A proposal for sustainable groundwater management as influenced by a pyramid of social needs: the case of Israel's coastal aquifer

A.J. Melloul * and M.L. Collin**

*Hydrological Service: P.O. Box 6381, IL-91 063 Jerusalem, Israel

* *Hydrological Service P.O. Box 57081, IL-61 570 Tel Aviv , Israel

Abstract The psychologist Abraham Maslow developed a pyramid of human social needs. A comparable pyramidal hierarchy of groundwater needs can be envisaged. In the pyramid of social needs, until lower level needs are fulfilled, higher level needs remain irrelevant to people. Analogously, only once a society's basic groundwater concerns are fulfilled can groundwater management decision-makers hope to press onwards towards an ultimate goal of attaining sustainable groundwater resources development. Groundwater resources of the Sharon region of Israel's coastal aquifer can be taken as a case in point. To effectively carry out management recommendations for achieving sustainable groundwater development, technical concerns must be integrated with social concerns. Alignment between comparable levels of the pyramids of social and groundwater needs can only be achieved by educating the society to perceive the significance of sustainable resource development for future generations. Only then will the society be fully prepared to pay the price for such development and to participate in the long-term environmental planning required.

Keywords Maslow's pyramid of human needs; hierarchy of groundwater needs; groundwater sustainability management; long-term environmental planning

Water Science and Technology **Vol 42 No 1–2 pp 249–253** © IWA Publishing 2000

Introduction

Eco-hydrological and socio-economic background of the study area

In order to relate practically to the quantitative and qualitative aspects of this proposal, the Sharon region, on Israel's coastal aquifer, has been considered here as regards its hydrological, ecological and socio-economic situation. This region stretches from the northern boundary of the Tel Aviv metropolitan region to the southern limits of the city of Hadera, and from the Mediterranean seacoast to the border of the region of Samaria (Figure 1). Underlying the region is the phreatic, sandstone coastal plain aquifer. This aquifer interfaces to the west with seawater. Inland, it receives percolating leachates of urban and agricultural anthropogenic pollutants from the ground surface. To the east, in some regions, it interfaces with saline groundwater of the neighboring chalky aquitards (Tolmach, 1979). The Sharon phreatic coastal aquifer region can be considered as a lens of fresh water impinged upon from the west by seawater and from below by brines. Inland, it is polluted from above by anthropogenic leaches from agriculture, industry, and the effluents of solid and liquid waste.

Table 1 presents mean desired and recent values of parameters representing the seashore and inland sub-regions as regards groundwater quality, as well as ecological, and social data (IHSR, 1987, 1997).

The seashore sub-region of the Sharon lies within 2000 m of the shoreline, and represents that portion of the aquifer at greatest risk from seawater intrusion. Population density of the sub-region is around 70 inhabitants/km^2, well density around one well/km^2, and potential pollution site density is around 0.2 sites/km^2. Notwithstanding low urban population density and comparatively few industries, even such benign land-usage as recreational activities have already adversely affected the area.

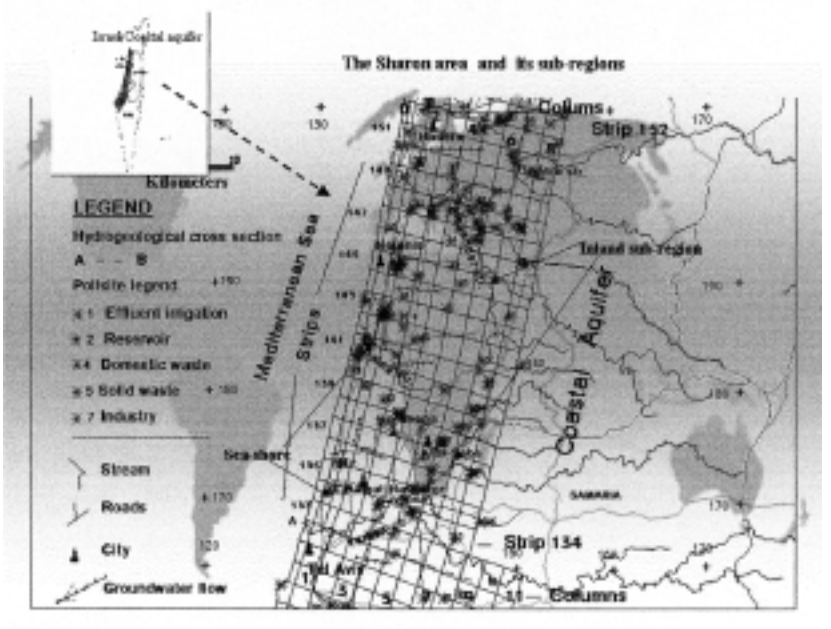

Figure 1 Location map of the study area in the Sharon region

Table 1 Eco- hydrological data of the two Sharon sub-regions

		Storage volume	Groundwater quality***				Ecological data		
Sub-region	Surface area km²	Water table levels*** m	Chlorides Cl Mean mg/l	Rate mg/l/yr.	Nitrates NO_3 Mean mg/l	Rate mg/l/yr.	Well density nr./km²	Population density nr./km²	Pollsite density nr./km²
Inland	~360	8 (10)	170 (250)	1.5 (0)	65 (45)	1 (0)	5	700	0.2
Seashore	~30	0 (1)	50→1000* (250)	>20 (0)	40→90** (45)	2 (0)	1	< 70	0.2

( ) = desired standard values for drinking water and hydrological planned values (From: WHO, 1993; IHSR, 1987);
* = higher levels in areas of sea water intrusion; ** NO_3 lower than 45 mg/l found in some wells; *** IHSR,1997

The inland sub-region beginning two km from the seashore, is relatively isolated from sea-water intrusion, but significantly impacted by anthropogenic pollution from the ground surface. Population density is around 700 inhabitants/km^2, well density is five wells/km^2, and potential pollution site density is around 0.2 sites/km^2. Untreated sewage is known to be channeled into streams and wadis.

In both sub-regions, land is relatively expensive and major portions of the population enjoy above-average salary levels. In spite of that, there are still significant portion of the population, which live with lower than average salaries .

The problem and the objective

Groundwater management consists mainly in resolving such problems as lack of adequate treatment for sewage effluents, seawater intrusion, polluted leachates, etc. What, then, is the local society prepared to pay to resolve such problems, and how might they participate in the resolution?

Resolution of such problems necessitates dealing simultaneously with a variety of disciplines such that satisfactory resolution of earlier concerns enables the management process to focus and increasingly converge on the target concern, that being sustainable long-term groundwater management. Involving a focal point of development and attainment, such a proposed management process more properly elicits the metaphorical format of a pyramid than that of a ladder. As such, it brings to mind the pyramidal hierarchy of five general levels of human social needs conceived by the psychologist Abraham Maslow (1937, 1943). His thesis was that until lower levels of needs had been fulfilled, people would be unable to deal with higher levels.

The base of the pyramid involves such physiological needs as those for air, water, food, etc. This involves the widest portion of a region's population. Once these needs are fulfilled, the next level of the pyramid involve such safety needs as stability, security, and health. Satisfaction at this level enables individuals to focus upon control and organisation of social requirements and a more structured community. Only having realized this level of needs can people proceed to meet their needs for status, recognition, and self-esteem. As one rises from one stage to another on the pyramid, more educated and restricted segments of the population are involved in order to deal with wider and wider geographic ranges of population concerns. At the pinnacle of the pyramid lie needs for self-fulfillment, understanding, æsthetic appreciation, spiritual concerns, the ability to sacrifice present personal welfare in order to advance an international plans and requirements for future generations.

With regard to groundwater management, a similar pyramidal hierarchy of societal needs can be envisaged. For the widest proportion of the population, only once the personal need for drinking water quantity has been fulfilled, can the society concern itself with its water security needs. Thus, the availability of the required groundwater quantity will be followed by concerns for social and economic well-being and health, involving quality, and the required legislation and clout to maintain it. Only once these concerns have been satisfied, will the population take an interest in inter-regional, long-term planning, remediation efforts, and social education for environmental awareness. At the pinnacle of this hierarchy lies the quest for sustainable water resource development (Pretty, 1996; Smithers and Walker, 1995). To attain this, the population must be sufficiently informed to be ready to sacrifice short-term welfare for future societal needs.

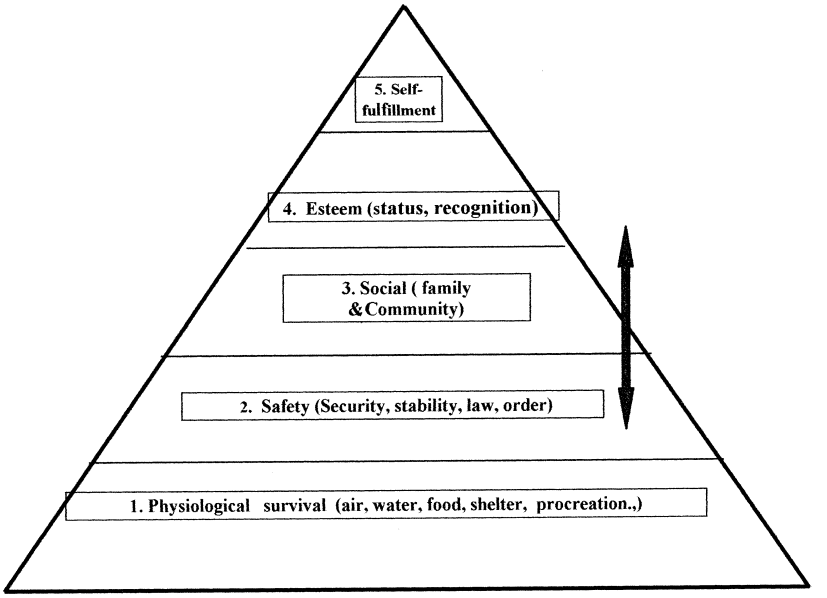

Figure 2 Maslow's pyramid of needs

This paper proposes an approach towards groundwater management planning which integrates a society's groundwater and socio-economic needs. By synchronizing these levels of public concern a successful implementation of sustainable groundwater development might be achieved. The Sharon region of Israel's coastal aquifer (Figure 1) has been addressed as a case in point.

Methodology

Just as Maslow's pyramid of social needs involves five levels of concerns, so groundwater management needs can involve five levels (Figure 3). At its base level is the quantitative need for an acceptable quantity of drinking water – a survival requirement of any human, or animal society. Once satisfied, a second level involves safety and security needs of individuals and small groups. At this stage, groundwater quality standards are set for drinking and agricultural usage, as well as the appropriate legislation to enforce such standards. Empirical monitoring networks can be established to provide early warning regarding groundwater quantity and quality degradation on a local scale. A third level consists of organized supply and treatment of water systems for the purpose of maintaining normal and healthy family and community life. At this stage, social needs focus upon safeguarding and advancing one's place in the community; similarly, short-term water management planning focuses upon safeguarding and advancing the regional community's local water supply and sewage treatment plants. More structured legislative guidelines, standards, and more sophisticated regional and watershed monitoring networks are developed. The fourth level involves national, long-term land-use and water management planning, remediation measures, use of reclaimed and treated effluent water for agricultural irrigation, etc. This stage necessitates educating the society to facilitate public awareness and to motivate citizens to participate in the decision-making process, requiring long-term thinking on the part of both citizenry and decision-makers. At the pinnacle of the pyramidal hierarchy of groundwater management needs, a fifth level arrives at the fulfillment of sustainable groundwater development. At this stage, attention is focused upon the needs of future generations. This involves long-term planning with ecological and humanistic aspects on a national and international scale.

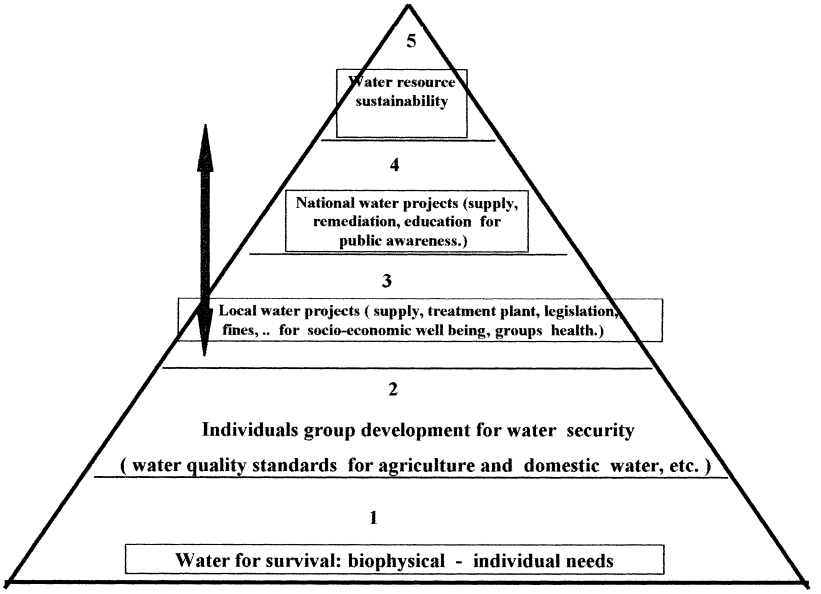

Figure 3 Groundwater pyramid of needs

Results and discussion

Based on the data presented above (Table 1), the Sharon region can be situated midway between levels 2 and 3 on the pyramid of social needs (the arrow on Figure 2), and between levels 3 and 5 on the pyramid of groundwater management needs (the arrow on Figure 3). This region occupies a lower position on the pyramid of social needs than on the hierarchy of groundwater management needs. This discrepancy would appear to imply that its society is not yet prepared to make the sacrifices necessitated by, and to participate in the processes involved in, the required measures towards groundwater remediation and sustainability. It indicates that management planning for groundwater resource sustainability remains a relative luxury for the population. Effective management for sustainability can be achieved only after the society's more basic needs have been filled.

The importance of integrating social and groundwater management needs can be seen when measures must be taken to recharge wells with imported, fresh water in order to maintain and raise water tables and storage capacity for times of drought. Without adequate legislative prohibitions against contaminators, such measures lose their efficacy. They also lose their punch because of insufficient education , public participation, and public support of forthcoming remediation efforts . Much recharged water is then immediately consumed by unconstrained pumpage or polluted owing to anthropogenic activities.

Conclusions

Major groundwater management operations, such as installation of treatment plants for sewage water, desalination plants to produce new fresh water, use of treated effluents for agricultural irrigation, etc. must be orchestrated in harmony with social concerns in order to be properly implemented. Only consensus between a society's citizenry and its groundwater management decision-makers can effect implementation of truly sustainable groundwater resource development. It is therefore further proposed that regional populations be surveyed with regard to ranking of their concerns previous to implementation of groundwater management operations. Thus, socio-economic realities will have been taken into consideration in future modelling of hydrological and ecological systems and long-term planning.

This work suggests integrating social concerns into the process of setting priorities and timing with regard to hydrological and ecological management and budgeting. Ideally, the level of a society's social needs should be synchronized with their needs for groundwater management – a situation which would be reflected on the two pyramids as occurring on the same level. In reality, where discrepancies are the rule, appropriate education must convince the population to embrace operational measures and make the necessary sacrifices required for sustainable groundwater development and for safeguarding the birthright of future generations.

References

IHSR. (1987). Hydrological situation in Israel in 1986: Trends and development for the years 1981–1986. ISSN03335/27, Israel Hyd. Situation Report. Jerusalem, pp. 72 (in Hebrew).

IHSR. (1997). Development of groundwater resources in Israel up to Autumn 1996: Israel Hydrological Situation Report (IHSR). p. 242 (in Hebrew).

Maslow, A. (1937). The comparative approach to social behavior. *J. Social Forces*, **15**, 487–490.

Maslow, A. (1943). A theory of human motivation. *Psycholo. Rev.*, 50, pp. 370–396.

Pretty, J.N. (1996). Sustainability works. UNEP. *Our Planet*, 8, No. 4, pp. 19–22.

Smithers, H. and Walker, S. (1995). The practical application of modeling to the sustainable management of water resources in northern England. Modeling and Management of Sustainable Basin-scale Water Resource Systems. *Proceedings of a Boulder Symposium*, July 1995. IAHS, No. 231, pp. 15–20.

Tolmach, Y. (1979). Hydrogeological atlas of Israel, coastal aquifer, Areas of Tel-Aviv through Hadera, **3–6**, 70 (in Hebrew).

WHO. (1993). *Guidelines for drinking water quality recommendations*. Second edition, World Health Organisation, Geneva, pp. 188.