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## WATER IN THE MIDDLE EAST

### Detailed Study Plan and Statement of Work for Phase I

#### Objectives

Competition over increasingly scarce water resources has become a source of tension among several Middle Eastern countries. Completion of proposed irrigation and hydroelectric projects on several shared river systems may result in demands for more water than is presently available, and could lead to armed conflict. We will, under this contract, provide a technical evaluation of water supplies and use within important Middle East river basins; we will begin to assess the political, economic, social and international conflict implications of the technical analysis during Phase I.

#### Scope

We will develop a comprehensive hydrological data base for key river basins, covering portions of Turkey, Jordan, Syria, Iraq, and all of Israel, the West Bank, and the Gaza Strip. Hydrological data for the Euphrates, Tigris, Jordan, and Litani should include historical records of stream flows, and ground water supplies, where available. In cases where actual water use data are not available, we will estimate the data through analysis of information on population and industrial requirements, irrigation acreage, crop types, crop water use requirements, irrigation return flows, and irrigation system characteristics and efficiencies. Existing and planned water use systems and practices will be described, including reservoirs, canals, and irrigation networks. We will also analyze the domestic and international political problems and socioeconomic consequences of development of these water supplies. Potential threats of international conflict over water usage will be addressed, and possible resolutions of any potential conflict will be projected.

Where feasible and relevant to the analytical issues, we will develop appropriate analytical models of Middle Eastern rivers, including both the technical and the political-economic aspects of the issues and their interactions. Full documentation will accompany all models developed for the study.

It is understood that variations will exist between each river basin's data base reflecting the differences in data availability, physical and socioeconomic environments, and the analytical problems unique to the region. The data base and technical hydrological portion of the report on each river basin will be structured to include as many of the following information categories as are appropriate.

## Water Data Categories

### Country

#### River Basin

Areas of basin in country (sq km)

### Precipitation (mm)

- distribution map
- annual average
- monthly average

### Streamflow of main streams and important tributaries (mcm)

- annual average
- monthly average
- historic annual and monthly flow (1930-present)
- soil characteristics affecting water usage
- water quality (stream load, chemical composition, pollution)

### Reservoirs (all existing and proposed reservoirs on main streams and major tributaries)

- name
- location (by place name and geographic coordinates)
- area of water surface (sq km)
- live storage (mcm)
- total storage (mcm)
- type of dam and dimensions
- year constructed
- year filled
- hydroelectric output (historic record)
- annual inflow
- annual evaporation
- historic record of annual and monthly flow through dam (mcm)
- historic record of annual and monthly flow into irrigation system (mcm)
- projected length of time until reservoir silts up

### Wells/Ground water

- number, type, and depth of wells
- annual output (cm)
- potential output (cm)
- aquifer characteristics (area, fossil/rechargeable, annual recharge)
- water quality (pollutants, chemical composition)

### Springs

- number and source
- location (nearest place name and geographic coordinates of major springs)
- annual output (mcm)
- amount of output used (mcm)
- water quality (pollutants, chemical composition)

### Industrial/Domestic Use

- population (1980-2000)
- per capita water use (1980-2000)
- water sources
- water treatment process
- industrial use (1980-2000)
- animal husbandry use (1980-2000)
- industrial pollution
- industrial clean-up policy and practices

### Irrigation Use

- project name (existing and planned)
- amount (dunums) irrigated 1980-2000 by crop
- net water use per crop per dunum
- irrigation efficiency (1980-2000)
- type of irrigation by crop (gravity, sprinkler, drip, etc.)
- soil drainage characteristics and problems (salt accumulation, waterlogging, etc.)
- amount of irrigation water returned to the system
- cost of irrigation per dunum

Map Collection: We will seek to obtain and include in the data base specialized maps of water and agricultural projects prepared by other organizations or individuals concerned with the development of the river basins under study.

## Study Questions by River Basin

Special problems and questions of fact and analysis will arise for each of the river basins under study. Those we anticipate at present, by river basin, are as follows:

**Litani River Basin.** Our research will seek to establish the amount of water available at various locations on the Litani River and identify and describe water control systems that have been built. Special attention will be given to determining the way existing water control systems have operated in recent years (e.g., operating practices for the Litani-Awail diversion system). Research will focus on Lebanese plans for future irrigation projects that will use Litani water. Our report will seek to answer the following questions: How much Litani water is being used by Lebanon now? How much will be used in Lebanon in the future under various scenarios that can be postulated for Lebanon? What are Lebanese and Israeli attitudes and policies toward transferring a portion of the Litani water to Israel.

**Euphrates/Tigris River Basin.** We will attempt to detail the current and proposed system of impoundments and canals and their effect on the respective states in the basin, to describe any Iraqi actions and proposals to transfer water between the Tigris and the Euphrates, and to determine the effect of Turkish impoundment of Euphrates water on current and future Syrian and Iraqi hydroelectric and irrigation projects. We ask specifically, how will the proposed expansion of the Turkish hydroelectric and irrigation network affect Syria's hydroelectric and irrigation capacities and Iraq's downstream use? Does demand for water in existing and proposed developments exceed historical water supplies in the basin? We will describe any existing cooperation on water-use issues among the riparians, and examine likely water-use scenarios. Attention will be given to water quality and pollution with emphasis on the potential for disease and on evidence that riparians place conflicting emphases on issues of water quality.

**Jordan River Basin.** Our research will seek to establish the amount of water available at various locations on the Jordan River and its major tributaries above and below Lake Tiberias; to describe and identify water use parameters of existing water control systems (e.g., Israel's National Water Carrier, Jordan's Jordan Valley Irrigation Project, and Syria's Yarmuk Basin Development Project). We will evaluate plans for future usage of the basin's waters, and will seek to answer the following questions: How much water is available in the basin and how much is currently used by the riparian states (from streams, springs and wells)? How much water will be used in the future employing various scenarios? Is enough water available to satisfy future requirements? Given current and plausible future demands, what are the economic, social and political implications of estimated future water usage in the Jordan Basin?