Republic of Tunisia

Ex-Post Evaluation of Japanese ODA Loan

"Water Resource Management Project"

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0. Summary

This project has aimed to improve agricultural productivity, increase livestock numbers and farmers' income, and consequently contribute to the conservation of water resources and prevention of soil erosion, etc. by constructing hill dams[1] and irrigation facilities in the north-central region of Tunisia, where precipitation was relatively high.

Tunisia formed a new government in February 2015 after completing a four-year transition process toward democracy since the Jasmine Revolution in 2011 and is currently in the process of formulating the next Five-Year National Development Plan. For the water sector, one of the key sectors of the country, the Second Ten-Year Hydraulic Resources Development Strategy (2012 – 2022) was developed by the Ministry of Agriculture, Hydraulic Resources and Fisheries (hereinafter referred to as the "Ministry of Agriculture"), based on which the Provisional Government continued to implement various projects. The new government took over the said Strategy and announced its intention to continue constructing hill dams toward improving agricultural productivity, preventing soil erosion in farmland, and meeting other development needs. This project was also consistent with Japan's ODA policy at the time of the project's appraisal. Therefore, the relevance of the project is high.

The project initially planned to construct both hill dams and irrigation facilities in 22 sites in 7 governorates. However, due to massive droughts between 1999 and 2002, the then already completed dams were unable to store enough amounts of water to allow constant operation of irrigation facilities. Because of this, a feasibility study (hereinafter abbreviated as "F/S") was conducted to review and revise the content of the planned irrigation facilities. As a result of the F/S, it was determined that it would be more appropriate to construct the original irrigation facilities in three dam sites and provide portable pumps and other irrigation equipment for other sites instead. The F/S also revealed that irrigation farming had been expanding in the target regions due to private investment, the residents' independent efforts, and other factors. However, the F/S did not

[1] Small-scale dams constructed under this project are called "hill dams *(French: barrages collinaires)"* in Tunisia. While the construction of hill dams began in earnest around 1990, Tunisia, since old times, has been adopting a water-harvesting technique that takes advantage of its hilly topography to utilize rainwater flowing down to the Mediterranean Sea by building a network of *wadis* (dry riverbeds that usually do not contain water) to direct and store water to and in the *wadis* during times of heavy rain for irrigation and other purposes. It can be said that "hill dams" originates from this technique. In addition, the term "hill dams" is used only when referring to dams constructed by the General Directorate of Dams and Large Hydraulic Works, Ministry of Agriculture while similar facilities constructed by the Department of Forestry and Soil Conservation are called "hill lakes *(French:lac collinaires)*.

go so far as to reexamine the operation and effect indicators or revise the target values of the project. For this reason, the total irrigated area[2], one of the effect indicators of this project, turned out to be 620.5ha, attaining only 27% of the target of 2,298.1ha.

On the other hand, the quantitative indicators, such as the farm size and production volume of major crops, have mostly achieved their respective targets as a result of promoting the farming methods[3] that take into account reservoir levels that fluctuate depending on annual rainfall, as well as groundwater recharge effects. However, because irrigation facilities were not constructed as originally planned in 19 of the total 22 dam sites, it is difficult to attribute the high attainment levels entirely to the effects of the project, which, likewise, may not be the sole contributor to the moderate increase and stabilization of agricultural production in the target regions. In addition, because the remaining service life for irrigation use of the hill dams constructed by the project is assumed to be 5 to 10 years depending on the sedimentation speed of each dam based on their average life span of 20 to 30 years, the project's contribution toward the increase of agricultural production will not be permanent but will likely be for a limited time period[4].

With regard to project impacts, the farmers' annual income mostly attained the target level and the annual production of livestock meat has increased since the time of appraisal, though it is difficult to ascertain whether or not these results are solely attributable to the effects of the project. Moreover, trees were planted around the dam sites to prevent soil erosion over a total area of 6,154ha, which was 200% of the planned area. These trees are also thought to be helping the retention of floodwater during the rainy reason, prevention of soil erosion in farmland, and sedimentation mitigation and life prolongation of large-scale dams.

Comprehensively considering the above, effectiveness and impact of this project are fair.

Although the project cost was lower than planned, the project period far exceeded the plan. Therefore, efficiency of the project is fair. With regard to operation and maintenance of the project, though the speed of sedimentation in each reservoir has been mostly as expected, the need remains to implement measures to enhance the O&M system of the hill dams in each governorate, fortify the institutional aspects, update the technical guidelines

[2] "Irrigated area" refers to an area of irrigated farmland that has been officially approved by the government in accordance with the Ordinance of the Ministry of Agriculture, which stipulates that the Tunisian government has the obligation to secure and provide irrigation water for farmers who engage in agriculture in publicly-approved irrigated farmland. However, since the small-scale dams constructed by this project are not permanent water resources, the irrigated crop fields are approved for limited periods only with the understanding of the farmers that permanent water supply is not guaranteed for those fields.

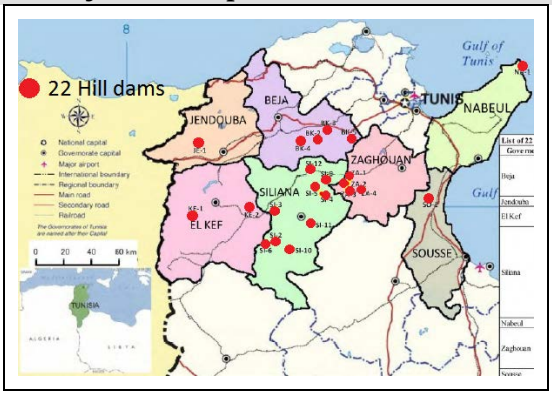
[3] Farming methods that take into account groundwater recharge effects refer to types of irrigation farming that draw water not from dam reservoirs but from shallow wells, etc. whose water levels have been raised.

[4] The service life of small-scale dams is said to be around 20 to 30 years, and the average 20-year life span is used in the estimation of this project. However, actual life span of each dam varies depending on how quickly or slowly the dam gets completely filled up with sedimentation.

by incorporating the accumulated know-how and providing response procedures to unexpected hazards, etc., and increase budget. Therefore, sustainability of the project effects is fair.

In light of the above, this project is evaluated to be partially satisfactory.

1. Project Description



Project location

Hill dam constructed by this project (photo taken in Sousse Governorate in June 2015)

1.1 Background

Tunisia is located in a semiarid climate zone. While overall precipitation is low, rainfall is erratic and varies significantly from year to year, causing floods in some years. For this reason, the country has been searching for ways to utilize excess rainfall (surface water) for many years. Since some regions rely heavily on groundwater in addition to rainwater, the Tunisian government has been promoting the conservation of groundwater resources as one of its major strategies as well.

Agriculture, which accounts for 13 – 15% of Tunisia's GDP, has been regarded as one of key industrial sectors that drive the country's economic growth. The Tunisian government was striving to achieve food self-sufficiency and secure stable food production, for which development of water resources and irrigation facilities became essential. Under these circumstances, the Tunisian government formulated the Water Resources Development Plan, under which to construct 1 large-scale dam, 20 medium-scale dams, 203 hill dams, 1,000 hill lakes, 1,760 wells, and other water facilities across the country between 1991 and 2000.

At the time of the project's appraisal, 63 of the planned 203 hill dams had been completed, 42 were under construction, and the remaining 100 or so were to be implemented under the Ninth Five-Year Development Plan (1997 – 2001). Hill dams were expected to bring about a variety of positive effects, including storage of surface water to secure irrigation water and replenishment/increase of groundwater resources, as well as

flood mitigation, soil erosion control, and prevention of sediment flow to downstream large dams.

Under these circumstances, the Government of Tunisia requested an ODA loan from the Government of Japan for the construction of some of the hill dams.

1.2 Project Outline

The objective of this project is to improve agricultural productivity through irrigation and groundwater replenishment by constructing hill dams and irrigation facilities in the mountainous regions in north-central Tunisia, thereby increasing livestock numbers and farmers' income, as well as contributing to the conservation of agricultural water resources and the prevention of soil erosion in farmland.

Loan Approved Amount/ Disbursed Amount	7,184million yen / 3,617million yen
Exchange of Notes Date/ Loan Agreement Signing Date	January 1999 / March 1999
Terms and Conditions	Interest Rate 1.7% Repayment Period 25 years (Grace Period 7 years) Conditions for Procurement General untied (Bilateral untied for the consulting service)
Borrower / Executing Agency	Government of the Republic of Tunisia / General Directorate of Dams and Large Hydraulic Works, Tunisian Ministry of Agriculture, Hydraulic Resources and Fisheries (At the time of appraisal: General Directorate of Hydraulic Studies)
Final Disbursement Date	November 2009
Related Studies (feasibility study (F/S), etc.)	Special Assistance for Project Formation Study (SAPROF) on Hill Dams Construction Project, Republic of Tunisia (JICA, August 1998) Special Assistance for Project Sustainability (SAPS) for Water Resource Management in the Republic of Tunisia (JICA 2014)

2. Outline of the Evaluation Study

2.1 External Evaluator

Machi Kaneko, Earth and Human Corporation

2.2 Duration of Evaluation Study

This ex-post evaluation study was carried out in the following schedule.

Duration of the study: August 2014 – November 2015

Duration of field study: January 29 – February 28, 2015 and May 26 – June 17, 2015

2.3 Constraints during the Evaluation Study

Field study was not conducted in some of the target locations in Kef and Jendouba Governorates pursuant to JICA's safety standards (travel restrictions) in Tunisia.

3. Results of the Evaluation (Overall Rating C[5])

3.1 Relevance (Rating: ③[6])

3.1.1 Relevance to the Development Plan of Tunisia

At the time of the project's appraisal, the Tunisian government was actively implementing water resources development projects under its Ninth Five-Year Development Plan (1997 – 2001). Specifically, construction of the following infrastructure facilities was being planned under the Water Resources Development Plan (1991 – 2000), which was aiming to construct hill dams in 203 locations.

Table 1 Water Resources Development Plan (1991 – 2000)

Facility	No. of locations	Developed water volume (million m^3/yr.)
Large-to-medium-scale dam	20	739
Hill dam (barrages collinaires)	203	110
Hill lake (lac collinaires)	1,000	50
Irrigation facility	4,000	43
Deep well	1,760	288
Water purification plant	98	200
Total		1,430

Source: Documents provided by JICA

With regard to irrigation facilities development, the Ninth Five-Year Development Plan intended to expand the irrigated areas by 30,000ha (with a scheduled investment amount of 300 million TND[7]), of which 3,000ha was to be created based on water resources to be developed through the construction of hill dams.

With regard to agricultural development, the Ninth Five-Year Development Plan was aiming to increase the country's self-sufficiency ratios for wheat, barley, and meat, which had been largely relying on imports, while reducing imports of dairy products and sugar

[5] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[6] ③: High, ② Fair, ① Low
[7] TND: an abbreviation of Tunisian dinar, the currency used in Tunisia.

and increasing exports of agricultural and food products in order to ensure food security.

As of the time of the ex-post evaluation, a new government has already been inaugurated in February 2015 after completing a four-year democratization process following the outbreak of the Jasmine Revolution in January 2011. Though no new national development plan has been established since the Revolution, the new government is currently in the process of formulating the next Five-Year National Development Plan for the period between 2016 and 2020.

In accordance with the new government's policy, each Ministry/Department is preparing for the formulation of a development plan for each sector and governorate. As for the development of water resources, which is one of Tunisia's priority agendas, the Provisional Government's plan to construct additional 50 hill dams based on the Second Ten-Year Hydraulic Resources Development Strategy (2012 – 2022) has been taken over and is now implemented by the new government, according to the Ministry of Agriculture. At the time of this ex-post evaluation, 3 of the planned dams had already been completed, 2 were under construction, and the remaining 45 were scheduled to be constructed during a nine-year period between 2014 and 2022.

With regard to agricultural development, the irrigated area expanded from 394,000 ha in 2001 to 459,570 ha in 2011 as a result of continuing promotion of irrigation farming by the Tunisian government. According to the Ministry of Agriculture, development strategies for the period of 2015 – 2020 are currently being developed at the national and governorate levels. For instance, the Regional Agricultural Office (CRDA) of Siliana Governorate, where 40% of the hill dams of this project were constructed, is currently formulating governorate-level development strategies toward reducing the cropped area of grain by 2020 while expanding the growing area of vegetables and promoting livestock farming by taking into consideration the central government's policy and the actual situations of the governorate. According to CRDA, the governorate intends to reduce the area of grain crops to mitigate soil erosion and flooding, which has been aggravated by the expansion of grain fields, and instead plans to improve the unit yield of wheat by introducing high-yield varieties, etc., expand vegetable crops, and promote livestock (especially cattle) farming. The strategies of Siliana CRDA suggest the Tunisian government's continued commitment to improving agricultural productivity, expanding intensive irrigation farming (vegetable cultivation), promoting livestock farming, and fortifying soil erosion control for agricultural development in the northern region. Therefore, development of water resources by this project is relevant to the Tunisian government's plan to improve agricultural productivity and expand intensive irrigation farming.

3.1.2 Relevance to the Development Needs of Tunisia

Water Resources Development

At the time of the appraisal, effective utilization of limited water resources was one of critical development needs of Tunisia. As shown in Table 2, the northern region, which was targeted by this project, is abundant with surface water and has a relatively high annual precipitation of 500 – 700 mm compared to other regions of Tunisia. For this reason, the region had been promoting the storage and utilization of limited water resources by constructing large-scale and hill dams and other water facilities.

Table 2 Available Water Resources in Tunisia by Region (2013)

	Region			
	North	Central	South	Whole
Area ratio of region	17%	22%	61%	100%
Surface water (million m^3/yr)	2,185	290	225	2,700
Groundwater (million m^3/yr)	550	465	830	1,845
Total (million m^3/yr)	2,735	755	1,055	4,545
Water resource ratio of region	60%	17%	23%	100%

Source: System Hydraulique de la Tunisie a l' Horizon 2030, 2014 edition

As of the time of this ex-post evaluation, there has been no change in Tunisia's general approach to utilizing limited water resources, and the need for storing surface water during floods for agricultural and other purposes is still very high. As shown in Table 3, agricultural water accounts for 80% of total water intake in Tunisia, calling for measures to use water even more efficiently. According to the General Directorate of Dams and Large Hydraulic Works, Ministry of Agriculture (DG/BGTH), 208 hill dams have been constructed as part of the water resources development strategies as shown in Table 4 below. The present total reservoir capacity of all dams in Tunisia is 1,645 million m^3/year, of which hill dams account for 270 million m^3/year or about 13% of the total. Though each hill dam has a short life span due to sedimentation, construction of many small dams is playing an important role in storing surface water effectively.

Table 3 Water Intake in Tunisia by Sector (2011)

(Unit: million m^3)

	Agriculture	Household	Industrial	Tourism	Total
Water intake	2,644	463	165	33	3,305
%	80%	14%	5%	1%	100%

Source: Agriculture in Tunisia, FAO, 2015

Table 4 Actual No. of Hill Dams Constructed under Water Resources Development Plan (1991-2000)

Financed by	Plan	Actual			
	No. of dams	No. of dams	Reservoir capacity (million m^3/yr)	Investment (million TND)	Completion
Tunisian government	-	84	121	126.9	2005
JICA	19	19	28.6	31.5	2001
JICA	22	22	19.8	34.4	2005
BEI	20	26	50	60	2010
FKDEA	30	15	12.4	27	2005
WB	6	15	18.8	23.8	1998
AFD	15	20	12.5	39.3	2010
Italy	2	2	3.6	14	In progress
China	7	7	3.2	14	2013
Total	203	208	270	371	

Source: Ministry of Agriculture

Development of Irrigation Farming

At the time of the appraisal, agricultural development through the construction of irrigation facilities was considered to be of high needs from the standpoints of Tunisia's economic development and food security/self-sufficiency, and the Tunisian government had been actively implementing water resources development projects to promote irrigation farming as described above.

As of the time of the ex-post evaluation, the irrigated farmland area in Tunisia has increased significantly from 394,000 ha in 2001 to 459,570 ha in 2011. While the irrigated area accounts for only 9% or so of the total farmland area, its agricultural production amounts to 35% of the total. For this reason, irrigation is regarded as a highly economical method for improving agricultural profitability in the semiarid zone in Tunisia. In addition, in order to make efficient use of precious water resources for agricultural purpose, the government has been actively promoting and subsidizing the adoption of water-saving irrigation techniques, increasing the need for drawing irrigation water from hill dams.

However, as later discussed in detail in Section 3.2, due to the record drought that hit the project's target regions while the dams were being constructed or completed, a F/S was conducted to redesign the irrigation system that would have accompanied each dam under the original plan. As a result of the F/S, it was determined that the originally planned stationary-type irrigation facilities should be built only in three dam sites (the planned irrigated area of these dams was 189.9ha) and that the other sites should be installed with portable-type facilities and equipment by taking into account the effects of

climatic other changes in the future. The F/S also confirmed that due to private investments and self-help efforts of the residents since the completion of the dams, irrigation farming was spreading by using water from the dams' reservoirs or drawing replenished groundwater from shallow wells, etc. For this reason, the project was partially modified to provide farming assistance, lend equipment, and extend other support through CRDA according to the actual conditions of each dam.

In light of the above, though the original irrigation facility plan had to be revised substantially, such revision was appropriate given the water levels of the reservoirs and the status of farming activities in the surrounding areas. Moreover, the plan at the time of the appraisal to attach an irrigation system to each small-scale dam was a generally accepted approach in those days, and thus it would have been difficult to devise a plan not to attach an irrigation system to a newly constructed reservoir at that time.

3.1.3 Relevance to Japan's ODA Policy

At the time of the project's appraisal, Japan's ODA policy for Tunisia was placing emphasis on the securing/utilization of water resources, reduction of poverty in rural areas, and enhancement of industrial competitiveness; and JICA had been implementing projects centered on the water resources sector (which included the agricultural sector in its wider sense), as Tunisia's economic activities were largely dependent on rainfall.

Since the resumption of yen loan to Tunisia in 1993, JICA had been continuously implementing assistance projects for the water resource sector of Tunisia, starting with a yen-loan project in FY1994 followed by two projects in FY1995, four in FY1996, and two in FY1997 to support the most pressing agendas of the Tunisian government. This project was part of such assistance for Tunisia's water sector, which includes agriculture, and therefore was relevant to Japan's ODA policy.

In Tunisia, there was a political regime change between the times of the appraisal and ex-post evaluation of the project, during which the country was unstable in the absence of official national policies. February 2015 saw the inauguration of a new government, which is in the process of formulating the next Five-Year National Development Plan and is continuing the construction of hill dams and related facilities based on the Second Ten-Year Hydraulic Resources Development Strategy (2012 – 2022). For agricultural development, the new government also announced its intention to give priority to the expansion of irrigation farming, improvement of agricultural productivity, and so forth, which were consistent with the objectives of this project both at the times of the project's appraisal and ex-post evaluation.

The Tunisian government's policy to efficiently use limited water resources to meet its

development needs did not change between the project's appraisal and ex-post evaluation, and it intends to continue promoting the construction of hill dams as an effective means for maximizing the use of surface water. The need for storing surface water and recharging groundwater to improve agricultural productivity is still high and will need to be satisfied further after the ex-post evaluation.

This project was also consistent with the ODA policy of the government of Japan.

In light of the above, this project has been highly relevant to Tunisia's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The original plan of this project was to construct: 1) hill dams and 2) irrigation facilities at the same time. However, though the dams were constructed as planned, the content of the irrigation facilities was revised.

The planned and actual scopes of this project are shown below.

Table 5 Scope of this Project

	Plan	Actual
1) Construction of hill dams	22 sites in 7 governorates	22 sites in 7 governorates
2) Watershed management (windbreak trees, etc.)	3,080ha	6,165ha
3) Irrigation facilities		
Main irrigation system *1	22 sites	3 sites
On farm irrigation system*2	22 sites (2,270ha)	2 sites (38.5ha)
4) Land acquisition	22 sites	22 sites
5) Surveying & engineering	1 set	1 set
6) Logistics and O&M equipment*3	1 set	-
7) Consulting service	Overall project management, supervision of civil works, institutional enhancement (promotional activities, farmer's association)	F/S on irrigation facilities in 6 governorates

Source: Documents provided by JICA (2014)

Note 1: pump stations, balancing tanks, pipelines, etc. were to be constructed as main irrigation facilities.
Note 2: sprinklers were to be installed as on-farm irrigation equipment.
Note 3: bulldozers, trailer trucks, backhoes, pickup trucks, and dump trucks were to be purchased as O&M equipment.

(1) Construction of Hill Dams

Under this project, construction of a total of 22 hill dams began as originally planned, of which 18 were completed between 2001 and 2002, and the remaining 4 were completed between 2003 and 2005 as shown in Table 6 below.

Table 6 No. of Hill Dams by Governorate

Governorate	Siliana	Kef	Béjà	Jendouba	Nabeul	Zaghouan	Sousse	Total
No. of dams	9	2	4	1	1	4	1	22

Source: Ministry of Agriculture

(2) Irrigation Facilities

Tunisia experienced extremely low precipitation between 1999 and 2002, and as a result, many of the reservoirs constructed by the project did not fill to sufficient levels. The General Directorate of Dams and Large Hydraulic Works of the Ministry of Agriculture submitted to JICA a request for concurrence to conduct a F/S on the irrigation facilities planned for each governorate. JICA officially agreed to the request in February 2006 and began the F/S. However, because the selection of a consultant for the F/S was not carried out by the Ministry of Agriculture but by CRDA, a local branch of MOA inexperienced in bidding produce, the selection process was delayed, and it took some three years to complete the study in all the target governorates.

Based on the results of the F/S, it was decided to install the originally planned main irrigation facilities (pipelines) in three sites and provide portable pumps to seven sites. Due to the subsequent political and other changes, however, construction and installation of the irrigation facilities and equipment did not complete until 2013. Given the weather conditions of the target regions at that time, the revision made to the original irrigation facilities as a result of the F/S was appropriate. The Tunisian side’s decision to conduct the F/S and revise the plan to construct stationary facilities was also appropriate, considering that many of the hill dams built under the project had already been operating for five years at the time of the F/S, which meant that their remaining service life was reduced to 15 years, assuming the average life span of hill dams for irrigation purpose to be 20 years.

Table 7 Status of Irrigation Facilities Development by the Project and Private Sector

Main irrigation facility	Plan	Actual	
		This project	Private
Pipeline facility with pump station	17 sites	1 site	
Gravity pipeline without pump station	5 sites	2 sites	2 sites (private)
Irrigation using portable pump (Portable pump is a type of equipment used to suck up water from hill dams)	4 sites 29 units	7 sites 24 units	10 sites
On-farm irrigation equipment (sprinkler)	2,270ha	38.5ha	Unconfirmed

Source: Documents provided by JICA (2014) and Ministry of Agriculture

When the Ministry of Agriculture began the F/S, private farmers had already begun using water from the dams for irrigating their crop fields. As shown in Table 7 above, gravity pipelines were laid in two sites and portable pumps installed in 10 sites while farmers in other sites also began adopting irrigation farming by drawing groundwater from shallow wells, which were recharged by the upstream dams, or by using tractors, etc. to draw and transport water from the dams. The expansion of private investments was encouraged by timely increase in government subsidies for water-saving irrigation facilities, etc. when impoundment of the dams began.

(3) Consulting Service

Though the consulting service for this project was initially to be provided by a Japanese company, the bidding for the service was unsuccessful because no Japanese companies made a bid. Subsequently, a consultant was selected from consulting firms in Tunisia, and JICA approved the consulting service contract in January 2002. However, the contract was later cancelled because most of the hill dams were completed while the negotiations with the consultant were taking place, and the Tunisian government decided to revise the irrigation facilities plan. As a result, another consultant was hired to conduct a F/S on the irrigation facilities instead of supervising the construction work of the originally planned dams and irrigation facilities and assisting residents' participation in decision making processes of CRDA, etc.

While the above change did not negatively affect the construction of the hill dams, irrigation farming would have been promoted even more efficiently if the support for residents' participation in the processes of CRDA, etc. had been provided at an appropriate timing.

3.2.2 Project Inputs

3.2.2.1 Project Cost

Under the original plan, the estimated total cost of this project was 9,609 million yen, of which 7,184 million yen was to be financed by a yen loan. The actual total cost was 5,105 million yen (of which 3,617 million yen was yen loan disbursement) accounting for 53% of the planned total project cost. In other words, the actual project cost was lower than the planned amount.

Table 8 below shows the breakdown of the total project cost. The actual cost of dam construction was 29,180,000 TND, which is significantly lower than the planned amount of 45,326,000 TND. According to the Ministry of Agriculture, the significant difference is due to overestimation of the project cost at the time of the project's appraisal, as well as competition among the bidders, which led to price discount. Considering that all 22 dams were constructed as planned, the project cost was appropriate for the output.

The construction cost of irrigation facilities was initially 8,808,000 TND but turned out to be 1,285,000 TND (15% against the original figure). Irrigation facilities were constructed in 3 locations instead of 22 locations as originally planned (14% against the plan). This portion of the project cost was also appropriate for the output for the most part.

The cost of watershed management increased from the original amount of 2,428,000TND to 7,673,000 TND. According to the Ministry of Agriculture, the reason for the increase was the fortification of control measures against soil runoff caused by flood, etc., which, as a result, doubled the tree-planting area from the original 3,080ha to 6,154ha. This decision to revise the plan was appropriate. It should be noted, however, that the cost of tree planting per hectare also increased from the original estimation due to rise in fuel price, etc.

In summary, the actual total project cost of 5,105 million yen was lower than the initially estimated cost of 9,609 million yen (54%) due to change in the irrigation facilities and overestimation of the initial dam construction cost, which more than offset the increase in watershed management cost.

Table 8　Planned and Actual Total Project Cost

(Unit: 1,000 TND)

Item	Plan	Actual	Ratio against plan
Construction cost	54,134	30,465	56%
(Construction of dams) (Irrigation facilities)	(45,326) (8,808)	(29,180) (1,285)	(64%) (15%)
Contingencies	2,853	1,004	35%
Consulting service	6,518	243	4%
Farmland development	2,707	97	4%
Due diligence (D/D)	600	0	0%
Watershed management	2,428	7,673	316%
Land acquisition, etc.	1,935	1,935	100%
Taxes, etc.	11,665	6,903	59%
Total	82,840	48,320	58%

Source: Documents provided by JICA

3.2.2.2　Project Period

The actual project period was 115 months from March 1999 to October 2013, which exceeded significantly than the planned period of 63 months from March 1999 to June 2004 (183% of the planned period) even though the outputs were smaller than planned as a result of reduction in irrigation facilities.

The major causes of the prolongation of the project period were delays in selecting a consultant and filling up the reservoirs due to droughts between 1999 and 2002, as well as the addition of the F/S to revise the irrigation system and resulting modifications of contracts, etc. Though the final disbursement of yen loan took place in November 2009, the Tunisian government continued the installation and provision of irrigation facilities and equipment until October 2013, which constitutes the official completion of the project.

3.2.3　Internal Rates of Return (reference only)

(1) Financial Internal Rate of Return (FIRR)

Due to the nature of the project, a quantitative analysis of the financial internal rate of return was not possible.

(2) Economic Internal Rate of Return (EIRR)

The result of recalculating the economic internal rate of return (EIRR) based on the parameters used at the time of the project's appraisal is shown below. Because of the change in irrigation facilities, the EIRR at the time of the ex-post evaluation was lower than that at the time of appraisal.

	At the time of appraisal (1999)	At the time of ex-post evaluation (2014)
EIRR	Max. 15.1%, Min. 3.1% (EIRR was calculated on all sites)	Max. 9.3%, Min. 0.54% (EIRR was calculated on 5 sites, for which data were available)

Source: Project Completion Report (PCR2014)

【Parameters of calculation】

- Cost: construction, O&M (including livestock feed and veterinary fees)
- Benefit: farmers' income from crop & livestock farming (TND)
- Project life: 20 years

Although the project cost was lower than planned, the project period far exceeded the plan. Therefore, efficiency of the project is fair.

3.3 Effectiveness[8] (Rating: ②)

3.3.1 Operation and Effect Indicators

As discussed in the Relevance and Efficiency Sections, the content of irrigation facilities was revised considerably from the original plan as a result of conducting the F/S. However, the F/S did not review or change the operation and effect indicators that were set at the time of the project's appraisal. Thus, the target figures set at the time of appraisal were compared to the actual figures in the ex-post evaluation.

(1) Irrigated Area

Total Irrigated Area

Irrigated areas that were to be or have been created by the project in the 22 target locations are shown in Table 9 below. The actual total area was 620.5ha (of which 440.5ha was created by the project), which was substantially smaller than the original target of 2,298.1ha. This was because only 3 sites (planned irrigated area: 189.9ha) were installed with the originally planned main irrigation facilities (pipelines, etc.), thus substantially reducing the irrigated area installed with stationary facilities as shown in the photo at right. However, 7 of the remaining 19 sites are irrigating fields using portable pumps and other equipment provided by the project while other sites have installed or are in the process of installing gravity pipelines or portable pumps and other equipment using private funds or government subsidies.

Zangou Dam area, Zaghouan Governorate
Top: 80ha irrigated land is installed with irrigation valves and pipes at 11 locations, which can be connected to drip tubes and sprinklers.
Bottom: sprinklers in a wheat field

[8] Sub-rating for Effectiveness is to be put with consideration of Impact.

Table 9　Irrigated Area Created by the Project

	Plan	Actual (2014)
Total irrigated area [1)]	2,298.1ha	620.5ha (Area created by the project: 440.5ha) (Breakdown) Main irrigation system(stationary pump) built by the project : 164.0ha (26%) Portable pump provided by the project : 276.5ha (45%) Private irrigation system : 180.0ha (29%) Total : 620.5 ha (100%)
Area installed with on-farm irrigation equipment under the project [2)]	2,270ha	38.5ha

Source: Documents provided by JICA

Note 1): The planned "total irrigated area" means the area of farmland that can be irrigated. The "actual" area indicates an area of irrigated fields officially approved by the Ministry of Agriculture that draw water from the hill dams constructed by the project. More specifically, it is the total area of 10 sites (3 sites installed with irrigation facilities and 7 sites provided with portable pumps by the project) and sites officially approved by MOA/CRDA as irrigated land installed with privately-funded pipelines and portable pumps and other equipment.

Note 2): The planned "area installed with on-farm equipment under the project" means the area where watering of crop fields is possible using sprinkler equipment. The "actual" figure means the area where the use of 2 sprinkler facilities installed by the project, as well as the amount of water to be sprinkled, is approved by MOA/CRDA. For this reason, the area which can be watered without sprinklers or by drawing recharged groundwater from shallow wells is not included.

According to the Tunisian Ministry of Agriculture, the actual total irrigated area refers to the area of irrigated farmland that has been officially approved by the government in accordance with the Ministerial Ordinance. In order to be approved by the Ministry of Agriculture, the "official irrigated farmland" must have "sufficient water resources for irrigating the land." The government has the obligation to guarantee a certain amount of irrigation water for the farmers growing crops in the official irrigated farmland while the farmers are required to engage in farming activities in the official irrigated farmland and may be subjected to penalties for non-performance. However, because the hill dams constructed by the project are not permanent water resources, the associated irrigated crop fields are approved for limited time periods only with clear understanding of the farmers that such fields are not guaranteed with permanent access to irrigation water.

The field survey of the ex-post evaluation observed some crop fields, other than those officially approved, that were also irrigated using the hill dams as water sources (including those drawing groundwater from recharged shallow wells). However, the area of these fields cannot be quantitatively ascertained at this time because the size of the

area fluctuates depending on the annual precipitation (expands when rainfall is high and shrinks when low) and because the Ministry of Agriculture has yet to grasp accurate data.

Area Installed with On-Farm Irrigation Equipment

The area installed with on-farm irrigation equipment refers to the area of two sites, where sprinkler facilities were installed by the project as originally planned, and for which use of water supplied by such facilities, as well as the amount thereof, has been approved by the MOA/CRDA. As shown in Table 5 above, the actual area was only 38.5ha, which is much less than the target of 2,298.1ha. This is because the target area size was set based on the assumption that all sites would be installed with sprinkler facilities according to the initial plan.

Top: Drip tubes installed in farmland 1.5km from Zangou Dam reservoir, Zaghouan Governorate. The agroforestry system is used to grow melons.
Middle: self-propelled sprinkler
Bottom: sprinkler truck

In the actual crop fields, multiple irrigation techniques are employed as shown in the photos at right. Sprinklers are used mainly for growing wheat and barley whereas drip tubes are used for cultivating vegetables and fruits. Since drip tubes are subject to government subsidies for water-saving irrigation farming, many farmers in the project's target regions have adopted this technique. Because drip tubes increase yield per hectare while saving water, the required irrigation area tends to be smaller than normal though no data were available to accurately grasp the actual area installed with drip tubes.

For the reasons stated above, it was determined not to use the "area installed with on-farm irrigation equipment" as an effect indicator of this project, as it does not accurately represent the status of various types of irrigation equipment adopted in the actual crop fields.

The unavailability of data on the agricultural activities of farmers around the dam sites is due to the limited personnel and financial resources of CRDA of each governorate, which are making it very difficult to collect chronological data of agricultural activities around numerous hill dams.

(2) Cropped Area of Major Crops

The planned and actual (2014) areas of major crops are shown in Table 10 below. By promoting farming methods that can cope with fluctuating reservoir and groundwater

recharge levels depending on annual rainfall, the project has created 3,098.3ha of irrigated land, which is very close to the original target of 3,165ha. However, as mentioned in 3.2 Efficiency, inputs of irrigation facilities were cut back substantially in 19 of the 22 target dam sites. For this reason, it is not possible to evaluate the effectiveness of the project based solely on the actual cropped area.

The agricultural activities observed during the ex-post field survey around each dam site are worthy of note and thus separately described in BOX 1 below.

Table 10　Cropped Areas of Major Crops in the 22 Target Sites of the Project

	Plan	Actual (2014)
Cropped areas of major crops[2)]	3,165 ha [1)]	3,098.3 ha[3)]
（By type of crop）		
Hard wheat		1259.2 ha
Soft wheat		710.7 ha
Barley		352.6 ha
Oats		408.8 ha
Livestock feed (barley fodder)		237.6 ha
Chickpeas		5.0 ha
Broad beans		19.4 ha
Olives		105.0 ha

Source: Documents provided by JICA

Note 1): the target cropped area at the time of planning was calculated based on the planned cropping intensity and irrigated area.

Note 2): including the area of livestock feed crops.

Note 3): refers to the area where crops are grown using water from new reservoirs that were created by the hill dams constructed by this project, including crop fields that are using the irrigation facilities or recharged groundwater due to the effects of the project.

BOX 1: Note-Worthy Agricultural Activities around the Target Sites of the Project

As mentioned in the Relevance Section, hill dams not only store surface water but also recharge groundwater. According to the interviews with farmers and CRDA personnel in the field survey, water situations of the crop fields around the reservoirs, including those not installed with irrigation equipment, changed dramatically from before to after the construction of the dams, making it possible to grow wheat (double cropping of spring wheat and winter wheat) in the lower reaches, as well as olives, almonds, and other fruits using portable pumps and sprinkler trucks in the upper reaches. These changes are also seen in crop fields around the dam sites, whose reservoirs are no longer storing water due to sedimentation, indicating that the current (and past) existence of the dams are having major impact on the surrounding farmland. In addition, the Ministry of Agriculture is promoting especially the cultivation of olives, which require irrigation when the trees are very young (1 – 5 years old) but can grow with rainwater alone after the sixth year, meaning that they can adapt to decline in reservoir level.

Breck Dam in Sousse Governorate as shown in the photos below (taken in June 2015), for instance, is one of the dams that are bringing notable groundwater recharge effects. According to the Sousse CRDA, most of water stored in Breck Dam is used to recharge downstream groundwater and deep groundwater. The maintenance record of the dam indicates that 600,000 to 700,000m^3 of water flows from wadis into the dam every year, most of which is released to downstream wadis. Because of the release, 18 shallow wells downstream of the dam are experiencing a rise in water level by 1.5m or so in general, expanding the irrigated area of about 100 farms (approx. 35ha per farm). Moreover, a drop in salinity of water (7 g/l → 3.5 g/l) in some shallow wells after the construction of the dams has been observed. In regards to deep wells, the static level of the Sidi Abiche Aquifer measured by a water gauge has dropped only slightly compared to other areas despite the recent increase in the volume of groundwater withdrawn.

		
Water level of this shallow well rose due to recharging effect of Breck Dam in Susse Governorate. The distance between wells is 50m in this area while it is normally 200m or greater.	Shallow well pump station of Breck Dam (electricity is supplied from the grid). Electrification is allowed only for households that already had wells before the construction of the dam.	Drip irrigation system drawing water from Breck Dam via a shallow well. Water conservation and diversification of crops have become possible by planting vegetables between olive trees.

(3) Annual Production of Major Crops

The target and actual annual production volumes of major crops are shown in Table 11 below. The actual production was 3,098 tons, which is 59% of the planned target of 5,250 tons. The annual agricultural income, which will be discussed in the subsequent Impacts Section, was 3,900,000 TND or 81% of the planned income of 4,800,000 TND. The reason behind this is the higher sales price of vegetables and olives than grain. However, as was the case in the preceding subsection (2), it is difficult to evaluate the effect of this project based solely on the actual production volume because the inputs of irrigation facilities were substantially reduced from the original plan.

Table 11　Annual Production of Main Crops in 22 Target Sites of the Project

(Unit: ton)

	Plan (2015, 1 year after completion)	Actual (2014)
Annual production of major crops[1)]	5,250	3,098

Source: PCR 2014

Note 1): including the annual production of livestock feed

3.3.2　Qualitative Effects

The intended effects of this project, which, under the original plan, were to be measured qualitatively by the increase and stabilization of agricultural production of the target regions, have materialized to a degree as described in 3.3.1. However, it is difficult to clearly determine whether or not these effects were brought by the project alone, as the irrigation facilities were not constructed as originally planned. In addition, based on the general life span of hill dams of 20 to 30 years, the remaining service life of the dams constructed by this project for irrigation purposes will be around 5 to 10 years depending on the progress of sedimentation, which means that the project does not guarantee stable agricultural production for farmers permanently in the future, but rather for limited time periods.

3.4　Impacts

3.4.1　Intended Impacts

(1) Annual Agricultural Income

The target and actual amounts of annual agricultural income are shown in Table 12 below. The actual income was 3,900,000 TND or 81% against the planned income of 4,800,000 TND. Farmers in Siliana Governorate responded to an interview by saying that, before the construction of the hill dams, they had been suffering from chronic water shortages and had to travel nearly 30km to the nearest water supply station to get drinking water for their livestock. They also said that several attempts to drill wells failed, but the dams solved the water problems in the surrounding farmland, increased the number of farmers that began growing fruits and other high-cash crops, and thus dramatically changed their lives in a positive way.

Currently, MOA/CRDA is encouraging farmers to change crops from wheat, barley, and other grains to more high value-added vegetables and fruits (such as olives and almonds), which is also contributing to the increase in agricultural income. Since young olive trees can be grown with rainwater alone after the sixth year as described earlier, the Ministry of Agriculture is especially promoting olive cultivation in anticipation of the end of service life of the dams due to sedimentation. However, such effort needs to be

accompanied with increased assistance for the adoption of water-saving irrigation techniques and the development of alternative water resources in order to ensure stable income for the farmers.

Table 12 Annual Agricultural Income of this Project

(Unit: 1,000 TND)

	Plan (2010)	Actual (2014)
Annual agricultural income	4,800	3,900

Source: PCR 2014

According to the result of the beneficiary interview survey[9], 57% of the surveyed households responded that their income increased after the construction of the hill dams as shown in Table 13. Though there are certain difficulties in obtaining an honest response to income-related questions, the fact that only 6% said their income decreased indicates that the project has generated an expected impact for the most part.

Table 13 Change in Agriculture/Livestock Income after Construction of Hill Dams

Response	No. of households	Percentage
1. Increased	42 1)	57%
2. Unchanged	20	27%
3. Decreased	6	8%
4. Do not know	6	8%
Total	74	100%

Source: beneficiary questionnaire survey

Note 1): Of the 42 households that enjoyed "increased" income, 62% answered that their income increased by about 1.5 times, 19% by about 2 times, and 19% by 3 times or more.

(2) Annual Livestock Numbers and Meat Production

The expansion of farmland to grow livestock feed (barley fodder, etc.) using the newly created water resources as a result of the construction of the hill dams by this project, led to the increase in livestock numbers. According to the beneficiary interview survey result, 46% of the households responded that their livestock increased as shown in Table 14. Though the figure seems low, it nevertheless indicates a positive impact of the project.

[9] A local consultant was hired to conduct a beneficiary survey in Siliana, Zaghouan, Béjà, and Sousse Governorates. Though the consultant intended to collect questionnaire responses from at least 100 households, the actual number of beneficiary households that the consultant was able to visit turned out to be 74 due to flooding and other problems in the northern region.

Table 14　Change in No. of Livestock Animals After Construction of Hill Dams

Response	No. of households	Percentage
1. Increased	34	46%
2. Unchanged	30	41%
3. Decreased	4	5%
4. Do not know	6	8%
Total	74	100%

Source: beneficiary questionnaire survey

Tables 15 and 16 show the numbers of livestock animals by year. Though it was difficult to obtain data that purely represent the effects of the project, the fact that 53% of cattle, 40% of sheep, and 29% of goats in all of Tunisia are being raised in the seven target governorates of this project according to data provided by each governorate, indicates that the target regions of the project are the key center of meat production in Tunisia. Meat production in Tunisia in 2012 increased from that of 2004 as shown in Table 17.

Table 15　No. of Livestock Animals in 7 Target Governorates and All of Tunisia (2010)

(Unit: 1,000 heads)

Governorate	Cattle		Sheep		Goats	
Nabeul	64	(10%)	250	(3%)	35	(3%)
Beja	92	(14%)	447	(6%)	58	(5%)
Jendouba	97	(14%)	216	(3%)	63	(5%)
Kef	27	(4%)	597	(8%)	40	(3%)
Siliana	40	(6%)	684	(9%)	128	(10%)
Zaghouan	27	(4%)	387	(5%)	44	(3%)
Sousse	11	(2%)	286	(4%)	12	(1%)
Subtotal	358	(53%)	2,867	(40%)	380	(29%)
National total	671	(100%)	7,234	(100%)	1,296	(100%)

Source: Agricultural Statistics FY2010, February 2012

Table 16　No. of Livestock Animals in Tunisia by Year

(Unit: 1,000 heads)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2012
Cattle	753	679	657	686	703	710	*	679	671	654
Sheep	6,833	6,613	6,949	7,213	7,484	7,618	*	7,361	7,234	6,802
Goats	1,449	1,379	1,411	1,426	1,497	1,551	*	1,455	1,296	1,273

Source: Statistical Yearbook 2008-2012, 2013 edition

*: Data not available due to drought

Table 17　Livestock Meat Production in Tunisia

(Unit: ton)

	Baseline (2004)	Actual (2012)
Cattle	89.8	105.2
Sheep	100.4	106.0
Goats	19.5	21.4
Poultry	142.5	170.7
Other	52.1	94.4

Source: Statistical Yearbook 2008-2012, 2013 edition

(3) Flood/Soil Erosion Control and Reduction of Sediment Inflow into Downstream Large/Medium-Scale Dams

Trees were planted around the dam sites of this project to prevent soil erosion. As shown in Table 18 below, compared to the planned area of 3,080ha, 6,154ha were actually planted with trees backed by the Tunisian government's reinforced effort to control soil erosion. According to CRDA and farmers, the tree-planting operation has contributed to the protection of downstream farms and facilities, as well as to the recharging of groundwater.

Table 18　Tree Planting Operation Around the Dam Sites of this Project

	Plan	Actual (2014)
Tree-planting	3,080ha	6,154ha

Source: Documents provided by JICA

The hill dams of this project were also expected to help protect the downstream structures and houses from floods and prevent soil runoff from farmland by retaining floodwater during the rainy season and keeping most of sediments carried by floodwater in the reservoirs. According to the result of SAPS conducted in 2014, the initially planned capacity of the dams was 21,185,000m^3, which was reduced to 13,188,000m^3 (62.3% of the plan) due to sedimentation. The difference between the planned capacity and the actual capacity was the volume of sedimentation, which amounted to some 8,000,000m^3, which was very close to the anticipated volume under the initial plan, meaning that the hill dams have been preventing soil erosion and producing other intended effects. These effects are also likely helping to retard sedimentation in large-scale dams, thereby extending their service lives.

3.4.2　Other Impacts

(1) Impacts on the Natural Environment

Implementation of this project was not assumed to have any negative impact on the natural environment, but was expected to prevent sedimentation, promote greening, and

bring other positive impacts to areas around the dam sites. According to the Ministry of Agriculture, no adverse effects of this project have been reported while positive effects, such as prevention of sediment discharge to the lower reaches and protection of downstream structures and houses from floods by some of the dams, have been observed.

(2) Land Acquisition and Resettlement

According to the Ministry of Agriculture, this project did not require resettlement of residents. Most of the land needed for the project was publicly owned, and the privately owned portion was acquired from, and compensations paid to, the landowners in accordance with the procedures prescribed by law.

(3) Impacts on Gender Issues

Drip irrigation has been adopted increasingly across the crop fields around the dam sites of this project, leading to the lessening of workload for women. The FAO study of 2014 reported that drip irrigation reduces farm work, as it does not require making of ridges and furrows. Some female farmers responded to the interview by saying that their work had been very hard before the completion of the hill dams because they had to make ridges and furrows to irrigate the farmland with water from sprinkler trucks. For growing olive and other fruit trees, they also had to plow the field and create a circular ridge around each tree to save water. Diffusion of drip irrigation using water supplied from the dams constructed by this project has reduced the workload of female farmers in the target regions, which is another positive impact of this project. No negative impact, on the other hand, has been observed so far.

To summarize, this project initially intended to construct hill dams and irrigation facilities in 22 locations in the mountainous regions in the northwestern and central parts of Tunisia, where precipitation was relatively high. However, due to massive droughts between 1999 and 2002, the completed dams did not fill to sufficient levels for consecutive years. Because of this, the plan was revised to construct the original irrigation facilities in three dam sites only and provide portable pumps and other irrigation equipment instead for the remaining sites. Concurrently, development of irrigation facilities by private investment also progressed. As a result, the total irrigated area created by this project (effect indicator) turned out to be only 620.5ha compared to the original target of 2,298.1ha.

On the other hand, the quantitative indicators, such as the cropped area and production of major crops, have mostly achieved their respective targets as a result of promoting irrigation farming that took into account the annual reservoir fluctuation of each dam and

its recharging effect on groundwater. The actual cropped area was 3,098.3ha against the original target of 3,165ha. However, because 19 of the 22 dam sites were not installed with the originally planned irrigation facilities, the expansion of the cropped area may not be purely attributable to the effect of this project. Likewise, though the project's objectives to increase and help stabilize agricultural production in the target regions have been achieved to a degree, it cannot be clearly attributed to the effects of the project because of the substantial reduction in the irrigation facilities. In addition, because the remaining service life of the hill dams constructed by this project will be around 5 to 10 years based on their general life span of 20 to 30 years, this project's contribution to the increase in agricultural production is not permanent but is for a limited time period.

With regards to impacts, the annual income of the farmers of the target regions has mostly achieved the target level though it may not be totally attributable to the project. The annual livestock meat production has increased since the time of the project's appraisal. To prevent soil erosion, trees have been planted around the dam sites over a total area of 6,154ha, which is 200% against the plan. In addition, the hill dams are preventing floods and soil erosion in farmland by storing excess rainwater during the rainy season and also helping the control of sedimentation in large-scale dams thereby extending their lives.

In light of the above, this project has to some extent achieved its objectives. Therefore, effectiveness and impact of the project are fair.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional Aspects of Operation and Maintenance

CRDA of each governorate has been operating and maintaining the hill dams under technical assistance from DG/BGTH as originally planned without major problems thus far. However, due to lack of budget and other resources, each CRDA does not have a department or personnel dedicated to the operation and maintenance of hill dams and hill lakes, resulting in situations from time to time, where dam maintenance cannot be performed adequately, as pointed out by the SAPS Report (2014)[10]. The Tunisian Government, which intends to continue constructing hill dams, needs to establish a long-term mechanism for ensuring the safety of dams that have lost their hydraulic power due to sediment buildup, as well as for proper operation and maintenance of existing and newly constructed dams. In order to sustain the effects of this project and the safety of the

[10] The SAPS Report (2014) points out that "a sufficient budget needs to be allocated for dam repair and maintenance to properly handle such problems as dam slope erosion, cracks in dam crest, and spillway slope failure, as it is important to secure the stability of the dam bodies even if they have been filled up with sedimentation."

dam facilities, it is important for each governorate to fortify its institutional structure.

On the central government level, on the other hand, the institutional aspects for hill dam projects are expected to be enhanced in the future, as indicated by the Decree of the Ministry of Agriculture of September 17, 2014 (Décret n° 2014-3486), which expressly states that a special department will be established within DG/BGTH of the Ministry of Agriculture for hill dam construction projects as part of the Second Ten-Year Water Resources Development Strategy. In addition, the Ministry of Agriculture, which was reorganized in June 2015 following the inauguration of the new government, has set out to restructure and mobilize its subordinate organs, including the said department.

However, the above Decree does not clearly provide as to how DG/BGTH should collaborate with the General Directorate of Rural Engineering and Water Management (DG/GREE) that supervises irrigation facilities accompanying hill dams. Furthermore, DG/GREE is not currently taking part in the planning of hill dam construction projects by DG/BGTH. DG/GREE's involvement begins with the planning of irrigation facilities after the completion of a related hill dam, which is the major cause of delay in providing support for the farmers around the dam site in installing irrigation facilities. In order to allow farmers to begin and develop irrigation farming within a limited life span of hill dams, which is said to be between 20 and 30 years, it is important for DG/GREE and DG/BGTH to collaborate in hill dam projects.

CRDA and the provisional farmers' associations are taking charge of the operation and maintenance of the irrigation facilities and equipment under the technical assistance of DG/GREE. As some of the responsibilities and rules of GDA (Groupements de Développement Agricole) are obscure, albeit they are government-approved bodies, the Ministry of Agriculture is in the process of establishing new organizations which are different from GDA and defining the division of their responsibilities, including the O&M of facilities and equipment. Accordingly, CRDA is supporting the formation of new farmers' associations, as a provisional measure for transition period, and has concluded an agreement with the new associations concerning the provision, operation, and maintenance of equipment.

MOA and CRDA are of the opinion that because obscurities also exist in the ownership of some farmland around the dam sites managed by the Ministry of the Environment and Sustainable Development, the cadastral system needs to be improved in order to continue expanding farmland around dam sites and provide an environment for farmers to engage in farming with a sense of ease and trust.

In summary, in order to sustain the effects of the hill dams and irrigation facilities, it is

necessary to improve the coordination between DG/BGTH and DG/GREE on the state level and fortify the organizational structure on the governorate level. Institutional enhancement is also needed to further promote the development of irrigated land.

3.5.2 Technical Aspects of Operation and Maintenance

According to the Ministry of Agriculture, dam facilities are being monitored by the hill dam project unit (PIU) appointed by DG/BGTH. PIU is headed by the Unit Manager and comprised of two divisions with one division performing surveys and monitoring related to construction and the other taking charge of five sectors (geological survey, soil engineering, civil works, financial management, and land acquisition). The staff members are engineers with specialized knowledge and skills, having adequate capacity to perform their respective duties.

According to DG/BGTH, DG/GREE, and CRDA, each PIU engineer has accumulated practical knowledge and skills for the operation and maintenance of hill dams and hill lakes through the implementation of numerous projects since 1990. In addition, each CRDA has a track record of successfully operating and maintaining hill dams by incorporating various creative approaches devised by local engineers. Sousse Governorate CRDA, for instance, has constructed farm roads, etc. to expedite water release and other operations to prevent sedimentation and control flooding. It is also planning to carry out bank protection work in some dam sites this year by using riprap stones from quarries. Because of these efforts, no major problems have surfaced so far.

However, each CRDA's experience and accumulated know-how in operating and maintaining hill dams are not fully shared, and the Guidelines for the Operation and Maintenance of Hill Dams do not provide as to how to control dams, in which sedimentation is building up, or how to ensure safety of dams that have already been filled up. While the Guidelines, which were established in 2001 and revised in 2008, provide how to conduct daily inspections and monitoring, they do not systematically incorporate the know-how and lessons learned by the on-site engineers through handling a variety of unexpected occurrences over many years. Also, no studies or surveys have been conducted to evaluate or check the operation and maintenance statuses of more than 200 hill dams across the country or their usages for irrigation and other purposes. In order to maximize the benefits of hill dams, the Guidelines need to incorporate the technical solutions applied in the past and the analysis results of monitoring activities. Fortification of the O&M system to cope with the recent climate changes is also called for. It is important to update the Guidelines by analyzing and incorporating the successful past experiences in dam operation and maintenance and share them with each CRDA.

In light of the above, though no problem is currently observed in the technical aspects of the operation and maintenance of the hill dams, there is a need to update the Guidelines in a systematic manner by incorporating the accumulated know-how and experiences in handling sudden or unexpected occurrences in order to ensure technical sustainability of the project.

3.5.3 Financial Aspects of Operation and Maintenance

Table 19 below shows the trend in annual budget of the Ministry of Agriculture. There is no significant change in the budget amount before and after the Revolution. Table 20 shows the budget for hill dams owned by DG/BGTH, which increased from 326,938,000 TND in 2013 to 521,565,000 TND in 2014 and has been sufficient in the opinion of the Ministry of Agriculture. Though data of budget execution was unavailable, the field survey did not confirm any situations, where problems were arising in O&M or personnel deployment due to lack of budget. Pursuant to the Ministerial Decree of September 17, 2014 described in Section 3.5.1, budgets for FY2015 and FY2016 were allocated to DG/BGTH, which has already begun carrying out activities under a new institutional system as of the time of the ex-post evaluation.

Table 19 Annual Budget of Ministry of Agriculture

（Unit: million TND）

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2,168	5,219	1,451	979	1,820	1,435	5,880	2,121	895	2,935

Source: Ministry of Agriculture

Table 20 Budget Execution in 2013 and 2014

	2013	2014
Budget for hill dam projects	326,938,447 TND	521,565,287 TND

Source: Ministry of Agriculture

The new government has been continuing to provide financial support for farmers, such as subsidizing 60% of the cost of installing water-saving irrigation systems (drip irrigation, etc.) and 25% of the cost of non-water-saving equipment (sprinkler, motor pump, etc.).

On the governorate level, the O&M cost actually spent by CRDA was 1,245,280 TND against the total annual budget of 303,780 TND (114,000 TND for hill dams, 107,280 TND for irrigation systems, and 82,500 TND for pumps). According to CRDA, the

collection rate of water charges from farmers, an important revenue source for CRDA, has dropped since the Revolution, as it brought to surface and intensified their distrust in the government. In order to raise the collection rate, it is necessary to regain their trust by providing technical and other forms of assistance for farmers. In addition, as mentioned in Section 3.5.1, budgetary reinforcement is called for in order to secure sufficient personnel and funds dedicated to the operation and maintenance of hill dams and hill lakes.

In summary, while the overall budget of the Ministry of Agriculture does not seem to present particular issues, CRDA of each governorate needs to strengthen its income stream and increase its budget to enhance its institution for operation and maintenance.

3.5.4 Current Status of Operation and Maintenance

As part of the ex-post evaluation, the evaluator visited the target sites in Zaghouan, Siliana, Béjà, and Sousse Governorates to exchange opinions with the CRDA personnel in charge of this project.

CRDA has continually been providing various forms of assistance for the farmers of the target regions, including provision of motor pumps and aqueducts appropriate for the irrigation capacity of each hill dam and the soil and other conditions of the fields, as well as support for the formulation of annual action plans. Periodic inspections and monitoring of the hill dams have been conducted mostly properly according to the guidelines. Therefore, operation and maintenance of the dams are generally satisfactory.

Operation and maintenance of the irrigation facilities by the farmers have been generally satisfactory, except for the chaotic year of the Revolution in 2011. The farmers have been operating and maintaining the provided pumps and pipelines with great care in accordance with the rules established by themselves, as such care is crucial for making the best use of the water-saving and other irrigation systems. CRDA is providing technical assistance for farmers in selecting and using appropriate equipment so that the equipment they purchased will produce the intended effects, thus promoting proper operation and maintenance of the irrigation facilities.

While the design reservoir capacity of the dams of this project was 21,185,000m^3, the estimated capacity as of 2014 was 13,188,000m^3, which means that about 8,000,000m^3 of sediments have accumulated in the dam reservoirs during this time. Though the sedimentation speed has been mostly as predicted, it could accelerate in the future depending on the geographical and climatic conditions of each dam site. While it is difficult to make accurate future predictions in the midst of global climate change, many of the dams will likely remain usable for irrigation purposes for another 5 to 10 years. For

this reason, it is important to continue enhancing the sustainability of the project by fortifying the institutional aspects, updating the guidelines, and increasing budget of each CRDA.

In summary, there are minor problems in the institutional, technical, and financial aspects of the operation and maintenance system. Therefore sustainability of the project effects is fair.

4. Conclusion, Lessons Learned, and Recommendations

4.1 Conclusion

This project aimed to improve agricultural productivity, increase livestock numbers and farmers' income, and consequently contribute to the conservation of water resources and prevention of soil erosion, etc. by constructing hill dams and irrigation facilities in the north-central region of Tunisia, where precipitation was relatively high.

Tunisia formed a new government in February 2015 after completing a four-year transition process toward democracy since the Jasmine Revolution in 2011 and is currently in the process of formulating the next Five-Year National Development Plan. For the water sector, one of the key sectors of the country, the Ministry of Agriculture developed the Second Ten-Year Hydraulic Resources Development Strategy (2012 – 2022), based on which the Provisional Government continued to implement various projects. The new government took over the said Strategy and expressed its intention to continue constructing hill dams toward improving agricultural productivity, preventing soil erosion in farmland, and meeting other development needs. This project was also consistent with Japan's ODA policy at the time of the project appraisal. Therefore, the relevance of the project is high.

The project initially planned to construct both hill dams and irrigation facilities in 22 sites in 7 governorates. However, due to massive droughts between 1999 and 2002, the then already completed dams were unable to store enough amounts of water to allow constant operation of irrigation facilities. Because of this, a F/S was conducted to review and revise the content of the planned irrigation facilities. As a result of the F/S, it was determined that it would be more appropriate to construct the original irrigation facilities in three dam sites and provide portable pumps and other irrigation equipment for other sites instead. The F/S also revealed that irrigation farming had been expanding in the target regions due to private investment, the residents' independent efforts, and other factors. However, the F/S did not go so far as to reexamine the operation and effect indicators or revise the target values of the project. For this reason, the total irrigated area, one of the effect indicators of this project, turned out to be 620.5ha, attaining only 27% of

the target of 2,298.1ha.

On the other hand, the quantitative indicators, such as the farm size and production volume of major crops, have mostly achieved their respective targets as a result of promoting the farming methods that take into account reservoir levels that fluctuate depending on annual rainfall, as well as groundwater recharge effects. However, because irrigation facilities were not constructed as originally planned in 19 of the total 22 dam sites, it is difficult to attribute the high attainment levels entirely to the effects of the project, which, likewise, may not be the sole contributor to the moderate increase and stabilization of agricultural production in the target regions. In addition, because the remaining service life for irrigation use of the hill dams constructed by the project is assumed to be 5 to 10 years depending on the sedimentation speed of each dam based on their average life span of 20 to 30 years, the project's contribution toward the increase of agricultural production will not be permanent but will likely be for a limited time period.

With regard to project impacts, the farmers' annual income mostly attained the target level and the annual production of livestock meat has increased since the time of appraisal, though it is difficult to ascertain whether or not these results are solely attributable to the effects of the project. Trees were planted around the dam sites to prevent soil erosion over a total area of 6,154ha, which was 200% of the planned area. These trees are also thought to be helping the retention of floodwater during the rainy reason, prevention of soil erosion in farmland, and sedimentation mitigation and life prolongation of large-scale dams.

Comprehensively considering the above, effectiveness and impact of this project are fair.

Although the project cost was lower than planned, the project period far exceeded the plan. Therefore, efficiency of the project is fair. With regard to operation and maintenance of the project, though the speed of sedimentation in each reservoir has been mostly as expected, the need remains to implement measures to enhance the O&M system of the hill dams in each governorate, fortify the institutional aspects, update the technical guidelines by incorporating the accumulated know-how and providing response procedures to unexpected hazards, etc., and increase budget. Therefore, sustainability of the project effects is fair.

In light of the above, this project is evaluated to be partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

- It is recommended that the existing Guidelines for the Operation and Maintenance of Hill Dams incorporate the practical skills and know-how that have been accumulated

in the actual sites, as well as measures against drought, flood and other conditions that may arise from recent climate changes. In doing so, measures that effectively address the technical recommendations made by the SAPS Report (2014) should also be included in the Guidelines. In addition, it is important to objectively evaluate and analyze the operation, maintenance, safety, and usage of each of the 200 or so existing hill dams, and incorporate the results thereof in future water resources development plans.

- CRDA currently does not have a department or personnel dedicated to the administration of hill dams and hill lakes. It is recommended that the Ministry of Agriculture allocate physical and human resources necessary for establishing a department within each CRDA that takes charge of O&M of hill dams and related facilities and provision of guidance for farmers concerning irrigation techniques and efficient use of water.
- It is recommended that DG/BGTH and DG/GREE work more closely together and define more clearly their respective responsibilities toward promoting irrigation farming after the completion of hill dams. More specifically, DG/BGTH and DG/GREE need to start exchanging opinions from the planning stage of each dam construction project so that upon completion of each dam by DG/BGTH, DG/GREE can immediately start installing irrigation facilities/equipment and providing support for farming activity of the farmers.
- In order to facilitate development of irrigation farming around the hill dams and increase the annual income of farmers, it is recommended that DG/GREE and CRDA expedite the reform of farmers' associations and implement measures to further expand the area of irrigation farming by clarifying the obscurities in the ownership of some farmland, which are of concern for DG/GREE and CRDA, in cooperation with the Ministry of the Environment and Sustainable Development.

4.2.2 Recommendations to JICA

JICA is advised to continue monitoring the operation and maintenance of the hill dams constructed under this project, as well as the use statuses thereof by the farmers, in cooperation with the Ministry of Agriculture until it becomes fairly certain that the dam facilities will continue to be operated and maintained safely and sustainably.

4.3 Lessons Learned

Water Resources Development and Diffusion of Irrigation Techniques among Farmers

The original plan of this project was to construct hill dams while concurrently installing irrigation facilities in all the dam sites to irrigate a certain area size of farmland.

However, as a result of subsequent droughts, it was decided not to implement most of the planned irrigation facilities, as they would not have functioned properly and could have worked disadvantageously to the farmers.

From the standpoint of food security, on the other hand, semiarid countries like Tunisia are faced with an increasing need to irrigate their land and have been promoting the adoption of irrigation farming techniques, especially those of water-saving type.

Therefore, in providing assistance for irrigation farming in the north-central regions of Tunisia, it is important to devise an effective plan from the perspectives of both hardware and software by taking increasingly into account climate issues to protect the farmers from making wasteful investments. Assistance for the diffusion of efficient irrigation techniques (water-saving irrigation, etc.) among farmers would be especially effective, as it would also lead to optimal use of limited water resources.

Development of O&M Personnel According to Chronological Change in Hill Dams

Opinions were expressed by the affiliate agencies of MOA that each CRDA should establish a department and personnel dedicated to the operation and maintenance of hill dams and hill lakes because situations arose from time to time, where making swift responses was difficult due to the absence thereof. The reason behind this is that in order to properly operate and maintain dams, each CRDA needs engineers, who are specialized in each life stage of dams from the construction phase to the end stage of service life, as well as the accumulation of experience and know-how over a long term. For this reason, when forming similar projects, it is important to examine the necessity of establishing a dedicated department, etc. for the O&M of the facilities from a long-term perspective, in addition to allocating resources to O&M for a short term.

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Comparison of the Original and Actual Scope of the Project

Item	Original Plan	Actual
1. Project Outputs	1) Hill dams 22 sites in 7 governorates 2) Watershed management Tree planting: 3,080ha 3) Irrigation facilities Main facilities: 22sites (Breakdown) ・With pump station: 17 sites ・W/o pump station: 5 sites Portable pump: 4 sites, 29 units On-farm system: 22 sites 4) Land acquisition, etc. 22 sites 5) Survey & engineering 1 set 6) Logistics and O&M equipment 1 set 7) Consulting service 1 set (Overall project management, supervision of civil works, organizational fortification (diffusion, farmer's association))	1) Hill dams Same as plan 2) Watershed management Tree planting: 6,165 ha 3) Irrigation facilities Main facilities: 3 sites (Breakdown) ・With pump station: 1 site ・W/o pump station: 2 sites Portable pump: 7 sites, 24 units On-farm system: 2 sites 4) Land acquisition, etc. Same as plan 5) Survey & engineering Same as plan 6) Logistics and O&M equipment None 7) Consulting service 1 set (Feasibility study on irrigation facilities in 6 governorates)
2. Project Period	March 1999 – June 2004 (63 months)	March 1999 – October 2013 (115 months)
3. Project Cost Amount paid in foreign currency Amount paid in local currency Total Japanese ODA loan portion Exchange rate	 2,840 million yen 6,769 million yen (58,340,000 TND) 9,609 million yen 7,184 million yen 1TND＝116 yen (As of July 1998)	 3,617 million yen 1,488 million yen (18,898,000 TND) 5,105 million yen 3,617 million yen 1TND＝78.7 yen (Average between January 2000 and October 2013)