

ALL THE
FOLLOWING
COMPILED BY
AMER STAFF

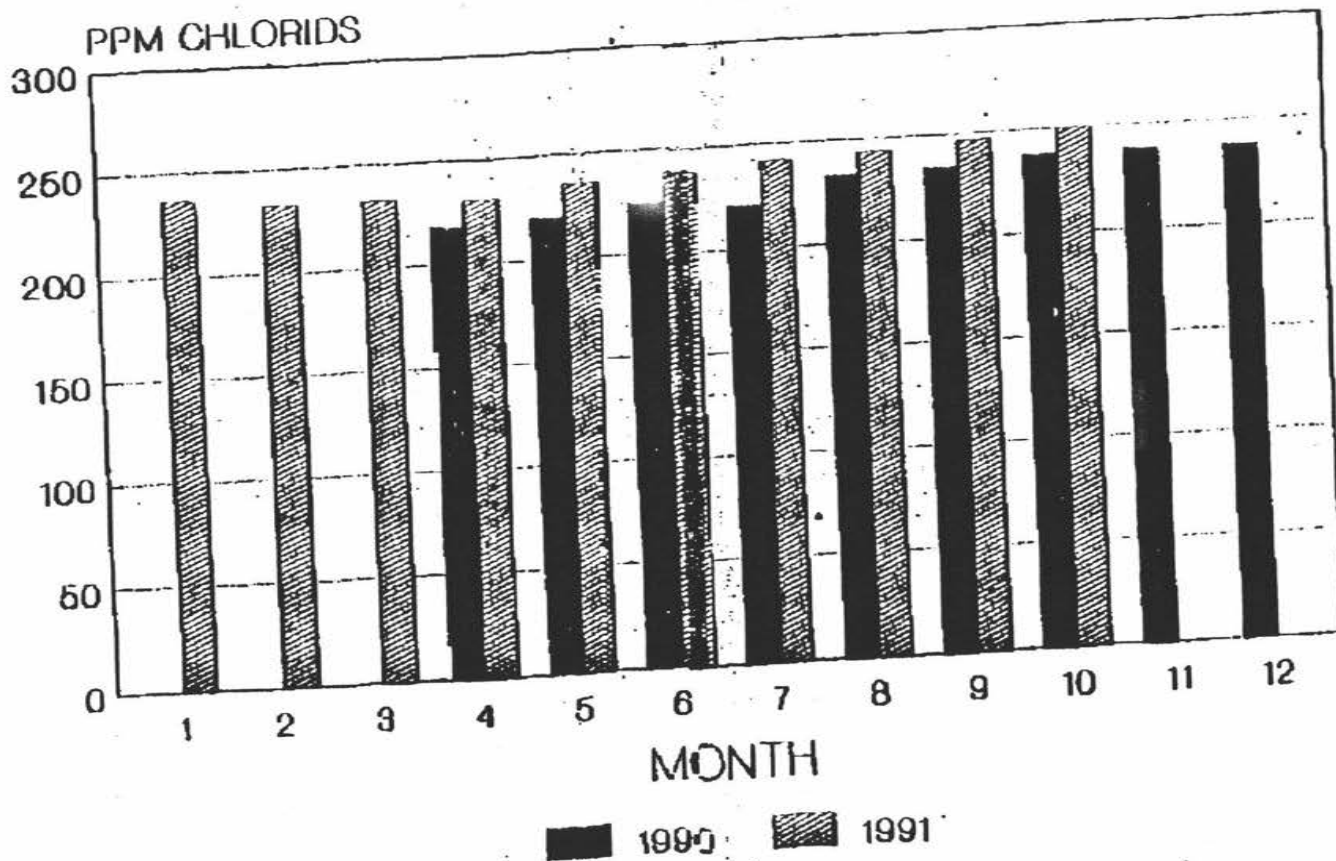
Plans for the Jordan River

Year	Plan	Sponsor
1913	Franghia Plan	Ottoman Empire
1922	Mavromatis Plan	Great Britain
1928	Henriques Plan	Great Britain
1939	Ionides Survey	Transjordan
1944	Lowdermilk Plan	U.S.A.
1950	MacDonald Report	Jordan
1951	All Israel Plan	Israel
1952	Bunger Plan	Jordan/U.S.A.
1954	Arab Plan	Arab League Tech. Comm.
1955	Baker-Harza Plan	Jordan
1955	Unified (Johnston) Plan	U.S.A.
1956	Israeli National Water Plan	Israel
1964	Jordan Headwaters Diversion	Arab League

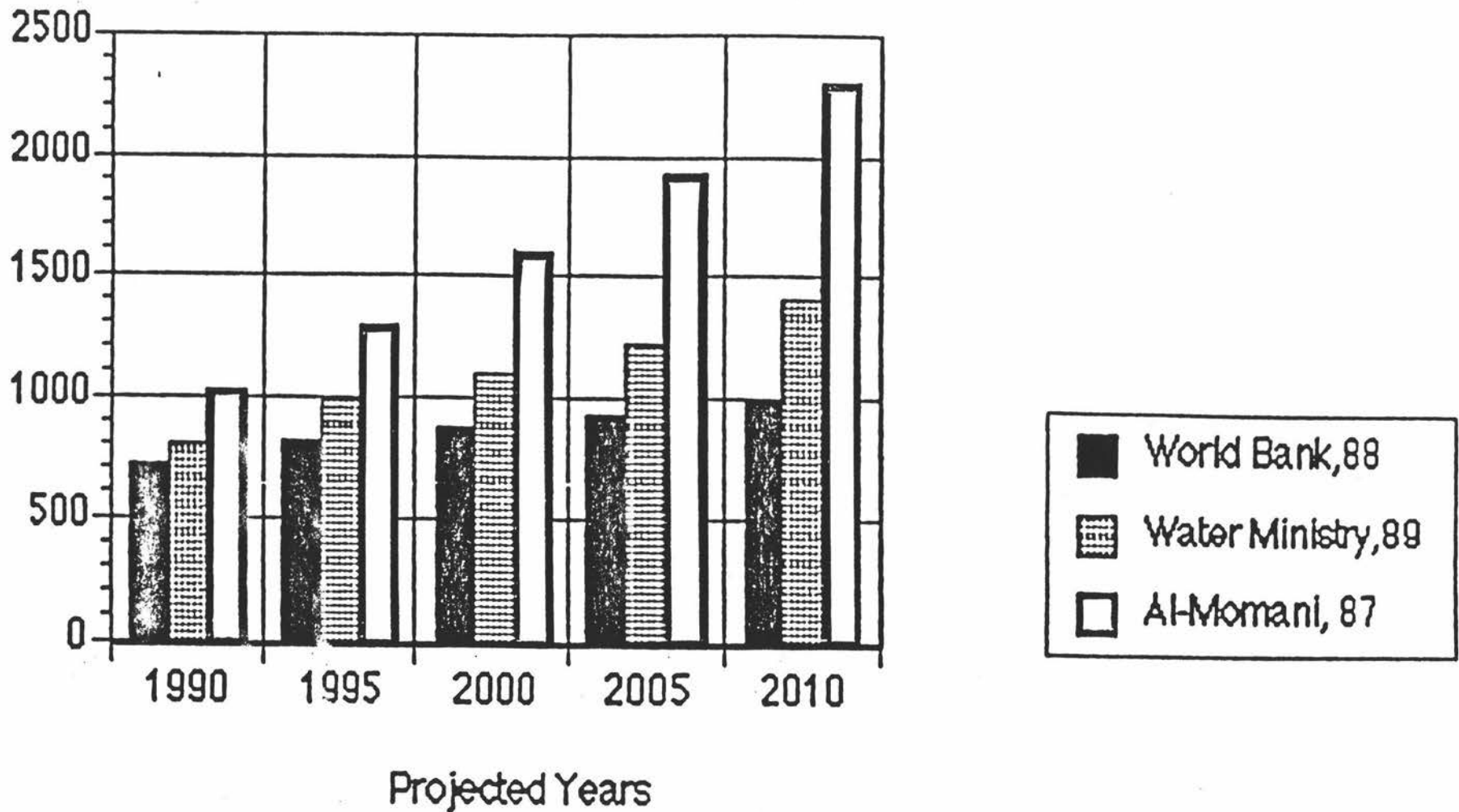
Flows in the Main Tributaries of the Jordan River System

Tributary	Average annual flow, MCM
Dan	245
Hisbani	138
Banias	121
Yarmouk	400
Side Wadis; springs; runoff	350

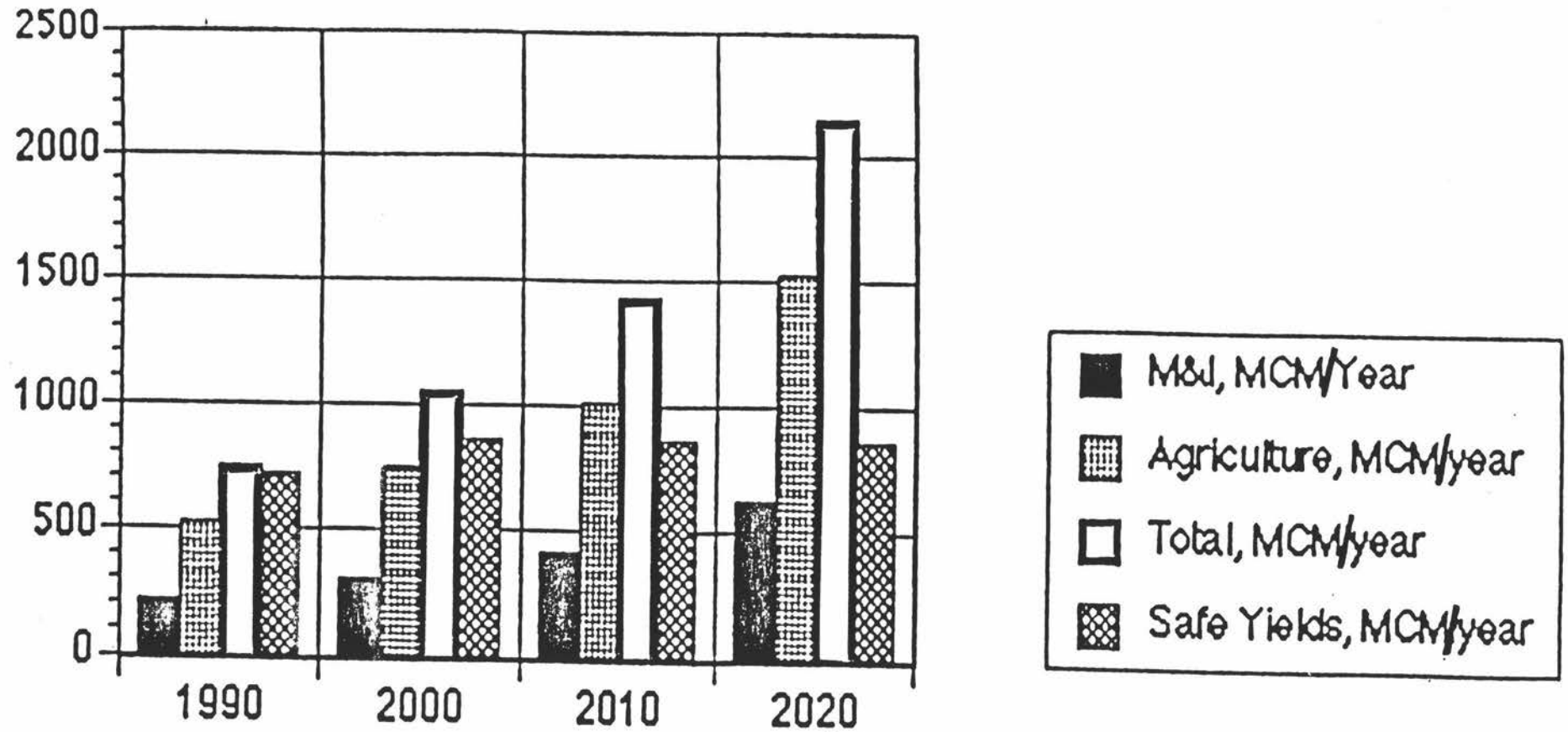
KINNERETH WATER SALINITY PPM CHLORIDS



08.10.1990

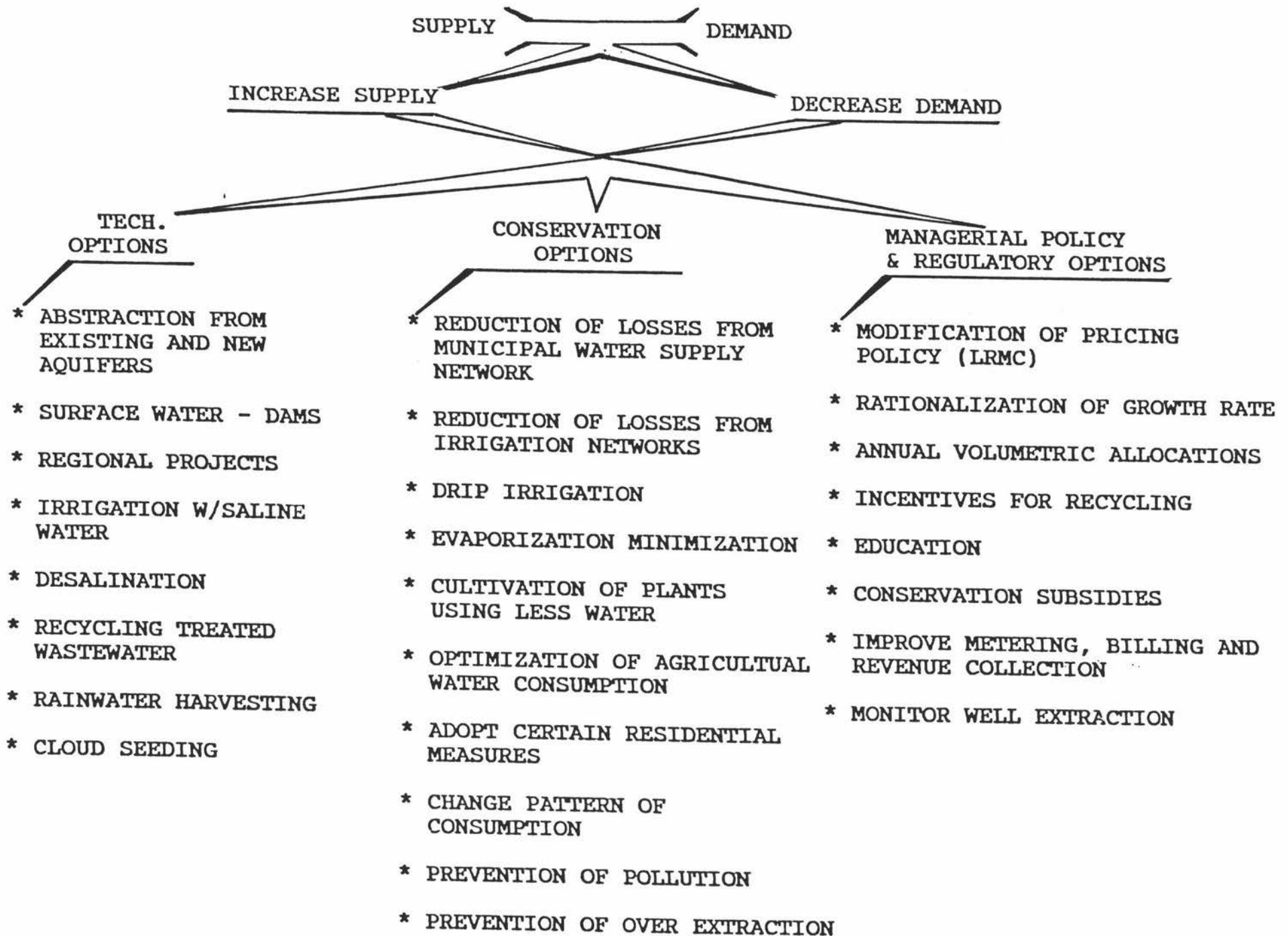
Forecasts of Total Water Demand, MCM per year

Projected water demand by each subsector



Characterization of Water Resources Problems in Terms
of Social and Economic Significance

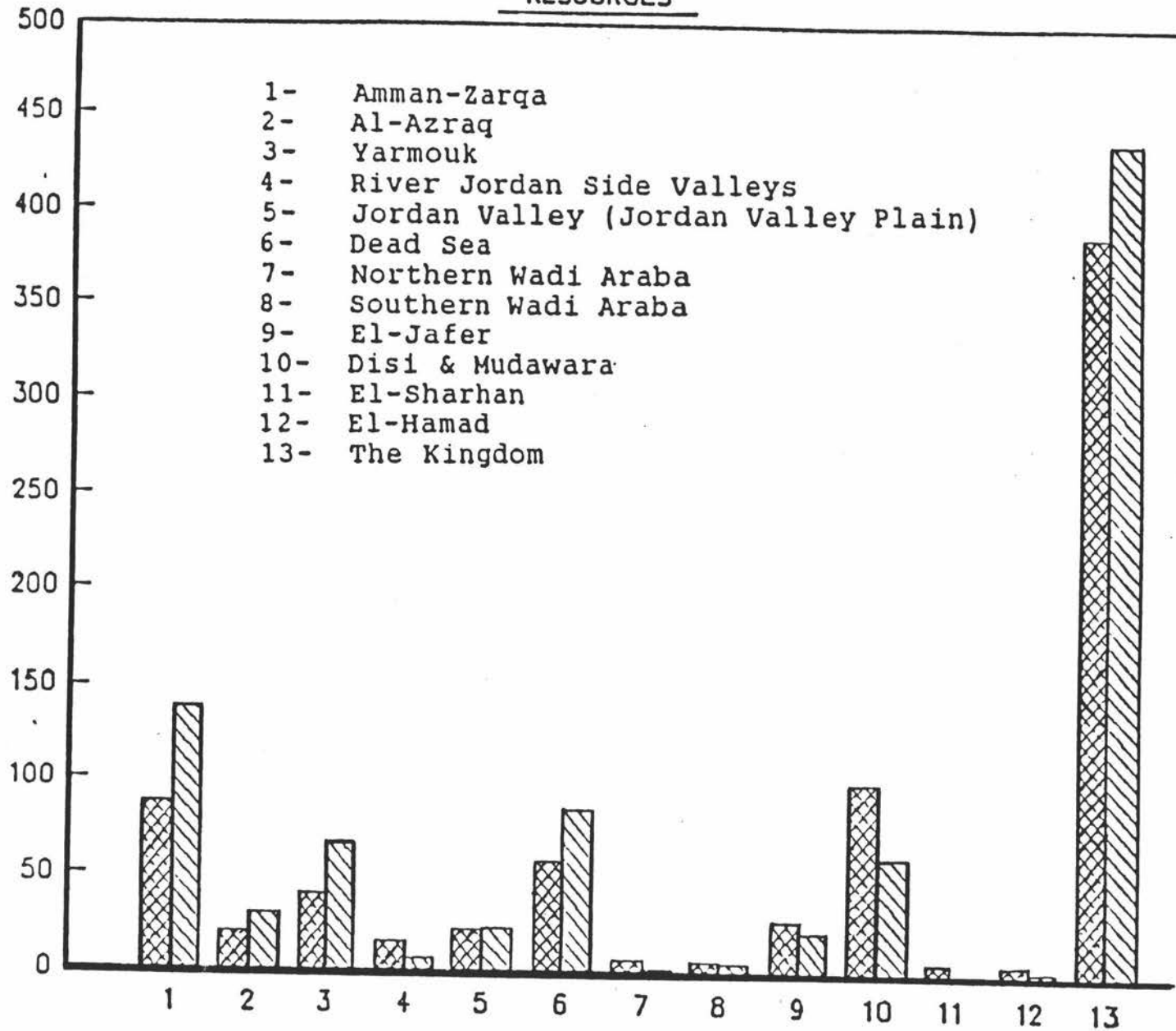
Physical Manifestation	Consequences	Economic and Social Significance
1. Semi-arid climate, low precipitation, high evap. rates.	Fluctuations in water supply; periodic droughts; naturally limited water resource base.	Planning, development targets plagued with uncertainty.
2. High population growth rates.	Increased demand and competition for water; non-renewable ground water depletion; pollution.	Reduced living standards; health problems.
3. Conflicting demands	Inequitable allocations and subsidies, regional price structuring.	Emergence of water lobbyists.
4. Riparian conflicts	Critical supply augmentation projects cannot be undertaken.	Destabilizing to the economy.
5. Absence of effective conservation program.	Water logging, environmental impacts, overall inefficiencies, losses.	Decline in productivity.
6. Financial constraints.	Supply augmentation cannot meet demand requirements.	Increasing health problems, loss of productivity (chain reaction).
7. Lack of integrated water policy.	Most of the above apply.	Low potential for social and economic development.



ALL WITHIN AN INTEGRATED FRAMEWORK.

AVAILABLE AND EXPLOITABLE GROUNDWATER RESOURCES

RESOURCES



GROUNDWATER RESOURCES



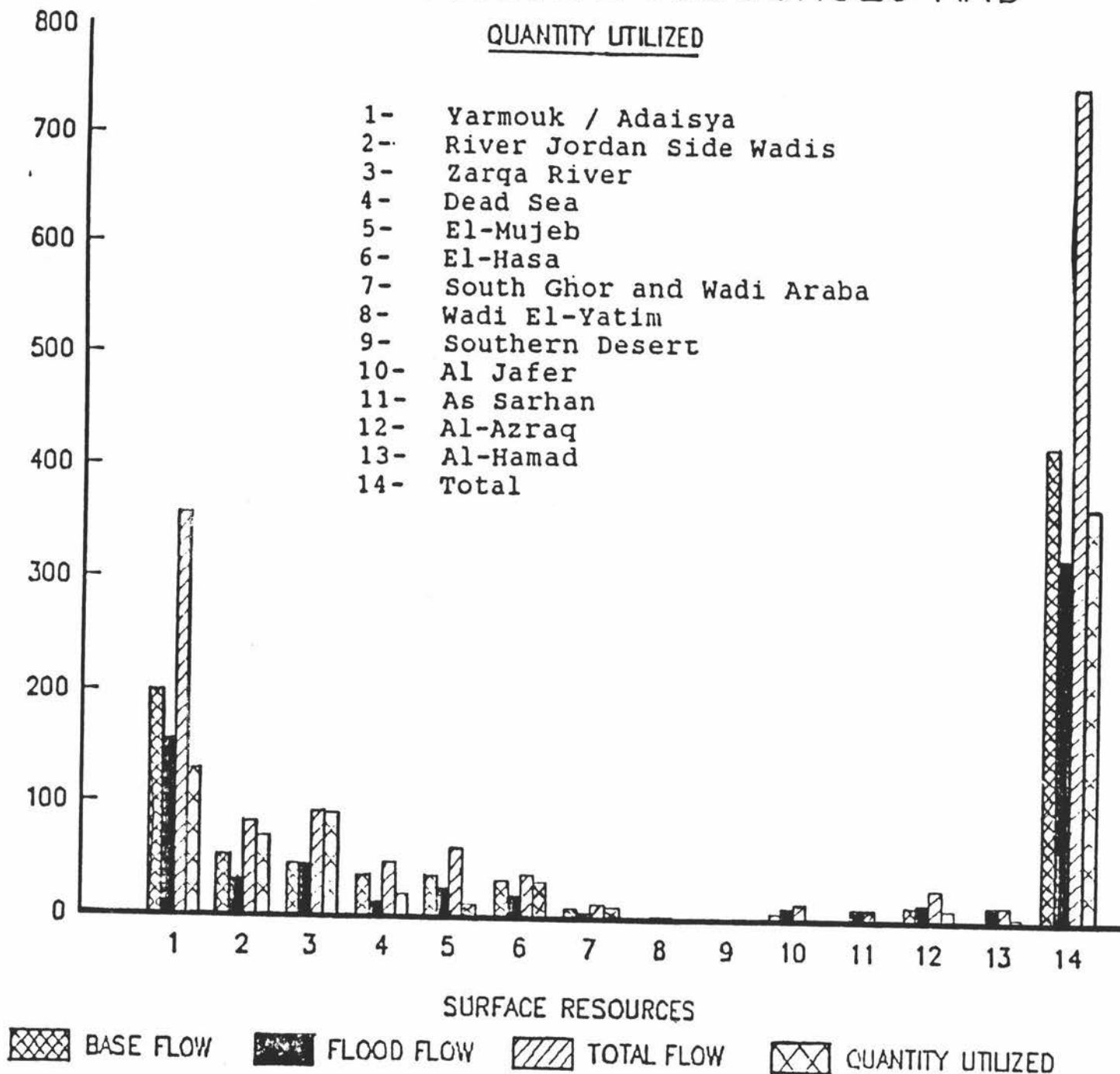
SAFE EXTRACTION



QUANTITY EXTRACTED

AVAILABLE SURFACE RESOURCES AND

QUANTITY UTILIZED



EXISTING DAMS IN JORDAN

DAM NAME	RIVER OR WADI	YEAR COMPLETED	CAPACITY MCM	PURPOSE
KING TALAL	ZARQA	1986	82.00	IRRIGATION, POWER
WADI AL-ARAB	W.AL-ARAB	1984	20.00	STORAGE, POWER
KAFREIN	KAFREIN	1976	4.80	IRRIGATION
SHUIEB	SHUIEB	1964	2.30	G.W. RECHARGE
SHARHABEIL	ZIGLAB	1964	4.30	IRRIGATION
SULTANI	MUJIB	1962	1.20	IRRIGATION, LIVE STOCK
QATRANA	MUJIB	1962	2.30	G.W.RECHARGE,LIVE STOCK
LAHFI	DHULIEL	1967	0.70	LIVE STOCK WATERING
BUWEIDA	YARMOUK	1967	0.70	LIVE STOCK WATERING
GHADEIR AL-ABYAD	YARMOUK	1967	0.70	LIVE STOCK WATERING
SAMMA SIRHAN	YARMOUK	1965	0.70	LIVE STOCK WATERING
AGIB	DHULIEL	1983	1.40	G.W. RECHARGE
BURGU'	RUWEISHID	1950	1.50	LIVE STOCK WATERING
SHAL'AN	RUWEISHID	1970	1.00	IRRIGATION
DEIR AL-KAHF	DEIR AL-KAHF	1950	1.50	LIVE STOCK WATERING

PROPOSED DAMS IN JORDAN

DAM NAME	BASIN	STORAGE CAPACITY MCM	STUDY CONDITION	WATER USES
WEHDA	YARMOUK	220	FEASIBILITY	MULTIPURPOSE
KUFRINJA	J.V.SIDE WADIS	5.2	FEASIBILITY	IRRIGATION
W.YABIS	J.V.SIDE WADIS	5.2	FEASIBILITY	IRRIGATION
KARAMA	J.V.SIDE WADIS	45	FEASIBILITY	IRRIGATION & STORAGE
RUMIEL	WADI WALA	25	UNDER STUDY	IRRIGATION
HAMAM	WADI WALA	3	REFEASIBILITY	G.W.RECHARGE
NUKHILA	WADI MUJIB	12	UNDER STUDY	MULTIPURPOSE
AL-ABYAD	WADI MUJIB	12	REFEASIBILITY	IRRIGATION
SWAQA	WADI MUJIB	2.8	REFEASIBILITY	G.W.RECHARGE
TANNUR	WADI HASA	14	REFEASIBILITY	IRRIGATION
DABA'A	WADI MUJIB	2.8	REFEASIBILITY	MULTIPURPOSE
ZATARI	ZARQA RIVER	2	REFEASIBILITY	IRRIGATION
RUWEISHID	WADI RUWEISHID	10.8	UNDER STUDY	MULTIPURPOSE
ABU HAFNA	WADI RUWEISHID	2.5	UNDER STUDY	MULTIPURPOSE
RAJIL	AZRAQ	2	UNDER STUDY	G.W.RECHARGE
RATAM	AZRAQ	2	UNDER STUDY	G.W.RECHARGE
BUTUM	AZRAQ	2	UNDER STUDY	G.W.RECHARGE
ABU SAFAT	JAFR	2.8	UNDER STUDY	IRRIGATION
JURDHAN	JAFR	4	UNDER STUDY	MULTIPURPOSE
USHEISHAT	JAFR	2.4	PROPOSED	G.W.RECHARGE
MATHK	JAFR	2	PROPOSED	LIVE STOCK WATERING
FASSU'A	JAFR	2	PROPOSED	LIVE STOCK WATERING
ABYAD	JAFR	2	PROPOSED	LIVE STOCK WATERING
UQEIQA	JAFR	2	PROPOSED	LIVE STOCK WATERING
AL-JAHDANIYA	JAFR	2	PROPOSED	LIVE STOCK WATERING

DESALINATION TECHNIQUES

- 1) DISTILLATION METHODS
 - MULTI-FLASH DISTILLATION (MSF)
 - MULTI-EFFECT DISTILLATION (MED)
 - VAPOR COMPRESSION (VC)

- 2) MEMBRANE PROCESSES
 - REVERSE OSMOSIS (RO)
 - ELECTRODIALYSIS (ED)
 - ELECTRODIALYSIS REVERSAL (EDR)

- 3) ION EXCHANGE

- 4) HYBRID SYSTEMS

CONSIDERATION

ENVIRONMENTAL BIOLOGICAL CHEMICAL PHYSICAL

INCREASED CHEMICAL IN BRINE
I.E. CHLORIDE, BIOCIDES, DESCALING CHEMICALS, HEAVY METALS
SLUDGE DISPOSAL
POST TREATMENT

COST COMPONENTS

INVESTMENT, ENERGY, CHEMICAL, O&M

COST COMPARISON (BY PROF. KEENAN
FROM SEVERAL SOURCES)

R.O. \$1.21 - 2.82/M³ 1991 PRICES
DISTILLATION \$1.25 - 3.07/M³ 1991 PRICES

Energy Requirements for Various Desalination Methods. The energy units are MJ/cu m of product.

Process	Energy
Seawater RO	21-36
Brackish RO	4-8
Seawater EDR	32-48
Brackish EDR	3-14
Seawater MSF	46-60
Seawater VC	45-68
Seawater MED	33-37

Cost comparison of distillation with RO desalination. The costs are in units of 1st Quarter 1991 U. S. dollars per cu m of product.

RO Cost	Distillation Cost
1.50-2.82	1.90-4.15
1.21-1.54	1.25-1.80
1.34-1.96	1.40-2.13
1.24-1.87	1.85-3.07
1.44	2.55
1.31-1.36	1.36-1.82

Cost comparison of EDR with RO desalination. The costs are in
units of 1st Quarter 1991 U. S. dollars per cu m of product.

TDS mg/L	RO Cost	EDR Cost
1000	1.25	1.56
5000	2.25	4.88

RECYCLING OF TREATED WASTEWATER

* QTY. 44 MCM - 1989

75-100 MCM - 2000

* ADVANTAGES: ADDITIONAL SOURCE OF WATER WITH NUTRIENTS

* LIMITATIONS

SALINITY

TRACE ELEMENTS & HEAVY METALS

MICROBIOLOGICAL CONTAMINATION SOIL, PLANTS, AIR
GROUND AND SURFACE WATER POLLUTIONS

RAINWATER HARVESTING

CAPTURE MAX. QTY OF RAINWATER

- MICRO CATCHMENTS
- MACRO CATCHMENT
- LOW HEIGHT WATER RETENTION STRUCTURES
- LARGE WATERING HOLES
- IMPREVIOUS SURFACES
- DESERT DAMS
- LARGE DAMS

QTY: RAIN DEPENDENT
ECONOMY