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Clean Soil and Safe Water

Edited by
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Clean Soil and Safe Water

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Preface

Of actual relevance to decision makers, industry and environmental managers is the link of contaminated land management programs to the protection of drinking water resources and to potential effects of climate changes with respect to availability of these same resources.

Environmental protection has recently embraced holistic concepts of preventing threats to soil and groundwater contamination as a first priority. Methods for preventing pollution (by process improvements, monitoring and by land use and planning initiatives) coupled with integrated soil and groundwater/drinking water management at contaminated lands, represent an actual priority for existing and newly industrialized countries. This integrated approach can positively affect land, groundwater and drinking water resources protection and restoration.

At the same time Environmental security is an increasing issue in world affairs. Among the most important environmental security threats over the next 10 years, water management and environmental pollution including soil, ground water/drinking water contamination are identified. The relevance of such environmental threats will increase because of expected climate change implications.

Soil and groundwater are important components of the environment, performing many functions vital to human activities and ecosystems survival. They are viewed today as essential resources to be managed according to sustainable development principles. Groundwater pollution is closely related to soil pollution. Major causes of soil and groundwater contamination are associated with improper management of waste and leakage of hazardous substances and wastewater from factories, sewage plants and business facilities. Obsolete or abandoned factories and industrial plants and pesticide storage facilities are major sources of soil and groundwater contamination.

Groundwater represents the major drinking water supply in most countries and contamination may render groundwater unsuitable for drinking use for many years. A large number of sites affected by soil and water contamination have been identified in industrialized countries in the last 20 years, but identification is not completed yet. It is expected that in the next years more contaminated aquifers will be discovered, new contaminants will be identified and more contaminated groundwater will be discharged into wetlands, streams and lakes. Recent studies have indicated that pollution of surface water and sediments pollution in alluvial plains and coastal areas are serious problems as soil and groundwater contamination problems.

A significant part of soil and groundwater contamination in densely populated areas is associated with the operation or the abandoning of small or large obsolete factories. This happens where old or abandoned industrial plants are presently located within or nearby residential or urban areas. But it happens also where improper disposal of wastes and of obsolete pesticides, outside urban districts, affect agricultural land, residential areas and groundwater. In these cases the risk of direct exposure of local population to contamination might be significant.

In certain areas degradation might be enhanced because of climate changes which might result in lower quality and quantity of these environmental resources. Special problems are faced in particular environmental and hydrogeological settings such as arid and karst areas. So, the risk in groundwater and drinking water supplies is estimated to be higher in the following years, starting from environmentally vulnerable regions and from regions with poor water management traditions.

The need for integrated and multidisciplinary views and exchange of scientific and technical experiences in the fields of prevention, assessment and remediation aimed at the protection of drinking water from land contamination has recently been recognized.

This consideration has led to the organization of the Advanced Research Workshop entitled "Drinking Water Protection by Integrated Management of Contaminated Land" which was held in Belgrade, Serbia, in March 2011, under the NATO Science for Peace and Security Program.

The book, which collects a selection of the contributes presented at the Workshop, includes a first part on water geochemistry and groundwater vulnerability assessment, contamination and climate change impacts and contamination prevention tools. The second part provides an overview on the state of the art of soil and groundwater remediation techniques with an insight into results from a number of recent research projects. Finally, specific chapters are dedicated to national programs and progress achieved in the management of contaminated land and water safety as well as in the development of cleanup technologies and research needs.

Acknowledgements

This book has been completed after the NATO Advanced Research Workshop "Drinking Water Protection by Integrated Management of Contaminated Land" which could take place thanks to consideration and funding awarded by the NATO Science Committee.

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Part I
Assessment and Climate Change

Chapter 1
Limitations and Challenges of Wastewater Reuse in Israel

Asher Brenner

Abstract Israel is a water-scarce country situated in a sensitive hydrological area. This has mandated a careful water resources management that integrates water resource augmentation and pollution control. Desalination of seawater and brackish groundwater, together with reclamation and reuse of municipal wastewater, has become a vital component of this concept. It is planned that by 2020, practically all municipal wastewater will be reused, mainly for agricultural irrigation. In this regard, water quality problems related to the presence of emerging trace substances, such as endocrine disrupting compounds (EDCs), may require a quaternary treatment stage that combines activated carbon adsorption, advanced oxidation processes, and desalination. The need for effluent desalination may also be required, due to salination of soil and groundwater caused by long-term irrigation with reclaimed wastewater. Since by 2020, almost 80% of Israel's fresh water supplies to the urban sector will consist of desalinated water, it will change considerably the composition of the water in use in general and consequently, that of the resulting wastewater.

1.1 Introduction

In Israel, water shortage on the one hand and the concern for water resources quality on the other, have led to the awareness that a national wastewater reclamation program must be developed. The national policy has promoted and enforced water conservation in the domestic, industrial, and agricultural sectors. However, there is a growing need for production of new water sources by desalination of seawater and

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brackish groundwater, as well as by reclamation and reuse of a greater proportion of municipal wastewater. Recent legislations issued by the Ministry of the Environment and by the National Water Authority require stringent quality standards for treated wastewater destined for agricultural irrigation or for disposal into rivers. These include the requirements to apply processes for nitrogen and phosphorus removal, and tertiary filtration.

Wastewater reclamation can contribute to substitution of higher quality water supplies for various applications, while preventing water pollution and health hazards. Although pollution prevention and protection of human health are global necessities in any sustainable development, the use of reclaimed wastewater for the augmentation of natural water supplies is a management issue peculiar to arid and semi-arid countries, due to increasing water shortages. If treated properly, municipal wastewater can provide valuable products, instead of being a problematic waste to be disposed and that can potentially jeopardize sensitive environments. There are many potential uses for reclaimed wastewater, some of which require high quality effluents; these include agricultural crop irrigation, recreational use, aquaculture, and groundwater recharge. In order to enable flexibility in reuse applications and to prevent pollution of surface- and ground- water, at times when there is no need for the reclaimed water, sophisticated water management should be implemented.

1.2 Water Balance in Israel

Two aquifers in Israel are the main sources of fresh water, the coastal and the mountain aquifers. Their annual production potential is approximately 300 and 350 Mm^3/Y, respectively. Other small local aquifers can add another 250 Mm^3/Y. The Sea of Galilee is a surface water source that can supply approximately 300 Mm^3/Y. There are also various local small aquifers of brackish water, especially in the southern part of Israel (The Negev Desert). This water is partly used in agriculture and industry, and its maximum production potential is approximately 300 Mm^3/Y. Most of the water is destined for the agricultural sector, which is gradually converting to the use of marginal water, especially treated effluents.

For several reasons, water management is not as simple. In Israel, as in many dry regions, most of the precipitation occurs during a short season of 4–5 months. Furthermore, there is a steep precipitation gradient from north (600–800 mm annual rainfall) to south (less than 100 mm annual rainfall) along a distance of approximately 500 km. This situation requires careful design of water conduits (from north to south) and storage reservoirs (from winter to summer). There is also uneven distribution of population (consuming water and consequently producing wastewater). The coastal plain is densely populated while the southern Negev Desert is much less so, but has the highest reserves of land for agriculture. Therefore, wastewater conveyance systems (from center to south) are required. Storage systems are also necessary for reclaimed wastewater, because it is continuously produced during the entire year, while agricultural demand is highest during the summer. Storage can be

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