Throughout the period, the emphasis was on specialised technical training. Upon instigation of successive evaluation missions, the projects' scope of work was eventually widened to address the more fundamental institutional development constraints hindering effectiveness of the technical training effort.

With the exception of the RIGW Hydrological Training Programme (1984–87), all other packages were put out to contract with Netherlands consulting firms and/or organisations under the technical assistance procedure. In most cases, tender requirements were waived and contracts were awarded directly to the Netherlands in-house or partner consultant in association with an Egyptian consulting firm or individual Egyptian experts. Additional expatriate manpower assistance was funded from the bilateral associate expert programme.

More details on project implementation, results and impact are found the following sections of this report dealing resp. with the Advisory Panel, the water research sector, the drainage execution sector and the Fayoum water management programme. The remaining group of 'other' activities is not reviewed in detail.

4 The Advisory Panel for Land Drainage

4.1 Background

Shortly after the Egyptian–Dutch bilateral co-operation programme was formally announced early in 1975, DGIS invited a Consultant to '*examine the possibilities of a project of technical co-operation between the two countries in the field of land drainage*'. In this report, the Consultant noted that '*considering the importance of land drainage in raising agricultural production in Egypt and the high priority the Egyptian Government is giving to solving the country's water logging and salinity problems—as well as the fact that any contribution from the Netherlands should necessarily reflect fields of activity where specific Dutch knowledge is available and could be beneficial in solving these problems—the author should like to recommend to the Dutch Government that it give favourable consideration to a project of technical co-operation in the field of land drainage*' (Schulze, 1975).

Project formulation followed a stormy discussion between the Egyptian Government and the World Bank over the engagement of consultants to assist EPADP with the management and execution of the first drainage project (Nile Delta I). The Bank's viewpoint was that the project required the resolution of technical issues in which the then Ministry of Irrigation had little or no experience. The Egyptian Government agreed to this only with the greatest reluctance, considering that an engineering organisation that had operated the oldest controlled irrigation system in the world for many years did not require permanently attached outside advisers. On other occasions, it claimed that strict governmental instructions did not allow the use of credit/loan funds for foreign consultants. A consulting firm was eventually engaged in December 1970. The Government's reluctance to make use of them, however, meant that the consultants were isolated, largely ignored, and not allowed to become involved in the mainstream of project execution. When their contract ended in March 1973, no other resident project consultants were engaged. Although there was little doubt that EPADP would have benefited from direct, in-house consultancy support, the set-up of a joint Egyptian–Netherlands Advisory Panel on Land Drainage clearly responded to EPADP's explicit preference for a short-term, advisory type of assistance.

Table 4.1 Advisory Panel on Land Drainage—Main project and Panel meeting data (1976–96)

Phase	Period	Expend. Dfl. 1,000	Panel meetings Nr	date	location	attendance Eg	Nl
Period 1976–82							
APLDP-I	01/10/75–	563	1	January 1976	Cairo	5	6
	31/12/77		2	May 1976	Utrecht	4	6
			3	May 1977	Cairo	5	6
APLDP-II	01/01/78	2,237	4	January 1978	Utrecht	5	6
	31/12/79		5	January 1979	Cairo	5	6
			6	September 1979	Wageningen	5	6
APLDP-III	01/01/80	2,650	7	September 1980	Wageningen	6	5
Extension	31/12/81		8	February 1981	Cairo/Aswan	7	6
	31/12/82		9	September 1981	Utrecht	6	6
			10	April 1982	Alexandria	7	6
			11	September 1982	Wageningen	6	5
Period 1983–96							
APLDP-IV	01/10/83–	1,663	12	February 1983	Aswan	5	6
	31/12/85		13	September 1983	Lelystad	6	7
			14	March 1984	Ismailiya	5	6
			15	September 1984	Wageningen	7	6
			16	February 1985	Aswan	7	6
			17	September 1985	The Hague	6	7
APLDP-V	01/01/86	2,296	18	February 1986	Fayoum	7	6
	31/12/88		19	September 1986	Paterswolde	8	6
			20	February 1987	Ismailiya	8	7
			21	September 1987	The Hague	10	8
			22	February 1988	Fayoum	6	7
			23	September 1988	The Hague	7	7
APLDP-VI	01/01/89	1,339	24	March 1989	Luxor	8	7
	31/12/90		25	March 1990	Cairo	7	7
APLDP-VII	01/09/91	1,050	1	September 1992	Wageningen	5	6
extension	31/08/94		2	May 1993	Taba	5	5
	31/03/96		3	April 1994	Port Said	5	5
			4	March 1995	Alexandria	5	5
			5	April 1996	Maastricht	7	7

Source: Advisory Panel on Land Drainage. Progress and Panel Meeting Reports.

The proposal was worked out in close co-operation with the Egyptian Public Authority for Drainage Projects (EPADP) and approved by the Netherlands without further appraisal in October 1975. Under the Technical Assistance agreement, the Panel of high-level experts was established in 1975/76. The Panel had an Egyptian Chairman and a Dutch Co-Chairman. A resident team of drainage experts from the Netherlands was attached to implement its recommendations.

For eight years, the Advisory Panel on Land Drainage Project (APLDP), or the Panel Project as it became known, assisted in getting solutions implemented in the field by EPADP and in problem-oriented research at the newly established Drainage Research Institute (DRI). During the period, the project was designed to transfer scientific and engineering knowledge through daily, on-the job training and through formal training programmes in drainage technology and research in the Netherlands and in Egypt.

As the scope of the research programme widened, the 'all-in one' approach was abandoned in 1983. Technical assistance for the drainage research programme continued under a separate project and the scope of APLDP was narrowed to activities of the expert Panel only. Since then, the Panel has formed the discussion platform of the Egyptian–Netherlands co-operation programme in the drainage and water management sector. From its conception until December 1996, the Panel met 30 times (twice yearly up to 1988 and once yearly thereafter, with some exceptions and interruptions). Information on the times, location and attendance of the meetings is given in Table 4.1.

By the end of 1996, the total financial contribution to the project by the Netherlands totalled some Dfl. 14.2 million (see Table 4.2). Excluding costs of the technical assistance

Table 4.2 Advisory Panel on Land Drainage Project (1975–96)—Project expenditures (in Dfl. 1,000)

Project	Total	1975–80	1981–85	1986–90	1991–96
Phase I (1976–77)	563	563	0	0	0
Phase II (1978–79)	2,237	2,094	143	0	0
Phase III (1980–82)	2,650	0	2,650	0	0
Phase IV (1983–85)	1,663	0	1,659	4	0
Phase V (1986–88)	2,296	0	0	2,296	0
Phase VI (1989–90)	1,339	0	0	1,310	29
Phase VII (1992–96)	1,564	0	0	0	1,564
Subtotal	12,312	2,657	4,452	3,610	1,593
Associate experts	1,877	729	1,148	0	0
TOTAL	14,189	3,386	5,600	3,610	1,593

Source: DGIS.

component, the net contribution to the expert Panel activities roughly totalled Dfl. 10 million (Dfl. 0.5 million on an annual basis).

During the initial Phase I–III period, expenditures included costs of a resident technical assistance team of up to five expatriate experts, advising EPADP on drainage execution and assisting the DRI in setting up the drainage research programme. Since 1983, project budgets covered costs of the Panel meetings, office investment support, specialised consultancies and formal training of staff of the National Water Research Centre.

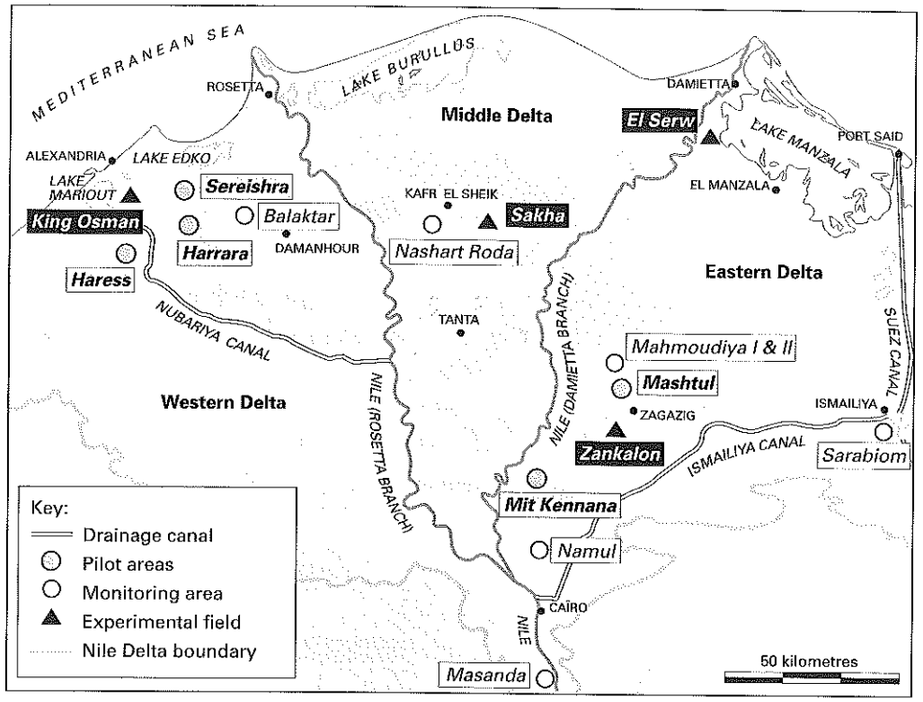
4.2 Implementation

Period 1976–1982

During this period, the objectives of APLDP were: (i) to assist EPADP in the planning of drainage works in the country, a proper co-ordination of drainage works with other activities of land reclamation, the scheduling and programming of drainage projects, and the evaluation of drainage projects and problems of water management; (ii) to assist EPADP in setting up a programme aimed at acquiring feasible technology for the execution of drainage projects at faster rates and lower costs; (iii) to assist EPADP in developing a monitoring system for drainage networks and in implementing water management and drainage studies; (iv) to assist with the training of Egyptian nationals in the field of land drainage.

The first meeting of the Panel resulted in the formulation of a number of important recommendations. Referring to the slow and inaccurate cement tile laying process, the Panel endorsed the on-going trial laying of corrugated pvc laterals and advocated a large-scale introduction of the new technique. On the basis of experience in the Netherlands and problems in obtaining the right cover material at reasonable cost, the Panel advised against the use of gravel as cover material in draining heavy clay soils (with more than 40% clay) and recommended further research into suitable cover materials in non-clay soils. In consideration of the general installation problems that confronted EPADP, further research on the improved installation of covered collector drainage systems was recommended, to be carried out in one or more suitable pilot areas before their application under actual field conditions.

The Panel agreed that the newly-created DRI should be the agency responsible for drainage research. During 1976–82 the following types of research were initiated: (i) measuring the effects of drainage in selected pilot areas, (ii) water management in rice-growing areas; (iii) research to obtain rough economic indications of the effectiveness of drainage and; (iv) the potential for drainage water re-use.



Map 2 Drainage research sites in Lower-Egypt

For the *pilot research*, areas were selected in the Eastern (Mashtul) and Western (Sereishra) Delta (see Map 2). The research programme set-up was plagued by a host of organisational and technical problems The arrival of the expatriate team was substantially delayed, and discussions with EPADP on design and construction modalities of the drainage network dragged on for more than two years. At Sereishra the network did not function properly; the collector system showed serious signs of sand clogging soon after installation and initial comparative studies with the neighbouring non-drained area were of little or no value. At Mashtul the experimental drainage network was not installed until some three years after the start of the programme and establishment of the measuring system took another year. Problems also developed with one of the three main collectors. Consequently, no field investigation programme was in place by the end of the period.

A *water management* study programme was carried out in two rice growing areas: Nokhrashi, a drained area, and Anwar Hammad, a non-drained area. After two years, the study confirmed earlier assumptions that considerable saving of water (up to 40%) could be achieved in rice growing areas by modifying the conventional layout of the field drainage system at relatively low cost. Both the conventional and modified layouts are

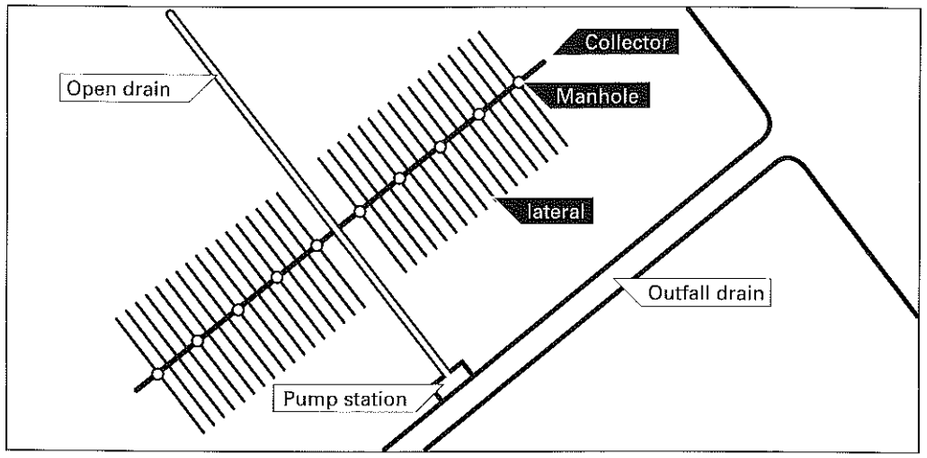


Figure 4.1 Sub-surface drainage system—conventional layout

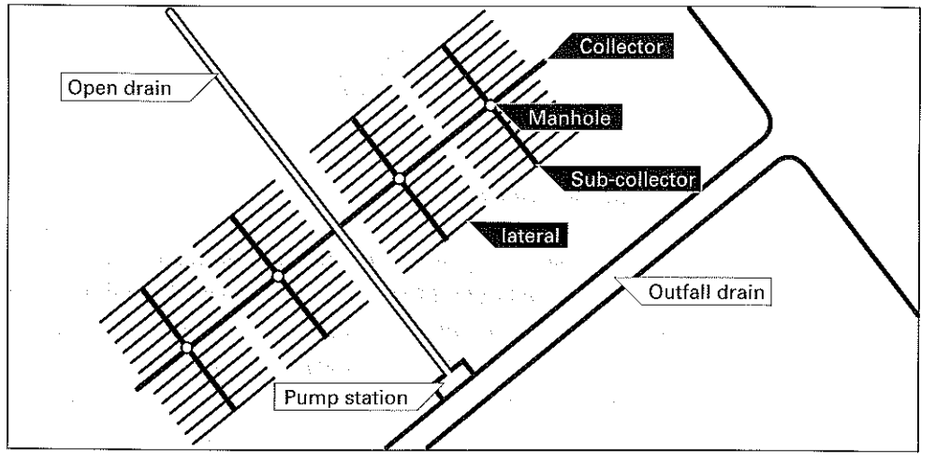


Figure 4.2 Sub-surface drainage system—modified layout

shown in Figures 4.1–2. The expert Panel agreed on further testing of the performance of the 'modified layout' under actual field conditions in a 5,000 feddan area in the East Bahr Saft area (Mahmoudiya). Discussions with EPADP on the final design and implementation modality of the testing area dragged on for more than two years, however, and the planned monitoring programme had necessarily to be postponed.

The *economic research programme* concentrated on crop yield and salinity measurements initially in two (later extended to three) pairs of twin villages (one with and the other without drainage) in the Western and Eastern Delta area respectively. The results provided

a moderately positive picture but did not show a consistent trend for at least three reasons: (i) although soil salinity varied in both sets of twin villages, it did not represent a serious constraint on growth of the five main crops: (ii) in the drained villages some 40% of the drainage system appeared to function inadequately, thus preventing proper comparison between drained and non-drained areas; (iii) contrary to the common belief that sufficient water was available to all farmers, several areas proved to suffer severe water shortages in the summer season thus affecting yields. Consequently, serious doubts arose about the usefulness of the programme under uncontrolled farming conditions. The research was discontinued when the Netherlands announced its intention to stop its support, a decision which led to a complete halt of DRI's economic evaluation work.

Substantial progress was made in the *drainage water re-use* research programme. The network data base was completed and a regular drain discharge and salinity monitoring programme was launched at some 100 locations in the Delta and Fayoum. On the Panel's instigation, a start was made with developing a mathematical model with which to study the effects of different water management strategies on the quantity and quality of drainage water and its suitability for irrigation re-use.

During the period 1976–82 the expert Panel met 11 times. It monitored the DRI research programme, invited expert opinions on the technical aspects of drainage and discussed these during the 3–4 day meetings. The number of documents discussed in each meeting varied between 12 and 20. Authors of the documents were usually invited to introduce the written material and to participate in the discussions. For a short period, meetings were also attended by external observers including representatives of the World Bank, the main donor in the drainage sector. Eventually, MPWWR objected to the full participation of other donors in Panel deliberations. Minutes of meetings reflected intensive but not always very structured discussions of numerous project-related matters and general topics of differing complexity and priority. On each occasion, a 4–5 page list of findings, recommendations, warnings and wishes was drafted.

Towards the end of the period the Co-Chairman of the Panel raised concern about the efficiency and effectiveness of on-going activities and called for a critical review. The view that development co-operation could better be based on the formulation of separate projects each with clearly defined objectives, detailed plans of operations and agreed budgets, was instantly supported by the Netherlands which was equally concerned by the lack of tangible results of the project.

Period 1983–96

In January 1983, APLDP returned to its primary objective of advising MPWRR on: (i) policy and planning issues involved in the improvement of drainage conditions; (ii) initiating new research activities; (iii) alleviation of drainage-related constraints in water management; (iv) human resources development and training needs in the area of land drainage; (v) issues related to the re-use of drainage water and its environmental aspects; (vi) prevention of environmental hazards related to the irrigation, drainage and groundwater systems, and (vii) organisation and management of drainage systems and the operational maintenance and rehabilitation of those systems.

In this advisory capacity, the Panel met 14 times between 1983 and 1989, discussing project activities and advising on the scope and continuation of the Netherlands co-operation programme in the field of drainage and drainage-related water management. Apart from the two DRI projects, the Panel was involved in the identification and formulation of new proposals in support of the Fayoum Irrigation Department, the Research Institute for Groundwater and EPADP.

Eventually, in 1989 and for the first time in its 15-year existence, the APLDP was evaluated by external Egyptian and Dutch experts. The evaluation mission concluded that '*the overall impact of 14 years of co-ordination of land drainage and drainage-related water management projects in Egypt by the Drainage Advisory Panel was very successful*', and recommended a three-year extension. (Advisory Panel, 1990). Despite this positive evaluation, the Netherlands pressed for restructuring of the project, for three main reasons:

- APLDP's authority and competence was becoming increasingly challenged by individual project evaluation missions exposing weaknesses in the project cycle management, the lack of clearly formulated sector and project strategies and poor communication among agencies directly or indirectly involved in the programme. Its advisory capacity was further weakened when its (Netherlands and Egyptian) economist-members resigned in 1985–86, following the Netherlands' earlier decision to suspend financial support for the economic research programme and to deny the economists a permanent seat on the Panel.
- In 1987, a Water Sector Specialist was stationed at the Royal Netherlands Embassy in Cairo to monitor and supervise the Netherlands co-operation programme in the water sector more closely. Also, DGIS was strengthened with sector specialists advising on the scope and progress of the programme.
- Whereas the expert Panel continued to serve as a useful discussion and project co-ordination platform, its general advisory function (towards the two Governments) became more and more problematic. Issues in projects discussed in Panel meetings increasingly dealt with the broader concept of water management rather than merely with drainage. In addition to being 'flooded' by a massive number of reports, the Panel faced difficulties in dealing with subjects as water distribution problems in the Fayoum and the use of computer models in surface and groundwater resources development. As a result, it became less and less able to respond adequately to the dual need of transferring technical expertise on drainage as well as advising policy makers at the highest level on managing Egypt's water resources.

Discussions on the scope and a new organisational set-up of the Panel project took another year until agreement was reached on a three-year extension in May 1991. The new set-up provided for the establishment of three complementary Steering Committees, meeting three times a year and reporting to the expert Panel, each on the progress and performance of a cluster of 2–4 individual projects. The Committees covered the field of drainage research, technology and implementation; water resources and their environmental aspects; and Fayoum regional development. By taking over the monitoring function, these Committees allowed the Panel to develop a more policy and planning oriented direction in its advice. Reflecting a further broadening of its advisory function, its name was modified into Advisory Panel for Land Drainage and Drainage Related Water Management with the important continuing restriction that it applied to Netherlands-funded projects only.

The Committees were slow in starting as appointment of their members was a time-consuming affair. Even thereafter, routine was slow to develop as virtually all organisational and secretarial work devolved on an already understaffed Egyptian Secretariat. On the final count, the three Committees met 22 times. As part of this monitoring task, they discussed progress and formulated general recommendations with respect to project progress.

Panel meetings also continued to produce extensive lists of recommendations, partly related to organisational matters, partly to research. Among the research topics discussed, the most important were: (i) ecology and economy of Nile water storage in Lake Burullus; (ii) performance indicators for drainage systems; (iii) guidelines for the rehabilitation of the tile drainage network; (iv) artificial recharge of groundwater, (v) water quality and; (vi) institutional aspects of drainage maintenance.

Towards the end of 1993, the Panel Secretariat requested an extension of the Panel's mandate for another three years (1994–97). The Netherlands decided to have the project re-evaluated. The evaluation mission concluded that the Panel had created the environment for better project execution and a higher return on investments in research, training and field projects implemented under the Panel's umbrella. The mission recommended an extension of at least three years.

Referring to the gradual shift in the Panel's project portfolio, a more balanced composition of disciplines was advocated. The Panel was further advised 'to set itself some simple rules to avoid any conflict of interest of its members'. The issue—the first time formally addressed in the eighteen-year history of the Panel—referred to the 'dualistic' position of its members in their capacity of chief executive officers of agencies that directly benefited from the co-operation programme.

By the time the present IOB review was concluded (December 1996), the extension proposal was still under consideration. Taking a much more affirmative and at the same time critical stance, the Netherlands re-opened discussions on the Panel's scope of work, its composition and organisational structure against the background of continuous concern over its efficiency and effectiveness.

4.3 Assessment

Results

During the period 1976–82, the APLDP was the main vehicle for the Netherlands–Egyptian co-operation programme in the drainage sector. The project's main achievement was the build-up of a national drainage research capability at the newly created Drainage Research Institute. In addition, the Panel of experts advised EPADP on a wide variety of technical issues affecting the implementation of the national drainage programme that was supported by the World Bank.

EPADP adopted the Panel's advise on several technical matters, although with a delay of some 4–6 years. The most prominent advise referred to the use of gravel envelopes which was recommended to be abandoned in heavy clay soils and yielded important savings in material costs. The Panel also advocated the general application of pvc pipes from 1980 onwards, a technology which had been tested under the 1965–75 FAO experimental research programme and was introduced under the Upper Egypt II drainage project, supported by the World Bank and USAID.

The Panel's impact on the rate of implementation and quality of execution of EPADP's drainage programme as such, was marginal. By and large, the execution of the programme continued to be affected by administrative delays in procuring and commissioning equipment, shortage of complementary national funding and adequately trained staff and deficiencies in contractor performance; non-technical, institutional problems which were largely beyond the Panel's direct sphere of influence and expertise.

In the period 1983–1996, the Panel project continued to provide a framework for the monitoring, guiding and co-ordination of water sector projects financed by the Netherlands. Its effectiveness and impact was subject of considerable debate. Apart from creating an environment for better project execution, at the level of the Ministry of Public Works and Water Resources, the Panel (and both evaluation missions), the project was thought to have substantial material benefits through a higher return on investments in research, training and field projects. At the level of the field projects and outside the Panel's immediate sphere of influence, however, there was generally little appreciation of its work and impact. On the whole, it is felt that its potential was not fully used because: (i) many of the members were direct stakeholders in the execution of the programme; (ii) it had limited expertise in modelling and specialised fields of work other than drainage. The opinion of the MPWWR is that the combination of Panel members advisory and executive functions was intended in order to make optimal use of available experiences. In addition, the Ministry considered that experiences of the Panel members was adequate to cover all relevant fields.

The restriction of its scope of work to Netherlands-financed activities and problems related to these activities, reduced the Panel's potential role in policy design and formulation. While a number of policy issues were discussed indeed, the actual policy and legislative framework in the drainage and water management sector was basically conceived under USAID and World Bank covenants without explicit involvement of the Panel.

Efficiency

The 1975 identification mission report excelled in its clarity of analysis and formulation of the project's basic objective: advising EPADP on the execution of its field drainage programme. Subsequent project extension documents have often been vaguely worded and have shown a confusing formulation of multiple project objectives and activities. This was particularly the case in the period 1982–95, when the Panel's advisory function was re-defined and would typically comprise 2–4 'general objectives' and sometimes as many as 7 'specific objectives', without indication of priority or properly documented records of outputs and achievements. In the final analysis, the project extension documents had a strong 'fund-raising' character with few if any binding arrangements for subsequent project execution.

The Panel concept as such fitted rather well into Egypt's institutional framework, which is characterised by rigid vertical bureaucratic structures and horizontal communication through formally-established committees and councils. However, the Panel had to discuss an excessive number of reports of highly varied quality and detail, sometimes presented

a few days before the meetings. Efforts to rationalise the Panel's working procedures f.i. through the establishment of Steering Committees were largely unsuccessful.

In retrospect, the project monitoring and evaluation effort was defective. Throughout the period, the Netherlands maintained a critical attitude towards the Panel's 'performance' but was not able to keep it focused on its original policy advisory function. DGIS retained formal responsibility for the execution of the programme and arrangements for the transfer of 'ownership' to the Egyptian-chaired Panel were inadequate. There was no agreed longer-term co-operation agenda based on comprehensive analysis of the sector's development constraints and with clearly formulated operational objectives and agreed standards of performance.

The evaluation reports (1990, 1994) provided an incomplete picture of the Panel's overall performance. Statements to the effect that the project contributed towards improved water management in Egypt and increased the return on investments in research, training and field projects, were poorly documented.

5 Water research

5.1 General

Within the last 20 years, the Netherlands has shown substantial interest in water research and in building water research capacity within Egypt. This interest has been expressed in increased support for a number of research institutes operating under the National Water Research Centre (NWRC).

Rather than developing first a general strategy for elaborating and implementing research support in specific areas, a series of individual technical assistance projects was initiated. Specialised Dutch consultants and missions were sent out to examine or to suggest possibilities for technical co-operation in their respective fields of competence. Logically, the missions established contact with Egyptian research organisations or Government agencies in the same field of expertise. In this way, the drainage research support programme was conceived by the leading research organisation in the Netherlands in the field of land reclamation and drainage, and the Drainage Research Institute, the organisation in Egypt charged with implementation of the national field drainage programme. Similar types of individual technical assistance programmes were initiated in the fields of weed control, groundwater development and hydraulic engineering research between specialised consultant organisations in the Netherlands and the Channel Maintenance, Groundwater and Hydraulics Research Institutes respectively. The following review is therefore logically divided into four sub-sections dealing with the four research support programmes mentioned.

The support programmes consisted of successive 3–5 year technical assistance packages covering the cost of stationing expatriate experts in the respective Institutes, short term consultancies, formal training, research infrastructure investment and project operational expenses. The manpower development component (long and short term consultancies and formal training) usually represented 60 to 70% of the total package costs. Some 10–20% of available funding was used for the procurement of equipment and materials needed to conduct research (vehicles, computers, measuring and laboratory instruments). The

balance was spent on recurrent cost financing including incentive payments to local staff participating in project activities.

5.2 Drainage Research Institute

5.2.1 *Background*

Although some research work was done in the 1940s and 1950s, the launching of the FAO/UNDP-financed Pilot Project for Drainage of Irrigated Land (1961–65) marked the beginning of systematic land drainage research in Egypt. Modern techniques of tile drainage were studied and tested through a pilot project implemented under the auspices of the UN Special Fund, with FAO as executing agency and a consulting firm from the Netherlands in an advisory capacity. The second landmark was the establishment of the Drainage Research Institute (DRI) to try out new methods of drainage investigation, construction and maintenance. The set-up of a specialised land drainage research agency was actively encouraged by the World Bank which has been the main donor of the field drainage programme since the early 1970s.

The mandate and responsibilities of DRI have not basically changed over the years. In short, it is charged with the development and testing of appropriate methods and technologies for planning, design and implementation of land drainage works and, the monitoring of drainage water quantity and quality and the study of the re-use potential. Since its establishment in 1975, DRI has functioned as a Government research institution under the authority of NWRC. In addition to office facilities, the infrastructure includes a laboratory which performs the chemical, physical and biological analyses of drainage water, soil and plant samples.

From the outset, research activities have been concentrated in two research units: the Covered and the Open Drainage Departments. The *Covered Drainage Department* studies, among others, concepts and techniques for the design and implementation of new drainage systems, evaluates the hydraulic performance of sub-surface or field drainage systems, and develops criteria for the use of envelope materials. The *Open Drainage Department* conducts research on open drainage channel design and is charged with the operation and maintenance of a nation-wide drainage water monitoring network. It is also engaged in developing a mathematical model for simulating the effects of changing water management scenarios on the quantity and quality of drainage water and in studying its re-use potential.

The *Drainage Water Management Department* and the *Special Research Unit* were established in December 1994. The former is charged with developing mathematical models

for evaluating the performance of drainage systems under variable field irrigation conditions, while the latter basically superseded the existing Field Studies Department charged with special studies and contract research on various drainage related subjects.

During the initial 5–6 years period of its existence, DRI was actively involved in monitoring and the economic evaluation of completed drainage works. Certain methodological controversies caused doubt as to the usefulness of the crop yield response evaluation programme and DRI staff were re-assigned to other activities in 1982. World Bank proposals to resume evaluation work and to enhance its significance were rejected by the Egyptian Government. Eventually, in 1994 it was decided that EPADP's monitoring and evaluation activities should be revamped under a separately financed project and the DRI's *Economic Evaluation Department* was closed down.

Since its establishment in the 1970s, the Netherlands-financed technical assistance programme has been the main vehicle for strengthening DRI's research capacity. Emphasis during the initial 5–10 years, was on capacity building. Young and inexperienced staff had to be trained and a physical infrastructure had to be built up. Later, the primary challenge became to strengthen and sustain existing research capacity, in the process of which close professional relationships developed between DRI and the Netherlands consulting organisations.

Apart from comprehensive Netherlands support, the Institute benefited from other nation-wide donor assistance programmes, such as the USAID-financed Water Use, Irrigation Improvement and Water Research Centre projects and the Canadian-financed Agricultural Response Programme, mostly in the form of training fellowships and (small) grants for research infrastructure. Occasionally, DRI was invited to participate in donor-financed projects.

During the initial period (1976–82), the research agenda was basically set by the Advisory Panel on Land Drainage. Subsequently, Netherlands funding continued on a project-by-project basis with the expert Panel in an advisory but de facto decisive role. The Egyptian Panel representatives included the Director of DRI and the Chairman of EPADP, the main client or beneficiary of research results.

In time, DRI evolved into a research organisation with a scientific staff of 65 and a general support staff of 69. Of the 65 scientists, 22 hold a PhD and/or Msc degree and two have diplomas in water management and soil science. At the time of the IOB review, 17 of the 65 scientific staff were on temporary leave.

Operating under the direct control and supervision of NWRC, the Institute's finances are still regulated by the nationally applied and unified budgeting and accounting system.

Table 5.1 shows DRI's annual, local expenditure budget of the years 1987–94.

Table 5.1 Drainage Research Institute—Annual recurrent and investment expenditures (in LE 1,000)

	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Salaries	200	220	225	235	240	250	258	540
Operational costs	1.7	1.7	1.7	1.7	1.7	6.8	11.8	6.7
Investments	186	253	257	375	374	n.a	n.a.	n.a.

Source: National Water Research Centre.

Although the external (i.e. the Netherlands) donor community fully supported DRI's work, its local financial basis remained weak. Apart from low salaries and compensation levels, the most precarious development was Government's difficulty to cover the recurrent costs involved in operating and maintaining the donor-financed research infrastructure and monitoring programmes. While DRI was allowed to retain its share of own revenues for topping-up basic salaries, its operation and maintenance allocation was kept constant up to 1991/92. Although this was increased substantially in 1992/93, it is totally inadequate in absolute terms to cover the cost of office or vehicle fleet recurrent costs.

5.2.2 *Programme characteristics*

The DRI was basically set up and developed with technical and financial assistance from the Netherlands. Shortly after its establishment early in 1975, the *Advisory Panel on Land Drainage Project* provided financial support for organising high-level drainage expert panel meetings on a six-monthly basis and for assisting the DRI in formulating and implementing a comprehensive drainage research programme. The three year assistance programme was eventually extended for five more years. After 1982, it was continued under two separate technical assistance projects. The *Drainage Technology and Pilot Areas Project* (DTPAP) assisted the Covered Drainage Department in implementing its pilot areas research programme initiated under the previous 'Panel project'. The objective of the *Re-use of Drainage Water Project* (RDWP) was to assist the Open Drainage Department in setting up a drainage water monitoring system and developing a mathematical model for predicting drainage water quality and quantity under different water management scenarios. After three extensions, both projects were terminated in 1994–95 to be followed by the *Drainage Research Programme* (DRP) project and the *Monitoring and Analysis of Drainage Water Quality* (MADWQ) project respectively, with scheduled execution periods of 4–5 years.

Up to the end of 1996, the Netherlands financial contribution to DRI totals some Dfl. 27.1 million, including Phases I–III of the Panel Project discussed earlier. A breakdown by project and time period is given in Table 5.2.

Table 5.2 Drainage Research Institute—Netherlands aid contribution 1975–96 (in Dfl. 1,000)

Project	Total	1976–80	1981–85	1986–91	1992	1993	1994	1995	1996
Advisory Panel on Land Drainage[1]	5,450	2,657	2,793	0	0	0	0	0	0
Drainage Technology and Pilot Areas Project									
Phase I	952	0	854	98	0	0	0	0	0
Phase II	1,626	0	0	1,626	0	0	0	0	0
Phase III	2,391	0	0	1,247	662	255	207	20	0
Drainage Research Progr.	2,515	0	0	0	0	0	300	767	1,448
Re-use of Drainage Water Project									
Phase I	3,008	0	2,831	177	0	0	0	0	0
Phase I—Ext I	1,618	0	0	1,618	0	0	0	0	0
Phase I—Ext II	280	0	0	280	0	0	0	0	0
Phase II	3,124	0	0	406	334	936	872	576	0
Re-use Monitoring Progr.	891	0	0	748	14	0	69	60	0
Monitoring and Analysis of Drainage Water Quality	1,155	0	0	0	0	0	0	580	575
Associate experts programme	4,134	729	1,148	2,065	192	0	0	0	0
TOTAL	27,144	3,386	7,626	8,265	1,202	1,191	1,448	2,003	2,023

Source: DGIS.

[1]Including expenditures of Advisory Panel meetings.

5.2.3 *Implementation*

A. Drainage technology

Projects in this programme were designed to support DRI in its pilot area research on drainage design criteria, specifications for pipe and envelope materials and their installation techniques. Ultimately, the project was intended to enhance the research capability of DRI in general and to contribute to the development and introduction of improved drainage technology, planning and design.

The initial phase started on 1 January 1983 without a detailed plan of operations. Instead, broad terms of reference were worked out and a preliminary workplan for one year was prepared. This indicated the main fields of investigation, i.e. the relationship between irrigation practice and drainage (water management), drainage design criteria (spacing, diameter and depth of lateral and collector drains) and the feasibility of using envelope materials for lateral drains.

Activities included under the projects were twofold: pilot research in the Eastern and Western Delta and observation surveys in regions already provided with piped drainage. The latter was combined with field studies in three areas in the Nile Delta of the performance of the modified layout for rice-growing areas under different soil and hydrological conditions. On the whole, the implementation record was rather disappointing.

The pilot research in the more difficult to drain sandy soils of the Western Delta (Sereishra) was abandoned in 1984 due to the malfunctioning of the drainage system. Also in a newly selected area (Harrara), installation of the network and measuring system was seriously delayed and the collector system was misaligned and damaged. Serious data collection started only in 1989. Apart from a report on the cleaning operation itself, final research results were never published. In spite of the problems, two new pilot research areas were selected (Haress and Mit Kenana) of which final research results were not yet published by the end of 1996.

At the end of the day, only for the Eastern Delta (Mashtul) a final report was prepared which summarised the results of ten years of research into the effectiveness of drainage systems in heavy clay soils. As such, it represented the first comprehensive effort to translate a massive amount of research data into a set of practical recommendations with regard to drainage design criteria. A summary of the generally accepted design standards and the corresponding set of research figures is presented in Table 5.3.

Table 5.3 Comparison of standard drainage design criteria and DRI research results on drainage criteria in heavy clay soils

	standard design	research results
Agricultural criteria		
– water table midway between drains (m.G.L.)	1.0	0.8
– leaching requirement (mm/day)	1.0	0.9
Technical criteria		
– drain pipe capacity		
(A) Laterals (mm/day)	4.0	1.7
(B) Collectors in rice area (mm/day)	4.0	2.0
(C) Collectors in non rice areas (mm/day)	3.0	–
Safety factors (%)	25	40
Maximum drain depths of laterals	1.5	1.4

Source: DRI.

The Mashtul research programme basically confirmed the validity of the agricultural criteria applied by EPADP. Although on the safe side (implying some over-design), differences were small and did not warrant any change of standards. With regard to technical criteria, research confirmed suspicions that the design rate for determination of

the capacity of drainpipes was too high and the safety factor insufficient for the currently used construction materials and methods in current usage.

Surveys of areas already provided with pipe drainage systems included the first large scale pilot area of Nashart (5,000 feddan) equipped with a modified design drainage network. The Nashart survey confirmed previous findings that substantial amounts of irrigation water could be saved by introducing the modified layout in rice-growing areas. Reports on collector drain performance yielded few surprises and corroborated earlier reports on the poor quality of construction and deficiencies in maintenance of the installed drainage network.

During the 1989–93 period, laser controlled trenchless drainage became an important point of discussion. The project was instrumental in mobilising expertise in the application of mechanical pre-wrapping of drain pipes. A trial test with a Dutch manufactured pre-wrapping machine was successfully conducted (for the first time in Egypt), using local corrugated drain pipes and synthetic envelope materials.

Activities under the project were discussed extensively by the Advisory Panel, exposing a laborious, if not antagonistic working relationship between DRI and EPADP, the presumed beneficiary of the research effort. While acknowledging the technical merits of the 'modified' design concept, the Chairman of EPADP repeatedly questioned its economic feasibility and practical applicability at the farm level. Similar reservations were voiced about the need and relevance of establishing one or more new pilot research areas in the difficult to drain, unstable sandy soils of the Delta fringes.

Throughout the period, the Advisory Panel of experts endeavoured to narrow the communication gap between the DRI scientific community and the executing agency EPADP. The Netherlands Embassy also expressed concern about the relevance and application of the research (relationship DRI-EPADP), the shortage of skilled DRI staff and the absence of concretely formulated research objectives and outputs.

Review missions visited the project in 1988 and 1992. The 1988 mission judged the research topics to be 'highly relevant' and derived from EPADP's implementation programme. The research work was of good quality and the local and in-service training adequate. The mission voiced concern about the continuing backlog in data processing and report writing and the absence of spectacular results in the pilot areas ('only appreciated by those who know the complications of drainage research'). Furthermore, it found justification in EPADP's reluctancy to implement some of them as long as they were not thoroughly tested on a project scale while a certain degree of antagonism between research and implementation agencies was considered 'natural and not restricted to Egypt'.

The mission's recommendation to share implementation responsibility between DRI and EPADP was rejected by the DRI.

The 1992 mission took place in an atmosphere of growing apprehension about the progress and relevance of the pilot areas research. The mission acknowledged the quality and dedication of project staff and the application of adequate research methodologies. However, it criticised the lack of proper field testing as a supplement to laboratory measurements, the weak organisational structure, and the different objectives of the research community and implementing organisation. It concluded that unsatisfactory progress had been made sofar and that no new phase should be started under the present organisational set-up. Nevertheless, the project was granted two budget neutral extensions for a period of more than two years under the existing organisational structure, to complete on-going research.

The critical 1992 evaluation shook the DRI research community to its foundations. In reaction, DRI management responded that '*a new era of co-operation between EPADP and the DRI was about to start*' and that continuation with the project was essential '*in order not to create gaps that might hamper the research activities and consequently affect the implementation quality of drainage projects.*' With the assistance of the Advisory Panel (which unanimously confirmed the need of further research), DRI presented a 5-year extension proposal '*to increase the number of skilled DRI staff and skill depth of already trained staff, replace available equipment and procure some extra equipment for carrying out new research.*'

The proposal hardly addressed the key issues raised by the evaluation mission. Upon instigation of the Netherlands, a Proposal Addendum was prepared putting greater emphasis on institutional strengthening and on achieving technical and financial self-reliance.

The concept of a joint DRI/EPADP project management unit was again discarded by the DRI which claimed full control over project funds. Subsequently in July 1995, the Netherlands dropped the joint management concept and approved the amended proposal on condition that detailed plans would be prepared to: (i) reach the institutional development targets mentioned and, (ii) eventually phase-out external technical and financial support.

It is too early to assess the project's effect on institutional development. The project team has produced an excellent Inception Report. Apart from providing a comprehensive review of DRI's research record for the first time in 20 years, the team prepared a logical framework matrix describing objectives, activities, inputs and outputs and a time-framework of the much advocated institutional development plan. For the first time also, the programme was established on the basis of organised workshop sessions with the

principal 'clients'. Specialised expertise was brought in to assist in the preparation of a procedures manual and a staff development plan. While focusing more on organisational sustainability, however, the project design did not address the fundamental problem of financial sustainability.

B. Re-use of drainage water

The drainage water re-use programme included two projects: the Re-use of Drainage Water Project (RDWP) implemented between 1983 and 1995, and the Re-use Monitoring Programme. The latter was originally included in the RDWP, supported as a separate project between 1988 and 1990, and continued in 1995 in a different form as the Monitoring and Analysis of Drainage Water Quality Project (MADWQP).

The history of the Re-use of Drainage Water Project dates back to the early period of the Netherlands–Egyptian development co-operation programme and the creation of the Advisory Panel on Land Drainage. During this period (1977–79), the Egyptian Government announced ambitious plans for reclaiming new lands along the Eastern and Western fringes of the Nile Delta in an effort to provide additional land resources for the expanding population. The politically inspired initiative forced water resource planners to reassess the country's water balance and to reconsider investment priorities accordingly. Early in 1978, the World Bank-financed Master Plan Study for Water Resources Development and Use was commissioned. Its objective was to prepare a comprehensive package of measures and proposals to rationalise water use in general and, in the process, to accommodate the new demand for water in the agricultural sector. One of the expert missions of the Advisory Panel also stressed the need for basic research in this field and argued for the development of a mathematical water balance model for the Delta.

The overall objective of the project was '*to supply the GOE with the information on location, quantity, suitability, and expected future changes of drainage water resources in the Nile Delta required for the utilisation of these resources in such a way that the envisaged land reclamation programmes can be implemented to the maximum feasible degree, with the minimal possible effect on the productivity of the new and old agricultural lands.*'

The immediate objectives were: (i) to assist DRI in setting up of a drainage water measurement network to keep record of the quantity and quality of drainage water at some 100 key points on the drainage network in the Nile Delta, and (ii) to develop a comprehensive mathematical model describing relations between irrigation and drainage for the analysis and testing of alternative national water management strategies.

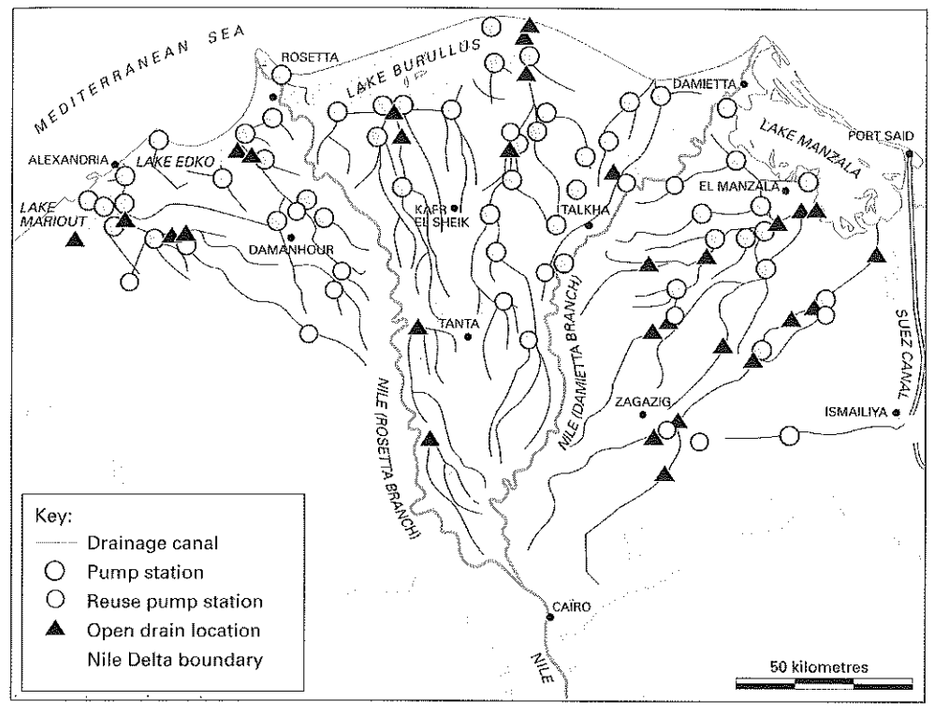
The *drainage water monitoring system* was completed early in 1986, although there was some delay due to the late arrival of expatriate experts, the late ordering of measuring instruments and equipment and the absence of reliable calibration measurements for most of the observation points. Time and manpower constraints also forced the project team to scale down the number of observation points from 100 to 78. Subsequently, a regular measurement and data processing routine was realised. More importantly, a team of 8–10 DRI engineers was directly involved in the set-up and maintenance of the measurement network and successfully trained in computerised data filing and processing.

An attempt was made to regionalise the measurement programme and maintenance of the monitoring network in order to reduce the high recurrent costs. Training courses were organised and supporting equipment was ordered for five teams to operate under the authority of the regional offices of the Irrigation Department. However, MPWWR over-ruled the plan and decided that responsibility should stay with DRI. Project files do not reveal the grounds on which that decision was taken.

In 1988, the re-use monitoring programme became a separate project due to uncertainty about the continuation of support for the re-use model exercise and DRI's difficulty to finance running costs. During the 1988–90 period, the measurement network was gradually expanded from 78 observation points to 98 in the Delta and 20 sampling locations in Fayoum (see Map 3). At the end of project implementation time (December 1990), the monitoring programme was incorporated into DRI's regular schedule of operations. The DRI had difficulty in raising its recurrent cost budget, however, and the data collection operation continued to rely on project rest-funding. More importantly, the planned and long overdue measurement recalibration programme was delayed because of staff shortages. As a result, the quality and reliability of flow data suffered.

Roughly five years after it had been phased out, the Netherlands support for DRI's Re-use monitoring programme resumed in August 1995 under the *Monitoring and Analysis of Drainage Water Quality Project (MADWQP)*. Following publication of the national Environmental Action Plan in May 1992, the World Bank proceeded with the preparation of detailed Terms of Reference for high priority projects related to water resources management. One of the projects proposed was the Water Quality Monitoring Planning for Water Quality Management project which envisaged expansion and strengthening of water monitoring activities and capabilities at three institutes (Nile Research Institute, Drainage Research Institute and Research Institute for Groundwater) and strengthening of the planning capabilities of the MPWWR.

At the level of DRI, the general objective of the new project proposal was '*to complement the on-going monitoring programme by expanding and upgrading the network for measuring the quality of drainage water by introducing modern technology for monitoring and data collection, storage and retrieval.*' The specific objectives were: (i) to set-up and implement an integrated network to monitor drainage water quality; (ii) to develop mathematical models to support water management, maximising re-use of drainage water of acceptable quality; (iii) to publish regularly data and data interpretation reports and; (iv) to enhance research capacity at DRI.



Map 3 Drainage measurement network Lower-Egypt

By the time the IOB review was completed, the project team produced its Inception Report describing the background, present monitoring capabilities and 'environmental status' of the drainage system, and the project's approach and methodology. The project design did not provide for increased 'financial' ownership by the recipient organisation DRI. In bearing the full recurrent and replacement investment cost of the integrated monitoring programme (including sharply increasing laboratory costs), the project virtually sanctions another three-year period of DRI's heavy reliance on external funding.

Implementation of the *Re-Use Model* element of the project was a painful exercise. From the beginning things went wrong so rapidly that the substance and realism of the identification and formulation process was called into question. As early as 1984, it was

observed that there were insufficient DRI fellows to participate in the exercise and that the DRI computer was not adapted to the complex data manipulation required, and DGIS failed to recruit a systems expert on time. At the beginning of 1985, the modelling team chose to develop its own, rather sophisticated water distribution simulation model. In so doing, it turned the relatively straightforward re-use forecasting exercise into an integrated water management and planning effort. Difficulties in collecting basic data, for example on existing irrigation and cropping systems, forced the team to reduce the geographical coverage to the Eastern Delta.

In October 1987, i.e some 3 1/2 years after the start of the project, the team claimed that the model had been formulated and programmed on the computer system and that DRI researchers were trained in application of the model for the evaluation of water management strategies. Progress reports contrasted with the picture that emerged from internal file reviews and interviews. In fact, the modelling team continued to face serious problems in testing and calibrating the model. Key DRI engineers gradually lost confidence in the outcome, while expatriate experts felt increasingly frustrated and isolated in carrying the exercise through its most critical phase. The testing and transfer of the model to the DRI computer was not completed and there was no written documentation on the model and its various sub-routines. The Advisory Panel also expressed concern '*about the complexity of the model and its influence on the use of it for the study of water management options in the Delta.*' Also an external evaluation mission criticised the formulation report for over-estimating the results and under-estimating the efforts required. It referred to the model as a comprehensive framework for further analysis of the processes related to irrigation and drainage in the Nile Delta but the water supply part was still a poor representation of the actual system and produced unrealistic results. On the institutional side, the mission noted that Advisory Panel members were not informed about the details of the project, that the model was largely developed in the Netherlands and, that the transfer of know-how and operational skills to DRI was not achieved. Winding up, the mission recommended a further extension of project implementation time in order to simplify the model, to finalise documentation, to calibrate and install it on the DRI computer and to complete the training programme of the DRI engineers. The mission invited the Advisory Panel to set up a small Steering Committee to ensure a more effective control and provide better technical guidance.

The new proposal was subsequently approved and the final testing and calibration of the Eastern Delta model took place in a much more relaxed atmosphere. The Steering Committee was instrumental in re-establishing good working relations and, more importantly, in raising the awareness and commitment of MPWWR as the ultimate beneficiary of the exercise. The final report was presented to the Advisory Panel at the end of 1990.

The report opened the door for approval of a follow-up covering two new simulation exercises for the Middle and Western Delta areas during the period 1991–93. The sequel also made it possible to improve the re-use model by cross-checking statistical information on non-agricultural land use and cropping areas with satellite images and to continue staff training.

Early in February 1995, the Monitoring Committee reported that (i) the software package (SIWARE) for the Middle and Western Delta had been duly tested and validated; (ii) the DRI and MPWWR staff was well trained and capable of applying and further developing the SIWARE software, and (iii) the package had successfully been transferred to DRI's newly installed computer system. A 12-year 'testing' period came to its final close.

5.2.4 Assessment

Results

The support programme was instrumental in building-up DRI's capability in applied drainage research. DRI staff were properly equipped and trained to set-up and conduct field drainage investigation experiments. The Re-use Model exercise was satisfactory insofar as (i) the mathematical simulation model SIWARE for the forecast of drain discharges and salinity, was developed, calibrated and validated, and (ii) the know-how and computer software was transferred to the DRI and the Planning Sector of MPWWR. In principle, the model is a valuable tool in assessing the impact of different water management scenarios on parameters such as crop productivity, soil salinity and drain discharges.

The programme was also instrumental in setting-up a drainage water monitoring network to measure quantities and salinity of drainage water. Project objectives were achieved within reasonable time and budget limits. During the period 1983–90, DRI staff was properly equipped and trained to collect instrument readings, to calibrate and repair measurement instruments and to process the data. The yearbooks are reported to be in great demand but no information is available on their actual use.

In general, the programme contributed to the establishment of DRI as the country's leading research institution in the field of land drainage. More specifically, the assistance programme was instrumental in: (i) setting-up and building capabilities in applied field drainage research; (ii) setting-up and maintaining a drainage water monitoring network to measure quantities and salinity of drainage water in the Nile Delta and Fayoum; and (iii) developing a mathematical model to assess the impact of different water management scenarios on the quantity and quality (salinity) of drainage water discharges.

Through the publication of research articles and attendance of international conferences, DRI gained stature in the international scientific community and established a valuable network of international contacts.

In the end, the DRI research programme had little effect on the progress and quality of EPADP's field drainage programme and the MPWWR planning system. There are several reasons for this limited impact. The research was often of a scientific nature and the presentation of the findings did not stimulate their use by executing agencies. Research results were often late in coming and confirmed the validity of current practices. The tested 'modified layout' for rice-growing areas was not implemented because no satisfactory solution could be found to the organisational problem of how to operate and maintain control structures in the field drainage system. The synthetic envelope programme did not get off the ground until 1992; it had methodological shortcomings and has yet to produce practical guidelines. While advocating the usefulness and relevancy of the re-use model exercise, neither the MPWWR Planning Sector nor the Irrigation Department, both principal end-users, have a water resources planning tradition in which the model is likely to be optimally used.

Sustainability

The programme focused mainly on transfer of technical know-how. Relatively little attention was given to the improvement of general conditions such that the continuity and the learning effects of the research would better be guaranteed. Among the most important problems affecting the maintenance of high-quality research capability are the difficulties in developing good research policies, obtaining funding and commissioned research and developing structured relations with clients. A second set of problems involves centralisation of decision-making authority, staff compensation, staffing and career development policies, and administrative capabilities. Ultimately, the long period of donor support has not resulted in a stronger financial position for DRI, which still depends for a substantial part of its recurrent expenditure on external assistance. In fact, donor-funded research projects are an important instrument with which to finance DRI recurrent costs and to supplement the salaries of its staff.

In the early 1990s, Egypt and the Netherlands came to recognise that the main shortcoming in their co-operation programme was the lack of attention given to the 'broader set of institutional capability issues'. Whether the ultimate objective of the present project, i.e. '*ensuring the permanent availability of a good quality research institute responding to the questions and problems arising from drainage practice in Egypt*' will be achieved, is uncertain. Details of the plan have yet to be worked out and Government's commitment to back it up with (substantial) financial and administrative support is not documented. All

in all, this is a less than satisfactory perspective in the context of a 20-year development effort.

Over the years, attempts to develop and maintain a research capacity in the drainage sector have been inhibited by a lack of supporting policy on the part of EPADP, the organisation responsible for the execution of the drainage works. The organisation remained suspicious of research, raising questions about existing policies and practices. In many cases, it was not convinced of the relevance of the research, fearing that it would be too academic, and was inclined to rely on conventional wisdom prevailing in civil service circles. It so happened that the research and technical assistance programme was insufficiently grounded in local executive capacity and was driven mainly by the externally funded Advisory Panel and the project team itself. With EPADP consistently refusing to engage in contract research or take the lead in setting the research agenda and strategy, the DRI drainage technology research programme continued to be identified (and formulated) through regular donor procedures. While regularly emphasising the long-term character of drainage research, neither the Advisory Panel nor the project team engaged until recently in the formulation of such long-term strategy and programming of activities.

5.3 Channel Maintenance Research Institute

5.3.1 *Background*

The Channel Maintenance Research Institute (CMRI) was established in 1975, under the name of Weed Control and Channel Maintenance Research Institute (WCCMRI). It then had a small research nucleus of 5–10 engineers and scientific staff advising MPWWR on channel maintenance technologies and on ways to increase the efficiency of channel maintenance operations. As such, it was part of the Water Research Centre (WRC). Since 1981, it owns and operates the Delta Breeding Station, a Government grass carp production and rearing research and training centre, built at the foot of the Delta Barrage.

By and large, the core of the CMRI is formed by three research departments. The *Weed Control Department* carries out research on manual, mechanical and chemical weed control methods. The *Design of Open Channel Department* studies the hydraulic efficiency of irrigation and drainage channels under different flow conditions. On the basis of these studies, the *Channel Maintenance Department* develops methods by which to increase the hydraulic efficiency of channels.

In 1975, the Netherlands-financed weed control research project was the main vehicle for strengthening the Institute's research capacity and capability. By 1985, it had evolved

into a middle-sized research organisation with a scientific staff of 20–25. The phasing-out of Netherlands technical assistance and financial support, described below, was a major setback. Follow-up support was originally secured under the US$ 70 million World Bank/ USAID-financed Channel Maintenance Project. However, the project loan agreement became effective in 1988 only and its implementation was less than satisfactory. In December 1990, the Egyptian Government decided to ban the use of herbicides for weed control, thus confounding the whole project design which was based on combined use of herbicides and mechanical weed control. Since then, CMRI depended on meagre annual Government budget allocations listed in Table 5.4.

Table 5.4 Channel Maintenance Research Institute—Recurrent and investment budget expenditures (in LE 1,000)

	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Salaries	150	160	170	188	190	210	240	310
Operational costs	6.0	6.0	6.0	6.0	6.0	7.2	6.8	5.8
Investments	156	198	140	258	177	n.a.	n.a.	n.a.

Source: National Water Research Centre.

Apart from low salaries and compensation levels, the most precarious development has been the Government's difficulty in securing funds necessary for operating and maintaining the infrastructure, more particularly the Delta Breeding Station. At present, scientific research is scaled down to a bare minimum. Apart from running the Delta Breeding Station, the main activity consists of organising lectures and courses for MPWWR staff.

5.3.2 *Programme characteristics*

The *Aquatic Weed Control Project (AWCP)* was one of the first major projects financed under the Netherlands development co-operation programme in Egypt. At the time (1975), a regular project identification and appraisal procedure did not yet exist and the initial allocation was committed solely on the basis of a MPWWR request to review its current mechanical/chemical channel maintenance practices and to evaluate various technical weed control techniques and options. Eventually, the project marked the establishment of CMRI, which was designated as project counterpart organisation. In the face of important institutional and financial constraints, mechanical weed control research was soon abandoned and the project focused on biological weed control by grass carp. The objective of the follow-up *Grass Carp Project (GCP)* was to assist CMRI in formulating and executing a research programme into the technical and economic feasibility of artificial grass carp breeding and biological weed control in Egypt. Pending the building of a new Governmental breeding station, the research programme was conducted under the

Mechanical weed control in irrigation channel

authority and with the assistance of the Aquaculture Research Department of the Suez Canal University, Ismailiya.

Early in 1981, the Netherlands honoured the request that technical and financial support be extended to the new Delta Breeding Station. For four years, the *Delta Breeding Station Project (DBSP)* assisted CMRI in setting-up the first large-scale breeding experiments and raising grass carp fingerlings to stocking size. Channel restocking experiments failed, however, and the Netherlands involvement in biological weed control research was phased-out in 1985. Eight years later, in 1993/94 a contribution was made towards the most urgent repair requirements of the breeding station.

The Netherlands financial contribution to the CMRI weed control research programme totaled Dfl. 16.4 million. A breakdown by project and time period is given in Table 5.5.

The respective projects were designed to transfer scientific and engineering knowledge through daily on-the-job training and formal training programmes in weed control in general and biological weed control in particular, in the Netherlands and in Egypt. The investment component covered research infrastructural needs such as fish hatchery and fish breeding station equipment. While CMRI covered the basic salary expenses of its staff, it relied heavily on project financing to retain trained staff, keep its research infrastructure

Table 5.5 Channel Maintenance Research Institute—Netherlands aid contribution 1975–94 (in Dfl. 1,000)

	TOTAL	1975–80	1981–83	1984	1985	1986	1993	1994
Weed Control Project	7,420	6,720	600	100	0	0	0	0
Grass Carp Project	4,743	2,171	2,572	0	0	0	0	0
Delta Breeding Station—Phase I	1,750	0	1,671	79	0	0	0	0
Phase II	1,980	0		1,300	510	170	0	0
Delta Breeding Station Rehab.	513	0	0	0	0	0	183	330
TOTAL	16,406	8,891	4,843	1,479	510	170	183	330

Source: DGIS.

in operational condition and, most importantly, cover the (relatively high) recurrent cost of its breeding station.

5.3.3 *Implementation*

The activities supported comprised three projects: mechanical weed control, biological weed control and the establishment of a breeding station for grass carp.

Aquatic Weed Control Project (1975–80)

The project allocation of Dfl. 5 million was financed from the first development loan by the Netherlands to Egypt and directly negotiated between the Egyptian government and a Dutch consulting firm.

During a three months inception phase, current channel maintenance practices were inventorised and a comprehensive research and testing programme was formulated. During the implementation phase various methods for mechanical weed control were tested. Activities started with the tendering of mechanical equipment and materials. The tendering, customs clearance and transport procedure was cumbersome and project activities were suspended for more than a year (some equipment arrived two years late). After the laborious process of ordering and importing the equipment, the test period was marked by constant mechanical breakdowns, lack of motivated operators, shortage of spare parts and inadequate maintenance facilities. Eventually, the consultant prepared a '*plan to improve the physical shape of canals (and drains) including embankments and drains gradually over a period of 20 years*.' This involved the decentralisation of MPWWR's current channel maintenance operation by expanding the number of public excavation companies (from 3 to 9) and providing them with a standard set of new maintenance equipment. MPWWR showed no support for the plan and the research institute was unable to carry the research effort forward on its own. Towards the end of the testing period, all equipment was transferred to a public excavation company and the mechanical weed control research programme was shelved indefinitely.

The Institute's bureaucratic procedures and lack of trained counterpart staff also upset the biological weed control experiments. The first (June 1977) was a total failure. Almost 40% of the first batch of the imported adult grass carps died within a day and the stock of fry was insufficient to allow a full-scale raising experiment. The second release (September 1977) was better prepared but the results were inconclusive because part of the fish population was poisoned by unauthorised dumping of chemicals. A third experiment was carried out on the premises of the aquaculture research unit of the newly established Suez Canal University, Ismailiya. With assistance from the project, some 30,000 imported carp fry were successfully raised.

When the end of project implementation time ended in February 1979, it was clear that much more research and development work needed to be carried out before grass carp could be introduced on a large scale in Egypt and that the Institute was insufficiently staffed and funded for that work. In consultation with CMRI, the Consultant worked out a proposal for 3 1/2-years extension in which to develop adequate breeding techniques and to prepare the first field experiments.

Grass Carp Project (1979–83)

Following a brief round of (positive) consultations, the Netherlands approved the Grass Carp Research Plan without modification, early in 1979. The objective was to assist in: (i) the establishment of a complete grass carp breeding station at Suez Canal University, and (ii) the preparation of a long term ecological research programme to determine optimum stocking rates and the effects on different types of aquatic vegetation.

The project's framework was not clearly defined. Formally, CMRI was the implementing agency but the setting of guidelines was entrusted to an Advisory Committee supervising a project team composed of expatriate consultants, CMRI and Suez Canal University staff.

Progress accounts show that the collaboration with Suez Canal University contributed to successful implementation of the breeding programme. Less handicapped by bureaucratic rules and regulations, the University's breeding station was quickly upgraded and by mid-1979 the first artificial breeding experiments were being successfully conducted under guidance of the team of expatriate advisers. By the end of the project period (July 1982), the technique had been firmly established. In addition, the technique of rearing fry to a stocking size was further improved and a grass carp feeding diet was developed on the basis of locally-available ingredients.

Beyond the breeding stage, the picture was less auspicious. The floating-cage rearing-units had to be moved on several occasions because of chemical poisoning while weed control monitoring and stocksizing experiments again failed due to intensive fishing and chemical contamination.

The performance record was depicted by an external evaluation mission visiting in June 1982. The breeding experiment was assessed as quite successful. With regard to the weed control monitoring experiments, the mission noted that '*there seems little point in starting on a major investment programme in carp fry production if there is no definite understanding of the proper circumstances in which they should be stocked and managed after stocking or of their capability of actually controlling weeds on a large scale under Egyptian conditions*.' The last remark was an oblique reference to the Delta Breeding Station project which had been initiated in the meantime (Zumker & Roberts, 1982).

Delta Breeding Station (1982–86/1994)

Convinced of the technical and economic feasibility of large-scale grass carp, CMRI pressed ahead with establishing its large-scale grass carp breeding station. The station, consisting of a hatchery, ponds, floating cage units and a feed production unit, was built with Government funds at the foot of the Delta Barrage and had an installed production capacity of 400–500,000 fingerlings, i.e. roughly three times that of Suez Canal University's breeding station. The Netherlands endorsed the proposal without further appraisal in 1978. This decision to support the station implied the discontinuation of the ongoing Grass Carp research programme with Suez Canal University (which was formally phased-out in 1982).

By mid-1981, halfway through the Grass Carp project implementation period, Delta Breeding Station was more or less operational. With the aid of the Netherlands consultant, the Institute prepared a financial and technical assistance request '*to help with the development and operation of DBS in the first two years*.' The objectives of the project were: (i) to raise the annual output of the breeding station to 400,000 carp of stocking size, and (ii) develop a proper organisational framework for the large scale introduction of grass carp by the Irrigation Department and in the respective Irrigation Districts.

The history of the project was almost identical to that of the preceding Grass Carp project. By and large, the objective of establishing the new and relatively large-scale breeding facility was achieved. Following completion of the work and installation of the (project-financed) hatchery equipment, the first breeding experiments in 1982 yielded some 50,000 fry. In 1983, the first year of full-scale operation, production amounted to

some 200,000 fish of stockable size. In September 1983, Egyptian staff was in full control of the breeding operation.

The successful production was overshadowed by stagnation of the restocking programme conducted in a series of irrigation and drainage channels of the neighbouring Mansouriya district. In fact, the area's entire fish stock was eliminated or disappeared because of fishing, removal of fences, illegal dumping of waste or poisonous materials, and lack of water. A final attempt was made in 1985. Optimistic expectations for a better result in the Fayoum area were again dashed. Despite its promises, the Fayoum Irrigation Department failed to inform the Institute of plans to inject the Sennouris canal with a weed control chemical and the entire fish stock was killed instantly.

On two occasions (January and September 1985), implementation problems were placed on the agenda of bilateral consultations. The lack of a response of the Egyptian Government demonstrated the intractable problems with which biological weed control had to cope in Egypt. In time, the Netherlands support programme was phased-out and CMRI was left with a grass carp breeding station that faced an uncertain future.

Delta Breeding Station Rehabilitation (1993–94)

Six years later, early in 1991, the Egyptian Government tabled an urgent request for the resumption of technical and financial assistance in the field of aquatic weed control. While acknowledging the problems of the past, reference was made to the Government's decision to ban the use of chemicals in channel weed/bilharzia control and to switch to integrated aquatic weed control. An appraisal-cum-formulation mission, fielded by the Netherlands in December 1991, reviewed the request for management support of a second grass carp breeding station in Aswan, built with Hungarian financial assistance. Apart from some minor technical shortcomings, the mission noted that the station's physical infrastructure was well-designed and built but that the Hungarian technical assistance was too short-term and too specific to train a completely inexperienced Irrigation Department staff. The Netherlands did not honour the mission's proposal for a small-scale technical assistance project.

Without being specifically asked to do so, the mission also formulated a proposal for upgrading the Delta Breeding Station. Referring to Egypt's newly-formulated Integrated Weed Control Plan and to involvement in the past, the Netherlands approved a contribution for rehabilitation of the breeding station and for strengthening research and training capabilities. The repair and rehabilitation work exposed CMRI's inability to secure proper funding for urgent, let alone regular, maintenance and repair. The renewed effort to enhance the Station's training function was unsuccessful.

5.3.4 *Assessment*

Results

The rationale for the Netherlands' involvement in the weed control subsector was to assist Egypt in sustaining and increasing agricultural productivity through the removal of major constraints that hindered the performance of existing irrigation and drainage facilities, i.e. the unique ecological conditions that encourage profuse weed growth in drainage and irrigation canals and inadequate channel maintenance techniques.

The co-operation programme helped establish the CMRI as the country's principal research institution in the field of biological weed control. Through the publication of research articles and attendance of international conferences, the Institute gained stature in the international scientific community and established a valuable network of international contacts. Following the termination of technical and financial support in 1985, basic research and infrastructure staff was maintained under CMRI's regular budget.

The assistance programme was instrumental in introducing mechanical and biological weed control concepts that were entirely new in Egypt. The introduction of grass carp breeding technology in particular was a major accomplishment. The breeding station was also successful, albeit on a modest scale, in propagating biological weed control methods. The use of grass carp is reported to have been introduced in about 2% of the country's 42,000 km of irrigation and drainage channels (World Bank, 1995).

The research and development effort was not embedded in a coherent and focused national plan to restructure channel maintenance operations, bringing together the different domestic stakeholders and institutions together around a set of agreed and previously identified priorities.

Although proven to be technically and economically feasible, the new mechanical weed control concept was not implemented. A follow-up effort to have it implemented under the World Bank-financed Channel Maintenance Project (1985–94) was unsuccessful. By and large, the Egyptian Government remained unconvinced of the merits of the new concept and continued to apply the old excavation technology. Consequently, the programme did not achieve its main objectives of increasing agricultural production and reducing environmental damage and maintenance costs.

Sustainability

The programme focused on the technical aspects of mechanical and biological weed control research. Little attention was paid to the question of maintenance or consolidation

of existing capacity and the improvement of general working conditions. The principal obstacle to the continuation of activities is the lack of policy support for biological weed control in spite of the Government's formal endorsement of the Environmental Action Plan in 1992. Moreover, the maintenance of research capabilities is hampered by the lack of funding and of commissioned research through structured relationships with clients and financial agencies. The recent contribution towards the repair and maintenance of the Delta Breeding Station was instrumental in maintaining minimum standard of operations during the coming years. Yet it also exposed the Institute's limited ability to protect the infrastructure and manpower investments made under the co-operation programme. Meanwhile, the Ministry of Agriculture independently proceeded (with assistance of USAID) with the development of its own aquaculture research and training capability at Abassa, Sharkiya and the establishment of fish breeding stations in nearly every Governorate.

5.4 Research Institute for Groundwater

5.4.1 *Background*

The Research Institute for Groundwater (RIGW) was formally established in 1975 by Presidential Decree No. 830 which created the Water Research Centre, including its eleven research institutes. Research in the field of groundwater had started many years earlier. In 1954, the Bureau of Groundwater and Drainage was set up in the then Ministry of Irrigation, and later was divided into two research Inspectorates (Groundwater and Drainage). The Groundwater Inspectorate formed the nucleus of RIGW.

One of RIGW's initial tasks was to establish a monitoring network of observation wells, aiming at continuous recording of the levels and quality of groundwater. The Institute subsequently evolved into the country's principal multi-disciplinary research body in this field. It manages a groundwater data bank, prepares groundwater maps, and executes geohydrological studies and surveys on aquifer transmissivity and groundwater salinity conditions. It also studies the applicability of vertical drainage in the so-called fringe zones of the river Nile. Moreover, it advises government agencies on groundwater development policies for domestic, agricultural and industrial use.

Until recently, the Institute's research staff was formally organised into five more or less homogeneous groups of senior and junior scientists. Next to a *Technical Office*, the *Groundwater Management Department* initiated groundwater development plans within the framework of the national water policy. The *Hydrogeological Studies Department* identified research needs according to requests made by MPWWR or outside agencies.

The data compilation and analysis unit in this department was responsible for the operation of a computerised groundwater data bank. The *Geological, Hydrochemical and Geophysical Studies Department* carried out studies in those disciplines. The hydrogeological mapping unit in this department prepared the national and regional groundwater maps. Finally, the *Wells Department* was responsible for designing and testing of wells and aquifers. Within each department, staff was sub-divided into 'regional' groups (Nile Delta, Nile Valley, Western Desert or General).

In the actual organisation of activities, research units were formed along more specific, functional lines (e.g. well unit, computer modelling unit, geophysical unit, mapping unit). For the purpose of multidisciplinary research, project teams were established with staff from different units. Flexible though it was, the expanding network of departments, research units and project teams increasingly affected the Institute's overall efficiency and effectiveness. Early in 1994, a new organisation chart was drawn-up based on the management of both regions and functions. The Nile Basin and Desert Research Departments were charged with groundwater development research projects in their respective areas, while functional activities such as data bank, hydrogeological mapping, laboratory etc. were regrouped under the Technical Services and Information Departments.

The Netherlands-financed technical assistance programme was the main vehicle for building-up research capacity. In the process, close professional relationships developed between RIGW and the Netherlands consulting office charged with implementation of the programme. Apart from comprehensive Netherlands support, the Institute benefited from other (nation-wide) donor assistance such as the USAID-financed Irrigation Management System-Water Research Centre project and the Canadian-financed Agricultural Response Programme, mostly in the form of training fellowships and small grants for research infrastructure. RIGW is occasionally invited to participate in other donor-financed projects.

Over time, RIGW has evolved from a research unit with a relatively small staff of 25 scientists in the early 1980s into a multi-disciplinary research organisation whose scientific staff now numbers 60–65. Some 50% hold PhD and/or MSc degrees. Operating under the direct control and supervision of MPWWR, its finances are regulated by the national budgeting and accounting system. Table 5.6 shows the Institute's annual, local expenditure budget of the eight years 1987–94.

Again, the most precarious development has been the Government's inability to cover the recurrent cost of operating and maintaining the donor-financed research infrastructure. While RIGW was allowed to retain its (modest) share of own revenues for topping up basic salaries, its operation and maintenance allocation was kept constant for almost ten

Table 5.6 Research Institute for Groundwater—Annual recurrent and investment expenditures (in LE 1,000)

	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Salaries	800	840	860	880	890	930	981	1,000
Operational costs	9	9	9	9	9	9	12	11
Investments	581	615	988	4,490	1,065	n.a.	n.a.	n.a.

Source: National Water Research Centre.

years at LE 9–12,000 (Dfl. 4–6,000) per annum, totally inadequate to cover the cost of even the most elementary office or vehicle fleet repairs.

5.4.2 *Programme characteristics*

The Netherlands' involvement with groundwater research in Egypt was initiated in 1983 with manpower development and training activities under the *Hydrology Training Programme (HTP)*. This was a joint initiative by the RIGW which was looking for additional funding and technical expertise and a Netherlands consulting firm which sought to expand its activities in Egypt. It heralded a thirteen-year period of technical co-operation between the Netherlands and RIGW. The Programme's basic goal was to strengthen the Institute's research capabilities in the field of groundwater resource assessment and the formulation of groundwater development and management plans. As the scope of work widened, the extent and character of the follow-up *Development and Management of Groundwater Resources Project (DMGRP)* changed but remained focused on the institute's core activities. Following presentation of the National Environmental Action Plan in May 1992, greater emphasis was put on the environmental protection of groundwater resources and support was extended under the (on-going) *Environmental Management of Groundwater Resources Project (EMGRP)*.

From 1985 onwards, the basic manpower development and training support programme was complemented with technical assistance for applied research, particularly research into the technical and economic feasibility of combating waterlogging and salinisation by means of groundwater extraction. The research programme was initiated under the *Vertical Drainage Study (VDS)* and followed-up under the *Feasibility Study of Groundwater Development Project (FSGDP)*, later renamed *Groundwater Development for Irrigation Project (GDIP)* and ultimately extended under the *Control of Waterlogging and Salinisation Project (CWSP)*. As the changing nomination suggests, the scope of the Institute's vertical drainage research shifted from investigating the drainage aspects of groundwater extraction only to studying groundwater management problems including the use of groundwater for irrigation purposes. In doing so, RIGW gradually digressed from its

core activity—groundwater assessment and monitoring. Since there were few prospects of vertical drainage becoming an attractive proposition, the 10-year support programme was phased out in 1994.

Up to the end of 1996, the Netherlands financial contribution to RIGW totalled about Dfl. 20.1 million. The breakdown by project and time period is given in Table 5.7.

Table 5.7 Research Institute for Groundwater—Netherlands aid contribution 1981–96 (in Dfl. 1,000)

	Total	1981–85	1986–91	1992	1993	1994	1995	1996
Development and Management of Groundwater Resources								
Hydrological Training Programme	4,100	2,700	1,400	0	0	0	0	0
Development and Management of Groundwater Resources								
– Phase I	2,400	0	2,400	0	0	0	0	0
– Phase II	5,028	0	4,151	877	0	0	0	0
Environmental Management of Groundwater Resources	3,055	0	0	0	0	1,332	767	956
Subtotal	14,583	2,700	7,951	877	0	1,332	767	956
Vertical Drainage and Control of Waterlogging								
Vertical Drainage Study	450	0	450	0	0	0	0	0
Feasibility of Groundwater Devel.	972	0	972	0	0	0	0	0
Programme Aid—Pump sets	1,273	0	1,273	0	0	0	0	0
Control of Waterlogging and Salinisation	2,481	0	0	1,220	1,183	78	0	0
Subtotal	5,176	0	2,695	1,220	1,183	78	0	0
BAD programme	312	0	0	85	129	11	87	0
TOTAL	20,071	2,700	10,646	2,182	1,312	1,421	854	956

Source: DGIS.

5.4.3 *Implementation*

A. Manpower development and training

– Hydrological Training Programme (HTP) (1983–86)

The history of co-operation dates back to 1979 when the Egyptian government tabled a request for upgrading and strengthening the Institute's capabilities in the field of groundwater assessment and development. The proposal was worked out with the assistance of a Dutch consulting firm and approved by the Netherlands without further appraisal, in August 1982.

The objective of the project was formulated in very broad terms and referred to various types of training. As approved, the aim was to provide: (i) formal training through courses, seminars, fellowships and classroom exercises, and (ii) practical, on-the-job training during the three phases of a hydrogeological investigation programme (inventory, investigation in pilot area, design and execution of a pilot groundwater scheme).

Implementation started in January 1983 with a hydrogeological investigation exercise in the Eastern Delta area (see Map 4). First, an inventory of hydrogeological data was established (containing readings of some 300 observation wells). In the second phase, some 30 vertical electric resistivity soundings were made, groundwater samples were examined, observation wells were constructed (fifteen in total) and a pumping test was carried out. The original plan to execute a pilot groundwater extraction scheme was abandoned and attention was focused instead on developing groundwater flow modelling skills. The modelling was successfully introduced with results duly reported. In the process, the project was instrumental in setting-up a computerised hydrogeological data base, listing the main characteristics of observation and pumping wells, groundwater levels and borehole logs.

Outside the scope of the project but at RIGW's specific request, the consultant assisted the Institute in setting-up a hydrogeological mapping unit. Due to 'some administrative and technical difficulties', production of the first (experimental) hydrogeological map could not be completed within the time available.

Over the two-year period, a comprehensive training programme was devised and implemented consisting of internal and external courses, on-the-job training, and fellowships. At the final count, 17 courses were organised and attended by some 45 staff members.

In November 1985 an evaluation mission concluded that the programme '*had a very good impact on RIGW, stimulated and broadened the activities of the Institute and enthused the personnel.*' With regard to the formal training programme, it was noted that '*in general, the training activities have been effective—efficiency and effectivity might have been further improved if a more elaborate manpower development plan had been made before the start of the project*' (Blom, Boekelman, 1985).

– Development and Management of Groundwater Resources (DMGR) (1986–92)

The continuation of assistance to RIGW was characterised by a shift away from formal manpower training towards in-service training by means of research support. The project

was executed in two phases with basically similar objectives and sets of activities. The objectives may be summarised as: (i) to continue assisting in the execution of geohydrological studies and making a groundwater development and management plan for the Nile Delta and Valley; (ii) to prepare hydrological map sheets of the Nile Delta; (iii) to upgrade the RIGW in terms of technology transfer, and (iv) to elaborate a groundwater pollution monitoring and control strategy.

The set of activities following from these objectives included the following:

- Consolidation of the effort to set up and manage a comprehensive groundwater research data base. The entry process was streamlined and groundwater data books of all observation wells were produced for each of the eleven Governorates in the Delta.
- Work on the numerical groundwater models for the Eastern and Western Delta and for the Nile Valley was finalised as planned. The models allowed MPWWR to assess the impact of different groundwater development scenarios in the new reclamation areas and to identify new areas for irrigation with groundwater. Responsible planning authorities (MPWWR) were slow in formulating alternative groundwater development scenarios and in providing further feedback and guidance to the planning exercise. As a result, the ultimate objective of preparing a groundwater development and management plan for the area could not be realised.
- The hydrological mapping programme proved most laborious and time-consuming, and could not be finalised within the time available. It was plagued by delays in field data collection and computer processing, internal discussions on map legends and printing problems. Eventually, the effort to inventorise and map Egypt's groundwater resources was brought to a successful conclusion after the project had been extended (1992).
- The set-up of a new monitoring and control of groundwater pollution programme and the preparation of a Strategy Report also took more time than planned. Delays were partly due to the late start and partly to unscheduled MPWWR requests for special information, stretching the Institute's limited manpower resources. One of those unscheduled requests concerned the preparation of an Album of groundwater potential.

Despite the shift to in-service training, an important part of the technical assistance effort continued to go into the organisation of formal training courses and workshops on a wide range of subjects varying from borehole logging to data base computer programming. In total, some 46 staff members participated in 11 activities. For the first time, activities stretched out beyond the confines of RIGW. Under the guidance of expatriate advisers, a training-of-trainers course was developed, enabling senior staff to organise and execute a training course on groundwater extraction for irrigation engineers of MPWWR. This has since become a regular activity.

The development of new technical skills increasingly exposed the need for internal organisation and management reform. While the project was instrumental in achieving better communication between the Institute's various technical units and its management, consultant proposals to integrate their responsibilities in the existing departmental structure and to decentralise decision-making were not implemented.

The project was visited by external evaluation missions in 1988 and 1992. The 1988 mission was deeply impressed by the results achieved. In brief statements, the mission confirmed that: (i) RIGW had benefited greatly from the project; (ii) the hydrogeological maps already played a role in planning discussions; (iii) the water resources data base was fully operational; (iv) the developed groundwater models for the Eastern Delta and other areas '*proved to be of great value in planning and decision making*'; (v) from a viewpoint of manpower development, the project had been successful. The mission noted, however, that plans to adjust the internal management structure and formulate internal manpower development plans had not got off the ground (De Vries, Hassan, 1988).

The 1992 mission took a much more critical look at project achievements. On the positive side, it confirmed that '*the technical services rendered to RIGW were for the larger part sustainable and RIGW's improved ability was already demonstrated through its involvement in other project activities and its growing capability to organize training courses for third parties*.' Referring to the substantial amount of modelling work done, the mission noticed that no follow-up was given to the elaborate groundwater management studies because MPWWR was not familiar with translating research results into policy options. The mission also addressed the project's inability to ensure the organisational and management reform that was necessary to consolidate achievements in the technical field. Apart from internal factors, the technical orientation and composition of both the project team and the supervising Steering Committee were mentioned as the main causes.

– Environmental Management of Groundwater Resources Project (EMGR) (1994–)

The June 1992 evaluation mission basically endorsed the 'Environmental Management of Groundwater Resources' project. Its proposal envisaged less intensive but continued assistance in the field of groundwater quality monitoring and artificial recharge, a new water conservation technique advocated by the Advisory Panel. The final formulation of the project took a full year. The technically oriented research project was combined with an Organisational Strengthening Programme (OSP) under the guidance of an independent expatriate management consultant. As such, OSP represented the first comprehensive attempt to address the Institute's internal management and organisational bottlenecks. In the meantime, the Egypt Environmental Action Plan was finalised early in 1993 and

called for further strengthening of MPWRR and its research institutes in water quality monitoring and analysis.

As approved, the objectives of the project were to assist the Institute with: (i) the installation of a monitoring and information system for groundwater quality consisting of about 150 yearly-monitored reference measurement locations; (ii) the construction of two pilot plants for controlled artificial recharge; (iii) the execution of groundwater pollution site studies; and (iv) support in its development into an efficient, goal-directed and client-oriented organisation.

The report on implementation during the first two years, was basically positive. Initial delays in setting-up the groundwater quality monitoring and pollution studies programme were largely made up in the following stages. Geohydrological surveys were completed to identify the most suitable areas for controlled artificial groundwater recharge experimentation. In general, the prospect is that training and reporting targets in the respective technical disciplines will be achieved.

In the field of institutional development, progress has been less spectacular. As planned, the Organisational Strengthening Programme focused initially on an assessment of the present organisation. This included the drafting of job descriptions for all middle and top management positions, the development of an effective internal communication system and the introduction of a performance-based incentive system. Time was too short, however, to work out and implement internal management systems and procedures for planning, budgeting, staffing and monitoring of the research programme. Plans to assess RIGW's 'market position' and to prepare an external marketing strategy also had to be scaled down. Towards the end of the implementation period, the OSP team concluded that '*the absorption capacity of the Institute and its managerial staff was limited*' and that the (ambitiously formulated) objective had only partly been achieved.

B. Vertical drainage

– Vertical Drainage Study (1984–86)

Soon after the basic Hydrology Training Programme started early in 1983, RIGW requested support for its plans to conduct a series of studies on the technical feasibility of groundwater extraction in areas affected by excessive waterlogging and salinisation. The request was initiated and prepared by Dutch consultants seeking to extend their activities in Egypt. The Netherlands recognised that while '*there was a certain risk that Egypt probably will fail to make optimum use of the maintenance-sensitive vertical drainage instrument, a single, small contribution was certainly meaningful if only to investigate its*

feasibility.' At the instigation of the Advisory Panel, the scope of the study was widened to cover economic feasibility aspects as well. Netherlands aid represented only a minor part of the total project cost, which included a LE 3 million contribution by MPWWR for the construction and installation of an experimental well field (73 pumping wells) in the Miniya area and a small grant by the Ford Foundation for additional socio-economic studies.

The objective of the project was to assist RIGW in carrying out a study into: (i) the effects of alternative pumping regimes on the lowering of the groundwater table and seasonal changes in storage of groundwater; (ii) the suitability of pumped groundwater for irrigation, and (iii) the economic and financial feasibility of vertical drainage.

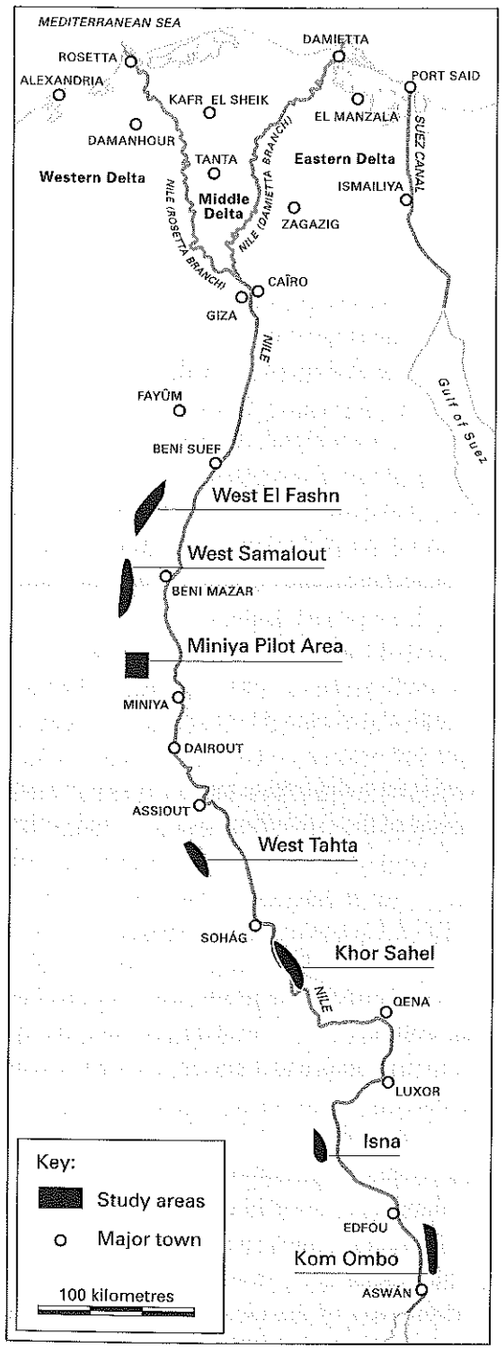
The relatively ambitious objective of the study was not realised. A theoretical model was developed based on data from geophysical surveys and groundwater observation wells. By the end of project implementation time less than half of the planned 73 pumping wells had been drilled and no pumping tests had been carried out to check the numerical modelling results and confirm the positive outcome of the technical and economic feasibility test.

Although most model predictions were believed to be near-reality, the team requested an extension of the project in order to verify the results under various pumping regimes and subsequently to work out design criteria for vertical drainage. This request was endorsed by the Advisory Panel in June 1986. Pending the extension approval, the project team prepared a well documented five-volume Final Report describing the model exercise and its preliminary results. Formulation and appraisal of the extension took a year and project implementation started in 1988.

– Groundwater Development (1988–90)

The objectives of the follow-up project were: (i) to verify earlier results with data obtained from the operation of the Miniya Pilot Area well field; (ii) to evaluate, technically and economically, different designs of well fields for irrigation and drainage, and (iii) to assist the MPWWR in developing groundwater resources.

The geographical scope of the project was widened considerably; apart from verifying and up-dating the Minyia Pilot Area Study, three more areas in the Nile Valley (Tahta, Khor Sahel and El Fashn) were added (see Figure 5.2). Implementation problems were similar to those encountered in the vertical drainage project. Models were developed for the three new areas but construction and installation of the tubewell fields to test the models were substantially delayed. In the Miniya Pilot Area, MPWWR needed some five years to complete the drilling of the 73 wells. For the El Fashn well field MPWWR was not



Map 4 Location of waterlogging study areas

able or willing to procure the planned 63 pumps. Eventually, the Netherlands agreed on the procurement of 10 mobile pump sets, the minimum required for the experiments. By the end of the project period, the models had not been checked with real field observation data.

A 1990 evaluation mission was highly critical about the lack of progress and about a proposal for an extension of financial support. It appreciated the dedication of the research team and was positive about the contribution to the strengthening of the Institute's technical capabilities with respect to tubewell drainage. However, it criticised the narrow focus of the study and the lack of effectiveness of its results. The project focused on studying the symptoms of waterlogging without paying attention to its causes: bad water management in neighbouring reclaimed areas. In addition, the mission doubted the effectiveness because of the lack of field verification and, more importantly, because two of the areas were unsuitable for tests as they were not really affected by waterlogging problems (Miniya and Khor Sahel).

The mission recommended reformulation of the extension proposal, emphasising the need to widen the scope of study and to select new and more representative areas. Reformulation of the new project proposal took considerable time because of the need to

incorporate more irrigation expertise in the research team and to refocus the research on integrated irrigation water management.

During the intervening two years 'dead period' (1990–91), RIGW continued to monitor the well fields using remaining funds from the previous phase. Following five years of tribulations, a series of five pumping tests was carried out in the Miniya pilot area well field. These confirmed expectations that, during irrigation periods at least, pumping was fairly ineffective in lowering the water table. Vertical drainage, as such, could not provide the solution to waterlogging problems unless irrigation efficiency in the higher-laying new reclamation areas was simultaneously improved.

Also during that period, tenders were launched in the Netherlands for procurement of the 10 mobile pump sets. Upon their arrival in Egypt early in 1991, the pumping experiment in the El Fashn well field was cancelled and it was decided to transfer the pumps to the neighbouring Samalut well field. Installation of the pump sets in Samalut was completed at the end of 1991 when the new project extension took effect.

– Control of Waterlogging and Salinisation in the Fringes of the Nile (CWS) (1992–94)

The objectives of the new project were ambitious, i.e.: (i) to analyse the physical, economic and socio-organisational aspects of waterlogging and salinisation in the selected areas; (ii) to assess the performance of the operational pilot well field in Samalut; (iii) to formulate proposals for long term scenarios and short-term measures for water management; (iv) to increase awareness among involved government agencies on the occurrence and causes of waterlogging and salinity problems related to desert reclamation and; (v) to improve inter-agency co-operation and exchange of data and information in relation to the planning, design and operational management of water resources on the fringes of the valley and the desert.

The new project was characterised by several organisational changes: tendering for the project resulted in a change of consultant; a Steering Committee was formed to supervise and monitor project implementation, and implementation was split into two phases, i.e. (i) data collection and review of available studies and (ii) the execution of detailed field studies.

During the Inception Phase, the new research team made reconnaissance visits to four of the areas reportedly affected by waterlogging problems (El Fashn, Samalut, Esna and Kom Ombo). It was rather surprised to find that: (i) three of the areas already had deep tubewells installed along the main irrigation canals which were either not finished or had been out of use for a long time; (ii) EPADP had almost completed the installation of horizontal piped

drainage systems in all four areas (characterised as '*an unfortunate coincidence*'); (iii) the Irrigation Department was already in the process of lining the main irrigation canals in the new reclaimed areas, thus greatly reducing conveyance losses through percolation; and (iv) waterlogging problems were less severe than originally thought, following the digging of a large number of (mostly illegal) shallow wells by private farmers.

These dramatic findings should have called for discontinuation or at least a drastic reformulation of the research programme. It was adjusted only marginally. Research continued in three of the areas, models were further developed, and pumping tests were carried out. The project even had to be extended to complete the latter activity.

Pumping tests revealed the limited scope for vertical drainage in the selected areas. Only during the winter closure period (when no irrigation takes place) was pumping of the main aquifer effective in lowering the groundwater level. During the irrigation season, the drawdown of the groundwater table was entirely compensated by a feedback mechanism in the phreatic groundwater reservoir. In some periods, the groundwater level even increased despite the pumping. Confronted with the problem that the drawdown was at its maximum when not needed (the closure period) and at a minimum when most needed (the summer irrigation period), the team concluded that '*vertical drainage evoked a lot of unnecessary replacement of groundwater*.'

The 1993 evaluation mission concurred with the research team's own conclusions and pointed out that: (i) most waterlogging problems in the selected areas were already solved at the time of starting-up the research project; (ii) the research effort by itself was well conducted and instrumental in raising RIGW's technical capabilities and in widening the area of co-operation with other research institutes and Government organisations involved in irrigation and drainage; and (iii) in studying waterlogging and salinisation problems more attention should be given to 'integrated' water management involving both surface and groundwater. The mission concluded that the project proposal '*bypassed vital information which would seem to be required for proper appraisal and final approval*.' Thereupon, RIGW decided to terminate the 10-year long vertical drainage research programme.

5.4.4 *Assessment*

Results

Historically, the Ministry has primarily been involved in developing the country's main surface water source (the Nile). Exploitation of groundwater resources was limited to

extraction for drinking water supplies and the (private) small-scale extraction of irrigation water in desert areas or tail end areas of irrigation canals.

The co-operation programme helped to establish the RIGW as the country's leading research institution in the field of groundwater assessment, development and management. Through the publications and attendance of international conferences, RIGW gained stature in the international scientific community and established a valuable network of international contacts.

In the process, a massive amount of high quality research reports, training manuals and technical notes has been produced, containing a wealth of information and data on the country's groundwater potential and on the results of the different research projects. The most important study outputs included the National Inventory of Groundwater Abstractions, the National Well Inventory, the Hydrogeological Map of the Nile Delta region, the Groundwater Development Plans for the Eastern and Western Delta and the fringes of the Nile Valley and the Album on Groundwater Potential.

In terms of impact on the Institute's technical capability, the performance record is positive. By and large, it is technically capable of carrying out most of the activities supported under the Netherlands-financed programme. With respect to the monitoring and control of groundwater pollution, capabilities are being upgraded under the current EMGR project. Apart from this, the Institute independently organises and implements high quality training courses in groundwater resource development and groundwater geology for MPWWR staff.

The ultimate relevance and effect of RIGW's work is mixed. In collecting and storing basic information on the country's groundwater resources and preparing groundwater development plans, it contributes to the formulation of national water resources policies. The programme also raised the Government's awareness of groundwater development. Groundwater maps play an important role in licensing groundwater extraction and the planning of land reclamation schemes in desert areas. Interesting enough, these maps were the kind of input which the Egyptian Government had specifically asked for.

The assistance programme has been less successful in introducing the concept of integrated water management and establishing more structured working relationships with sister research organisations in tackling the wider issues that face the country. The applied research on vertical drainage was a costly failure. Results were irrelevant for executing agencies and the only positive effect was that it raised the technical capabilities of RIGW's staff. Finally, little use has been made of the regional groundwater development plans for the Eastern and Western Delta.

Sustainability

Longer-term sustainability of the research programmes is a point of concern. Assistance has focused primarily on the transfer of technical know-how, with limited attention for the research environment. A number of problems already mentioned for other research institutes continue to affect the maintenance of a high-quality research capability.

The increased sharing of recurrent costs is an important, perhaps even the most important, constituent of project ownership. The various project budgets have invariably covered project recurrent costs and a relatively important part of the Institute's own establishment costs. Project financial agreements did not contain phasing-out arrangements of recurrent cost financing.

Recently, the Netherlands and Egyptian Governments have come to recognise that the main shortcoming in the design of the co-operation programme was the lack of attention given to the broader set of sustainability issues mentioned. The objective of turning RIGW into 'an efficient, goal directed and client oriented Institute' has yet to be achieved.

5.5 Hydraulics Research Institute

5.5.1 *Background*

The Hydraulics Research Institute (HRI) was founded in 1949 when the Egyptian Government established the Hydraulics Research and Experiment Station to study regulation and degradation problems in the Nile River basin. The station, basically consisting of an office building and three physical modelling laboratories, was built some 25 km north of Cairo, along the left bank of the Nile near the Delta Barrage. In 1975 it was upgraded into the Hydraulics and Sediment Research Institute (HSRI) and integrated into the newly-established Water Research Centre of MPWWR. In 1994, a fourth experimental hall was added and the organisation was renamed again into Hydraulics Research Institute (HRI).

HRI's organisation chart is more than 20 years old and reflects the logical division of work between the different parts of the organisation. The core is formed by four research departments. The *Physical Modelling Department* studies problems of river training, design and remodelling of hydraulic structures and coastal erosion with the help of physical fixed and movable bed models. The *Mathematical Modelling Department* develops computerised modelling techniques to simulate hydraulic and sediment transport patterns. The *Sedimentation and Hydrological Survey Section* carries out hydrographic and hydrological surveys and conducts theoretical and experimental investigations on

sediment transport in the river as well as on sedimentation in reservoirs and intakes. The *Calibration and Instrumentation Department* carries out field calibration of barrages, regulators and weirs and periodically checks their performance.

HRI maintained professional contact with numerous hydraulics research stations and organisations throughout in the world but it was not until 1985 that a more structured type of technical co-operation was established with the Hydraulics Research Station of Wallingford, Great Britain. The project was concerned primarily with the development of a mathematical model for degradation of the river Nile and was funded by United Nations and ODA/UK. In the absence of further funding, the co-operation programme was phased-out in 1988. Meanwhile, a Dutch consulting firm sounded-out HRI as to a possible technical assistance project. Over time, the project has evolved into a programme of close professional co-operation which is currently in its ninth year.

Over the years, HRI has been relatively successful in attracting and retaining qualified research staff. In the 1980s, it employed some 45–50 permanent staff, half of whom held a Masters and/or PhD degree in civil and other engineering disciplines. Staff continued to grow subsequently to the present level of 75, of whom more than half 42 (56%) hold a university degree.

Operating under the direct control and supervision of National Water Research Centre, the Institute's finances are regulated by the national budgeting and accounting system. Table 5.8 shows the annual budget allocations over the last eight-year period, 1987–95.

Table 5.8 Hydraulics Research Institute—Recurrent and investment budget expenditures (in LE 1,000)

	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Salaries	500	550	570	630	650	670	678	835
Operational costs	7.9	7.9	7.9	7.9	7.9	7.9	7.9	6.4
Investments	165	206	399	210	684	n.a.	n.a.	n.a.

Source: National Water Research Centre.

Following the announcement of economic reform measures in 1987, government policy to improve fiscal performance and control expenditure also hit the HRI. While salary allocations barely covered basic salary needs, the recurrent cost and investment budget allocations declined in real terms. Unlike most of the sister research institutes, HRI developed a close working relationship with a series of Government agencies, resulting in a steady flow of supplemental income generating research contracts. The Special Fund facility currently allows HRI to retain some LE 500,000 (Dfl. 250,000) on an annual basis to supplement basic Government salaries and investment allocations.

5.5.2 *Programme characteristics*

The Netherlands involvement with hydraulics research in Egypt was initiated in 1986 with a project proposal '*to strengthen the activities of HRI and continue a nation-wide programme for collecting and analysing field data along the River Nile.*' The proposal was thought to contribute to the improvement of water management and inland water transport in Egypt, two priority sectors in the development co-operation programme, and marked the beginning of a long term technical co-operation. By the end of 1995, some Dfl. 9.1 million of aid funds had been disbursed (Table 5.9).

Table 5.9 Hydraulics Research Institute—Netherlands aid contribution 1975–96 (in Dfl. 1,000)

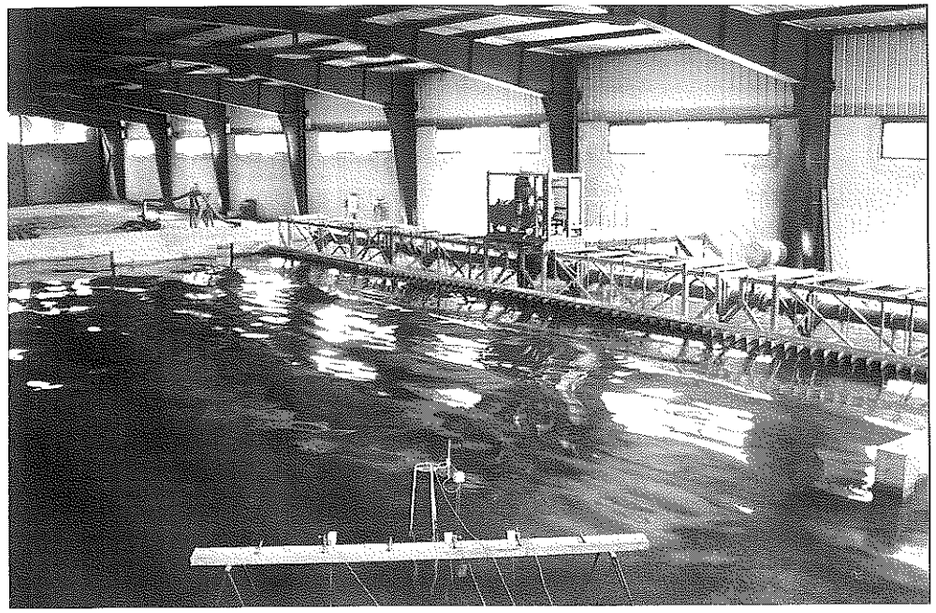
	TOTAL	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Phase I	3,577	350	423	1,381	1,121	302	0	0	0	0	0
Phase II	4,005	0	0	0	0	1,146	1,337	1,122	400	0	0
Phase III	1,550	0	0	0	0	0	0	0	350	866	334
TOTAL	9,132	350	423	1,381	1,121	1,448	1,337	1,122	750	866	334

Source: DGIS.

5.5.3 *Implementation*

The objective of the *Hydraulic Studies on the Nile River and its Structures Project (1987–)* was and still is '*to enhance the scientific and technical ability of HRI in such a way that HRI can fulfil the main objective for which it has been established, namely to solve the hydraulic problems related to the multidisciplinary use of the River Nile and its associated irrigation and drainage networks in the most efficient way.*' To reach that objective, one expatriate expert was stationed at the Institute during the period 1987–94 and a substantial number of short missions (70 in total) were carried out by specialised engineers. The formal training programme included attendance of one-year hydraulic engineering courses (10 junior engineers) and a series of short-term training missions, including management training (18 senior engineers).

Characteristic of the project was the high degree of independence and flexibility in approach. HRI directly awarded contracts to the consultant and the project operated outside the scope of the Advisory Panel. Instead, a Steering Committee advised MPWWR and the Netherlands Embassy on project progress. The flexible approach appeared from the early decision by the management team to refocus the technical assistance effort on river morphology rather than the originally selected hydraulic structures and river surveying. This meant an adjustment to the priorities of clients reflected in the large



Wave generation machine Hydraulics Research Institute (photograph: Delft Hydraulics)

number of research contracts on Nile navigation problems. Subsequently, the equipment budget was brought in line with the modified research priorities.

Missions, training programmes and modernisation of the research infrastructure contributed to the successful completion of some 85 research contracts. The vast majority of these were commissioned directly by the Ministry of Transport and Communications, the Ministry of Electricity and Energy, other government agencies and international consulting consortia.

Project performance was assessed twice by external evaluation missions. The 1990 mission came out in full support of the project's set up and its results. '*The evaluation mission has a positive appreciation of the effectivity of the various components of the Project. The Project has attained the objective. The evaluation mission is also of the opinion that the mix of instruments (components) to achieve the results was well chosen and that it would be difficult to achieve a higher efficiency (cost effectiveness).*' The 1993 mission was also positive. Judging by the high quality of the scientific publications, the many research contracts awarded and the positive appreciation of its principal clients, the mission expressed satisfaction with '*the proficiency in performance of HRI. Even though this performance is to a very high degree due to its Director and his staff, the Dutch Technical Assistance had been instrumental in attaining this level of performance.*' On the basis of

discussions with the Shore Protection Authority and the Coastal Research Institute, the mission concluded that '*there was a need for facilities to deal with experimental coastal investigations and recent developments at HRI offer good opportunities to accommodate these needs*.'

Phase III (1994–97) focused on consolidation of the Institute's enhanced research capacity and the phase-out of external support. In addition, new research methods are being developed in the fields of coastal engineering and industrial hydraulics.

HRI continues its basic and applied hydraulic research programme activities for various clients, including the Egyptian Electricity Authority, the Ministry of Transport, and MPWWR. Short-term expatriate support missions (at the rate of 2–3 per quarter) are welcome in order to monitor research methodology, to keep in touch with the latest scientific developments, and to keep the research infrastructure in good working condition. During the first year, considerable time and manpower was devoted to setting-up a Coastal Hydraulics unit. This included the installation and commissioning of the 25-meter-long wave generation machine and the training of staff in coastal engineering and morphological modelling techniques. The outcome of that investment is in doubt. Almost a year after installation, the first coastal research contract has yet to be secured. Prospects for using the facility effectively and efficiently are less than certain in the absence of any clear delimitation of tasks and arrangements for co-operation with the Coastal Research Institute.

5.5.4 *Assessment*

Results

The assistance programme was initiated and identified by a consultant from the Netherlands seeking to market technical knowhow, and the HRI soliciting additional funding for maintaining and upgrading its skills and research infrastructure. Throughout the period, HRI's research agenda was demand-driven and basically set by national and international agencies looking for expert advice and assistance in the field of hydraulic engineering. Therefore, technical training and research infrastructure needs were identified more or less on the basis of actual client demand.

In providing technical training and investment support, the co-operation programme helped to establish HRI as the country's leading hydraulics research institution. New hydrographic survey and data processing techniques were introduced and the scientific staff was acquainted with modern movable bed, industrial hydraulics, and two-dimensional flow mathematical modelling techniques.

Project objectives were basically achieved. By and large, HRI is capable of independently carrying-out studies in the field of: (i) hydrographic and hydrometric surveying; (ii) river sedimentation, degradation and navigation; (iii) hydraulic structure design and; (iv) industrial hydraulics. In addition, it independently organises and implements high quality training courses in hydraulic engineering for university and MPWWR staff. In the process, an impressive amount of quality research articles have been prepared and attendance of international conferences has enhanced its stature in the international scientific community.

The ultimate relevance and impact of HRI's work on the Egyptian economy is difficult to assess. The majority of research has been of an applied nature, commissioned by Government institutions involved in infrastructure maintenance and development, power generation and water resources development in general. The most important investment projects that have been directly or indirectly supported have included the new Esna barrage on the river Nile, the Northern, Southern and Western Cairo and Koureimat Power Plants, and the Lahoun regulator and power plant. River sediment and hydraulic studies have played an important role in maintaining navigability on the River Nile and a series of canals in the Delta. In the river transport sector, the payoff has been low due to the Government's policy bias towards road transport and to the poorly-functioning inland water transport sector that is dominated by inefficient state-owned companies.

Sustainability

Over time, HRI has acquired the know-how and research infrastructure needed for it to become an independent, quality research institution in the field of applied hydraulics. Assisted by the co-operation programme, it has further developed its scientific basis and, even more importantly, built up a structural relationship with its principal (paying) clients. In so doing, it has optimally benefited from the Special Fund facility to pay incentives to its scientific and supporting staff and reduce its dependency on the Government investment budget allocations and Netherlands investment support. Longer-term sustainability will therefore primarily be contingent on consolidating its market niche in applied hydraulics research within the country, and extending it elsewhere.

5.6 General assessment of research support

5.6.1 *General*

During the twenty years of development co-operation between Egypt and the Netherlands in the water management and drainage sector almost half of total disbursements were channelled to four research institutes under the National Water Research Centre. Support

has varied in intensity, type and duration. The Drainage Research Institute was the main recipient with Dfl. 25 million over the two decades; the Hydraulics Research Institute was the smallest recipient with some Dfl. 9 mln.

Attempts to develop the research capacity of the institutes suffered from lack of supporting policy. With respect to the Drainage Research Institute, the executing agency EPADP was not convinced of the relevance of the research for implementation practices; for the Research Institute for Groundwater, the MPWWR's traditional focus on the Nile as the main source of surface water for Egypt was a limiting factor. In addition, the introduction of biological weed control through grass carp involved the introduction of a new technique which initially was met with reluctance on the part of the irrigation departments. By contrast, the Hydraulics Research Institute's activities were demand-driven and fulfilled the need for expert advice in the field of hydraulics engineering. For the other three institutes, the research agendas continued to be set by the Advisory Panel, the donor and the institutes themselves. Identification and formulation of research activities were regulated through donor project cycle procedures.

The approach was basically project-oriented. In the absence of a clearly-formulated research policy for the sector, a series of individual technical assistance projects were identified. Co-operation with the four research institutes was based on initiatives of the Advisory Panel and Netherlands consultants, but not on any comprehensive inventory of the tasks and responsibilties of the various institutes under the National Water Research Centre and of the relevance of those tasks to the principal policy objectives of the Netherlands. Specialised consultant missions from the Netherlands were sent out to examine or suggest possibilities of technical co-operation in their respective fields of competence.

For all institutes, donor support emphasised the transfer of technical know-how, with little attention being given to broader issues of manpower development and institutional strengthening. In recent years this has situation changed and both the Drainage and Groundwater Research Institutes now pay more attention to these issues.

5.6.2 *Effectiveness*

The support provided to the research institutes under the National Water Research Centre has helped in the establishment and technical strengthening of the institutes and in the development of crucial research capabilities in the water sector in Egypt. The institutes have not only become leading research organisations in their respective fields in the country, but have also gained stature in the international scientific community and established a valuable network of international contacts.

Many research activities were of an innovative nature, such as the development of mathematical models to assess the impact of water management scenarios and the new hydrographic survey and data processing techniques. Also, the modified drainage design research was of a high scientific quality. Furthermore, the introduction of new mechanical and biological weed control methods and the grass carp technology, was innovative in the Egyptian context.

The research effort resulted in a wealth of data on groundwater potential, hydrogeological maps and groundwater development plans. The setting-up and maintaining of a monitoring network on drainage water quantity and salinity has also been an important achievement. Research results have been published in an impressive number of publications and contributions to international conferences. At the policy level, the research has increased the Government's awareness of groundwater resources and of the potential for re-using drainage water.

The main questions in assessing effectiveness is the impact that the research has had on concrete policies and activities of the executing organisations. The establishing of a drainage water monitoring network and the production of hydrogeological maps appear to have been the most useful activities. The former made a valuable contribution to government policy in optimising the use of available water resources through the construction of re-use pumping stations. The groundwater maps, produced at the explicit request of MPWWR, play an important role in licensing groundwater extraction and in planning land reclamation schemes in desert areas.

Furthermore, the impact of hydraulics research is indicated by its practical use for clients. Most of this research was commissioned to support investment projects in the field of power generation and infrastructure, such as the new Esna barrage on the Nile, the four Cairo and Kouraimat power plants and the Lahoun regulator and power plant at the boundary of the Fayoum depression. River sediment and hydraulics studies have played an important role in maintaining navigability on the river Nile.

In contrast to these positive effects, drainage research has had little impact on progress and quality of the field drainage programme (see also next chapter). The mathematical model exercise has not yet been used in water resources planning and hardly any use is made of the groundwater development plans. Moreover, the vertical drainage research programme was terminated after ten years because of the limited scope and relevance of this type of drainage. Finally, the weed research programme did not result in biological weed control becoming a widely practiced form of weed control in Egypt.

The main reasons for this rather disappointing effectiveness were:

- The lack of relevant results. In many cases, the outcome of the research confirmed current practices in Egypt or the findings of similar types of research undertaken elsewhere in the world (pilot areas drainage research).
- The long period needed to undertake the research and the late availability of research findings (drainage criteria and synthetic envelope research).
- The scientific and rather complicated presentation of research findings, insufficiently adapted to the practical needs of executing agencies (data books without analysis, complex mathematical models, envelope materials with too many options for a wide range of different soil types).
- Insufficient co-ordination with executing agencies in designing the research and in carrying-out practical experiments (construction of pilot research areas, grass carp stocking experiments).

5.6.3 *Efficiency*

The efficiency of support to the research institutes is assessed with regard to the main phases of the project cycle: preparation, implementation and monitoring and evaluation. In general, efficiency was low in all phases.

On the whole, project identification and formulation took an inordinate amount of time and manpower. Documents hardly exposed the role of organisations involved in the sector and providing complementary support, such as the executing agencies under the Ministry of Public Works and Water Resources and the Ministry of Agriculture. The documents also usually lacked any review of available manpower resources, needs for training and other forms of manpower development for the institutions involved, and the activities of other donors. Programming of project activities and output was often over-optimistic and did not address institutional constraints.

The package of activities combined long-term on-the-job technical training, short-term advisory missions and investment support in office equipment, laboratory and field instruments and transport facilities. The relative weight of the various components differed per institute. For the Drainage Research Institute there was a heavy component of resident consultants over a long period of time. For the Hydraulics Research Institute the emphasis was on short-term specialised missions. The latter form appeared to be much more cost-effective.

Project design usually did not contain phasing out arrangements or a gradual increase in the sharing of recurrent costs by the recipient organisation. Finally, project design

neglected the mobilisation of various crucial executing agencies in field experiments and in the application of research results.

Implementation also showed a number of deficiencies. With the exception of the Hydraulics Research Institute, implementation was characterised by serious delays and a consequent sub-optimal use of available manpower and financial resources. The main reasons for the delays were the over-optimistic planning, shortcomings in project formulation, and inadequate implementation arrangements with supporting government agencies. The rigidity of organisational structures and the tenacity of bureaucratic regulations in Egypt's public sector also played a role.

By and large, working relations between institute staffs and expatriate consultants were very good, and consultant teams were staffed with competent and highly motivated local and expatriate experts.

In general, monitoring performance has been deficient. The Netherlands Embassy heavily relied on the judgement of the Advisory Panel, which was not officially assigned any monitoring task before 1983. Later, the Panel was hampered in its execution of that task as it largely consisted of persons involved in one way or another with the implementation of activities. In several cases the setting-up of a special Steering Committee improved monitoring quality. The committees for the HRI and for the Re-use model under DRI may serve as examples.

Evaluations had a rather limited effect on improving the quality of the respective research support programmes. During the period 1975–85 activities were not evaluated at all. Then, evaluations were at first superficial and more oriented towards continuaton of the project rather than assessing performance. The quality of the project evaluations improved considerably during the 1990s.

5.6.4 *Sustainability*

The sustainability of the results of technical assistance to the research institutes is rather doubtful. The programme has focused mainly on the transfer of technical know-how with little attention being given to the long-term issues of institutional strengthening and financial viability. Among the most important conditions for maintenance of a high quality research capability are the design of good research policies, the obtaining of funding and commissioned research and the developing of structural relationships with clients. Recently, the National Water Research Centre has produced a long-term and comprehensive research plan for its affiliated institutes, which also forms the basis of government

funding. In addition, most institutes have expanded their volume of contract research in recent years but only the Hydraulics Research Institute was in a position to build-up a structured relationship with its clients and to reduce its dependency on government budget allocations and donor support. Sustainability will primarily be contingent on consolidating its market niche in applied hydraulics research inside the country and extending it abroad.

The focus on the transfer of technical know-how in the technical assistance programme explains the limited attention given to long-term sustainability, such that the continuity, learning effects and the constituency of research are guaranteed. Recently the Egyptian and Netherlands governments have come to recognise this principal shortcoming in the design of the co-operation programme. By integrating an Organisational Strengthening Programme and specialised generic skills in the on-going research programme, efforts are made to consolidate the research capability of the Drainage and Groundwater Research Institutes.

Some factors that influence sustainability are largely outside the control of the research institutes. They include central decision-making procedures, rigid staff and career development policies and low salaries.

6 Drainage Sector Support Programme

6.1 Background: the Egyptian Public Authority for Drainage Projects (EPADP)

In 1972, the Egyptian Government decided to merge the Nile Delta Drainage Authority (NDDA) with the Egyptian General Authority for Drainage Projects which was responsible for drainage in Upper Egypt. Accordingly, the Egyptian Public Authority for Drainage Projects (EPADP) was established by Presidential Decree in February 1973 with responsibility for executing all drainage works in Egypt. This decision was strongly influenced by the fact that a second IDA/World Bank credit for drainage, this time in Upper Egypt, was under consideration and the World Bank did not want to deal with two organisations. Secondly, a unified organisation would best meet the need to utilise top management more fully and would ensure more efficient use of construction equipment and repair facilities.

EPADP was given comprehensive responsibility for the field drainage programme. This included collection of data, planning of projects, preparation of designs, contracting and supervising the installation of pipe drains, monitoring the impact of drainage, budgeting, and operation of project accounts. In 1979, responsibility for open drains was transferred from the Irrigation Department to EPADP to improve the allocation of funds, supply of equipment and co-ordination of activities. The change-over was also prompted by the fact that drainage directorates consist of contiguous geographic drainage units, while irrigation directorates and districts are administrative units.

EPADP is headed by a Chairman with the rank of First Under-Secretary, who reports directly to the Minister of MPWWR. While the basic concept has not changed significantly since the creation of EPADP, the Authority has expanded greatly with the widening of its operations. In 1996, EPADP employed about 6,600 permanent staff in its headquarters and regional offices, up from some 3,600 in the mid 1970s when the field drainage programme was launched. Of these, some 700 are civil, mechanical and agricultural engineers, and another 1,100 are technical supervisory staff.

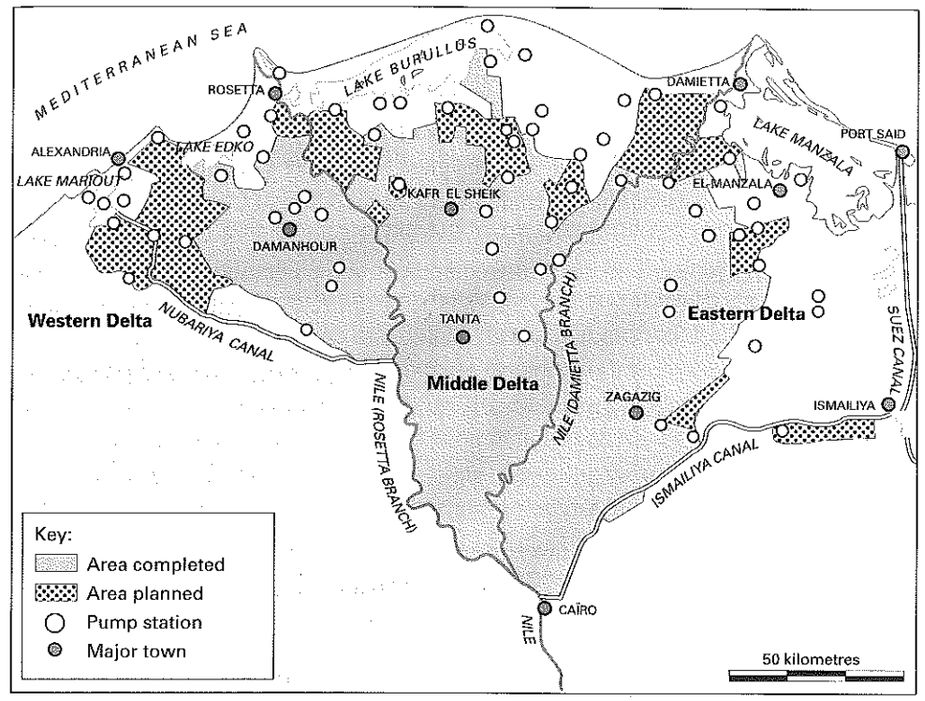
Some EPADP functions are centralised at its headquarters in Cairo. The Directorate General Planning and Follow-up is responsible for preparing 5-year plans, annual work programmes, budgeting and monitoring implementation progress. The Research and Design Department is responsible for all pre-drainage investigations, the design of field drainage works, the procurement of equipment and for pipe plants. Also, administrative and financial functions are centralised under EPADP's Administration and Finance Department.

Most of the implementation of project and maintenance works is decentralised to the regional directorates. In 1990, a re-organisation promoted both the decentralisation of powers and the more effective use of manpower and other resources at the regional level, thus ensuring better communications and the control of field operations.

EPADP has been able to achieve an average annual construction rate of about 170–190,000 feddan during the past decade, covering areas within and outside the World Bank financed projects. The area covered (up to 1996) and planned to be covered (up to 2,000) is shown in Map 5. While this was a significant achievement, progress within the WB-financed areas has been only about 60–70% of appraisal expectations. The shortfall caused time overruns of two to four years over scheduled implementation. While one could argue that the expectations were optimistic, each project could have been better implemented with the resources available. In general, delays were caused by weaknesses in EPADP construction planning and management as well as by the low implementation capacity of the public and private sector contractors. In the public sector, contractor performance was affected by excessive Government regulations. The main handicap for the private sector was the lack of foreign currency and capital resources.

6.2 Programme characteristics

The Netherlands involvement in the drainage sector was initiated in 1976 under the Advisory Panel for Land Drainage Project (APLDP). At the time, the technical assistance effort focused on strengthening the research function of the Drainage Research Institute rather than on solving EPADP's implementation problems. Research support was complemented by direct financial assistance to EPADP for the procurement of drainage construction and laboratory equipment under the *East Bahr Saft Project*. Towards 1982, the *Training Programme for Drainage Projects (TPDP)*, was formulated to improve EPADP's construction planning and management practices and increase its design, monitoring and supervising capabilities. The scope and intensity of training was subsequently improved under the *Drainage Executive Management Project (DEMP)*. Again, the technical assistance effort was complemented with a financial contribution to EPADP's on-going



Map 5 Sub-surface drainage

drainage construction programme (*Drainage V* co-financing arrangement with the World Bank).

On the final count, the financial contribution by the Netherlands to EPADP and the Egyptian drainage construction sector during the period 1975–96 totaled almost Dfl. 42 million. A breakdown by major component and time period is given in Table 6.1.

Table 6.1 Netherlands development co-operation contribution to EPADP and the Egyptian drainage sector, 1975–96 (in Dfl. 1,000)

Project	Total	1975–80	1981–85	1986–91	1992	1993	1994	1995	1996
East Bahr Saft Drainage	9,867	7,427	2,342	98	0	0	0	0	0
Drainage V	9,877	0	0	9,877	0	0	0	0	0
PVC raw material	2,980	0	1,855	1,125	0	0	0	0	0
Training Programme	640	0	640	0	0	0	0	0	0
DEMP	18,270	0	0	7,053	961	1,867	2,551	2,893	2,945
Associate experts programme	260	0	0	0	0	0	130	130	0
TOTAL	41,894	7,427	4,837	18,153	961	1,867	2,681	3,023	2,945

Source: DGIS.

Out of that Dfl. 41.9 million, some Dfl. 22.7 million was spent on direct investment support and Dfl. 19.2 million on technical assistance. The latter programme basically provided resident manpower/short term consultancy (40%), formal training (30%), office infrastructure support (28%) and a minimum of operational costs (2%). In essence, the technical assistance programme was designed to transfer scientific and engineering knowledge through daily on-the-job training and through formal training programmes in drainage technology either in the Netherlands or in Egypt. The investment component covered the cost of project vehicles, office equipment, computers and drainage machinery for training purposes.

6.3 Implementation record

6.3.1 *Investment support*

The Netherlands provided direct investment support for two drainage projects, a bilateral project in East Bahr Saft and a joint co-financing project with the World Bank (Drainage V).

– East Bahr Saft Drainage Project

Following the 1975 high-level Netherlands mission, which marked the beginning of the co-operation programme, EPADP solicited financial support for the procurement and testing of new drainage machinery. At first, a Dfl. 1 million contribution was committed '*to be used for the purchase of a trenchless drainage machine and a pvc pipe production unit.*' This initiative was soon followed by a more elaborate proposal to finance a 'Project for the development of new drainage techniques'. Apart from new heavy drainage machinery, this included provisions for foreign technical and management expertise. Under the rules then governing the utilisation of loan funds, further questions were not asked by the Netherlands and, in January 1976, the allocation for a pilot project in the East Bahr Saft area (Eastern Delta) was set at Dfl. 7.6 million.

At this stage, the objectives of the project were: (i) to support the Government in its effort to alleviate waterlogging and salinization problems; (ii) to introduce modern drainage technologies and techniques enabling EPADP to step up the implementation speed of the drainage programme; and (iii) to upgrade management skills of local contractors through a joint-venture with an experienced foreign contractor.

Following the commitment of funds, EPADP launched a tender in the Netherlands for execution of the project. The one offer of Dfl. 23.5 million far exceeded engineering

cost estimates. This prompted EPADP to ask for tenders for the drainage equipment package only and to use the normal local contractor tendering for execution of the drainage works. A review mission estimated the cost of the whole project (including execution) at Dfl. 11.1 million. This included the first collector laying machines in Egypt and a pvc pipe production unit with spare parts and raw materials. The mission insisted on the involvement of foreign (i.e. Netherlands) expertise in the execution of the project and EPADP agreed to a separate tender for contractor services by a Netherlands–Egyptian joint venture. On the mission's recommendation, the Netherlands revised the budget allocation to Dfl. 10.4 million. While the equipment tender progressed, that of the joint-venture contractor services limped through an indecisive period of discussion and negotiation. The logjam was eventually resolved by the Netherlands, softening its position (in June 1978) when it agreed to the traditional tendering of local contractor services and execution under the supervision of an expatriate expert. A drainage expert was assigned to assist EPADP in planning and organising the work, to examine execution of the drainage works by the contractor and to advise EPADP on the quality of the contractor's performance. The commitment of Dfl. 10.4 million, which included a Dfl. 2.8 million technical assistance component, was not amended and the entire allocation was made available for the procurement of equipment.

Table 6.2 East Bahr Saft Drainage Project—Equipment deliveries and value (in Dfl. 1,000)

Items	Value	Items	Value
1 pvc pipe production unit 850 tons of pvc powder	3,138	4 truck trailers	485
8 lateral pipe laying machines	2,499	spare parts pvc plant	47
3 collector laying machines	1,262	spare parts pvc plant	124
2 truck tractors	542	6 motor pumps	111
4 gravel trailers	249	other equipment	393
350 tons of pvc powder 2 tons of purge powder	768	technical assistance	249
TOTAL			9,867

Source: DGIS.

The technical adviser spent most of his time in solving logistical and technical problems affecting construction of the pvc plant and the deployment of drainage machinery. In fact, it took almost two years to have all the drainage machinery delivered on site and the pvc production unit operational. In the meantime, the Egyptian contractor could do nothing other than start to lay collector pipes manually. By the end of 1980, the original time of project completion, some 50% of the collector network and 25% of the lateral network was in place. On the assumption that the project would be completed during 1981, the contract of the expatriate adviser was extended on a short-term visiting basis.

Technical problems with the pipe laying machines persisted during most of the year, however, and implementation was further delayed. The expatriate adviser paid a final visit to the project in March 1982, when most of the technical problems with drainage machinery were solved.

The Bahr Saft drainage project was eventually completed at the end of June 1983, some seven years after being identified and earmarked for financing under the co-operation programme. The Netherlands did not follow-up the final completion of the construction works and hence missed the opportunity to assess the ultimate impact and to draw the lessons from the project. In the absence of monitoring reporting at the EPADP level, no information was (and is) available on the quality of contractor performance or on the installed drainage network itself.

– Drainage V Project (1988–92)

In 1984, soon after completion of the East Bahr Saft, preparations started for the World Bank financed Drainage V project. This covered 465,000 feddans in the Nile Delta and 84,000 feddans in Upper Egypt.

At appraisal, the Drainage V objective was to increase farm production by reversing the deteriorating salt and water balance in the areas and to strengthen EPADP through an investment package. The project involved: (i) the remodelling of some 668 km of existing surface drains; (ii) the installation of 3,900 km of subsurface collectors and 46,200 km of field drains with associated field and outfall structures; (iii) the construction of 9 maintenance centres and 90 subcentres and the provision of maintenance equipment; and (iv) training and technical assistance to EPADP. At the time of appraisal, no co-financing by the Netherlands Government was envisaged; the project cost was to be shared between the World Bank (US$ 68 million), the African Development Bank (US$ 28 million) and the Government of Egypt (US$ 102.1 million).

Shortly after the WB loan became effective in February 1987, the Netherlands started discussions with EPADP on possible co-financing. The initiative was inspired by alarming reports on the poor state of maintenance of the drainage equipment supplied earlier by the Netherlands under the East Bahr Saft project, by delays in approval of the contribution of the African Development Bank (ADB) and by attempts to accelerate Netherlands aid disbursements. The offer of a Dfl. 10 million cash grant, was readily accepted by EPADP and, with the assistance of the World Bank, a '*carefully selected*' list of goods was prepared ensuring '*that the components to be financed by the ADB remain unaffected*' (World Bank, 1987).

After formal commitment of the funds, EPADP repeatedly revised the equipment list. More complications arose when part of the list could not be procured in the Netherlands and the Netherlands Procurement Agency was brought in to supervise the tender for those items. Furthermore, EPADP's own tendering procedures lacked transparency and disputes continuously arose over the quality of goods delivered. By the end of 1990 less than 60% of the budget had been disbursed. Implementation continued to be plagued by a host of technical and organisational problems until well into 1992 when the last orders were placed and EPADP had issued most of the payment authorisations.

In retrospect, implementation was inefficient. Judging from World Bank review documents, procurement problems were endemic for the entire Drainage V project and were caused by complicated procurement guidelines and the superficial assessment of equipment needs by the World Bank. Problems are best illustrated by the following comparison of equipment needs identified at appraisal and actual purchases under the Drainage V project.

Table 6.3 Drainage V—Drainage construction and maintenance equipment—Planned and actual types of equipment procured

Item	Planned	Actual	Actual sold to contractors	Actual Netherlands contribution
Draglines	12	10	0	0
Hydraulic excavators	100	41	1	0
Bulldozers	29	5	0	0
Collector layers	16	9	9	2
Lateral layers	50	27	27	8
Laser equipment	45	0	0	0
Tractors	263	305	0	0
Flushing equipment	31	305	0	25
Mud/booster pumps	263	305	0	0
1 Mobile water tanks	0	255	0	0
Wheelloaders	21	35	0	0
Forklifttrucks	0	10	0	0

Source: WB Drainage V Implementation Completion Report. June 1995 and EPADP.

Apart from contributing to completion of the drainage works, Netherlands' participation allowed the Egyptian Government to reduce the World Bank loan by the equivalent of US$ 5 million (from US$ 68 to US$ 63 million) and to reduce debt service charges accordingly.

6.3.2 *Institutional development*

– Training Programme for Drainage Projects (TPDP) (1984–85)

Until 1982, the activities of the Advisory Panel for Land Drainage Project had focused on improving the drainage research capability mainly. The research bias was somehow broken in September 1982 when the Panel noted that '*EPADP should receive its appropriate share in the training facilities offered through the activities of the Panel*' and supported EPADP's initiative to formulate a comprehensive training programme.

As approved, the objective was to improve the quality of the execution of drainage and optimize the use of available manpower and equipment by training EPADP staff and Drainage Contractor personnel.

The project was largely executed according to plan. By the end of the project (July 1985), 18 senior and 10 junior staff members had attended 2–6 weeks training courses on the planning and execution of drainage works given in the Netherlands. An in-service training team, consisting of two Netherlands and three Egyptian instructors, traveled to the 10 regional directorates. During their 3–4 weeks stay, the team identified the most urgent training needs and organised on-the-job training sessions on subjects such as surveying, laying of tile drains, manufacturing and transportation of concrete collector pipes and pvc laterals, maintenance of drainage machines and quality control of work. The regional courses were attended by a total of some 460 EPADP and contractor personnel.

Rounding off the project, the Advisory Panel considered '*the preliminary results acceptable*' but recommended closer co-ordination with the MPWWR to make better use of their courses on quality control, operation and maintenance and management of irrigation and drainage projects.

– Drainage Executive Management Project (DEMP) (1986–)

The Training Project functioned as a pilot exercise which marked the beginning of a long period of co-operation and continues until the present day. The follow-up Drainage Executive Management Project was carried out in separately financed phases. Its objective was to strengthen the drainage executive manpower of EPADP and the contractors in order to improve and accelerate the implementation of the national drainage programme.

Initially, the approach was similar to that of the previous training programme: a combination of courses in the Netherlands and in-service training by mobile teams visiting the regional directorates. In 1988, when an extension proposal was presented, and in spite of a positive external evaluation and the Panel's approval, the approach was critically reviewed

by the Netherlands. The Netherlands explicitly criticised the lack of any comprehensive analysis of actual training needs and of arguments justifying expatriate support. Asked for a second opinion, an advisory committee of the International Agricultural Centre (then the Netherlands advising body for agricultural projects) confirmed that stand and concluded that the proposal failed 'to elaborate on the reasons why the activities were still warranted and the quantitative improvements in EPADP which the project expected to bring about.'

Central issues in the requested reformulation included the transfer of junior staff training to Egypt, the procurement of heavy drainage machinery for training purposes only, and the design of a manpower development plan identifying basic problems and future training needs. The reaction in the final proposal was to 'continue to offer the previously started training in parallel with manpower development planning'. The Netherlands softened its position and the original document was only marginally modified.

The main change materialised in the construction of a Drainage Training Centre (DTC) at Tanta which became operational in mid-1991. The Centre had a staff of 25 technicians and trainers and was equipped with modern training tools and drainage machinery. Subsequently, the in-service training of the mobile teams was integrated into the regular DTC programme. In 1995, DTC received its thousandth trainee; with support of the project, the number of standard training courses was increased, tailor-made courses were developed and the building infrastructure was expanded.

In addition, the design office of the Field Investigation and Research Department was upgraded with the installation of computer equipment, refitting of the reproduction and dark room, the development of Geographical Information Systems software, and the establishment of a Directorate for Management Information Systems. Short-term management courses in the Netherlands were continued.

Finally, in the early 1990s, a modest beginning was made with formulating the much advocated long-term manpower development plan. Initial efforts concentrated on establishing an institutional framework by setting-up a high-level Unit for Development, Education and Training which was charged with preparing a general policy paper on human resources development. This was a lengthy process but ultimately EPADP management endorsed the proposal to establish a full-fledged Human Resources Development Unit under direct authority of the Chairman. A data base system was set-up containing personal data of all EPADP staff, and a comprehensive training plan was completed.

Further progress in the sphere of human resources development and general management stagnated. At the end of 1995, establishment of the Human Resources Development Unit

had still not been sanctioned by the Government's Central Agency for Organisation and Administration, and introduction of a computerised Management Information System was delayed because the consultant found difficulty in developing a suitable system. Early in 1996, the newly-recruited Netherlands–Egyptian consortium of management consultants had yet to present its proposal and final plan of implementation.

The impact of the project on EPADP's performance has been an issue of regular debate. The consultant stated in his reports that the training had a positive impact on the quality of drainage works. Little impact was noted on drainage machinery maintenance and productivity because most of the equipment was relatively old and prone to breakdown. The introduction of computerised design and project management techniques was thought to be successful insofar a small core of staff members was capable of producing much better quality designs and maps.

The 1987 and 1991 evaluation missions had great difficulty in measuring impact and provided little or no factual information on effectiveness. Nevertheless they concluded that the training had a considerable impact on drainage implementation (1987), and that the Drainage Executive Management Project contributed to improving EPADP's organisational structure. Also, the Advisory Panel was generally positive about project performance and impact. Asked for a second opinion, the World Bank (IPTRID desk) came out in 1992 in full support of the project but was critical of its impact, noting that 'EPADP's project performance indicators have remained extremely low, which should be of concern to DEMP and its sponsors'. DGIS took a critical stand when extension proposals were presented, but eventually gave its approval and continued financial support.

6.4 Assessment

Results

Since its establishment in 1973, EPADP has evolved as the technically capable and relatively well-managed authority of MPWWR charged with construction and maintenance of the national drainage network. During the period 1976–82, EPADP benefited from advisory support under the Panel project, but that support was too scattered to have a lasting effect on organisational performance. In 1983, a regular training programme was identified in response to specific requests of the Advisory Panel and the World Bank that EPADP's management capabilities be enhanced in order to speed up and improve implementation of the field drainage programme. Supported by the Netherlands, substantial numbers of senior and junior engineers in EPADP and the contractors were trained in surveying, construction management, quality control, operation and maintenance of

drainage machinery, pvc pipe production, computerisation of design, planning and follow-up work, and modern printing and drawing techniques. In the process, a massive amount of high quality technical reports and training manuals was produced. In general, EPADP and contractors' staff appreciated the training effort which was seen to boost working morale and motivation. By far the most important achievement was the establishment of a self-sustainable, in-house technical training facility (the Drainage Training Centre) and of a Human Resources Development Department to carry the training assistance effort forward into the longer-term future.

In financing the East Bahr Saft project, the Netherlands made a (small) contribution to implementation of the national drainage programme. The ultimate objective of installing field drainage in the 40,000 feddan area was achieved. After withdrawal of expatriate technical assistance, project completion was not followed-up. No further information is available on construction quality and the functioning of the system since that time. The drainage machinery was reported to have been transferred to the (public sector) contractor but information on the transfer modality and utilisation could not be traced (the machinery was decommissioned in 1990). The pvc pipe production unit was a good investment. Now almost thirteen years old, it is near the end of its technical and economic life and on the point of being decommissioned.

The Drainage V co-financing contribution covered 4% of the total project cost. In quantitative terms, the overall objective of installing field drainage in an area of approximately 550,000 feddan was achieved. The WB and ADB loans were closed in March 1994 and December 1995 respectively. In this case also, there has been no follow-up. The Netherlands-financed drainage machinery was reportedly transferred to public and private sector contractors, but details about the transfer modality are not known.

Until recently, the focus of the technical assistance was mainly on the transfer of technical know-how. Relatively little attention was paid to the broader range of internal and external institutional constraints that affected EPADP's functioning and performance and, consequently, the impact of the technical training effort. The most important constraints include: (i) uncertainty about (national) funding for the drainage programme in general and for operation and maintenance of the network in particular; (ii) the lack of a structured relationship with the farming community; (iii) inadequate staff compensation and rigid staffing and career development policies; (iv) restrictive Government regulations governing the tendering and execution of construction contracts (Law No 9); and (v) excessive Government dominance limiting the self-management and productivity of public and private sector contractors. The latter factor is gradually becoming of less significance as a result of the Government's privatisation policy.

While acknowledging the pervasiveness of some of the institutional constraints mentioned, project and World Bank appraisal documents noted a positive impact of technical assistance on improving EPADP's performance. The actual evidence of such impact is rather thin.

In the final analysis, the goal of speeding-up the implementation rate of the field drainage programme through new technology and improved management has partially been achieved. Table 6.4 demonstrates that there has been a gradually upward trend in the annual implementation rate but the original (ambitious) target of 300,000 fedddan/year has not been achieved.

Table 6.4 EPADP—Field drainage programme progress (in 1,000 feddan)

	pre-1970	70/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	TOTAL
NILE DELTA												
Nile Delta I	0	950	0	0	0	0	0	0	0	0	0	950
Nile Delta II	0	400	0	0	0	0	0	0	0	0	0	400
Drainage V	0	1	7	127	75	98	85	59	10	0	0	462
NDP	0	0	0	0	0	0	0	12	40	55	71	178
Netherlands	0	44	0	0	0	0	0	0	0	0	0	44
Canada	0	0	0	0	1	5	9	12	10	14	0	51
GOE	550	82	95	47	27	14	12	9	46	34	50	966
UPPER EGYPT												
Up. Egypt I	0	300	0	0	0	0	0	0	0	0	0	300
Up. Egypt II	0	367	34	23	12	8	14	7	0	0	0	465
Drainage V	0	0	0	4	13	27	16	5	6	12	3	86
NDP	0	0	0	0	0	0	0	2	13	12	12	39
GOE	250	23	0	4	17	21	23	24	19	16	14	411
REHABILIT.	0	32	15	15	20	20	22	35	31	37	46	273
TOTAL	800	2,199	151	205	165	193	181	165	175	180	196	4,610
average/year		129	151	205	165	193	181	165	175	180	196	147

Source: EPADP.

There is little quantitative evidence of drainage equipment being better maintained or utilised by the contractors over the years. Despite numerous efforts on the part of World Bank and the project to enhance quality control, EPADP still has no established guidelines to ensure that uniform standards of quality control are actually applied and that execution takes place in accordance with the requirements of each contract. Although systematic and verifiable information on the subject is not available, it may be expected that construction standards have indeed improved due to the experience gained by EPADP and the contractors.

The ultimate objective of sub-surface drainage is to increase crop yields through improving soil and thus crop production conditions by lowering groundwater tables and

decreasing or eliminating salinity problems. The World Bank has estimated that, in general, yields in Egypt increased by 20–30% following the installation of field drains. In economic terms, economic rate of return (ERR) estimates vary between 20 and 30%; sensitivity analysis shows that if assumed yield increases were to be cut by half, the ERR would still be above 10%; if it is assumed that there would be no fall in yields (without drainage), the rate of return would still be above 20%.

However, these figures are educated guesses based on the technical judgment of performance audit missions rather than on the type of benchmark work that that might have been expected in view of the experience of sub-surface draining some four million feddan over more than two decades.

The *pilot research studies*, discussed earlier, covered only small areas and a few crops. Although useful in helping to establish design criteria for drainage works, the information they offered on the impact of drainage on yields was partial and inconclusive. The DRI *Crash Programme*, carried out between 1978 and 1981, also did not provide a clear and consistent picture of the impact of drainage. Although, as expected, yields in pipe-drained villages were on average higher or equal to those in the non-drained 'twins', there was great divergence in individual crop and village results. The '*Ex-post Evaluation Programme*' of EPADP (1976–85) provided a continuous assessment of yield response to drainage, and ultimately covered some 600,000 feddan in the Delta and 200,000 feddan in Upper Egypt. The programme had several shortcomings. Yield figures were not related to soil and water table characteristics or other relevant parameters, and there was obscurity regarding the way in which field data had been collected and processed. Moreover, there was no comprehensive study that coherently presented the methodological aspects and results. More recent attempts to assess economic benefits, made with assistance of Cairo University's Faculty of Agriculture, again did not produce reliable information on the subject (World Bank, 1995).

In retrospect, it appears that 30 years after sub-surface drainage started in Egypt on a sizeable scale and 20 years after the beginning of the first World Bank-supported drainage project, information is still not available to answer acurately the question of the financial and economic impact of the national drainage programme. In general, however, there is a widely acknowledged consensus on the positive impact, if only reflected by farmers' explicit desire to have drainage installed in their fields.

Efficiency

On the whole, project identification and formulation has been unsatisfactory, reflected in the inordinate amount of time and manpower effort needed. Training objectives have been formulated in very general terms and programming of activities was not based on any systematic assessment and analysis of the EPADP organisation and its sectoral or national policy framework. On the instigation of the Netherlands, the formulation of basic project documents was corrected to some extent in the Inception Reports prepared by consultants after approval of the Netherlands contribution. While there was a rationale for a 'process' approach in the first stage of the programme, there was little justification for such an approach in the subsequent phases.

Identification and formulation of the two investment projects was particularly scanty. In the case of East Bahr Saft (EBS) there was little in-country commitment to the original project design (joint-venture contracting). The identification of equipment packages in both the EBS and Drainage V projects amounted merely to the allocation of free spending block grants. The East Bahr Saft investment proposal was not supported by cost–benefit analysis or a comprehensive review of equipment availability and needs. The Drainage V co-financing contribution was covered under the WB appraisal and loan covenants. The rationale for the co-financing contribution was rather auspicious, given that full funding of the project was already secured.

Implementation of the two investment projects was erratic and inefficient. The East Bahr Saft project consultant was not allowed to become involved in the mainstream of project execution, despite good official and personal relationships with the authority. Apart from imprecise identification initially, in both the EBS and Drainage V cases, the procurement of machinery and equipment was delayed by cumbersome tendering practices (non-respect of deadlines, re-opening of bids after final call, seizure of performance and bid bonds, etc), partly due to donor intervention in the procurement process.

In general, implementation of the technical assistance programme was characterised by excellent working relationships between the expatriate and local consultants and the EPADP staff. Through the respective projects, a valuable twinning-type relationship was built-up. Training activities addressed a wide range of relevant subjects, while the acquisition of modern computer facilities and training instruments enhanced the quality and efficiency of the assistance effort. Throughout the period, training programme implementation was affected by problems in recruiting consulting staff and delays in administrative approval of project documents. The situation improved considerably after establishment of the Drainage Training Centre at Tanta.

Drainage Training Centre—Tanta

In general, project design was satisfactory, providing not only for the transfer of technical know-how but also for the building-up of a self-sustaining in-house training and human resources development capability. By so doing, a valuable effort was made to consolidate the benefits of technical training in the longer term future.

The Netherlands was formally charged with supervising, monitoring and evaluation of the co-operation programme. In practice, monitoring was delegated to the Advisory Panel whose role was limited to formulating (generally positive) statements on project performance, amending project formulation and advising the Netherlands on the extension of financial support. Little or no attention was paid to broader institutional issues that affected programme efficiency and effectiveness. Due to the absence of standardised performance indicators (inputs, outputs, purposes and goals), evaluative material has not been very substantive. Both the quantity and quality of data in the evaluation documents were insufficient to permit rigorous comparative analysis that would lead to generalizable lessons regarding the institutional development effort.

Sustainability

Sustainability of the drainage programme is related to cost recovery and to institutional capability. The history of the drainage programme in Egypt has been marked by intensive discussions between the World Bank, insisting on full recovery of drainage costs, and the Government which was unwilling to put an additional financial burden on the farming

community. In time, the Egyptian Government introduced legislation (Law 12/1984) to recover, over a twenty-year period, the investment costs of field drainage without interest, beginning one year after project implementation. The amounts collected increased significantly from LE 2.6 million in 1987 to LE 11.5 million in 1994, representing about 86% of total amounts due. Plans to recover operational and maintenance costs through raising the land tax, however, were blocked by political and social opposition. Land tax assessments were not adjusted to actual land market values, collections tended to lag, and coverage of the land tax system remained restricted to owners of three feddans or more. In the final analysis, the present increase in land tax revenues is estimated to represent only about 10% of the actual operation and maintenance costs of the drainage system (World Bank, 1995).

While progress was made in cost recovery at the national level, EPADP remained entirely dependent on central Government budget allocations to cover local operational and investment expenditures (foreign loans are repaid by the Ministry of Finance). In general, The Egyptian Government has given high priority to the field drainage programme and has provided EPADP with funds to continue implementing the programme and to guarantee a minimum maintenance standard. Further and substantial financial support will be required not only to keep the network in operational condition but also to renew the older parts which have reached their normal expected lifetime. In view of the importance of land drainage, it may be expected that the Egyptian Government will provide such support.

At the organisational level, the longer-term effectiveness of the technical training effort is a point of concern. As in the case of research institutes, the assistance effort has focused primarily on the transfer of technical know-how, and in that respect EPADP's capability has structurally improved. Until recently, limited attention was given to overall institutional strengthening and to changes in the management environment in which EPADP operated and continues to operate. The main institutional issues that constrain EPADP's performance are rigid staffing and career development policies, complex internal management systems, and problems of co-operation and co-ordination with other government agencies. Although serious attention has been given to the question of maintenance or consolidation of technical capabilities, further progress in the sphere of human resources development appears to stagnate.

7 Fayoum Water Management

7.1 Background

Geographical and socio-economic profile

The Fayoum is a circular depression in the Egyptian Western Desert, 25 km west of the Nile and 90 km southwest of Cairo and encompassing three sub-basins: the Fayoum depression itself, the Wadi El-Raiyan and Wadi Muwellih.

Of the three sub-basins, the major and only inhabited one is the Fayoum depression which measures roughly 45–50 km in diameter, starts at an elevation of 25 m (above sea level) at Lahoun, and spreads to the easterly and central areas of the depression as a more or less level tableland. Beyond these areas, the ground slopes away to the north to Lake Qaroun which forms the bottom of the basin, at an average level of 43–44 m below sea level.

The Wadi El-Raiyan sub-basin is a 15 km wide desert area, separated from the Fayoum to the north by a limestone ridge. With a maximum depth of 64 m below sea level, the area is used as a second, natural drainage outlet for the Fayoum depression. Since the opening of the drainage water tunnel in 1973, the lower areas of the depression have been progressively covered by two lakes.

The third sub-basin, Wadi Muwellih, is a smaller, shallower and uninhabited desert depression, southwest of the El-Raiyan depression, with no particular function.

In 1986 (the latest National Census year), roughly 1.54 million people or 3.2% of the Egyptian population were registered as living in the Fayoum. Pre-census annual population growth rates of 3–4% are estimated to have fallen to 2.5%, bringing the 1996 population figure close to 1.88 million. Population is fairly evenly distributed among the five administrative districts (markaz); densities vary between 600–750/km^2 in the more rural districts of Tamiya and Itsa and 1,000–1,600/km^2 in Fayoum, Sinoures and Ibshway districts which have urban centres of 150–250,000 inhabitants (see Map 6).