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PLANNING AND DESIGN OF AN ESCWA WATER RESOURCES DATABASE (EWDB)

94-0006

Foreword

This document has been prepared as a technical publication on the establishment of an ESCWA water resources database. The study was carried out in implementation of activity 2(b) of the 1992-1993 work programme.

The Economic and Social Commission for Western Asia acknowledges the valuable assistance of Mr. Jean Khouri, who served as ESCWA consultant during the preparation of this study.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION*

A. General information

The United Nations Water Conference, in recommendation A of the Mar del Plata Action Plan, stressed the importance of acquiring greater information about the quantity and quality of water resources, in order to improve their management. To this effect, it states that the "regular and systematic collection of hydrometeorological, hydrological and hydrogeological data needs to be promoted and to be accompanied by a system for processing quantitative and qualitative information for various types of water bodies".

The Conference made a number of recommendations for action at the national level; those within the scope of this report are listed below:

(a) Establish a national body with comprehensive responsibilities for water resources data, or allocate existing functions in a more coordinated way, and establish data banks for the systematic collection, processing, storage and dissemination of data in agreed formats and at specified intervals of time;

(b) Expand and extend the network of hydrological and meteorological stations, taking a long-term view of future needs, following as far as possible the recommendations of the United Nations specialized agencies on standardization of instruments and techniques and comparability of data, and use existing meteorological and hydrological data series for the study of seasonal and annual fluctuations in climate and water resources. Such analyses could also be used in the planning and design of networks;

(c) Establish observation networks and strengthen existing systems and facilities for measuring and recording fluctuations in groundwater quality and level; organize the collection of all existing data on groundwater (borehole logs, geological structure, and hydrogeological characteristics, etc.), systematically index such data, and attempt a quantitative assessment to determine the present status of and gaps in knowledge; increase the search for, and determination of, the variables of aquifers, with an evaluation of their potential and the possibilities of recharge;

(d) Standardize and organize as far as possible the processing and publication of data so as to keep the statistics up to date and take advantage of the observations made in stations operated by different institutions.

The need for information arises at all levels, from the individual level to the national, regional and international levels. One of the main objectives of chapter 40 of Agenda 21, adopted by the United Nations Conference on Environment and Development convened in Rio de Janeiro from 3 to 14 June 1992, is "strengthening existing national and international mechanisms for information processing and exchange in order to ensure effective and equitable availability of information generated at the local, national and international level".

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* Footnote references have, whenever possible, been verified.

While a considerable amount of information may exist at the national and subregional level in the ESCWA region, additional data and reliable information indicating the status of and trends related to water resources (both quantity and quality) is required for assessing the available resources and then potential for meeting current and future demands, and for monitoring the impact of human influences, drought and climate change on the resource.

In many countries of the ESCWA region, the available water-sector data are insufficient, and sometimes lack the consistency and continuity required to facilitate the establishment of a national comprehensive water database for planning and management purposes. In some countries of the region, programmes designed to measure basic data from relevant observational stations, as well as to collect, process, store and periodically disseminate these data, have been undertaken in recent years. Plans to strengthen and update the existing observational networks are also being considered in most countries of the region. However, the lack of coordination and of access to reliable water data with long-term relevance is a common phenomenon in most of the concerned government institutions in the region, due to the unavailability of a comprehensive national water resources database, or to the restrictive nature of such data (in compliance with the internal policies of some member countries).

The 1987 INFOHYDRO information indicated that six countries in the region (Egypt, Bahrain, Jordan, Lebanon, Oman and Qatar) were known to have established computerized data banks (i.e., databases) for at least partial analysis. However, it appears that (when studied in 1987) the basic information stores were relatively low, and that the amount of data analysed was even lower. For the most part, it appears that much of the available information comes from primary data (field observations) and laboratories (in the case of water quality), rather than in the form of analysed data -- especially statistics related to averages, duration curves, unit hydrographs, etc. Existing data are (generally) stored manually, in files, and are not easily accessible. As a result, these data remain relatively useless for planning and management purposes.1/

B. Scope and objective of the study

The study was undertaken in two phases. The first phase was implemented during the 1990-1991 biennium. It presents important time-independent data, such as regional hydrological and hydrogeological set-ups and shared water resources (surface water and groundwater units and systems). In addition, regional time-dependent information and data on water resources supply and demand (surface water and groundwater, rainfall rates, etc.) and water networks are tabulated to the greatest possible extent.

This report comprises the output of the second phase of activity 2(b) of the 1992-1993 work programme, which aims at proposing an appropriate design for the establishment of an ESCWA water resources database (EWDB).

The establishment of national water databases may facilitate the development of a regional water database, the main objectives of which are:

1/ Economic and Social Commission for Western Asia, "Water resources database in the ESCWA region", April 1992 (E/ESCWA/ENR/1992/6).

(a) To minimize wasted and scattered efforts in searching for, obtaining, and checking the availability, reliability and adequacy of water data;

(b) To develop and maintain a relatively simple, operational system for the improvement, updating and continuous monitoring of the water data presently available;

(c) To define future data collection, compilation and processing needs;

(d) To enhance and facilitate research and the efficient planning, development and management of water resources;

(e) To provide the information needed for enhancing cooperation on a regional basis and for the exchange of regional data and information among riparian states in transboundary basins;

(f) To monitor the assessment of water resources and water demand in the region in order to assemble and disseminate basic regional data for use in the management of resources within shared surface water and groundwater systems and also for use in studies on climate changes.

An attempt has been made to take the above mentioned factors, objectives and functional needs into account in the design of the EWDB.

The database would not only enhance the capabilities of ESCWA's Natural Resources Division to respond quickly to information requests relating to water resources, but could also contribute to broader objectives such as meeting information needs for implementing Agenda 21 for the freshwater sector in the region. A major objective of Agenda 21 is the integration of environment and development issues at the national, subregional and international levels. In the design of the database, special attention was given to the evaluation of water resources and to the impact of human activities.

As water is a transboundary resource, all water information -- including water quality and water quantity issues -- should be dealt with at the basin level. The planning and design of the EWDB was therefore preceded by studies which led to the delineation of major surface water and groundwater basins. Information needs for dealing with water-related issues in the major hydrological and hydrogeological units were assessed, and the output was taken into consideration in the design of the database.

The report on the study is composed of two chapters and an annex.

The first chapter includes the proposed design for the EWDB and presents the basic considerations employed in this design. Chapter II includes a sort of "user's guide". Finally, the annex contains a data chart and the data sheet format for the designed EWDB.

It should be noted that the proposed design of the EWDB and the formulated data sheets should not necessarily be considered the final version for the establishment of the database. Possible modification of the design and the data sheets are envisaged whenever necessary, once the EWDB is in use.

I. PLANNING AND DESIGN OF AN ESCWA WATER RESOURCES DATABASE

A. Delineation of reference units for data-input: basins and aquifer systems

Extensive hydrological and hydrogeological investigations have been carried out in the region during the last decade. Based on these studies and for the purpose of establishing meaningful reference units, the principal surface water basins and aquifer systems existing in the region have been delineated. Natural units recognized by countries were taken into consideration when the criteria used for dividing the country into major water resource units were based on hydrological or hydrogeological concepts. However the main purpose was to delineate the transboundary basins and aquifer systems.

1. Identification and delineation of surface water units

Surface water units are classified as individual basins when the river is large and the flow is permanent or intermittent. Ephemeral drainage is usually classified into systems or networks of several wadis.

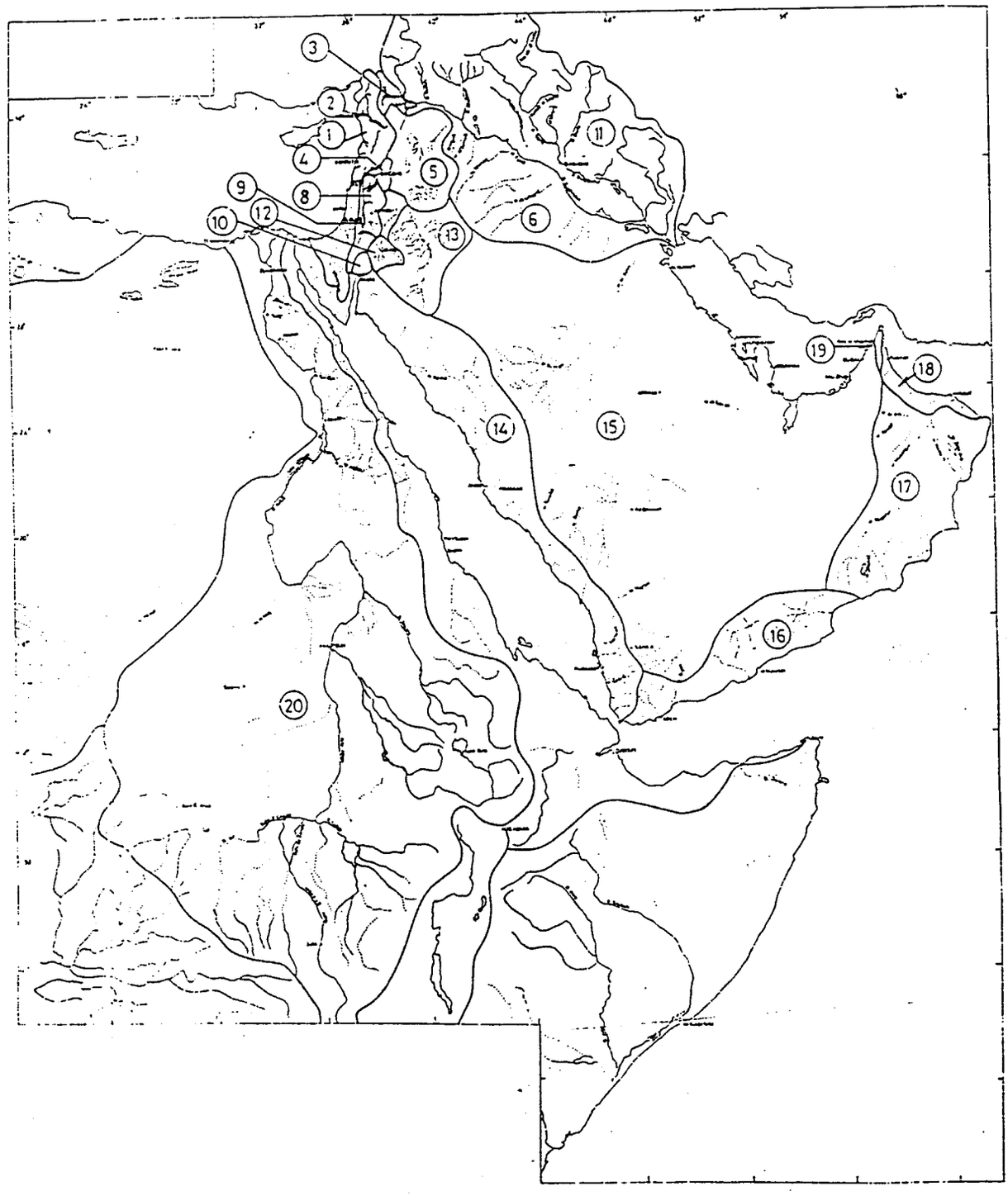
Surface water units or basins are delineated on a regional basis. Boundaries of perennial rivers (surface water divides) are usually well defined, as is the case with the Nile, Tigris, Euphrates, Yarmouk, Litani, Orentis and others.

In arid zones, large wadis are recognized as hydrological units at national levels. Although such delineation is useful for practical or even scientific purposes, it cannot be adopted at the regional level, though larger units comprising several wadis originating at a regional divide and emptying into the same base level (sea, sabkha, etc.) are recognized. Regional hydrological units or "wadi systems" could, of course, be subdivided at the national level into several smaller units; twenty such hydrological (drainage) units are recognized in the region (figure I). The description of stream and flow characteristics is systematic, facilitating the establishment of a regional hydrological database. Table 1 shows the main hydrological units recognized within the region.

2. Identification and delineation of aquifer systems

Twenty aquifer systems are recognized in the ESCWA region (figure II). Some of these, such as the western Arabia sandstone aquifer system, extend over a vast area, while others such as the Ghouta (Damascus plain) and Batina alluvial aquifer system (Oman) are of limited areal extent, but form distinct natural units of a composite nature and are of great economic importance. Some aquifer systems extend beyond the limits shown in figure II; this is particularly true for the sandstone aquifer systems of Saudi Arabia and the carbonate aquifer system of the eastern Mediterranean. Table 2 shows the main aquifer systems existing in the region.

Figure I. Surface water basins in the ESCWA* region



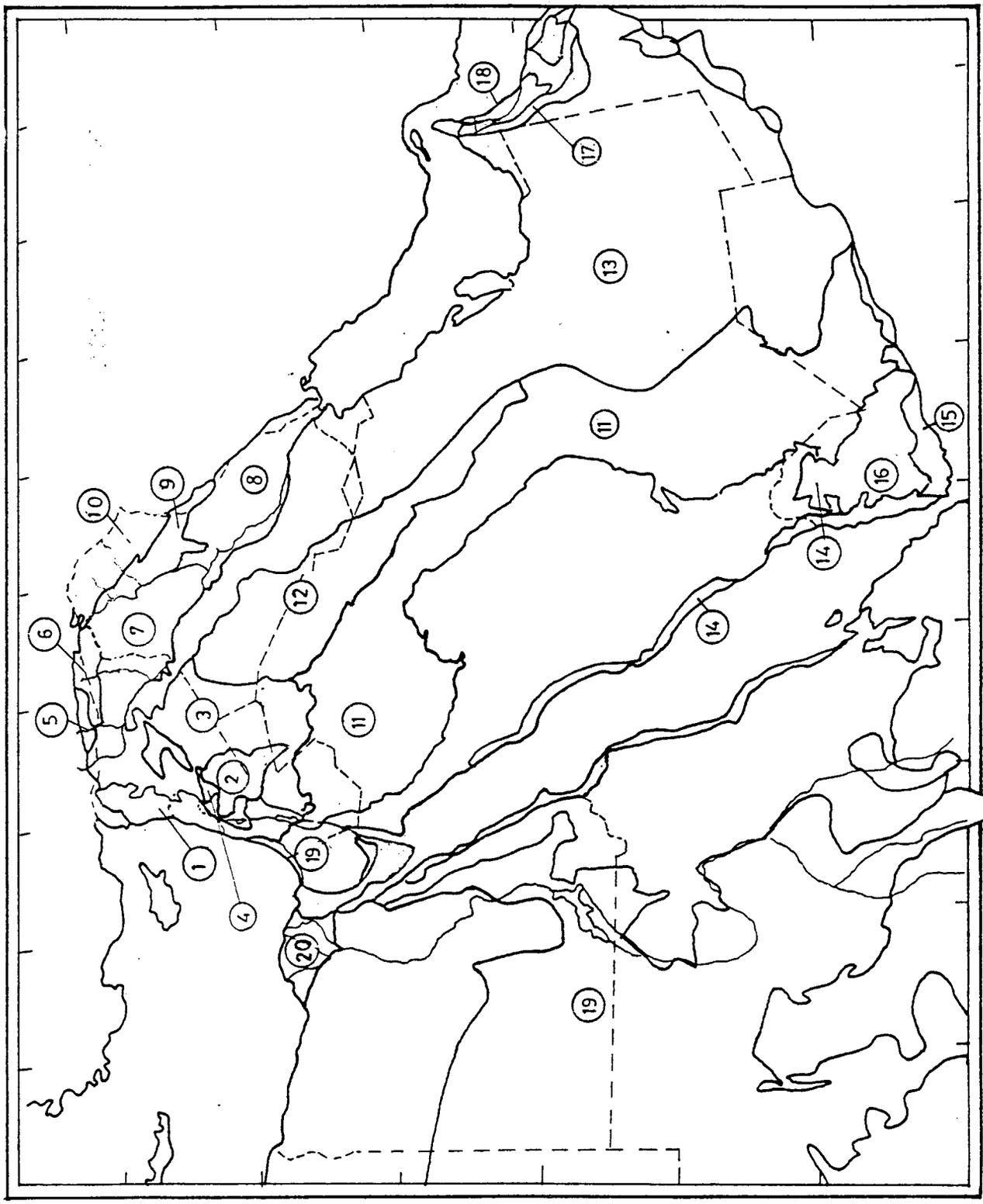
* Economic and Social Commission for Western Asia.

Table 1. Surface water basins in the ESCWA* region

Basin number	Description
SW1	Mediterranean coastal basin
SW2	Orontes basin
SW3	Aleppo basin
SW4	Damascus basin
SW5	Syrian Steppe basin
SW6	Euphrates River basin
SW7	Tigris River basin
SW8	Jordan River basin
SW9	Dead Sea basin
SW10	Wadi Araba basin
SW11	Azraq basin
SW12	Jafr basin
SW13	Wadi Sirhan basin
SW14	Tihama wadi system
SW15	Eastern Arabia wadi system
SW16	South Yemen wadi system
SW17	West and south Oman desert wadi system
SW18	East Oman mountain (Batina) wadi system
SW19	United Arab Emirates (UAE) wadi system
SW20	Nile River basin

* Economic and Social Commission for Western Asia.

Figure II. Aquifer systems in the ESCWA* region



* Economic and Social Commission for Western Asia.

Table 2. Aquifer systems in the ESCWA* region

Aquifer number	Description
GW1	East Mediterranean carbonate aquifer system
GW2	Jabal Al-Arab basaltic aquifer system
GW3	Syrian desert aquifer system
GW4	Ghouta (Damascus plain) aquifer system
GW5	Jezira Tertiary limestone aquifer system
GW6	Jezira clastic aquifer system
GW7	Jezira Lower Fars-Upper Fars aquifer system
GW8	Mesopotamian alluvial aquifer system
GW9	Mesopotamian clastic aquifer system
GW10	Zagros carbonate aquifer system
GW11	Western Arabia sandstone aquifer system
GW12	Central Arabia cretaceous limestone aquifer system
GW13	Eastern Arabia Tertiary carbonate aquifer system
GW14	Tihama alluvial aquifer system
GW15	Gulf of Aden alluvial aquifer system
GW16	Yemen highlands aquifer system
GW17	Western Oman Mountains Bajada aquifer system
GW18	Batina alluvial aquifer system
GW19	Nubian sandstone aquifer system
GW20	Nile Valley-Nile Delta aquifer system

* Economic and Social Commission for Western Asia.

B. Types of data

The term data is used rather freely by both specialists and non-specialists. Some people equate data with numbers, others with information. Data have been defined as "numerical expressions of measurements of some dimensions of a natural or man-made object or phenomenon", while information is defined as "the result of processing time and space series of data in various ways so as to provide insight into the characteristics of the object or phenomenon and for use in decision-making.[2/]

The CODATA Task Group for the Accessibility and Dissemination of Data has suggested a classification scheme through which six major categories are recognized:[3/]

(a) Data with respect to the time factor;

(b) Data with respect to the location factor;

(c) Data with respect to the mode of generation or derivation;

(d) Data with respect to the nature of the quantitative values;

(e) Data with respect to the terms of expression;

(f) Data with respect to the mode of presentation.

Categories (a) and (b) include the results of measurements which are time and space dependent or independent. Category (c) includes three sub-classifications:

(i) Primary data;

(ii) Derived data: data derived from the combination of several primary data;

(iii) Theoretical data: data produced by theoretical calculations or predictions.

Category (d) comprises deterministic and stochastic data, while (e) distinguishes between quantitative and qualitative data. Category (f) includes three major types of data: numerical, graphical and symbolic.

2/ World Meteorological Organization and the United Nations Educational, Scientific and Cultural Organization, "Water resources assessment activities", a handbook for national evaluation (1988), p. 116.

3/ D. G. Watson, "The use, misuse and non-use of scientific data", a paper presented at the CODATA/UNESCO/DFI Seminar, held in Stockholm from 15-22 October 1983 (ICSU Press, 1983), p. 9-15.

Most water resources databases are factual numeric databases. Databases at the national level deal mainly with primary and observational time or space dependent data, whereas regional databases are usually concerned primarily with derived data, the sources of which are national numeric data banks.[4/] The growth of computerized data banks (i.e., databases) in the ESCWA countries provides a unique opportunity to establish a regional database.

C. Information needs

The activities of ESCWA include the coordination of international water resources activities in the region as they pertain to economic and social development. Water is vital for economic and social development -- for energy production, agriculture, industry and domestic uses.

The Ministerial Declaration of the Second World Climate Conference recognized that among the most important impacts of climate was its effect on water management systems -- and consequently socio-economic systems -- especially in extreme cases such as floods and droughts. With the growing recognition of such issues, there is an increasing need for reliable data and information at the national and regional levels.

In addition to such issues, which are of continental and global significance, there are several other issues which must be dealt with in the ESCWA region that are related to the special hydrological characteristics of the area. These are described in some detail in what follows.

1. Water security

The region is characterized by on arid and semi-arid climate; water security is a priority to countries with such a climate. This necessitates the development of strategies appropriate for variable, unpredictable and scarce water resources. Moreover, the groundwater resources of major aquifers occurring in the region are often non-renewable. The development of such resources requires a special approach and the concepts for their management need further development. Information on the status, conditions and trends related to both the quality and quantity of non-renewable water resources is required as a foundation for their future development. Future generations will certainly benefit from decisions made at present and from the information on which these decisions are based.

2. Shared water resources

Shared surface water basins and groundwater aquifers are among the most important sources of water in the ESCWA region. Five major shared river basins and eight major shared aquifers have been recognized. Each member country shares at least one important surface water or groundwater basin.

4/ Arab Centre for the Studies of Arid Zones and Dry lands and Bureau de Recherches Géologiques et Minières, "Data bank for water resources in the Arab countries", Orlean-Damascus, Report No. BRGM-82 AGE 023 (ACSAD/HS/R-23 P84), 1982.

The International Conference on Water and the Environment (ICWE), held in Dublin from 26 to 31 January 1992, addressed the issue of transboundary basins and also urged United Nations agencies and organizations to help in the exchange of information among riparian States sharing basins. Actions recommended by the Conference include:

(a) Harmonizing the interests of riparian States;

(b) Monitoring water quality and quantity in transboundary basins;

(c) Developing concerted action programmes;

(d) Strengthening existing regional mechanisms in order to harmonize policies, strategies and programmes.

As regards shared aquifer systems, the ICWE recommended that exploitation of aquifers should take into account the safe yield of the live aquifers, while developing principles for the control of pollution. The development of principles and policies for the exploitation of non-renewable water resources is left to countries. However, at the regional level it is recognized that water resources are coming under increasing stress, with the rapid growth of population. This requires the development of a framework for the formulation of regional and international water-related monitoring programmes, policies and strategies.

D. Selection of the database system

Several thousand machine readable databases exist in the world. More than half of these provide numerical or factual data rather then being limited to bibliographical data.

A database is defined as an organized collection of related information or data. According to Rumble (1983), a database is a collection of data on a computer. The term is frequently used for bibliographical files as well as for numerical data files.5/

Certain groups have attempted to differentiate the latter by calling it a "data bank". In this report the term "database" is used, and the concern here is with a database expressed in some computer readable mediums.

The database envisaged for the Natural Resources Division of ESCWA is a factual-numeric database and includes most of the same components as other relevant databases in the region, and is therefore compatible with them.

E. Design criteria

The following factors were taken into consideration in designing the database:

5/ J. Rumble, "Planning and designing numeric database systems in science and technology, a paper presented at the CODATA/UNESCO/DFI Seminar, held in Stockholm from 15-22 October 1983 (ICSU Press, 1983), p. 131-138.

(a) Internal factors: the information needs of ESCWA, the volume of data that the database should support, and the kind of records and data items considered important in the field of water resources. These needs have been already discussed in some detail;

(b) External factors: the use of a software package that would ensure the exchangability of the data and the system's compatibility with the databases of other organizations;

(c) Software: the capability of the software package to create the database, and its search and report-generation capabilities.

F. Preparation of data-input sheets

The first step involved the preparation of the following data-input sheets for future computerization:

(a) National water resources:

(i) Country information;
(ii) Surface water resources;
(iii) Groundwater resources;
(iv) Non-conventional water resources;
(v) Water use and water demand;

(b) Shared water resources.

In addition to the names of the concerned countries, the basic framework (reference units) for data input is the hydrographic basin for surface water and the aquifer system for groundwater. Since several transboundary basins exist in the region, shared resources occurring in these basins are treated independently, and sub-sheets were prepared for "shared rivers" and "shared aquifers". These sheets were designed to include information pertaining to the characteristics (quality and quantity) of flow in each country sharing an aquifer or river basin.

Data sheets depicting national water resources include information and data on water resources, water use, and current and projected demand for each country in the region. The sheets were designed to provide a synthesis of available knowledge and data on the water resources (the quality and quantity of surface water and groundwater), in each hydrological (basin) and hydrogeological (aquifer system) unit. The designed data-input sheets describe potential basins, in addition to basins and sub-basins or tributaries, aquifers and sub-aquifers; partial basins are the sections or parts of the international basin which belong to the country in question.

G. Compilation of data and information

The main sources of information and data to be compiled are national databases. These databases acquire their data from various hydrological, hydrogeological and hydrometeorological services and other agencies involved in water-related activities. Original sources of data and information at the national level comprise water resources assessment projects and activities,

monitoring systems, and water resources development activities which include the planning, design and operation of water projects.

With recognition of the importance of such issues as the environmental impact of human activities, there is a greater emphasis on acquiring information on the sustainable development of water resources.

The regional water resources database of ESCWA is designed to locate and acquire on a continuous basis all documents that may contain data pertinent to its assigned scope.

Data is presently available mainly in hard-copy form. Future data will be collected in both computer and hard-copy forms. After the documents are organized, this bibliographic file becomes a resource for the department to be used in establishing the numerical database. Additional data could be acquired through questionnaires once gaps are identified and if such data cannot be extracted from documents. Eventually liaisons with water-related regional and international databases could be established.

H. Data elements (DEs)

1. Types of data elements

The data sheets contain four types of DEs:

Numerical
Alphanumeric
Date
Options

Numerical DEs are either integral or decimal/real numbers. Integers should be used for all DEs (areas, water resources, water demand, etc.), except water-quality items and hydraulic parameters where decimal numbers can be used (e.g., for salinity, storativity chemical oxygen demand [COD], etc.).

Coordinates should be indicated by their geographical coordinates and altitude: for example, latitude 22 24' 48"; and longitude 42 04' 25".

North-south (N-S) and east-west (E-W) references indicating the hemisphere are omitted, since coordinates of observation points outside the region will not be included in the database.

Alphanumeric DEs are combinations of letters, numbers and some special characters. These elements are used for text data such as ESCWA codes, remarks and descriptions.

The date DE is used to store dates, since this type of data is considered neither numerical nor alphanumeric. It is designed to accept only correct dates.

The options element is an advanced technique for storing pre-defined text data. In some cases, where data are known to be part of certain options or cases, these options appear when required in a menu format. This helps users

to identify what should be recorded in the respective data element. Users can record the desired option without retyping the text. This makes input easier, faster and more reliable. The option menu is provided with a "user entry" option which can be selected if the user needs to enter a text other than those displayed.

2. Definitions

Aquifer system: a groundwater unit chosen as a basic unit for the assessment and management of groundwater resources, defined according to hydrodynamic and hydrogeological criteria. It may include several sub-aquifer systems defined according to structural and hydrodynamic conditions.

Surface water system (basin): defined, on a hydrographic basis, as a sub-basin or "partial basin" in the national part of a shared river basin.

Simple drainage: a drainage system consisting of one main channel and tributaries.

Composite drainage: a drainage system comprising several water courses (usually ephemeral) sharing the same base level (sabkha, lake, sea, etc.).

Drawdown: corresponds to the quantity of water taken from its natural environment. If the only information available is the amount of water distributed to users, losses should be calculated or estimated to find the quantity tapped.

3. Systematic description of data elements

Most of the DEs in sheets 1-8 are self-explanatory. However, certain DEs may be interpreted in different ways. The following definitions and explanatory notes might help to prevent ambiguities or misinterpretations.

(a) "Country information" data sheet

(i) "Potential water resources" DE. This DE relates to "natural flow" for surface water and to safe yield for groundwater. It is the result of quantitative water resources studies. The values cover the whole basin (or aquifer system), and are averages over a fairly long period of time. The data source is a study of water balance; the user should check whether the sum of total inflow is equal to that of outflow (check evapo-transpiration and flow to sea or lakes, or to other basins for regional systems);

(ii) "Development of water resources" DE. This DE concerns the total amount of water developed from its natural environment by means of: surface water structures; modifying the water balance components (increasing or decreasing runoff, soil moisture through rainwater harvesting, conservation, etc.); extractors (pumps); wells; and Aflaj systems, etc.

Non-conventional water resources are included in order to arrive at an average value of total resources developed or planned for development;

(b) "Surface water resources" data sheet

(i) "Shared basin" DE. Shared and national basins are indicated by numbers 1 and 2, respectively. The regional set-up of shared basins is dealt with in a separate data sheet on "shared water resources". In this field details are given on the parts of the basins located within the territorial limits of the country in question. It allows for an estimate of the total resources of the country to be made. The status of the observation networks is also indicated.

Some countries, however, have not reached a formal agreement on their share of transboundary resources. In this case a knowledge gap would exist until an agreement among riparian States is concluded. The first and second table could be completed but the DE on "average annual flow" would have to be left blank;

(ii) "Water quality network" DE. These data elements concern water quality stations that conduct measurements of the following:

Electrical conductivity
Complete or partial chemical analysis
Certain pollution indicators
Sediment concentration

(iii) "Stream flow evolution" DE. These data items are chosen to give an indication on the evolution of stream flow during a given climatic period at selected stations in major surface water basins;

(iv) "Water quality" DE. The aim here is to monitor the evolution of water quality in the basin in question, the changes in water quantity and quality that may be depicted over a sufficiently long period would give an indication on regional trends.

Such trends may reflect the impact of climate and human activities. Additional information would be needed to distinguish natural from man-made effects;

(c) "Groundwater resources" data sheet

(i) "Lithology" DE. Aquifer complexes may include several rock types. Only predominant rock types should be indicated;

(ii) "Flow system" DE. A flow system consists of a recharge zone, discharge zone and a zone of lateral flow. The groundwater flow system is classified as local (e.g., wadi systems, intermountain basins), regional (e.g., carbonate or Nubian-type systems) or intermediate when flow takes place in sub-basins or sub-aquifer systems rather than in major groundwater basins or aquifer systems;

(iii) "Geological age" DE. The terminology should conform with that used in international geological legends. If an aquifer spans an important part of the stratigraphic column, only the lowest and highest stages need to be indicated;

(iv) "Hydraulic parameter" DE. Hydraulic parameters may show large variations. Extreme values should be ignored. The ranges "from ____ to _____" refer to the low and high values that represent the general or predominant hydrodynamic conditions. The chosen values should allow for a classification of the aquifer system with regard to its overall productivity--low or medium or high;

(v) "Water quality" DE. This record comprises chemical data items and items that give an indication about pollution. The range of salinity (or electrical conductivity) should be representative of the water quality of the aquifer.

High values of salinity characterizing certain discharge zones should not be indicated as representative of the higher value of the range;

(vi) "Groundwater observation" DE . Observation wells selected to represent the groundwater conditions (quality and quantity) should give an indication of the evaluation of the aquifer system. Both regime wells and wells reflecting aquifer development should be selected and their water levels and the indicated chemical parameters entered into the database at intervals that permit an assessment of general or regional trends. The effects of development on the groundwater reservoir can be measured at observation wells located near the major pumping centres, whereas the observations of regime wells may reflect recharge conditions and climatic effects;

(d) "Non-conventional water resources" DE. Non-conventional water resources, particularly desalinated water, constitute the main water supply source for the Gulf countries. The importance of these resources will increase as water demand increases. The cost of desalinated water is an important data element, since it is a critical factor for the future development of such a resource in the ESCWA region. This primary data element is dependent on several factors; the cost of energy and the method used are considered the most significant here. The same applies to the cost of wastewater or drainage water reuse (mainly for certain irrigated agriculture). The most important data element for such a source is the level of treatment;

(e) "Shared water resources" data sheet. Since some 12 major surface water and groundwater systems are identified as shared water resources, the acquisition and dissemination of information on the status and trends of these resources is an issue of fundamental importance to most countries of the region.

DEs relating to transboundary basins should give indications of the impact of development and other human activities.

Both quantitative and qualitative effects can be monitored by carefully selecting gauging stations in each riparian State, and compiling data on certain parameters such as sediment transport, salinity and pollution.

The rates of increase and decrease of these parameters would give an indication of the impact of development, the effects of management, the evolution of the system, and the integrated effects of natural and human factors.

I. Database system structure and programming

In the preparation of the data-input sheets of the EWDB, interconnections among the various data items have been into account. The data sets were modified in the final stage of the design of the database system. The project has become well defined and manageable as the structure has improved. Redundant and dependent data items were removed.

The standard database management system dBase IV was chosen as the database programming system for the EWDB. The system functions on the IBM and IBM compatible computers available within ESCWA's Natural Resources Division and used by the majority of water resource services in the Arab countries.

The EWDB is menu-driven; it is designed to be user-friendly. The various processes for data input and modification, as well as those for handling specific enquiries and extracting printed output were designed to be quite straightforward. They do not require previous programming knowledge or experience with an operating system.

II. REQUIREMENTS, INSTALLATION AND USE OF EWDB

A. Requirements for the EWDB

The EWDB runs on dBASE IV version 1.1 or version 1.5; dBASE IV should be installed on a hard disk before running the program. The path for the dBASE sub-directory must be included in the Autoexec.bat file.

B. Installation of the EWDB

Installation involves copying all the files required to run EWDB from the attached program diskette to the hard disk. The following steps should be followed for installation:

1. Insert the program diskette in drive A: and make drive A: the working directory by the instruction:

   C:\> A: <Enter>

2. Run installation batch file:

   A:\> INSE <Enter>

   Installation will create a new sub-directory under the name "EWDB" and will copy all the files into this sub-directory.

3. Change the working directory to EWDB:

   C:\> CD\EWDB <Enter>

4. To start EWDB, type the following command:

   C:\EWDB> DBASE EWDB <Enter>

C. Using the EWDB

The EWDB is a menu-driven program. In every menu, the available options are displayed and the first character of each option is highlighted (displayed in a different color than the other characters). To activate any option the highlighted character should be pressed.

The main menu of EWDB in its current version consists of three options:

Add/Change Data: Input new data or update/modify existing data.
Report: Print data.
Exit: End EWDB program and return to the operating system.

The status bar at the bottom of the screen keeps track of user selections. For example, when the user selects the **Add** procedure, this title will be displayed on the status bar (and so on for other menus) in a way that allows the user to be informed about the program flow.

Data in EWDB are organized in two primary categories (see data chart in the appendix for more details):

(a) National water resources;
(b) Shared water resources.

After selecting the desired function--Add or Report--a sub-menu appears to select one of the two primary data categories. Then a third menu is displayed, showing secondary categories of data. Before logging into the next procedure, the program asks the user to input the Country name, which is the key item for all operations in National Water Resources. In Shared Water Resources, the River name or the Aquifer name is the key item. Country, river and aquifer names are listed alphabetically. The program will check their validity and will not proceed to the next step if the names are "illegal", blank or numeric.

If the Add option is selected from the main menu, the input procedure will check to find out if any data for this particular key item are stored in the data files. If so, then the old data will be brought up for updating and modifying. If not, then a new record will be set up and the new data saved.

When several menus are displayed sequentially on the screen, the active menu can be recognized by a blinking arrow [↓] in the upper left corner of the menu area. The symbol [▬] appears when a menu is not active. The user can return to the previous menu by pressing <Esc>.

1. Input procedure

The input procedure starts when a correct key item is entered. An input screen appears in accordance with the selected data category. The user can now fill in new data or update/modify old data.

When the user reaches the last data item (or file) in the input screen, a "quit menu" is automatically displayed. This menu can be accessed at any time during the input by pressing the <Esc> key. The quit menu shows further actions that can be taken afterwards. It includes the following options:

<PgDn> Move to the next page if available.

<PgUP> Move to the previous page if available.

<Home> Return to the first field on the screen for data editing.

<F10> Save the data and return to the last step.

<F6> Move to another page by entering the page number. When <F6> is pressed, a page index is displayed which shows available page numbers and the data groups contained on each page. A user can go directly to the desired page.

<Esc> Ignore all inputs and return to the previous screen without saving the data.

2. Pre-defined data and data menus

Some data items (fields) offer a choice of possibilities. For example the field Type of Aquifer can be confined, unconfined or semi-confined. When the cursor is placed on the appropriate field, the user should press <Enter> to have a data menu of the different items contained; he can select one of them by using the arrow keys [↑↓], then access his choice by pressing <Enter>. Data menus help save the user from having to type text data, making inputs faster and error-free.

The data menu includes two other options (in addition to those related to regular information):

(a) **User Entry:** Enables the user to input new information (other than that shown on the menu).

(b) **Unknown:** Leaves the field blank (no data is entered).

In some cases, the user may wish to ignore the data menu, for instance when the related field includes data. Using the right arrow < → > will release the menu and will make the cursor skip to the next field.

The fields that have this facility (pre-defined data), are marked with the symbol [▒], which enables the user to detect them easily.

3. Report procedure

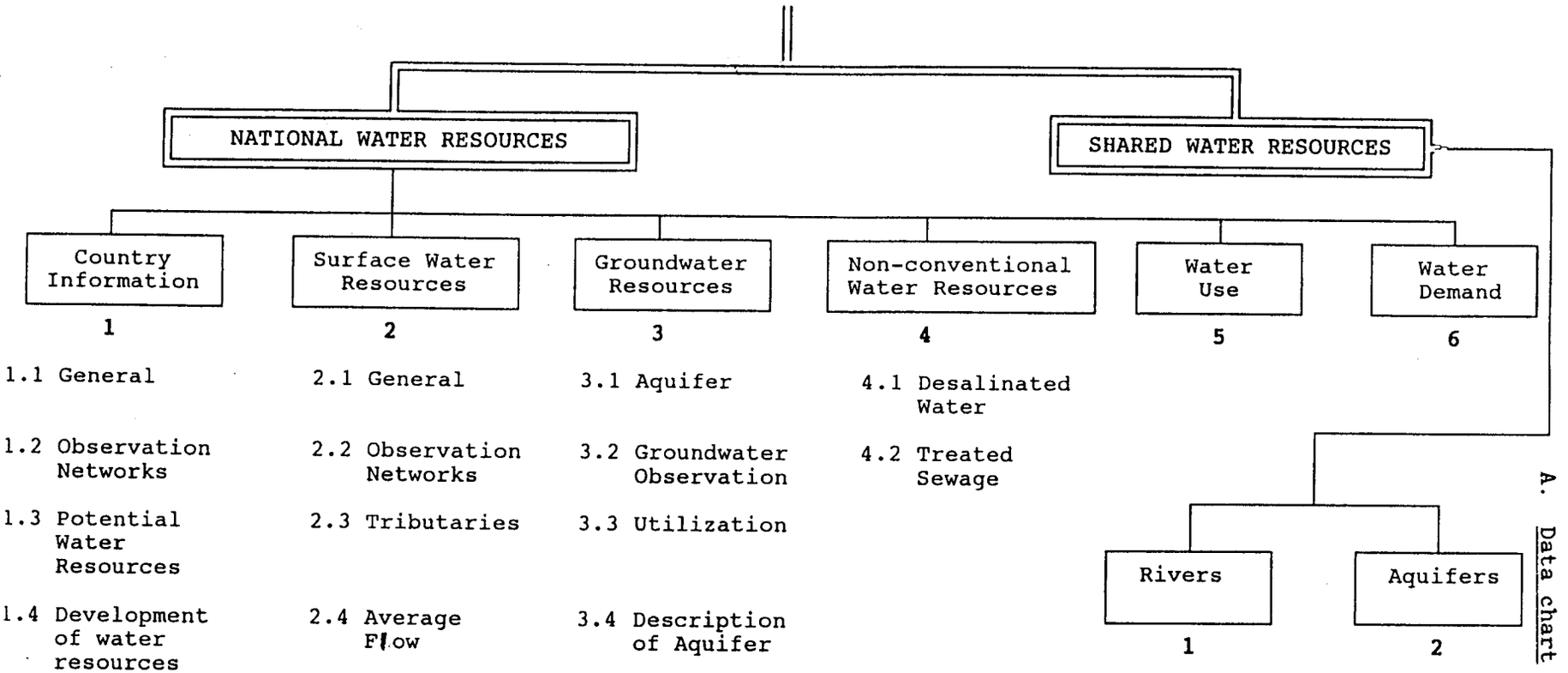
Selecting "R" from the main menu will run the report procedure, which sends the required data to the printer.

After the requested data category is defined, a list is displayed on the screen which includes all the key items available in the related file. The user can use the arrow keys [↑↓] and then <Enter> to select the item. The list shows only six items at one time. If the existing number of key items exceeds this range, the down arrow [↓] can be used to scroll other items.

A message appears to remind the user to put the printer on before beginning the printing. <Enter> must then be pressed. If the program detects any errors during the sending of the data to the printer port, the job is cancelled and the program will start again from the main menu.

Annex

DATA CHART AND DATA SHEETS


NATIONAL WATER RESOURCES
SHARED WATER RESOURCES
Country Information
Surface Water Resources
Groundwater Resources
Non-conventional Water Resources
Water Use
Water Demand
1
2
3
4
5
6
1.1 General
1.2 Observation Networks
1.3 Potential Water Resources
1.4 Development of water resources
2.1 General
2.2 Observation Networks
2.3 Tributaries
2.4 Average Flow
2.5 Stream Flow Evolution
2.6 Water Quality
2.7 Major Dams
2.8 Utilization
3.1 Aquifer
3.2 Groundwater Observation
3.3 Utilization
3.4 Description of Aquifer
3.5 Potential Groundwater Resources
4.1 Desalinated Water
4.2 Treated Sewage
Rivers
Aquifers
1
2

A. Data chart

B. Data sheets*

* Data sheets are reproduced as submitted.

[I] NATIONAL WATER RESOURCES

1. COUNTRY INFORMATION

1.1 General

Country : .....
Total Area : ..... Km^2
Total Population : ..... 10^6.h Census in 19..
Urban : ..... 10^6.h
Rural : ..... 10^6.h
Per Capita GNP : .....
Area of irrigated lands : ..... ha
Main crops : .....
Surface Water : ..... ha
Groundwater : ..... ha
Non Conventional : ..... ha
Area of rainfed lands : ..... ha
Main crops : .....

1.2 Observation Networks (Country Wide Scale)

- *Meteorological*

Number of stations: .... Operational Date :../../....

- *Precipitation*

Number of stations: .... Operational Date :../../....

- *Hydrometric*

Number of stations: .... Operational Date :../../....

Recording: ..... Non-Recording: .....

- *Hydrogeological*

Number of stations : .... Operational

Water Level : ..... Water Quality : .....

Storing and Processing : Manual ☐ Data Bank ☐

1.3 Potential Water Resources

Total : ..... 10^6m^3 Date of estimates :../../....

Surface Water : ..... 10^6m^3 Date of estimates :../../....

Groundwater : ..... 10^6m^3 Date of estimates :../../....

1.4 Development of Water Resources in : 19..

Present

Total : ..... $10^6 m^3$ /yr

Surface Water : ..... $10^6 m^3$ /yr

Groundwater : ..... $10^6 m^3$ /yr

Non Conventional : ..... $10^6 m^3$ /yr

Planned

From : ..... To : .....

Total : ..... $10^6 m^3$ /yr

Surface Water : ..... $10^6 m^3$ /yr

Groundwater : ..... $10^6 m^3$ /yr

Non Conventional : ..... $10^6 m^3$ /yr

2. SURFACE WATER RESOURCES

2.1 General

HYDROLOGIC UNIT Name :..... ESCWA Code : .....

Drainage Area : ..... Km^2

Type : Single(1) Composite(2) ☐

Main river / Stream name : .....

Total Length : ..... Km

Altitude : From ..... To ..... m

Annual Precipitation : From ..... To ..... mm

Volume of precipitation : ..... 10^6m^3 /yr

Topography Mountainous ... % Undulated ... % Plain ... %

Soil Cover rocky ... % Sandy ... % Clayey ... %

Shared Basin Yes (1) No (2) ☐

2.2 Observation Networks

	Total Number of station	Recording	Non Recording
Meteorological			
Precipitation			
Hydrometric			
Evaporation			
Water Quality			

2.3 Tributaries

Name	Drainage Area Km^2	Average annual flow 10^6m^3	ESCWA Code

2.4 Average flow

Total Average Annual Flow : ..... 10^6m^3 /yr
Average flood flow : ..... 10^6m^3 /yr
Average base flow : ..... 10^6m^3 /yr
Period : ..... yr

2.5 Stream Flow Evolution

Country : .....

Hydrologic Unit : ..... Code : .....

Name of Station : ..... Area Covered : ..... Km^2

Latitude : ..... Longitude : ..... Altitude : .....

Type of gaging station : .....

Date of Installation: .. / .. / ....

Number of Years Recorded: .....

Stream Flow :

Year	Stream flow $10^6 m^3$			Sediment Concentration Kg mg^{-3}
	Average	Max	Min	

2.6 Water Quality

Year	Salinity mg/l	BOD mg/l	COD mg/l	Nitrate mg/l	SAR mg/l	E.C m.siemens/cm

2.7 Major Dams

Name	River/Wadi	Capacity $10^6 m^3$	Length (m)	Height (m)	Max Retention $10^6 m^3$	Utilization			
						I	D	H	R

I. Irrigation
D. Domestic
H. Hydroelectric
R. Regulation

2.8 Utilization

Irrigation : ..... $10^6 m^3/yr$

Irrigation area : ..... ha

Industrial : ..... $10^6 m^3/yr$

Domestic : ..... $10^6 m^3/yr$

Total : ..... $10^6 m^3/yr$

3. GROUNDWATER RESOURCES

3.1 Aquifer

Name: ..... Code: .....

Total area : ..... Km^2

Geological Age .....

Lithology Carbonate ☐ Detritic ☐ Volcanic ☐

Crystalline ☐ Evaporite ☐

Other ☐ Specify : .....

Structure Single Layer (1) - Multilayer (2) ☐

Media Fissured ☐ Inter-granular ☐ Karstic ☐

Type Unconfined ☐ Confined ☐ Semi-Confined ☐

Thickness From ..... m. To ..... m.

Flow System Local (1) Intermediate (2) Regional (3) ☐

Recharge

Type:

Precipitation ☐ Surfacewater ☐

Leakage ☐ Lateral Flow ☐

Non ☐

Amount: ..... $10^6 m^3/yr$

Discharge

Type :

Stream Flow ☐ Springs ☐

Sebkha ☐ Submarine ☐

Hydraulic Parameters

Permeability (m/day)	From ..... To .....
Storativity %	From ..... To .....
Transmissivity (m^2/day)	From ..... To .....
Depth to Aquifer (m)	From ..... To .....
Productivity (Yield)	From ..... To .....

Water Quality

Total Salinity (g/l) From ..... To .....
E.C. (m.siemens/cm) From ..... To .....
SAR (m.eq/l) From ..... To .....
Irrigation Water Class .....
Pollution Indicators
- Nitrate : From ..... To ..... (mg/l)
- BOD : From ..... To ..... (mg/l)
- COD : From ..... To ..... (mg/l)

3.2 Groundwater Observation

Aquifer Name : ..... No. .....

Number of observation : .... In .....
Recording .....
Non recording .....

Observation From : ..... To : .....

Yearly Observation Recording

Well No. : ..... Code : ... /.....
Depth of Well : ..... (m).
Latitude : ..... (m).
Longitude : ..... (m).
Altitude : ..... (m).
Recording From : .....

Recording (1) Non recording (2) ☐

Year	Water Level (m)	Water Quality			Collifrom count
		Nitrate mg/l	Salinity mg/l	E.C m.siemens/cm	

3.3 Utilization

Irrigation : ..... $10^6m^3/yr$

Irrigation area : ..... ha

Industrial : ..... $10^6m^3/yr$

Domestic : ..... $10^6m^3/yr$

Total : ..... $10^6m^3/yr$

Urban : ..... $10^6m^3/yr$

Rural : ..... $10^6m^3/yr$

3.4 Description of Aquifer

Description of Aquifer: Geology, Occurrence, Groundwater Flow, Development and Management...

.....
.....
.....
.....
.....

3.5 Potential GroundWater Resources

Basin Name	Aquifer existing	Potential yield 10^6m^3	Number of wells	Storage 10^6m^3	Depth of water (m)

4. NON-CONVENTIONAL WATER RESOURCES

4.1 Desalinated Water

Number of plants	Date of Operation	Location	Capacity $10^6m^3/yr$	Water sources	Salinity		Method	Cost	
					Raw water	Produced Water		Energy $/m	Water $/m³

Total production : ..... $10^6m^3/yr$
Planned production : ..... ha
By product : .....
Power generation : ..... MW
Brines : ..... $10^6/yr$
Salt production : ..... Kg/yr
Others : .....

4.2 Treated Sewage Effluent and Re-use

Source of waste water :

Municipal : ..... $10^6m^3/yr$
Industrial : ..... $10^6m^3/yr$
Irrigation : ..... $10^6m^3/yr$
Volume of total water : ..... 10^6m^3 Date : .. / .. /
Method of treatment : ..... Average cost : ..... $/m^3$

Level of treatment : .....

Average production of TSE

Present : ..... $10^6m^3/yr$

Planned : ..... $10^6m^3/yr$

Number of plants : .....

Population served (%) : .....

Re-use ($10^6m^3/yr$)

Irrigation : ..... Date : . . / . . /

Industrial : ..... Date : . . / . . /

5. Water Use

Year : ..... Total : ..... 10^6 m^3 /yr

	Domestic	Irrigation			Industrial	Grand Total
		Urban	Rural	Total		
Surface water						
Groundwater						
Desalinated						
Treated sewage effluent						
Others						

6. Water Demand

1 ■ Horizon: ....

Total: ..... $10^6 m^3$ /yr Population: ..... 10^6 inh

Irrigation	Domestic	Industrial
.....	.....	.....

2 ■ Horizon: ....

Total: ..... $10^6 m^3$ /yr Population: ..... 10^6 inh

Irrigation	Domestic	Industrial
.....	.....	.....

3 ■ Horizon: ....

Total: ..... $10^6 m^3$ /yr Population: ..... 10^6 inh

Irrigation	Domestic	Industrial
.....	.....	.....

Projection Creterid

.....
.....
.....
.....
.....
.....

[II] SHARED WATER RESOURCES

1. Rivers

HYDROLOGIC UNIT Name :..... ESCWA Code : .....

Drainage Area ..... Km^2

Length of main water course : ..... Km

Altitude : From ..... To ..... m

Annual Precipitation : From ..... To ..... mm

Volume of precipitation : ..... 10^6m^3 /yr

	Country	Drainage Area Km^2	Length Km	ESCWA Code	Average annual precipitation m.m
1					
2					
3					
4					
5					

Tributaries

	Name	Countries Concerned	Drainage Area Km^2	Average annual precipitation m.m	ESCWA Code
1					
2					
3					
4					
5					

Average Annual Flow Per Country Concerned (10^6 m^3 /yr)

Country	Name of station	co-ordinates (m)			Average Annual Flow (2)	Max	Min
		X	Y	Z			

Water quality at the main hydrometric station :

Country	Name of station	Total Salinity (g/l)		E.C m.siemens/cm		Sediment concentration (Kg m^3)	Nitrate m.g/l	B.O.D m.g/l	COD m.g/l
		From	To	From	To				

Water Utilization ..... 10^6m^3 /yr Date : .. / .. /

Country	Irrigation	Domestic	Industrial	Total

2. Aquifers

Name: ..... Code: .....

Total area : ..... Km^2

Countries Sharing Aquifer

	Country	Aquifer Name	Areal extent Km^2	Total withdrawal $10^6m^3/yr$	ESCWA Code
1					
2					
3					
4					
5					

Geological Age .....

Lithology Carbonate ☐ Detritic ☐ Volcanic ☐

Crystalline ☐ Evaporite ☐

other ☐ Specify : .....

Water Quality

Total Salinity (g/l) From ..... To .....

E.C. (m.siemens/cm) From ..... To .....

Potential storage ..... 10^6m^3

Utilization ($10^6m^3/yr$)

Irrigation : .....

Domestic : .....

Industrial : .....

Total : .....