resolved when PCU revised the Terms of Reference of the TA consultant and added the preparation of the EA and EMP to the Consultant's tasks.

Figure 1. EWRMP Implementation Arrangement Chart



2.2.3 Mid-term Review (MTR).

32. The Project MTR took place between November 9 and 20, 2014, 21 months after project effectiveness. At this point, USD 3.1 million or 53 percent of the Grant was committed but disbursement was only USD 0.87 million or 15 percent of the Grant. The MTR noted that delays in project start-up affected all activities and slowed down overall implementation progress. In light of the delays, the MTR highlighted the need to extend the project implementation period by 18 months to ensure completion of all activities. Despite the slow progress, the MTR noted some bright spots in implementation. For instance, the PCU had good management structures and a new Project Director provided much-needed guidance and focus. Moreover, the addition of the TA Consultant and FM specialist to the PCU team helped improve procurement, financial management and other PCU functions. The MTR rated overall implementation progress "moderately satisfactory".

33. There was a missed opportunity at MTR to do a formal revision of the results framework. In particular, the large number of indicators had to be rationalized, ambiguous indicators had to be clarified and target values could have been revised as well. Moreover, there were no indicators to monitor achievement of the GEO and these could have been added during MTR. A formal revision along these lines would have greatly enhanced the clarity of M&E activities.

2.2.4 Restructuring

34. A short form, Level 2 restructuring took place in early 2015, building on the recommendations of the MTR. The Grant Closing date was extended by 1.5 years, from June 30, 2015 to December 31, 2016.

2.2.5 Completion

Implementation Issues by Component

Component 1: Pilot Schemes (USD3.659 million)

35. **High standards set in Law 48 for effluent water quality**, particularly for disposal in drains, posed a challenge for the in-stream treatment activity. To resolve this issue, HCWW and MWRI agreed to measure compliance with the Law at the end of instream treatment rather than at the point where primary treatment effluent entered the drain. This integrated approach – instream treatment plus advanced primary treatment of wastewater - was considered a "breakthrough" contribution of the project for improving rural sanitation and drainage water quality.

36. **The lack of formal licenses by many of the factories** in the Mubarak industrial estate proved an impediment to industrial wastewater management in Khadrawia. Factories discharged untreated wastewater into the Khadrawia drain but existing measures to control industrial pollution and ensure compliance with environmental regulations were inadequate. Moreover, the activity did not differentiate among different types of industrial pollution sources (eg. heavy metals as opposed to high biochemical oxygen demand (BOD) effluent, making it difficult to identify the most impactful intervention measures.

37. **The GIS activity** was meant to benefit MWRI staff and BCWUAs, but the latter lacked computer and language skills needed to make full use of the GIS. The GIS was instituted within MWRI and is already being used by its staff but the technological impediments still need to be addressed for GIS to be used by water users (see Annex 2 for more details).

38. **The SWM activity faced some challenges during implementation** due to turnover in leadership at the governorate and local levels. The change in counterparts at sub-national level obliged the project team to explain the importance of SWM for IWRM and court the newly constituted authorities' support each time there was a change in leadership. This activity also faced the hurdle of finding suitable land for composting and recycling activities, as Government regulations stipulated that landfills had to be at least 500 meters away from any residential areas, drains or canals. In general, the availability of land is a major issue for IWRM in rural Egypt, particularly in the Old Lands. The problem was resolved when the Governor of Behaira intervened and provided land in an area that was suitable from both an environmental and residential point of view.

Component 2: Capacity Building for Surface Water and Groundwater Management and Monitoring (USD 4.144 million)

39. **The technical studies under Component 2 took a long time to start** due to a couple of reasons. First was the unstable situation in Egypt after the Revolution; second was the long time spent in recruiting the TA Consultant. The delay in the start of Component 2 was one of the reasons for extending the project implementation period.

Component 3: Project Management (USD0.564 million)

There was **high turn-over of key implementing agency staff**. During the three years of project implementation, there were four Heads of the Planning Sector and five PCU Directors.[6] However, the last-serving Project Director was in place for over a year and this helped to focus and accelerate implementation.

2.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization

i) Design

40. **Broadly formulated results framework:** The results framework was aligned with the PDO in the Grant Agreement and included a range of outcomes in line with the multi-sectoral nature of the project. The results framework comprised 23 indicators in all, of which 7 were PDO indicators. There were some shortcomings in certain indicators, for instance, duplication in the Dissolved Oxygen and Biochemical Oxygen Demand indicators, which measured the same outcome (i.e. water quality). In addition, a couple of indicators were poorly formulated, containing compound sentences (e.g. "increased monitoring stations and water samplings") or vague wording (e.g. the binary indicator on "stakeholder analysis and policy formulation completed". Moreover, the GEO seemed ambitious given the scale of the project and was a longer term objective beyond the scope of the project. The MTR or project restructuring could have been the occasion to rationalize the number of indicators and improve their formulation. Nevertheless, the indicators were certainly relevant to the project objectives and the results framework on the whole fit the needs of the project.

41. **Collaboration with various agencies**: M&E design and implementation involved collaboration with multiple stakeholders. The PCU had to gather data from the PMUs of the three ongoing projects (IIIMP, NDP2 and ISSIP) as well as from each of the research centers involved in the technical studies. This data was used to generate the EWRMP baseline, to create synergy indicators[7], to generate monthly and semi-annual progress reports on physical and financial implementation and to prepare a consolidated annual M&E report.

ii) Implementation

42. **M&E initially did not proceed as planned due to the significant delay in appointing the TA Consultant**, who only started work in January 2014. The Consultant's task for M&E specifically was to prepare an M&E report that was to be used as the basis for planning M&E activities. An international consultant was also recruited to develop an M&E Plan, as part of the overall TA. Once completed, the M&E Plan was well-received and its quality was deemed satisfactory by the Bank team.

43. The results framework included a binary indicator on the establishment and effective implementation of an M&E system and database. This indicator was achieved by September 2015 and the M&E rating was upgraded to satisfactory by December 2016 when the project closed.

[6] Based on a review of aide memoires from the first pre-appraisal mission to the final mission.
[7] The MTR includes a list of 29 synergy indicators that were added to the IIIMP, NDP2 and ISSIP project M&E database

iii) Utilization

44. **While coordinating different entities for M&E was cumbersome, the results were quite positive**. One of the challenges was to train PCU staff on operating the M&E system and to align data reporting efforts with the three ongoing Bank projects. The M&E system included methodological documents, baseline data, a system of monthly reporting and a Management Information System (MIS) Access Database among other features. One of the key success factors for collaboration was that PCU, at the Bank's urging, invested a lot of time in consultation early in the development of the M&E Plan. This ensured the buy-in of all the reporting agencies.

2.4 Safeguard and Fiduciary Compliance

45. The project was classified as category B according to OP 4.01, as there were no associated significant, sensitive, diverse, unprecedented or irreversible impacts. Overall, the project activities complied with all applicable Bank policies.

46. **Social Safeguards**. There were no social safeguards triggered for the EWRMP. The EWRMP comprised a number of activities with social implications, particularly activities on IWRM awareness raising. There were also specific roles allocated to farmers and other water users. In addition, stakeholder analysis was conducted in all three pilot schemes. There was also extensive training, workshops and awareness raising across all the activities. Despite the range of social-related activities, there were no significant social issues reported during project implementation.

47. **Environmental Safeguards**. The following safeguard policies were triggered for this project: OP/BP/GP 4.01 (Environmental Assessment); OP&BP 4.04 (Natural Habitats); OP&BP 4.37 (Safety of Dams) and OP&BP 7.50 (Projects on International Waterways).

48. While the environmental impacts of the project were considered to be minimal on the whole, the Environmental Assessment safeguard was triggered to account for the physical activities under the pilot schemes. Many of these activities involved the use of water resources from irrigation canals (e.g. SRI, continuous flow and controlled drainage), although the pilots were expected to have a negligible impact on the quantity or quality of the water. Other project activities entailed small-scale interventions such as instream wetlands and landfills to reduce pollution in drains.

49. Similarly, the Natural Habitats safeguard was triggered to account for the Khadrawia pilot scheme, which entailed dredging solid and liquid pollutants from the Khadrawia drain and disposing of them at least 300 meters away from waterways, farmer lands and wildlife habitats. However, for both the Environmental Assessment and Natural Habitats safeguards, the expected impacts were deemed insignificant.

50. The justification for triggering the safeguards on Safety of Dams and International Waterways was that the technical study on evaporation losses in Lake Nasser could be relevant for both the Lake and the High Aswan Dam. However, the EWRMP did not involve any physical works or a program on any dams, and therefore could have foregone triggering OP&BP 4.37. The safeguard on International Waterways was considered at the time to be important given that the evaporation losses study would also consider the impacts on the Sudanese portion of Lake Nasser. In reality, no physical activities directly related to dams were planned or implemented under the EWRMP. As the safeguard policy applies to projects that involve the use or potential pollution of international waterways or detailed design and engineering studies related to such projects, it was clearly not necessary to trigger International Waterways for EWRMP.

51. An Environmental and Social Management Framework was prepared for the EWRMP as a whole. It identified some likely environmental impacts, how they would be monitored, mitigation measures and associated capacity building, training and budget requirements. In addition, Environmental Assessments (EAs) and Environmental Management Plans (EMPs) were developed for each pilot site to ensure adequate handling of environmental and social issues according to Bank safeguard policies. The EAs and EMPs had to be completed before any physical activities in the pilot schemes could begin. Accordingly, were prepared and submitted during 2014 for Nekla Menesi and Khadrawia and for Okda-Tellin 2015 but this was quite late into the project cycle. The delay in developing the environmental plans also delayed the beginning of the pilot schemes.

52. **Fiduciary**: PCU opened a designated account to manage the project's financial transactions. Aide Memoires from February and May 2014 noted that the PCU had efficient automated accounting records and a sound financial management system that allowed quarterly Financial Monitoring Reports and annual financial statements to be generated properly, as per requirements under the Grant Agreement. The project took a couple of years to appoint an External Auditor, which was a requirement under the Agreement. The Auditor was only appointed in January 2016, but thereafter, there was an improvement in the auditing of annual financial statements and more regular reviews of Interim Financial Reports.

53. **Procurement**: Procurement staff members from MWRI's Central Procurement Department (CPD) were assigned to the PCU to undertake procurement activities under the EWRMP. However, the CPD had no previous experience processing World Bank projects. As a result, early in the project cycle, World Bank staff provided training on procurement matters to concerned MWRI officials and explained the Bank's procurement guidelines. The PCU prepared a Procurement Plan for the project, for which the Bank provided no objection in June 2016. The procurement methods used included international competitive bidding, national competitive bidding and shopping. Both post and prior review were used.

54. While a Procurement Capacity Assessment found the overall project risk for procurement to be substantial, mitigation measures were applied to diminish this risk. In addition to the training mentioned above, procurement post review was carried out annually on a sample of contracts awarded during the review period. The first review took place in March 2015 on a 30 percent sample of contracts awarded between February 2013 and February 2015. A second review took place in December 2015 for contracts awarded since 2015 (the sample represented 43 percent of contracts). In both cases, the contracts were found to be in compliance with Bank Guidelines and contract administration was found to be satisfactory.

2.5 Post-completion Operation/Next Phase

55. **Any follow-up operation would need to consider the following priorities**. The first is the impact of climate change on water resources; second, the need to conserve water resources and meet increasing and competitive demands; third, enhancing the provision of public services through improved efficiency of infrastructure; and fourth, facilitating private sector development. A countrywide IWRM program could be a way of integrating these different elements into one coherent approach, as stated in the EWRMP's global objective of establishing the basis for scaling up investments through the GOE's National Water Resources Plan (2005 – 2017), its programs for reducing water pollution and its strategy for Climate Change Adaptation. Lastly, Egypt should seek to benefit, when scaling-up the EWRMP experience, from other countries' experience (for instance Spain, China, France and some Latin American countries) with IWRM.

56. The **technical studies have the potential to inform the design and modification of policies and laws**. For instance, the results of the groundwater modelling activity directly led to the revision of the Groundwater Chapter in the Irrigation and Drainage Law. The National Water Resources Plan, which the government is currently updating to 2050, will include a Master Plan for each governorate. There is

therefore scope to draw on the successes of the pilot schemes to develop longer-term interventions under the umbrella of the national Plan.

57. There is significant **potential to build on the capacity building activities** initiated by EWRMP to benefit the various research institutes and specialized centers involved in technical work. For example, PCU indicated that it would like to seek financial support from the Green Climate Fund to expand the Climate Change Lab that the Environment and Climate Research Institute (ECRI) established in November 2016. Another area for continued work is the modelling, research and analysis undertaken by the various research institutes. The model packages for surface water and groundwater need to be updated continuously to achieve finer resolutions (e.g. for groundwater) and a wider scope (e.g. more sampling wells for surface water quality monitoring). There is also a need to maintain and upgrade the computers, mobile laboratories and other equipment used in monitoring groundwater and surface water quality. The research teams within the Planning Sector and NWRI's research institutes are already capable of undertaking the research and analysis but require additional resources to scale up the work.

58. Given that water availability is becoming less assured, particularly for rice cultivation, **the GOE issued a decree stating that it will reduce the area of land under rice cultivation in Egypt** from 1 million feddans to 704,000 feddans as a means of boosting rice productivity while reducing water use. Because the SRI activity resulted in higher rice yields, but without an increase in water use, it will likely be expanded to meet the Government's new goal of reducing the area under rice cultivation. With higher yields, there would be less need for new land for rice production, although whether SRI will reduce water use in rice production remains to be seen. Farmers, who praised the good results achieved through SRI - notably increased rice productivity, reduced fertilizer usage and increased incomes - share the Government's interest in this activity.

59. **The PCU has demonstrated that it can be an effective coordinating body** for water resources management in Egypt and is well-positioned to continue future cross-sectoral water interventions. PCU staff will require training and exposure to international practices to keep their competencies sharp. If PCU remains a coordinating body for IWRM in future projects, it would also need a set of incentives, negotiating skills and communication tools to manage the competing interests of various Government agencies and local stakeholders.

3. Assessment of Outcomes

3.1 Relevance of Objectives, Design and Implementation

60. **Relevance of Objectives: High.** The ICR confirms that the project objectives were and remain highly relevant, given their success in addressing two key gaps in IWRM implementation. The first part of the objective, piloting IWRM in the Nile Delta, helped to pioneer IWRM implementation in Egypt at the project level. The second part of the PDO, awareness raising, fostered the participatory nature of IWRM, by including various institutions, water users, NGOs and farmer groups in all project activities. The project objectives remain consistent with the Government's 2005 - 2017 National Water Resources Plan (which is currently being updated to 2030). In addition, the World Bank's current Country Partnership Framework (CPF) for Egypt (2015 – 2019) includes Focal Area 2 (Improved Opportunities for Private Sector Job Creation) which focuses on irrigation, drainage and sewerage.[8] The CPF mentions the need to shift from sector-specific approaches to a holistic approach for agricultural and water

[8] Objectives 2.4 and Objectives 3.4

management, which is in line with IWRM. Therefore, EWRMP's objectives continue to be reflected in GoE and World Bank priorities and plans.

61. **Relevance of Design and Implementation: Substantial**. As mentioned in Section 2.3, the design of the results framework was well-suited to the project activities and objectives, despite some shortcomings in terms of number and formulation of some indicators. The overall project design promoted synergy among three national programs - irrigation improvement, drainage and rural sanitation - implemented by GOE and supported by the World Bank and other development partners. The IIIMP, NDP2 and ISSIP are the most recent phases of these programs respectively. The project design aimed to create synergy among these three projects and EWRMP. Synergy in this context meant investment contributions from the three projects to EWRMP where project areas were shared, common monitoring of project indicators and overall cooperation across agencies and at different levels of government. This synergy was important, as the three projects had features in common with EWRMP (irrigation, drainage, sewerage) and coordination helped reduce redundancy while serving each project's individual goals.

62. The designation of the PCU as the main implementing body was relevant, as PCU is located in the Planning Sector, which is responsible for overall water resources management and strategic planning. Because this was the first time that the Planning Sector implemented a Bank project, the inclusion of the Project Management component was instrumental in supporting the PCU in its work. However, the dependence on PCU to coordinate so many Government entities without higher-level support or an official coordination mechanism (e.g. regular inter-ministerial meetings) was a flaw in the implementation approach. For instance, PCU could not convince some key water sector institutions in the continuous flow pilot to support this activity. More incentives could have been included to facilitate the cooperation of government and non-government stakeholders.

3.2 Achievement of Project Development Objectives

63. **Overall Rating: Substantial**. The project achieved 6 out of 7 of its PDO indicators and achieved most of its intermediate indicators. The PDO is composed of two parts: (i) pilot IWRM in the Nile Delta; and (ii) enhance the knowledge and capacity of water sector institutions for IWRM in Egypt.

a) Piloting IWRM in the Nile Delta
Sub-Rating: Substantial.

64. The first part of the PDO – to pilot IWRM in the Nile Delta - was assessed through the following PDO level indicators: PDO2: Water saving volume used per feddan (167% achievement); PDO 3: increased percentage of reliability of water supply (100% achievement); PDO 5: demonstration activities developed and implemented in the pilot areas (121% achievement) and PDO 6: increased monitoring stations and water samplings (100% achievement). Given that all four PDO indicators were fully met or exceeded, a rating of substantial is warranted.

PDO2: Water saving volume used per feddan.

65. Target exceeded (167%). This indicator focused on rice, the most intensive water use crop in Egypt. Typically, rice used 11,000 m3/feddan/ year of fresh irrigation water but the project resulted in water savings of 2,500$m^{3/}$ feddan/year.

PDO3: Increased percentage of reliability of water supply.

66. Target met (100%). This indicator, which refers to the time that a sufficient quantity of irrigation water is available in pilot schemes, was included in order to illustrate the benefits of some IWRM

approaches. The target was met in part through continuous flow, which improved the equity in water distribution at both top and tail ends of the canals. Increased water productivity for rice due to SRI application also contributed to this result, as it enabled a higher ratio of water availability between the top and tail of canals.

PDO5: Demonstration activities developed and implemented in the pilot areas.

67. Target exceeded (121%). A total area of 112,660 feddans was used for demonstration activities in the pilot areas of the three projects linked to EWRMP. This area included SRI, continuous flow, controlled drainage and SWM pilot schemes under the project (26,000 feddans) as well as synergy activities in ongoing projects: 12,460 feddans in ISSIP, 14,200 feddans in NDP2 and 60,000 feddans in IIIMP.

PDO6: Increased monitoring stations and water samplings

68. Target not met (62%). This indicator measured improvements in monitoring the quality of surface water. Some of the activities included training of NRI and DRI staff, which shared responsibility for this activity. The institutes undertook laboratory analysis, studied seasonal variation along the Nile and took sediment samples to measure changes in contaminant concentration, among other activities. Another important activity was the procurement of equipment, which helped to increase the number of locations with surface and groundwater monitoring and water samplings. This equipment included flow-tracking equipment, Acoustic Doppler Current Profiler (ADCP), metal boats and portable flow meters for example. The purchase of a mobile laboratory was particularly impactful, as it was used to respond to emergency cases of contamination of water sources.

b) Enhancing Knowledge and Capacity of Water Sector Institutions
Sub-Rating: Substantial.

69. The second part of the PDO – to enhance the knowledge and capacity of water sector institutions for IWRM in Egypt - was assessed through the following PDO level indicators: PDO1: Technical and institutional capacity building training (140% achievement); PDO 4: government documents issued for IWRM policies/ procedures/ implementation (112% achievement) and PDO 7: increased IWRM awareness and effective roles of local WUAs, farmers and stakeholders (329% achievement). Given that all three PDO indicators were fully met, a rating of substantial is fair. Details follow for each PDO indicator.

PDO1: Technical and institutional capacity building training.

70. Target exceeded (140%). Institutional capacity building was an integral part of the project and focused in large part on training. There were two types of training in the EWRMP: technical training for PCU and other Government entities and training for farmers and water users. On the first point, specific training activities (IWRM practices, environmental plans, negotiation, communication and surface and groundwater modeling) supported the PCU, EPADP and other sectors of MWRI. For example, PCU members participated in training on GIS models at UNESCO-IHE, which helped enhance the surface water quality monitoring in Component 2. The second kind of training took place through the pilot schemes to help farmers understand improved water management techniques. For instance, the continuous flow activity involved training for BCWUAs, district engineers and technicians and mesqa operators. This kind of training was important to build capacity and raise awareness among end-users on applying IWRM principles.

PDO4: Government documents issued for IWRM policies/procedures/implementation.

71. Target exceeded (112%). The following Government documents were issued for IWRM policies/procedures/ implementation: i) Evaporation Losses Analysis in Lake Nasser; ii) Climate Change Scenarios; iii) Climate Change Adaptation Strategy; iv) Development of a Decision Support System for the Nile Delta; v) Groundwater Modeling Analysis in the Nile Delta; vi) Groundwater Water Quality Monitoring Capacity Enhancement in the Nile System; vii) EWRMP Sustainability; viii) EWRMP Lessons Learned and ix) NDP2. "Government documents" was defined rather broadly. It included policy briefs, implementation plans and other Government reports that could be used for IWRM policies, procedures, measures and activities. While the documents developed under the project were all useful, a more concrete definition could have made the link between these outputs and policy making more clear.

72. Based on the research and studies that were done under EWRMP, the PCU took the initiative to prepare several policy notes/procedures[9] that were meant to disseminate the main IWRM activities undertaken by the project. These documents are a useful and good example of how to use the research and studies that were carried under EWRMP to influence decision-making and improve water management in Egypt. Annex 2 provides details on the impacts of these documents and studies.
PDO7: Increased IWRM awareness and effective roles of local WUAs, farmers and stakeholders.

73. Target exceeded (329%). WUAs were trained on environmental issues and solutions. There were also activities such as preparation of communication and visibility strategies, action plans for awareness campaigns, proper distribution of communication materials, use of videos with SRI principles and dissemination of videos and policy papers through the media. For example, farmers were initially skeptical about SRI as it required them to stop irrigation, to dry out the land and to plant the crop wide apart. These practices contradicted the farmers' long-held notion that they needed to irrigate rice all the time and that plants should be close together. However, training and awareness raising convinced the farmers to try the new approach and by the end of the project, even farmers in non-project areas had heard about the success of the SRI approach and were keen to adopt it.

74. A total of 319 organizations (1 DWB; 24 BCWUOs; 276 WUOs; and 18 Non-WUOs-NGOs) benefited from these activities. Awareness raising was important not only to inform the public about specific environmental regulations and irrigation techniques but also to elicit behavioral changes. For instance, there was an awareness campaign in Behaira to entice local communities to pay fees to service providers for SWM collection. A willingness to pay survey was done to tailor the campaign to the needs of communities. As a result, residents in Sharkiya started to pay 4 LE (about USD 0.25) and those in Behaira paid 3LE (about USD 0.15) per household per month, leading to formalized collection of solid waste, with positive knock-on effects on drainage pollution.

Achievement of the GEO

75. Even though there were no formal monitoring indicators of the GEO objective, some activities had a bearing on the pollution control and the improved ecosystem health of the Mediterranean Sea. The first was the Surface Water Modeling in the Nile Delta under Component 2. This activity used two models, both of which generated important findings about the quality and quantity of water reaching the Mediterranean Sea. One of the models, SIWAT, helped to improve the understanding of water flows into the Northern lakes and the salt load reaching the Mediterranean Sea. The second one, RIBASIM, focused on water demand and allocation scenarios in the Nile Delta as well as sources of water quality e.g.

[9] Water Allocation and Distribution, Reduction of Pollution, Controlled Drainage, Solid Waste Management and System of Rice Intensification

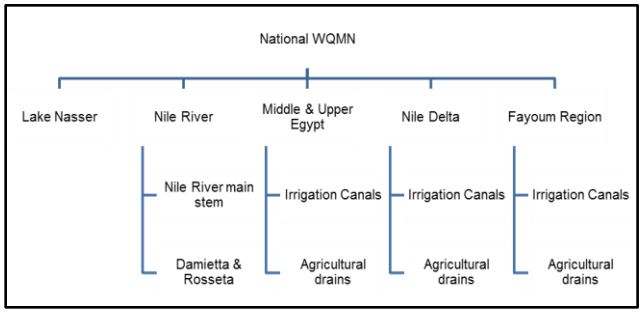
suspended solids from domestic, agriculture and industry for the whole Delta. Together, the two models provided a solid picture of the quality of surface and drainage water in the Nile Delta, which in turn has implications for water quality reaching the Mediterranean.

76. Another activity was geared towards supporting the National Water Quality Monitoring network (NWQMN), which is hosted by NRI and DRI. NWQMN monitors key water quality variables for Egypt's major water resources, namely Lake Nasser, the Nile River and various irrigation canals and agricultural drains (Figure 2). EWRMP supported the NWQMN by developing a training program for staff on water quality sampling, data storage, use and processing. All aspects of water quality monitoring were upgraded, included the selection of 5 new monitoring stations. Sophisticated equipment was purchased, allowing for improved information collection and water quality monitoring in the Nile Delta. By extension, the monitoring of water flows into the Mediterranean Sea also improved.

77. In addition to the activities mentioned above, the activities on pollution reduction in the drainage network, such as the instream-wetland activity in the Okda/Tellin scheme, undoubtedly improved the quality of drainage water, as substantiated by the positive results on the BOD and DO indicators. As a result, cleaner drainage outflows made their way to coastal lagoons and the Mediterranean Sea.

78. Another aspect of the GEO was to establish the basis for scaling up investments through the GOE's IWRM Plan. While there are no indications yet of which investments might be scaled up, it is possible that the successful activities on drainage pollution could be scaled up, as the evidence is quite strong on the positive impacts of interventions such as SWM and instream wetlands. It is reasonable to expect that follow-up activities would continue to contribute even further to pollution control and improvement of the ecological health of the Mediterranean Sea and its biodiversity resources. In addition, the technical study on evaporation losses in Lake Nasser, and climate change forecasting undertaken by ECRI, could ensure that Egypt continues to build its capacities to engage in relevant technical dialogues with its riparian counterparts in the Mediterranean as well as under the Nile Basin Initiative. This could have an important effect on transboundary water management as well.

Figure 2. National Water Quality Monitoring Network



3.3 Efficiency

79. **Rating: Substantial**. The project had USD 8.367 million in funding and managed to come just under budget at USD8.286 million. Of this amount, the GEF funding of USD 6.68 million was fully disbursed. The GEF grant managed to leverage additional funding from GOE, beneficiaries and the three ongoing projects. In particular, there was USD 30 million of investments from IIIMP, NDP2 and ISSIP for activities in project areas that overlapped with EWRMP. Another sign of efficiency is that the project managed to complete all activities despite initial delays, and thanks to a 1.5-year extension. Lastly, the project reached a wide range of beneficiaries, from the 319 organizations that benefited from

awareness raising activities, to the national research institutes involved in the technical studies, not to mention the PCU and the rest of MWRI.

80. The PAD included economic and financial analysis on the activities proposed under the Nekla/Menesi pilot scheme. The analysis found that these activities, plus the addition of the use of the organic fertilizer for crop production, would result in an economic rate of return of 12 percent. This analysis did not include the value of the public and global impacts that the EWRMP would generate. At the end of the project, an economic assessment was undertaken of the individual activities under the Nekla pilot scheme (Annex 3). Due to data limitations, the analysis did not quantify the full economic benefits of all the Nekla pilot activities, but it did do so in depth for the SRI activity. Considering only SRI, the analysis found an economic rate of return of 12.1%. This finding does not consider the public or global benefits to be generated as IWRM is adopted over a broader scale, nor does it consider the long-term benefits accruing from all the pilot activities. The 12.1% figure is therefore likely to be higher in reality.

3.4 Justification of Overall Outcome Rating
Rating: Satisfactory

81. Overall, the project implemented most of its planned activities and met most of the targets. In addition, the project objectives continue to be highly relevant to the country's priorities for water sector development and management. Given the High relevance of objectives, the Substantial relevance of design and implementation, the Substantial achievement of the PDO, and Substantial efficiency, the overall outcome rating is Satisfactory.

3.5 Overarching Themes, Other Outcomes and Impacts

(a) Poverty Impacts, Gender Aspects, and Social Development

Poverty Impacts

82. While poverty alleviation was not an explicit objective of the EWRMP, some activities helped to improve the living conditions of people living in the project areas, which tend to be rural and poor. The poorest 40% of Egyptian households is concentrated in rural regions, with over half of the national's poor in Lower Rural Egypt. The activities had a knock-on effect in improving farmers' incomes, which can be reasonably expected to lead to better living conditions. For instance, the SRI increased rice yields by up to 24% and reduced the use of production inputs such as pesticides, thus contributing to increased farmer incomes. Similarly, one of the benefits of controlled drainage (CD) was reduced usage of fertilizer, thus leading to cost savings for farmers and, probably, environmental benefits as well. CD also reduced the amount of time spent in irrigation, potentially freeing farmers to engage in revenue-generating activities.

83. In addition to income gains, there is anecdotal evidence that improvements in the quality of drainage water through the instream wetland and solid waste management activities generated health benefits for farmers. Farmers in Sharkiya recounted that in summer time, the polluted Tellin drain used to attract mosquitos and small insects but they were fewer since the instream wetland pilot began. Local residents' health has improved as a result, although the impact has not been assessed quantitatively and is likely restricted to a few people.

Gender Aspects

84. Women are important players in water and agriculture, accounting for 47% of the labor force in agriculture in Egypt.[10] Female participation in the project was significant, even if there was no formal monitoring on gender aspects. In particular, female farmers participated in training events and workshops in the villages and some of them took on key roles as members of BCWUAs and DWBs. During the ICR mission's field visit to Tellin, for instance, two out of the ten BCWUA members were women, both of them landowners, and there is reason to believe this level of female representation is common in other BCWUAs. Some of the activities, particularly SRI, which required transplanting the crop, were labor intensive and women did the bulk of the work. Moreover, within the Government and research institutes, women with high academic levels received opportunities for technical training through their participation in the technical studies.

(b) Institutional Change/Strengthening

85. Significant data collection, model building, modeling and analysis took place in order to build the knowledge base for groundwater and surface water management in Egypt. The various institutes and MWRI staff benefited from new equipment, exchange visits abroad and training opportunities.[11] For example, as part the Surface Water Modeling in the Nile Delta, MWRI staff participated in training sessions in the Netherlands with Deltares and Altera, two global leaders in water resources analysis. Because the complexity of the surface water system in the Nile Delta is similar to the Dutch water system, the project team was able to learn from the Dutch approach to analyzing water resources using computer systems and models. These kinds of opportunities were a key benefit of the EWRMP and introduced new knowledge to MWRI. In addition, PCU staff benefitted from on-the-job training provided by the Technical Consultant.

(c) Other Unintended Outcomes and Impacts

86. In addition to meeting the expected goals and outcomes, some of the project activities generated unplanned and beneficial impacts. These outcomes include the following.

Climate Change Laboratory

87. ECRI constructed a Climate Change Laboratory for real time weather monitoring and climate change assessment. The Laboratory is already functioning and is equipped with high performance computers, software (weather forecasting, climate prediction, climate change assessment, DSS[12]), and display and visualization equipment (video wall, large monitors, smart data). The Lab was financed with funds from the project and the GOE budget. As a sign of its strong capacity, the ECRI Lab has already started hosting officials from other countries who want to learn from MWRI's experience. For example,

10 According to International Labor Organization data, as reported by the World Bank: http://data.worldbank.org/indicator/SL.AGR.EMPL.FE.ZS

[11] Research institutes participated in training on the following selected topics: groundwater monitoring, geo-statistical assessment network performance, assessment of groundwater quality data, groundwater modelling analysis, surface water quality monitoring, surface water modelling analysis, climate change scenarios and evaporation loss analysis.

[12] The decision support system (DSS) is a powerful tool for better understanding the water system and can answer many questions related to different water management strategies and scenarios. At the time EWRMP began, the Government's DSS for IWRM was still lacking substantial equipment and staff capacity. EWRMP was meant to fill the gaps of the DSS so that the Government would be able to make optimal decisions for IWRM based on the options provided by the DSS simulation models using hydrological data collected by an improved hydrological data collection network.

MWRI and the Ministry of External Affairs hosted an African entourage (from Sudan, Chad and Mozambique) on watershed management and rainwater harvesting for a couple of weeks in February 2016. Similarly, in May 2016, MWRI hosted a training session for specialists from Iraq who wanted to see the climate change model developed by ECRI and apply it to study their own country's climate change status.

Nile Forecasting System

88. EWRMP supported MWRI in enhancing its tools for rainfall forecasting and prediction of extreme rainfall events, in order to alert authorities in due time and minimize risks. The Nile Forecasting Center's satellite receiver, used for estimating rainfall, was upgraded and five work stations and storage devices were purchased to improve the Center's modeling capabilities. In addition, 25 automatic weather stations were installed in the Delta region to verify the accuracy of rainfall forecasting. Four meteorological experts received training in Germany. Moreover, a WhatsApp group, administered by the PCU Director, was created with high-level officials from MWRI, other ministries and governorates. For example, using the data and maps generated from the NFS, the WhatsApp group proved effective in alerting participants about the storm in Alexandria in 2015 and the storm that hit the Sinai and the Dead Sea and GOE leaders took prompt action as a result.

Decree Limiting the Amount of Area under Rice Cultivation

89. GOE issued a decree stating that it would limit the amount of land allocated for rice cultivation amid ongoing concerns about water scarcity. The decree also states that the amount of land will be decreased by 34.6% and will be limited to six governorates, including Sharkiya and Behaira, where the EWRMP was implemented. The new land for growing rice was set at just over 704,000 feddans in 2017, compared to over a million feddans in 2016. While other factors – notably the pressure on water resources and socioeconomic trends –contributed to the decision making on the rice decree, the SRI pilot had some impact as well, as it showed that rice productivity could increase without an increase in water use. In fact, SRI resulted in an increase of rice yields of up to 24% compared to traditional rice cultivation. Crop productivity is also higher (0.66kg/m3) when using SRI than using conventional technology (0.54 kg/m3). While SRI does not yet demonstrate reduced water use for rice production, after three consecutive seasons of SRI, it is clear that SRI is producing more rice with the same water, an indication of improved productivity.

3.6 Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops

See Annex 5 and Annex 6.

4. Assessment of Risk to Development Outcome
Rating: Substantial

90. The project supported a number of capacity building, training and awareness raising activities, which all helped to generate support for various IWRM practices. The contributions of the studies, research and technologies under the project are expected to guide policymaking and investment programs that should increase over time, especially if a follow-up project takes place. There is strong Government commitment to IWRM, and the National Water Resources Plan, which is currently being updated, could be a platform to integrate many of the project's findings and knowledge into national planning. Moreover, the success of the SRI pilot contributed in part to GoE's decision to reduce the area of rice under cultivation as part of its broader strategy of boosting crop productivity and reducing water use. However, there remains some risk that there may not be enough resources to continue and maintain some of the capacity building work, particularly the equipment, models and training conducted for the PCU. There is also no clear indication yet about which of the pilot activities will be scaled up. Therefore, the risk to project outcome is rated Substantial.

5. Assessment of Bank and Borrower Performance

(relating to design, implementation and outcome issues)

5.1 Bank

(a) Bank Performance in Ensuring Quality at Entry
Rating: Moderately Satisfactory

91. The project design aligned well with the Government's development priorities for water related issues. The Bank spent considerable time preparing the project, including three pre-appraisal missions, advising on the selection of pilot schemes, identifying the technical studies and holding stakeholder meetings in the chosen governorates. Moreover, the risk assessment done at appraisal proved to be adequate and relevant. However, the project required substantial coordination among several public agencies and stakeholders because of the crosscutting nature of IWRM. The Bank could have helped MWRI to define stronger coordination mechanisms rather than relying on PCU alone. Incentives should have been developed to encourage cooperation among participating agencies and other stakeholders. Accordingly, the rating of Bank performance at entry can be considered Moderately Satisfactory.

(b) Quality of Supervision
Rating: Moderately Satisfactory

92. During supervision missions, the Bank team acted in an efficient and proactive way and worked closely with the PCU to solve problems facing project implementation. Most of the project team was based in Cairo – including the co-TTL, FM Specialist, Social Development Specialist, Procurement Specialist and Program Assistant. This on-the-ground presence was effective and helped improve overall project performance.

93. The MTR took place on time and the team took steps to extend the project to account for the initial delays. However, the team missed the opportunity presented by the MTR to discuss and agree with PCU on rationalizing the monitoring indicators.

(c) Justification of Rating for Overall Bank Performance
Rating: Moderately Satisfactory

94. Given the Moderately Satisfactory rating of Bank performance at Entry and Supervision, the overall Bank Performance is Moderately Satisfactory.

5.2 Borrower

(a) Government Performance
Rating: Satisfactory

95. The Borrower complied with all legal covenants to establish a Project Steering Committee, completed all internal control procedures, allocated budget for counterpart funding and appointed a social development specialist. Government ownership was very high and the project continued despite serious turmoil that began in early 2011, right when the project was under preparation.

(b) Implementing Agency or Agencies Performance
Rating: Moderately Satisfactory

96. It took a while to put in place implementation arrangements, particularly to define the roles and responsibilities of the PMUs of the IIIMP, ISSIP and NDP2. For instance, PCU only submitted a Project

Implementation Manual in March 2014, a year after effectiveness. Progress in implementation only took off following the recruitment of a TA Consultant in January 2014, whose task was to support the PCU on various aspects of the project. There was also a delay in preparing the EA / EMPs (which were required before construction in pilot schemes could begin) and high turnover in PCU Directors.

97. Despite the initial implementation challenges, performance significantly turned around in the last 18 months of the project due to changes in PCU leadership. Because of these positive efforts, all the pilot schemes and technical studies were completed by project closure in December 2016. Moreover, PCU delivered a comprehensive Borrower's Completion Report in a timely manner.

98. The improved performance of the implementing agency in the last half of the project is laudable. Moreover, the PCU managed to coordinate several different departments within MWRI, other ministries, research institutes, governorates and local authorities. This was no small feat, particularly in the context of political changes across the government as the result of the Revolution. However, given initial delays in hiring a TA Consultant and the high turnover in staff within the PCU (including PCU Directors), a rating of Moderately Satisfactory is appropriate.

(c) Justification of Rating for Overall Borrower Performance
Rating: Moderately Satisfactory

Given the Satisfactory rating for Government Performance and Moderately Satisfactory rating for Implementing Agency Performance, the overall Borrower Performance is Moderately Satisfactory.

6. Lessons Learned

99. **The project showed that addressing water resources challenges should go beyond the prism of the water sector alone and take an integrated, multi-sectoral approach**. Several sectors and water related users have a direct impact on the quantity and quality of water resources, particularly irrigation, drainage, solid waste and industrial pollution. The multiple pressures on water resources require a cross-sectoral, coordinated approach. Given the lack of precedence in applying IWRM at the project level in Egypt, the biggest impact of the EWRMP was to demonstrate that implementation of IWRM is possible and indeed, can yield good results in terms of water savings, improved water quality, higher farmer incomes and better environmental outcomes.

100. **A dedicated Project Management Unit is essential for managing cross-sectoral interventions.** While EWRMP faced significant delays in the beginning, the fact that it was able to complete all activities and achieve good results is a testament to the impact an effective PCU can have in achieving good outcomes. The positioning of PCU within the Planning Sector of MWRI was essential, as the PS was a powerful, cross-cutting unit that could offer strong backing to PCU. In addition, the inclusion of a Project Management component was crucial, as was the recruitment of a TA consultant to support PCU in its daily operations. However, incentives for stakeholder participation should have been developed to make PCU's task of coordinating all the key water sector players smoother. In addition, remedial actions should have been taken to ensure the early and swift recruitment of the TA Consultant, as their involvement was crucial for the progress of most project activities.

101. **Local Communities' Participation**. Participation of local stakeholders is an indispensable part of IWRM. The project showed that involving local communities generates positive benefits. As one example, awareness raising activities built demand for solid waste collection, enticed rural residents to pay for this service and helped reduce the discharge of solid waste into open drains. The involvement of BCWUAs in the SWM pilot was also key for the success of the pilot. However, local stakeholder participation has its limits. The lack of behavioral change by industrial companies that discharge effluent

in the Khadrawia drain is an example. The lesson learned is that awareness raising and involving local stakeholders in IWRM activities is not enough to overcome entrenched interests but incentives need to be developed to ensure the full cooperation of stakeholders.

102. **Implementing IWRM requires a strong evidence base to inform decision-making.** Developing a sound understanding of the state of water resources – and projections of how they can change in the future – is essential in helping policymakers to design investment plans and make necessary reforms. Given the recent closing date of the project, the full impact of the technical studies will likely materialize in the medium and long term. However, the examples of the change in the Irrigation and Drainage Law due to the groundwater studies, and the new decree to enhance the productivity of rice cultivation thanks to SRI, show that data and analysis can help inform policymaking. With the revision of the National Water Resources Plan underway, there is even greater scope to link research and policy.

7. Comments on Issues Raised by Borrower/Implementing Agencies/Partners
(a) Borrower/implementing agencies

Arab Republic of Egypt
Ministry of Water Resources & Irrigation
Planning Sector

جمهورية مصر العربية
وزارة الموارد المائية والرى
قطـاع التخطيط

Our Ref. No. : .....
File No. : .....
Date : .....

رقم المكاتبة : ١١٢٤
رقم الملـف : .....
التاريـــخ : ٢٠١٧/٥/١٨

Dear Mr. Azad

We have reviewed the Bank's ICR with our colleagues in the PCU. We are in agreement with the outcomes, the results and the ratings.

We have to mention that during the course of the implementation of the EWRMP (January 2014 to March 2016), we have found all World Bank staff very supportive and their responses were very fast.

The supervision missions were very useful and proactive in giving the project team and the implementing agencies guidance and pushing the implementation of the activities.

During the midterm review and the restructuring the Bank was very much understandable to realize the political situation of the country and agreed to extend the grant closing date for one and half year, and the closure date was postponed to 31 December 2016.

Finally I am looking forward for future cooperation between the Planning sector and the World Bank.

Sincerely yours,

Eng. Asrar Mowady

Asrar Mewafy

Head of the planning sector

Ministry Building, 6th Floor
Corniche El-Nil, Embaba, Giza, Egypt
Tel.: (202) 35449456 - 35451077 - Fax : (202) 35449456
E-mail:plsector6@yahoo.com

مبنى الوزارة - الدور السادس
كورنيش النيل - إمبابة - الجيزة - جمهورية مصر العربية
تليفون : ٣٥٤٤٩٤٥٦ - ٣٥٤٥١٠٧٧ فاكس : ٣٥٤٤٩٤٥٦

Annex 1. Project Costs and Financing

(a) Project Cost by Component (in USD Million equivalent)

Components	Appraisal Estimate (USD)	Percentage of Appraisal
Total Baseline Cost	**8,154,000**	97%
Physical Contingencies	-	
Price Contingencies	213,000	3%
Total Project Costs	**8,367,000**	100%
Project Preparation Facility (PPF)	0.00	
Front-end fee IBRD	0.00	
Total Financing Required	**8,367,000**	

(b) Project Cost by Component in Detail

S. No.	Component	Original	*GEF Amount	GOE Amount	Beneficiaries*** Amount	Total Amount
A.	**Pilot Schemes**					
1.	Nekla/ Menesi Pilot Scheme	1,443	1,429	200	100	1,729
2.	El-Okda/ El-Tellin Pilot Scheme	1,030	1,029	320	80	1,429
3.	Khadrawia Pilot Scheme	352	349	50		399
	Subtotal Pilot Schemes	**2,825**	**2,807**	**570**	**180**	**3,557**
B.	**Capacity Building for Water Management and Monitoring**					
1.	Evaporation Losses Study at Lake Nasser	187	200	130		330
2.	Climate Change Impact Assessment Study in Water and Agriculture in the Nile Delta	548	465	100		565
3.	Surface Water Modeling Analysis Study in the Nile Delta	305	299	75		374
4.	Groundwater Modeling Analysis Study in the Nile Delta	319	348	150		498

5.	Surface Water Quality Monitoring in the Nile System	1,238	1,207	200		1,407
6.	Ground Water Quality Monitoring Capacity in the Nile System	663	620	220		840
	Subtotal Capacity Building for Water Management & Monitoring	**3,260**	**3,139**	**875**		**4,014**
C.	**Project Management**					
1.	Project Management + Price Contingencies + Operating Budget	597	595	120		715
	****Total**	**6,682**	**6,541**	**1,565**	**180**	**8,286**
			97.89%			

* There is a 10% recognized margin for accuracy standards.

** The disbursed percentage will approach 100% once PCU gets the current (under review) final invoice of the TA consultant ($140,950) approved.

*** The allocated budget includes but not limited (SW Land assignation, labor costs for SRI cultivation)

(b) Financing

Source of Funds	Appraisal Estimate (USD millions)	Actual/Latest Estimate (USD millions)	Percentage of Appraisal
Borrower	1.56	1.56	18.00%
Global Environment Facility (GEF)	6.68	0.00	80%
Local Sources of Borrowing Country	0.12	0.18	2.00%
Bilateral Agencies (unidentified)	-	-	0%
Total	**8.36**		**100%**

Annex 2. Outputs by Component

Component 1: Pilot Schemes

Nekla/Menesi Scheme

i) Application of Continuous Flow

1. **Background**: Continuous Flow (CF) entails delivering water continuously to each branch canal (instead of the traditional rotation across branch canals with farmers having access to water every couple of weeks). The discharge at the head of the branch canal is regulated according to pre-determined volumetric water allocations. This approach to delivering water is meant to provide a more reliable and flexible supply of water at the point of abstraction by farmers, thereby contributing to more equitable water distribution, more timely and efficient irrigation and increased crop productions. It also enhances the effective night storage capacity of the canals and therefore reduces the cost of improved mesqa systems.

2. CF had been applied in Egypt before EWRMP, notably through demonstration projects under IIIMP and IIP. However, previous CF pilots and demonstrations did not have proper water delivery, as the actual discharge of water into canals fluctuated substantially, sometimes with a cyclical pattern akin to the traditional rotation system. Moreover, BCWUAs were responsible for water distribution at the mesqa level but there was insufficient coordination between their work and that of MWRI's Irrigation Sector. There was a risk that water was not distributed equally and tail-end farmers were receiving less than those at the head of the canal.

3. **Results**: The goal of piloting CF in Nekla was to test whether the conceptual results would be realized and to see if CF could be replicated in other areas. The piloting of CF began in summer 2015 and continued to summer 2016. The results of the two seasons are noted below:

- Farmers coordinated pumping hours for scheduling operations without any particular tools and with no communication among mesqa operators. As a result, there was **uniform distribution of pumping hours** along the entire branch canal, resulting in higher **equity in water distribution** along the head-, middle- and tail sections of the canal.
- Water supply was almost 100% in line with planned allocations, within a 20% range from theoretical water duty for almost the whole summer season, indicating a **high reliability of water supply**.
- The local irrigation district did not register **major complaints and/ or violations** in the Nekla branch canal, possibly due to the availability of water and consequently, the reduced conflicts related to distribution.
- It was not possible to verify the **actual volume of water supplied** to the canal. There needs to be more accurate measuring devices to verify the volume of water supplied through the head gate.

4. The main conclusions drawn regarding CF are: (i) no clear differences between areas with CF and those under rotation with regard to cropping pattern or growth crop parameters were observed; (ii) farmers were satisfied with CF, which may be related to the ability to pump excess water volumes; (iii) the results cannot be seen as reflecting the real application of CF as it should be, so it is not conclusive; (iii) the main reason of not being able to apply proper CF is the non-availability of sufficient equipment to accurately control volumes of water flowing into the canal head gate. On the whole, the CF pilot in Nekla command area achievements can only be seen as a preparation stage for coping with a future situation of tighter overall water availability.

ii) **Adoption of Controlled Drainage**

5. **Background**: Controlled Drainage (CD) is a type of sub-surface drainage that involves adding some closed end sub collector pipes to the main network to keep water for a longer time and in different soil levels in order to get the optimum use of water. CD is preferred for soil salinity areas with less than 6 mS/cm, as for high salinity areas the normal sub surface drainage network is recommended because of its requirement for regular wash. CD was expected to lead to cost savings with regard to fertilizers, fuel for water lifting and labor. In the Nekla pilot, CD was implemented over an area of 180 feddan. Farmers were responsible for operating the controlled drainage.

6. **Results**: The main take-away from the CD pilot is that it is an effective method for reducing the volume of irrigation water supplied, which confirms the findings of a similar pilot carried out in the same area under IIIMP in 2012/13. Other results are reported in the tables below.

Rice Crop (after one season)

Indicator	Before CD	After CD	Δ
Hours/ irrigation	4	3	-25%
Days between irrigation	6	8	+25%
Fertilizers amount (kg/feddan)	200	150	-25%
Total water amount for feddan/	6,000m3	4,320 m3	-28%

No. of irrigations per season: 16
Irrigation time per feddan: 3 hours
Discharge: 25 l/sec
Amount of consumed water/ feddan: 16*3*25*60*60 = 4,320,000 L = 4,320m3/ feddan/ season

Maize Crop (after one season)

Indicator	Before CD	After CD	Δ
Hours/ irrigation	4	3	-25%
Days between irrigation	12	15	+25%
Fertilizers amount (kg/feddan)	400	300	-25%
Total water amount for feddan/	3,000m^3	2,160m^3	-28%

No. of irrigations per season: 8
Irrigation time per feddan: 3 hours
Discharge: 25 L/sec
Amount of consumed water/ feddan = 8*3*25*60*60 = 2,160,000 L = 2,160 m3/ feddan/ season

7. CD in the Nekla pilot confirmed its potential to increase water use efficiency, maintain crop yields in periods of water stress, and ensure land drainage systems work to the maximum benefit of farmers. It also enables cleaner re-use and protection of drainage water from potential pollution as it reaches open drains. CD was implemented over an area of 180 feddan and farmers were responsible for operating it.

8. The main conclusion was that it is an effective technique especially in rice crop areas for saving water and fertilizers and, as a result, money is saved[13]. However, it was also concluded that effective application of CD requires social participation, institutional supervision (M&E), and awareness for proper operation and crop rotation. With these pre-requisites three main Policy Implications are necessary for CD to be enforced: (i) the Irrigation Advisory Service (IAS) and Drainage Guidance (DG) should be in charge of its implementation for awareness and monitoring; (ii) formation, activation and capacity building for drainage water associations for each sub collector need to assume the responsibility to insert and unplug plugs and spread awareness between beneficiaries; and (iii) an effective cooperation is needed between MWRI and MALR to modify crop rotation to be compatible with sub collectors of CD networks.

iii) System of Rice Intensification

9. **Background**: System of Rice Intensification (SRI) is an integrated and ecologically sound approach to rice cultivation. It involved the use of organic fertilizer, using new varieties of rice, transplanting seedlings at a young age and planting hills at a sufficient distance to allow root development. The main benefits of SRI are higher yields, reduced water use, lower irrigation costs and reduced requirement for agricultural inputs (seed, fertilizer and pesticides). EWRMP implemented three SRI pilots during three consecutive summers (2014, 2015 and 2016) covering a total of 225 farmers and 348 feddan.

10. **Results**: After three seasons of SRI, the following results were noted:

- There was on average a 15 to 24% **increase in rice yields** with SRI compared to traditional rice cultivation. The key success factors were managing nurseries, increasing the distance among hills, reducing the number of seedlings per hill, using locally available organic matter and using promising rice varieties.
- The increase in rice yields was particularly high for the rice varieties **Sakha 104 and Sakha 106**.
- The **cost of labor** increased from 500LE per season before the pilot to 700LE – 800LE during the pilot. The higher cost with SRI is attributable to the considerable manual labor needed during transplanting seedlings. Farmers reported during the ICR mission that labor was the most expensive cost item during the pilot for them.
- According to the overall results **SRI has not yet demonstrated a reduced water use for rice production**. However, it has been confirmed that SRI offers the possibility to increase rice yields using the same amount of water per feddan, enhancing the water crop productivity.
- **Dissemination was an important aspect of the SRI activity**. Media at regional and national level were aware of the implementation of the SRI activities and the adoption of this technology by farmers. As part of the support for promoting SRI technology, some publications (flyers, posters and technical guides) were prepared by the SRI team. SRI benefits already started to be shared at national, regional and local levels conjointly between the MWRI and MALR, and also with national and international research institutions regarding rice cultivation.

11. In conclusion, according to the overall results SRI has not yet demonstrated a reduced water use for rice production. However, it has been confirmed that SRI offers the possibility to increase rice yields using the same amount of water per feddan, enhancing the water crop productivity. After the SRI pilot at least it can be said that SRI produce more rice with the same water, being an indicator of higher productivity.

[13] CD is preferred for soil salinity areas with less than 6 mS/cm, as for high salinity areas the normal sub surface drainage network is recommended because of its requirement for regular wash.

iv) Feasibility Study and Implementation of Solid Waste Management

12. **Background**: EWRMP established a Solid Waste Management (SWM) Unit under the respective BCWUAs, provided consultants, and carried out studies to strengthen this new entity. Following an EIA for the pilot scheme, a feasibility study for SWM led by local governments was carried out to prepare for interventions on SWM. Alternatives for waste processing and composing sites, social issues and a willingness to pay assessment were done. Studies were completed in December 2015. Thereafter, SWM service providers were selected and trained, sites for separation, recycling and composting activities were selected and site visits organized.

13. **Results**: A concept paper was prepared on the institutional set-up, roles and responsibilities for SWM. A technical paper was then prepared, translated and distributed for discussion in 2014, followed by the start of the feasibility study itself in 2015. The study entailed field sampling of waste collection, a community survey of 1,000 households and a calculation of potential benefits, costs, service fees and profit ranges. It also included alternatives for waste processing and composing sites, social issues and a willingness to pay assessment[14]. The final feasibility study was submitted in December 2015. Thereafter, SWM service providers were selected and trained, sites for separation, recycling and composting activities were selected and site visits were organized.

v) Provision of Geographical Information System to Monitor IWRM

14. **Background**: EWRMP provided the IWMD and four BCWUAs with a GIS in order to monitor irrigation water allocation, water requirements, cropping patters, extension of crop damage by insects and other related indicators.

15. **Results**:

- A **GIS platform**[15] was put in place and PCU is starting to acquire information on certain command water areas, problems encountered in the field and so forth. PCU also reported to the ICR mission that the district engineer in the field is using the GIS. This is the first time that a GIS system is functioning on a website although there have been other GIS systems before.

- In September 2014, six staff members from MWRI[16] participated in a **study tour to Armenia**, which has successfully used GIS for IWRM. While the Armenian case was eye opening, it may not applicable to Egypt because in Armenia there was water pricing but in Egypt irrigation water is free. Moreover, WUAs should be the ones using the GIS (this was the case in Armenia) but in Egypt, the GIS is available only at central level. In Armenia, BCWUAs can collect money and hire people to manage the system, buy computers, buildings etc. However, in Egypt, the lack of resources has constrained the roll out of GIS at WUA level. There could be potential at the district water board level though.

- While the original intent was to **provide BCWUAs (in addition to MWRI) with a GIS system** and to capacitate them to monitor water usage, the lack of IT infrastructure and patchy internet service made this option impossible.

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[14] WTO for Sharkiya was 4 pounds per household per month (higher than in Behaira, which was 3 pounds/HH/month because in Sharkiya, the transportation distance for the waste was further away.

[15] The link to the website is: http://gisportal.mwri.gov.eg/arcgis/apps/webappviewer/index.html?id=f63b6094c93a4442a29a706997750340 - User Name: gisguest Password: guest123)

[16] Six staff members – 6 people from Mahmoudia district and Mahmoudia governorate but none from WUAs

Okda/ Tellin Scheme

1) EIA and EMP to Mitigate Against Identified Pollution Sources

16. **Background**: The EWRMP supported EPADP's Environmental Management Unit (EMU) and the Integrated Water Management District (IWMD) – the local administrative entity in charge of the irrigation and drainage pilot schemes in Mahmoudia districts - to carry out a field survey of environmental impacts in the Okda and Tellin drains. The survey also involved sampling water quality in the drains. EPADP EMU and IWMD also carried out an EIA that identified the main sources of pollution, the state of water quality and the extent of law enforcement. An EMP was subsequently prepared. It identified mitigation measures for pollution reduction in drains including SWM, instream wetland and awareness campaigns.

17. **Results**: The responsible agencies prepared and submitted the EA for the Okda-Tellin drains in 2015. The World Bank formally approved it in September 2015. The EMP for this area was completed in December 2015. Among other issues, it addressed solid waste pollution and wastewater collection and treatment.

2) SWM in Irrigation and Drainage Canal System

18. **Background**: SWM in Tellin covered various services: collection, sorting, transportation and dumping. The expected results were higher hydraulic efficiency of canals and drains; a significant improvement of water quality particularly in drains; improved health and environmental conditions and availability of more drainage water for reuse. The activity started late because of hurdles in securing land for the combusting stations. Ministry of Agriculture regulations stipulated that landfills had to be 500 meters away from any residential areas, drains or canals. It was difficult to find any land that fulfilled that requirement in the Nile Delta as the area was virtually all farms.

19. **Results**:

- A service provider (NGO) implemented this activity. They undertook garbage collection by distributing containers to villagers and collecting waste directly from houses and fields.
- The pilot had employment generation benefits. The service provider hired about 30 people to help him in garbage collection. To put that figure in context, the typical population of a village is 3,000 people.
- The service provides services to 2,000 households (about 8,000 people).
- A waste collection charge came into effect in 2015. Households pay 10 pounds a month for this service.
- Public awareness campaigns took place to disseminate information on environmental regulations to farmers. The campaigns also focused on schools. Community leaders attended the awareness campaigns, thus giving confidence to villagers about the importance of paying for waste collection.

4) Cost-Effective Pollution Reduction Interventions

20. **Background**: Instream wetlands function by modifying existing streams or watercourses, forcing water around islands and land wedges, through dense vegetation and similar obstacles.

21. **Results**:

- EPADP finalized the construction of the instream wetland facility in November 2016. The instream facility is operating under the supervision of EPADP engineers.
- There has been a reduction in BOD and total dissolved solids (TDS) in treated water.

- The cost of instream wetlands is relatively low – approximately a quarter of the price of conventional treatment systems. The cost was equivalent to about 40 LE per capita ($4.40 based on an early 2016 exchange rate).
- Instream wetlands enhance the quality of water but does not solve the problem of untreated sewerage. Ideally, the instream wetland facility needs to have a wastewater treatment facility associated with it to ensure full treatment of water.

Khadrawia Pilot Scheme

1) Activities for Resolving Drainage Pollution

22. **Background**: The Khadrawia drain is located in the southern part of the Central Nile Delta, about 70km north of Cairo. The drain passes through the Mibarak industrial complex and except for a few industries who treat their own wastewater, all industrial wastewater from the complex is discharged untreated into the Khadrawia drain. The drain also receives municipal wastewater from villages located in nearby districts. In order to reduce pollution in the drain, a wastewater treatment plant was planned for the area and a district water board (DWB) was established to ensure coordinated action among stakeholders in the area (water users, government law enforcement authorities and investors from the industrial complex).

23. **Results**:

- The Governor officially signed the decree to establish the DWB in August 2016.
- The DWB comprised 35 members, of which 19 were BCWUAs. The use of district water boards was a useful innovation of EWRMP, as it provided different stakeholders a platform to resolve the challenges of wastewater discharge in Khadrawia.
- A series of workshops took place with the members of the newly created DWB to identify the main issues in the district. The DWB does not carry out any concrete activities. Rather, it is a forum to raise awareness about drainage pollution and coordinate on environmental compliance.
- Internal procedures and regulations of the DWB were prepared.
- A central treatment plant was under construction. Its purpose was to treat both municipal and industrial sewerage but because many industrial companies did not pre-treat their effluent before discharging it to the drain through sewerage networks, the plant faced constant degradation due to heavy pollutants and metal remnants in the sewerage.
- The DWB was not able to entice its industrial members to stop discharging untreated pollutants into the drain. Moreover, the strong economic interest among the investor community is beyond the capacity of the law enforcement agencies.

Component 2: Capacity Building for Surface Water and Groundwater Management and Monitoring

24. This component included a number of activities aimed at an integrated management of Egypt's surface water and groundwater resources. Under this component, four strategic studies and two capacity enhancement activities were carried out by various entities. The National Water Research Institute (NWRI) was the umbrella body for these activities and included the Drainage Research Institute (DRI), Nile Research Institute (NRI), the Research Institute for Groundwater (RIGW) and the Environmental and Climate Research Institute (ECRI). EWRMP assisted the institutions concerned to strengthen their technical capacity and knowledge in monitoring and managing the surface water and groundwater more effectively and efficiently. In addition, the component included provision of monitoring equipment,

training and modelling, and strategic studies needed to monitor and assess Egypt water resources, from the Nile River and groundwater aquifers.

The section below summarizes the main outputs for each activity.

2.1: Evaporation Losses Analysis in Lake Nasser

25. **Background**: Even though 50 years have passed since the formation of Lake Nasser, there has not been an accurate estimate of the lake's evaporation losses. The study aimed to provide better estimates and more insight on temporal and spatial distribution over the lake's surface as a function of water level variation in the Lake over the year. The knowledge gained from this study was meant to improve the High Aswan Dam (HAD)'s operation and reduce the evaporation losses, thus contributing to increased water resources over the long term.

26. **Process**: The Nile Research Institute (NRI) implemented the study using historical climate data, and new data collected under the EWRMP. NRI undertook a literature review and analysis of published research and studies on evaporation losses and acquired new topographical maps and remote sensing data. The institute also developed a dedicated model for computing the evaporation losses for different scenarios of reservoir surface area.

27. NRI was responsible for the study, which it started in February 2014. A first mission of the international expert focused on assessing the available experience and capacity and the modelling tool to be configured. It was agreed that the open source modelling suit "Delft3D" would be utilized. Afterward a first working copy of the model that calculates evaporation was prepared and selected NRI staff were then trained in the basic use of the Delft3D modelling suite. Nearly all participants were able to make a rough model of the lake and a first calculation of evaporation volume.

28. **Outputs**: The report on data collection and analysis by the NRI staff was completed and a report on model construction and basic setup was subsequently produced, thus ensuring a transfer of knowledge to future users within the MWRI. A report on the meteorological data evaluation was presented to the MWRI. The actions on remote sensing and hydrological system analysis were completed with their respective action plans and these were implemented. Hydrological analysis started in June 2015 and at least five sessions were carried out. Model construction, test simulation and calibration tasks were finished. Mathematical modelling of the studied area was prepared. Outputs of 3 different methods to measure evaporation loss are now available and were compared. Office equipment was procured and delivered.

29. **Added-Value of Study:** The study added-value both in terms of methodology and the recommendations its findings generated. First, this was the first time that remote sensing was used to estimate evaporation losses on Lake Nasser. Another innovation was the evaluation of existing meteorological stations along the lake rather than collecting data from the field.

30. On the second value-added, the findings of the study provided decision-makers with concrete options for action. The study simulated several measures for reducing evaporation losses in Lake Nasser as well as their technical and economic feasibility.[17] The use of photocells was considered to be probably

[17] The full list of measures is: i) using a spraying method; ii) using bank trees to reduce wind velocity iii) changing lake operation conditions to reduce evaporation; iv) closing or covering some of the lake secondary channels; v) closing Kalabsha (or its inner part) and Alaqi (or its inner part) plus combination of these two and vi) partially covering the lake using solar panels, photo cells or solar balls.

the most effective and most environmentally friendly. The recommendations provided operational guidelines that could be used by the HAD Authority to more effectively and efficiently operate the HAD to reduce evaporation losses. The recommendations outlined resources that MWRI should mobilize to enhance its monitoring capacity for the lake in future.

2.2: Climate Change Impact Assessment in Water and Agriculture in the Nile Delta

31. **Background**: Egypt is vulnerable to effects of climate change due to higher temperature, sea level rise which may flood up to one third of the Nile Delta and possible decrease of the Nile inflow. The climate change impacts could have severe effects on Egypt's water and food security unless proper mitigation/adaptation measures are in place.

32. The study included an assessment of results of different climate change scenarios on water and land use in the Nile Delta and the expected impacts on surface water and groundwater availability, agricultural productivity and socio-economic conditions in Egypt. The main objective was to improve Egypt's resilience to expected impacts of and its capacity for adaptation to climate change. This study was implemented by the Environment and Climate Research Institute (ECRI) of the NWRC. The study used the available Global Circulation Models (GCMs) and/or Regional Climate Models (RCMs). It also assessed different downscaling methods (including the use of RCMs) and recommends a specific methodology for use in the Nile Basin and Egypt.

33. **Process**: During 2014, the appropriate climate scenarios for the study were selected, access was created to sources for collecting the climate data, ECRI staff was trained how to process these data for subsequent hydrological modelling and general training was provided to ECRI on various climate data related issues.

34. In August 2015, an introductory training of RIBASIM Model and capacity building of ECRI staff took place. Fourteen participants from ECRI and MWRI were trained focused on basic principles of RIBASIM modelling. Capacity building was developed with the use of presentations and practical exercises on the laptop.

35. ECRI was not able to carry out the study as anticipated for the Nile Basin and the Nile valley. Regarding the Nile delta, ECRI decided to adopt and further develop a locally made model. The model is developed for and will be applied in an area of about 500,000 feddan along el Nasr main canal, located west of the Rosetta Branch. The model was linked to other software including CROPWAT.

36. Hardware including 10 weather stations and different types of specialized software was procured and provided by the project. Another 14 weather stations were provided by the GoE. Hard and software are operational in the newly created laboratory of ECRI.

37. **Outputs**: CC reports on Decision Support System, Adaptation Strategy and Climate Scenarios were completed.

38. **Added Value**: ECRI was able to establish the CC lab with funds coming from different sources including EWRMP. The study provided new information on climate change impacts in Egypt that had not been developed before.

2.3: Surface Water Modelling Analysis in the Nile Delta

39. **Background**: The intensive surface water channel system in the Nile Delta is extremely complex. It has been managed over the years by the MWRI to satisfy multiple agricultural, industrial and domestic

uses. The growing demand, increasing reuse of drainage water for irrigation, and increasing pollution trends have further complicated water management in Egypt.

40. Surface water modelling capacity has been developed by the Drainage Research Institute (DRI) of the NWRC during the 1990s with Dutch assistance. The recent changes in population, water availability and quality, and water uses and their planned expansion call for further development and update of the modelling capacity of the DRI to accommodate these changes.

41. **Process**: The study included updating the model framework DELTADSS and its hydrological schematization, developing a module to simulate the different reuse options based on the available information related to water quality and quantity, improving routines for managing the wealth of collected data through the national surface water monitoring system, and training DRI staff.

42. The main anticipated outcome of this study was the increase of drainage water reuse and the strengthening of MWRI's capacity for managing the surface water distribution system (spatially and temporally) on a sustainable basis by integrating the water demands with the quantity and quality of the available surface water.

43. **Outputs**: i) One main output was an updated, operational and calibrated modelling software package (based on RIBASIM-SIWARE); ii) The definition of the surface water modelling approach and data requirements was completed; iii) Data collection and model building along with SIWARE model simulation were ready by the end of 2015; iv) A first training abroad was provided; v) DRI prepared a report on re-use of drainage water; vi) An Inception Report was presented in December 2015 and a final report completed in November 2016.

44. **Added-Value**: This was the first time that the monitoring network for drainage and irrigation canals in the Nile Delta had been extensively studies, with an expansion of the monitoring locations and water quality measurement.

2.4: Groundwater Modelling Analysis in the Nile Delta

45. **Background**: Sea water intrusion in Nile Delta has serious implications on groundwater quality and availability. The NWRC's Research Institute for Groundwater (RIGW) carried out in-depth analysis to define areas of high vulnerability to sea water intrusion in the Nile Delta aquifer system. The study aimed to consolidate and strengthen a GIS linking groundwater aquifer information with land use information. This consolidated data would then allow analysis of the changes in the fresh/saline water interface for different scenarios of sea level rise and groundwater abstraction rates using flow and solute transport modelling techniques.

46. **Process**: To support and further enforce of the study, a change to the work plan was approved in September 2015 to create an effective density-driven groundwater model of the Nile Delta combined with successful capacity building. This entailed a review of previous studies related to hydro-geological conditions and sea water intrusion, groundwater data model building and a final report of the technical study. All activities and tasks related to groundwater research activities and data model building were completed. Initial runs of the model took a long time and final running time was considerably less, even when more data was added. Assumptions underlying the model were revised / adjusted. Activities related to capacity building (including workshops and training courses) were undertaken.

47. **Outputs**: The Nile Delta Groundwater model simulated the most effective scenarios for reducing salinity in the Nile aquifer and found that limiting extraction would be the most effective. Drawing on the findings of the model, the study produced a toolkit for sustainable groundwater management in case of

sea level rise. It was based on The output is expected to be used by the Groundwater Sector of the MWRI for decision making.

48. **Added-Value**: The model was innovative as it was the first model that included the whole Delta, that covered the heterogeneity of the Delta and that analyzed the extent of the aquifer under the sea.

Capacity Enhancement in Surface Water Quality Monitoring in the Nile System

49. **Background**: The NWRC is the custodian of the National Water Quality Monitoring (NWQM) network of the Nile System, operated and maintained by its research institutes NRI and DRI. The collected data and processed information support water management decision capacity of the MWRI. Monitoring of water quality in Lake Nasser, the Nile River system and its two branches as well as in drains discharging directly into the river is the responsibility of NRI. The DRI takes the responsibility of monitoring water quality in canals, and drains in the Nile Delta.

50. This activity under the EWRMP was implemented jointly by both institutes and supported by the analytical services of the Central Laboratory for Environmental Quality Monitoring (CLEQM) under the supervision and coordination of the NWRC Management. The overall objective is to enhance and update the monitoring capacity of the NWQM network.

51. **Process**: The main activities of this study included:

- Analysis of the existing monitoring network (locations, objectives and equipment) and formulate recommendations for upgrading the water quality monitoring network, including upgrading procedures and cost estimates. The NRI and DRI were supported in all aspects related to the implementation of the water quality monitoring network upgrading;
- Assist in the selection of the location of 5 new monitoring stations, and provide guidelines for design, operation and maintenance of the 5 new stations;
- Assist in the quantification of the time-variability of water quality parameters (through surveys), and in the statistical analysis to quantify inter-relationships among these parameters;
- Design a training program on sampling, data storage, use and processing.
- Capacity building in the field of water quality monitoring, data processing and -interpretation.

52. Surface Water Quality Monitoring progressed at a satisfactory rate, but individual sub-activities were somewhat behind. The work plan for the full period of the study was addressed with detailed activities and the related supporting missions by the consultant. Moreover, DRI/NRI representatives formulated the main tasks.

53. **Outputs**: The DRI and NRI teams completed the assessment of the monitoring network (water quality variables and sampling frequency). An overview of the status of water quality of the Nile River and Delta was prepared. Water quality equipment, flow-tracking equipment and office equipment were procured and handed over to the corresponding entities. Training on using Matlab and running the Matlab codes for the assessment of both the Water Quality Variables and Sampling Frequency; and Water Quality Data Analysis Training Course were completed respectively in August 2015 and January 2016. The following reports were produced: i) Water Quality Data Analysis Protocol; and ii) final report on National Water Quality Monitoring Network Assessment and Redesign.

54. **Added-Value**: The NWQM network is in a much stronger position to monitor the water quality of Egypt's main water resources and drainage system. The knowledge generated on water quality can help

decision makers to plan appropriate remedial actions for the benefit of Egypt and Mediterranean water resources.

2.6: Capacity Enhancement in Ground Water Quality Monitoring in the Nile System

55. **Background**: The National Groundwater Monitoring Network currently includes 240 sites covering most of the groundwater aquifers in the Nile Valley and all the deserts of Egypt. Its main purpose is to quantify the medium- and long-term quantitative and qualitative changes that are caused by either abstraction, land use activities or salt-water intrusion. The main objective of this study was to provide decision makers with temporal and spatial information about the present and future status of groundwater quality by combining monitoring information with model simulations to predict changes to groundwater quality as a result of different water management scenarios.

56. **Process**: The main activities included inter alia:

- Database management and control: issues related to storage and retrieval for further data handling and processing as well as the control of the data in terms of analytical errors, coding errors, etc.
- Conceptual interpretation of data: hydrogeological interpretation of the data where the data points are put in their geo-scientific ‘’environment’’ with respect to flow conditions, recharge, land use, sediment-petrological composition of the rocks encountered during groundwater flow, etc. An important aspect that commonly needs attention for groundwater quality monitoring is the identification of anthropogenic versus gelogenic controls on this composition.
- Geo-statistical or statistical interpretation of data, in terms of spatial and temporal variability, grouping of samples, etc. Comparison with criteria for e.g. drinking water, irrigation water, groundwater contamination is another aspect executed under this aspect. Whether a geo-statistical or a statistical interpretation is most optimal depends on the spatial heterogeneity encountered versus the data density. When the heterogeneity is larger than the spatial density of the data points, a statistical interpretation is more suitable where an approach using homogenous groups based on system characteristics may be very suitable.
- Capacity building includes provision of equipment, software, and specialized training courses as well as on-the-job related to the tasks in which the project is involved.

57. In June 2014, improvements were made to the RIGW database and solutions were proposed for its further upgrading. RIGW purchased commercial database software, in particular WISKI, for this upgrading. WISKI software was installed at RIGW in August 2015. Training in WISKI was provided to 10 participants by the software provider in September. A server with three clients was procured and installed.

58. In December 2015, the roles and responsibilities for each of the participants and the conditions to operationalize the WISKI technical software were defined. Finalization of the database and preparation of a WISKI manual took place in January 2016. RIGW then proceeded with the migration of the database from the old to the new system. The project also supported RIGW with topics such as export of data to other software, data-analysis and reporting. Moreover, a user interface was developed and installed. The database was ready for use by September 2016.

59. **Results:**

- An inventory and mapping of actual and potential groundwater and analysis of data-gaps were completed.

- Various investigations, analysis and assessments were completed. These included hydro-geological field investigation, updating and classification of anthropogenic and land use activities, preparation of groundwater thematic maps in data gap areas, identification of main sources of groundwater pollution, groundwater flow and solute transport modelling and detection of location of new monitoring points.
- Three new monitoring points were drilled.
- Training was provided by RIGW in the field of the optimal spatial distribution of monitoring wells, using gap-analysis and interpolation techniques. Training on geo-interpretation/processing was completed to model development under Technical Study 4 and the acquisition of GIS and other software.
- A final research study report was completed.

60. **Added-value**: The EWRMP project does not have the resources to develop the database further. However, there is enough of a foundation to do so in the future should resources materialize.

Component 3: Project Management

Activity 1: Investment to strengthen the Project Coordination Unit (PCU)

61. **Background**: The objective of this activity was to strengthen the PCU, make it more effective in performing its tasks and fulfilling its responsibilities and train the PCU in the use of knowledge management tools and results-based M&E systems.

62. **Results**: The First Assistant Minister of the MWRI approved the creation of the PCU, which was headed by a Project Director. It was comprised of technical staff from MWRI and a number of consultant. In particular, the Technical Assistance consultant (from Mott McDonald), provided crucial on-the-job training and implementation support for the PCU. The consultant and PCU worked together to prepare appropriate and timely annual work plans, quarterly and bi-annual progress reports and results-based monitoring reports. In addition, a financial management consultant and a social development consultant were recruited to support the PCU.

Activity 2: Results-based monitoring and evaluation system

63. **Background**: Activities included the development of a M&E system and associated indicators, data collection, analysis and reporting. In addition, the goal was to establish a "dynamic information system", in conjunction with the ongoing projetcs linked to EWRMP (ISSIP, NDP2 and IIIMP) in order to monitor project outputs and track the physical and financial progress of the project.

64. **Results**: An M&E Plan was developed in 2014, which formed the basis of establishing the results-based M&E system. Project Feedback Sheets (PFS) were developed specifically for this project as a data collection tool for the M&E system. These sheets address qualitative and quantitative aspects of progress, outcomes, achievements, challenges and reports prepared for the project. PFS were defined for each of the key EWRMP activities and were updated on a quarterly basis by the EWRMP coordinators and M&E staff from the related projects. In addition, a Management Information System was developed to facilitate data storage and analysis as well as reporting.

Activity 3: IW Learn: A Tracking Tool for Disseminating Lessons Learned and Investment for Sharing Information at International Conferences

65. **Background**: This activity aimed to promote the exchange of information and experience gained from the pilot schemes and demonstrations at international conferences. The budget for this activity (USD73,000) covered the travel costs for MWRI staff participating in dissemination activities.

66. **Results**: PCU developed a website that was meant to be linked to the GEF IW Learn platform. The IW Learn platform will strengthen the PCU's position as a Knowledge Centre, that can collect, assemble, organize, manage and disseminate knowledge on IWRM in the Egyptian context. Moreover, key training on uploading and maintenance of the website was offered to PCU staff. At the time of the ICR writing, the website was undergoing testing and was scheduled for completion by April.

Annex 3. Economic and Financial Analysis

1. The economic and financial analysis (EFA) presented in the PAD estimated that the mitigating interventions proposed under the first component would justify costs even before quantifying environmental and global benefits. The impact of the second component was not quantified, but given the "public goods" nature and benefits, it would also significantly contribute to improve both economic and the global environment impact.

2. The ex-ante EFA focused on the proposed interventions in the Nekla pilot scheme, where benefits would be derived from three main sets of activities: (i) enhanced surface water management by introduction the continuous flow (CF) regime on branch canals and mesqas with irrigation scheduling, controlled drainage (CD), and users participation in water allocation through a GIS based system to be managed by BCWUAs; (ii) diverting organic wastes from households for recycling into organic fertilizers together with agricultural residues through composting; and (iii) introducing the system of rice intensification (SRI) technologies through demonstration fields to improve yields by using less water (alternating flooding and drying instead of continuous flooding of rice) and less inputs (seeds, agrochemicals and inorganic fertilizers, and increasing organic fertilizers).

i) CF and irrigation scheduling

3. The main activities performed were application of CF, monitoring pumping hours and data collection and analysis in order to understand the behavior of farmers in operating their pumps under CF regime. Annex 1 summarized the main findings. To compare and evaluate the performance of both CF and rotational flow it is necessary to control volumes of water entering the canal[18]. Hence, to the effect of this EFA, benefits were not quantified (as done for in the PAD) as more research with CF needs to be done.

ii)Controlled drainage

4. The main conclusion was that it is an effective technique especially in rice crop areas for saving water and fertilizers and, as a result, money is saved. If widely replicated, CD has the potential of realizing substantial water savings (up to 30-40%) which is highly significant given the increasing water stress in Egypt. Currently, there is no policy within the MWRI related to applying CD, and there are no plans of relevant capital investment on CD initiatives within EPADP. The pilot confirmed the advantages of expanding CD and that it would be worth being considered among mitigation measure in the national water resources management plan. However, the lack of a clear policy to implement CD, and the higher installation cost over the regular drainage system, offers insufficient ground for assuming a significant adoption of CD in the near future, so benefits from CD findings were not quantified.

iii) Recycling of organic waste

5. Recycling of organic waste was the aim of a SWM unit created under the respective BCWUAs. Consultants were provided, studies prepared and institutional set-up, roles and responsibilities defined. A feasibility study entailed field sampling of waste collection, a community survey of 1,000 households and estimation of potential benefits, costs, service fees and profit ranges completed. Alternatives for waste

[18] The existing ultra-sonic flow meters provide an excellent opportunity to enable practical application of CF in the future. This application will not cause any significant implication, and has the advantage of being doable and practical with relatively low cost. The feedback and experience to be gained from this exercise will assist in having better insights within the whole distribution system, as well as enable dealing with future water shortage situations.

processing and composing sites, social issues and a willingness to pay assessment were done. Studies were completed in December 2015. Thereafter, SWM service providers were selected and trained, sites for separation, recycling and composting activities were selected and site visits organized.

6. The establishment of SWM in seven villages of Sharkiya and Mahmoudia included installing the collection and treatment equipment. They are producing compost from the organic waste to use in Agriculture, as well as recyclables (glass, plastic, paper, cloth, metals etc.), and non-recyclable waste to be dumped in sanitary land fill. Burning rice crop residues still contributes to CO2 emissions. Improved equipment such as the rice straw baler machine could help to reduce burning and GHG emissions. The benefits of these recycling activities are evident but are yet too early to measure and quantify them for this EFA.

iv) SRI

7. After three years (2014 -2016) of project demonstrations involving 225 feddans in Nekla pilot area, the results attained places SRI as the most successful story for local farmers. Rice yields obtained with SRI and conventional cultivation method were compared for 2015 and 2016 (no data was available for 2014 under conventional method). The increasing rice yields with SRI were 39% and 29% respectively for the mentioned seasons. SRI showed consistently increasing rice yields in an average of 34% as compared to traditional rice cultivation practices, resulting in higher profits and improved social and economic conditions for farmers and their families

8. Based on the results obtained by farmers on the three seasons with SRI demonstrations, Table 1 presents the average crop budgets showing the net returns being obtained without and with SRI technology. Water consumption was similar in the SRI and conventional areas, but water productivity was higher (0.66 kg/m3) when using SRI than with conventional technology (0.54 kg/m3). While in the PAD it was assumed that yields per feddan would increase by 12.5% and net revenues by 13.2%, it was estimated that on average increases were 34% and 66% respectively. These results are conservative estimates since the improved yield is assumed to be reached in the third year of SRI activities and because the technology packages still need to be improved with complementary measures as CF and CD that will also contribute to additional productivity gains.

Table 1 Rice Crop Budget with Conventional and SRI Technology

Rice in Improved Areas Nekla Crop Model FINANCIAL BUDGET (In LE Per fed)	Existing Technology	New Technology		
	1 to 15	1	2	3 to 15
Revenue				
Rice	7,480	7,480	8,800	9,900
Rice straw	600	600	680	760
Sub-total Revenue	8,080	8,080	9,480	10,660
Input costs				
Soil Preparation	240	240	240	240
Pumpset Depreciation & Maintenance	35	35	35	35
Electricity	21	21	21	21
Rice seed	390	390	348	300
Urea (45%N)	800	800	700	600
Superphosphate	300	300	255	210
Organic Fertilizer	-	-	20	40
Insecticides	30	30	25	20
Herbicides	45	45	45	45
Fungicides	100	100	80	60
Sprayer	28	28	28	28
Animal w ork (cultivation/transportation)	120	120	140	160
Threshing	184	184	212	240
Sub-total Input costs	2,292	2,292	2,148	1,998
Income (Before Labor Costs)	5,788	5,788	7,332	8,662
Labor costs				
Land preparation/nursery	600	600	660	720
Cultural practices/irrigation	480	480	600	720
Harvesting	1,200	1,200	1,320	1,440
Sub-total Labor costs	2,280	2,280	2,580	2,880
Income (After Labor Costs)	3,508	3,508	4,752	5,782
Yields (MT/feddan)	3.4	3.4	4	4.5

9. The differences between SRI and conventional rice production mainly concern the seed rate, the use of organic fertilizer, the labor needed for transplanting, the use of herbicides and time spent on weeding, and the costs of supply of irrigation water. This derives in different production costs, yields and profits. The overall economic aspects for the three years' observations have been summarized in Table 1. The data suggests that there is no significant difference between the water used by the two systems (although the literature on SRI claims that SRI uses less water)[19]. However, as the yields of SRI are higher than of the conventional rice, the SRI "crop per drop" is higher and hence less water is needed to produce the same amount of rice.

SRI Impact on Farmers' Income

10. Table 2 presents a typical farm model (2 feddan) representative for the Nekla area. The farm was assumed following the parameters used on the PAD EFA. Main crops include 1.2 feddan with rice, 0.6 feddan with cotton and 0.2 feddan with long berseem in summer; and wheat (1 feddan), and 0.8 feddan, with short berseem (fodder crop) in winter. Gross revenue from summer crops increases by LE 2,900 which with some reduction on rice production costs results in increases of net income of about LE 3,100, 6.5% over the conventional rice technology.

[19] Reduction of water use in SRI can be realized in combination with CF in the mesqa. Farmers have a strong incentive to reduce the number of irrigations and the water depth per irrigation, as this saves them pumping time and costs. However, they only are willing to reduce irrigation if they have assured water supply and evidence to support it. If CF is not assured, they over-irrigate as a buffer for possible water shortages during the remaining growing season. Hence the shift from rotational to CF in the mesqas is a precondition for water savings in crop production.

Table 2 Farm Model on the Nekla Area: Impact on the farmers' Income

FINANCIAL BUDGET (AGGREGATED) (In LE)	Without Project	With Project		
	1 to 14	1	2	3 to 14
Main Production				
Winter Crops	18,127	18,127	18,127	18,127
Summer Crops	16,902	16,902	18,486	19,806
Animal products	4,785	4,785	4,785	4,785
Sub-total Main Production	39,815	39,815	41,399	42,719
By Products	1,830	1,830	1,926	2,022
Gross Value Of Production	41,645	41,645	43,325	44,741
On-Farm Use	3,650	3,650	3,650	3,650
On-Farm Consumption	7,445	7,445	7,445	7,445
Net Value Of Production	30,550	30,550	32,230	33,646
Off Farm Employment	18,948	18,948	18,792	18,612
Purchased Consumption	385	385	385	385
INFLOWS	49,113	49,113	50,637	51,873
Production Cost	8,877	8,877	8,704	8,524
OUTFLOWS	8,877	8,877	8,704	8,524
Cash Flow Before Financing	40,236	40,236	41,933	43,349
Farm Family Benefits Before Finai	47,681	47,681	49,378	50,794
Net Financing	-	8,790	2	-
Cash Flow After Financing	40,236	49,026	41,934	43,349
Sub-Total Change in Net Worth	-	-8,788	-	-
Farm Family Benefits After Financ	47,681	47,683	49,380	50,794
Returns per Family-Day of Labor	263	263	263	263

SRI Rice Scenarios for the next years and expected benefits from the Nekla pilot

11. To the effect of estimating the impact of the validated technology under EWRMP, three scenarios were used: it was assumed that in 5 years the area adopting SRI could reach 3%, 5% or 10% of the rice area in the country: (i) in the first case, after spending about LE 30 million between 2017 – 2022 in demonstration and dissemination campaigns, about 25,000 farmers cropping 30,000 feddan of rice would be adopting SRI in their fields by 2022; (ii) in the second, after spending LE 50 million in the same period and the same but more intense campaigns, 40,000 farmers in 50,000 feddan of rice would be using SRI by 2022; and (iii) in the third scenario, after investing LE75 million to the same purpose, about 83,330 farmers with 100,000 feddan (10% of the total) would be using SRI by 2022.

12. These are considered conservative targets for the next five years taking into account that SRI had been rapidly expanded in similar situations in the past: in Vietnam for example, in only 5 years between 2007 - 2011 of extension work led by OXFAM, more than 1 million of very small farmers had adopted the SRI in the areas where targeted extension work towards that end was developed. Even the poorest farmers respond quickly to well-designed new SRI technology promotion interventions, changing their traditional practices once proved being positive.

13. Project costs used for the estimation of the Nekla pilot impact economic analysis were all costs incurred in the Nekla scheme under component 1, including not only those related to the SRI demonstration activities, but also those related to CF, CD, and composting technologies (organization and installation of facilities for recycling organic wastes into organic fertilizers), totaling LE 166 million (US$1.73 million). It also included the cost of installing some water measurement devices for monitoring the water used under the proposed approaches (including CF, irrigation scheduling, controlled drainage, SRI, etc.), and the cost of the international TA required for the introduction of the technologies and processes that were new for Egypt.

14. The base case scenario was assumed to reach 5% of the rice area adopting SRI by 2022. The economic analysis of the EWRMP Nekla pilot scheme investments, assuming that MOWI and MALR

would invest additional LE 50 million in the next 5 years for intensifying the dissemination of SRI, shows an economic rate of return of 12.9% and a NPV of LE 50 million (with 6% as discount rate, representing the marginal utility of consumption of the project beneficiaries[20]). Table 3 shows that a total EWRMP investment of about US$1.73 million in the Nekla pilot scheme, even without quantifying the benefits of the CF, CD, SWM and composting organic wastes, nor the global benefits of reduction of GHG emissions to be attained through the validation of the new IWRM holistic approach; would yield sufficient returns for justifying the investment involved, and the additional costs of dissemination SRI during the next 5 years.

Table 3 Economic Impact of the Nekla pilot scheme

Nekla Pilot Scheme (SRI reaching 50,000 fed - 5% of rice area) Subproject Model

ECONOMIC BUDGET (AGGREGATED) (In LE Million)	Without Project	With Project									
	1 to 15	1 to 2	3	4	5	6	7	8	9	10	12 to 15
Main Production											
Winter Crops	725	725	725	725	725	725	725	725	725	725	725
Summer Crops	676	676	676	676	676	676	677	679	691	720	792
Animal products	134	134	134	134	134	134	134	134	134	134	134
Sub-total Main Production	1,535	1,535	1,535	1,535	1,535	1,535	1,536	1,538	1,550	1,579	1,651
By Products	73	73	73	73	73	73	73	73	74	76	81
Gross Value Of Production	1,608	1,608	1,608	1,608	1,609	1,609	1,609	1,611	1,624	1,655	1,732
On-Farm Use	146	146	146	146	146	146	146	146	146	146	146
On-Farm Consumption	252	252	252	252	252	252	252	252	252	252	252
Net Value Of Production	1,211	1,211	1,211	1,211	1,211	1,211	1,211	1,214	1,227	1,257	1,335
Purchased Consumption	11	11	11	11	11	11	11	11	11	11	11
INFLOWS	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,203	1,216	1,246	1,324
Production Cost											
Purchased Inputs	345	345	345	345	345	345	345	344	343	339	329
Labor	435	435	435	435	435	435	435	436	439	446	464
Sub-Total Production Cost	780	780	780	780	780	780	780	780	782	785	794
Other Costs											
Nekla Pilot Investments	-	33	33	33	33	10	10	10	10	10	-
OUTFLOWS	780	813	813	813	813	790	790	790	792	795	794
Cash Flow	420	387	387	387	387	410	410	412	424	451	530
Net Economic Benefits	671	638	638	638	638	662	662	664	676	703	782
Participating Farms (avge. 2 feddan)	0	0	68	70	87	200	1,600	8,240	20,600	40,000	40,000
Rice Area in Participating Farms (fed	0	0	82	84	104	240	1,920	9,888	24,720	48,000	48,000

IRR = 12.1%
NPV (6% discount rate) = LE 109.6 million
NPV (10% discount rate) = LE 27.3 million

Sensitivity Analysis

15. The other 2 scenarios described before (adoption of SRI reaching 3% and 10% of the rice area in Egypt as pessimistic and optimistic SRI expansion alternatives) were used for the sensitivity analysis of the Nekla pilot scheme. In these scenarios the ERR would be 7.3% and 20.5% while the NPV (6% as discount rate) would be LE 17.9 million and LE 385.9 million respectively.

Overall Conclusion

16. *The ex-ante economic and financial analysis presented in the PAD focused on the proposed interventions in the Nekla pilot scheme where water management would be improved through three main sets of activities:* (i) enhancement of surface water management by

[20] See Discounting Costs and Benefits in Economic Analysis of World Bank Projects, OPSPQ. May 9, 2016. "Where no country-specific growth projections are available, we suggest using 3% as a rough estimate for expected long-term growth rate in developing countries. Given reasonable parameters for the other parameters for the other variables in the standard Ramsey formula linking discount rates to growth rates, this yields a discount rate of 6%." Note prepared by Marianne Fay (GGSVP) et al, February 18, 2016.

introduction the continuous flow (CF) regime on branch canals and mesqas; irrigation scheduling; controlled drainage; and users participation in water allocation through a GIS based system to be managed by BCWUAs; (ii) diverting organic wastes from the household level for recycling it together with agricultural residues, through composting (and vermi-composting) into organic fertilizers; and (iii) introducing the system rice intensification (SRI) technologies through demonstration fields in the Nekla pilot to improve yields by using less water and less inputs. The PAD analysis concluded that the investment of about US$2 million in the Nekla pilot scheme, would yield an ERR of 12.4%, even without considering public or global benefits to be generated through the validation of the new IWRM holistic approach after its adoption on Nile System.

17. *The project could not achieve all the expected outputs and impact mainly because the social unrest prevailing in Egypt during most of the implementation years.* However, the ICR analysis found out that even without considering many of the benefits from activities regarding CF, CD, GIS participatory management or advances in the SWM activities, only with the expected impact around the SRI demonstration activities the ERR could reach to 12.1%. The quantification of the benefits of all the other activities mentioned above was not possible for different reasons, but they will generate significant impact as they are followed up and completed in the project operational phased.

18. If these EWRMP activities are continued properly, the project would have done a much higher contribution to IWRM in Egypt than expected, and better solutions will be available for managing the imminent water crisis expected in Egypt in the near future. Egyptian government and the entire population need to act swiftly and decisively to mitigate water scarcity by implementing water conservation techniques, more efficient irrigation technologies, controlling water pollution and developing plans accordingly in order to avoid a disaster.

19. CF, CD, SRI, SWM and most of the EWRMP main interventions have provided crucial elements to introduce massively water management components to help succeed in coping with water scarcity and quality problems. For example, the recycling of wastes would contribute to mitigate GHG emissions from the recurrent burning of residues that produce the “black cloud” over Cairo. Water would be better saved and productivity increased due to enhancing water management with increased user’s participation, and through the use of SRI the demand for irrigation water in the peak demand season will be better handled. Water savings could then be released as fresh water to be used by other users.

Annex 4. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Yoshiharu Kobayashi	Sr Water Resources Spec.	GWADR	Water resources analysis
Heba Yaken Aref Ahmed	Operations Analyst	GWA05	Co-TTL
Zakia B. Chummun	Program Assistant	GWA06	Administrative support
Hani Abdel-Kader El Sadani Salem	Sr Water Resources Engr.	MNSWA - HIS	Water resources analysis
Akram Abd El-Aziz Hussein El-Shorbagi	Sr Financial Management Specialist	GGO24	Financial Management
Badr Kamel	Senior Procurement Specialist	GGO05	Procurement
Sergio Margulis	Consultant	GEN04	Environment
Supervision			
Yoshiharu Kobayashi	Sr Water Resources Specialist	GWADR	Task Team Leader
Abdulhamid Azad	Lead Water Resources Specialist	GWA05	Task Team Leader
Heba Yaken Aref Ahmed	Operations Analyst	GA05	Co-TTL
Badr Kamel	Senior Procurement Specialist	GGO05	Procurement
Basheer Jaber	Procurement Specialist	GGO05	
Mohammad Kandeel	Environmental Safeguards Specialist	GEN05	Environment
Wael El Shabrawy	Financial Management Specialist	GG023	Financial management
Amal Faltas	Social Development Specialist	GSU05	Social issues
ICR			
Dambudzo Muzenda	Water Resources Specialist	GWA05	Lead Author
Usaid El-Hanbali	Water Resources Consultant	-	Consultant
Rita Cesti	Practice Manager	GWA04	Chair of QER meeting
Bill Young	Lead Water Resources Management Specialist		Peer reviewer
Nagaraja Harshadeep	Lead Environmental Specialist	GENDR	Peer reviewer
Eileen Burke	Senior Water Resources Management Specialist	GWA02	Peer reviewer

(b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	USD Thousands (including travel and consultant costs)
Lending		
FY12	14.2	92.3
FY 13	5.2	50.4
Total:	19.4	142.7
Supervision/ICR		
FY14	6.1	59.01
FY15	4.2	31.4
FY16	3.7	50.7
FY17	4.9	33.2
Total:	18.9	174.3

Annex 5. Beneficiary Survey Results

A social survey/ questionnaire was undertaken in 2016 for the continuous flow activity, with 55 respondents. The results are reported below:

- Most farmers appreciate the benefits of the CF
- Although some farmers complain due to power failure and low capacity of pump stations, they are in general satisfied with the water availability due to CF
- 92% of farmers related increased productivity due to CF availability
- 94% of farmers stated that they were able to more efficiently organize their field under CF
- 95% of farmers said there is no coordination of pumping operations at the mesqa level
- 95% of farmers responded that there is no coordination at the canal level
- 32% of farmers said that water levels are getting low while operating pumps. They attributed this to the fact that many farmers operate pumps at daytime and few of them at night. They admitted that coordination among the canal would solve this problem
- 25% of farmers thought that increasing canal flow rate will eliminate problems of low water levels
- 50% of farmers agreed to have fixed days and dates defined for pumping stations

Source: *Piloting Continuous Flow in Nekla Command Area: Final Report*, MWRI and Euroconsult/ Mott McDonald, November 2016

Annex 6. Stakeholder Workshop Report and Results

Brief on the Enhanced Water Resources Management Final Workshop

The final workshop for the Enhanced Water Resources Management Project was held on 27 December 2016. It was attended by the Minister of Water Resources and Irrigation, Minister of Local Development, Governors of Sherkia and Behaira and the Deputy Governor of Behaira with representation from the Parliament, media and the Administrative Control Authority.

In the workshop, the outcomes of the project were presented. Both the governors of Sherkia and Behaira expressed their strong satisfaction with the outputs of the solid waste management (SWM) and the system of rice intensification (SRI) pilots and stated that they want to build on the success of these pilots. It was noted that the early warning system provided reliable information during the flood this year and that senior management acted based on it.

Workshop participants also acknowledged the capacity building that was carried out through the project for the different research institutes and the link established with the end users to benefit from the models provided, especially the National Water Resources Plan.

It was announced that the Project Coordination Unit will be maintained to follow up on the implementation of the project's activities and that an Inter-Ministerial Committee was formed including the Ministry of Environment, Ministry of Local development and the Ministry of Water Resources to scale up SWM for other governorates.

Annex 7. Summary of Borrower's ICR and/or Comments on Draft ICR

1. The overall objective of the EWRMP is to establish the basis for scaling up investments through the Government's IWRM programme and contribute significantly to pollution control and improved ecosystem health of the Mediterranean Sea. The successful operationalization of the IWRM approach and principles in the pilot schemes should demonstrate the benefits of synergy on the on-going World Bank co-financed projects (IIMP, NDP2 and ISSIP). The approach will likely be replicated in the Nile Delta, resulting in increased water use efficiency and availability for reuse and improved water quality, health status, productivity and living conditions of the poor. The improved surface water quality will eventually reduce the pollution load of Nile water flowing into the Mediterranean Sea.

Achievement of Project Development Objectives

2. **PDO 1**: **Technical and institutional capacity building and training.** Training supported the PCU and other MWRI sectors on the following selected topics: M&E system, environmental plans, negotiation and effective participatory communication skills and surface and groundwater models. NWRC institutes benefited from capacity building through procurement of office equipment. Other governmental agencies (irrigation districts, technicians), farmers and NGOs were trained in IWRM.

3. **PDO 2: Water saving volume used per feddan**. SRI combined with rehabilitation of infrastructure and other benefits from IIMP have buffered the government's policy on irrigated rice areas. SRI results have identified a couple of possibilities where water reduction could happen without affecting rice yields. The first possibility is that SRI reduces the volume of water applied during the nursery stage as SRU promotes the short age of seedlings for transplantation to permanent land. The second area is growth development, as SRI requires soil to dry out before the next irrigation, as drying soils after transplantation has a favorable effect on the growth of seedlings.

4. **PDO 3: Increased percentage of reliability of water supply**. This was achieved by synergizing EWRMP and IIIMP activities. The key factors driving this good result include equitable water distribution in both top and tail end mesqas, increased water productivity of rice through SRI and farmers' reporting that they have access to improved irrigation services in the Mahmoudia Canal.

5. **PDO 4: Government's documents issued for IWRM policies/ procedures/ implementation**.

A summary of the studies under Component 2 and their out were as follows:

No.	STUDY	MAIN OUTCOME
1.	Evaporation Losses Analysis in Lake Nasser	• The importance of applying different approaches to get more accurate estimation for lake evaporation losses • A processes-based numerical model for Lake Nasser including a comprehensive heat balance model was constructed and utilised to calculate evaporation. The model is the first of its kind for the lake • Awareness raising and capacity strengthening. The staff of NRI were offered different training courses and extensive on the job training on the theoretical background, the use of new tools and methods and numerical modelling using Delft3D.
2.	Climate Change Impact Assessment in Water and Agriculture in the	• Climate Change Adaptation Decision Support System • Two approaches were used for the definition of climate scenarios, one of them show that precipitation is expected to decrease by 10% while temperature is expected to increase by 2.5 to 3.5 °C

No.	STUDY	MAIN OUTCOME
	Nile Delta	• Two Climate Change Adaptation Strategies were produced by ECRI • Investments for Climate Change Lab at ECRI was an additional value
3.	Surface Water Modelling Analysis in the Nile Delta	• The decision support system (DSS) is a powerful tool for better understanding of the water system and can answering key questions in relation to different water management strategies and scenarios. One of the important questions is the impact of water shortage on Delta soil salinity. • National and international training on SIWARE and RIBASIM models
4.	Groundwater Modelling Analysis in the Nile Delta	• Technical Report on Nile Delta Groundwater Model • Activities related to capacity building (including workshops and training courses) were developed • Procurement of groundwater monitoring equipment for new strategic locations
5.	Capacity Enhancement in Surface Water Quality Monitoring in the Nile system	• Technical Report on Surface Water Quality Monitoring Capacity • Recommendations on how to improve the NRI Water Quality Yearly Book • Training abroad and on job training on surface water quality monitoring • Procurement of sophisticated equipment to monitor water quality
6.	Capacity Enhancement in Ground Water Quality Monitoring in the Nile system	• Spatial and temporal assessment of the effectiveness of the current monitoring network by RIGW • Two major training courses were conducted; introduction to groundwater hydrology for newcomers, and application of geostatistical analysis and using MATLAB as a tool for monitoring networks assessment • Procurement of refine software and office equipment

6. **PDO 5: Demonstration activities developed and implemented in the pilot areas**. 112,660 feddans from EWRMP, IIIMP, ISSIP 2 and NDP2 adopted demonstration activities in their project areas.

7. **PDO 6: Increased IWRM awareness and effective roles of local WUAs, farmers and stakeholders**. More end-users have increased awareness on environmental issues and solutions thanks to EWRMP activities such as awareness campaigns, distribution of communication materials, use of videos on SRI principles and dissemination of policy papers.

Challenges and Achievements

8. The project suffered from a number of implementation challenges early on, which effectively slowed down the pace of progress. Some of these challenges included weak coordination and poor cooperation among project stakeholders. The Arab Spring events caused severe disruptions, particularly through the imposition of curfews and deteriorating security conditions which made some project sites inaccessible. The disbursement rate was low, at only 13% at mid-term. There were also several changes in the PCU and World Bank team membership which undermined the stability of implementation. In addition, the local currency fluctuations and the difficulties to find suppliers under the very variable economic environment was another key implementation challenge.

9. Despite these challenges, the project saw a significant turnaround in the last two years of the project. Disbursement rose to 99.99% by project closure and all of the PDO indicators were achieved. This success is the result of a stronger PCU team, including stable leadership in the last 18 months. All the supporting elements fell into place in the second half of the project, particularly the TA Consultant and the necessary EMP Plans. In addition, the awareness raising activities starting to generate buy-in from stakeholders and the political and economic conditions in Egypt stabilized. The turnaround of the project is a testament to the strong ownership and commitment of the PCU, the Ministry of Water Resources and Irrigation and the Government of Egypt on the whole.

Lessons Learned and Recommendations

10. **Continuous flow** cannot work properly without some form of volumetric control and distribution. The present regulation system does not allow controlled distribution of volumes per day, but it is possible to distribute volumes of water quite accurately on a weekly basis. For this, ultra-sonic measurement of flow has to be used by a dedicated District Engineer who can adjust daily flows according to the measured volumes. The possibilities of what is the best way to enable volumetric distribution to branch canals needs to be further investigated and piloted. The role of BCWUAs in distributing the allocated volumes of water should be enhanced.

11. **Controlled drainage** proved that it is an effective technique especially in rice crop areas for saving water (or at least easing the pressure in the water supply system) and fertilizers. Consequently, it is also effective for cost savings. The controlled drainage network should be expanded in saline areas in particular. The system can be expanded through implementation in new and rehabilitated areas.

12. **SRI**: Three consecutive years (2014-2016) of good results placed SRI as the most successful activity in the eyes of farmers and local communities. To ensure the full benefits for water savings, it would be worth integrating SRI with continuous flow and controlled drainage.

13. **Climate Change**: The work at ECRI shows that the ranges of climate change are narrower now than, say, 10 years ago. The current water-related disasters require a Disaster Risk Reduction Plan, included for each affected city, in the short term, as well as the integration of climate change into national development plans in the long term. Climate change should be mainstreamed in MWRI projects and activities and a detailed climate change adaption plan for the water sector should part of the National Water Resources Plan.

14. **SWM**: The EWRMP pilot impacted agricultural water quality to a certain extent. As SWM is a new area for MWRI, there needs to be a clarification of future roles and actions, both legally and institutionally. Local institutions should be involved in making this decision. Cooperation with the Ministry of Local Development and the Ministry of Environment will facilitate applying SWM activities. However, cooperation with MARL will be needed on composting of agricultural waste in farming communities. It is important to remember that it has taken decades to resolve solid waste and wastewater problems in Europe. The same will be true for Egypt.

15. **The importance on groundwater resources in the Nile Delta** necessitates the highest level of groundwater management to ensure the optimal use of the resource. Groundwater management should include full monitoring of both groundwater quality and quantity through monitoring networks.

16. **Good communication and coordination** is very important for the project's success. The PCU should keep the collaborative spirit and maintain contact with partners interested in water issues and the water resources management process.

Annex 8. Comments of Cofinanciers and Other Partners/Stakeholders

N/A

Annex 9. List of Supporting Documents

Project Documents

- *Project Appraisal Document on a Proposed Grant from the Global Environment Facility (GEF) Trust Fund in the Amount of US$6.6 Million to the Republic of Egypt for the Enhanced Water Resources Management Project*, June 13, 2012

- Financing Agreement

- *Integrated Safeguards Datasheet*, World Bank, 7 April 2011

- *Restructuring Paper on a Proposed Project Restructuring of Enhanced Water Resources Management Project to the Arab Republic of Egypt*, January 22, 2015

Aide Memoires:

- First Pre-Appraisal Mission, June 2011
- Second Pre-Appraisal Mission, August 2011
- Third Pre-Appraisal Mission, October 2011
- Implementation Support Mission, February 2013
- Implementation Support Mission, May 2013
- Implementation Support Mission, October 2013
- Implementation Support Mission, February 2014
- Implementation Support Mission, April 2014
- Mid-Term Review, November 2014
- Implementation Support Mission, August 2015
- Implementation Support Mission, November 2016

Implementation Status and Results (ISR) Reports:

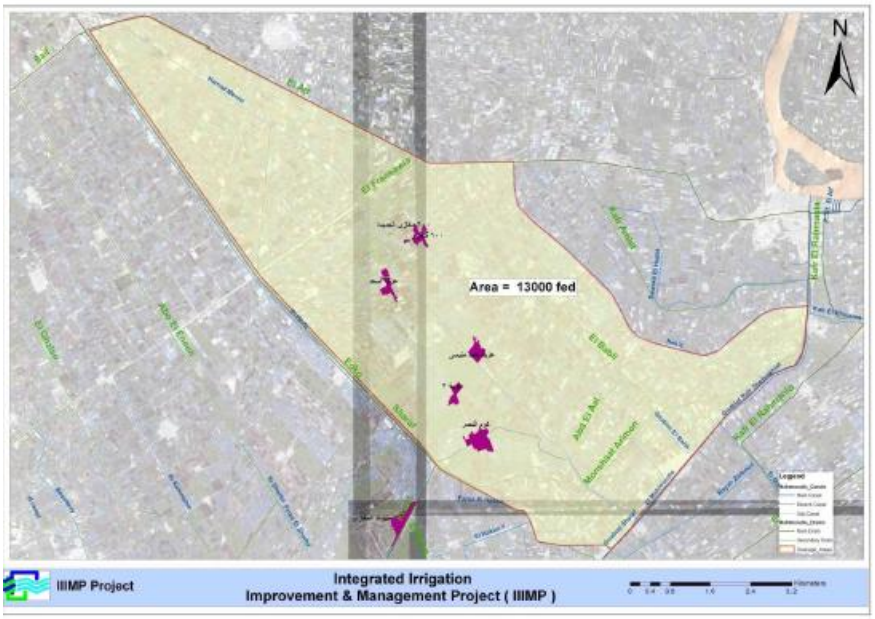
- December 2012
- July 2013
- December 2013
- April 2014
- October 2014
- April 2015
- December 2015
- June 2016
- December 2016

Documents from Borrower/ Implementing Agency

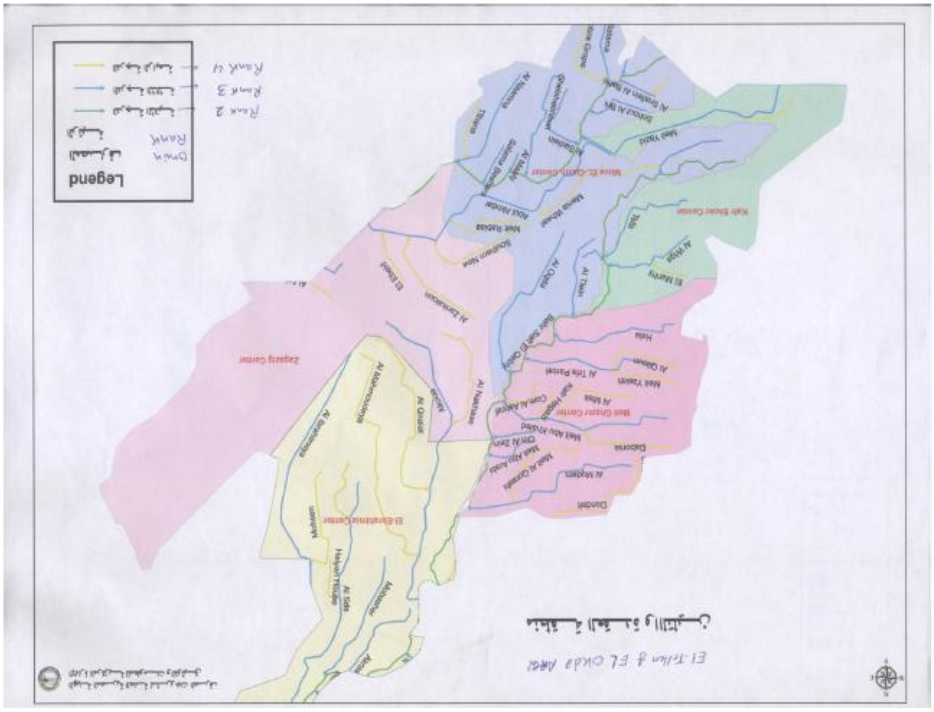
- *Okda and Tellin Pilot Project: Environmental Management Plan, Ministry of Water Resources and Irrigation Egypt (MWRI)*, Euroconsult/ Mott McDonald, June 2016
- *Implementation Completion Report: Enhanced Water Resources Management Project*, Ministry of Water Resources and Irrigation Egypt, January 2017
- *Summary Report: System of Rice Intensification Activity (2014-2016)*, MWRI and Euroconsult/ Mott McDonald, November 2016
- *Piloting Continuous Flow in Nekla Command Area: Final Report*, MWRI and Euroconsult/ Mott McDonald, November 2016
- *Final Activity Report: Controlled Drainage Pilot*, MWRI and Euroconsult/ Mott McDonald, 30 January 2017
- *Evaporation losses analysis in Lake Nasser/ Nubia*, MWRI/ NWRC/ NRI, Undated
- *Climate Change Adaptation Strategy for Egypt and the Nile Delta*, MWRI & Euroconsult/ Mott McDonald et al, 26 October 2016
- *Climate Change Impact Assessment in Water and Agriculture in the Nile Delta: Main Findings of TS2 and What is Next*, MWRI & Euroconsult/ Mott McDonald et al, November 2016
- *Definition of Climate Change Scenarios for Egypt and the West Delta*, MWRI & Euroconsult/ Mott McDonald et al, November 2016
- *Report on the ECRI Decision Support System (DSS)*, MWRI & Euroconsult/ Mott McDonald et al, November 2016
- *Surface Water Modeling in the Nile Delta: Updating the Delta Decision Support System (DSS-Delta)*, MWRI & Drainage Research Institute, January 2017
- *Groundwater Modeling Analysis in the Nile Delta*, MWRI, NWRC, RIGW and Deltares, December 2016
- *Assessment of the National Surface Water Monitoring Network of Egypt*, MWRI & NWRC, November 2016
- *Groundwater Quality Monitoring Capacity Enhancement in the Nile System*, No attribution, Undated

MAPS

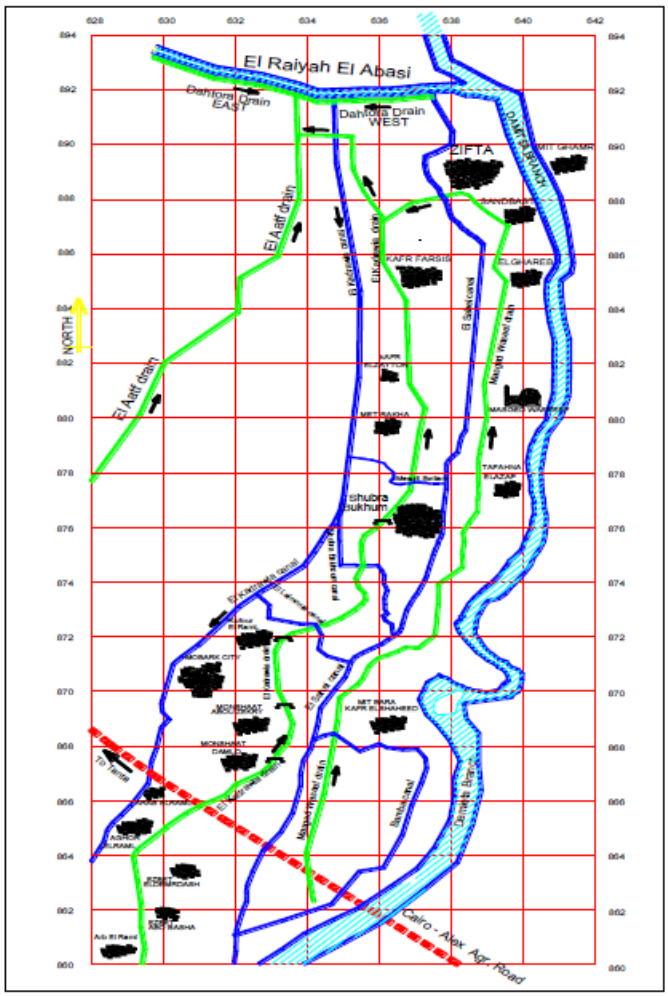
Nekla/ Menesi Pilot Scheme



Okda/ Tellin Pilot Scheme



Khadrawia Pilot Scheme



Pictures of Project Activities

Component 1: Pilot Schemes

Stakeholder Analysis

Continuous Flow

Controlled Drainage

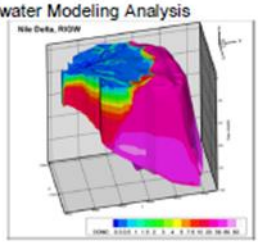
Institutional Strengthening and Capacity Building

Pollution Reduction Intervention

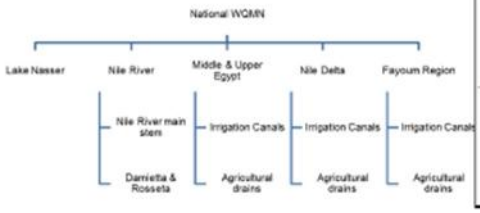
Awareness Campaign to address Solid Waste

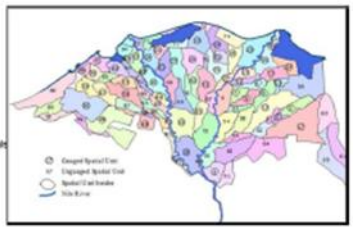
Component 2: Technical Studies

Groundwater Modeling Analysis



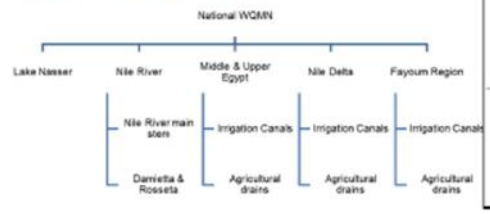
Surface Water Quality Monitoring

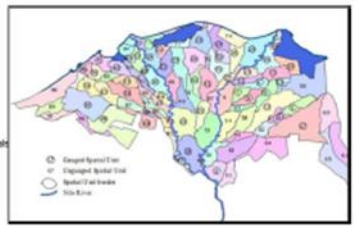




Evaporation Losses Analysis, Lake Nasser

Surface Water Quality Monitoring





Groundwater Quality Monitoring

Component 3: Project Management