President Words

Water sector is currently facing large challenges that require combining efforts among all stakeholders towards improving the people’s quality of life and achieving sustainable development on the ground.

Scientific applied research is the driving force for the sustainable development. Human resources and their high professional capacity, research environment, updated technologies, and international cooperation are the main key elements for performing high quality applied research towards providing scientifically sound solutions to the various problems that face the water sector.

NWRC is a national research institution with regional and international cooperation essence. This cooperation is the main operation spirit of NWRC towards facing the water challenges.

Our Vision to be an international center of excellence facing water resources challenges and problems by providing scientifically sound, practical, socially accepted, economically affordable, and environmental friendly solutions.

Prof. Mohamed Abdel Motaleb
President,
National Water Research Center
(NWRC)
Historical Background

Water, as a natural precious resource, is a powerful driving force for economic growth, social well-being and a healthy population in Egypt. This critical interest is reflected in the diversity of water-related research initiatives at NWRC and its institutes. NWRC is an inter-disciplinary research Centre dedicated to furthering these interests and is committed to fostering an environment that encourages basic and applied research spanning both traditional water-related disciplines, as well as non-traditional and emerging disciplines.

At NWRC we concentrate on addressing the unique water resources system and its peculiar water management problems and issues that we in Egypt face. NWRC serves the Ministry of Water Resources and Irrigation (MWRI) to advance and expedite the implementation of the national water policy. As a MWRI research and development arm, NWRC coordinates and conducts basic and applied research to identify, characterize, and quantify water-related problems in Egypt. For these problems NWRC is mandated to provide innovative solutions and communicate them to the end users; therefore, enhance research uptake. Its role as a national organization goes beyond the MWRI; it assists the other ministries as well as the private sector facing water related problems through facilitated access to interdisciplinary expertise.
NWRC’s organization consists of twelve research institutes; basically tackling the following water resources related fields: Irrigation and Drainage, Hydraulics, Hydraulic structures and Machinery, Surface and Groundwater Hydrology, Sediment Transport, Water Quality and Pollution Control, Coastal Protection and Lake/Shore Environment, Climate Change and Geo-Measurements Analysis, Water Socio-Economics.
Water Management Research Institute (WMRI)

The Institute covers the research areas of:

- Irrigation Scheduling
- Optimal agriculture water allocation and distribution
- Socio economic impact of irrigation systems
- Assessment of performance indicators of irrigation schemes

Drainage Research Institute (DRI)

The Institute covers the research areas of:

- Functional design criteria of tile drainage network
- Testing and evaluating new technologies and materials utilized in field drainage networks
- Socio-economic impacts of field drainage networks
- Development of guidelines for the reuse of marginal water in agriculture
- Improvement of open drains self-purification capacity
Water Resources Research Institute (WRRI)

*The Institute covers the research areas of:

- Hydrologic analysis of Wadi Systems and flash floods
- Optimal design criteria for flash flood control structures and drainage networks
- Impacts of Nile socio economic development on inflow to Lake Nasser
- Optimal National Water Resources development strategy

Nile Research Institute (NRI)

*The Institute covers the research areas of:

- Assessment of hydrologic, morphologic, and quality alterations of lake Nasser
- Safety measures of river navigation routes
- Morphological changes of river islands and flood plains
- Most advantageous design criteria for river engineering works
Hydraulics Research Institute (HRI)

*The Institute covers the research areas of:*

- Hydraulic design of grand water control structures
- Physical and mathematical modeling of open channels
- Assessment of hydraulic and morphological impact of anthropological interventions on the Nile Course and irrigation canals

Channel Maintenance Research Institute (CMRI)

*The Institute covers the research areas of:*

- Control and management of aquatic weeds
- Setting design measures for open drains and channels
- Most effective techniques and methods for channel maintenance and rehabilitation
- Minimization of head, distribution and conveyance losses
Research Institute for Groundwater (RIGW)

*The Institute covers the research areas of:*

- Groundwater resources management
- Surface-groundwater interaction and conjunctive use
- Optimal planning and protection of well fields
- Assessment of groundwater potential; quantity and quality.

Construction Research Institute (CRI)

*The Institute covers the research areas of:*

- Design criteria of hydraulic structures
- Testing new materials and construction technologies
- Development of hydraulic structures safety guide lines
  Channels cross section and bank stability
Mechanical and Electrical Research (MERI)
The Institute covers the research areas of:
- Optimal design and operation of pumping systems
- Potential utilization of renewable energy in the operation of irrigation and drainage systems
- Analysis of protection mechanisms for hydro mechanical elements and pipe systems
- Development of automated control and power distribution systems

Survey Research Institute (SRI)
The Institute covers the research areas of:
- Testing remote modern geo measurement technologies
- Development cost-efficient spatial surveys and analysis techniques
- Testing and adaptation of hydro graphic surveys technologies
- Optimization of ground truth comparing
Coastal Research Institute (CoRI)

*The Institute covers the research areas of:*

- Design criteria of cost-effective environmental friendly shore protection structures
- Adaptation integrated coastal zone management
- Detecting and analysis morphological changes of shorelines
- Adoption of physical and mathematical modeling of coastal wave hydraulic interaction

Environmental and Climate Change Research Institute (ECRI)

*The Institute covers the research areas of:*

- Studying of long-term effects of climate change on water resources and environmental systems
- Design (Identification) of cost-effective measures of force adaption
- Down scheming GCM (Global Climate Models) to the regional and national level
- Analysis of environmental changes relevant to water resources system changes /interventions
Central Laboratory for Environmental Quality Monitoring (CLEQM)

The Institute covers the research areas of:

- Provide timely, high quality, analytical services at the national and regional levels
- Assist in the diagnosis of environmental problems in the area of environmental chemistry, microbiology and aquatic toxicology
- Assist with the development of water quality protection guidelines and legislations
- Train and upgrade capability of young professionals in the areas of environment and water quality

Strategic Research Unit (SRU)

The Strategic Research Unit carries out strategic research that supports the planning and management of the different water resources utilizing comprehensive approach that includes the environmental and socio-economic aspects as a basis to draw the national water policy and strategy guided by the National Water Research Center research plan pillars.
**NWRC Research Facilities**

In keeping with its integrated approach to water research, NWRC has a wide range of capabilities. Researchers should concentrate on research, not resources. Our comprehensive, state-of-the-art facilities allow them to do just that. NWRC utilizes a number of modern facilities fitted with top-of-the-line instrumentation and equipment to provide high quality support to universities, other research centers and decision makers across multiple research efforts including:

**Research Stations and Pilot Fields:**

**Meteorological research stations:** ECRI has established several stations to measure meteorological data.

**Artificial recharge research stations:** RIGW has established four experimental (Bustan, Burg El Arab, Abu simbel and Abu Rawash

**Climate, soil texture, and cultivated crops research stations:** WMRI runs ten experimental research stations provided with various equipment. These research stations were selected to represent the variations in climate, soil texture, and main crops cultivated in the entire country

**Grass carp production and weed management research stations:** CMRI manages two research stations with associated laboratories for performing hydraulic experiments and various researches related to grass carp production and weed management. These stations are located in Delta Barrage and Bahteam region.
Coastal research stations: CoRI two main research stations (Abu-Quir and Ras El Bar) and four local ones (Rosetta, Burg El-Burullus, El-Arish and Hurghada).

**Laboratories:**

Central Laboratory for Environmental Quality Monitoring (CLEQM) provides timely, high quality full-service analytical services including sampling and complete physical, chemical (organic and inorganic) and microbiological analysis for water, soil, sediment, plant and aquatic life. Committed to quality control, we provide highly accurate results through the use of state-of-the-art analytical instrumentation (ICP-MS, ICP-OES, IC DX500, GC-ECD, GC-MS, GC-FID, real time PCR…etc) and certified methodologies based on well-established, internationally-recognized procedures such as those published by the United States Environmental Protection Agency (USEPA) and the American Public Health Association (APHA), as well as local country standards. Research and Development teams are challenged to deliver on specific methodologies, which may be unique to specific client applications.

CLEQM is an internationally accredited facility since 2005 through the Canadian Association for Laboratories Accreditation (CALA). The system insures a full-scale enforcement of QA/QC program under ISO/IEC 17025-2005, general requirements for the competence of testing and calibration laboratories. To provide accurate analytical data for its clients, CLEQM analytical services are controlled through the implementation of ISO 17025. All analytical methods are regularly checked to accuracy, precision and reproducibility by analysis of certified reference standards and participation in inter-laboratory comparison programs.
Soil Mechanics and Foundations Engineering Laboratory: provides integrated geotechnical engineering services including; consulting, testing, monitoring, modelling, and all geotechnical aspects. State-of-the-art indoor and in-situ testing equipment are used to determine the basic soil properties as well as the advanced and specialized parameters of different soil and rock types. It is well equipped with state-of-the-art geotechnical devices and testing equipment that provides all facilities required to deepen understanding of the principles governing soil engineering properties and behavior (soil identification and description, particle size distribution, including sedimentation test). Laboratory equipment include up-to-date instruments such as computer controlled triaxial compression machines, mobile mechanically controlled drilling rigs provided with the necessary accessories to conduct the Standard Penetration Test, Static Cone Penetration Test, a field Vane Shear device, and Mobile Dutch Cone Penetrometer (20 tons).

Structural Modeling Laboratory: contribute to the development of society, as exhibit the solution that is solved problem occurred in the construction work place by analyzing structure by investigating soil-structure interaction, suggesting the suitable solutions and monitoring the behavior of both existing and new structures during and after construction to make sure of their performance according to the design assumptions. The lab is equipped with field monitoring instruments such as piezometers to measure the pore water pressure, inclinometers and Soundex systems to measure horizontal and vertical displacements, and strain gages to measure the strains. The monitoring tools are equipped with the required data acquisition systems and software.

Properties of Materials Laboratory: determine physical and mechanical properties of construction materials and their relationship to structural elements in addition to designing concrete mixes, suggesting quality assurance and quality control programs and executing them. The lab is equipped with universal testing machine, humidity chamber, Schmidt hammer and Ultrasonic apparatus for nondestructive tests.
**Geosynthetic Testing Laboratory:** geosynthetics that are used to solve complex engineering problems require a high level of quality and durability. This can only be assured by conducting extensive regular checks of key performance criteria according to international standards and norms under controlled laboratory conditions. The lab is equipped with universal testing machine (UTM), apparent opening size, thickness device, permittivity apparatus, Xenon-Arc type apparatus and bursting strength tester.

**Aquatic Life Analysis Laboratory:** considered good base for specialized analytical studies on the impacts of pollutants, in open water channels, on aquatic living organisms and biological control efficiency. The lab perform physiological analysis for fish and aquatic weeds in order to determine impact of pollutants, soil structure pollution analysis and water quality analysis. The analysis includes, fish physiology and diseases.

**Sedimentation Mobile Laboratory:** determine the physical characteristics of bed and suspended sediment (suspended-sediment concentration (SSC), fine/sand separation, and particle size distribution (PSD) in addition to complete chemical analysis.

**Physical Modelling Laboratory:** laboratory space at the Delta Barrage (Al-Kanater) location totaling more than 30,000 sq. meters, is the largest commercial operation in the Middle East. It accommodates models with footprints as large as 40 m by 30 m, and flows in excess of 2.0 cms, operate in-house model fabrication and instrumentation shops, and can accommodate the most intricate of model-construction requirements and the most demanding of data-acquisition and experiment-control needs. HRI has performed physical modeling for hundreds of projects over since 1947. Typical applications include (Sedimentation, Navigation, Hydroelectric, Coastal and Industrial).

**CoRI** has a physical model laboratory located in Abu Qir station with flume of 40.0×1.2×1.2 m was provided with water feeding, discharge system, power system and control room. Wave generation systems has been
**Monitoring Networks:**

**National Water Quality Monitoring Network:**
This network has been established within the NAWQAM project to present the water quality status in Lake Nasser, the Nile River, main drains, canals and groundwater aquifers where it continued after the end of the project to monitor water quality through RIGW, NRI, DRI and CLEQM facilities within NWRC budget.

The network includes monitoring the quality of surface water at 232 locations distributed along the Nile River (25 sites), Lake Nasser (4 sites), irrigation canals (59 sites), drainage canals (129 sites) and drain outfalls to Northern lakes (15 sites). A groundwater-monitoring program is well-established since 1995 for 203 locations with 60% of the monitored wells located in the Nile basin and 124 wells of the national network are located in priority areas where there is a risk of pollution.

**Meteorological Monitoring Network:**
WRRI has installed different types of stations all over Egypt to measure rainfall, temperature, humidity, solar radiation, wind speed and direction and evaporation. Water level recorders are also installed at the outlet of representative experimental basins.

**Early Warning System Network:** WRRI
Early Warning System Network: WRRI established an Early Warning Systems (EWS) that provides additional lead-time, which may reduce damages. Yet, many challenges still exist to achieve operational, accurate forecasts. Rainfall events in arid areas are hard to forecast, as they are irregular, highly variable in space and time and often highly localized. In addition, hydrological and hydraulic understanding are challenging due to insufficient insights in the response of a Wadi to rainfall events.

Databases:

Water Quality Database: Collects water quality data from 290 locations distributed along the Nile River (conducted jointly with the NRI), irrigation canals and drains (DRI). A groundwater data (RIGW) from 166 locations after being analyzed in CLEQM through the National Water Quality Monitoring Network.

The groundwater database includes data on (Well characteristics, Lithology of different layers, Chemical analysis, Groundwater depths and levels and Extraction data obtained from regular inventories of production wells). The NWRDB supports time series of groundwater chemical analysis in different labs, using different analytical methods and in different units. The system contains groundwater levels from 1955 to 2014 for over 2000 wells and over 300 000 single records. The product supports over 100 types of reports and provides easy links with commercial software for mapping and charting.
**Equipment:**

NWRC houses all types of high-quality, cost-effective scientific equipment necessary to carry out its research work including:

Environmental quality analysis equipment (Total organic carbon analyzer, Gas chromatography with Electron Capture Detector (GC-ECD), Gas chromatography with Mass detector (GC-MS), Gas chromatography with Fourier Ion detector (GC-FID), ICP-MS, Perkin Elmer Sciex, Elan 9000, ICP-OES, Perkin Elmer, Optima 5300 DV, IC Dionex-DX500, IC-Metrom and IC Dionex- DX5000, Flame photometer 410, Real time RT-PCR, Spectrophotometer, Gel Electrophoresis, High magnification power microscopes and colony counters and Stereomicroscopes) in addition to in-situ measurement equipment for:

- Dissolved Solids (TDS), and turbidity. (CLEQM)
- Mobile climatic equipment (wind, hygrometer, illumination), Gas emission equipment (ECRI)
- Geophysical Instruments (geo-electric and magnetic) (RIGW)
- Measuring and analyzing pressure, r.p.m, flow rate, power, vibration, noise, laser alignment, welding faults, electrical power variables and power quality analysis measurement devices, insulations resistance, earth resistance measurement devices, different types of variable speed drives. (MERI)
- Satellite-based GPS equipment, Gravity equipment: (D&G), Land Surveying equipment and Computer Center with all accessories. (SRI)
- Terrestrial survey, electromagnetic for measuring water velocity, echosounders for aquatic weed survey, GPS, hydraulic parameters and others. (CMRI)

**Computational Facilities:**

NWRC is highly equipped with high performance computational facilities and software including:

- **Simulation Package Tool (ANSYS ver. 14.5 &16)** - used to simulate the pump flow and give pressure, Flow-rate and velocity distribution of pump impeller and volute for different pump types.)

- **KY pipe 2000 design software** - used to Evaluating the steady state and transient state of pressure variation in pipe line system and selects the
• suitable devices of anti-protection water hammer).

• **Actwin for PLC** - used to program the PLC where any one even the technician can write the code, because it is user friendly.)

• **WinCC for Scada Systems** – used to control and monitor the automated system remotely. The supervisor could control the system using computer with this software without going to the field.) **Power quality analysis** - used to analyze the measure of all electrical parameters such as (voltage, current, active power, reactive power, power factor harmonic).

• **XPR 300 with 01 db (Metra vib.)** - used to analyze vibration spectrum for pumping stations and other mechanical machines.

• **HYPACK** - It provides hydrographic surveyors with all of the tools needed to design their survey, collect data, process it, edit it, and generate final products.

• **Beam- VISAT** - is an open-source toolbox and development platform for viewing, analyzing and processing of remote sensing raster data. Originally developed to facilitate the utilization of image data from Envi-sat’s optical instruments, BEAM now supports a growing number of other raster data formats such as GeoTIFF and NetCDF as well as data formats of other EO sensors such as MODIS, AVHRR, AVNIR, PRISM and CHRIS/Proba. Various data and algorithms are supported by dedicated extension plug-ins.

• **ILWIS** – is open-source software used for analyzing remote sensing images.

• **MD_SWMS** - Multi-Dimensional Surface-Water Modeling System (MD_SWMS) is a pre- and post-processing application for computational models of surface-water hydraulics. The GUI tool of the MD_SWMS is a sophisticated one-, two-, and three-dimensional interactive graphical user interface that is used to design and visualize all aspects of data commonly associated with computational surface water applications. This modeling system includes the following models FaSTMECH and SToRM.

• **HEC-RAS** - A one dimensional numerical model can be used for surface water. The program is window environment and easy to use. The water surface profile is calculated by the standard step method. Different
scenarios of steady and unsteady flow can be modeled. Calibration of the water surface can be carried out by adjusting Manning roughness to match real situation.

- **SMS (Water Surface Modeling System)** - It is a two dimensional mathematical model used for surface water. The program can be applied for steady and unsteady flow conditions for predicting sediment transport in the direction of main flow and in the perpendicular direction. Several applications can be modeled by SMS such as local scour around bridge piers, spur dikes and abutment. The outputs of the programs are many; such as flow velocities in two directions, discharge and water levels.

- **Mike 21** - is a one dimensional model and designed for surface water modeling. It is capable of estimating and predicting the water surface profile, and water quality items.

- **Mike 21** - is a two dimensional model developed for surface water modeling. The model is based on the finite elements method to simulate the main hydraulic equations. The model is a coupled model to predict sediment transport in rivers and water quality elements.user interface that is used to design and visualize all aspects of data commonly associated with computational surface water applications. This modeling system includes the following models FaSTMECH and SToRM.

**Library:**

Central Library of the National Center for Water Research boasts including content of the national wealth of albums and historical documents reflect the history of irrigation in Egypt is a specialized library in various areas of Water Sciences and the areas of agriculture, environment, technology and other basic science and applied engineering, science, etc. They are keen to acquire the latest scientific journals such as Science Direct, making it a model for the library supervisor sophisticated electronic.
The library contains more than 50,000 documents, including:

- Books, reports, conferences’ proceedings, scientific theses and researches.
- Rare books (such as original copy of “Description of Egypt” – “Personality of Egypt” by Gamal Hamdan – “Almaqreze manuscripts” – “Taqvim al-Nil (Calendar of the Nile)” – “Al-Jabarti’s History” – “Basics of Rhetoric - the brilliant stars regarding the kings of Egypt and Cairo” – “the greatest canal in the world Ibrahimmia canal” – “Lisan al-Arab (The Arab Tongue)” ....... etc.
- Electronic scientific periodicals such as Science Direct that includes about 2,000 journals in various water fields.
- Historical albums and maps in addition to many books about the irrigation history in Egypt. Also, it contains an album of launching Suez Canal and all the construction stages of Mohamed Ali Barrages.
- Additionally, there are many important book series; the most famous of them is the “Nile Basin”.

It is worth mentioning that the Central Library have got a “shield of excellence in performance” and award best display of Prof. Dr. Minister of Water Resources and Irrigation, during the second regional conference of the Arab water, which was held in Cairo in September April 2004 in addition that the library is proud of been selected for a “shield of outstanding Library” in 2004 by the Egyptian society for libraries and information.

Flash floods Atlases are established by WRRI as a source of general information on flash floods characteristics in the province as well as a reference in the preliminary planning and design stages of water resource and development projects. The Atlases describe the geology, climatology, hydrology, water harvesting structures and flash flood hazards. The hydrology section gives information on: drainage basins, gauges, flood zones, as well as rainfall analysis. They also include summary maps accompanied by supporting text, illustrations and photographs.

- Flashflood Atlas Sinai
- Flashflood Atlas Aswan
- Flashflood Atlas Qena
- Flashflood Atlas Luxor
**Water Science Journal:**

Water Science Journal has been published by NWRC since the early 80’s. At the end of 2013, it transferred to an open access online journal produced and hosted by Elsevier. Water Science Journal addresses both basic and applied water research, and policy issues of prime interest to the water community. The scope of the journal encompasses high quality scientific papers and original research studies in all Water Resources Related fields. In 2014 WSJ was granted the ‘Highest performance journal’ award according to several indicators set by Elsevier.

**Regional Training Center:**

The Regional Training Center of the Hydraulics Research Institute (HRI) has been established in 1995 as a response to, and a reflection of, regional training needs in the field of Hydraulics and River Engineering. The initiative to establish a regional training center was taken by the Egyptian Government with the support of the Netherlands Government and technical assistance by IHE Delft. The center offers specialized training programs at national and regional levels. Since 1996, a three-month diploma course is organized annually for professionals from all Nile basin countries on “Hydraulic Engineering of River Basins”. Short courses and tailor made on different topics of large interest for the Arab, African countries and Nile basin Countries are also organized each year. The center is highly equipped with all training facilities including; lecture rooms, computer lab, accommodation, restaurant and a social room. The Alumni trained at HRI Regional Training Center (RTC) forms a big network of professionals from more than 20 countries.
**Water Studies and Research Complex in Toshka**

The research complex in Toshka located in south of Egypt, and covers an area of 125 acres, of which about 115 acres for the experimental farm to irrigate through five modern irrigation systems (sprinkler, surface bubbler, subsurface drip, leakage and pivot). This special research unit had been established to provide technical solutions to problems raised during the development process in new reclaimed areas with special circumstances. Furthermore, to propose indicators for measuring performance progress of irrigation, drainage and ecology.

**International Relationships & Collaborative Research Projects**

NWRC has long and strong relationships of various types with many international and regional organizations and research institutions. NWRC and its staff are members in several regional and international organizations. It is one of the founding institutions of the International Commission on Irrigation and Drainage (ICID). Many of the senior and junior researchers are members in its committees and groups.

It is also a founding member of the World Water Council (WWC) and the Arab Water Council (AWC). The first Chairman of the WWC was the Chairman of NWRC and held the position for 3 terms. The same person also held the position of Chairman of the AWC since its establishment till now. The NWRC acts as the representative organization of Egypt in AWC Board.

In addition, NWRC fulfilled the positions of the Chairman and the Deputy Chairmen of the International Water Resources Association (IWRA) for 4 different terms. Besides, NWRC is also represented in the Boards of the International Commission on Large Dams (ICOLD) and the International Federation of Surveyors (FIG), the International Centre for Advanced Agronomic Studies (CIHEAM).

Moreover, NWRC received and is still receiving funding for research projects from various agencies. USAID supported the institutional development of NWRC during the period 1984-1995 by providing fellowships for researchers to pursue their M.Sc. and Ph.D. studies in US universities. CIDA contributed to the establishment and
operation of the National Water Quality Monitoring Network (NWQMN) as well as supporting the implementation of the Central Laboratory for Environmental Quality Monitoring (CLEQM) and its accreditation. JICA and The Italian Directorate General for Development Cooperation (DGDC) also contributed in the strengthening of the researcher staff skills and capacities. Funds from these donor agencies were made available for NWRC institutional development and staff advancement.

Furthermore, a number of twinning agreement had been signed and are already functional with a number of universities in different countries including USA, Canada, Japan, UK, Germany, Italy, the Netherlands, etc. Thus, many of the NWRC researchers had the opportunity to visit these universities and carry out their studies abroad either for academic degrees or for collaborative research projects.

NWRC staff are recognized for distinction and more than 30 researchers received the Academy of Scientific Research and Technology State Encouragement Award. Many researchers also received Sultan Bin Abdel Aziz Prize for research advancement and innovation. In international and regional conferences, NWRC researchers are always acknowledged for their research findings and recommendations in the field of water.