Monitoring and Controlling Use of Pesticides and Fertilizers

Special laws have been legislated and various regulations enacted, which considerably reduce the risk caused by using pesticides and materials that contain nitrates. These laws and regulations specify ways of using fertilizer and pesticides and should be enforced. They include:

A. Prohibition of the use of toxic pesticides and fertilizer application should be reduced to the extent possible.
B. Pesticides that decompose into harmless substances should be used.
C. Landfills, cow sheds, chicken coops, etc., must be kept at a distance from water sources and facilities for supplying water.

In addition to these laws and regulations, scientists currently are engaged in searching for alternative ways of growing crops without using chemical pesticides. This form of cultivation is called “organic farming” and still is in its infancy. Such produce is more expensive because the yield per soil unit is smaller and the investment in research for pesticide substitution is considerable. Perhaps in the future, ways will be found to increase yields by organic farming methods.

It is however, possible to encourage plant growth while eradicating pests by other means and reduce pesticide use:

**Biological control**: many plant pests have natural enemies, creatures that “enjoy” eating the pests. Introducing certain animals that prey on those pests, eradicates the insects without using toxic materials.

**Genetic engineering**: Today science offers new and special solutions related to genetic engineering, such as planning and developing plants that are more resistant to attacks by pests

**Sex attractants**: application of pheromones (sex attractants) that attract male pests, drawing these away from the field, and keeping them from fertilizing the female pests, thus ultimately preventing a new generation of pests.
Municipal Sewage

Every day, each of us makes a modest contribution to the great stream of sewage. Where does it go?

Sewage systems drain wastewater from private homes and public buildings and gather it in special ponds for primary treatment. Most sewage systems purify the sewage only partially, then direct it to streams or to the sea. On its way there it also seeps into the ground. In many parts of our region, including villages and suburbs, the use of septic tanks is common. The contents of the tanks are pumped out periodically by special trucks and dumped onto dunes and soils. From there, this sewage percolates to the ground water. At times a direct leak occurs from these septic tanks to the ground water.

Reducing Contamination from Municipal Sewage

Many measures are taken to reduce the contamination caused by municipal sewage, yet much remains to be done:

A. Most septic tanks were removed and domestic sewage systems were connected to orderly and supervised sewage systems.

B. Treatment plants were built in many towns and villages for primary treatment of sewage water. These purification plants are designed to reduce the level of biological pollution and remove suspended solids from the sewage.

C. Additional plants were built for more advanced treatment after the primary treatment. These plants treated the wastes to a quality enabling the water to be used for agricultural purposes. Today, farmers are encouraged to build recycling plants in the vicinity of their fields in order to treat additional quantities of water.
Solid Waste Sites

Solid waste materials accumulated in designated landfill sites decompose over time, and their various components dissolve and are washed away by rain. Their fate, like the rest of their “sibling” pollutants, leads them to the ground water. Most pollution caused by solid waste sites comes from the kind of garbage that we are all familiar with--the home garbage (paper, food leftovers, bottles, cans, building materials, scrap metal, etc.). In recent years, new measures have been taken to treat solid wastes.

Measures to Treat Solid Wastes

We must control the way wastes are transported to designated sites. The locations must be carefully selected, the most serious consideration being a location that will not affect ground water. Dumping garbage in these sites reduces the danger that various substances will percolate down to the ground water upon which we all depend. Companies and individuals that dump their garbage in open fields, and not in an official waste disposal site, are subject to heavy fines. Regulations must clearly define how to prepare the special dumping sites. According to these regulations, the bottom of each such site must be completely sealed to prevent leakage of waste materials to the ground water. A series of monitoring boreholes are drilled at the sites at regular intervals to check whether the various materials are percolating down to the ground water. Similar to industrial dumping sites, these waste disposal sites should sort out different types of wastes, part of which could be incinerated in a controlled manner or buried in sealed containers.

Various types of waste are sorted and transported for recycling or supervised dismantling. These actions reduce the pollution potential of various materials. Batteries, for example, are highly polluting and particularly dangerous material. Their separate collection and transfer to controlled dismantling very much reduces their potential risk.
**Fuel Spills**

The principal energy source that turns the wheels of the modern world is oil. Oil, along with its various products (gasoline, diesel oil, heavy oil, etc.) is transported from place to place via pipelines and tankers in a liquid state. Systems that transport liquids have a tendency to leak and liquids easily find their way into the soil, and ultimately to the ground water. Leaks can be attributed to technical malfunctions and to human error. Fuel that percolates into the soil seriously endangers water resources.

To understand the magnitude of this danger it is important to learn certain facts:

A. A leak of one liter of fuel can contaminate one million liters of water!
B. Fuel materials are lighter than water, so they float on top of water in the ground and are nearly impossible to flush out.
C. Fuel materials do not decompose in water and remain in the ground for a long time.

**Preventing Fuel Leaks**

The only effective solution for preventing pollution by fuel is to prevent fuel leaks because once fuel is absorbed in the soil there is no way to reverse the damage. In gas stations and industrial plants fuel is stored in sealed containers, which are placed in another concrete container whose volume is 1.5 times greater than that of the fuel container. In the event of a leak from the fuel container, the fuel is trapped in the concrete container, thus preventing it from percolating into the ground. To deal with fuel leaks as quickly as possible, monitoring boreholes can be located in the vicinity of fuel tanks, enabling detection of leaks shortly after they begin.

**Salinization of Ground Water**

Salinization of ground water stems from several factors:

1. Water penetrating rock layers dissolves certain salts present in the rocks. The longer the rock is in contact with the water, the more salts are dissolved, and the water becomes more saline. As the temperature of the water increases, it can dissolve more salt, so the salt concentration in the water increases. It has been noted (in deep bores through rock) that the temperature rises the deeper one drills into the earth, and therefore the deeper the ground water aquifer, the greater the salinity of its ground water.

Ground water is recharged with fresh water that comes from rain. If fresh water is pumped from underground reservoirs at a rate that exceeds the natural recharge rate - the underground water table falls. This is referred to as “over-pumping”. In such a state, saltwater rises from the bottom of the aquifer layer and causes salinization of wells and water boreholes.
2. In the densely populated coastal area, underground water salinization occurs, in part, because of proximity to the sea. Saline underground water in the sea bed penetrates into the continent. Fresh underground water, which is lighter than saltwater, floats over the saline water and forces it down. But when the fresh water is pumped at a rapid rate, its pressure on the saline water is reduced, allowing it to rise, “takeover” the freshwater bodies, and penetrate into wells, which then can no longer be used.

3. Well salinization also is caused by extensive building and the covering of large areas with concrete and asphalt. Because of this cover, the aquifer’s recharge surface area is reduced, that is to say, the area that can absorb rain is restricted. Instead of penetrating and reaching underground reservoirs, water flows on the streets and washes out to sea. Thus, underground water reservoirs are insufficiently recharged, causing a rise in the level of salinity of their water.

4. In recent years we have witnessed yet another source of salinity in ground water: treated sewage water recycled for irrigation contains proportionally greater levels of salt than fresh water. Extensive irrigation of fields with recycled water, causes additional salts to penetrate to the aquifer.

**Reducing the Risk of Salinization**

One of the ways of coping with salinization of wells is to select an appropriate water source on the basis of demand and in accordance with the winter rainfall.

Managers may reduce pumping in places liable to become salinized, and transport water from more distant sources. During the rainy season water reservoirs are recharged with fresh water, which dilutes the salty water. Pumping then may be resumed from wells that were previously salinized. Artificial recharge of the aquifer causes a rise in the water table, which reduces the salinity (due to dilution). Therefore, recharge delays the danger of salinization.

To reduce the extent of salinization caused by irrigation with treated wastewater, it is possible to desalinate the treated wastewater prior to using it in agriculture.
The Best Treatment Method: Prevention

Identifying sources of pollution (like diagnosing a disease) is an essential stage for finding a cure. It is easier, wiser, and cheaper to deal with the problem by way of prevention: designing efficient sewage systems, developing devices for monitoring and supervising water quality, and erecting water treatment plants at the early stages, before pollution reaches the water sources. However, dealing with pollution and salinization of ground water is an expensive and complicated matter, requiring the construction of huge infrastructures, since water has a “tendency” to penetrate into every crack and leak from every pipe. Even coping with the problem of pollution caused by pesticides and fertilizers requires sizeable investments in time and resources for research and development of new methods and materials.

Today, the tendency is to combine three approaches:

A. Constructing disinfecting and filtering systems that treat the water at the various stages of the water supply system.

B. Treating the sources of pollution thus preventing the various pollutants from reaching the water sources.

C. Encouraging and providing incentives for farmers and industrialists to build treatment systems and use less dangerous materials (such as pesticides that breakdown).

The combination of these three approaches, together with strict enforcement of the laws and regulations defining the exact standards of quality for fresh water and for purified sewage water for irrigation, will make it possible to preserve water quality and ensure a reasonable quality of the water we drink.

If we could...

1. Choose one of the four case studies described in this chapter. Refer to sources of information and describe the rehabilitation programs carried out in the site that you have chosen. If you could turn back the wheel of time how would you prevent the pollution or salinization of water resources at this site?

2. Express your opinion on the difference between dealing with a problem by way of prevention and dealing with it “after the fact”. Bring examples based on your own experience.
And to sum up…

1. Review all the sources of pollution, one by one, and analyze their effect on all types of water resources. Summarize the connection between water quantity and water quality.

2. Compare between direct water pollution and different types of indirect water pollution. Describe how the things that we “buried” come back to haunt us.

3. We also contribute to water pollution at home. Things that we dump in the garbage bin or our yard eventually reach ground water. Such substances may include: detergents (found in the various cleaning materials), food leftovers, batteries, oils, etc. Make a list of such materials (those mentioned and others) and alongside each, list what we can do to reduce possible pollution by that substance.
Water Use and Water Management

It is a beautiful summer day and you are venturing out on a three-day camping trip. You loaded your vehicle with three water containers to provide all your water needs during the trip: water for drinking, cooking, washing clothes that are especially dirty, and maybe even for splashing a little water over yourself in the heat of the day. In the evening, at the campsite, you discover that one of the containers sprung a leak through which water was lost, and is now empty. Another two days of travel remain before you. There are no known water sources on your route or in the vicinity of the campsite and you certainly do not wish to shorten your trip and return home. How will you divide up the water remaining in the containers? What will you give up? Certainly not drinking, but then what? Who will decide how much water each person will receive and how it will be used? If perchance you were to meet someone who was willing to sell you some water, who amongst you will decide how much to buy? Who will pay?

These questions all relate to water management, and this is what we are actually dealing with, in every home, municipality and government authority. Managing water is akin to managing money in a bank account: water going in and water going out, credit and debit, income (water sources) and expenses (water uses). And like in a bank account, we strive to balance the debit column (expenses) against the credit column (income). We, the ordinary consumers, affect the debit column in the general water balance every time we open a water tap at home.

But how many of us contribute directly to the credit column of the water balance? We can contribute to the “incoming” column for instance in the following ways: individuals can collect rainwater in cisterns and special devices on rooftops; farmers can irrigate with treated wastewater; water authorities can increase the water sources available to us by proper management; and all of us, city dwellers, farmers or industrial workers, can contribute to the water credit column by saving water! Whenever we use water wisely and close the tap while showering, shaving, or brushing our teeth, we are indirectly creating a water resource - a reservoir of precious water that has not been wasted.

Water Balance

Look in the previous chapters and make a sketch of the water balance with credit and debit columns.

A. In the credit column, summarize the water entering the system, that is, the water resources; and in the debit column — the water leaving the system, that is, the various water uses.

B. In which items of the debit column can we “reverse the sign” for certain quantities and add these to the credit column (meaning, to prevent waste)? What action must be taken in order to achieve this?
A Treasure in Our Hands

Water is an essential and scarce resource in our region. Its scarcity is particularly striking after several consecutive drought years. Protecting this “treasure” is of paramount importance, which means proper management is needed to enable us to preserve it for ourselves as well as for future generations.

Water management is directed by designated authorities, and only they may decide how much water to produce, from which source, and for what needs. Water management focuses on four principal aspects:

A. Technical aspect - Water authorities are responsible for constructing various water enterprises, installing pumping systems, developing water saving devices, etc. All this is designed to make water resource exploitation more efficient and economical.

B. Economic aspect - Water authorities determine the water price for consumers based on the nature and time frame of its use. Different consumers (farmers, private citizens, industrialists) pay different tariffs per cubic meter they consume. Water price is liable to change over the years.

C. Legal aspect - Consumer rights and obligations regarding water use are determined by law. Because water is a scarce resource, the laws determine that water is public property and that citizens must use water according to the laws and regulation dealing with the production and distribution of water.

D. Management aspect - The authorities distribute the “treasure” among various sectors (agriculture, industry, public usage, and domestic usage) and determine how much water each farmer or industrialist will receive per year. The water authorities also initiate campaigns to encourage saving by creating awareness of the shortage through advertising, education and increasing awareness of water scarcity.
**Searching, Digging, Pumping and Conserving**

**Managing and Conserving Water Resources**

A gigantic complex of pipes, pools and reservoirs connects our private faucet to water sources. In the modern world, managing water systems is a complicated matter. Management often is about weighing the pros and cons of alternative technologies. It also deals with a range of responsibilities reaching far beyond the frame of individual (citizen) action and even beyond activities within villages, cities and water plants. Therefore, water systems are often the responsibility of regional and governmental authorities. In a region such as ours that suffers from a permanent shortage of water, the way we manage, produce and distribute this natural resource is of extreme importance. Management includes producing water from existing natural sources and alternative sources, allocating it for various uses, supervising its use and preserving its quality.

There are two major approaches for managing water and sewage systems. One approach is to establish large-scale regional projects, encompassing several cities, while the other is to establish separate local plants under the responsibility of individual municipalities. Each approach has its advantages and disadvantages. Discuss the issue. Refer to the following points in your discussion and consider both approaches.

1. Cost of the plant construction and maintenance: Which is less expensive — one large facility or several smaller ones?
2. Operating efficiency: Which is easier to control?
3. Long-term planning ability and the degree of motivation to save water and treat sewage: Which encourages greater official and communal involvement — large or small?
The King Abdullah Canal (previously called Ghor Canal) is one of the main development projects in the eastern part of the region, conveying water to the Jordan Valley for agricultural, domestic, and industrial use. The Canal, a total of 110.5 km long, transfers water from both the Yarmouk and Zarqa Rivers along the Jordan River basin, nearly reaching the Dead Sea, collecting along its route the greater part of floodwaters of streams to the east of the Jordan River.

The King Abdullah Canal issues water from the Adasiyya area (at the north central part of the region) just before a bend in the Yarmouk River. It commences its route in a tunnel 800 meters long that crosses the ridge to the Jordanian Plateau. Some 110 to 130 million m$^3$ of water per year flow through the tunnel. At its other end the tunnel is connected to an open canal, whose width permits a flow ranging from 20 m$^3$ per second at its beginning to 2.3 m$^3$ at its end.

Construction of the tunnel was carried out in 4 stages, from 1957 to 1987. During the 1970s, after the completion of the first stage, the canal was extended and additional parts were gradually added, integrating side streams flowing into the Jordan River from the east. Each such stream is blocked by a dam that impounds its water. The impounded water flows into the canal and is collected by it on the way south together with the Yarmouk River water from the north, as well as the remaining side streams. The Yarmouk water is of better quality than that collected from the side streams.
**Water Climbing the Mountain: The National Water Carrier**

The National Water Carrier is one of the largest water enterprises in the region. Since its completion in 1964, water has been transported from Lake Tiberias to the coastal and Negev desert regions in order to support agriculture and to help populate the regions. Water is pumped from the northern end of the lake and raised from a depth of 212 meters below sea level to a large reservoir located 44 meters above sea level. From the first reservoir, water flows in an open channel to a second reservoir where it is treated and purified. The water then continues to the central part of the region where another system carries it to other central and southern parts of the region. Each year the carrier, which extends 130 km, carries an average of 350 million m³ of water pumped from Lake Tiberias.

In order to preserve water quality along the long route, filtration and purification plants were constructed in many parts of the system. At various stations along the route, water samples are taken to permit continuous monitoring of the level of pollutants in the water.

In recent years, the quantity of water pumped by the National Water Carrier has increased due to population growth and a rising standard of living. The quantity of pumped water also is dependent on the rainfall in the recharge area that feeds the lake, which affects the water level in the lake and the surrounding aquifers.
Connecting Wells: The Bethlehem-Hebron Pipeline

The summer of 1998 offered all those driving from Bethlehem to Hebron the chance to witness a surprising scene. On one side of the road, a pipeline was being placed that would link two newly drilled wells to the water supply network of the Hebron municipality. On the other side of the road, a second pipeline was being laid, linking four newly drilled wells to the water supply network of the Hebron and Bethlehem municipalities. The second pipeline, with a diameter of 90 cm, is capable of conveying much more water than the 8 million m³ produced by the four wells starting in December 1999.

Work on the four wells has been completed and their total production is estimated at 1,000 cubic meters per hour, which means that the new wells will raise the amount of water supplied to Bethlehem and Hebron area to about 7.3 million m³ per year, doubling the quantity available before the new wells were drilled.

Along the water network, two regional reservoirs were built: the first in Deheisheh near Bethlehem with a capacity of 10,000 m³, and the other in the city of Halhoul, near Hebron, with a capacity of 25,000 m³. The two reservoirs are connected via a system of pipes and jointly constitute an integral part of the national carrier that serves the population of the region.

Answer the following questions based on the case studies in the previous Chapters and information and data presented in this Chapter.

1. Explain how various water projects influence the credit and debit sides of the water balance.
2. How do they increase the amount of water available to us?
3. Do these projects lead to excessive use of water?
How Much Does It Cost?

Water Prices

What would a king lost in the desert give for a glass of water? How much would a forest ranger living along a riverbank pay for a glass of water? What is the price of water? What does the price depend upon? According to what criteria is the price determined? Who pays for water and how much?

Water resources are developed by the government water authorities. Producing water, building facilities and pipes, supervising its quality, and designing sewage systems - all of these activities cost large sums of money. Determining the price of water is aimed primarily at retrieving the cost of producing and supplying the water. Setting water prices also is a means of supervising its consumption.

The water authorities set water prices according to several criteria:
A. Volume of consumption - If the water consumption is extremely wasteful, the price is raised.
B. Different uses of water - It is possible to subsidize and assist certain sectors according to various considerations - to encourage or restrict certain crops or products in agriculture or industry. For example, a high freshwater price would encourage farmers and industrialists to grow crops requiring less water, manufacture products that do not require large quantities of water, or to examine the possibility of using lower quality water (at a lower price). A high freshwater price also would encourage industrialists to invest in recycling systems in their plants to save expenditures on water and thus also saving precious water.
C. Water quality - Reducing the price of treated sewage water encourages its use in the agricultural and industrial sectors, which could permit larger allocations of freshwater for domestic consumption.

By scaling prices, and imposing high prices for over-consumption, it is possible to “penalize” consumers for irresponsible use, for wastefulness, for neglecting to repair their water systems and for luxurious usage.
A. Check your home water bill. Find out the criteria used for fixing water prices for different sectors. What, in your opinion, is the purpose of this categorization?

B. If you had to determine the price of water based on the way it was used, how would you rank prices for the following consumers: (arrange in descending order starting with the most expensive):

- Public park in an agricultural area
- Greenhouse irrigated by computerized drip irrigation
- Tomato field irrigated by sprinklers
- Farmer’s private garden
- Public park in the city center
- Apartment in a residential building
- Olive grove
- Banana plantation
- Soft drink bottling plant
- Pharmaceuticals factory
- Paper mill

Can the ranking that you propose be implemented? Is it reasonable, practical or desirable? Would you recommend it?

C. Discuss “Free Economy and Water Prices” amongst yourselves.

With a severe shortage of water, should water authorities have control over the kinds of crops farmers grow or the type of products manufactured in industrial plants? (Hint — think about the amount of water needed to grow a specific crop or to produce a specific item.)

D. Some oil producing countries are united under an umbrella organization known as “OPEC”. The organization fixes production levels, which in turn strongly control oil prices according to various local and global economic considerations. Would it be worthwhile to adopt a similar policy for global water prices?