NUCLEAR DESALINATION ACTIVITIES AND PROSPECTS IN THE ARAB COUNTRIES

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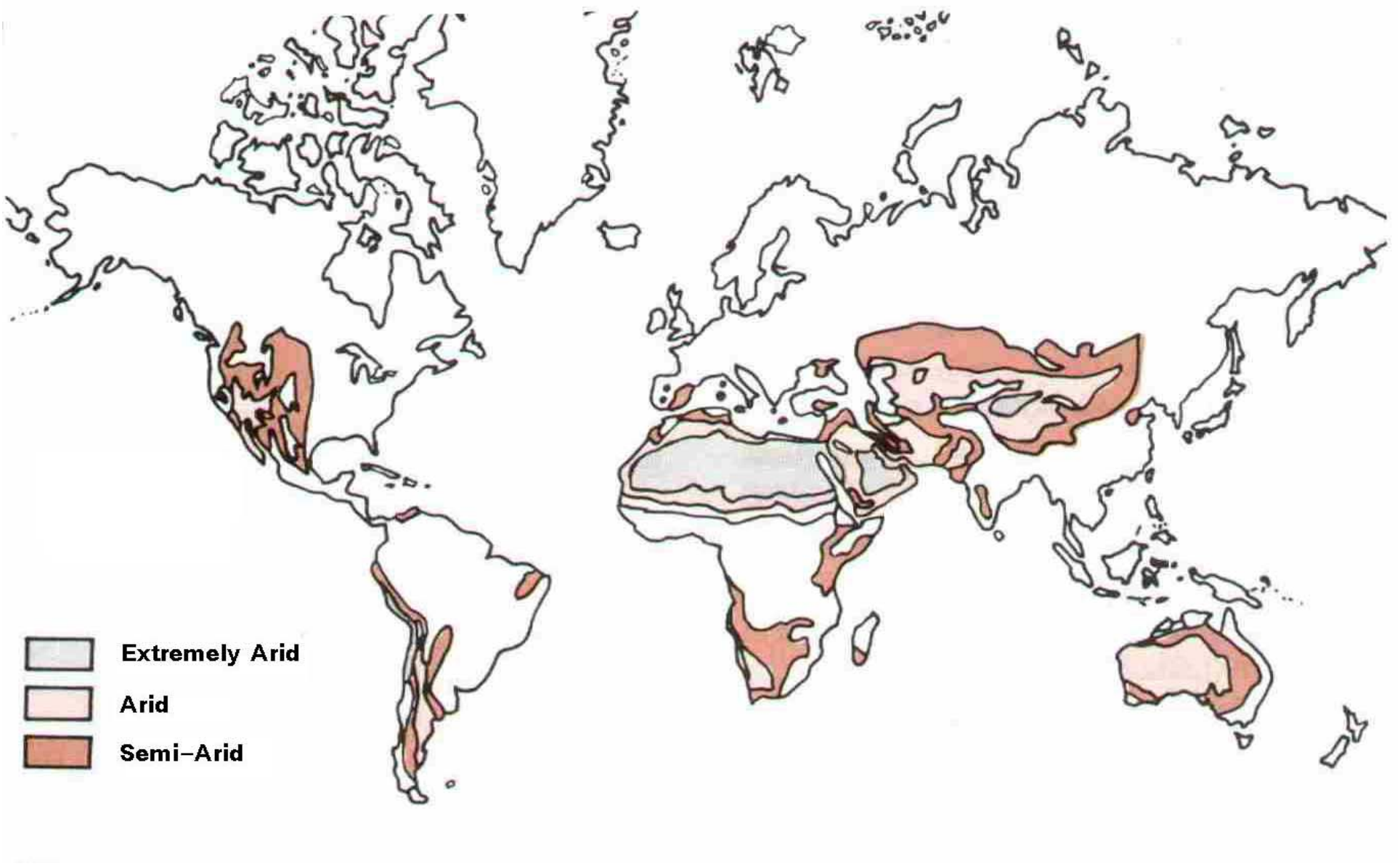
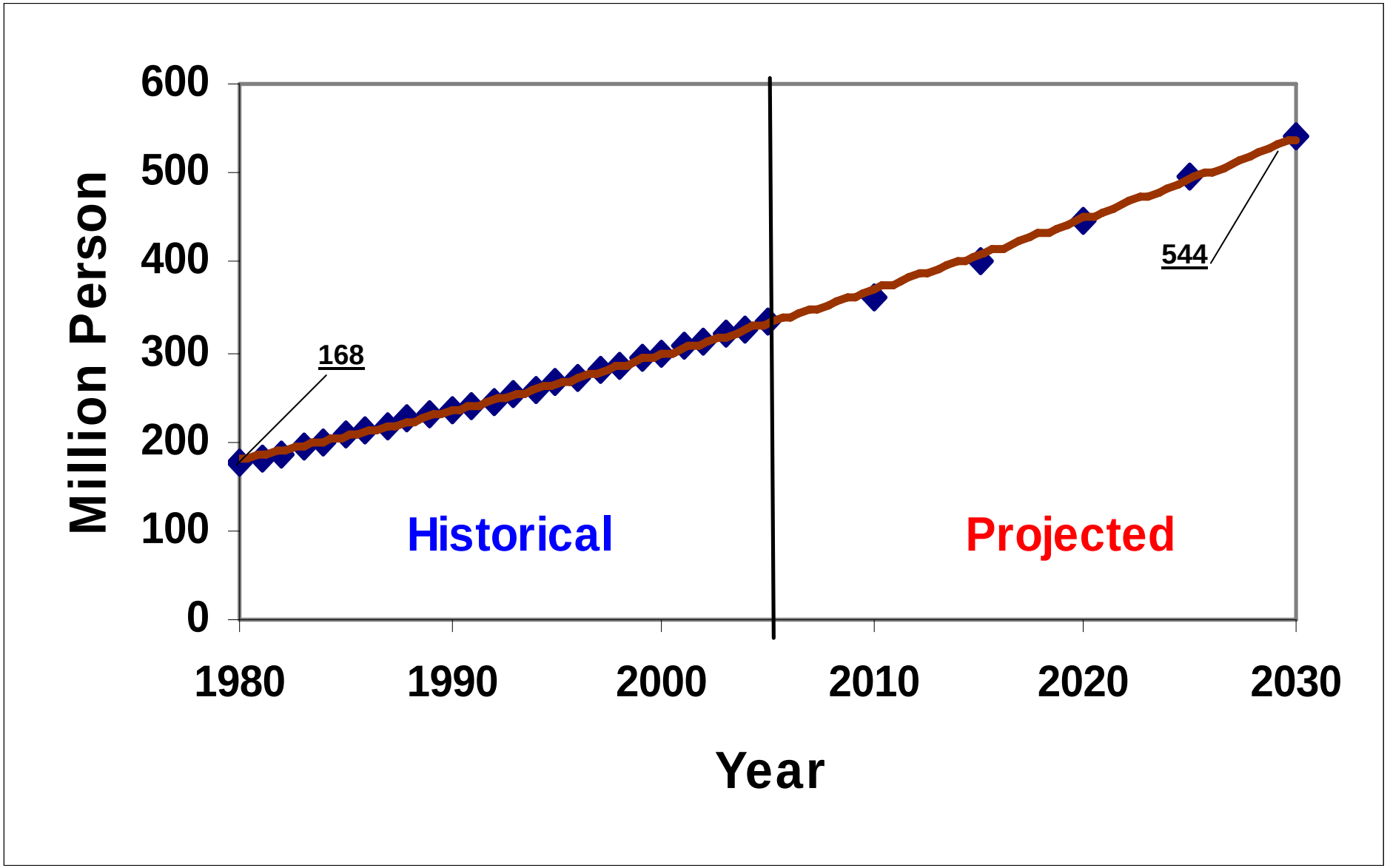
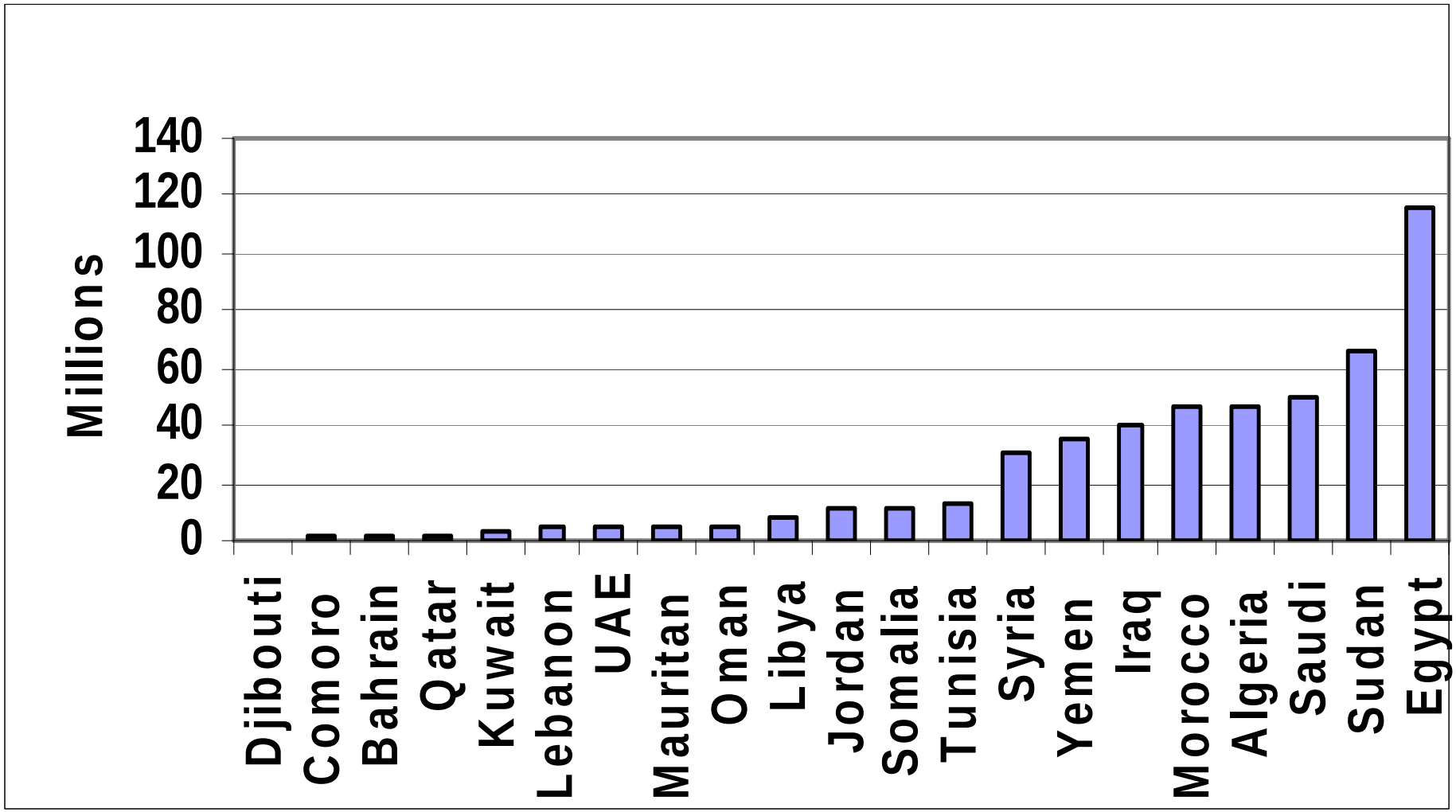
World Arid Regions



Historical and Projected Population of the Arab Countries

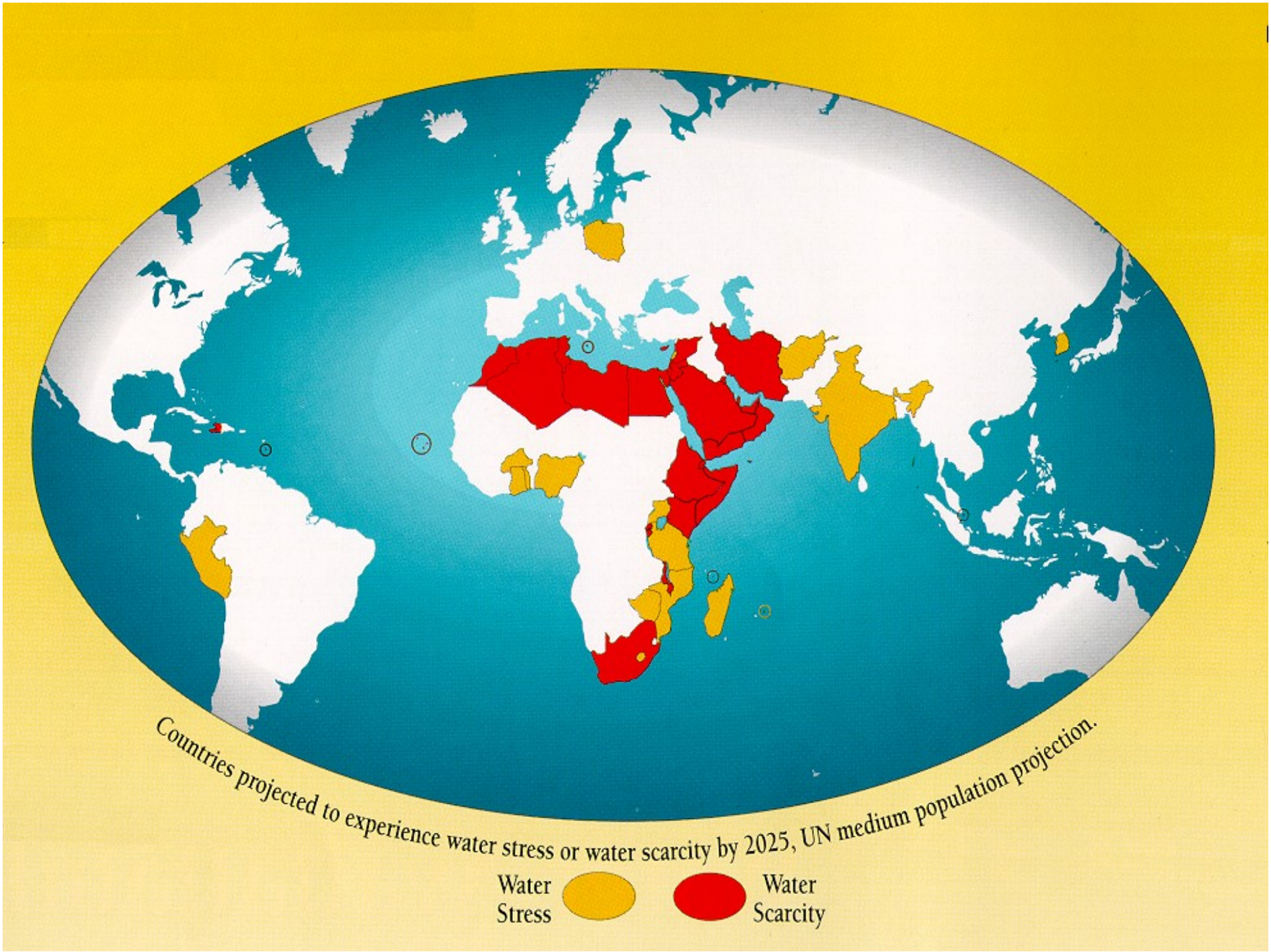


Projected Population of Individual Arab Countries in 2030

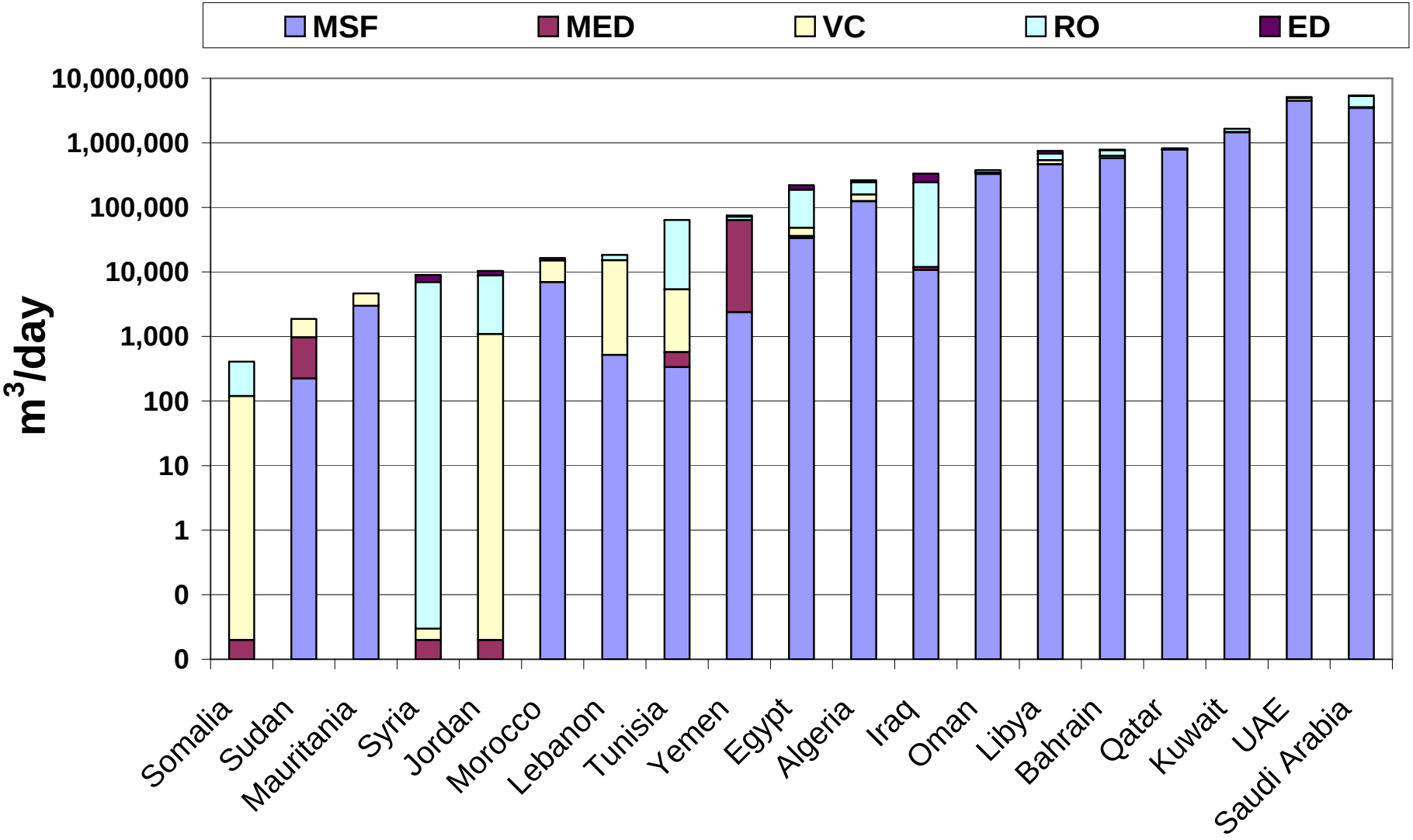


Renewable Water Resources

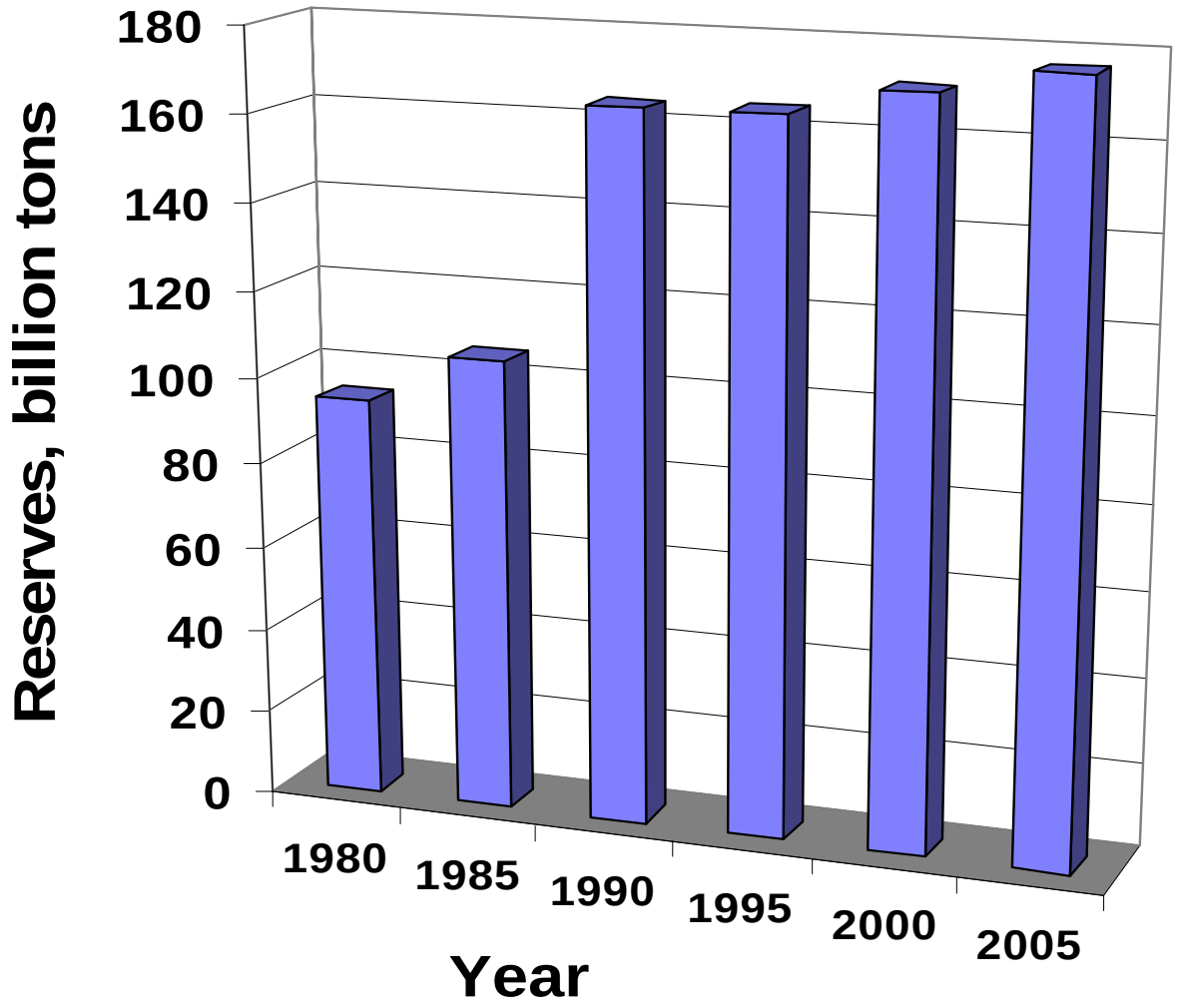
- **Rivers**
  - **Nile 84 billion m^3/y**
  - **Euphrates 30 billion m^3/y**
  - **Tigris 40 billion m^3/y**
  - **Jordan 1.3 billion m^3/y**
- **Renewable Groundwater & Smaller Rivers 196.7 billion m^3/y**
- **Total 352 billion m^3/y**


Countries projected to experience water stress or water scarcity by 2025, UN medium population projection.
Water Stress
Water Scarcity

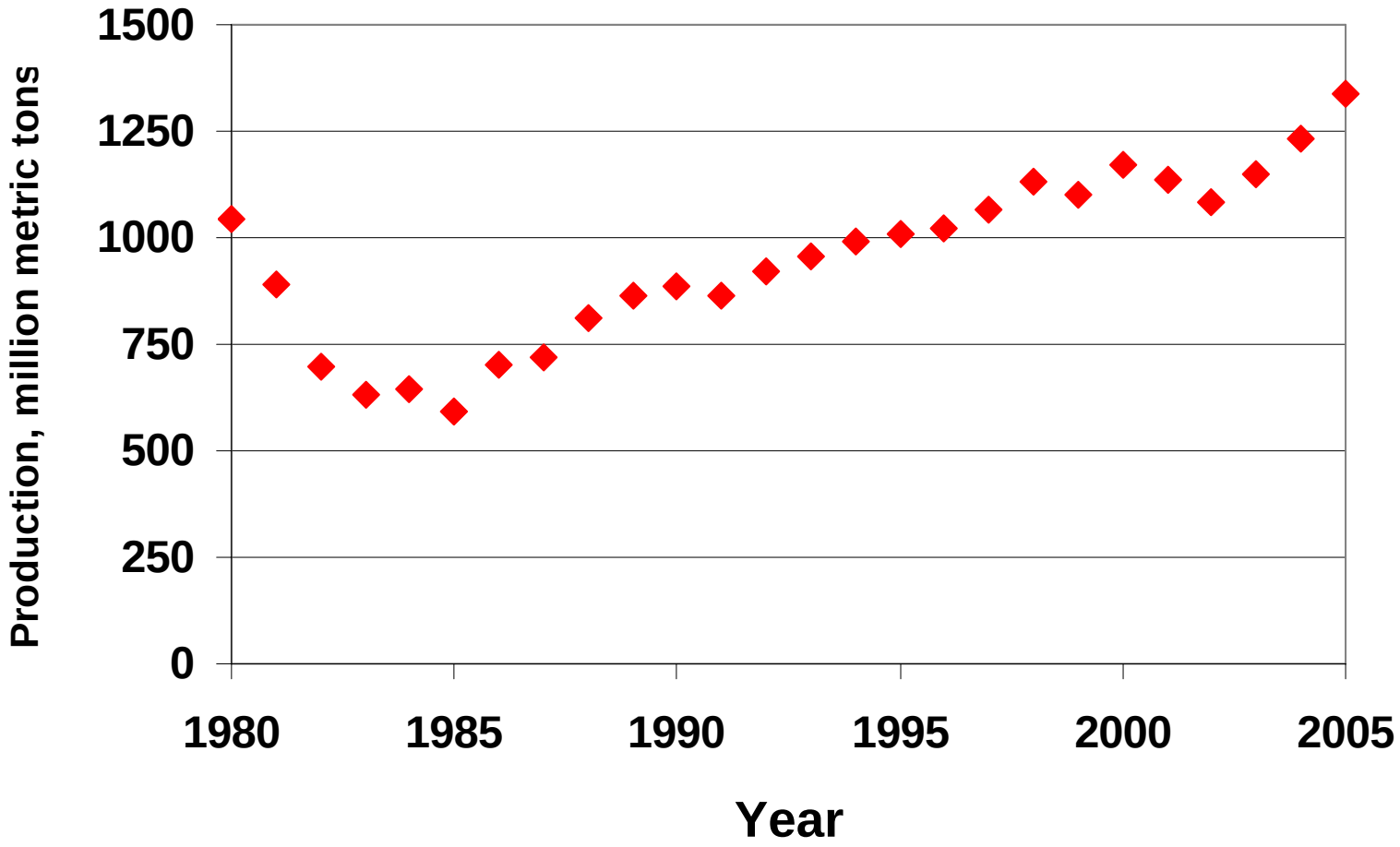
Desalination Inventory by Country and Process (2000)



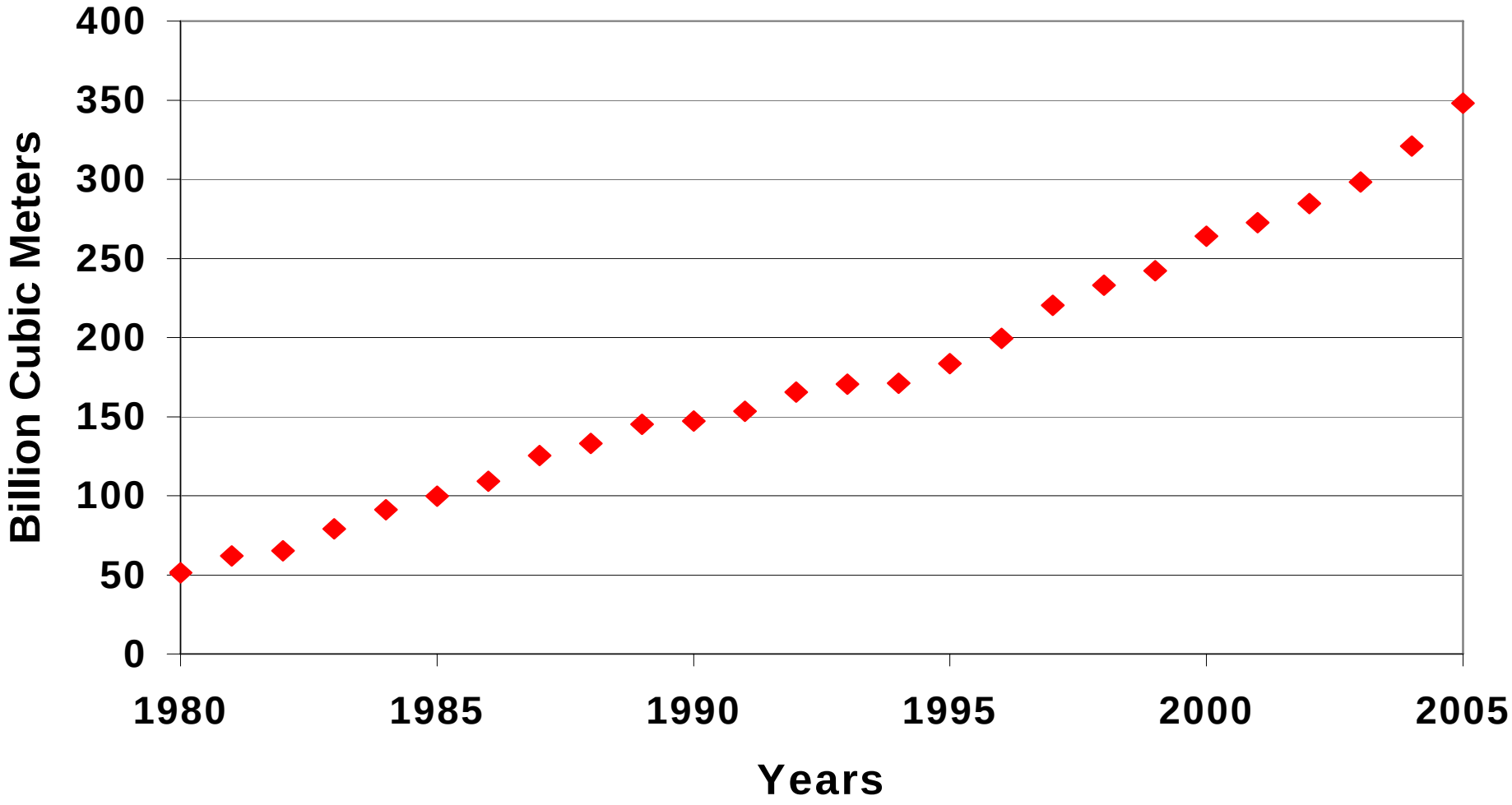
Development of Arab Crude Oil Reserves



Development of Arab Crude Oil Production



Development of Arab Natural Gas Production



Motivations for Considering Nuclear Desalination

- Steadily increasing demand for electricity and water.
- Insufficient known national primary energy resources.
- The desire to save depletable fossil energy resources for future generations, and utilization of these resources as irreplaceble raw material in petrochemical industries.
- Limited potable water resources.
- The energy intensive desalination technologies will play an important role in mitigating potable water deficit
- Perception of nuclear power as convenient, economically competitive and viable source of energy.
- NPP designed to meet the energy needs for electricity generation and seawater desalination will be larger than single purpose NPP would benefit from economy of scale

These reasons have not only retained their validity, but have been reinforced by the developments which have been taking place.

NUCLEAR DESALINATION ACTIVITIES IN THE ARAB COUNTRIES

- North African Study
- Egypt
  - ASRT Study
  - El-Dabaa Study
  - Comparative Assessment Study
  - El-Dabaa Experimental Facility
- Morocco
  - NHR-10 (Tan-Tan)
  - Aghadir and Laayoune Study
- Saudi Arabia
  - Several studies in Universities and KASC
- Tunisia
  - TUNDESAL Study in cooperation with CEA
- UAE
  - Technical and economic feasibility study of nuclear power and water desalination plant for the United Arab Emirates, started in 2005.

INTRODUCTION OF SMRs IN THE ARAB COUNTRIES

- **Most of the reactors considered in the various Arab studies were (SMRs), i.e. ≤ 600 MWe.**
- **SMRs are perceived as a convenient, economically competitive and viable source of energy which, would promote technological development, serve as an incentive for social and economic progress, and secure potable water needs**

Rationale for the Development of SMRs

- SMRs could open up additional energy market sectors (e.g. heat production), not accessible to large reactors.
- SMRs can provide a better response to slow grow rates of energy demand.
- SMRs fit better into small electricity distribution grids and are good candidates for the replacement of older (usually small) fossils fueled plants.
- SMRs have a simple and more rugged design:
- Increased safety margins leading to, for example, longer grace periods, i.e. longer times before operator actions are needed;
- Lower core damage risks.
- Small (if any) accident consequences for the population.

Main Technological Features of SMRs

- Elimination of external primary system re-circulation loops and pumps (integrated design);
- Reduction of large bore primary piping;
- Elimination of safety-grade coolant make-up systems;
- Increased in-vessel heat storage capacity;
- Application of passive emergency cooling;
- Application of passive residual heat removal systems;

Main Technological Features of SMRs

- Location of reactor pressure vessel (RPV) penetrations in the upper part of the vessel;
- Incorporation of large pressurizers (internal or external);
- Minimization of the number of seismic structures, simplification of the building concept and use of seismic isolation.
- Elimination of emergency diesels.
- Modularization of design to allow a higher degree of off-site manufacture and reduced construction time.

REGIONAL COOPERATION

- **Factors Facilitating Cooperation**
  - **The Arab countries share a common land without any natural barriers as well as common language, culture and national feelings.**
  - **They are all members of the Arab league, i.e. links already exist to support cooperation activities.**
  - **Although the present level of cooperation between Arab countries is quit low, there is a room for improving the level of regional cooperation between the Arab countries.**

REGIONAL COOPERATION IN THE FIELDS OF ELECTRICITY AND WATER

- **Advantages of Cooperation**
  - **Reduction of short and medium term needs for installation of new power plants through unification of their national power systems, allowing utilization of existing reserves in each country.**
  - **Standardization of power plants will facilitate local participation and manufacturing on the country and regional levels, as well as, enlarging the market for local industry.**
  - **A more efficient utilization the Arab countries limited highly qualified and skilled manpower, as well as minimizing the cost of developing further manpower capabilities.**

Prime Areas of Regional Cooperation in Nuclear Desalination

- **Legal Framework**
  - **Mutual consultation could be of benefit in facilitating the smooth development of joint undertakings.**
  - **The Arab countries have the opportunity of building-up their regulatory structures adopting a joint approach and establishing similar or even the same rules and procedures .**

Prime Areas of Regional Cooperation in Nuclear Desalination

- **Manpower Development**
  - Development of an adequate manpower infrastructure requires a long time and major efforts. If these efforts can be shared, it would benefit all.
  - Cooperative approaches can be applied both to desalination plants and to nuclear reactors.
  - In addition to sharing resources and experiences, regional training centers equipped with sophisticated training facilities such as simulators, could be of substantial benefit to all.

Prime Areas of Regional Cooperation in Nuclear Desalination

- **Regional Participation**
  - This aims at maximizing regional share in all activities that can be evaluated by money such as: construction, erection, commissioning, operation and maintenance.
  - Manufacturing should be considered from the regional point of view, because this would effectively increase the size of the potential market.
  - Standardization improves regional participation. The benefits of joint approach are not limited to nuclear reactors, they could also be applied to desalination plants.

Prime Areas of Regional Cooperation in Nuclear Desalination

- **Regional Participation**
  - **Sharing of experience, mutual assistance, reduction of engineering effort and costs through repeated projects, could reduce costs of product water.**
  - **Transfer of knowledge, skills and experience in the areas of construction, erection, commissioning, operation and maintenance, would ultimately result in mutual benefits to all countries of the region.**
  - **The Arab countries could start developing specific QA/QC codes of practice for the region, which should be acceptable, and if possible mandatory within the region, in order to escape from the current fragmentary situation.**

Prime Areas of Regional Cooperation in Nuclear Desalination

- **Acquisition and Financing**
  - Regional cooperation in the acquisition phase of projects, at least in the development of bid invitation specifications and in evaluation of bids, would increase local capabilities, tend to avoid the repetition of mistakes, and promote a trend towards standardization.
  - Regarding financing, taking into account that very large investments are required, sharing of the financial load and eventually the benefits, might very well facilitate solving this problem.

Prime Areas of Regional Cooperation in Nuclear Desalination

- **Research and Development through:**
  - **Sharing the experience and consultations**
  - **Coordinated research programmes utilizing existing R&D institutes in each country or the establishment of a joint R&D Institute.**
  - **Other forms of cooperation could be through the enhancement of the role of the Arab Atomic Energy Authority (AAEA), which provides a good forum for advancing peaceful uses of nuclear energy in the Arab World.**

CONCLUSIONS

- Most of the Arab Countries lie within the temperate zone, and the bio-climate varies from arid to extremely arid. Most of the Arab Countries are water-scarce countries.
- The only significant primary energy resources in the Arab World are crude oil, natural gas. Limited hydropower exists in some Arabic countries, but it is nearly fully utilized.
- There is a potential for solar and wind energies but the technology for large-scale electricity production is not yet economic.
- Several Arab countries have been considering for sometime utilization of nuclear energy for electricity generation and seawater desalination

CONCLUSIONS

- Algeria, Egypt, Libya, Morocco and Tunisia, as well as Saudi Arabia and United Arab Emirates carried out ND feasibility studies and other national activities.
- These studies indicated that nuclear power could play an important role in meeting the expanding needs for energy that can be supplied to the grid in the form of electricity, or to desalination plants as heat and/or electricity.
- Most of the reactors considered in the various Arab studies are Small and Medium Reactors (SMRs).
- From the viewpoint of nuclear desalination, the prime areas of regional cooperation are: Legal Framework, Manpower Development, Regional Participation, Acquisition and Financing, and Research and Development


Thank You