



## North Africa Regional Water Sector M&E Standardization and Harmonization Framework Report



### MEWINA

مشروع للتقييم والمتابعة لقطاع المياه بدول شمال أفريقيا  
Monitoring and Evaluation for Water In North Africa



# North Africa Regional Water Sector M&E Standardization and Harmonization Framework Report



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**Consultant:** Misr Consult for Environmental and Infrastructure Studies (Dr. Sameh Abdel Gawad)

**Main Author:** Misr Consult Team

**Supervision & Review:** Khaled AbuZeid, Ph.D., P.E.; Mohamed Elrawady, M.Sc., CEDARE

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## Executive Summary

Monitoring and evaluation (M&E) of the water sector have been considered the weakest link in progress towards achieving the Millennium Development Goals (MDGs) in Africa as it faces several challenges at the national and regional levels. Accordingly, it is required to build and develop capacities of governments and non-government agencies in North African States to cope with the challenges of data collection, analysis, monitoring, evaluation and reporting; where human resources development and capacity building could become one of the major areas of investment for the African Water Facility (AWF) over the following years.

Therefore, the N-AMCOW countries have decided to harmonize and standardize their water sector M&E framework, aiming at increasing the countries capacity in it. This is carried out through setting up an M&E mechanism that allows N-AMCOW to annually produce a periodic and hopefully unified report, such report should provide a statement on the status of water resources availability, water uses and water services. It should also address the measures adopted towards achieving goals of National Water Resources Management and National Water Supply and Sanitation Targets, using harmonized and comparable information.

Sets of indicators that may be included in the intended unified report are selected from three predefined large sets to report on water-related issues (water resources; how water is used in agriculture, industry and energy production; urban water use; water and the environment.....etc.). The largest set of the three is CEDARE / Arab Water Council List of State of the Water indicators. The second set is defined in "Pan-African Water and Sanitation Monitoring and Evaluation and Reporting Format: The Guidelines" (Pan-African G). While the third is recommended by the UN-water Task Force on "Indicators, Monitoring and Reporting (IMR). However, the selection process is mainly guided by the indicators that could be or are actually evaluated.

Selection of indicators is carried out at two levels (sets): adequate and full. The **adequate set** of indicators can only suggest an overall picture of the water sector and does not, necessarily, allow in-depth analysis leading to interventions. For almost all of adequate set indicators, data are available at the national level, and there exist regional/global information systems that could support updating them. Nevertheless, such a set can be used to illustrate global water issues. In general, the selection of indicators in each set has taken into account the following four requirements): Policy relevance, Manageability, Measurability and Analytical soundness of the data.

It is worth mentioning that the standardized definition of the key terms, used in this report and not necessarily specific to the adequate set of indicators, is a pre-requisite for the development of the standardized and harmonized sub-regional monitoring and evaluation framework. It is conceptualized to be mostly applied for the two sets of indicators. Yet, the indicators standardization guidelines target only the adequate set of indicators. The full set is not targeted by the standardization guidelines process; however, they are selected as an overreaching aspiration.

It was found that all CEDARE/AWC indicators are measurable, as sound preliminary values have already been calculated for all of them, which qualifies the current CEDARE/AWC set which is comprised of nine categories of indicators to be the adequate set. However, there are many categories in the CEDARE/AWC set that need to be expanded for a more detailed and comprehensive look at the state of the water in The MEWINA Region, especially that one of the project objectives is to develop an enhanced Monitoring and

Evaluation system in MEWINA countries beyond the current measurable indicators. Regional and National Action plans will also be developed under the project's framework, where all the technical and institutional capacities needed to assess necessary currently unmeasured indicators will be discussed. Therefore the full list of indicators will be included in a separate report.

The ultimate goal of the unified routinely produced national/regional State of the Water reports is to contribute to public information and inform decision making in the water and related sectors, including the sanitation sector, through improved monitoring, evaluation, and reporting. Progressing towards achieving this goal, it is recognized that all countries of N-AMCOW region have a national M&E systems that depend, more or less, on a basic set of indicators to provide information on all of the water resources/sector issues and aspects. However, the purposes for which that information is generated differ, which in turn influences the definition of indicators used, the specific parameters measured, and the monitoring or data collection schemes utilized.

Within the water lead ministry, in each country, a unit or administration has been identified to play the role of national MEWINA office. Such administration should have the responsibilities of water resources coordination and planning, monitoring and evaluation, or a host of a core water information system or data base. MEWINA national offices responsibilities comprise collecting, interpreting and exchanging data, monitoring, periodical reporting and coordination with MEWINA management unit at CEDARE. Periodical national reports are produced by the national office in each country and submitted to the Management unit, which is the host of MEWINA-IMS. National reports are compiled by the management unit at CEDARE in a regional report that is presented and discussed in AMCOW's meeting.

The proposed MEWINA Web Based Information System (MEWINA-WBIS) is specifically designed towards the monitoring and evaluation of water sector, both at the socio-economic and political levels. Therefore, it is updated by data and indicators that are collected periodically by national statistics office, and/or water related department (within other water concerned ministries) as well as hydrologic monitoring networks (within the authorities of water lead ministry or transboundary organizations). Therefore, it is recommended to make use of new emerging applications so-called "Web Based Information System" to design and generate reports from a wide range of data sources. MEWINA-WBIS integrates and streamlines all the required data and information elements that have been detailed in the indicators standardization sheets. This applies to either the already monitored and surveyed elements, or new elements that have to be collected to fulfill the adequate set of indicators and beyond. Therefore, the envisaged WBIS provides the comparable control and operational capabilities as those available to a user in traditional IT environment, for both the web server owner or manager (Management Unit-CEDARE) and the co-owners or clients (MEWINA national focal units) in each member country.

It is suggested to make the production frequency of the national State of the Water reports once every two years; while the sub-regional M&E of water sector report has to be issued every five years. Generally, a display (table or graph) of the indicator's time series is recommended to report quantitative indicators. For quantitative indicators, a display (table or graph) that compare the recent indicator's value with the value of the selected reference year is used to report countries progress. Governance indicators are typically qualitative; therefore, an elaborate description is to be provided for each element as expressed in the indicator definition box. Reports dissemination takes different forms: hard copy (either full report or abbreviated one), web-based report, newspaper coverage, Radio/TV coverage, and public presentations/speakers bureau.

Based on the previously proposed framework and Rapid Assessment Reports (countries and transboundaries) portrayal of the actual indicators that are reported and water M&E systems, a specific set of standardization and harmonization measurements/action are recommended for each country. A larger set of measurements/actions are common and can be prescribed to more than one country of the N-AMCOW region. Only the degree or level of implementation of such common actions will differ from one country to another.

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## List of Acronyms

ABH	Agences de bassin hydrographique (Algeria) Hydrographic Basin Agencies
ADE	Algerienne Des Eaux (Algeria) Algerian Foundation of Water
AMCOW	African Ministers' Council On Water
ANBT	L'Agence Nationale des Barrages et des Transfer (Algeria) National Agency of dams and transfers
ANGED	Agence Nationale de Gestion des Déchets (Tunisia) National Agency for waste management
ANRH	Agence Nationale des Ressources Hydrauliques (Algeria) National Agency for Water Resources
ANPE	Agence Nationale de Protection de l'Environnement (Tunisia) National Agency for Environmental Protection
APAL	Agence de Protection et d'Aménagement du Littoral (Tunisia) Coastal Development and Protection Agency
ARC	Agriculture Research Center (Egypt)
AWF	African Water Facility
AWOS	Automatic Weather Systems
BADGE	Hydrogeology Database
BASHYD	Climatology Database
BPEH	Bureau de Planification et des Equilibres Hydrauliques (Tunisia) Office of Planning and Hydraulic Equilibria
CAPMAS	Central Agency for Public Mobilization and Statistics (Egypt)
CCRMP	Climate Change Risk Management Program
CDM	Clean Development Mechanism
CERTE	Centre d'Etudes et de Recherches sur les Techniques de l'Eau (Tunisia) Research Center for Water Techniques Studies
CHIP	Children's Health Insurance Program
CITET	Centre International Tunisien des Etudes Technologiques (Tunisia) International Tunisian Center for Technological Studies
CLEQM	Central Laboratory for Environmental and Quality Monitoring
CNRE	Centre National des Ressources en Eau (Mauritania)

	National Center for Water Resources
COPEAU	Contrôle de la Pollution des Eaux (Tunisia) Control of Water Pollution
CRDA	Commissariat Régional au Développement Agricole (Tunisia) Regional Commissary for Agricultural Development
DAPE	Département de l'Assainissement et de Protection de l'Environnement (Algeria) Department of Sanitation and Environment Protection
DBMS	Database Management System
DGACTA	Direction Générale de l'Aménagement et de Conservation des Terres Agricoles (Tunisia) General Directorate for Development and Conservation of Agricultural Land
DGBGTH	Direction Générale des Barrages et des Grands Travaux Hydrauliques (Tunisia) General Directorate of Dams and Grand Hydraulic Works
DGDD	Direction Générale du Développement Durable (Tunisia) General Directorate for Sustainable Development
DGEQV	Direction Générale de l'Environnement et de la Qualité de la Vie (Tunisia) General Directorate for the Environment and Quality of Life
DGRE	Direction Générale des Ressources en Eau (Tunisia) General Directorate of Water Resources
DGGREE	Direction Générale du Génie Rural et de l'Exploitation des Eaux (Tunisia) General Directorate of Rural Engineering and Water Use
DH	Direction nationale de l'Hydraulique (Mauritania) Department of Hydraulics
DHB	Département de l'Hydrologie et des Barrages (Mauritania) Department of Hydrology and Dams
DHMPE	Direction de l'Hygiène du Milieu et de la Protection de l'Environnement (Tunisia) Directorate of Environmental Health and Environmental Protection
DHU	Direction de l'Hydraulique Urbaine (Tunisia) Directorate of Urban Water
DPCSE	Direction du Département de la Coopération, Suivi et Evaluation (Mauritania)

Directorate of Cooperation, Monitoring and Evaluation Department

DRHA	Directions Régionales de l'Hydrologie et de l'Assainissement (Mauritania) Regional Directorates of Water and Sanitation
DRI	Drainage Research Institute (Egypt)
EEAA	Egyptian Environmental Affairs Agency (Egypt)
EGA	Environment General Authority (Libya)
EMA	European Medicines Agency
ENIS	Ecole Nationale des Ingénieurs de Sfax (Tunisia) Sfax National School of Engineering
ENIT	Ecole Nationale des Ingénieurs de Tunis (Tunisia) National Engineering School of Tunis
FAO	Food and Agriculture Organization
GAI	General Authority for Information (Libya)
GDA	Groupement de Développement Agricole (Tunisia) Group for Agricultural Development
GIS	Geographic Information System
GCWW	General Company for Water and Wastewater (Libya)
GMMRA	Great Man Made River Agency (Libya)
GWA	General Water Authority (Libya)
HCPWSD	Holding Company of Potable Water and Sanitary Drainage (Egypt)
IAO	Istituto per l'Agronomico Oltremare (Italy) in Algeria's section Institute of Overseas Agronomics
IFAD	International Fund for Agriculture Development
IISD	International Institute for Sustainable Development
IMR	Indicators, Monitoring and Reporting
IMS	Institute of Mathematical Statistics
INAT	Institut National de l'Agriculture de Tunisie (Tunisia) National Institute of Agriculture of Tunisia
INM	Institut National de la Météorologie (Tunisia) National Institute of Meteorology
INRAA	Institut National de Recherche Agronomique d'Algérie (Algeria) National Institute of Agronomic Research of Algeria
INRGREF	Institut National de Recherche en Génie Rural, Eaux et Forêts (Tunisia) National Research Institute for Rural Engineering, Water and Forestry

INS	Institut National de la Statistique (Tunisia) National Institute of Statistics
INSP	Institut National de Santé Publique (Algeria) National Institute of Public Health
IRA	Institut des Régions Arides (Tunisia) Institute of Arid Regions
IRESA	Institution de Recherches et de l'Enseignement Supérieur Agricole (Tunisia) Institution of Research and Higher Agricultural Education
JMP	Joint Monitoring Program
JPEP	Joint Poverty and Environmental Program
M&E	Monitoring and Evaluation
MALR	Ministry of Agriculture and Land Reclamation (Egypt)
MARH	Ministère de l'Agriculture et des Ressources Hydrauliques (Tunisia) Ministry of Agriculture and Hydraulic Resources
MARS	Monitoring, Analysis and Reporting System
MDGs	Millennium Development Goals
MDR	Ministère de Développement Rural (Mauritania) Ministry of Rural Development
MDWSF	Ministry of Drinking Water and Sanitation Facilities (Egypt)
MEWINA	Monitoring and Evaluation for Water in North Africa
MHE	Ministry of Hydraulics and Water (Mauritania)
MHU	Ministère de l'Habitat et de l'Urbanisme (Algeria) Ministry of Housing and Urban Development
MoHP	Ministry of Health and Population (Egypt)
MRE	Ministère des Ressources en Eau (Algeria) Ministry of Water Resources
MPTIC	Ministère de la Poste et des Technologies de l'Information et de la Communication (Algeria) Ministry of Post, Information Technology and Communication
MSEA	Ministry of State for Environmental Affairs (Egypt)
MWRI	Ministry of Water Resources and Irrigation (Egypt)
N-AMCOW	Northern Region of the African Ministerial Council on Water
NBI	Nile Basin Initiative
NCM	National Center for Meteorology (Libya)

NFPS	National Company of Drilling and Well (Mauritania)
NGO	Non-Governmental Organizations
NRI	Nile Research Institute (Egypt)
NSAS	Nubian Sandstone Aquifer System (Egypt)
NWRC	Centre of Natural Water Resource (Mauritania)
NWRC	National Water Research Center (Egypt)
NWRP-CP	National Water Resources Plan -Coordination Plan
NWSAS	Système Aquifère du Sahara Septentrional (Algeria) North Western Sahara Aquifer System
OMVS	Senegal River Basin Organization
ONA	Office National de l'Assainissement (Algeria) National Office of Sanitation
ONAS	Office National de l'Assainissement (Mauritania) (Tunisia) National Office of Sanitation
ONID	Office National des Irrigations et du Drainage (Algeria) National Office for Irrigation and Drainage
ONM	Office National de Meteorology (Algeria) National Office of Meteorology
ONS	Office National de la Statistique (Algeria) National Office for Statistics
ONSER	Office National des Services d'Eau en milieu Rural (Mauritania) National Office of Water Services in Rural Areas
OTEDD	Observatoire Tunisien de l'Environnement et du Développement Durable (Tunisia) Tunisian Observatory for Environment and Sustainable Development
PTJC	Permanent Technical Joint Committee (Egypt)
QA	Quality Assurance
QC	Quality Control
RAR	Rapid Assessment Report
RIGW	Research Institute of Ground Water (Egypt)
SASS	Système Aquifère du Sahara Septentrional (Tunisia) North Western Sahara Aquifer System
SGIAR	Système de Gestion Intégré de l'Information Agricole et Rurale (Algeria) Integrated Management System of Agricultural Information and Rural

SISOLS	Système d'Information sur les Sols (Tunisia) Soil Information System
SINEAU	Système d'Information National sur l'Eau (Tunisia) National Water Information System
SONEDE	Société Nationale d'Exploitation et de Distribution des Eaux (Tunisia) National Operating Company and Water Distribution
SOW	State of Water
SOWR	State of the Water Report
SNFP	Société Nationale des Forages et Puits (Mauritania) National Company for Drilling and Well
SNDE	Société Nationale d'Eau (Mauritania) National Water Company
SYGREAU	Système de Gestion des Ressources en Eau (Tunisia) Management of Water Resources System
TARWR	Total Actual Renewable Water Resources
TOR	Terms of Reference
WBCSD	World Business Council for Sustainable Development
WBIS	Web Based Information System
WMO	World Meteorological Organization
WSS	Water Supply and Sanitation (Egypt)
WRI	Water Resources Research Institute (Egypt)
WWDR	World Water Development Report
WWTP	Wastewater Treatment Plants
UNDP	United Nations Development Program
UNEP	United Nations Evaluation Program
UNESCO	United Nations Education, Science and Culture Organization
UNIDO	United Nations Industrial Development Organization

## 1. Introduction

Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia constitute the Northern Region of Africa and are the member countries of the Northern Region of the African Ministerial Council on Water (AMCOW), commonly named N-AMCOW. Issues of sustainable development in each country are distinctive; however, the socio-economic and culture context of these countries determine the manner in which these challenges manifest themselves. This context also imposes the approach adopted by national governments to handle (deal with) them. Countries and regions are increasingly required to measure and report on their progress towards achieving sustainable development, through a group of preset indicators, to the international community.

The monitoring and evaluation (M&E) of the water sector have been considered the weakest link in progress towards achieving the Millennium Development Goals (MDGs) in Africa as it faces several challenges at the national and regional levels. Accordingly, it is required to build and develop capacities of governments and non-government agencies in North African States to cope with the challenges of data collection, analysis, monitoring, evaluation and reporting; where human resources development and capacity building could become some of the major areas of investment for the African Water Facility (AWF) over the following years.

### 1.1 Background

In September 21-22, 2006, AWF drafted a regional Monitoring and Evaluation (M&E) action plan and underscored the primacy of national M&E processes. The main recommendations of the Action Plan were that AWF, under the auspices of African Ministerial Council on Water (AMCOW):

- a) Undertake a comprehensive assessment of existing M&E systems at regional, sub-regional and national levels;
- b) Support a program for strengthening national and regional M&E capacity based on the results of the assessments; and
- c) Build on the existing M&E systems instead of creating new ones.

The N-AMCOW countries have decided to harmonize and standardize their water sector M&E framework, aiming at increasing the countries capacity in water sector M&E. This is carried out through setting up an M&E mechanism that allows N-AMCOW to annually produce a periodic and hopefully unified report, such report should provide a statement on the status of water resources availability, water uses, water services and measures adopted towards achieving goals of National Water Resources Management and National Water Supply and Sanitation Targets using harmonized and comparable information.

### 1.2 Methodology Adopted

The definitions of both standardization and harmonization processes are lent from the accounting discipline and adopted after modification, henceforth. Standardization is defined as the formulation, publication, and implementation of guidelines, rules, and specifications for common and repeated use, aimed at achieving optimum degree of order or uniformity in water sector monitoring and evaluation. The goals of right standardization can be to help, with independence of each country, reports compatibility, interoperability, efficacy, repeatability, or quality.

While harmonization process is defined as the adjustment of differences and inconsistencies among different measurements, methods, procedures, schedules, specifications, or systems to make them

partially uniform or mutually compatible. Each country has its own institutional regulations and practices; therefore, harmonization is a process of ascertaining the admitted limits of regional unification but does not necessarily amount to total uniformity.

This report builds on the findings of five National Water M&E Rapid Assessment Reports (RARs) and four trans-boundary Basin Water Assessment reports as well as the Regional Synthesis report. According to the TOR the consultant team was required to study and carefully analyze the following background documents:

- Pan African Water Sector M&E Assessment (Volume I: Main Report);
- Pan African Water Sector M&E Assessment (Volume II, Rapid M&E Assessment Template);
- The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socioeconomic Development;
- MDGs Monitoring and Evaluation for Water in North Africa: Appraisal Report;
- All documents produced by the AWF, AFB, AMCOW, WHO/UNICEF, JMP MDGs Reports and Snap Shots, the World Water Development Reports, Africa Water Development Report, Arab State of Water Report and FAO AQUASTAT;
- CEDARE / Arab Water Council List of State of the Water indicators; and
- All documents produced by selected countries regarding State of the Water, and Water M&E sector indicator, and any other relevant documents.

Selection of the two indicators' sets: adequate and full-set, is carried out by searching and screening large number of indicators listed or utilized in the above mentioned and other documents, based on prescribed criteria. Specific consideration will be given to: "The Pan African Water and Sanitation Monitoring, Evaluation, and Reporting Format: The Guidelines" report (2012), and UN-Water Task Force on Indicators, Monitoring and Reporting (UN-Water, TF-IMR) final report (2009): "Monitoring progress in water sector: A selected set of indicators" along with the CEDARE / AWC comprehensive list of SOW indicators, which covers many aspects of water resources and other socio-economic related issues. Standardized and harmonized sub-regional monitoring and evaluation framework is conceptualized to be mostly applied for the two sets of indicators.

Countries' existing water sector M&E systems, as described by RAR's, are measured up against the standardization and harmonization regional framework and M&E systems of trans-boundary organizations. National systems are calibrated individually through a cluster of country specific or general standardization and harmonization measures. Conferring the initial definition makes standardization measures primarily directed towards data collection, survey methods, indicators computation, analysis, storage, report preparation and dissemination. Whereas harmonization measures are more oriented to water sector's institutional setup, roles and responsibilities of primary and affiliated institutions, policy environment, budgets, financing mechanisms and activities of donors.

### 1.3 Report Structure and Content

The ultimate goal of this report is to contribute to public information and informed decision making in the water sector, at regional and national levels through improved monitoring and reporting. The scope of work includes the following:

- Developing standardized indicators for monitoring water sector progress and performance at regular intervals, that support both national decision-makers and N-AMCOW;
- Harmonizing water sector monitoring efforts at the regional level to improve reporting of water sector progress and performance; and
- Identifying priority actions in support of country-level monitoring in terms of how the information should be collected, analyzed and reported to be used in regional assessments.

The second chapter discusses the different categories of the available regional and international indicators. It lays out the criteria for selecting the two sets of indicators: adequate and full. The final suggested list of each set is described in details.

A standardization and harmonization framework for M&E of the water sector is provided in chapter three. The proposed framework is elaborated in terms of data and information collection, data processing and indicators computations, information management system, and reporting and dissemination.

Chapter four identifies required standardization and harmonization measures for each country to match the conceptualized sub-regional M&E framework. The report is annexed by three Annexes: Terminology and Definitions, Indicators standardization guidelines, and National and Regional Reporting format.

## 2. Target and Status of Water Indicators

There are numerous definitions of indicators according to the organization using them and how they are employed in the management practice. One of the very well-articulated definitions is the one given by the International Institute for Sustainable Development (IISD) on its web-link:

"An indicator quantifies and simplifies phenomena and helps us understand complex realities. Indicators are aggregates of raw and processed data but they can be further aggregated to form complex indices."

Many organizations employ indicators to measure their performance by focusing on small, manageable, and telling pieces of a system to give people a sense of the bigger picture of the entire management system. Indicators are used to measure trends in social, economic, and environmental systems, and help people to comprehend a regional or global panorama through small details. Performance of complex systems or trends of convoluted phenomena cannot be measured directly; therefore, indicators are aggregates of raw and processed data.

The overall goal of UN-Water's global monitoring initiative is to 'monitor the water sector performance, from the point of view of a sustainable development objective'. Rey and Vallée (2009) identified four categories of indicators:

- **Context:** Some indicators relate to the natural context (e.g. water availability, rainfall), to infrastructure (such as water treatment capacity, or storage), or to human and economic capitals. 'Context indicators' are required to act as benchmarks when assessing the achievements of another territory with a comparable context.
- **Function:** Function relates to inputs, outputs and outcomes (e.g. water use intensity). A number of indicators relate to describing the dynamic functioning of the water sector at the national level (e.g. water withdrawals, water depletion, or wastewater actually treated).
- **Performance:** Performance adds an element of evaluation. Performance assessment relates to considering the functioning of the sector in relation to its objectives and within a given context. Issues of efficiency/productivity, effectiveness and impact can be considered (e.g. access to water supply and sanitation or value added in agriculture or industry).
- **Governance:** A set of governance indicators is required to track the possible explanations behind the different levels of performance achieved between the given territory and different benchmark territories. The breadth of governance indicators must embrace territorial water resources and water uses management to provide an insightful diagnosis of possible weak spots in need of further investigation and possible improvement or reforms.

Rey and Vallée (2009) concluded the UN Initiative mandate and presented in its final report: "Monitoring progress in the water sector: A selected list of indicators," a short list of 15 "key" indicators. As shown in Table 1, the selected limited list of indicators provided the overall picture of water sector as well as embraced a set of more explicit objectives related to specific dimensions of water management (Status of Water, SOW) and related Millennium Development Goals (specifically, Goal 7). Nevertheless, this limited list of indicators did not encompass any indicator under the governance category.

**Table 1. UN-Water set of key water sector indicators (TF-IMR, 2009)**

	Issues	Short Term (now)
<b>Water availability or situation of scarcity?</b>		
CONTEXT	Context finite resources and population	1-Total actual water renewable resources per capita or water crowding indicator (people/m <sup>3</sup> )
	Climate change impact on water resources and adaptation capacity	2. Storage capacity compared to potential (or per capita) (+ irrigated areas / irrigation potential)
	Ability to invest for sustainable management	3. Importance of national expenditure for water supply and sanitation as a % of total budget
<b>How intense are our water use? Is it sustainable?</b>		
FUNCTION	Intensity of human uses of renewable but finite resource	4-Intensity of use of water resources: Total water withdrawals over total actual renewable water resources (TBRWR) (+ intensity of groundwater use compared to recharge)
	Importance of different consumptive uses	5.Use by abstraction by main sector as a % of total withdrawals
	Importance of on-stream direct use of freshwater services: fishery Trade and water use	6.Importance of on-stream direct use of freshwater services: fishery 7. Share of blue, green, virtual water used to produce food in a country
<b>How effective are our uses?</b>		
<b>Social performance: Are we reaching the MDG target?</b>		
PERF	Access to improved water supply	8. % population with access to improved water sources
	Access to sanitation	9- % population with access to improved sanitation (JMP)
	Access to water for improved livelihood	
<b>Economic performance: are we producing enough value per m<sup>3</sup> distributed, used or stored?</b>		
<b>Effectiveness of use</b>		
PERF	Food production	10- change in water productivity in irrigated agriculture
	Industrial production	11- water productivity in industrial Sector
	Energy production	12-Change in Hydropower productivity (production/ potential)
<b>Environment performance: How environmentally sustainable are human uses?</b>		
PERF	Degradation of key renewable water resources in quality	13. Change of quality of freshwater systems (% of samples compared to standards/limits): - concentrations of nutrients in freshwater - concentrations of salt in aquifers

Mitigation efforts to reduce pollution  
Risks of biodiversity Loss

14. Urban wastewater treatment connection rates  
15. Threatened freshwater species

The Executive Committee of AMCOW, on its 10<sup>th</sup> ordinary session in Johannesburg on October 21<sup>st</sup>, 2011, took the decision of adopting the Pan-African Monitoring, Evaluation and Reporting Format for use in preparing AMCOW's reports to the African Union Summit on the progress made in implementing the Sharm El Sheikh Declaration (2009). Based on that decision the "Pan-African Water and Sanitation Monitoring and Evaluation, and Reporting Format: The Guidelines" was drafted on April 2012.

This guidelines document for collecting information, from the countries, provides also the format for the country's report. It identifies two main areas, seven themes, prioritizes 25 performance categories and about 17 temporary "performance indicators" to be tracked and regularly reported on by the AMCOW member states (STCAU, 2012). They are adapted from existing modes of application taking into consideration the unique situation of the opportunities and challenges in Africa's water sector, especially with regard to data acquisition and analysis. The two main areas and seven themes are:

- Water for Sustainable Development
  - Water infrastructure for economic growth
  - Managing and protecting water resources
  - Achieving the water and sanitation MDGs
  - Global changes and risks management
- Enabling Mechanisms for Development
  - Governance and management
  - Financing
  - Education, knowledge, and capacity development

To facilitate the analysis and comparison of the 17 indicators with TF-IMR "key indicators", they are analyzed and categorized according to TF-IMR framework (Table 2). Most of the indicators under the second category are expected to be categorized as governance indicators. Although there are indicators for the specific theme of achieving water and sanitation MDGs, they seem to be defined and may be computed differently from the global (TF-IMR) standards. Groundwater was identified as performance category yet no corresponding indicators were provided. Moreover, neither water quality nor related environment was recognized as performance category.

No direct link can be established between TF-IMR "key indicators" and Pan-African temporary "performance indicators" except for MDGs, water and sanitation finance, and IWRM plan indicators.

The second State of the Water report (AWC and CEDARE, 2013), structured and categorized more than 90 indicators under nine classes of "Water and": Availability; Consumption; Land Use Changes; Services and Accessibility; Demographics; Quality; Climate; Economics; and Policy and Politics. One of the main differences between the AMCOW set of indicators and the CEDARE/AWC set of indicators is that the AMCOW indicators are targeted indicators, where the different indicators under each category are formulated so as to report on the status of achievement of a particular target. The CEDARE/AWC

indicators, on the other hand are purely “status” indicators that are not related to a certain target (Misr Consultants, 2013 h).

Whether CEDARE/AWC indicators have set targets or not, they cover broad areas, so that they encompass both TF-IMR "key indicators" and Pan-African temporary "performance indicators. "No doubt, such comprehensive list indicators, if feasible, draw a full or complete picture of the water resources status.

The N-AMCOW region geographical boundary is clearly defined; however, it is not as easy as it sounds when it comes to indicators selection. It is often difficult to be restricted to a single boundary definition. The boundary(ies) of a region should relate to the performance of the region with respect to water sector, depending upon countries involved in the M&E process. Unfortunately, monitoring and evaluation of water sector often suggest multiple boundaries. The boundaries linked to status of water resources (watershed) indicators may be very different from those associated with national indicators that measure progress towards the MDGs. Therefore, N-AMCOW current M&E initiative adopted multiple boundary definitions and included trans-boundary aquifers as well as international river basins' organizations.

Within the region, geographic subunits are delineated by available data, i.e. municipalities and counties, the jurisdiction of the reporting agency, and/or the membership of a trans-boundary organization. When multiple organizations are involved, this issue can become chaotic. Subunits are better defined by the served area of the reporting organization — it is they who frequently determine what should be measured and how. The choice of indicators should also be guided by decision makers. The process of indicators selection could be through advisory board, in-house staff, community surveys or meetings, working groups or steering committees, surveys of local leaders, and surveys of other indicator reports.

The way regions select the indicators they report reflects the characteristics of the reporting organization(s) and the changes shaping the region. While many indicators are used across multiple nations, others will clearly be expressive of the unique character of each country.

**Table 2. Analysis of PAN-African “Performance Indicators” according to TF-IMR categories**

Area	Theme	Performance Category	Indicator	Cont.	Func.	Perf.	Gov.	
Water for Sustainable Development	1. Water Infrastructure for Economic Growth	1.1 Develop infrastructure to increase hydropower	1- Rate of increase in hydropower utilization index			X		
		1.2 Water for agriculture	2- Rate of increase in water productivity			X		
			3- Rate of increase of irrigated areas			X		
		1.3 Water for multiple uses	4- Rate of increase of water demand satisfaction index			X		
	2. Managing and Protecting Water Resources	2.1 Basin and Trans-boundary	5- Water efficiency plan					X
		2.2 Trans-boundary infrastructure development	N/P					
		2.3 Groundwater	N/P					
		2.4 Rainwater	6- Percentage of rainfall use in total municipal water consumption		X			
	3. Achieving the Water and Sanitation MDG's	3.1 Urban water supply	7- Rate of water inaccessibility reduction				X	
		3.2 Urban water sanitation	8- Rate of sanitation and hygiene inaccessibility reduction				X	
		3.3 Rural water supply	7- Rate of water inaccessibility reduction				X	
		3.4 Rural water sanitation	8- Rate of sanitation and hygiene inaccessibility reduction				X	
	4. Goleable Change and Risks Management	4.1 Adaptation to climate change		9- Climate change adaptation strategy				X
				10- Action plans on water for climate change resilience				X
4.2 Water-related hazards			11- Programs for implementing the actions plans				X	
			12- Early warning system for disaster prevention at the national level		X			
Enabling Mechanisms for Development	5. Governance and Management	5.1 Institutional arrangements	13- Water policy that reflects good governance principles				X	
		5.2 Ethics, transparency, and empowerment	13- Water policy that reflects good governance principles				X	
		5.3 Public and private roles	13- Water policy that reflects good governance principles				X	
		5.4 Right to water	13- Water policy that reflects good governance principles				X	
		5.5 Regulatory approach	13- Water policy that reflects good governance principles				X	
	6. Financing	6.1 Financing water and sanitation	14- Percentage of GDP to sanitation and hygiene		X			

Area	Theme	Performance Category	Indicator	Cont.	Func.	Perf.	Gov.
			15- Percentage of national budget to water and sanitation	X			
		6.2 Pricing strategies	16- Water tariff structure in urban settlements that addresses cross-subsidy and the need of poor				X
			17- Water tariff structure in rural settlements that addresses cross-subsidy and the need of poor				X
		6.3 Pro-poor financing strategies	16- Water tariff structure in urban settlements that addresses cross-subsidy and the need of poor				X
			17- Water tariff structure in rural settlements that addresses cross-subsidy and the need of poor				X
	<b>7.Education, Knowledge and Capacity Development</b>	7.1 Education and capacity development	N/P				
		7.2 Information	N/P				
		7.3 Water and technologies	N/P				

Region indicators are ideally used to identify trends and issues that could be affected by actions. Such indicators give the countries a common target to work towards.

Selection of indicators is carried out at two levels (sets): adequate and full. The adequate set of indicators can only suggest an overall picture of the water sector and does not, necessarily, allow in-depth analysis leading to interventions. For almost all of them data is available at the national level, and for which regional/global information systems exist and could support updating them. It is clear that such an adequate set is used to illustrate global water issues.

It is expected that the adequate indicators set will be improved as standardization, harmonization, and data availability at the global level improves. When data is available, some disaggregated indicators are suggested, to be included in the adequate set, to support the interpretation of the related key indicators in the adequate set. Some new indicators are also suggested, to be inserted to the advanced set, to illustrate important water issues where national data sets are lacked. There are also diverging views on the relevance of sectorial water productivity indicators; as some would favor "water efficiency indicators" and an evaluation of "corporate water footprints" particularly for the industry and agriculture sector.

In general, the selection of indicators in each set should take into account the following four requirements (TF-IMR, 2009):

- *Policy relevance*, with respect to major water challenges of the region, including concerns for increased water scarcity and degradation, and lack of access;
- *Manageability*, indicators' diversity, capacity required for activities ranging from monitoring to reporting, geographical coverage and data frequency are factors to be considered;
- *Measurability*, is the data used for indicator computation available compared with the update frequency (annual, biannual, or every five years); and
- *Analytical soundness of the data*, accuracy and reliability to inform civil society, support broader communication with the public, and provide a snapshot of regional water issues.

Ultimately, any selected set is expected to include performance indicators related to issues such as water quality, effectiveness of the water use, value added in the different socio-economic sectors, or impact on the vital ecosystem. The indicators correspond to varying degrees of policy relevance and policy priorities for different countries. For the purpose of regional/global reporting they can only be comprehended in context and must be supplemented with country-specific information to attain their full meaning.

## 2.1 Selected Indicators

The following sets of indicators are selected from three predefined large sets to report on water-related issues (water resources; how water is used in agriculture, industry and energy production; urban water use; water and the environment.....etc.). The largest set of the three is CEDARE/AWC List of State of the Water indicators. The second set is defined in "Pan-African Water and Sanitation Monitoring and Evaluation and Reporting Format: The Guidelines" (Pan-African G), (STCAU, 2012). The third is recommended by the UN-water Task Force on "Indicators, Monitoring and Reporting (IMR)", (TF-IMR, 2009).

However, the selection process was mainly guided by the indicators that could be or are actually evaluated, and more importantly, data elements that could be measured in the countries as presented in the RARs. Careful selection of indicators sets is neither inclusive nor conclusive. There will be always room for enhancement as knowledge and data availability improves; and as changes, to accommodate water issues' dynamics, is required. This is why a step wise approach is recommended. In the short term, the start should be with an adequate set. Through the experience gained in utilizing the adequate set and improvement trials, it will be possible to reach the full set. The action plan will address what can be done in the short and medium terms to reach the level of adequacy.

The CEDARE/AWC, Pan-African, and UN Initiative indicators sets were sieved, same indicator under different names were identified. Such mixed up and diverse portrayal of different sets of indicators precluded any systematic analysis or comparison of the different sets of indicators. Nevertheless, Table 3 checks the resemblance between the CEDARE/AWC, Pan-African G, and UN TF-IMR indicators.

The approach adopted in the selection process was to, review the available three lists and allocate all measurable indicators to comprise the adequate set. It was found that all CEDARE/AWC indicators are measurable, as sound preliminary values have already been calculated for all of them, which qualifies the current CEDARE/AWC set which is comprised of nine categories of indicators shown in table 4 to be the adequate set. However, there are many categories in the CEDARE/AWC set that need to be expanded for a more detailed and comprehensive look at the state of the water in The MEWINA Region, especially that one of the project objectives is to develop an enhanced Monitoring and Evaluation system in MEWINA countries beyond the current measurable indicators. Regional and National Action plans will also be developed under the project's framework, where all the technical and institutional capacities needed to assess necessary currently unmeasured indicators will be discussed. Therefore the full list of indicators will be included in a separate report.

Table 4 shows a comparison between the selected Indicators from Regional organizations and the National indicators of MEWINA countries under study. The table shows clearly what regional indicators are available in MEWINA countries. It is observed that not all regional indicators are available in the countries and not all countries are similar in availability of indicators. Egypt came first in place with respect to availability of indicators and Mauritania came last with minimum available and measurable indicators similar to Libya.

On comparing regional sets of indicators and national available indicators in Table5, the standardized and harmonized set of indicators chosen are shown in Table 5 under 15 categories. For each category, related indicators are mentioned and are expected to be measured in all countries.

**Table 3. Resemblance and Intersection between the UN set and other sets of indicators**

Indicator	Pan-African G	UN TF-IMR	CEDARE/AWC
1- Total Blue Renewable Water Resources per Capita		X	X
2- Surface storage capacity compared to potential (or per capita)		X	
3- Irrigated areas compared to irrigation potential	X	X	X
4- Average annual rainfall (20 years average)			X
5- Installed hydropower capacity as a % of the total installed electricity generation capacity	X		X
6- Total public budget for water resource management as a % of total budget			X
7- Total water withdrawals over Total Blue Renewable Water Resources		X	
8- % of population with access to improved water sources	X	X	X
9- % of population with access to improved sanitation	X	X	X
10- Water productivity in irrigated agriculture	X	X	X
11- Ratio of annual hydropower production to the installed Hydropower capacity	X		X
12- Quality of freshwater systems (% of samples compared to standards)		X	X
13- Wastewater treatment connection rates			
14- Documented and approved IWRM policy/plan	X		X
15- Enforcement of water legislation	X		
16- Existence of effective institutions	X		
17- Effective transboundary water organization/schemes	X		

The default geographical scale for the adequate set is the national level. If some indicators could be monitored at other disaggregated levels (urban, rural or sectoral), they are forwarded to the full set as finer or detailed indicators. Data and indicators at the national level have to be used with caution as

data/indicators can be estimated, modeled using different assumptions, or derived from other data. Some of the hydrological and water resources parameters/indicators should be based on regular intensive monitoring programs at disaggregated levels (basin or aquifer). However, they are estimated based on generic water resource balance approach that utilizes available national or regional information and verified experts' questionnaire.

Typically national information documents or sources do not indicate the method used to compile and produce these indicators or figures. For most countries, withdrawals or abstraction are not metered, particularly agriculture withdrawals. Therefore, data and knowledge on water resources are much better than on uses. In many cases, only limited disaggregated information exists (sparse field surveys or unrepresentative sample), and even this shows deficiencies of validity and homogeneity and provides extremely distorted information on trends.

**Table 4. Comparison between the selected Indicators from Regional organizations and the National indicators of MEWINA countries**

	Selected Regional Indicators	Mauritania	Algeria	Tunisia	Libya	Egypt
<b>Water &amp; Availability</b>	Annual Average Precipitation Depth	NA	√	√	NA	√
	Annual Average Precipitation Volume	NA	√	√	NA	√
	Internal Renewable Surface Water (IRSW)	√	√	√	NA	√
	Internal Renewable Groundwater (IRG)	√	√	√	√	√
	Total Internal Renewable Blue Water Resources (TIRBWR)=(IRSW+IRG)	NA	√	√	NA	√
	External Surface Water Inflow (ESWI)	NA	NA	√	NA	√
	External Surface Water Outflow (ESWO)	√	√	√	NA	√
	External Groundwater Inflow (EGI)	NA	NA	√	√	√
	External Groundwater Outflow (EGO)	√	√	√	√	√
	Total External Renewable Blue Water Resources (TERBWR)=(ESWI+EGI)	NA	NA	√	NA	√
	Total Renewable Blue Surface Water (TRBSW)=(IRSW)+(ESWI)-(ESWO)	NA	NA	√	NA	√
	Total Renewable Blue Groundwater (TRBG)=(IRG)+(EGI)-(EGO)	NA	NA	√	√	√
	Overlap Between Surface Water and Groundwater (OSW)	NA	NA	NA	NA	NA
	Total Renewable Blue Water Resources (TRBWR)=(TRBSW)+(TRBG)-(OSW)	NA	NA	NA	NA	NA
	Total Rainfed Agriculture Abstractions	NA	NA	NA	NA	√
	Total Natural Pasture Abstractions	NA	NA	NA	NA	NA
	Total Forest Abstractions	NA	NA	NA	NA	NA
	Total Renewable Green Water Resources (TRGWR)	NA	NA	NA	NA	√
	Total Renewable Water Resources (TRWR)=(TRBWR+TRGWR)	NA	NA	NA	NA	NA
	Produced Municipal and Industrial Wastewater (PMW)	NA	√	√	NA	√
	Treated Municipal and Industrial Wastewater	NA	√	√	NA	√
	Reused Treated and Industrial Municipal Wastewater	NA	NA	NA	NA	√
	Produced Agricultural Drainage (PAD)	NA	NA	NA	NA	√
	Reused Agricultural Drainage	NA	NA	NA	NA	√
	Produced Desalinated Water (PDW)	NA	√	NA	NA	√
	Total Non-Conventional Water Resources (TNCWR)=(PMW)+(PAD)+(PDW)	NA	NA	NA	NA	√
	Total Non-Renewable Groundwater Resources (TNRGR)	NA	NA	NA	NA	√
	Total Conventional Water Resources (TCWR)=(TRWR)+(TNRGR)	NA	NA	NA	NA	√
	Total Available Water Resources (TAWR)=(TCWR)+(TNCWR)	NA	NA	NA	NA	√

	Selected Regional Indicators	Mauritania	Algeria	Tunisia	Libya	Egypt
<b>Water Withdrawals and Consumption</b>	Annual Total Water Withdrawal	√	√	√	√	√
	Withdrawals by the Domestic Sector	NA	√	√	NA	√
	Withdrawals by the Industrial Sector	NA	√	√	NA	√
	Withdrawals by the Agricultural Sector (blue water + non-conventional water)	NA	NA	NA	NA	√
	Agricultural consumptions from Green Water	NA	NA	NA	NA	√
	Total Agricultural Withdrawals	NA	NA	NA	NA	√
	Withdrawals From Blue Surface Water	NA	NA	NA	NA	√
	Withdrawals From Blue Groundwater	NA	√	√	NA	√
	Withdrawals from Non-Renewable Groundwater	NA	√	√	NA	√
	Withdrawals From Non-Conventional Resources	NA	NA	NA	NA	√
	Overall Water Use Efficiency	NA	NA	NA	NA	√
	Water Sustainability Index	NA	NA	NA	NA	√
	Wastewater and Drainage Outflows	NA	√	√	NA	√
	<b>Water and Land use Change</b>	Total Irrigated Agricultural Land	NA	NA	NA	NA
Total rain-Fed Agricultural Land		NA	NA	NA	NA	√
Total Forest Land		NA	NA	NA	NA	NA
Total Natural Pasture Land		NA	NA	NA	NA	√
<b>Water Services and Accessibility</b>	Water Supply Coverage (JMP)	√	√	√	√	√
	Water Supply Coverage (Sector Ministry)	√	√	√	√	√
	Urban Water Supply Coverage (JMP)	√	√	√	√	√
	Urban Water Supply Coverage (Sector Ministry)	√	√	√	√	√
	Rural Water Supply Coverage (JMP)	√	√	√	√	√
	Rural Water Supply Coverage (Sector Ministry)	√	√	√	√	√
	Sanitation Coverage (JMP)	NA	√	√	√	√
	Sanitation Coverage (Sector Ministry)	NA	√	√	NA	√
	Urban Sanitation Coverage (JMP)	NA	√	√	√	√
	Urban Sanitation Coverage (Sector Ministry)	NA	√	√	NA	√
	Rural Sanitation Coverage (JMP)	√	√	√	√	√
	Rural Sanitation Coverage (Sector Ministry)	√	√	√	NA	√
	Length of water supply pipe networks	NA	√	√	NA	√
	Length of Sewage pipe networks	NA	√	√	NA	√
	Length of Irrigation Networks	NA	NA	NA	NA	√
	Length of Drainage Network	NA	NA	NA	NA	√
	Total drinking water treatment plant capacity	NA	NA	NA	NA	√
	Dam Capacity (Installed)	NA	√	√	NA	√
Desalination Capacity	NA	√	√	NA	√	

	Selected Regional Indicators	Mauritania	Algeria	Tunisia	Libya	Egypt
	Installed Hydropower Capacity	√	√	√	NA	√
	Electricity Generated Using Hydropower	√	√	√	NA	√
<b>Water and Demographics and Human Development</b>	Total Population	√	√	√	√	√
	Internal Renewable Water Resources Per Capita	NA	√	√	√	√
	Total Renewable Blue Water Resources Per Capita	NA	NA	NA	NA	√
	Total Renewable Water Resources Per Capita	NA	NA	NA	NA	√
	Blue Water Withdrawal Per Capita	NA	NA	NA	NA	√
	Green Water Consumption Per Capita	NA	NA	NA	NA	√
	Total Available Water Resources Per Capita	NA	√	√	√	√
	Total Water Consumption Per Capita	NA	√	√	√	√
	Agricultural Water Withdrawal Per Capita	NA	NA	NA	NA	√
	Industrial Water Withdrawal Per Capita	NA	√	√	NA	√
	Domestic Water Withdrawal Per Capita	√	√	√	√	√
	Population Without Improved Water Supply	√	√	√	√	√
	Population Without Adequate Sanitation	√	√	√	√	√
	<b>Water and Quality</b>	The Water Quality Index	NA	NA	NA	NA
Diarrhea Reported Cases		NA	NA	NA	NA	NA
Dracunculiasis Reported Cases		NA	NA	NA	NA	NA
Cholera Reported cases		NA	NA	NA	NA	NA
Open Defecation Practice		√	NA	NA	NA	NA
<b>Water and Climate</b>	Flood Events in the Last Two Decades.	NA	NA	NA	NA	√
	Flood Events 1989-2000	NA	NA	NA	NA	√
	Flood Events 2000-2011	NA	√	√	NA	NA
	Existence of Early Warning Disaster prevention System	NA	NA	NA	NA	√
	National Climate Change Adaptation Plan	√	√	√	NA	√
<b>Water and Economics</b>	Industrial Water Productivity (GDP/Water Use)	NA	√	√	NA	√
	Employment in Agriculture	NA	NA	NA	NA	√
	Agricultural Water Productivity (GDP/Water Use)	NA	√	√	NA	√
	Water and Sanitation Charges as % of the lowest Household Income Groups	√	√	√	√	√
	Subsidy (Domestic-Industrial-Agricultural)	NA	√	√	NA	√
	Public Expenditure on Water Related Projects	NA	√	√	NA	√
	Foreign Development Assistance for Water (Total 2009-2012)	√	√	√	√	√
	Foreign Development Assistance for Water (average yearly )	√	√	√	√	√
	Percentage of national Budget directed to Water and Sanitation	√	√	√	√	√

	Selected Regional Indicators	Mauritania	Algeria	Tunisia	Libya	Egypt
	Virtual Water Imports related to Trade in the Agricultural Sector	NA	NA	NA	NA	√
	Virtual Water Exports related to Trade in the Agricultural Sector	NA	NA	NA	NA	√
	Virtual-Water net Flow Related to Trade in the Agricultural Sector	NA	NA	NA	NA	√
<b>Water Policy and Politics</b>	IWRM Plan in Place	√	√	√	NA	√
	Existence of National Water and Sanitation M&E, & R System	NA	NA	NA	NA	NA
	Water Rights/year	NA	NA	NA	NA	NA
	Well Permits/year	NA	NA	NA	NA	NA
	Irrigation related complaints	NA	NA	NA	NA	NA
	Water Supply and Sanitation related complaints	NA	NA	NA	NA	NA
	Transboundary Water Bodies Dependency Ratio	√	√	√	√	√
	Standpoint in the 1997 UN Convention	NA	NA	NA	NA	NA

**Table 5. Final Standardized and Harmonized chosen Indicators**

	National State of Water Indicators
<b>Water &amp; Availability</b>	Annual Average Precipitation Depth
	Annual Average Precipitation Volume
	Internal Renewable Surface Water (IRSW)
	Internal Renewable Groundwater (IRG)
	Total Internal Renewable Blue Water Resources (TIRBWR)=(IRSW+IRG)
	External Surface Water Inflow (ESWI)
	External Surface Water Outflow (ESWO)
	External Groundwater Inflow (EGI)
	External Groundwater Outflow (EGO)
	Total External Renewable Blue Water Resources (TERBWR)=(ESWI+EGI)
	Total Renewable Blue Surface Water (TRBSW)=(IRSW)+(ESWI)-(ESWO)
	Total Renewable Blue Groundwater (TRBG)=(IRG)+(EGI)-(EGO)
	Overlap Between Surface Water and Groundwater (OSW)
	Total Renewable Blue Water Resources (TRBWR)=(TRBSW)+(TRBG)-(OSW)
	Total Rainfed Agriculture Abstractions
	Total Natural Pasture Abstractions
	Total Forest Abstractions
	Total Renewable Green Water Resources (TRGWR)
	Total Renewable Water Resources (TRWR)=(TRBWR+TRGWR)
	Produced Municipal and Industrial Wastewater (PMW)
	Treated Municipal and Industrial Wastewater
	Reused Treated and Industrial Municipal Wastewater
	Produced Agricultural Drainage (PAD)
	Reused Agricultural Drainage
	Produced Desalinated Water (PDW)
	Total Non-Conventional Water Resources (TNCWR)=(PMW)+(PAD)+(PDW)
Total Non-Renewable Groundwater Resources (TNRGR)	
Total Conventional Water Resources (TCWR)=(TRWR)+(TNRGR)	
Total Available Water Resources (TAWR)=(TCWR)+(TNCWR)	
<b>Water Consumption</b>	Annual Total Water Withdrawal
	Withdrawals by the Domestic Sector
	Withdrawals by the Industrial Sector
	Withdrawals by the Agricultural Sector (blue water + non-conventional water)
	Agricultural consumptions from Green Water
	Total Agricultural Withdrawals

	National State of Water Indicators
	Withdrawals From Blue Surface Water
	Withdrawals From Blue Groundwater
	Withdrawals From Non-Renewable Groundwater
	Withdrawals From Non-Conventional Resources
	Overall Water Use Efficiency
	Water Sustainability Index
	Wastewater and Drainage Outflows
<b>Water and Land-use Change</b>	Total Irrigated Agricultural Land
	Total rain-Fed Agricultural Land
	Urban Encroachment on Agricultural land
<b>Water and Services</b>	Water Supply Coverage (JMP)
	Water Supply Coverage (Sector Ministry)
	Urban Water Supply Coverage (JMP)
	Urban Water Supply Coverage (Sector Ministry)
	Rural Water Supply Coverage (JMP)
	Rural Water Supply Coverage (Sector Ministry)
	Sanitation Coverage (JMP)
	Sanitation Coverage (Sector Ministry)
	Urban Sanitation Coverage (JMP)
	Urban Sanitation Coverage (Sector Ministry)
	Rural Sanitation Coverage (JMP)
	Rural Sanitation Coverage (Sector Ministry)
	Percentage of population with improved water supply
	Percentage of population with improved sanitation
	Length of Networks (Water supply, Sewage, Irrigation, and Drainage)
	Dam capacity
	Water Supply Capacity
	Desalination capacity
	Number of water supply meters installed
<b>Water and Energy</b>	Electricity Generated using Hydropower
	Installed Hydro-capacity
<b>Water and Population</b>	Total Population
	Internal Renewable Water Resources Per Capita
	Internal Renewable Blue Water Resources Per Capita
	Total Renewable Blue Water Resources Per Capita
	Total Renewable Water Resources Per Capita
	Blue Water Withdrawal Per Capita

	National State of Water Indicators
	Green Water Consumption Per Capita
	Total Available Water Resources Per Capita
	Total Water Consumption Per Capita
	Agricultural Water Withdrawal Per Capita
	Industrial Water Withdrawal Per Capita
	Domestic Water Withdrawal Per Capita
	Population Without Improved Water Supply
	Population Without Adequate Sanitation
<b>Water and Health</b>	Diarrhea Reported Cases
	Dracunculiasis Reported Cases
	Cholera Reported cases
	Open Defecation Practice
	Percentage of open defecation
<b>Water and Climate</b>	Flood Events in the Last Two Decades.
	Flash-flood events in the last two decades
	Drought events in the last two decades
	Existence of Early Warning Disaster prevention System
	National Climate Change Adaptation Plan
<b>Water and Socio-Economics</b>	Industrial Water Productivity (GDP/Water Use)
	Employment in Agriculture
	Employment in Industry
	Agricultural Water Productivity (GDP/Water Use)
	GNI per capita
	Subsidy (Domestic-Industrial-Agricultural)
<b>Water and Finance</b>	Public Expenditure on Water Related Projects
	Foreign Aid for Water
	Percentage of national Budget directed to Water Sector
	Operational cost recovery for water supply and sanitation
	Cost recovery for irrigation
<b>Water and Trade</b>	Virtual-water flows related to trade in crop, animal, and industrial products, per country
<b>Water and Governance</b>	IWRM Plan in Place
	Existence of National Water and Sanitation M&E, & R System
	Water Rights/year
	Well Permits/year
	Irrigation related complaints
	Water Supply and Sanitation related complaints
<b>Water and Politics</b>	Transboundary Water Bodies Dependency Ratio

National State of Water Indicators	
	Multilateral agreement status
<b>Water and Quality</b>	Water Quality Index
<b>Water and Ecosystems</b>	Number of wetlands sites acknowledged by RAMSAR
	Total wetland areas

**Table 6. Final Chosen Transboundary Indicators**

	Transboundary rivers and aquifers
<b>River Basin SOW</b>	Water and Availability: The main focus will be Blue Renewable Surface Water related to the basin of interest. The total precipitation on the whole basin and the associated green water consumptions will be showcased. Also, in some cases, there will be some focus on groundwater if it is connected to the river basin system
	Water & Consumptions: The main focus will be direct consumptions from the transboundary river system of interest with some emphasis on direct beneficial consumptions from green water within the basin
	Water & Land Use Change: This category will focus on the Land Use within the river's catchment area
	Water & Infrastructure: This category will focus on the infrastructure related to storage and power generation on the river of interest
	Water & Population: This category will feature different demographical data about a particular basin, the total basin-bound population (which is different than the total basin countries population) has to be known.
	Water & Politics: This category will showcase any transboundary cooperation between riparian countries in terms of bilateral or multilateral agreements. It will also show the collective transboundary water bodies' dependency Ratio for all riparians, i.e the percent of all annual volumes abstracted from a transboundary water body to total annual renewable water resources available to all riparian countries.
<b>Aquifer SOW</b>	Water & Availability: The main focus will be Blue Renewable and Non-Renewable Groundwater associated with a transboundary aquifer. In case of renewable aquifers, recharge rates will be presented.
	Water & Consumptions: The main focus will be direct abstractions by different water-use sectors from the transboundary aquifer of interest.
	Water & Population: This category will feature different demographical data about a particular aquifer; the total aquifer-bound population has to be known.
	Water & Politics: This category will showcase any transboundary cooperation between riparian countries in terms of bilateral or multilateral agreements. It will also show the collective transboundary water bodies' dependency Ratio for all riparians, i.e the percent of all annual volumes abstracted from a transboundary water body to total annual renewable water resources available to all riparian countries.

### 3. Standard Harmonized Sub-Regional M&E Framework

Standardization and harmonization, of the sub-regional M&E framework are primarily directed towards the adequate set of indicators. However, standardized definition of the key terms, used in this report and not necessarily specific to the adequate set of indicators, is a pre-requisite for the delineation of such framework. The list of terms presented in Annex I should not be considered exhaustive.

Monitoring can be defined as a regular systematic process of observing one or more elements of the water resources system and/or environment in space and time, for defined purposes using comparable methodologies for data collection. While, evaluation can be defined as the assessment of the state variables of water system in relation to the context, human effects, and the actual or intended uses. Monitoring is carried out to enable evaluation of the current state of water services coverage, quantity, quality and their spatial and temporal trends (Misr Consultants, 2013 d).

It is recognized that all countries of N-AMCOW region have a national M&E systems that depend, more or less, on a set of indicators to provide information on all of the water resources/sector issues and aspects. However, the purposes for which that information is generated differ, which in turn influences the definition of indicators used, the specific parameters measured, and the monitoring or data collection schemes utilized. Therefore, it is difficult to monitor and report on the progress of global commitments (MDGs) through individual or joint programs (JMP, WWDR), and to confirm that global water principles (IWRM) are being practiced. It is even more difficult to provide reliable information about the impact of broader socio-economic and climatic trends that impact upon water resources and their use (TF-IMR, 2009). Thus, standardization and harmonization of the national M&E processes, as defined earlier, is mandatory to serve regional and global targets.

#### 3.1 Institutional Setup

Within the water lead ministry, in each country, a unit or administration has to be identified to play the role of national MEWINA office. Such administration should have the responsibilities of water resources coordination and planning, monitoring and evaluation, or a host of a core water information system or data base. MEWINA national offices responsibilities comprise collecting, interpreting and exchanging data, monitoring, periodical reporting and coordination with MEWINA management unit at CEDARE (Figure 1). Periodical national reports are produced by the national office in each country and submitted to the Management unit, which is the host of MEWINA-IMS. National reports are compiled by the management unit at CEDARE in a regional report that is presented and discussed in AMCOW's meeting.

The proposed IMS is specifically oriented towards the monitoring and evaluation of water sector, both at the socio-economic and political levels. Therefore, it is updated by data and indicators that are collected periodically by national statistics office, and/or water related department (within other water concerned ministries) as well as hydrologic monitoring networks (within the authorities of water lead ministry or transboundary organizations). Links between MEWINA national office and other entities depicted in Figure 1 indicate the flow of data and information. One way link denote either sending or receiving while the two way link express the data sharing between two entities. In any case it is recommended to formulate and officiate such links through protocols that guarantees continuous and regular data/information flow as well as mutual benefits.

### 3.2 Data and Information Collection, Processing and Indicators Computation

It is possible to present a sketch for the water sector; its context, functioning, performance and governance, using the selected adequate set of indicators that are responsive to Pan-African Monitoring and Evaluation guidelines. Data and information, that constitute the ingredients for indicators computation process, are typically measured, collected or estimated at the national level. Therefore, the recommended geographical scale for the adequate set of indicators is the national level, although some indicators elements are monitored at other levels and more detailed assessments could take place (water bodies, sectors, basins, local).

The adequate set of indicators takes into consideration the peculiarity of the opportunities and constraints in N-AMCOW water sector, especially with regard to data acquisition and analysis.

It must be stressed that the indicators, parameters, definitions and methods adopted in what follows, have been carefully selected and proposed within the context of the water sector in N-AMCOW. However, these guidelines have to be approved through the National Consultation workshops. Most of the indicators should be updated regularly every 1 to 5 years according to the data set.

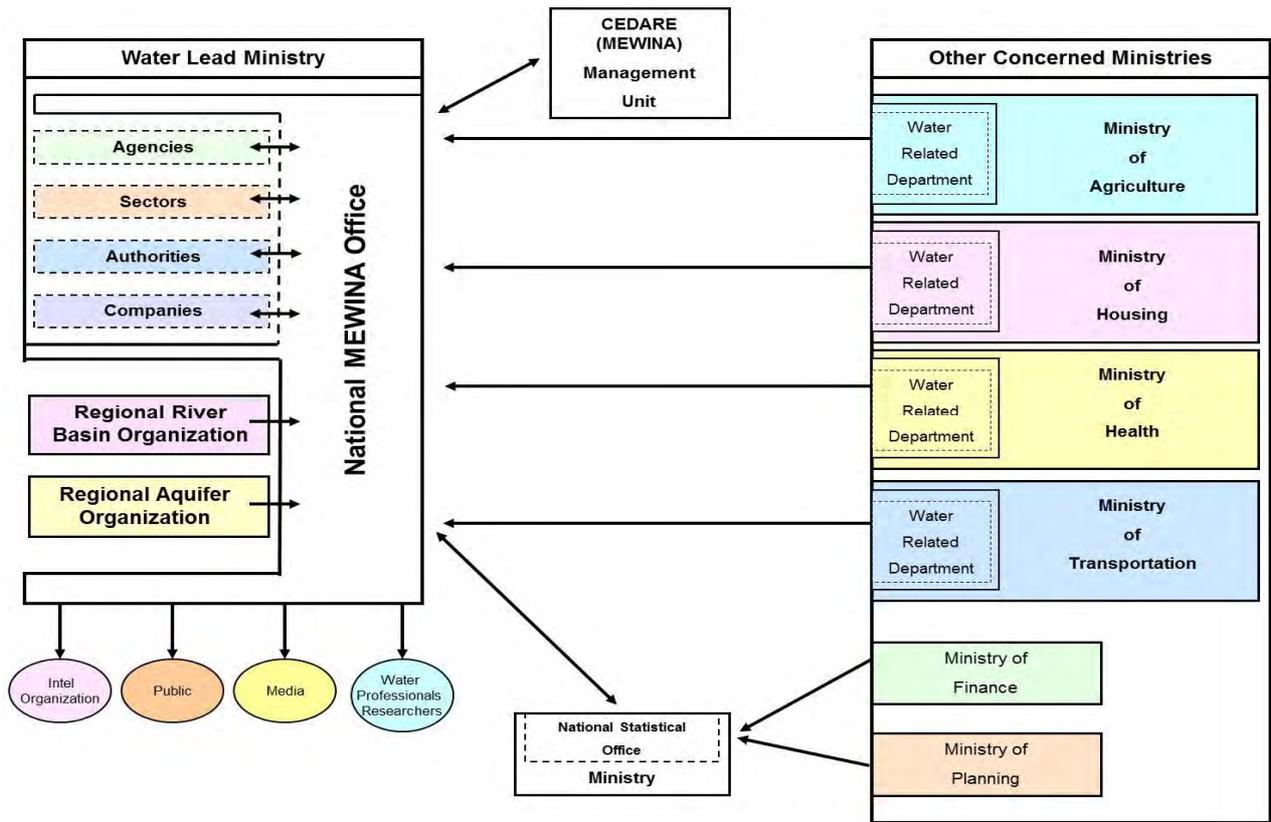


Figure 1. Proposed Generic Institutional Setup for M&E in Water Sector NAGLAA

### 3.3 Web Based Information System (WBIS)

Almost all of the water related organizations of N-AMCOW countries are collecting more hydrological and socio-economic data than is being processed. These organizations simply do not have the right data/information management tools to centralize storage, control quality, analyze, evaluate indicators and publish regular reports on progress made in the water sector. It is rather difficult for them to support the regional and international stakeholders' demands for information. Without the right tools to automate quality assurance and quality control (QA/QC) water organizations cannot provide reliable statistics or information. Many of these organizations are under-equipped to centrally manage their water data; and they are expected to store data in different locations, using disconnected software tools. Their legacy systems cannot be updated to meet current data diversity, analytical method, dynamic reporting needs and graphical visualization.

Therefore, it is recommended to make use of a new emerging applications so-called "Web Based Information System" to design and generate reports from a wide range of data sources such as: Microsoft Excel spreadsheets, Oracle databases, Microsoft SQL Server databases, Microsoft Access databases, Business Objects Enterprise business views, and local file system information. Such applications are becoming widely used due to the ability to update and maintain them without distributing and installing software on large number of client computers. They also provide an intrinsic support for cross-platform compatibility. Web Based Information System (WBIS) could feature all or some of the following common functions: reporting, online analytical processing, analytics, data mining, process mining, complex event processing, business performance management, benchmarking, text mining, predictive analytics and prescriptive analytics.

MEWINA Web Based Information System (MEWINA-WBIS) should integrate and streamline all the required data and information elements that have been detailed in the indicators standardization sheets. This applies to either the already monitored and surveyed elements, or new elements that have to be collected to fulfill the adequate set of indicators and beyond. Therefore, the envisaged WBIS ought to provide the comparable control and operational capabilities as those available to a user in traditional IT environment, for both the web server owner or manager (Management Unit-CEDARE) and the co-owners or clients (MEWINA national focal units) in each member country. Such an objective will not require the full harmonization of the national databases/sources in terms used software, data structures and relationships, deviant data detection, correction, and validation, as well as updating and maintenance. However, the owner of the web server (either virtual or physically hosted at CEDARE) has to make additional technical and developmental efforts. The MEWINA-WBIS is intended to present and visualize water M&E results that lead to the publication of N-AMCOW regional report as well as national reports, in a standardized format. Therefore, only these reports should be made available for other stakeholders of the system.

Two options can be followed in implementing web based application, namely (Salewicz, 2001): a) **the thin client and thick server**, or b) **the thick client and thin server** option. It is recommended to adopt the thin client and thick server option in the implementation of MEWINA-WBIS. When, a co-owner/client of the WBIS is connected to Internet, his computer acts as communication terminal only. He can interactively enter elementary data required for computation of the adequate set of indicators and generate national reports as computations are performed virtually on the server. All computation tools and indicators' database (elementary data) as well as reporting software are residing on the server and deployed,

maintained, modified and updated by the server manager, refer to Figure 2. Only the server manager can generate the regional report. In future development, a similar web application could be developed at the national level, where the server owner/ manager will be the MEWINA focal unit within the lead ministry and the clients are other national relevant parties (e.g. national statistics office).

There are a number of advantages associated with this approach such as limited programming effort. The relatively low amount of data that has to be transmitted is particularly important for users from countries where the transmission rates are not very high or reliable. Another advantage of this solution is associated with high security and consistency of data and computation tools: since both data and models are residing on the server, they are protected from manipulation and unauthorized changes. A very positive feature this approach requires limited programming effort associated with the implementation. The disadvantage of this approach is that as the computation burden and data loads get heavier it may require a more powerful machine to act as server (Salewicz and Nakayama, 2004).

It is typical, in this case, to develop (code) the WBIS in a browser-supported programming language such as JavaScript, combined with a browser-rendered markup language like HTML and rely on a common web browser to render the application executable. WBIS could utilize Java technologies for statistical results presentation and mapping navigation: Java Applet for navigation, with JavaScript components for the toolbar J2EE architecture based on Struts framework Dynamic JavaScript elements (tables, trees) for an enhanced browsing experience Advanced graphics (Java Applet) to present results (pie, charts, graphs) (Misr Consultants, 2013d).

Nevertheless, there are several commercial applications that allow users to graphically design data connection(s) and report layout. Where, users can select and link tables from a wide variety of data sources, including Microsoft Excel spreadsheets, Oracle databases, Microsoft SQL Server databases, Microsoft Access databases, Business Objects Enterprise business views, and local file system information. Fields from these tables can be placed on the report design surface, and can also be used in custom formulas, using either BASIC or Crystal's own syntax, which are then placed on the design surface. Formulas can be evaluated at several phases during report generation as specified by the developer. Both fields and formulas have a wide array of formatting options available, which can be applied absolutely or conditionally. The data can be grouped into bands, each of which can be split further and conditionally suppressed as needed. Crystal Reports also supports sub-reports, graphing, and a limited amount of GIS functionality.

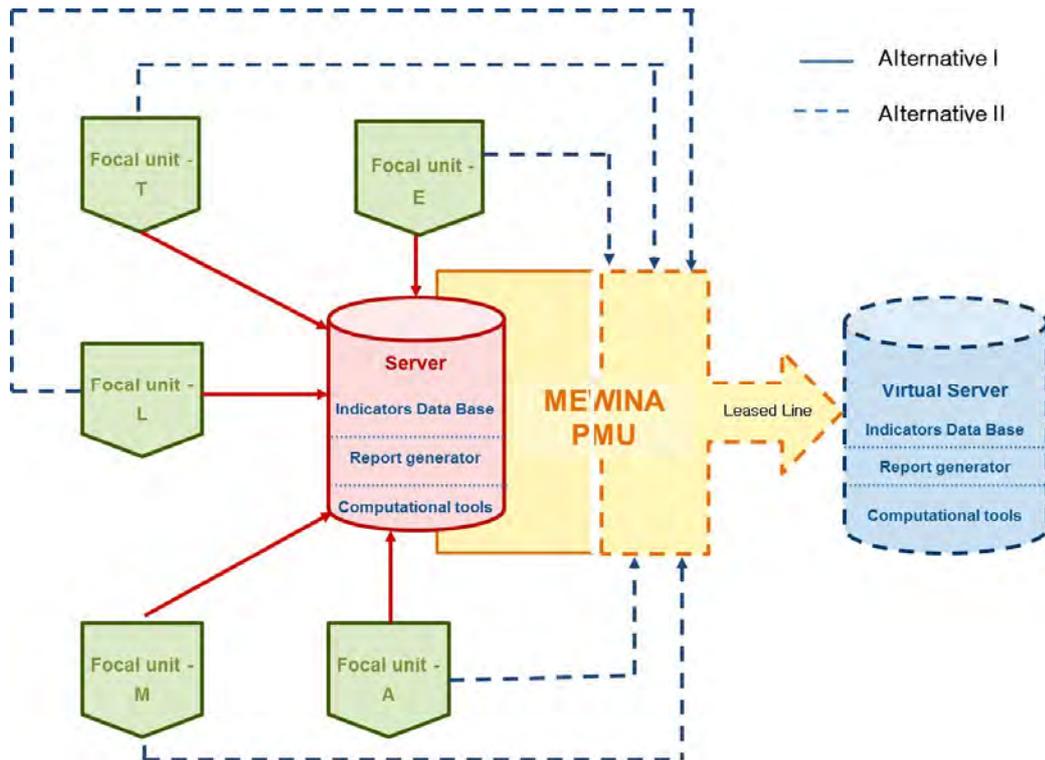
### 3.4 Reporting and Dissemination

Indicator reports are produced and disseminated for multiple purposes. National indicators' (adequate set) reports should be generated to inform civil society and to support broader intra-governmental and public communication. If well streamlined and harmonized with the regional and international monitoring and evaluation programs, they constitute a direct input to global databases indicator's reports. The production frequency of the national reports could be once every two years.

Generally, in the **Indicators Section of National Reports**, a display (table or graph) of the indicator's time series is used to report quantitative indicators; refer to the reporting format and examples in Annex III. Under each indicator section a customized rationale and standardized definition may be provided as well as specific actions or measures taken so far to achieve the target level, before the time series display.

Specific comments and progress obstacles (if incremental achievement is not satisfactory) ought to be mentioned at the end of Indicators Section.

Governance indicators are typically qualitative; therefore, an elaborate description should be provided for each element as expressed in the indicator definition box. Such description will enable MEWINA management unit to carry on the evaluation (scoring) of governance indicators and make countries comparison. Nevertheless, self (country) scoring could be included for each governance indicator in the national report. A radar graph for each indicator, showing elements scores may be added.



**Figure 2. Proposed MEWINA – Web based Information System**

**Moreover**, all national agencies, other than MEWINA office, that contributed to the report through data/information provision, analysis, or revision have to be acknowledged.

MEWINA regional report ought to be compiled to measure progress toward set MDGs and other water resources management goals, investigate particular trends, and/or motivate regional action plans. Regions conducting indicator reports must determine the level of effort that they are willing to undertake to locate and synchronize data. While a low degree of variance is acceptable, the majority of data must be consistent throughout the report (ARS, 2005). The production frequency of the regional report should not be more than once every three years; yet,

**The Indicators Section of the Regional report should also include**, a display (table or graph) that compares the recent indicator’s value with the value of the selected reference year is used to report countries progress; refer to the reporting format and examples in Annex III. Under each indicator section a customized rational and standardized definition may be provided as well as significant national/regional actions or measures taken so far to achieve the target level, as an introduction of the display. Specific

comments withdrawn from the comparative analysis among countries' incremental achievements as well as overall regional achievement compared to global progress in that respect could to be pointed out at the indicator's section end. Governance indicators are qualitative; therefore, an elaborate description should be provided for each element, as expressed in the indicator definition box, for each country. Such description will enable MEWINA management unit to carry on the evaluation (scoring) of governance indicators and make countries' comparison presented in detailed table (elements and indicators scores). Scoring of each governance indicator is displayed in a figure that encompasses countries' radar graphs so that analysis can be made and commented on.

**A section on Data Limitations and Method should be written**, such section reveals used data sources, and discusses its accuracy and reliability. Methods adopted in data/information collection and acquisition, analysis and processing, and indicators' evaluation are described.

Dissemination method of regional or national indicator reports can significantly affect the impact of the report upon the region and its influence on public awareness. Most countries use several dissemination modes or style, in order to influence the maximum number of people and organizations. The more people who see the report and find the data to be of value to them, the more likely it is that action will be taken to improve a quality being reported upon (ARS, 2005).

Dissemination can take different forms: hard copy (either full report or abbreviated one), web-based report, newspaper coverage, Radio/TV coverage, and public presentations / speakers bureau. Experience of various indicators projects showed that 95 percent of regions use public presentations or a speakers bureau to disseminate the report. Ninety percent use a web based report or distribute a hard-copy report, and 81 percent utilized newspaper coverage (ARS, 2005).

Hard copies and CDs of the full report are intended, mainly for professionals and decision makers. They are disseminated at the national level through the circle described in the institutional setup, while they spinoff internationally the host of MEWINA management unit (CEDARE). The proposed MEWINA-IMS allows for web-based dissemination which covers a wide spectrum of audience (professionals, researches, and public at large). For wide public awareness campaigns extracts of the full report, including abbreviated hard copies, brochures, posters, radio or television coverage, and e-newsletters, may be disseminated/organized.

## 4. Standardization and Harmonization of Countries' Water M&E Systems

Based on the previously proposed framework and Rapid Assessment Reports (countries and transboundaries) portrayal of the actual indicators that are reported (Misr Consultants, 2013 a) and water M&E systems a specific set of standardization and harmonization measurements/action are recommended for each country. A larger set of measurements/actions are common and can be prescribed to more than one country of the N-AMCOW region. Only the degree or level of implementation of such common actions will differ from one country to another.

### 4.1 People's Democratic Republic of Algeria: *Water M&E Systems*

The following diagnosis of water M&E sub-systems is abridged from the national Rapid Assessment Report ((Misr Consultants, 2013 b).

#### 4.1.1 Environment and Water Quality

The National Office of Sanitation (ONA) has acquired the ISO14001 certificate for efficient environmental management systems. In this context, ONA has committed to establish an organization that identify and manage environmental risks and impacts. The ISO14001 certificate requires a plan-do-check-act system to be implemented, which is the core for the monitoring and information system for sanitation. The activities undertaken by the ONA include: monitoring the quality of water at the inlet and outlet of the Wastewater Treatment Plants (WWTP).

#### 4.1.2 Field Surveys

Physical surveys is part of the periodic updating of the inventory of sewerage throughout the country, the Department of Sanitation and Protection of the Environment (DAPE) has launched an investigation on the evaluation of the pipeline networks existing across the 48 counties of the Wilaya. The survey was launched during the year 2006 on the basis of a standard questionnaire sent to all Directorates of Water Resources of Wilaya. The questionnaires were filled and returned to DAPE for processing and consolidation. Among the information requested in the questionnaire were primary and secondary pipeline networks coverage and the connection rate to sewerage networks.

#### 4.1.3 Census and Socio-economic Conditions

The National Office of Statistics (ONS) is responsible for collecting and publishing census and socio-economic data in. All data is published online and it is the responsibility of every institution to take what it needs from the online database. While census data is used extensively in water and sanitation sector, this data is updated every 10 years depending on physical surveys for population (1998 and 2008 data are published). For in-between years, a projection method that is developed by the US National Census Office (Demographic Analysis-Population Analysis System) is applied using Excel. The timeline of the census is different from water and sanitation monitoring and planning. Therefore, interpolations that might lead to inaccurate figures are conducted. One more weakness is that the household surveys performed by the ONS for demographic purposes, do not include sufficient questions in relation to accessibility of water and connection to sanitation services. Moreover, latest information on water and sanitation published by the ONS is 2002 data.

#### 4.1.4 Meteorological Networks

The National Office of Meteorology (ONM), under the Ministry of Transport is the entity responsible for developing and operating a network of weather observation stations covering all climatic regions of the country. The monitoring stations include:

77 surface observation stations; 12 observation stations in altitude; 3 research stations and special observation (Tamanrasset, TiaretKsarChellala); 5 weather radars (one of them is a Doppler radar) and more than 400 climate stations.

ONM is responsible for monitoring and collecting continuous daily information about temperature, precipitation and evapotranspiration, all of which are used by the various water sector institutions especially Agence Nationale des Ressources Hydrauliques (ANRH) and ONA. ONM has a high level of scientific and technical capability for carrying out the weather monitoring efficiently using high tech recording stations and equipment. Therefore, the recorded data is considered of very high quality to be utilized in the water sector.

Special weather reports and bulletins are shared with the different organizations in the water sector through collaboration protocols.

#### 4.1.5 Agriculture Sector

Ministry of Agriculture and Rural Development does not have monitoring stations for monitoring water resources but rather uses data from Ministry of Water resources. However, in 2000, collaboration between the Istituto per l'Agronomico Oltremare (IAO) and the National Institute of Agronomic Research of Algeria (INRAA) resulted in the project SGIAR (Integrated Management System of Agricultural Information and Rural). The project intervention area remained at the local level represented by the provinces of Tiaret Tissemsilt Relizane and Mostaganem. Its main result is the creation of a system for the collection, exchange, management, and dissemination of information on agricultural and rural areas (SGIAR). The outputs were excellent working information systems for monitoring of agriculture and related water resources.

#### 4.1.6 Transboundary Water

Algeria transboundary water does not come from a shared river basin; it comes from an underground aquifer, North Western Sahara Aquifer System (NWSAS). This aquifer is shared amongst Algeria, Libya and Tunisia. The cooperation between the three countries is in the form of consultation mechanism that aims to better manage the related resources with no risk or conflict.

NWSAS consultation mechanism has established wide monitoring water points spread across the aquifer in the three countries. In the perspective of providing decision makers a complete picture for managing resources and identifying related risks, the monitoring networks is used for hydrology, socio-economy and environmental aspects of aquifer water resources. Various types of data are collected through this network; Water abstraction, groundwater table piezometric head, drawdown, water quality, water salinity, farming practice, irrigation water consumption (by remote sensing), and socio-economic data.

These types of data are shared between the three countries; however, due to the embryonic nature of the M&E framework, it is not yet clear whether this data is really used in M&E for Algerian Water sector. However, due to its quality and spread, it would constitute an excellent component in Algeria M&E

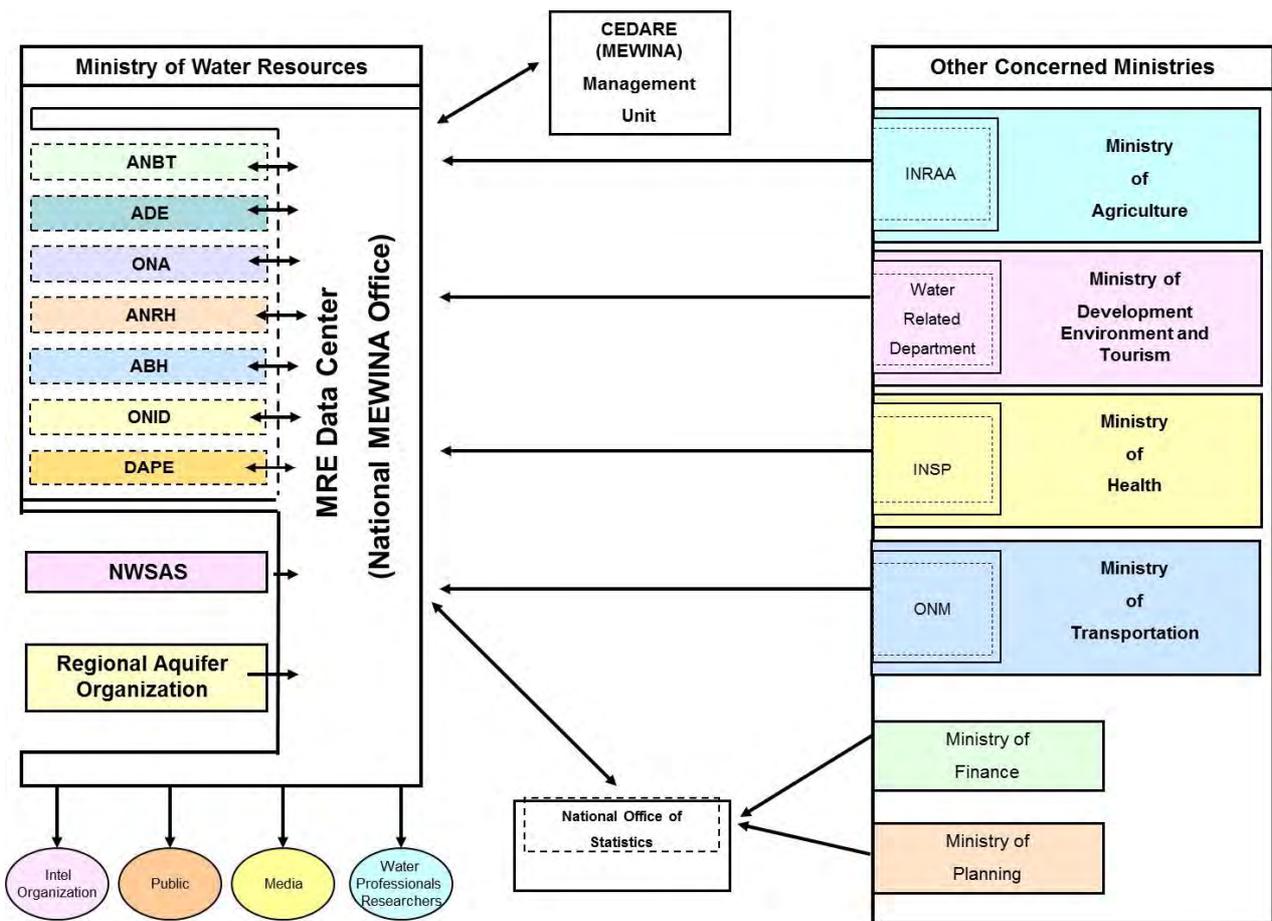
system provided that the water related institutions in Algeria are linked to all NWSAS tool; databases, hydrologic models and remote sensing.

#### 4.1.7 Climate Change

With more frequent droughts and a decreased rainfall over the past 30 years affecting dams, groundwater and environment; Algeria is considered highly vulnerable to impact of climate change. Algeria adopted an action plan for mitigating the inverse impacts of climate change on environment and water resources in 2003. In the consequent plans of 2010 and 2012, the Algerian Government sets adaptation measures focused on the vulnerability of water resources and identify setting, operating and enhancing monitoring networks as the most important target for the action plan. These monitoring networks are used to provide officials with measurements on water delivery efficiency, water contamination from various sources, severe floods, climate parameters, hydrology, hydrogeology, volume of water behind dams and water for agriculture. These action plans are managed by the Ministry of Development, Environment, and Tourism.

#### 4.1.8 Specific Recommended Actions

- Adopt the institutional setup illustrated in Figure 3
- Allocate financial resources for supporting existing databases such as BADGE, BASHYD & Data Center of MRE to be the initial step towards a single integrated Management Information System in water sector.
- Allocate financial resources to link the existing national database information systems with the geo-database information system of the NWSAS to have a unified information system shared by all water sector institutions



**Figure 3. Proposed Institutional Setup for M&E in Water Sector (Algeria)**

## 4.2 Islamic Republic Of Mauritania: Water M&E Systems

The following diagnosis of water M&E sub-systems is abridged from the national Rapid Assessment Report (Misr Consultants, 2013 c).

### 4.2.1 Environment and Water Quality

The Joint Poverty and Environmental Program (JPEP) plays an important role in Mauritania water sector M&E as it identified in 2010 key monitoring indicators that will be used for natural resources, water and sanitation, water pollution and desertification. This constituted the first organized work in M&E framework for water sector in Mauritania. It is not clear whether the JPEP will contribute by its resources to M&E for water sector. Moreover, sharing its data concerning pollution control and desertification is not guaranteed, especially that the monitoring network is not yet realized in Mauritania.

### 4.2.2 Field Surveys

Physical surveys in Mauritania are only done by the National Office for Statistics for the purpose of collecting data on population in different areas of the countries and this data is very useful for use in water sector as it is used in calculating main indicators for water supply and sanitation coverage as explained before. It is not an M&E data but rather counts of population every 10 years.

#### 4.2.3 Census and Socio-economic Conditions

ONS is responsible for collecting and publishing census and socio-economic data in Mauritania. All data is published online and it is the responsibility of every institution to take what it needs from the online database. While census data is used extensively in water and sanitation sector, this data is only published every 10 years depending on physical surveys for population, it was published 2000 and 2012. For census data in any other year, the office provides a projection method that is developed by the US National Census Office for Demographic Analysis, Population Analysis System Using Excel. Therefore, the timeline for the census is not the same as that for water and sanitation monitoring and planning. It is reported that these interpretations might lead to inaccurate figures. One more weakness is that the household surveys performed by the ONS for purpose of population surveying, do not include sufficient questions in relation to accessibility of water and connection to sanitation services. Since the M&E framework in Mauritania water and sanitation sector is not yet developed and/or implemented, there is no harmonization for the boundaries used in census and that required to calculate important related water indicators.

#### 4.2.4 Metrological Networks

The system of meteorological observation consists of 13 synoptic stations and 70 rainfall stations equipped with telecommunication (BLU and others). The stations cover only 5% of the national territory and are mainly installed in the regional capitals (except Aleg and Selibaby) and two provinces (Boutilimit and Bir Moghreïn). Climate data is not digitized due the lack of personnel and computer equipment. Currently; very limited work is done to making some data correction and storing it using Excel and CLICOM data base. Agro meteorology and some rainfall stations have always been managed by the Ministry of Rural Development, while the data collection, from the field, is carried out by the Ministry of the Interior. However, such data is not utilized in the water sector. While no problems are raised about the technical performance of stations, several issues raised about the lack of human resources needed for stations operation and maintenance, and the inadequacy of these stations coverage across the nation. Owing to difficulties and problems encountered in the management of meteorological activity by different entities, and the occurrence of extreme weather events as well as the need to develop a tool for monitoring and prevention of these phenomena, the State established in 2006 a public administrative entity called "National Office of Meteorology". The objectives of this structure is to consolidate all meteorological activities at the national level and provide user-friendly products to end users and help mitigate the adverse effects of disasters due to weather and climate.

#### 4.2.5 Agriculture Sector

Agriculture in Mauritania is managed by the Ministry of Rural Development, Directorate of Cooperation, Monitoring and Evaluation and department (DPCSE) and the Directorate of Rural Reclamation. In 2006, DPCSE received a fund to conduct a survey for collecting information on small dams in country (technical state, storage volume) and another Japanese funded project for placing some gauging stations on Senegal River but all projects stopped and stations are not working anymore. Thus, the Ministry of Rural Development has no monitoring stations and obtains its only data about surface water from the OMVS national Unit.

#### 4.2.6 Universities and Research Institution

Although the University of Nouakchott is the only university in Mauritania; it does not have a water syllabus or research program. The only center that is related to water resources research and funded by

the World Bank is the National Center for Water Resources (CNRE). As discussed before, CNRE host the SIPPE2 access database, which is only used for storing data rather than monitoring data and evaluating water resources. This access database is an excellent data storage and analysis tool that can be integrated with DPSC information system and can be updated regularly with data. DPSC Information System: Lately the Ministry of Water and Sanitation launched an information system in rural and urban water supply and sanitation. Due to insufficient funds, the program is not yet implemented and generalized throughout water sector institutions; however, simple infrastructure for the system are available at the Department of Planning Monitoring and Evaluation.

#### 4.2.7 Transboundary Water

The Senegal River Basin Organization (OMVS) structure is supplemented at the level of each member state by an OMVS National Unit which is the instrument through which the OMVS and Ministry of Water and Sanitation ensure the follow-up of the organization's activities.

In the framework of the Senegal River Basin water resources management, PASIE is an action program which defines a whole set of measures designed to correct, optimize and monitor the environmental impacts of the So-called first generation structures (Diama and Manantali dams as well as their ancillary structures). This is mainly achieved through the Observatory for Environment, which objective aims to provide the OMVS and the three riparian member states with the necessary information to measure or assess the environmental impacts induced by the dams and the hydro-agricultural projects sited in the Senegal River Basin, their management systems and the induced effects as a result of modifications brought to the hydrologic regime of the river and the sanitary conditions thereof.

The Observatory publishes on an annual basis "A state of the environment in the basin" including hydraulic and hydrologic data in the valley. Some data like water level at locations around the two dams are in real time and other information might not be the same. The information supplied to Mauritania through the OMVS can be very useful if used within a framework of M&E in water sector, when implemented. However, currently there is no clear implemented IWRM plan in Mauritania and thus the info obtained from OMVS is not utilized as it should be.

#### 4.2.8 Climate Change

The Mauritanian government, through Ministry of Rural Development and Environment, and Climate Change project unit in the Ministry of Environment, has launched an Adaptation Program of Action on Climate Change (PANA-RIM) in the year 2004 (Mauritania Action Plan is attached in Appendix). In accordance with the Adaptation Action Program on Climate Change (PANA-RIM), future adaptation options regarding water resources are aimed at continuing the implementation of national agriculture, livestock and ecosystem protection strategies mainly.

More specifically, the following actions have been incorporated into this project: (i) Improvement in the monitoring of piezometric groundwater networks and water quality, (ii) Improvement of water resources management, (iii) establishment of a balance between the availability of water resources and water needs for irrigation and consumption for the population and livestock and (iv) support to the dissemination of water saving technologies for irrigation. In the Climate Change action plan, the Climate change Project Unit in the Ministry of urban development is responsible for initiating and coordinating any related project under the technical supervision of the Ministry of Hydraulics and Water (MHE) in addition to private sectors and donors. The department of Agriculture and Centre of Natural Water

Resources (NWRC) are also involved in case of groundwater projects. However, as of 2012, there seems to be minimum achievement with respect to the climate adaptation and monitoring plan with scarce fragmented efforts in individual directories. Examples are found in the NWRC, which database has occasional records for scattered observations of piezometric levels in some groundwater wells with various temporal scales but not being used for real evaluation and action taking.

#### 4.2.9 Specific Recommended Actions

- Adopt the institutional setup illustrated in Figure 4
- Allocate financial resources for supporting existing databases such as DPSC MySQL database and SIPPE2 access database to be the initial step towards a single integrated Management Information System in water sector.
- Implement a national rural water and sanitation database system hosted in the Ministry of Water and Sanitation

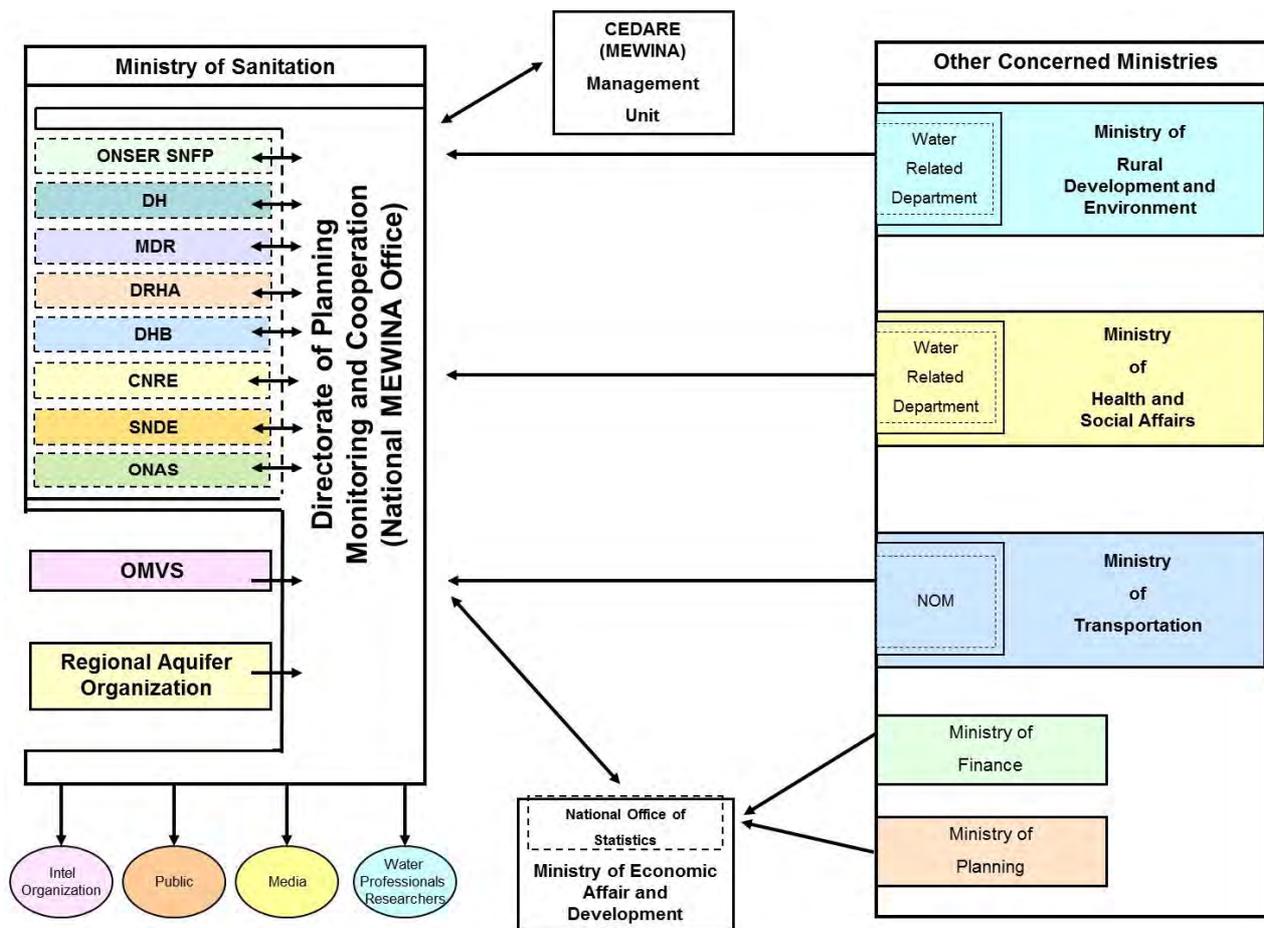


Figure 4. Proposed Institutional Setup for M&E in Water Sector (Mauritania)

### 4.3 Libya: Water M&E Systems

The following diagnosis of water M&E sub-systems is abridged from the national Rapid Assessment Report (Misr Consultants, 2013 e).

#### 4.3.1 Environment and Water Quality

The major related organization is the Environment General Authority (EGA). It has a mandate of monitoring all indicators / parameters related to safe water supply and appropriate sanitation.

Currently, EGA has weak systems and capacities for M&E. However, EGA is restructuring and is adding a GIS hub that can be used for mapping contaminant levels. Opportunities exist for generating and sharing data between EGA and the General Company for Water and Wastewater (GCWW) and the General Water Authority (GWA) as part of a national M&E system. The available infrastructure can be upgraded to use of the data management capabilities of the HydroManager at the GWA in storing and sharing collected information by the EGA.

#### 4.3.2 Field Surveys

Several physical surveys take place which can be useful to the M&E of the water sector. Agricultural farm surveys are conducted to determine areas under full, partial, rain-fed, and other irrigation practices as well as water demands. They are also used to collect data on crop productivities, incomes, labor force, power consumptions, fertilizers, pesticides, etc...and to monitor used water sources, agricultural water consumptions, etc...

Data and information on sources, quantities of water used and wastes generated by Industry, tourism, oil and gas production and manufacturing, and other sectors as well as their variations, and treatments used, etc..., are also collected via physical surveys. Domestic water and wastewater house surveys include items such as: number of connections and water use rates, water quality and variations, and user satisfaction levels and complaints. They are used also to monitor and evaluate performance and pressure distributions and variations, user compliance expenses and net returns.

The above surveys can be supplemented with other related surveys such as population, climate, environment, economy, legislation to ensure a comprehensive M&E database.

#### 4.3.3 Census and Socio-economic Conditions

The last census was conducted in 2006. Census is being conducted once every 10 years. Census results are interpolated during in-between years by the General Authority for Information (GAI). These interpretations are generally good because the population growth in Libya is very small and almost constant (1.8- 2.0%, 2007).

GAI produces a yearly book that has separate sections on population, water, and agriculture. Census data is clearly being used in water and sanitation M&E. However, there is always a discrepancy due to accounting Non-Libyans at times and eliminating them at other times.

Socio-economic surveys have not been made in the field of WSS so their significance or relevance cannot be evaluated. Except for few areas, the boundaries that cover the census are the same as those covering the WSS M&E.

#### 4.3.4 Meteorological Networks

The National Center for Meteorology (NCM), a semi-autonomous organ of the Ministry of Transportation, is responsible to run and operate meteorological stations in Libya. There are 19 meteorological continually working stations. Its data can be incorporated into the water sector's M&E program simply through identifying the data and indicators needed by the water sector and having these data / indicators exported at the required frequency to the national water database. As an example, climate affects demand rates in both agricultural sector and domestic sector markedly. Collected temperature and rainfall information are essential to water resources studies and climate change impact studies.

Climatic data sometimes lacks continuity and has a limited coverage. Advances in geo-statistics and interpolations techniques have made it possible to fill data gaps, however, with good reliability.

#### 4.3.5 Agriculture Sector

The Ministry of Agriculture is the government agency responsible for monitoring any information related to the agriculture sector. However, formal agriculture monitoring networks are weak with some reliance on weather stations located within agricultural projects or near them but with no independent networks.

In Libya, the private sector is the major player in agricultural production and has no monitoring network as traditionally this has been the mandate of the state . As such, the information collected by this sector is not reliable and it cannot be integrated or used by the water sector (MEWINA local office, 2013).

#### 4.3.6 Universities and Research Institutions

Almost all major universities and technical institutions in Libya are working in the water sector. Generally, these institutions utilize M&E data. In some instances, they provide data through projects which rely on monitoring of parameters of use to the water sector, e.g., monitoring changes in water quality of basins or in sections of cities, etc.

#### 4.3.7 Transboundary Water

Libya relies mainly on groundwater transboundary basins: NSAS and NWSAS. Formal bodies for managing these basins have been established and consulting/ coordination committees formed. Basic water quality and water level monitoring systems have been established; however, accurate withdrawal figures are not available. Modeling efforts are used to estimate withdrawals. Illegal mining is a key issue.

The following information is being shared between riparian countries?

- Basic water quality and water level data are being shared between riparian countries with quantity estimates at times.
- The quality of the data shared is good as is its timeliness.
- Many of the wells lying within the transboundary systems are monitored by the GWA so they are part of the national water sector M&E system.

The monitored data can be integrated into the water sector's M&E system simply by classifying the transboundary basin among the national water sources and ensuring that the same indicators used by the national M&E system are applied to the transboundary systems. M&E networks used should be unified (no duplication) and whosever transboundary monitoring system is better should be used.

#### 4.3.8 Climate Change

Libya is at risk from climate change, partly because of current severe water scarcity, high temperatures, and its generally low elevation with respect to the Mediterranean sea level. However, climate change impacts have not been systematically assessed for Libya (Goodland, 2007). A few academic studies have been conducted to assess the impact of climate change on certain regions of Libya with some relevance to the water sector.

A national committee on climate change and a project to assess the impact of climate change has been formed but they are still in their evolutionary stages. The issue of climate change and its impacts are being undertaken by a multi-sectoral committee headed by EGA. The National Strategy for Integrated Water Resources Management does not address climate change adaptation explicitly. Thus, Libya needs to direct more resources to formally address the issue of climate change impacts and formulate adaptation strategies that can respond to future climate change challenges.

#### 4.3.9 Specific Recommended Actions

- Adopt the institutional setup illustrated in Figure 5
- Allocate more financial resources to the operation and maintenance of wells, for information systems such as GIS, and for DBMSs like Hydro Manager;
- Support GWA to be the hub for any nationwide M&E activity. It is one of the oldest institutions around. It hosts the Hydro Manager and GIS lab. It stores all information related to the GMMRP, the GCD, and the transboundary aquifers.

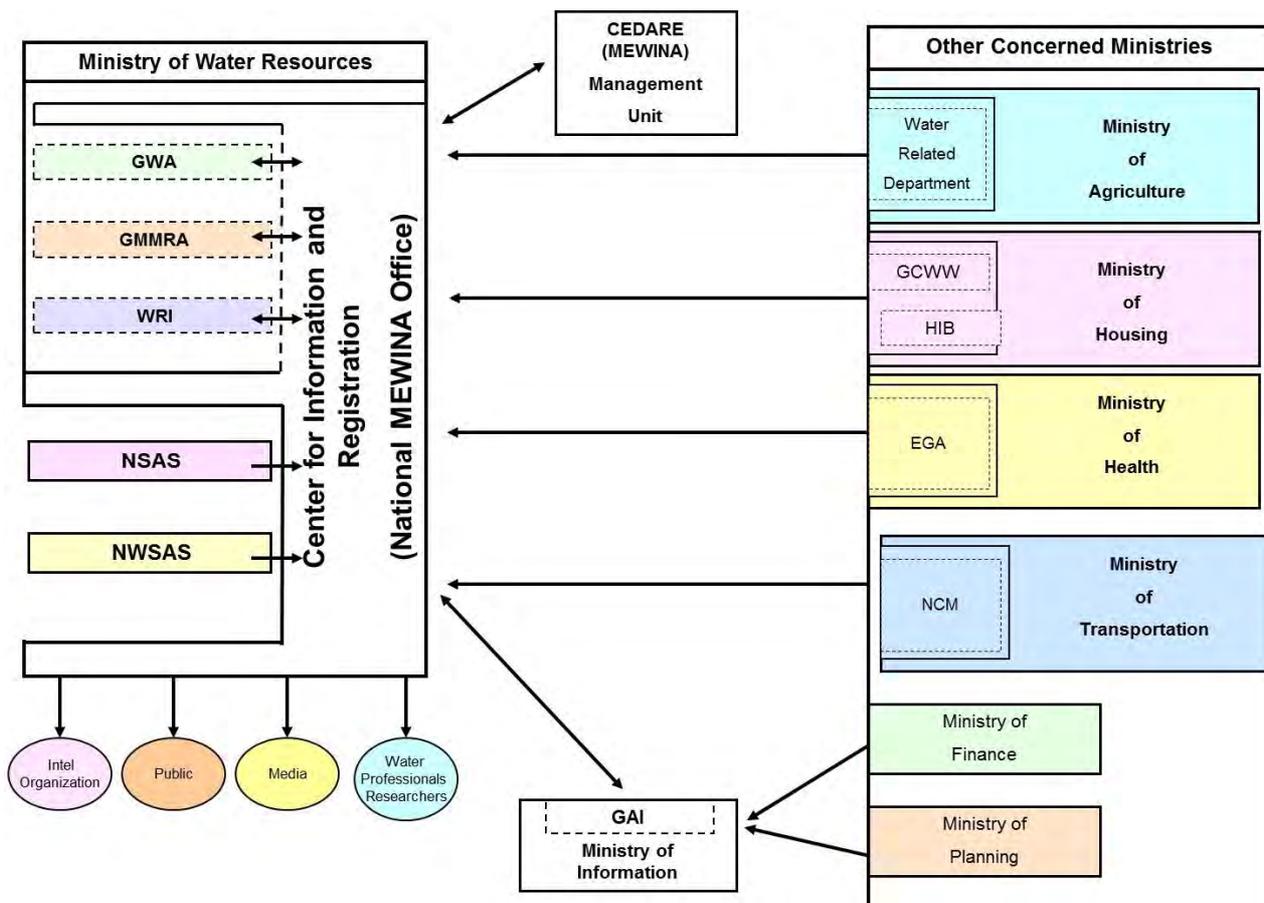


Figure 5. Proposed Institutional Setup for M&E in Water Sector (Libya)

#### 4.4 TUNISIA: Water M&E Systems

The following diagnosis of water M&E sub-systems is abridged from the national Rapid Assessment Report (Misr Consultants, 2013 f).

##### 4.4.1 Environment and Water Quality

The Ministry of Environment is the leading organization in charge of environmental protection and sustainable development through its agencies: DGEQV and DGDD. Other organizations like Trust, ANPE, ONAS, APAL, CITET, ANGED, and OTEDD play important roles in environmental protection. Each of these ministries/organizations has its own system for collect, store, analyze and disseminate data. ANPE and ONAS are among the actors in the water sector. The ANPE is responsible for monitoring and control of all sources of emission and pollution. It operates a network of water quality measuring stations. Contrôle de la Pollution des Eaux (COPEAU), is a Tunisian initiative that monitors water quality for different watersheds, dams, lagoons, and aquifers. Samples are collected once every six months, analyzed, stored in a database, and published in annual reports. This database is a subsystem of SINEAU. ONAS also has its own system of monitoring and evaluation as it was described in the Rapid Assessment Report. Sharing of data between the various stakeholders with the Ministry in charge of water and related institutions is currently on as needed basis. However, SINEAU will bring together all the subsystems related to water, including the environmental subsystem.

##### 4.4.2 Field Surveys

In Tunisia, physical surveys are not conducted on a planned or regular basis. However, ad-hoc surveys are being conducted to collect data according to the governmental and private stakeholders needs. Collected data can be used to fill data gaps regarding: geography, topography, soil properties, land use, roads, services, housing, water quality, rural water/wastewater infrastructure, etc... Such data can be better sourced if their acquisition and collection are planned so that accuracy, reliability, homogeneity, representativeness and harmonization are gained. Also efforts should be directed to data/information storage, analysis and management.

##### 4.4.3 Census and Socio-economic Surveys

The census and socio-economic surveys are often used in the M&E of water and sanitation. They provide baseline data on population and household's statistics. Censuses are done in Tunisia every ten years; in which the last one was conducted in 2004 and the next will be completed in 2014.

INS is the governmental authority that is responsible to conduct the census and to collect and provide statistical data. They publish their results on their website (<http://www.ins.nat.tn/>). Data is reported for the administrative divisions: 24 governorates, 264 delegations, 264 towns, and 2073 sectors. However, sometimes between two censuses (ten years apart) new areas, new towns, new delegations can be created, causing high risk of error in the estimation of the population and its distribution for interpolated years. More efforts are needed to homogenize the water districts (like SONEDE's districts) with the formal division of the country.

##### 4.4.4 Meteorological Networks

There are two providers of meteorological and rainfall data in Tunisia: (i) DGRE, operating 850 rainfall stations and 120 hietograms (70 with automatic data acquisition system), (ii) and the INM that belongs to the Ministry of Transport which has 212 weather stations (information available at <http://www.meteo.tn/default.html>). Rainfall data is recorded continuously in weather or synoptic

stations, and collected every day in the secondary stations. Rainfall data of DGRE are collected, verified, stored in the management system of water resources (SYGREAU). It is processed, homogenized, analyzed, and disseminated in newsletters, monthly reports of specific directories.

The parameters measured by the INM in its weather stations are: rainfall, air temperature, soil temperature, humidity, solar radiation, evaporation, wind speed and wind direction, and atmospheric pressure. The information (data and meteorological observations) collected from these stations can be used directly in the case of rainfall data, or after treatment in the case of statistics on the rain or in the determination of evaporation rates.

The meteorological station data is also essential for the development of weather (rain forecast in particular, aired on website). The rainfall data from the INM are distributed in newsletters and presented to the media in near real time. Specialized bulletins such as agro-meteorological bulletins are also presented to subscribers, radio, and television.

#### 4.4.5 Agriculture Sector

MARH is the leading water resources organization in Tunisia that conduct field measurements and/or data collection, through its departments and sub-organizations, to monitor rainfall and runoff, as well as groundwater piezometric head and quality. It delegates DGRE (one of MARH's sub-organs) to manage the national information system on water (SINEAU) linking the following three networks in one DBMS: SYGREAU (DGRE), CHIP (ANPE), and SISOLS (DGACTA). The information from these networks is reliable; already integrated into the monitoring and evaluation of the water sector, and is used as such for planning and management of water resources.

#### 4.4.6 Universities and Research Institutions

Several universities, training institutions, and research centers are involved at different levels in the water sector M&E, either directly or indirectly. They are attached to the Ministry of Higher Education and Scientific Research (CERTE, ENIT, ENIS, Faculty of Science, etc..) or the Ministry of Agriculture (IRESA: INRGREF, IRA, INAT, etc. ...). Generally, these institutions utilize M&E data. However, they sometimes provide data to the water sector through funded projects and research activities. Examples include: water quality data, results of analyses, results of surveys, groundwater mapping, groundwater modeling, etc...).

The water sector can better relate, serve, and draw upon academic, technical and other institutions through joint programs, in which the research needs of the sector are identified and researched in collaboration with government authorities.

#### 4.4.7 Transboundary Water

Some wadis (catchments) in the west of the country, on both sides of the Tunisian-Algerian border, are of transboundary nature. Nevertheless, SASS project is the only transboundary organization that collects data on the shared water among Tunisia, Libya, and Algeria.

The project was able to combine national expertise from the three countries to dynamically assess such fossil resource and to establish a trilateral dialogue mechanism. This approach has helped to inform policy makers on the development prospects and the risks associated with them but also.

As such, the monitoring systems that have been implemented by the three countries are composed of: (i) a network of rainfall and hydrometric stations for the measurement and collection of rainfall and runoff

in the shared catchments (wadis), (ii) a piezometric network that monitors drawdowns and water quality for SASS.

For SASS, basic water quality and water level monitoring systems have been established. Accurate withdrawal figures are not available. Modeling efforts are used to estimate withdrawals; where Illegal mining is a key issue.

The quality of the shared data is good as is its timeliness. Many of the wells lying within the transboundary systems are monitored by the GWA so they are part of the national water sector M&E system. The monitored data can be better integrated into the water sector's M&E system simply by classifying the transboundary basin among the national water sources. The transboundary organization M&E should be compatible with the national M&E and upgraded to its level if needed.

#### 4.4.8 Climate Change

Tunisia has initiated a vision, reflecting on the impacts of climate change on agriculture and natural resources targeting sustainable adaptation measures. This vision was incorporated in the National Strategy for the adaptation of Tunisian agriculture and ecosystems to climate change (prepared by MARH in 2006). In order to monitor the impact of climate change on both internal and transboundary, water resources, Tunisia through the MARH has been continuously measuring key climate change indicators to aid decision making in water resources and agriculture. However, several ministries are involved in monitoring of the data required for climate change studies, since such task cannot be rendered to one specific ministry or organization.

#### 4.4.9 Specific Recommended Actions

- Adopt the institutional setup illustrated in Figure 6.
- Complete of the development of SINEAU and its various components to evolve as a decision support system that can be used to report on the progress in achieving the Millennium Development Goals and the African Water Vision 2025, and other international commitments.
- Construct new subsystems (DBMSs) in institutions, which do not have them, to be integrated to SINEAU.
- Bridge the institutional gap for rural sanitation and reallocate mandate among the key player: GDA, DGGREE, and ONAS.

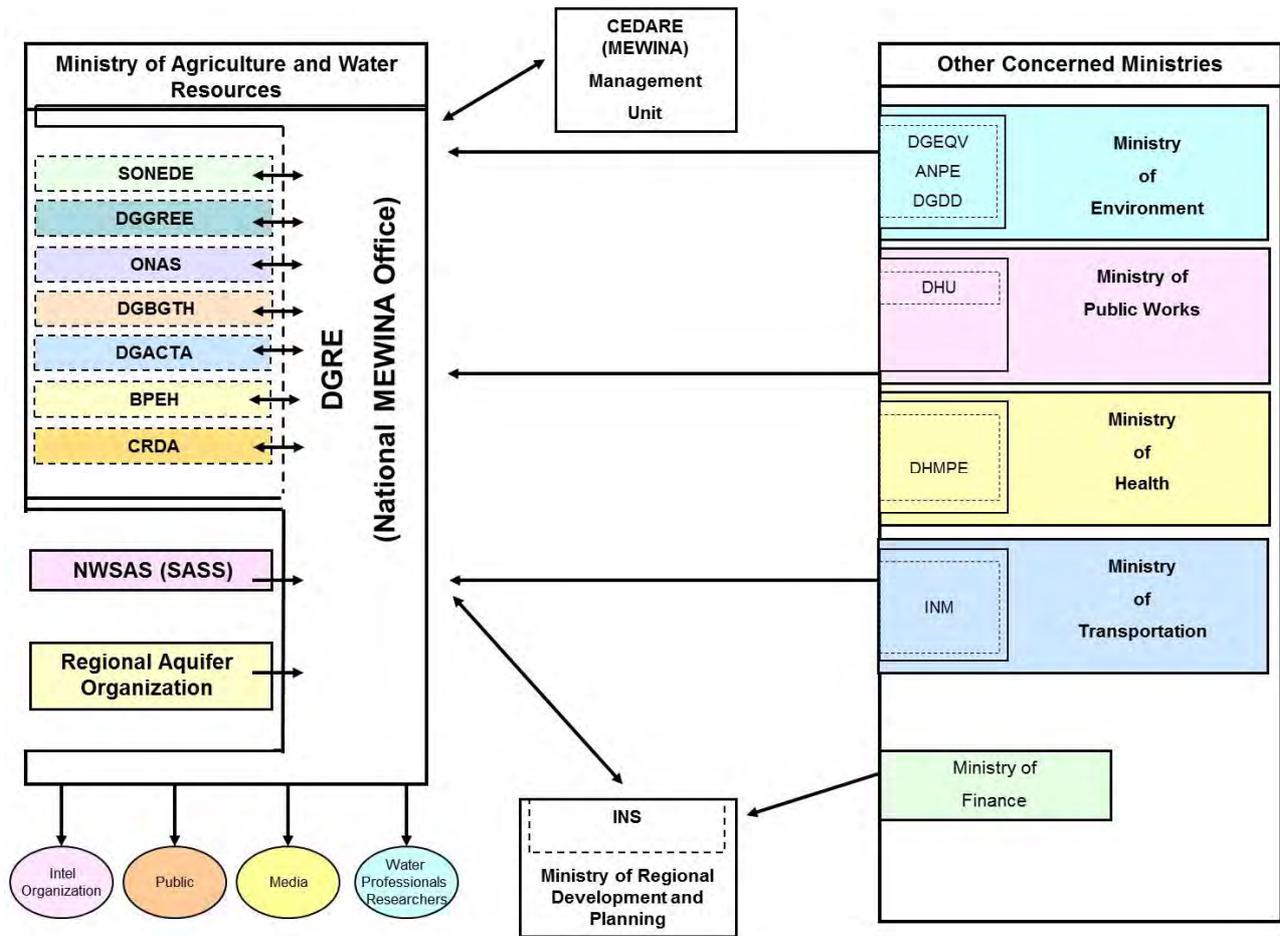


Figure 6. Proposed Institutional Setup for M&E in Water Sector (Tunisia) NAGLAA

## 4.5 ARAB REPUBLIC OF EGYPT: Water M&E Systems

The following diagnosis of water M&E sub-systems is abridged from the national Rapid Assessment Report (Misr Consultants, 2013 g).

### 4.5.1 Environment and Water Quality

There are three major related organizations that protect the Environment in Egypt: (1) MSEA, (2) MoHP, and (3) MWRI. The main mandate of the MSEA or, Egyptian Environmental Affairs Agency (EEAA) as mostly referred to in Egypt, is to protect Egypt's environmental ecosystems including: air, water, soil, and protectorates from any adverse anthropogenic environmental impacts. It also monitors all indicators/parameters related to industrial discharges and the water quality of receiving water bodies.

MWRI has the mandate to protect River Nile, groundwater resources, irrigation and drainage canals and Lake Nasser. Its NWRC operates a water quality network covering River Nile, Lake Nasser, irrigation canals and the groundwater wells. Results are being assembled in annual reports that are shared with the Cabinet of ministers.

MoHP undertakes monitoring and evaluation in order to protect public health. It mainly focuses on potable water quality, River Nile quality, and the water quality of agricultural canals.

Currently, the three involved organizations have well positioned systems and capacities for monitoring, evaluation and reporting. MSEA and MWRI are more advanced in terms of technical and infrastructural capabilities of the DBs (or IMS) and the skill of the involved employees than the MoHP. The MSEA is the most advanced in terms of good reporting mechanisms. GIS tools and IMS are being used extensively by MSEA and MWRI. Opportunities exist for generating and sharing data between the two ministries. MSEA coordinates its reporting with MWRI and MoHP through the Higher Ministerial Committee for Water that involves all water related ministries in Egypt including MESA, MWRI, and MoHP.

### 4.5.2 Field Surveys

The following regularly conducted physical surveys generate data that can be useful to the monitoring and evaluation of water sector:

- Agricultural farm surveys to determine water demands, productivities, incomes, labor force, power consumptions, fertilizers, pesticides, etc... to determine / monitor / evaluate used water sources, agricultural water consumptions, crop yield, etc...
- Industry, tourism, oil and gas production and manufacturing, and other sectors: sources, quantities of water used and effluent volumes generated their variations, treatment technologies used, etc.
- Domestic water and wastewater surveys to determine / monitor number of connections and water use rates, water quality and variations, user satisfaction levels and complaints, pressure distributions and variations, user compliance and net returns, Expenses (capital, operation and maintenance) and Maintenance records.

The above surveys can be supplemented with other related surveys such as population, climate, environment, economy, legislation to ensure a comprehensive database.

#### 4.5.3 Census and Socio-economic Surveys

In Egypt, the last census was conducted in 2006. Census is being conducted once every 10 years. CAPMAS produces a yearly statistics book that has separate sections on population, water, agriculture, economy, etc... Census data is clearly being used in IWRM and WSS monitoring and evaluation. It is the official source for providing, preparing, and publishing statistical data, information and reports for all organizations, ministries, universities, research centers, and international organizations.

Census data is available for all communities. It is relevant to water sector monitoring and evaluation, since it is related to all other sectors whose water demands depend heavily and directly most of the time on population served. This is especially the case for Water Supply and Sanitation (WSS). Because census is conducted every 10 years, interpolations have to be made to feed WSS monitoring and evaluation with census information. Socioeconomic surveys are still in a pre-mature phase in the field of WSS so their significance or relevance cannot be evaluated.

The boundaries that cover the census are the same as those covering the WSS monitoring and evaluation as there is a good coordination between CAPMAS and MDWSF.

#### 4.5.4 Meteorological Network

The EMA is the lead organization in conducting meteorological surveys. EMA has over 80 years of data about meteorological parameters such as temperature, wind speed, wind direction, relative humidity, barometric pressure, sun shine duration, radiation and rainfall. The Automatic Weather Systems (AWOS) provide meteorological observations to users in real-time basis by gathering data from a network of automatic weather stations through various communication channels. However, this is not applied to all weather stations yet.

In terms of data validation and quality, EMA uses the World Meteorological Organization (WMO) data quality control procedures. In addition, the planning and monitoring department of EMA assesses the performance of the services offered by EMA sections. This assessment is based on users' satisfaction and that EMA users included: Aviation Authority, Navigation Authority, Army, MWRI, and MALR. In terms of reporting, EMA produces daily weather reports for all Egyptian governorates and daily marine forecast reports, monthly air quality reports, and trend report once every 30 years. All reports can be accessed on EMA website. In addition, a 10 daily report is prepared for use by the MALR. In addition to the EMA, the MSEA and MWRI have operational weather stations but data is not typically shared with EMA.

The data collected are utilized by the water sector. As an example, climate affects demand rates in both agricultural sector and domestic sector markedly. Collected temperature and rainfall information are essential to water resources studies and climate change impact studies.

#### 4.5.5 Agriculture Sector

The MALR is the government agency responsible for monitoring any information related to the agriculture sector. MALR keeps records and collects data on cropping pattern, total cropped area, crops, yield production and average net return at different disaggregated graphical scales.

MALR's Economic affairs section is responsible for data gathering, processing and annual reporting and produces an annual report. The Agriculture Research Center (ARC), universities, other research centers, and NGOs also play a role in gathering and processing M&E agricultural information; however, these

information are scattered in unorganized publications that do not serve the purpose of periodic reporting. In terms of data quality and validation methods, there is not a structured methodology for quality checks: MARL has enough staff to survey and collect field data. In addition, the production data of each crop is also collected from what the agriculture cooperatives receive from farmers and quality checks are conducted for data verification.

In terms of existing M&E systems in MALR, each project has its own M&E system with indicators that suit its objective(s). In addition to this, MALR has an M&E unit in the Agriculture Research Center (ARC) that is responsible for M&E at the ministry level. However, this system is still under implementation. Upon completion, availability of dynamic information about crop water use, crop yield, and cropping pattern is important for agricultural water use allocation, studying the impact of climate change on water use and crop yield, and help decision makers in prioritizing water use allocations in general.

#### 4.5.6 Universities and Research Institutions

Almost all major universities and technical institutions in Egypt are working in the water sector: Cairo University, Ain Shams University, Alexandria University, Agriculture Research Center, National Research Center,...etc.

Generally, these institutions utilize M&E data. For example, researchers obtain long-term data about climate variables, cropping pattern, water use to study the impact of climate change on irrigation and agriculture. In some instances, they provide data through projects which rely on monitoring of parameters of use to the water sector, e.g., monitoring changes in water quality of basins or in sections of cities, etc.

The National Water Research Centre (NWRC) supports the MWRI management efforts. Most of its institutes collect and measure in the field several hydrologic, hydraulic, and meteorological parameters through their research projects, experimental stations, and pilot areas. Most of these monitoring efforts do not qualify as neither a routine practice nor systematically functioning network.

Nevertheless, within the NWRC, three institutes are focusing on the Nile, the irrigation and drainage canals and groundwater. These are the Nile Research Institute (NRI), the Drainage Research Institute (DRI) and Research Institute for Groundwater (RIGW). NWRC and its institutes established and maintain a national water quality monitoring network (see the section on National Water Quality Monitoring Network). NWRC operates a modern, well equipped water quality laboratory (CLEQM) and operates a database where all MWRI water quality data is consolidated and an annual national water quality status report is issued.

The National Water Quality Monitoring network covers 106 sites on the drainage canals and 54 sites on the irrigation canals of the Nile Delta. Monthly data collection is carried out on a basis by DRI during each year. More than 34 water-quality parameters are collected. Different modes of visualization and analysis are exercised to furnish enough information to judge the overall Water Quality Status of the Delta drainage system. Groundwater quality is monitored at over 250 wells in the Nile Delta, Nile valley, Eastern and Western, and Sinai once a year by RIGW. Most of wells are observation wells that are used to monitor groundwater table. For the main river Nile, Lake Nasser and drains outfalls in Upper Egypt there are more than 65 sites where water quality samples are collect twice a year by NRI. Also the Water

Resources Research Institute (WRI) possesses a hydro-meteorological network that utilized for flash flood studies in Sinai Peninsula.

The water sector can better relate, serve, and draw upon academic, technical and other institutions through joint programs where the research needs of the sector are identified then researched by these institutions. Good communication sealed with sound cooperation agreements to conduct result-based research is essential for success. A catalyst that speeds and ensures sustainability of the research is funding by the water sector.

#### 4.5.7 Transboundary Water

Egypt relies mainly on River Nile, a transboundary basin. In addition, Egypt groundwater resources are closely linked to the NSAS.

Currently the distribution of Nile water is governed by the Nile Waters Treaty - a bilateral agreement between Egypt and Sudan that was signed in November 1959. More recently, countries of the Nile Basin have been engaged in regional cooperative activities, like the Nile Basin Initiative (NBI). As for the NBI, there are historic data for trend analyses for many years that were acquired from many sources over the years. OSI inventory consists of hydrologic, environmental, and socio-economic data. However, data sharing agreement is neither mature not fully implemented. There is a history of mistrust between basin countries, limiting openness in data sharing. As such, beside the information collected by the Egyptian MWRI to server NBI, no transboundary collected data is of use to Egypt's M&E activities in the current time.

On the other hand, the Joint Authority for Study Development of the Nubian Sandstone Aquifer System (NSAS) coordinates the activities of the NSAS to make sure that the transboundary resource is sustainably managed, including M&E activities.

Basic water quality and water level data are being monitored and shared between riparian countries with quantity estimates at times. Accurate withdrawal figures are not available. Modeling efforts are used to estimate withdrawals. Illegal mining is a key issue. The quality of the data shared is good as is its timeliness. Many of the wells lying within the transboundary systems are monitored by the MWRI so they are part of the national water sector M&E system.

The monitored data can be integrated into the water sector's M&E system simply by classifying the transboundary basin among the national water sources and ensuring that the same indicators used by the national M&E system are applied to the transboundary systems.

#### 4.5.8 Climate Change

Egypt is at risk from climate change, partly because of current severe water scarcity, high temperatures, and its generally low elevation with respect to the Mediterranean Sea level. However, there are no practical measures being undertaken to monitor the impact of climate change on domestic and transboundary water resources and WSS. Many ministries, universities, research centers (EEAA, ARC, NWRC, .....governmental associations) conduct studies to assess the impact of climate change on certain regions of Egypt with some relevance to the water sector.

The Egyptian NWRP for the year 2017 explicitly addressed climate change impacts and adaptation. The MSEA dedicates a full reporting chapter about climate change in its annual state of environment report It

collects data from EMA and MWRI to help in producing its annual report. In addition to the State of Environment Report that reports on Climate Change, Egypt prepares (MSEA) National Communication Reports to United Nations Framework Convention on Climate Change (UNFCCC) to meet its obligations under Kyoto protocol. These reports are prepared every 2-3 years, upon funding availability, and describe the national actions and efforts that have been done in response to climate change and the needs for technical and financial support.

The CCRMP, initiated in 2008 and just terminated in 2013 addressed both climate change adaptation and mitigation issues in Egypt. On the other hand, the adaptation side of the CCRMP paved the road for providing tools to make strategic decisions to strengthen institutional capacity to develop and implement national strategies in the areas of water resources, agriculture, and other climate change vulnerable sectors.

#### 4.5.9 Specific Recommended Actions

- Adopt the institutional setup illustrated in Figure 7.
- Stretch the NWRP-CP their mandate to include an annual state of water rapid assessment report, making use of the existing database and capacity used for the M&E&R of the NWRP.
- Use more structured water quality indicators that group priority contaminants at different times of the year are needed for better reporting on water quality. The MSEA can lead this effort.
- Harmonize methodologies of the MDWSF for defining water and sanitation indicators with JMP definitions as an addition to existing definitions to be able to compare indicators on a similar basis.
- Implement a sector wide M&E plan with respect to water supply & Sanitation that builds up on existing MARS DBMS and produced annual report but to include more disaggregated data and information.
- Increase budgetary allocations for monitoring programs especially in rural areas.

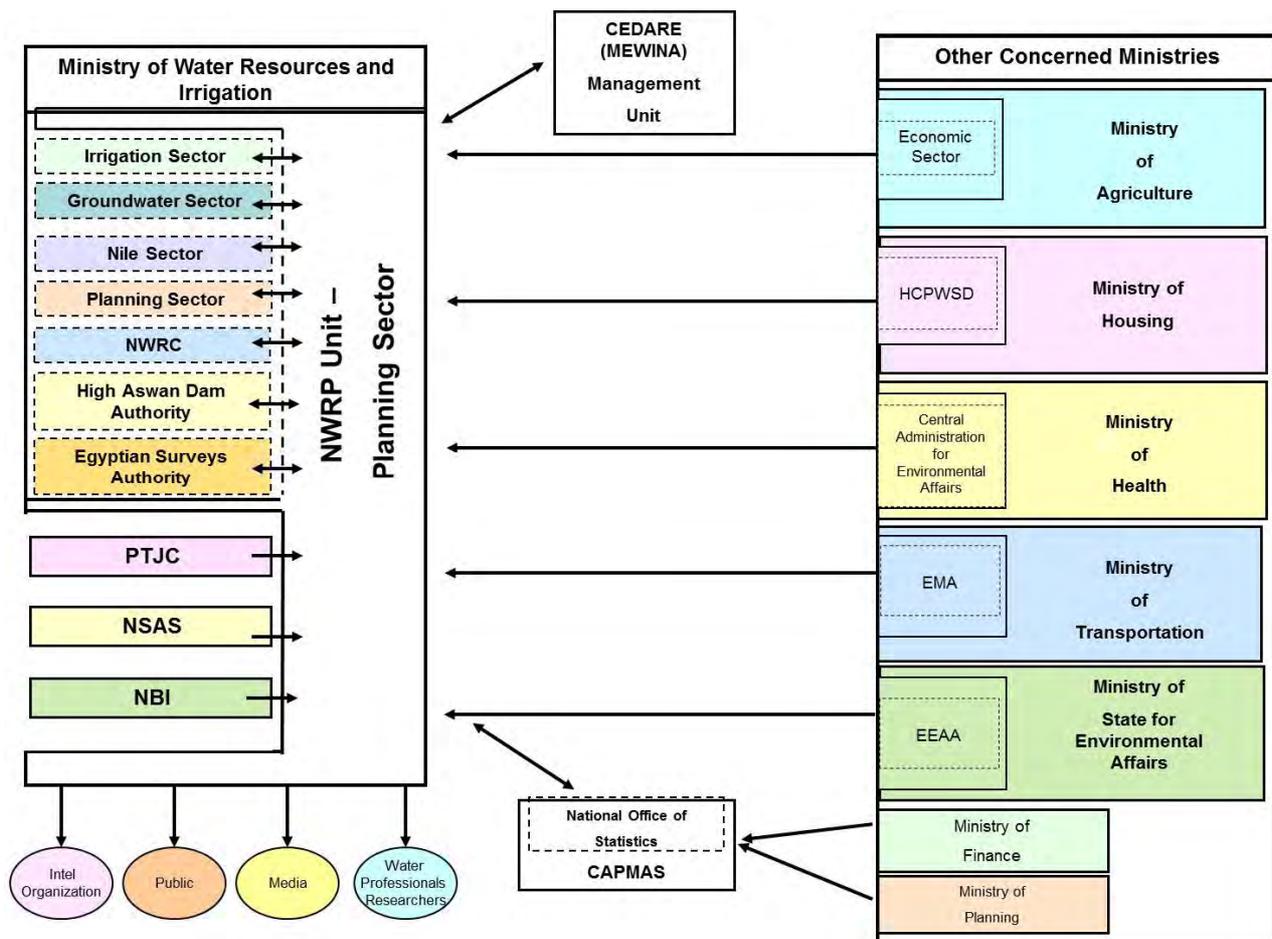


Figure 7. Proposed Institutional Setup for M&E in Water Sector (Egypt)

## 4.6 Common Standardization and Harmonization Actions

The first suggested common action is to adopt the proposed “Standardization and Harmonization Framework” in terms of definition, selected adequate set of indicators, monitoring methods, indicators computation, IMS, and institutional setup as well as the measures for quality control to strengthen existing data collection processes. The recommended common actions are classified into four areas: enhancement of institutional arrangement, improving monitoring processes, capacity building, and effective dissemination and raising awareness.

### 4.6.1 Enhancement of Institutional Arrangements

- Review, approve, and the proposed institutional setup and develop proposals for enhancements to facilitate the effective and efficient implementation and ongoing operation of the M&E programs carried out by the different entities
- Establishment of the MEWINA management unit at CEDARI to coordinate and manage the operation of the N-AMCOW initiative for M&E in water sector as well as administration of the MEWINA-IMS.
- Develop protocols for sharing the data collected from all relevant national organizations/institutions to be entered into the MEWINA-IMS (by expansion of the built-in procedures for data sharing, or by a separate, specific new agreement).

### 4.6.2 Improving Monitoring Processes

Most of the following actions are adapted from NBI Monitoring Strategy Report, (2012).

#### a. *Meteorological and Hydrometric Monitoring*

- Assess the existing meteorological/hydrometric monitoring stations (gauging or observation wells)
- Design an optimal network that satisfies the evaluation requirement of the adequate set of indicators
- Upgrade existing stations to be included in the optimal network of hydrometric monitoring stations.
- Install new stations for the optimal network of meteorological/hydrologic monitoring stations.
- Continuously operate and maintain all stations within the optimal network of meteorological/hydrologic monitoring stations.

#### b. *Water Quality and Environmental Monitoring*

- Review the existing water quality monitoring networks and programs to confirm suitability for inclusion in the national water quality monitoring network.
- Design the national water quality network according to the guidelines “Water Quality Management and Monitoring and Information Dissemination Package: for Mashreq and Maghreb Countries” (El-Sayed and Fahmy, 2007)
- Establish or revise the water quality standards for the different water bodies and uses.
- Establish or upgrade central water quality lab so that it can meet the national water quality monitoring network objectives (adequate or adequate set of indicators)

- Continuously operate and maintain all stations within the national water quality monitoring network.

**c. Sediment Monitoring**

- Undertake sediment load monitoring at all large dams' reservoirs as a part of the hydrologic monitoring program.
- Develop and implement a program of bathymetric surveys for sedimentation monitoring for selected lakes (natural and large dams' reservoirs).

**d. Census and Socio-economic Surveys**

- Update population census data every 10 years (every five years if financial resources are available) by the means of physical surveys and well-designed questioners that include an elaborated section on water supply and sanitation.
- For in-between years, employ the Demographic Analysis-Population Analysis System developed by the UN Population Division- DESA to project population data and household surveys to sample/estimate water and sanitation data according to JMP approach.

**e. Support Transboundary Water Resources Monitoring Initiatives**

Endorse and partly support either the existing or proposed water resources M&E systems of the Nile Basin, Senegal Basin, North-West Sahara Aquifer System (NWSAS), and Nubian Sandstone Aquifer System (NSAS).

- For in-between years, employ the Demographic Analysis-Population Analysis System developed by the UN Population Division- DESA to project population data and household surveys to sample/estimate water and sanitation data according to JMP approach.

**4.6.3 Effective Dissemination and Raising Awareness**

- Produce national and regional baseline report of the water sector using the adequate set of indicators according to the structure and format suggested by standardization and harmonization framework
- Design and implement a common dissemination and awareness raising strategy
- Produce simple and attractive material (posters, brochures, and CDs) on water sector using the adequate set of indicators for public or community awareness campaigns
- Implement public awareness campaigns to pave the way for successful household and socio-economic surveys through the media and local field officers extension services

**4.6.4 Capacity Building**

- Assess training needs in all relevant areas of water M&E region member countries.
- Develop a federated web-based information system to support reporting needs and define functioning as envisaged in the proposed "Standardization and Harmonization Framework"
- Design and implement training programs for professionals in all relevant national entities within the proposed institutional setup in the areas of:
  - Design of hydrometric/ meteorological monitoring networks

- Census and socio-economic questioners design
- Statistical and geo-statistical analysis
- RS, GIS, hydrologic modeling techniques
- Web-based databases and information systems
- Water quality and environment monitoring management
- New technologies to be introduced into the water M&E programs.
- Design and implement training programs for all data monitoring technicians, in the areas of:
  - Earth measurement and surveys
  - Bathymetric surveys
  - Water quality and sediment sampling
  - Hydrometric measurement
  - Census and socio-economic (household) surveys
- Prepare and implement training programs as

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## ANNEX A: TERMINOLOGY AND DEFINITIONS

<b>Term</b>	<b>Definition</b>
<b>Abstraction</b>	Removal of water from any source, either permanently or temporarily. Note: abstracted water may not be consumed. See withdrawal.
<b>Agricultural water withdrawal (km<sup>3</sup>/year)</b>	The annual quantity of water withdrawn for agricultural purposes. This includes water used for irrigation and livestock watering. It includes water drawn from renewable freshwater resources as well as through over abstraction of renewable groundwater or withdrawal of fossil groundwater, as well as the use of agricultural drainage water, desalinated water and treated wastewater.
<b>Aquifer</b>	Permeable water bearing formation capable of yielding exploitable quantities of water
<b>BOD</b>	The biological oxygen demand (BOD) measures the strength of an organic waste by the amount of oxygen consumed in breaking it down. A sewage overload in natural waters exhausts the water's dissolved oxygen content. While wastewater treatment by contrast reduces BOD.
<b>Blue water</b>	The liquid flowing in rivers, lakes and aquifers SIWI et al. 2005.
<b>Context</b>	Description of the production capacity of a territory (such as water storage facilities)
<b>Data item</b>	An occurrence of a data element – a term used by statisticians to refer to parameters or variables
<b>Degradation</b>	a concept related to the lowering of a water body
<b>Depletion</b>	continued withdrawal of water from groundwater or other water body at a greater rate that the rate of replenishment
<b>Domestic water withdrawals (km<sup>3</sup>/year)</b>	The annual quantity of water withdrawn for domestic purposes. It includes renewable freshwater resources as well as any over-abstraction of renewable groundwater or withdrawal of fossil groundwater or the use of desalinated water or treated wastewater. It is usually computed as the total water withdrawn by public distribution network. It can include that part of industries that is connected to the network.
<b>Economic water Scarcity</b>	It results from insufficient human capacity or financial capacity to provide water (lack of infrastructures to store, transport to where water is needed).
<b>Ecosystem services</b>	The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other non-material benefits. The classification of water as a provisioning service rather than a regulating service is debated, but this does not affect its general meaning.
<b>Environmental flow</b>	A concept related to the quality and quantity of water within any surface or subsurface water body that provides water flows sufficient to maintain ecosystem functions and the goods and services dependent on those functions
<b>Exploitable water resources</b>	(Also called manageable water resources or water development potential): The water resources considered to be available for development under specific social, economic and environmental conditions. The computation of exploitable water resources considers factors such as dependability of the flow, extractable groundwater, and minimum flow required for non-consumptive use.
<b>Term</b>	<b>Definition</b>
<b>Functioning</b>	Physical and economic flows occurring during a period of time on a territory (such as water used by different sectors)

<b>Governance</b>	The web of policies, institutional arrangements and management instruments mobilized by decision-makers who impact the functioning of the production system of a territory
<b>Green water</b>	Water in soils and vegetation in the form of soil moisture and evaporation.
<b>Green water Footprint</b>	The volume of rainwater and irrigated water that evaporates during the production process. This is mainly relevant for agricultural products (e.g. crops, trees) where it refers to the total rainwater evapo-transpiration (from fields and plants).
<b>Groundwater</b>	Subsurface water occupying the saturated zone.
<b>Index</b>	A set of aggregated or weighted parameters or indicators that describes a situation.
<b>Indicator</b>	A parameter or a value derived from parameters, which points to, provides information about, and describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value.
<b>Industrial water withdrawals</b>	The annual quantity of water withdrawn for industrial purposes. Usually this refers to the self-supplied industries not connected to any distribution network. It includes renewable freshwater resources as well as any over-abstraction of renewable groundwater or withdrawal of fossil groundwater or the use of desalinated water or treated wastewater. In some situations, industrial water withdrawals are included in the domestic water withdrawal category.
<b>Fossil water</b>	Water infiltrated into an aquifer during an ancient geological period under climatic and morphological conditions different from the present and stored since that time. See Nonrenewable water.
<b>Reservoir</b>	Body of water, either natural or manmade, used for storage, regulation and control of water resources.
<b>Renewable water</b>	A concept referring to water quantities that are maintained by the hydrologic cycle and thus renewed on a predictable basis.
<b>Non-renewable water</b>	Groundwater bodies (deep aquifers) that have a negligible rate of recharge on the human time-scale and thus can be considered as non-renewable. While renewable water resources are expressed in flows, non-renewable water resources have to be expressed in quantity (stock). See also fossil water.
<b>Non-point source Pollution</b>	Non-point sources are pollutants mobilized by precipitation as it flows over the land and infiltrates the soil.
<b>Parameter</b>	A property that is measured or observed.
<b>Precipitation</b>	(1) Liquid or solid products of the condensation of water vapor falling from clouds or deposited from air on the ground. (2) Amount of precipitation (as defined under (1)) on a unit of horizontal surface per unit time.
<b>Performance</b>	Judgment of the functioning of a production system related to explicit objectives of the system or recognized norms or standards.
<b>Performance indicator</b>	Qualitative or quantitative information about results or outcomes associated with and effort that is comparable and demonstrates change over time.
<b>Term</b>	<b>Definition</b>
<b>Physical water scarcity</b>	It occurs when the demands outstrips the lands availability to provide the needed water (dry areas are scarce are not necessarily water scarce).
<b>In stream water Use</b>	The use of water in situ (e.g. for a dam for hydroelectric power or navigational transport on a river).

<b>Off stream water use</b>	The use of water that requires removal from the natural body of water or groundwater aquifer (e.g. pumping or diversion for municipal, agricultural or industrial uses).
<b>Point source Pollution</b>	Point sources are pollutants from pipeline and other readily identifiable sources.
<b>Pollution</b>	Chemicals or other substances in concentrations greater than would occur under natural conditions.
<b>Sewage treatment</b>	The removal of physical, chemical and biological contaminants from wastewater, both surface drainage and domestic, using physical, chemical and biological processes.
<b>SMART indicators</b>	Indicators selected as: S Specific; M Measurable; A Achievable; R Relevant; T Time-bound
<b>Surface water</b>	Water that flows over and is stored on the ground surface.
<b>Sustainable Development</b>	Political compromise between social equity, economic efficiency and environmental sustainability (identified as IWRM for the water sector).
<b>Treated wastewater</b>	Water that has received primary, secondary or advanced treatment to reduce its levels of pollutants or health hazards and is subsequently released back to the environment. It can also be a form of effluent.
<b>TARWR</b>	Total actual renewable water resources: defined as the sum of internal renewable water resources (IRWR) and external renewable water resources (ERWR), taking into account the quantity of flow reserved for upstream and downstream countries through formal or informal agreements or treaties, and the possible reduction of external flows due to upstream water abstraction. IRWR comprise the average annual flow of rivers and recharge of groundwater (aquifers) generated from endogenous (internal) precipitation. ERWR are the portion of the country's renewable water resources that is not generated within the country, including inflows from upstream countries and a portion of border lakes or rivers. TARWR distinguishes between the natural situation, which corresponds to a situation without human influence (natural renewable resources), and the current or actual situation
<b>Total water withdrawals (km<sup>3</sup>/year)</b>	The annual quantity of water withdrawn for agricultural, industrial and domestic purposes. This is either expressed as a single total (if no desegregation is available by sectors of use) or as the sum of agricultural, domestic and industrial withdrawals. It does not include other categories of water used, such as for cooling of water plants, navigation, recreation, mining, etc., which are sectors that are characterized by a very low net consumption rate
<b>Variable</b>	Something that varies or is prone to variation. Parameters are also variables.
<b>Virtual water</b>	The virtual water content of a product (a commodity, good or service) is the volume of freshwater used to produce the product, measured at the place.
<b>Term</b>	<b>Definition</b>
<b>Water availability</b>	A concept expressing the amount of water available at a location.
<b>Water quality</b>	Water quality refers to the physical, chemical, biological and organoleptic (taste related) properties of water.
<b>Water scarcity Water shortage Water stress</b>	Terms such as water shortage, scarcity and stress are commonly used interchangeably. They all relate to an excess of demand over available supply. Water scarcity is a relative concept that can occur at any level of supply and demand. It refers to an imbalance of supply and demand under prevailing institutional arrangements and/or prices. It occurs when so much water is withdrawn from lakes, rivers, or groundwater that supplies can no longer

	adequately satisfy all human and ecosystem requirements. Similarly water shortage is used to describe a state where levels for water supply do not meet the adequate levels necessary for basic needs. And Water stress would be the symptomatic consequence of scarcity.
<b>Water supply</b>	See water availability.
<b>Water use</b>	Refers to use of water by agriculture, industry, energy production and households, including in stream uses such as fishing, recreation, transportation and waste disposal.
<b>Water sector</b>	All means and activities devoted to creating net added value from the water resources available in a given territory (Examples of 'net added value' include production of food, maintaining or improving the health status of the population through provision of potable water etc.).
<b>Withdrawals (km<sup>3</sup>/year)</b>	Water withdrawals represents the gross amount of water for a given use, either surface water or groundwater. It includes conveyance losses, consumptive use and return flow. It does not include water reserved for uses with a low consumptive rate or on stream water uses such as navigation, recreation, mining, cooling of power plants etc. see water abstraction.

## ANNEX B: INDICATORS STANDARDIZATION GUIDELINES

### 1. Adequate Set Of Indicators Definitions:

#### 1. Water Availability:

##### I. Blue Water:

a) **Total Internal Renewable Blue water resources:** Long-term average annual flow of rivers and recharge of aquifers generated from endogenous precipitation. Double counting of surface water and groundwater resources is avoided by deducting the overlap from the sum of the surface water and groundwater resources. (FAO)

b) **Surface water Inflow (Natural):** That part of the country's annual renewable surface water resources that are not generated in the country. It includes surface inflows from upstream countries, and part of the water of border lakes and/or rivers without human influence), it also takes into account the quantity of flow protected by formal agreements or treaties, and therefore, it may vary with time. (Modified from FAO)

c) **Surface water Outflow:** Long-term average annual quantity of Surface water leaving the country

d) **Transboundary Groundwater Inflow:** Long-term average annual quantity of groundwater annually entering the country, taking into consideration treaties (FAO)

e) **Transboundary Groundwater outflow:** Long-term average annual quantity of groundwater leaving the country (FAO)

f) **Total external renewable water resources:** the portion of the country's renewable water resources which is not generated within the country (FAO).

g) **Total renewable Blue water resources:** a+f-j

h) **Groundwater recharge from precipitation:** Groundwater Recharge is the total volume of water entering underground sources of water (typically aquifers) within a country's borders from endogenous (internal) precipitation and surface water flow (FAO)

i) **Local runoff:** The amount of precipitation that is neither beneficially abstracted from the atmosphere, nor infiltrated in the ground, but flows overland and routed through channels or joins bigger water bodies.

j) **Overlap between surface water and groundwater:** Part of the renewable freshwater resources that is common to both surface water and groundwater. It is equal to groundwater drainage into rivers (typically, base flow of rivers) minus seepage from rivers into aquifers. (FAO)

##### II. Green Water:

a) **Rainfed:** The total amount of precipitation directly consumed by rain fed agriculture.

b) **Pasture:** The total amount of precipitation directly consumed by pasture areas.

c) **Forest:** The total amount of precipitation directly consumed by forests.

d) **Total Renewable Green Water Resources:** a+b+c

### III. Treated Wastewater & Agricultural Drainage:

a) **Volume of Municipal wastewater produced:** Annual quantity of wastewater generated in the country, in other words, the quantity of water that has been polluted by adding waste. The origin is domestic use (used water from bathing, sanitary, cooking, etc.) It does not include agricultural drainage water, which is the water withdrawn for agriculture but not consumed and returned to the system” (modified from FAO)

b) **Volume of Industrial wastewater produced:** Annual quantity of wastewater generated in the country, in other words, the quantity of water that has been polluted by adding waste. The origin is industrial wastewater routed to the wastewater treatment plant. It does not include agricultural drainage water, which is the water withdrawn for agriculture but not consumed and returned to the system” (modified from FAO)

c) **Volume of Municipal wastewater treated:** Quantity of generated municipal wastewater that is treated in a given year and discharged from treatment plants (effluent). (Modified from FAO)

d) **Volume of Industrial wastewater treated:** Quantity of generated industrial wastewater that is treated in a given year and discharged from treatment plants (effluent). (Modified from FAO)

e) **Volume of produced Agricultural drainage:** Total volume of the water withdrawn for agriculture but not consumed and returned to the system (modified from FAO).

IV. **Desalinated Water:** Water produced annually by desalination of brackish or salt water. It is estimated annually on the basis of the total capacity of water desalination installations (FAO).

### 2. Water Demographics and Human Development:

a) **Internal water resources per capita:** The maximum theoretical amount of water produced internally and actually available, on a per person basis (modified from FAO).

b) **Total renewable water resources per capita:** the maximum theoretical amount of water actually available, on a per person basis (FAO).

### 3. Water Withdrawals, Consumption, and Use:

a) **Abstractions from non-renewable resources:** Total annual volumes abstracted from nonrenewable resources, namely, fossil groundwater.

b) **Abstractions from non-conventional resources:** Total volumes abstracted annually from water resources other than surface and groundwater

c) **Total Annual water withdrawal:** the gross amount of water extracted from all sources, either permanently or temporarily, for all uses. It can be either diverted towards distribution networks or directly used. It includes consumptive use, conveyance losses, and return flow” “modified from Earth Trends’

- d) % of total water withdrawal by sector: Domestic: Percent of water withdrawals used for domestic purposes (FAO)
- e) % of total water withdrawal by sector: Industrial: Percent of water withdrawals used for industrial purposes (FAO)
- f) % of total water withdrawal by sector: Agricultural: Percent of water withdrawals used for agricultural purposes (FAO)
- g) Surface water withdrawal: Annual gross amount of water extracted from rivers, lakes and reservoirs. It includes withdrawal of primary renewable surface water resources and secondary freshwater sources (water previously withdrawn and returned)." (FAO)
- h) Groundwater withdrawal: Total abstractions from groundwater sources, including nonrenewable sources per year
- i) Groundwater withdrawal by sector: Industrial: Total annual abstractions from groundwater sources including nonrenewable sources, for industrial purposes.
- j) % of Non-renewable groundwater withdrawal by Sector: industrial: ratio of annual abstractions from nonrenewable groundwater sources, for industrial purposes to the total annual abstractions from all groundwater sources for industrial purposes, expressed as a percentage.
- k) Groundwater withdrawal by sector: Domestic: Total annual abstractions from groundwater sources including nonrenewable sources, for domestic purposes.
- l) % of Non-renewable groundwater withdrawal by Sector: Domestic: ratio of annual abstractions from nonrenewable groundwater sources, for domestic purposes to the total annual abstractions from all groundwater sources for domestic purposes, expressed as a percentage.
- m) Groundwater withdrawal by sector: Agricultural: Total annual abstractions from groundwater sources including nonrenewable sources, for agricultural purposes.
- n) % of Non-renewable groundwater withdrawal by Sector: Agricultural: ratio of annual abstractions from nonrenewable groundwater sources, for agricultural purposes to the total annual abstractions from all groundwater sources for agricultural purposes, expressed as a percentage.
- o) Green water fraction (%) of total crop water consumption: The ratio of total green water crop consumption to the total overall crop consumption expressed as a percentage.
4. Water and land use changes:
- a) Urban encroachment on green areas (ha lost/yr): The average green areas loss per year, will be estimated by comparing two maps for two different years and dividing the difference in area by the time difference between the two maps.
- b) Equivalent Annual Water Impact of Urban Encroachment on green areas: The total amount of water lost or saved as a direct result of the shift from agriculture to other activities.
- c) Irrigated land: Total water managed agricultural area.

- d) **Average change in irrigated land (ha/yr):** The average annual change in water managed agricultural land.
- e) **Rainfed land:** The total rainfed agricultural area (ha).
- f) **Average Change in rainfed land (ha/yr):** The average annual change in rainfed agricultural land.
- g) **% of irrigated land with treated wastewater:** the ratio of the amount of agricultural lands managed by treated wastewater to the total amount of water managed land, expressed as a percentage.
5. **Water Services and Accessibility:**
- i. **Water Coverage and Accessibility:**
- a) **Urban Water Supply coverage:** Percentage of population provided with piped drinking water in urban areas
- b) **Rural Water Supply coverage:** Percentage of population provided with piped drinking water in rural areas
- c) **Urban Sanitation Coverage:** Percentage of population covered with sanitation in urban areas.
- d) **Rural Sanitation Coverage:** Percentage of population covered with sanitation in rural areas.
- e) **% of population with improved water supply:** An improved drinking-water source is defined as one that, by nature of its construction or through active intervention, is protected from outside contamination” (JMP)
- f) **% of population with improved sanitation:** Defined looking at the following facilities as indicators: Flush or pour-flush (piped sewer system, septic tank, pit latrine), Ventilated Improved Pit (VIP) latrine, pit latrine with slab, composting toilet. (JMP)
- ii. **Water Infrastructure:**
- a. **Total drinking water treatment plant capacity:** Total capacity of all drinking water treatment plants.
- b. **Total wastewater primary treatment plant capacity:** Total capacity of all primary wastewater treatment plants.
- c. **Total wastewater secondary treatment plant capacity:** Total capacity of all secondary wastewater treatment plants.
- d. **Total wastewater tertiary treatment plant capacity:** Total capacity of all tertiary wastewater treatment plants.
- e. **Dam capacity:** The total capacity of all water regulating structures.
- f. **Desalination capacity:** The total capacity of all desalination plants.

iii. **Water and Energy:**

a. **Electricity Generated using Hydropower: Hydropower production as percent of total electricity production (World Bank).**

b. **Hydropower potential: Hydropower production potential.**

6. **Water and Quality:**

a. **Organic Water Pollutant BOD (kg/day): Emissions of organic water pollutants are measured by biochemical oxygen demand, which refers to the amount of oxygen that bacteria in water will consume in breaking down waste. This is a standard water-treatment test for the presence of organic pollutants (World Bank).**

b. **Average dissolved Nitrate level (mg/l): The average amount of dissolved nitrates in surface and groundwater.**

c. **Average dissolved phosphate level (mg/l): The average amount of dissolved phosphates in surface and groundwater.**

7. **Water and Health:**

a. **Diarrhea prevalence (% of children under five): % of children under five suffering from Diarrhea.**

b. **Dracunculiasis reported cases: number of annual incidents of the disease.**

c. **Open defecation practice: Number of people who continue to practice open defecation.**

8. **Water and Climate:**

i. **Extreme Weather Events:**

a. **Flood events in the last two decades.**

b. **Drought events in the last two decades.**

ii. **Changing Precipitation and Evapotranspiration:**

a. **Long –term Precipitation Average in depth: average annual precipitation based on precipitation records of at least 30 years.**

b. **Volume of evaporation and ET: The annual amount of water consumed as evaporation or transpiration from plants.**

c. **Change in precipitation (over a fixed period) : Difference in average annual precipitation in 10 years.**

d. **Change in ET (over a fixed period): Difference in average annual ET over a period of 10 years.**

iv. **Climate Change Adaptation**

a. **National adaptation plan (yes/no).**

## 9. Water Economics:

### i. Water Productivity:

- a. **Industrial water productivity: Agriculture GDP / (Agricultural water withdrawal – Water return to environment)**
- b. **Agricultural water productivity: Economic value added (in US\$) per cubic meter of water withdrawn by agriculture: The gross agricultural revenue divided by the total agricultural water consumption.**

### ii. Tariffs and Affordability:

- a. **Water and Sanitation charges as % of average household income**
- b. **Subsidy (Domestic-industrial-Agricultural): percentage of subsidy applied for different sectors.**

### iii. Water and Finance:

- a. **National Investment in Large Scale Hydraulic projects (\$)**
- b. **Cost of irrigation projects (\$)**
- c. **Overseas Development assistance for Water**

### iv. Water and Trade:

- a) **Virtual-water flows related to trade in crop, animal, and industrial products, per country: Total inflow and outflow of virtual water**
- b) **Water Footprint: Total amount of fresh water that is used to produce the goods and services consumed by the inhabitants of the nation. The water footprint of national consumption can be assessed in two ways. The bottom-up approach is to consider the sum of all products consumed multiplied with their respective product water footprint. In the top-down approach, the water footprint of national consumption is calculated as the total use of domestic water resources plus the gross virtual water import minus the gross virtual-water export (Water footprint.org).**

## 10. Water Policy and politics:

### i. Water and Governance:

- a. **IWRM plan in progress (yes/no)**
- b. **National Water Law (yes/no)**
- c. **Water NGOs: number of officially recognized Non-Governmental Organizations with mandates that are directly related to water.**

### ii. Transboundary issues:

- a. **Transboundary water bodies' dependency Ratio:** the percent of annual renewable water resources that is abstracted from a transboundary water body.
  - b. **Multilateral Agreements Status:** Standpoints on UN water conventions
  - c. **Disputes and agreements over transboundary rivers (international freshwater treaties)**
- iii. **Water Sustainability:**
- a) **Non-Renewable Groundwater Depletion Rate:** The amount of annually abstracted nonrenewable groundwater divided by the nationally identified safe yield.
  - b) **Surface Water sufficiency rate:** The amount of annual surface water abstractions divided by the total annual consumed water.

## UN Initiative set of indicators

### 1- Total Actual Renewable Water Resources per Capita

#### Objective / Rationale:

It is important for planning in all sectors and the comparison between countries of water resources per capita gives a measure of “water wealth”. Countries are poor or scarce in water if they have less than 1000 m<sup>3</sup>/cap; and water stressed if less have less than 500 m<sup>3</sup>/cap.

**Category:** Context

**Issue :** Water scarcity

#### Definition:

It is the theoretical maximum annual volume of water resources available in a country divided by the total number of people of the same country.

The maximum theoretical amount of water actually available for the country is calculated from: sources of water within a country itself, water flowing into and out of a country (off border environmental requirements or treaty commitments). Availability, defined as how much of the annually renewed surface and ground water resource volume is theoretically available for sustainable use.

Actual conditions at a given time take into account human influence either through uptake abstraction of water or through agreements or treaties. Natural conditions (without human influence) are considered stable over time while actual situations may vary with time and refer to a given period.

**Elements of Data and Information:** are presented in Table II.a.1.

#### Method of Computation:

$\text{TARWR} = (\text{EAI} + \text{SWAR} + \text{GAR}) - (\text{Over} + \text{OBER})$	<b>Units:</b> km <sup>3</sup> /yr
$\text{TARWR PC} = (\text{TARWR} * 10^9) / (\text{TPop} * 10^6)$	<b>Units:</b> m <sup>3</sup> /cap/yr

**Table II.a.1 Data and Information Elements of TARWR**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>External Inflows</b>	EAI	External water resources volume entering the country-long term moving average (30 years)	Ann.	Measurements of river flow occurring at the border entry point/s, in case of surface water in case of groundwater it is very difficult to measure, a sophisticated regional groundwater model will be needed	Km <sup>3</sup> /yr
<b>Surface Water Runoff</b>	SWAR	Surface water runoff volumes generated in the country-long term moving average (30 years)	Ann.	Measurements of river flow occurring within the country	Km <sup>3</sup> /yr
<b>Groundwater Recharge</b>	GAR	Ground water recharge (GAR) taking place in the country-long term moving average (30 years)	Ann.	Estimated from measured rainfall, in arid areas, where rainfall is assumed to infiltrate into aquifers	Km <sup>3</sup> /yr
<b>Overlap</b>	Over	The volume in the country of the total resource effectively shared as it interacts and flows in both the groundwater and surface water systems-long term moving average (30 years)	Ann.	Assumed to be zero or estimated by simple hydrologic model	Km <sup>3</sup> /yr
<b>Off Border Environmental Requirement (or Treaty Obligations)</b>	OBER	The volume that flows to downstream countries based on formal or informal-long term moving average (30 years)	Ann.	Measurements of river (or drain) flow occurring at the border exit point/s, in case of surface water in case of groundwater it is very difficult to measure, a sophisticated regional groundwater model will be needed	Km <sup>3</sup> /yr
<b>Total Population</b>	TPop	Sum of urban population (UPop) and rural population (RPop)	Ann.	Demographic census, in between census estimates can be made using assumed growth rates or other statistical techniques	Mill/cap

## 2- Surface Storage Capacity Compared to Potential (or per Capita)

### Objective / Rationale:

With increasing uncertainty, due to climate change, it is impossible to do without some form of water storage, either surface (reservoirs or water harvesting systems) or underground (cisterns, aquifers). The mitigation approach to climate change elevates the need for water storage – small to large – to a higher priority. This indicator focuses on ‘existing coping infrastructures compared to potential.’

**Category:** Context

**Issue:** Climate change

### Definition:

Total developed capacity to store surface water in natural or man-made surface reservoirs created by large dams compared with potential surface storage capacity (or total population). If it is possible to assess ground storage (aquifers) or with capacity to pump where it is most needed, it could be added to the surface capacity to give a measure of the country’s ability to cope with water resources variability (worsened in the context of climate change).

A large dam is that of a height of 15 meters or more from the foundation. If the dam height is between 5 and 15 meters and its reservoir volume is more than 3 Million cubic meters, it is also classified as large dam.

Potential storage (reservoirs) are sited upstream of major demands to take advantage of rainfall in one area to conserve water for use at another location or time. Reservoirs that are too far downstream in relation to basin demands, should not be accounted in the total potential capacity.

**Elements of Data and Information:** are presented in Table II.a.2.

### Method of Computation:

$$SSC = (DSS - CSV) / (DSS - (CSV * 10^{-3}) + PSS)$$

**Units:** Million m<sup>3</sup>

$$SSC\ PC = (DSS - (CSV * 10^{-3})) / TPop$$

**Units:** m<sup>3</sup>/cap

**Table II.a.2 Data and Information Elements of SCC**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Developed Surface Storage</b>	DSS	Total storage volume of fresh water natural lakes and reservoirs created by large dams.	5 yrs	Technical design data drawings for manmade reservoirs; hydrographic surveys and pathmetric maps in case of natural lakes.	Million m <sup>3</sup>
<b>Potential Surface Storage</b>	PSS	Total volume of undeveloped potential storage sites.	5 yrs	GIS spatial analyst can be used to estimate volumes from DEM or DTM with suitable resolution.	Million m <sup>3</sup>
<b>Cumulated Sediment Volumes</b>	CSV	Total sediment volume in all natural or developed reservoirs	Ann.	Monitoring or estimating sediment inflow load in addition to hydrographic surveys and pathmetric maps and GIS spatial analyst	Thous . m <sup>3</sup>
<b>Total Population</b>	TPop	Sum of urban population (UPop) and rural population (RPop).	Ann.	Demographic census, in between census estimates can be made ap using assumed growth rates or other statistical techniques	Mill/c ap

### 3- Irrigated Areas Compered to Irrigation Potential

#### **Objective / Rationale:**

Irrigation increases yields of most crops by 100 to 400 percent, and irrigated agriculture on 20% of cropland (277 million ha) currently contributes to 40 percent of the world's food production. The rest is produced in rainfed agricultural systems (but in some cases with supplementary irrigation in dry periods) (FAO). This indicator shows to what extent suitable soil and available water resources, actually used for food production. In many areas there are irrigation infrastructures but, due to reduction in water availability or malfunctioning, it is not used for agriculture anymore.

**Category:** Context

**Category:** Context

**Issue:** Food security

**Definition:**

Irrigated area is defined as an area equipped with functioning hydraulic structures. Irrigation potential is "Arable land under a specific plan for which water supply is or can be made available and which is (planned to be) provided with irrigation, drainage, flood protection, and other facilities necessary to sustain irrigation." (USBR Land Suitability for Irrigation)

**Elements of Data and Information:** are presented in Table II.a.3.

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Irrigated Areas</b>	IA	Area equipped with functioning hydraulic structures.	Ann.	Field surveys, or estimation using well licenses and irrigation permissions.	Thous . ha
<b>Irrigation Potential</b>	IP	Arable land under a specific plan for which water supply is or can be made available.	5 yrs	Field surveys, soil sampling and classification, water quantity and quality measurement.	Thous . ha

**Method of Computation:**

$$PIA = IA * 100 / IP$$

**Units:** %

**Table II.a.3 Data and Information Elements of RIA**

## 4- Total Rainfall Depth

### Objective / Rationale:

Following this indicator trend over long term period shows how significant is the impact of climate change in terms of flood, droughts and may groundwater depletion.

**Category:** Context

**Issue:** Climate change

### Definition:

Long-term double average over space and time of the precipitation falling on the country in a year, expressed in water depth.

**Elements of Data and Information:** are presented in Table II.a.4.

**Table II.a.4 Data and Information Elements of TRD**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
Total Rainfall Depth	TRD	Total rainfall depth precipitated over the country-long term moving average (30 years).	Ann.	Measurements of national meteorological network, GIS spatial analyst.	mm/yr.

## 5- Installed Hydropower Capacity as % of the Total Installed Electricity Generation Capacity

### Objective / Rationale:

Hydropower is the most important and widely-used renewable source of energy, as it Hydropower represents 20% of world's total electricity production. Approximately two-thirds of the economically feasible potential remain to be developed. There could be untapped hydro resources still in N-AMCOW. Hydropower does not pollute the water or the air and incase of in-stream plants (no dams) it has minimum environmental impacts. This indicator shows to what extent hydropower could contribute to energy production. In many areas hydropower infrastructures is very much dependent on the existence of hydraulic structures that controls and regulate surface water courses.

**Issue:** Energy and Sustainable Development

**Category:** Context

### Definition:

Sum of all generator nameplate power ratings (in GW) from the installed Hydropower Plants as a percentage of the total national capacity to generate electricity from all other sources as well as hydropower (in GW).

**Elements of Data and Information:** are presented in Table II.a.5.

### Method of Computation:

$$PIHC = IHC * 100 / TIEGC \quad \text{Units: \%}$$

**Table II.a.5 Data and Information Elements of PIHC**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
Installed Hydropower Capacity	IHC	Sum of the capacities of the hydropower plants that are functioning (either in stream or attached to hydraulic structures) at the national level.	5 yrs.	National Statistical Book, or directly from the ministry of energy.	GW
Total Installed Electricity Generation Capacity	TIEGC	Sum of the capacities of electricity generation plants either thermal, nuclear, or other renewable source including hydropower.	5 yrs.	National Statistical Book, or directly from the ministry of energy.	GW

## 6- Allocated Public Budget for Water Resource Management

### Objective / Rationale:

Agenda 21 explicitly considers items such as the protection and preservation of freshwater resources. Achieving the MDG's and implementing water resources development and protection projects, typically requires large public investments that get beyond the national financial capacity. However, governments need to show their commitment to international donor agencies, specially with private sector reluctant to get engaged.

### Category: Context

### Issue: Commitment to MDG's

Environmental sustainability

### Definition:

Share of total annual public fund allocated for all water resource management endeavors presented in government budget documents.

**Elements of Data and Information:** are presented in Table II.a.6.

### Method of Computation:

$$PPBAWR = ABWS * 100 / TAPB \quad \text{Units: \%}$$

**Table II.a.6 Data and Information Elements of PPBAWR**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
Total Annual Public Budget	TAPB	Annual governmental budget approved by the parliament.	Ann		Billion \$USD
Allocated Budget to Water Sector	ABWS	Annually allocated budget to water projects or activities of the lead ministry and other related ministries.	Ann		Billion \$USD

## 7- Total Water Withdrawals Compared to TBRWR (Water Exploitation Index WEI)

### Objective / Rationale:

The pressure on renewable water resources is increasing in many countries with growing population and their multiple demands. Environmental performance can be assessed against domestic objectives and international commitments. The MDG reporting process has now included this MDG water indicator under its strategic Objective/Goal 7 (ensure environmental sustainability).

**Category:** Function

**Issue:** Environmental sustainability

### Definition:

An MDG water indicator defined as the total annual volume of freshwater withdrawn for agricultural, industrial and domestic purposes. It includes renewable freshwater resources as well as potential over-abstraction of renewable groundwater or withdrawal of fossil groundwater and eventual use of desalinated water or treated wastewater. It does not include other categories of water use, such as for cooling of power plants, mining, recreation, navigation, fisheries, etc., which are sectors that are characterized by a very low net consumption rate.

**Elements of Data and Information:** are presented in Table II.b.1.

### Method of Computation:

$$TWW = (WWI + WWIN + WWD)$$

**Units:** km<sup>3</sup> / yr.

$$WEI = (TWW * 100) / TBRWR$$

**Units:** %

**Table II.b.1 Data and Information Elements of TWW**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
Water Withdrawn for Irrigation	WWI	It includes water annually withdrawn for irrigation purposes.	Ann.	Metering at the field gate or pumping well. Estimation is possible based on cropping pattern, water requirement (meteorological data) and assumed application and conveyance efficiency.	km <sup>3</sup> / yr.
Water Withdrawn for Industrial Uses	WWIN	It is usually computed as the total water withdrawn annually by self-supplied industries not connected to any distribution network.	Ann.	Self-monitoring, operation record and field surveys as well as data collection campaign.	km <sup>3</sup> / yr.
Water Withdrawn for Domestic Uses	WWD	It is usually computed as the total water withdrawn annually by the public distribution network. It can include that part of the industries, which is connected to the domestic network.	Ann.	Discharge measurement at the outlet of the treatment plants or well fields. Otherwise, metered connection and assumed distribution efficiency.	km <sup>3</sup> / yr.
	TBRWR		Ann.		km <sup>3</sup> / yr.

## 8- Percent of Population with Access to Improved Drinking Water Sources

### Objective / Rationale:

It gives an indication of the level of satisfaction of people basic needs. It is used to measure progress in reaching the Millennium Development Goals 7-Target 7C (UN, 2008). The world is on track for meeting the MDG 2015 water supply target. Current trends suggest that more than 90% of the global population will use improved drinking water sources by 2015.

**Category:** Performance

**Issue:** Public Health / MDG's

### Definition:

The proportion of the population (total, urban and rural) with sustainable access to an "improved" water source is the percentage of the population who use any of the following types of water supply for drinking: piped water, public tap, borehole or pump, protected well, protected spring or rainwater. Improved water sources do not include vendor-provided water, bottled water, tanker trucks or unprotected wells and springs.

"Access" is defined for urban areas as access to an improved source within 200 meters of a dwelling or housing unit. For rural areas, within reasonable distance is taken to mean that a family member need not spend a "disproportionate" part of the day collecting water. "Sustainable" means that water is available during the time(s) of the year when the water supply is least reliable.

No specific level of water quality is implied, but access must be to water used for drinking, cooking, cleaning and bathing. "Improved" source includes sources that, by nature of their construction or through active intervention, are protected from outside contamination, particularly fecal Coliform.

**Elements of Data and Information:** are presented in Table II.c.1.

### Method of Computation:

$PRPDW = (RPDWC * 100) / RPop$	<b>Units:</b> %
$PUPDW = (UPDWC * 100) / UPop$	<b>Units:</b> %
$TPop = UPop + RPop$	<b>Units:</b> Mill. Cap
$PPAIDWS = ((UPDWC + UPDWC) * 100) / TPop$	<b>Units:</b> %

**Table II.c.1 Data and Information Elements of PPAIDWS**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Urban Population</b>	UPop	Households who dwell in urban centers and areas, where water and sanitation services can easily be provided.	Ann.	Household sizes are computed into population figures. Demographic census (Typically 5 every years), in between census estimates can be made using assumed growth rates or other statistical techniques.	Mill.Cap
<b>Rural Population</b>	RPop	Households who dwell out of urban centers and areas. They settle in the countryside, desert which is difficult to be provided with water and sanitation services.	Ann.	Household sizes are computed into population figures. Demographic census (Typically 5 every years), in between census estimates can be made using assumed growth rates or other statistical techniques.	Mill.Cap
<b>Urban Population Drinking Water Coverage</b>	UPDWC	Urban population who use any of the following types of water supply for drinking: piped water, public tap, borehole or pump, protected well, protected spring or rainwater.	Ann.	Five year census or in between random household surveys is used to calculate the proportion of the population with access to improved drinking water. A linear regression line is drawn through these points to estimate the coverage for a certain year.	Mill.Cap
<b>Rural Population Drinking Water Coverage</b>	RPDWC	Rural population who use any of the following types of water supply for drinking: piped water, public tap, borehole or pump, protected well, protected spring or rainwater.	Ann.	Five year census or in between random household surveys is used to calculate the proportion of the population with access to improved drinking water. A linear regression line is drawn through these points to estimate the coverage for a certain year.	Mill.Cap

## 9- Percent of Population with Access to Improved Sanitation

### Objective / Rational:

This indicator thus provides a measurement of both the potential exposure of the population to infectious agents associated with poor sanitation, and of the action taken to improve domestic sanitation. It is used to measure progress in reaching the Millennium Development Goals 7-Target 7C (UN, 2008). Good sanitation is important for urban and rural populations, but the risks are greater in urban areas where it is more difficult to avoid contact with waste.

**Category:** Performance

**Issue:** Public health

### Definition:

Proportion of the urban and rural population with access to improved sanitation refers to the percentage of the population with access to facilities that hygienically separate human excreta from human, animal and insect contact. Improved sanitation facilities encompass flush or pour flush toilet/latrine to: piped sewer system, septic tank, pit latrine; ventilated improved pit (VIP) latrine; pit latrine with slab; and composting toilet. Bucket latrines are not included in the list.

“Access” means that the household has a private improved facility or shares a facility with others in the building or compound. Regarding shared facility, a cut-off number of families per facility might be set. For example, if more than five families are sharing a facility they would not be considered to have “access.”

**Elements of Data and Information:** are presented in Table II.c.2.

### Method of Computation:

$$PRPS = (RPSC * 100) / RPop$$

**Units:** %

$$PUPS = (UPSC * 100) / UPop$$

**Units:** %

$$TPop = UPop + RPop$$

**Units:** Mill. Cap

$$PPAIS = ((UPSC + RPSC) * 100) / TPop$$

**Units:** %

**Table II.c.2 Data and Information Elements of PPAIS**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Urban Population</b>	UPop	Households who dwell in urban centers and areas, where water and sanitation services can easily be provided.	Ann.	Household sizes are computed into population figures. Demographic census (Typically 5 every years), in between census estimates can be made using assumed growth rates or other statistical techniques.	Mill. Cap
<b>Rural Population</b>	RPop	Households who dwell out of urban centers and areas. They settle in the countryside, desert which is difficult to be provided with water and sanitation services.	Ann.	Household sizes are computed into population figures. Demographic census (Typically 5 every years), in between census estimates can be made using assumed growth rates or other statistical techniques.	Mill. Cap
<b>Urban Population Drinking Water Coverage</b>	UPSC	Urban population who use any of the following types of sanitation systems: flush or pour flush toilet/latrine to: piped sewer system, septic tank, pit latrine; ventilated improved pit (VIP) latrine; pit latrine with stab; and composting toilet.	Ann.	Five year census or in between random household surveys is used to calculate the proportion of the population with access to improved sanitation. A linear regression line is drawn through these points to estimate the coverage for a certain year.	Mill. Cap
<b>Rural Population Drinking Water Coverage</b>	RPSC	Rural population who use any of the following types of sanitation systems: flush or pour flush toilet/latrine to: piped sewer system, septic tank, pit latrine; ventilated improved pit (VIP) latrine; pit latrine with stab; and composting toilet.	Ann.	Five year census or in between random household surveys is used to calculate the proportion of the population with access to improved sanitation. A linear regression line is drawn through these points to estimate the coverage for a certain year.	Mill. Cap

## 10- Water Productivity in Irrigated Agriculture

### Objective / Rational:

Resource use efficiency is an important aspect of economic growth. In regions with water shortages, water use efficiency is very important, particularly in irrigated systems that withdraw the largest part of the water. This indicator measures the intensity of water use in terms of volumes of water per unit of value added in dollars, or to jobs created, or to unit product. It is an indicator of pressure of the economy on the water resources.

**Category:** Performance

**Issue:** Economy / Efficiency

### Definition:

The gross value contributed by irrigated agriculture to the society per unit of water.

“Value” produced could be defined in non-monetary terms in order to look at how different agricultural systems, including fishery and livestock, perform for different objectives (economic, health, livelihood). This water productivity indicator could be defined as follow: tons produced by irrigated agricultural activity per cubic meters of water used.

**Elements of Data and Information:** are presented in Table II.c.3.

### Method of Computation:

$$WPIA = TIAP / WWI$$

**Units:** kg/m<sup>3</sup>

**Table II.c.3 Data and Information Elements of WPIA**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Water Withdrawn for Irrigation</b>	WWI	It includes water annually withdrawn for irrigation purposes.	Ann.	Metering at the field gate or pumping well. Estimation is possible based on cropping pattern, water requirement (meteorological data) and assumed application and conveyance efficiency.	km <sup>3</sup> /yr.
<b>Total Irrigated Agriculture Production</b>	TIAP	Total annual crop production in terms of weight	Ann.	Cropping patterns and field surveys/data collection campaign to estimate production per unit area for each crop.	Mill. ton /yr.

## 11- Ratio Annual Hydropower Production to the Installed Hydropower Capacity

### **Objective / Rationale:**

Global use of hydropower increased at a rapid rate during last decade. Hydropower use reached a record 3,427 terawatt-hours, or about 16.1 percent of global electricity consumption, by the end of 2010. The cost of hydropower is relatively low, making it a competitive source of renewable electricity. The average cost of electricity from a hydro plant larger than 10 megawatts is 3 to 5 U.S. cents per kilowatt-hour. Hydropower is also a flexible source of electricity since plants can be ramped up and down very quickly to adapt to changing energy demands.

**Issue:** Energy and Sustainable Development

**Category:** Performance

### **Definition:**

Sum of electricity produced from all hydropower plants (in GW-hrs) at the national level as compared to the sum of all generator nameplate power ratings (in GW) from the installed hydropower plants.

**Elements of Data and Information:** are presented in Table II.c.4.

### **Method of Computation:**

$$RAHP = AHP / IHC$$

**Units:** hrs

**Table II.c.4 Data and Information Elements of RIA**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Annual Hydropower Production</b>	AHP	Sum of the electricity produced by all (either in stream or attached to hydraulic structures) at the national level.	5 yrs.	National Statistical Book, or directly from the ministry of energy.	GW-hrs
<b>Installed Hydropower Capacity</b>	IHC	Sum of the capacities of the hydropower plants that are functioning (either in stream or attached to hydraulic structures) at the national level.	5 yrs.	National Statistical Book, or directly from the ministry of energy.	GW

## 12- Quality of Freshwater Systems

### **Objective / Rationale:**

A main concern relate to the degradation of water quality and the impacts of water pollution (eutrophication, acidification, toxic contamination) on human health, on aquatic ecosystems, and on the additional cost for producing 'improved drinking water'. The WWAP (2006) estimates that every day, 2 million tons of human wastes are disposed of in water courses and that 70 percent of industrial wastes in developing countries are dumped untreated into waters where they pollute the usable water supply. Pollution loads from diffuse agricultural sources are a concern in many countries.

**Category:** Performance

**Issue:** Environmental sustainability / Public health

### **Definition:**

Total number of analyzed water samples, that failed to meet the intended standards, compared to the total number of collected samples in all/any water quality monitoring program/network.

Water samples are collected from: rivers, fresh lakes, irrigation canals, agriculture drains, or groundwater aquifers. Standards, typically, determine the maximum allowable concentration of different pollutants in a water body. They may be intended for specific water use or for maintaining aquatic ecosystems.

**Elements of Data and Information:** are presented in Table II.c.5.

### **Method of Computation:**

$$PWQS = (NWQFS * 100) / TNWQCS$$

**Units:** %

**Table II.c.5 Data and Information Elements of PWQS**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Number of Water Quality Failing Samples</b>	NWQFS	Number of samples failed to meet the standards for one water quality parameter or more, during a year.	Ann.	Water quality monitoring network program and preset concentration standards as well as reliable analytical laboratory.	Samples
<b>Total Number of Water Quality Collected Samples</b>	TNWQ-CS	Number of samples failed to meet the standards for one water quality parameter or more, during a year.	Ann.	Water quality monitoring network program and preset concentration standards as well as reliable analytical laboratory.	Samples

### 13- Percent of Population Connection Wastewater Treatment

**Objective / Rationale:**

Even appropriately treated wastewater is eventually returned to the environment and may have significant impact on both quantity and quality of natural water resources, as well as health if reused in agriculture or fishery.

The extent of secondary and tertiary treatment provides an indication of efforts to reduce pollution loads. When interpreting this indicator it should be noted that wastewater treatment is at the center of countries efforts to abate pollution.

**Category:** Performance

**Issue:** Environmental sustainability / Public health

**Definition:**

Percent of population who is not only connected sanitation systems but also to public wastewater treatment plant (secondary, and tertiary).

“Secondary” is basically biological treatment, while and tertiary is the chemical treatment.

**Elements of Data and Information:** are presented in Table II.c.6.

**Method of Computation:**

$TPop = UPop + RPop$	<b>Units:</b> Mill.Cap
$PPCWWT = (TPCWWT * 100) / TPop$	<b>Units:</b> %

**Table II.c.6 Data and Information Elements of PPCWWT**

Element	Symb.	Definition/Data Requirement	Freq.	Measurement/Estimation Method	Units
<b>Total Population</b>	TPop	Sum of urban population (UPop) and rural population (RPop).	Ann.	Demographic census, in between census estimates can be made using assumed growth rates or other statistical techniques	Mill. Cap
<b>Total Population Connected to Wastewater Treatment Plant</b>	TPC-WWT	Population who is not only connected sanitation systems but also to wastewater treatment plant.	Ann.	Household sizes are computed into population figures and service providers record on household connection.	Mill. Cap

## 14- Documented and Approved IWRM Policy/Plan (APP-AfDB, 2010)

### Objective / Rationale:

Integrated Water Resources Management (IWRM) presents a model for managing water resources based on sound principles of good governance. IWRM is essentially a political process, providing a viable framework for sustainable use and management of water resources at catchment or basin level. The overall goal is to have water resource allocations in line with sustainable use, economic efficiency and social equity principals. Basin plans should be developed incorporating stakeholder views on management and development priorities for the basin.

**Category:** Governance

### Elements:

- A. Progress is being made towards integrated water resources management through pilots or on-going programs.
  - B. Water allocations are in line with sustainable use, social equity and economic efficiency.
  - C. Functional transboundary watershed management mechanisms are in place.
  - D. Basin-level plans are regularly updated through participatory involvement of basin stakeholders and incorporate their views and priorities.
- Climate change and its potential impacts have been incorporated into the planning, management and use of water resources.

### Method of Computation:

Each element is assigned a score as follows: 1: Poor 2: Unsatisfactory 3: Fair 4: Satisfactory 5: Good

$$IWRM = ( A + B + C + D ) / 4$$

## 15- Water Legislation Framework (APP-AfDB, 2010)

### Objective / Rationale:

Legislation is crucial to policy implementation. In most African states, the water sector's legal framework is a combination of related water resources, utilities, health and environmental laws and regulation dating back often to colonial times. Typically, their updating is a complex and on-going effort.

**Category:** Governance

### Elements:

- A. Sector laws and regulations are up-to-date and being implemented.
- B. Regulation achieves efficient pricing and consumer protection, as well as equity, efficiency and sustainability in allocation and management of water resources.
- C. Contracts and agreements between parties (private/public) are enforceable, contract law is adhered to.
- D. Legislation supports policies and strategy implementation and avoids duplication, gaps and conflicts in institutional mandates and roles.

### Method of Computation:

Each element is assigned a score as follows: 1: Poor 2: Unsatisfactory 3: Fair 4: Satisfactory 5: Good

$$WLF = (A + B + C + D) / 4$$

## 16- Effective Institutions (APP-AfDB, 2010)

### Objective / Rationale:

The efficiency and effectiveness of the water institutions directly affects sector governance. Due to institutions overlap and often have conflicting interests and responsibilities, rights and regulations are difficult if not impossible to enforce.

Key issues are the extent of decentralization and whether or not the responsibilities allocated to lower tiers of government have been matched with the necessary authority and resources (financial, human and logistical).

Although several countries use informal regulation mechanisms, in each, the degree of independence from government and political influence or interference needs to be assessed, particularly from the perspective of consumer protection and fairness to all parties.

### Category: Governance

### Elements:

- A. Institutional rules and responsibilities are clear and separated with minimum overlap, gaps, duplication and/or conflict.
- B. Approaches used by sector institutions reflect principles of good governance in that they are transparent, inclusive, and equitable.
- C. The regulatory framework provides for:
  - a. Complaint and recourse mechanisms
  - b. Setting of fair tariffs
  - c. Assurance of service standards, and
  - d. Market competition
- D. Skills, capabilities, assets, resources (human and financial) and mandates are decentralized in ways that efficiently and effectively support responsibilities at regional and local levels.
- E. Capacity building has ensured adequate competencies and at all levels.

### Method of Computation:

Each element is assigned a score as follows: 1: Poor 2: Unsatisfactory 3: Fair 4: Satisfactory 5: Good

$$EI = (A + B + C + D + E) / 5$$

## 17- Effective Transboundary Water Organization/Schemes

### Objective / Rationale:

All of N-AMCOW countries share transboundary aquifer or river basins either with each other or with countries outside the region. The efficiency and effectiveness of the management of this water directly depend very much on the existence transboundary management agreements, schemes, or organization. Such organization affects significantly national water sector governance. They could overlap with national water institutions and often have conflicting interests and responsibilities, rights and regulations. Key issues are the extent of harmonization with national governance structure decentralization and the availability of financial, human and logistical resources.

### Category: Governance

### Elements:

- A. Institutional rules and responsibilities are clear and separated with minimum overlap, gaps, duplication and/or conflict with national governance structure.
- B. Approaches used by transboundary organization reflect principles of good governance in that they are transparent, inclusive, and equitable.
- C. The legal framework:
  - International agreement
  - Cooperation protocol
  - Basin or aquifer committee
- D. Skills, capabilities, assets, resources (human and financial) and clear mandates are defined in ways that efficiently and effectively support responsibilities at regional and local levels.
- E. Capacity building has ensured adequate competencies and at all levels.

### Method of Computation:

Each element is assigned a score as follows: 1: Poor 2: Unsatisfactory 3: Fair 4: Satisfactory 5: Good

$$EI = (A + B + C + D + E) / 5$$

## ANNEX C: NATIONAL AND REGIONAL REPORTING FORMAT

### Country Profile Sheet

Indicators	Element	Units	Year				
			2012	2014	2016	2018	2020
	Urban Population	Mill. Cap	xxxx	xxxx	xxxx	xxxx	xxxx
	Rural Population	Mill. Cap	xxxx	xxxx	xxxx	xxxx	xxxx
	Total Population	Mill. Cap	xxxx	xxxx	xxxx	xxxx	xxxx
	Total Annual Public Budget	Bill. USD	xxxx	xxxx	xxxx	xxxx	xxxx
	Potential Surface Storage	Million m <sup>3</sup>	xxxx				
	Irrigation Potential	Thous. ha	xxxx				
	Potential Surface Storage	PSS	xxxx				

### Country Water Sector Evaluation Sheet (Quantitative-Context)

Surface Storage Capacity Compared to Potential (or per Capita)	Developed Surface Storage	Million m <sup>3</sup>	xxxx	xxxx	xxxx	xxxx	xxxx
	Cumulated Sediment Volumes	Thous. m <sup>3</sup>	xxxx	xxxx	xxxx	xxxx	xxxx
	<b>INDICATOR's VALUE</b>	<b>m<sup>3</sup>/capita</b>	xxxx	xxxx	xxxx	xxxx	xxxx

Indicators	Element	Units	Year				
			2012	2014	2016	2018	2020
Total Actual Renewable Water Resources per capita	External Inflows	Km <sup>3</sup> /yr	xxxx	xxxx	xxxx	xxxx	xxxx
	Surface Water Runoff	Km <sup>3</sup> /yr	xxxx	xxxx	xxxx	xxxx	xxxx
	Groundwater Recharge	Km <sup>3</sup> /yr	xxxx	xxxx	xxxx	xxxx	xxxx
	Overlap	Km <sup>3</sup> /yr	xxxx	xxxx	xxxx	xxxx	xxxx
	Off Border Environmental Requirement (or Treaty Obligations)	Km <sup>3</sup> /yr	xxxx	xxxx	xxxx	xxxx	xxxx
	<b>INDICATOR's VALUE</b>	<b>m<sup>3</sup>/cap/yr</b>	xxxx	xxxx	xxxx	xxxx	xxxx

Indicators	Element	Units	Year				
			2012	2014	2016	2018	2020
Irrigated Areas Compered to Irrigation Potential	Irrigated Areas	Thous. ha	xxxx	xxxx	xxxx	xxxx	xxxx
	INDICATOR'S VALUE	%	xxxx	xxxx	xxxx	xxxx	Xxxx

Indicators	Element	Units	Year				
			2012	2014	2016	2018	2020
Allocated Public Budget for Water Resource Management	Allocated Budget to Water Sector	Billion USD	xxxx	xxxx	xxxx	xxxx	xxxx
	INDICATOR'S VALUE	%	xxxx	xxxx	xxxx	xxxx	xxxx

Total Water Withdrawals Compared to TARWR	Water Withdrawn for Irrigation	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	Water Withdrawn for Industrial Uses	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	Water Withdrawn for Domestic Uses	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	INDICATOR'S VALUE	%	xxxx	xxxx	xxxx	xxxx	xxxx

Total Water Withdrawals Compared to TARWR	Water Withdrawn for Irrigation	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	Water Withdrawn for Industrial Uses	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	Water Withdrawn for Domestic Uses	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	INDICATOR'S VALUE	%	xxxx	xxxx	xxxx	xxxx	xxxx

## Countries Profile Sheet

Indicators	Element	Units	Countries				
			Country 1	Country 2	Country 3	Country 4	Country 5
	Urban Population	Mill. Cap	xxxx	xxxx	xxxx	xxxx	xxxx
	Rural Population	Mill. Cap	xxxx	xxxx	xxxx	xxxx	xxxx
	Total Population	Mill. Cap	xxxx	xxxx	xxxx	xxxx	xxxx
	Total Annual Public Budget	Bill. USD	xxxx	xxxx	xxxx	xxxx	xxxx
	Potential Surface Storage	Million m <sup>3</sup>	xxxx				
	Irrigation Potential	Thous. ha	xxxx				
	Potential Surface Storage	PSS	xxxx				

## Regional Water Sector Evaluation Sheet (e.g.: Quantitative-Context)

Indicators	Element	Units	Countries											
			Country 1		Country 2		Country 3		Country 4		Country 5			
			2012	2016	2012	2016	2012	2016	2012	2016	2012	2016		
<b>Total Actual Renewable Water Resources per capita</b>	External Inflows	Km <sup>3</sup> /yr	xxxx		xxxx									
	Surface Water Runoff	Km <sup>3</sup> /yr	xxxx		xxxx									
	Groundwater Recharge	Km <sup>3</sup> /yr	xxxx		xxxx									
	Overlap	Km <sup>3</sup> /yr	xxxx		xxxx									
	Off Border Environmental Requirement (or Treaty Obligations)	Km <sup>3</sup> /yr	xxxx		xxxx									
	<b>INDICATOR'S VALUE</b>	<b>m<sup>3</sup>/cap/yr</b>	xxxx		xxxx									

<b>Surface Storage Capacity</b>	Developed Surface Storage	Million m <sup>3</sup>	xxxx	xxxx	xxxx	xxxx	xxxx
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Compared to Potential (or per Capita)	Cumulated Sediment Volumes	Thous. m <sup>3</sup>	xxxx	xxxx	xxxx	xxxx	xxxx
	<b>INDICATOR'S VALUE</b>	<b>m<sup>3</sup>/capita</b>	xxxx	xxxx	xxxx	xxxx	xxxx

Total Rainfall Depth	<b>INDICATOR'S VALUE</b>	mm/yr.	xxxx	xxxx	xxxx	xxxx	xxxx
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Indicators	Element	Units	Countries											
			Country 1		Country 2		Country 3		Country 4		Country 5			
			2012	2016	2012	2016	2012	2016	2012	2016	2012	2016		
Irrigated Areas Compared to Irrigation Potential	Irrigated Areas	Thous. ha	xxxx		xxxx									
	<b>INDICATOR'S VALUE</b>	%	xxxx		xxxx									

Indicators	Element	Units	Countries											
			Country 1		Country 2		Country 3		Country 4		Country 5			
			2012	2016	2012	2016	2012	2016	2012	2016	2012	2016		
Allocated Public Budget for Water Resource Management	Allocated Budget to Water Sector	Billion USD	xxxx		xxxx									
	<b>INDICATOR'S VALUE</b>	%	xxxx		xxxx									

Total Water Withdrawals Compared to TARWR	Water Withdrawn for Irrigation	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	Water Withdrawn for Industrial Uses	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	Water Withdrawn for Domestic Uses	km <sup>3</sup> / yr.	xxxx	xxxx	xxxx	xxxx	xxxx
	<b>INDICATOR'S VALUE</b>	%	xxxx	xxxx	xxxx	xxxx	xxxx

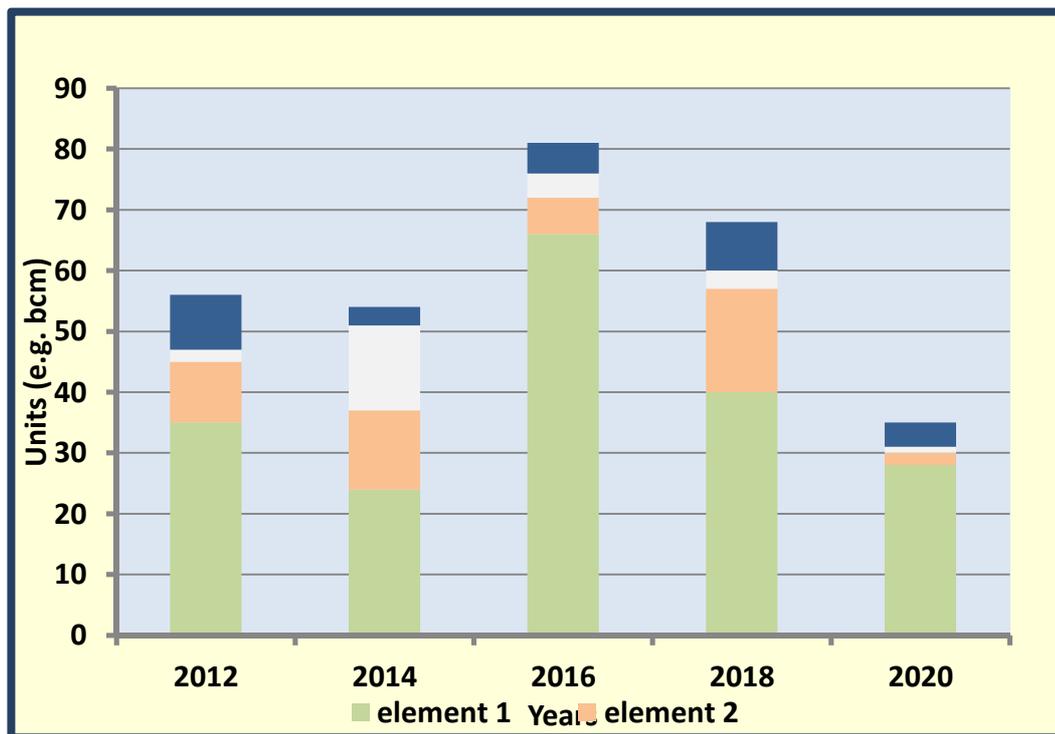


Figure 5: Plot of Quantitative Indicator's Elements to be Included in the National Report

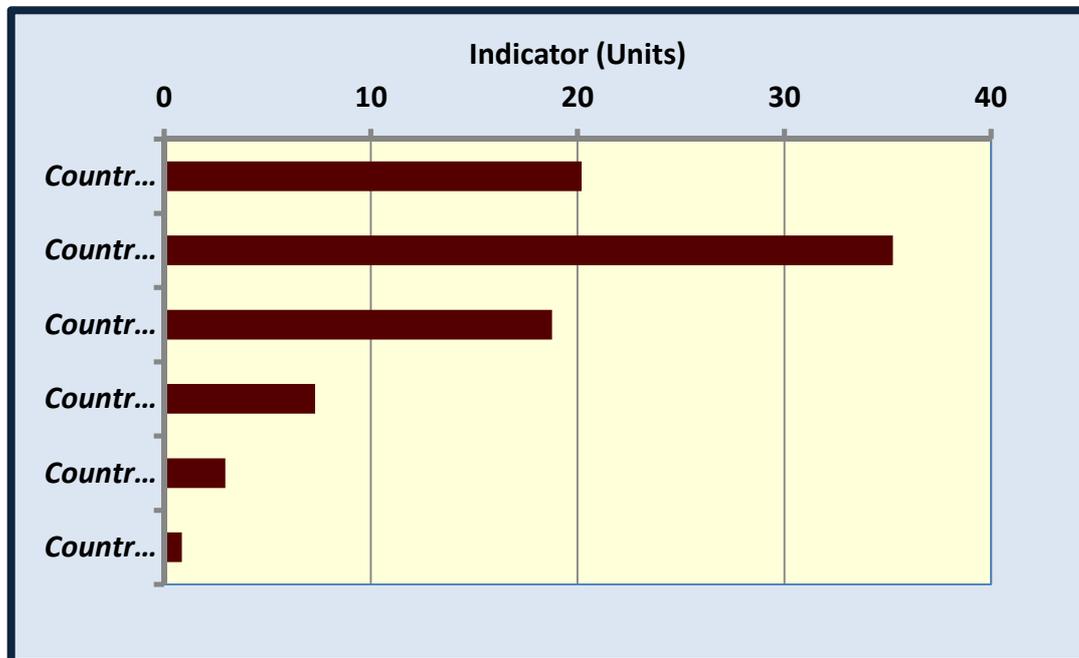


Figure 6: Plot of Quantitative Indicator to be Included in the Regional Report

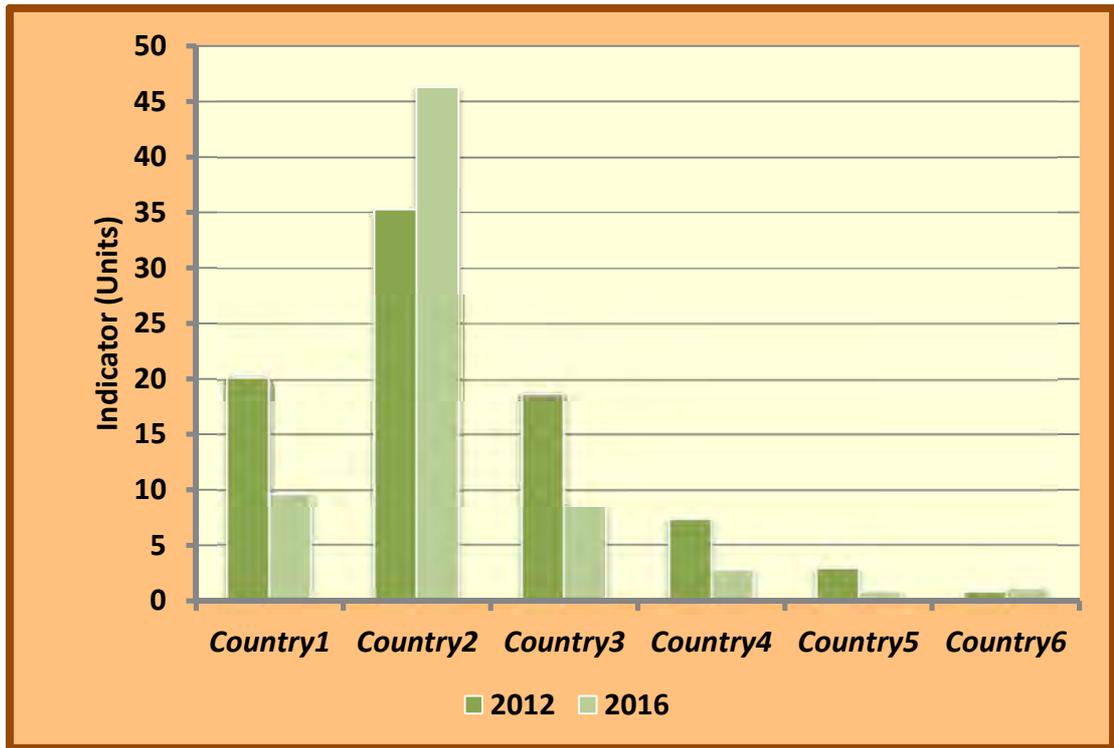


Figure 7: Plot of Quantitative Indicator to be Included in the Regional Report

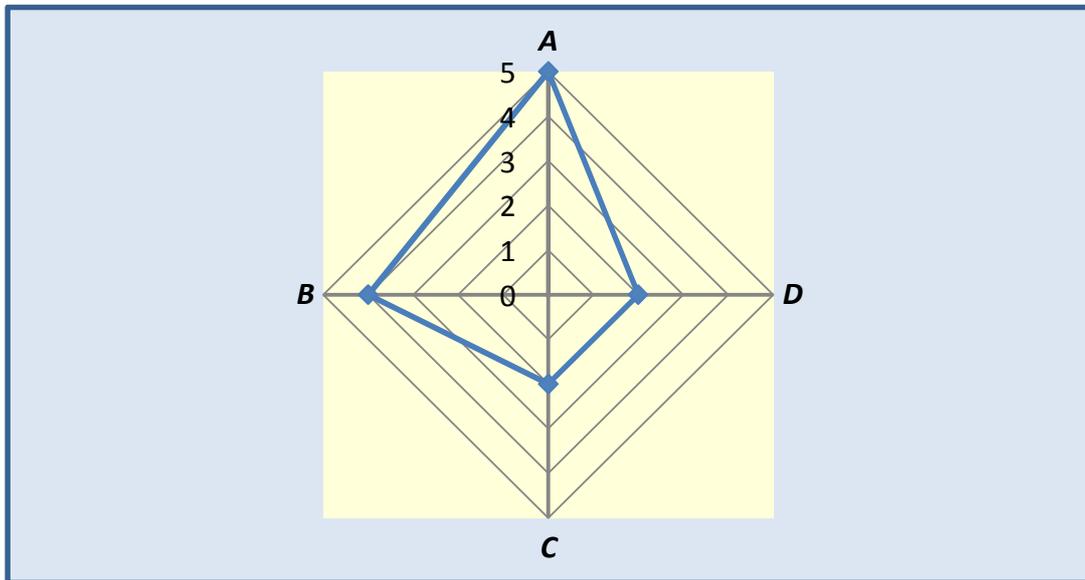


Figure 8: Plot of Governance Indicator to be Included in the National Report

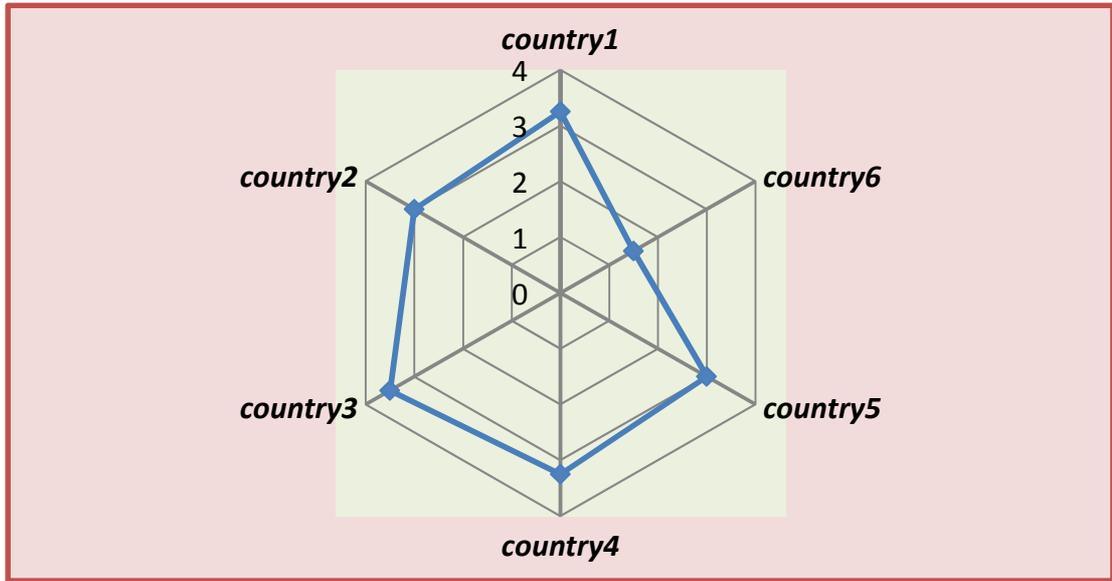


Figure 9: Plot of Governance Indicator to be Included in the Regional Report

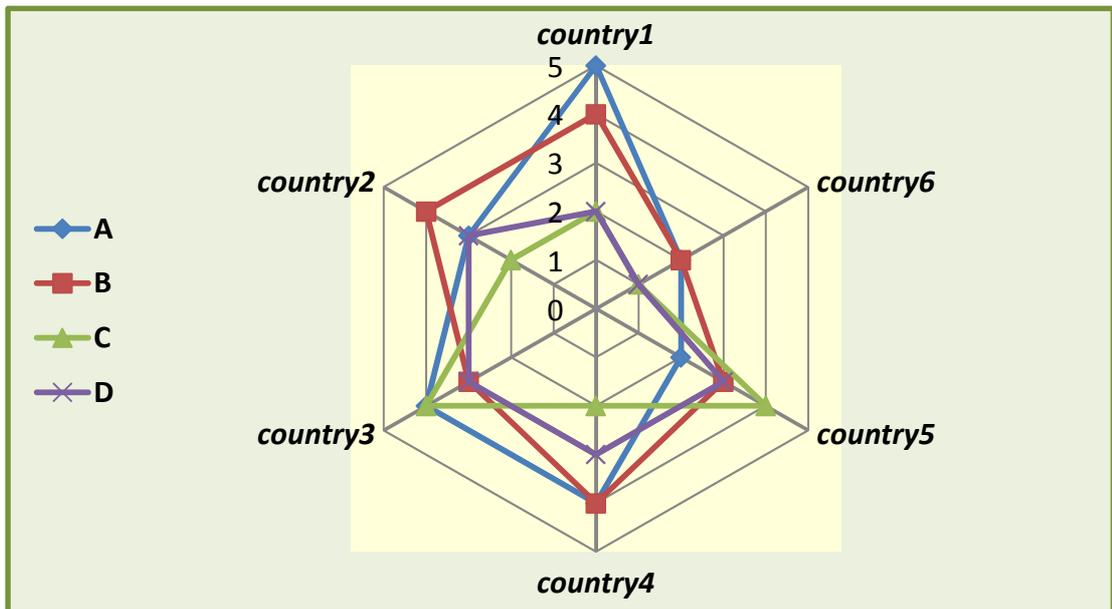


Figure 10: Plot of Governance Indicator's Element to be Included in the Regional Report

## Contacts

# MEWINA

مشروع التقييم والمتابعة لقطاع المياه بدول شمال أفريقيا  
Monitoring and Evaluation for Water In North Africa

Monitoring & Evaluation for **Water In North Africa (MEWINA)** Project

**North-African Ministers Council On Water (N-AMCOW)**, Technical Secretariat

C/o **CEDARE**, 2 ElHegaz Street, Heliopolis, Cairo, Egypt

**Phone:** (202) 2451-3921/2/3/4, Extension: 656

**Fax:** (202) 2259-5673, (202) 2451-3918

**E-Mail:** namcow@cedare.int

**Web Site:** namcow.cedare.int/mewina

## Consultant

**Misr Consult** for Environmental and Infrastructure Studies

**Address:** 72, Gameat ElDawal Street, Mohandessin, Cairo, Egypt

**Phone & Fax:** (202) 3762-0366/77/196

**E-Mail:** mc@misrconsult.com

**Web Site:** www.misrconsult.com

