WATER MANAGEMENT ISSUES IN DRYLANDS IN THE TWENTY-FIRST CENTURY

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Summary

During the twentieth century, dryland regions have been subjected to ever increasing pressures on finite resources as population numbers have grown at least five-fold. Demand for water has grown rapidly, particularly for irrigation, but until the 1980s this demand was able to be met from newly developed sources of surface and groundwater. From then on, all renewable sources of water were committed to one use or another. The water needs of new developments in urban regions can now only be met by the reallocation of irrigation water to more wealth-creating uses or by desalination. In the twenty-first century in dryland regions water may become too precious to be used for irrigation. This will lead to agricultural decline, unemployment, and severe social problems in rural areas. In turn it will cause increased migration to urban centers.

1. Nature of Dryland Environments

From a topographical point of view dryland regions can be very varied. In the Middle East different environments exist in close proximity. For example, in Israel and Jordan it is possible to go from the Mediterranean Sea to 1000 meters above sea level in Jerusalem, then down to 400 meters below sea level in the Dead Sea lowlands and up once again to more than 1000 meters above sea level in Amman all within a three hour

drive. Such conditions are by no means unique. In northern Iran the Caspian Sea is approximately 90 meters below sea level but in a two hour drive towards Tehran the road traverses the Elburz mountains with peaks rising to over 5000 meters before dropping to the central Iranian plateau at a height of around 1000 meters. In contrast to the rich topographical and ecological diversity of the Middle East the drylands of central Australia and sub-Saharan Africa reveal a remarkable topographical and ecological uniformity. Here similar conditions can prevail over hundreds of kilometers with very little in the way of change occurring.

Dryland areas, by their nature, are characterized by low precipitation totals on an annual or seasonal basis. Perhaps even more important in terms of human settlement is the fact that in drylands the variability of precipitation from one year to another is very high. In Aswan in southern Egypt the average precipitation is quoted as 4 mm per annum, but it is possible for a number of years to pass in which no precipitation at all occurs. This might then be followed by a storm which produces over 15 mm of rainfall within a few hours. Similarly in the grassland steppe regions of either Syria or the African Sahel rainfall may average around 200 to 250 mm, but in some years it may fall to less than 100 mm, while in others it could rise to 400 mm.

As a result any settlement which has come into existence has had to reflect the low and variable carrying capacity of the environment. Not surprisingly most of the settlements have been built in the wetter parts of the dryland regions. Although water may have been in short supply at certain times of year the overall water balance was such that communities could exist and even prosper under such conditions. Indeed, in many dryland environments there were often periods during the annual cycle when excessive volumes of water were available. For example, floods were common along rivers like the Nile and in the Tigris-Euphrates basin. In an historical context the main form of economic activity in drylands has been arable farming with irrigation playing a key role in providing high yields. The wealth created by this agriculture along major rivers has often been immense, leading to the great civilizations that characterized the Nile and the Tigris-Euphrates basins. Elsewhere much of the agriculture has been of a subsistence nature centered on small village settlements.

In the drylands of the Middle East the close proximity of different topographical and ecological zones meant that abnormally long periods of drought seldom affected all areas at the same time. This ensured that the peoples living here were able to survive such conditions by accessing food from the different ecological niches which were available to them. As s result great famines and large losses of life were a very rare occurrence. In contrast, the dryland areas of Sub-Saharan Africa have almost uniform topographical and ecological conditions stretching over hundreds of kilometers. When drought conditions occurred in these regions the local people could not resort to alternative food collection strategies owing to the prevailing environmental uniformity. As a result, major droughts had a huge impact resulting in the failure of crops, the death of animals, and in turn great losses in the human population.

2. Population Growth in the Twentieth Century

In dryland areas the twentieth century has been characterized by massive changes that have affected both the environment and way of life of the people who live there. During that century many developing countries in dryland regions saw their populations grew by more than five fold. For example, Egypt, Iran, and Turkey all had populations of between 9 and 14 million in 1900, yet by the mid 1990s these figures had risen to more than 60 million (Table 1). What is even more worrying is that by the year 2025 these three countries are projected to have populations of around 100 million. While it is difficult to estimate the total population of the Middle East and North Africa in the early years of the twentieth century owing to a lack of accurate data it seems likely that it was little more than 100 million. Yet by the year 2025 it is estimated to have risen to around 725 million, which if correct will represent at least a 7 fold increase over a period of 125 years.

Country	Early	Late	1960s	1985	1995	2010	2025
	20C	1930s					
Turkey	13.9	17.8	31.4	50.7	61.4	79.2	95.6
Iran	9.9	14.6	25.1	49.7	61.3	83.7	106.1
Egypt	9.7	15.9	30.9	46.6	61.9	80.7	97.9

Source:- 1995 World Population Data Sheet and Clarke and Fisher, 1972

Table 1. Population changes since the beginning of the twentieth century (population in millions)

A similar situation is observed in Australia, the driest continent, where the population was around 3.8 million in 1900. By 1995 it had grown to 18 million and it was predicted that it would reach slightly more than 23 million by 2025. The same is true for South Africa. Here a population of 5.2 million at the beginning of the twentieth century grew to 43.5 million by 1995 and is predicted to be around 70 million by 2025. What all these data clearly show is that in dryland regions all over the world there has been a massive increase in pressure on available resources as a result of the rapidly growing populations.

3. Water Usage

In modern societies water is used for a variety of different purposes. By far the most critical is water for drinking. However, although the quality of the water has to be high the volumes required are small and amount to only 2 to 6 cubic meters per person per year. Much more important in terms of volume is the use of water in urban systems to transport waste products generated in the home and in industry. This includes washing of cooking utensils, clothes, and human beings themselves and the discharge of human waste products through toilet flushing. The actual volumes of water used for these purposes reveal considerable variation from one country to another. At the lower end of the scale a dryland country like Israel is able to maintain an advanced urban society by using only 100 cubic meters per annum per person. In contrast, in the USA, the richest country in the world, average water use is over 250 cubic meters per person per annum.

These two values can be thought of as the "minimum" and "maximum" needs for a modern urban society and so permit calculations to be made as to future water demands.

By far the most important use of water in terms of volume is for irrigation. In many dryland countries irrigation water accounts for at least two-thirds of all water use and can in certain cases exceed 90%. The actual volume used depends entirely upon the area which is devoted to irrigated agriculture. It can, however, be stated that average water use for most field crops is around 10 000 cubic meters of water per hectare per annum.

The result of the rapid population growth which has occurred in the twentieth century has been that ever greater pressures have been put on finite resources such as water. As population numbers have increased more and more, water has been abstracted from rivers and groundwater sources in dryland regions to supply the growing needs. In the period up to the time of the Second World War this was achieved largely by the use of low technology solutions that had been in existence for hundreds, if not thousands of years. These included the use of timber and brushwood to form diversion structures in rivers and human labor to construct irrigation channels and to extract groundwater. However, particularly since 1950, new water resources have been made available from rivers by the construction of dams and their associated reservoirs, while for groundwater the mechanically pumped well has become a common feature.

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Bibliography

Albert J., Bernhardsson M., and Kenna R. (1998). *Transformations of Middle Eastern Natural Environments: Legacies and Lessons*, 498 pp. Bulletin Series, Yale School of Forestry and Environmental Studies, Number 103. New Haven: Yale University. [This book contains a series of papers dealing with specialized topics relating to environmental issues in the Middle East.]

Beaumont P. (1993). *Drylands: Environmental Management and Development*, 536 pp. London: Routledge. [A comprehensive survey of the major issues facing drylands at the present day.]

Beaumont P. (1997). Water and armed conflict in the Middle East—Fantasy or Reality? In N. P. Gleditsch, ed. *Conflict and the Environment.* Dordrecht: Kluwer Academic Publishers. pp. 355–374. [An article which argues that wars over water are not likely to occur in the twenty-first century.]

Beaumont P. (2000). *The Quest for Water Efficiency—Restructuring of Water Use in the Middle East. Water, Air and Soil Pollution*, (123) pp. 551-564. [Examines the wealth which can be created by water use in different sectors of the economy.]

Fradkin P. L. (1984). *A River no More: the Colorado River and the West*, 360 pp. Tucson: University of Arizona Press. [A book that examines the impact of human activity on the Colorado River.]

Gleditsch N. P., ed. (1997). *Conflict and the Environment*, 598 pp. Dordrecht: Kluwer Academic Publishers. [A series of specialized papers examining the possible conflicts that might arise over environmental issues.]

Howell P. P., and Allan J. A., eds. (1990). *The Nile—Resource Evaluation, Resource Management, Hydropolitics and Legal Issues*, 238 pp. London: Centre of Near and Middle Eastern Studies, School of Oriental and African Studies, University of London. [In depth studies of the hydrology and water resource issues of the Nile basin.]

Kliot N. (1994). *Water Resources and Conflict in the Middle East*, 309 pp. London: Routledge. [Extremely detailed reference volume dealing with water resource issues in the Middle East.]

Lonergan S. C. and Brooks D. B. (1994). *Watershed—the Role of Fresh Water in the Israeli-Palestinian Conflict*, 310 pp. Ottawa: International Development Research Center. [Study of the water problems facing the Palestinians and the Israelis.]

Starr J. C. and Stoll D. C., eds. (1988). *The Politics of Scarcity—Water in the Middle East*, 198 pp. Boulder: Westview Press. [A series of papers examining the likelihood of conflict over water in the Middle East.]

The Second World Water Forum and Ministerial Conference (2000), www.worldwaterforum.org/main.html [Reports of discussions between representatives form governments, NGOs, universities and other organizations interested in water issues in the twenty-first century.]

Biographical Sketch

Peter Beaumont is Professor of Geography at the University of Wales, Lampeter, UK; a position he has held since 1978. Prior to this he was a Lecturer and Senior Lecturer in Geography at the University of Durham, UK. Over the years his research has concentrated on water resource management in drylands, with particular emphasis on the countries of the Middle East. He has written more than 80 specialized papers and is the author of a number of books, including *Drylands - environmental management and development* (1993); *The Middle East - a geographical study*, 1988 (with G.H.Blake and J.M. Wagstaff); *Agricultural development in the Middle East*, 1985, (with K.S., McLachlan); *Qanat and Khattara: traditional water systems in the Middle East and North Africa*. (with M. Bonine and K.S. McLachlan). He has also held a number of international fellowships including a Harkness Fellowship; a NATO Fellowship (on two occasions; Visiting Fellow, Wolfson College Oxford, UK; Visiting Fellow, Oxford Centre for Islamic Studies, UK; Visiting Professor, University of California, Berkeley, USA; Visiting Professor, University of Texas, Austin. USA).