DWINDLING GROUNDWATER LEVEL

Dhaka city on the verge of subsidence

Recently, Aquifer Storage and Recovery (ASR) method is gaining acceptance worldwide as a water-storage technology. ASR essentially involves injecting water (such as rainwater) into an aquifer through wells during the rainy season and then pumping it out during the dry season. This method has widely been used in many parts of the USA, Australia, and Europe.

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DHAKA city, the capital of the country has always been the core of political, cultural, and educational movement and evolution. Home of about 15 million people, the city is now worn out providing supplies to growing demand for housing, infrastructure, water supply and sanitation. Among many civic problems faced by city dwellers inadequate drinking water-supply, most of which comes from groundwater, is one of the critical issues that draws periodic attention, particularly during the dry season (March to May) when so-called "load shedding" of electricity across the city especially disrupts groundwater abstraction (withdrawal) from its deepest levels in the underlying aquifer.

For the rest of the year, when people move on forgetting their short-term pain and suffering to some degree, unfortunately, very little is done to combat this acute crisis of drinking water-supply and dwindling groundwater levels. Over the last few years, many research papers and newspaper articles reported the extent of this problem and proposed several mitigation options. The objective of this article is to remind us, for one more time, of the potential catastrophic consequences of rapidly declining groundwater levels in Dhaka city.

In 1963, Dhaka Water Supply and Sewerage Authority (DWASA) was established in order to provide better services to the city dwellers. Currently, there are some 546 water-supply pumps. DWASA supplies about 1.9 million cubic metres (MCM) of water a day against city's daily demand of 2.2 MCM. About 85% of the current demand is met of which only 15% comes from surface water treatment plants. This figure clearly shows the overwhelming dependence on groundwater supplies that come from underlying aquifers.

The total groundwater abstraction from licenced production wells operated by the DWASA and private (mainly industrial) operators is around 700 MCM per year. In addition to DWASA tubewells, there are more than 1000 privately managed deep tubewells that are primarily unlicenced and no abstraction data are available. Although the quantity of water abstracted by many unlicenced tubewells is not known but estimated to be significant since it meets the demands for areas that are not connected to the DWASA water-supply network.

What happens when the rate of groundwater abstraction is too high? If we look at the long-term groundwater-level hydrograph at a monitoring well in Mirpur area managed by Bangladesh Water Development Board (BWDB) we see a steady decline in water-level since the mid-1980s. Recently, groundwater level is declining at even greater (>2 m/year) rate. Groundwater level in 2007 was about 70 m below ground level (bgl), which was only a few meters below ground level during the 1970s.

Why is pumping too much groundwater in Dhaka city a problem? To answer these questions one has to understand the groundwater system sitting underneath the city and its adjacent areas. Most part of Dhaka city is located on the southern fringe of the Madhupur Tract composed of red-brown clay. Underlying the clay, the sand body belongs to a geological unit called the "Dupi Tila Formation" which forms regional alluvial aquifers not only for Dhaka city but for most parts of north-central Bangladesh. Groundwater has been abstracted for urban and industrial water supplies (mostly in Dhaka, Narayanganj and Gazipur areas), and irrigation purposes (rest of the north-central region) from the Dupi Tila aquifers for last few decades.

As a result, groundwater levels started to fall at variable rates in north-central parts of Bangladesh. Most rapid and higher rates of decline occur over Dhaka city and adjacent areas where groundwater abstraction is the highest in the country. These aquifers are replenished (known as recharge) each year during the monsoon season when rain and flood water finds its way into the aquifer slowly percolating down through overlying soils and sediments. The rate of recharge varies depending on the property of soil and geology of the area. Unfortunately, the recharge rate over Dhaka city is much slower than that of the adjacent floodplain areas.

Let us now look at the water balance in and around Dhaka city and see if we are using more water than the rate of annual groundwater recharge. Estimation of actual groundwater recharge to the aquifer is a difficult task, which requires a lot of information regarding aquifer and soil property, groundwater pumping, rainfall, and evaporation. A recent study at the University College London, UK has estimated that the mean annual recharge for Dhaka city and its adjacent area is 300-350 MCM, which is much less than the annual abstraction of about 700 MCM.

Where does the remaining water supply come from? Abstraction of groundwater, therefore, includes actual recharge water plus some fraction of aquifer storage. In the recent years, the aquifer depletes its storage in order to meet increased demand for water supplies in the city and, consequently, groundwater levels are declining.

Where are the areas in Dhaka city with deep groundwater table? One can see the dry-season (April-May) groundwater table (2007), contoured from weekly monitored water-level in BWDB wells, on a satellite image (taken from Google Earth) which shows three distinct areas of deep water-table; such areas are located in Dhanmondi, Mirpur, Motijheel Thanas where dry-season water-table is located 50 m below ground level. Groundwater table in the central part of the city (Moghbazar, Tejgaon, Rampura, Mohakhali, and Gulshan) is between 40 and 50 mbgl. Groundwater table in Mohammadpur and around the northern boundary of the city (Uttara) is shallower than 30 mbgl.

Why is falling groundwater table a concern? There are many consequences associated with groundwater storage depletions. These include drying up of production wells, reduction of water in streams and lakes, deterioration of water quality, increased pumping and water supply costs, and land subsidence.

Rapid decline in groundwater levels means sands of the aquifer are dewatered leaving pore spaces to be filled mainly with air. Moreover, continuing decline in groundwater levels and increased urbanization can reduce the water content in overlying soils and sediments. Currently, water-dependent ecology within Dhaka city is primarily sustained by the water held in pore-spaces in soils and Madhupur clay. In a particularly prolonged dry year, these water-sustained ecosystems (lakes, trees, and parks) can be threatened to substantial damage and even partial extinction.

One of the major threats to the city due to declining groundwater levels is land subsidence, which can be triggered by earthquakes of greater magnitudes. Recently, a series of earthquakes of magnitudes ranging from 4 to 5.2 on the Richter scale jolted Dhaka and other parts of the country. The epicentre of the earthquake was estimated to be approximately 45 km southeast of Dhaka city. Although no damage to the infrastructure of the city was reported but there is a great potential of collapse of infrastructures and land subsidence associated with earthquakes, particularly in areas of greater groundwater-storage depletion. Such phenomena were observed in many parts around the world such as Bangkok City (Thailand), Mexico City (Mexico), several places in California State, USA and so forth.

What can we do to improve subsurface groundwater conditions? Many mitigation options have been proposed by university researchers and engineers over the last decade and some are underway which include (i) proper maintenance of existing surface water treatment plants and construction of more such water-supply system, (ii) construction of groundwater well field (analogous to gas field) outside of Dhaka city where groundwater storage is not falling (one such well field has been recognised in Singair Upazila of Manikganj district), (iii) rejuvenation of canals and wetlands in and around Dhaka city to enhance groundwater recharge to aquifers, and (iv) artificial recharge to aquifers through a number of measures of which relatively cheap and most popular methods are rainwater harvest, dug well and borehole recharge via natural or injection, basin or pond recharge, and storage reservoirs.

Recently, Aquifer Storage and Recovery (ASR) method is gaining acceptance worldwide as a water-storage technology. ASR essentially involves injecting water (such as rainwater) into an aquifer through wells during the rainy season and then pumping it out during the dry season. This method has widely been used in many parts of the USA, Australia, and Europe. However, a clear knowledge of water quality with a better understanding of sustainable treatment processes in aquifers is necessary to enable water utilities to take full advantage of this technology.

Currently, research on artificial groundwater recharge is being conducted at the Department of Geology, University of Dhaka and the team has already identified potential sites in Dhaka city for artificial recharge.

Above all, public awareness campaigns on this matter should be undertaken to improve the current condition. Involvement of private sectors alongside government initiatives is critical to alleviate the current situation and build a sustainable water-supply system for Dhaka city.

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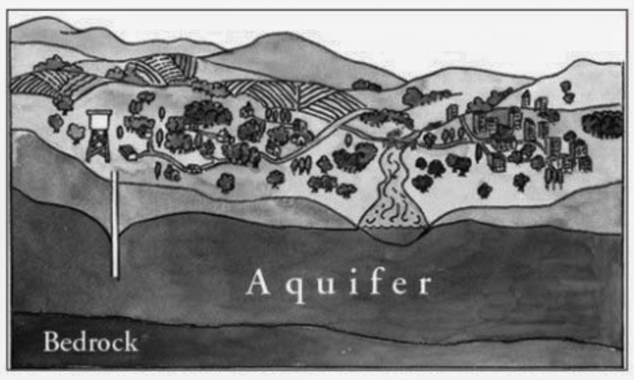
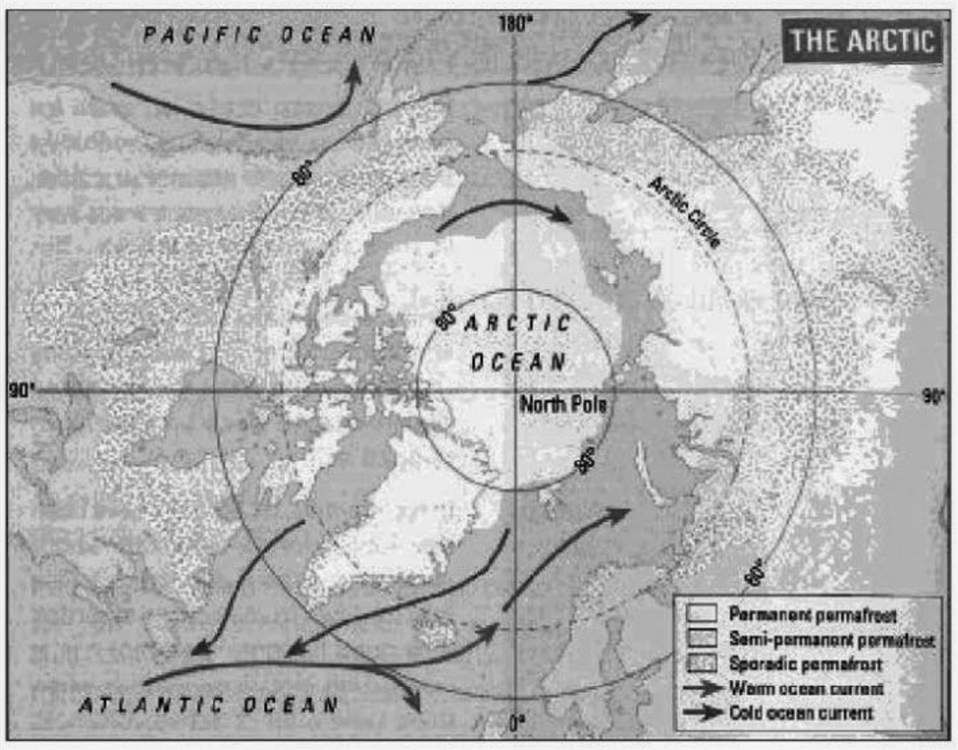


ARCTIC RESOURCES

Growing conflict and threat of climate catastrophe

The very idea of oil and gas exploration in the Arctic circle seems an absurd proposition. Instead, there are strong reasons to demand that Russia and other Northern nations refrain from any exploration or extraction of fuel resources in the North Pole and the Arctic.



DR. PETER CUSTERS

AT first the event sounds like a simple textbook story illustrating the conflicts which the world's rich nations have for centuries been fighting over access to fossil fuels and other natural wealth. On September 21 last, an Arctic Forum was held in the Russian capital of Moscow. Organized by the Russian Geographic Society together with Russia's press agency RIA Novosti, the Forum brought together hundreds of scientists and politicians hailing from countries bordering the Arctic region and from countries located farther away. Russia's government, evidently pleased with the Forum, used the occasion to boost its own claims over large parts of the North Pole which is (still) covered by an icecap.

In 2007 Russia already had pushed its claims, when its scientists had boarded a mini-submarine and had planted a rust-free flag of their nation on the bottom of the North Pole. Earlier yet, in 2001, Russia had submitted its bid to ownership over the underwater ridge known as 'Lomonosov' to the United Nations, arguing that the given geographic formation is an extension of Russia's continental shelf. As Russian news reports on the Arctic Forum indicate, - Russia believes its claim to 1.2 million kilometer of the Arctic circle are in line with the rules set by the UN Convention on the Law of the Sea.

Yet Russia is by no means the only country that lays claims to a part of the North Pole. In fact, each of the five nations bordering the Arctic has been making its own separate bid. Denmark for instance, which rules over the vast ice-covered land mass of Greenland, largely located within the Arctic circle, has carried out its own scientific expedition aimed at backing up its own claims. And Denmark's Scandinavian neighbour Norway has officially demanded that its rights over the eastern part of the Arctic be extended. The rationale underlying the fever of the Arctic border states appears to be just one: to reach out to the rich reserves of oil and gas deposited at the bottom of the Arctic circle, - either before or after the icecap of the North Pole melts.

Both Russia and the USA, which too borders the region, i.e. from its Western side via Alaska state, are convinced that vast quantities of fossil fuels and other raw materials lie buried under the Arctic sea. According to figures of American experts that were cited at the Moscow Forum, - the Arctic's extractable reserves include an estimated 90 Billion barrels of crude oil, and 50 Billion cubic meters of natural gas. Such figures suffice to entice energy-hungry nations. Especially at a time when the world is reaching 'peak oil', the point at which any further growth in the world's size of oil production becomes elusive in view of the physical exhaustion of extractable reserves.

This story regarding competing 'territorial' claims may appear ordinary. Still, the circumstances surrounding future extraction of Arctic resources are by no means average. First, the North Pole, as indicated, is no land mass, but a deep sea area. Like the Antarctic, i.e. the pole located towards the Southern extreme of the globe, the North pole has been covered by ice ever since humans started roaming the earth. But the geographical circumstances of the two polar regions are widely divergent. Whereas the Antarctic is an ice-covered landmass surrounded by sea, - the centre of the Arctic features a deep sea area capped by ice.

For two reasons, the idea of oil and natural gas extraction in this polar region is an extremely hazardous proposition. For one - the experience which the world's oil corporations have gathered with drilling in areas covered by ice is limited. More ominously: BP's oil spill in the Gulf of Mexico in April brings out that all deep sea drilling is risky, and that such drilling can easily result in a human and environmental catastrophe. In the wake of the oil spill, opponents of Arctic drilling in Alaska have intensified their efforts to prevent exploratory drilling by Shell along Alaska's Northern shore. Yet one wonders whether the prohibition on deep sea drilling need not be greatly extended, so as to cover all sections of the Arctic.

To bring out that this proposition is not far-fetched, we need to place Moscow's Arctic Forum and the 'territorial' conflicts over the North Pole against the background of the debate over climate change. The risks deriving from the warming-up of the earth can very well be illustrated with data on the situation in the Arctic. If the whole ice sheet covering Greenland today were to melt, - this change alone according to climate experts would result in a 7 meter rise in sea levels worldwide. But the melting of ice in Greenland is not a distant prospect, for the effects of climate change are already visible here.

Some of Greenland's glaciers for instance have accelerated the speed at which they flow towards the sea along the country's coast. One of these glaciers, the Kangerdlunggssuag, is reported to have doubled the velocity of its flow. As to the Arctic circle as a whole: the Arctic ice sheet has lost a reported 15 percent of its surface over the last thirty years, and 40 percent of its thickness. Both indigenous hunters and animals which depend on the ice sheet for their habitat suffer in consequence. The ice bear is one instance. Considered to be the symbol of the Arctic, the ice bear is threatened with extinction in the short term.

Against this background, the Moscow Forum on the Arctic seemed a rather surrealistic event. For the Arctic circle is the very region where the drama of the world's climate catastrophe threatens being enacted. Two of the natural phenomena which scientists describe when speaking of 'tipping points', of natural changes that in the future will speed up the pace of climate change, occur in the Arctic circle and its surroundings. The Arctic´s ice sheet causes what´s called the albedo effect, i.e. the reflection of the sun´s light back into space. And the permafrost, i.e. frozen soil, which covers a vast expanse of Russian territory along the Arctic, contains huge amounts of the potent greenhouse gas methane. Hence, the melting processes taking place in this part of the globe may ultimately cause a worldwide deluge, - a rise in sea water levels so rapid that hundreds of millions of people will be swept way almost overnight.

Meanwhile, some states are getting prepared to enforce their claims over portions of the Arctic by military means. Russia reportedly is building special Arctic armed forces, and Canada has started construction of a military base in the region. Yet the very idea of oil and gas exploration in the Arctic circle seems an absurd proposition. Instead, there are strong reasons to demand that Russia and other Northern nations refrain from any exploration or extraction of fuel resources in the North Pole and the Arctic.

Dr. Peter Custers writes from Leiden, the Netherlands

Special to The Daily Star.

Urban green spaces: More important than structures

MAHFUJUR RAHMAN

GREEN areas are dwindling in an unprecedented rate in the cities all over the world. World wide urbanization in the fifties and sixties was marked by extensive use of construction materials to build contiguous anthrosphere costing destruction of natural environment. Technological advancement and economic solvency the urban people achieved made them forget the pastoral and rural lifestyle their parents and ancestors lived. They became quite oblivious to understand the importance of nature and natural goods and services in their lives.

The common trend for urbanizing a locality is destruction of nature and natural feature. The problem is more intense in developing countries. Bangladesh as a developing country located in South Asia is facing a great transition time in terms of urbanisation and industrialisation. More people are migrating towards the cities. For accommodating the incoming people, pressures on the land is escalating day by day. In such a situation the remnant green spaces of Dhaka city are at stake. The complex of problems encountered by the green spaces hinders the ecosystem, economic and social services that should come from them. There are various ecological roles of urban green spaces that are yet to be recognised.

Base of ecosystem in the urban complex

The remnant green spaces in the city are the presence of nature there. The diversity and integrity of nature is seriously being damaged due to destruction of wild vegetation and conversion of agroecosystem into built environment. The birds are directly dependent on the trees for their existence. The amphibians, reptiles and the mammals depend for their food on trees and other plant species indirectly. These animals feed on the insects and birds those directly depend on the plants of varying types. All plants, animals and microorganisms comprise the biotic community. There exists intricate relationship among these organisms. The biotic communities along with physical environment comprise the holistic environment.

Maintaining water cycle

The urban water cycle is tremendously influenced by the vegetation cover present in the city. The evapotranspiration, precipitation, infiltration and run-off all are influenced by presence, quality and quantity of green space in a city. Cycling of water in the environment is crucial for maintaining the life sustaining processes. Moreover, availability of water in useable form is most important in the urban environment because of huge water requirement by the densely located population. The green spaces considerably increase the infiltration of rainwater in urban areas where most of the land is covered by impervious materials.

The dependence of city dwellers on the groundwater is on rise. At present Dhaka WASA depends on the ground water source for 80% of its water supply. This is ultimately staking the city's existence.

Providing fuel, fruits and medicine

The green spaces in the urban environment can provide various goods to the citizens. These goods include various types of fruits, fuel for cooking and medicinal materials. The urban poor get the maximum benefits from these green spaces. Since the poor has limited capacity to meet their needs by purchasing or growing materials, the goods provided by the green spaces are very crucial for their livelihood. Moreover, the shrinkage of open spaces in the cities made these land parcels very crucial for the poor. The youngsters of poor sect get considerable nutrients from the fruits and nuts grown on roadside, parks and graveyards. The women collect foliage from the roadside and parks to cook with. The value of medicinal matters collected from the various plant species of the green spaces is great to these people.

Wildlife habitat and species conservation

Urban green spaces can play a significant role for conservation of native plant ,animal and microbial diversity .With progress of urbanisation the land of a city is mostly used up for more economically benefit raising purposes. The native plant and animal species face hard time for existence. The remnant green spaces become last abode for wild plants and animals fighting to exist before being locally extinct.

Pollution abatement

The green spaces act as purifier of the total environment. First of all, the plants of the green spaces remove suspended particulate matters and volatile organic compounds from air. The root systems of these trees help microbes convert the organic waste materials into plant nutrients. Secondly, the infiltration of rainwater through soil ultimately aids to purify the down moving water. This down moving along with infiltration is highly associated with green spaces i.e. places covered with vegetation where water can be captured and allowed to go into soil. Most of the land area in a city is covered with asphalt or concrete that reduces the infiltration rate. Finally, the plant stands purifies the air by removing the particulate matters, absorbing hydrophobic compounds and capturing other toxic materials on their leaves and barks.

Conditioning the total environment

The ambient temperature, humidity and solar heat are three basic components of natural environment in the city. The comfort of living in a city mostly depends on these factors. The citizens are usually not conscious about miraculous effects of the green spaces in controlling these factors. It was found in several studies that temperature of the green spaces in a city in hot summer is much cooler than the surrounding locality. Again, humidity of air is raised by green spaces in winter.

Conservation of soil and waste assimilation

Soil conservation and value extraction from fertility of soil can be ensured from the green spaces that comprise the botanical gardens, public parks and places where cultivation is done in a city. The soil of the city can be better utilized and conserved by covering the open spaces with green plantation. Green spaces can assimilate organic waste materials by the process of biodegradation.

Conclusion

The ecological role of urban green spaces is multifaceted. The green spaces condition the urban environment by controlling the temperature and humidity. The green spaces play significant role in maintaining water cycle, abating pollution and harbouring a variety of plants, animals and microbes. From ecological perspective, the green spaces are only productive areas in the city, the biotic community of city somehow or other depends on them. The human being is also benefactor of the green spaces; the green spaces provide various ecosystem goods and services. But the paradox is this that the developing countries are facing great crises of loosing greenery from their cities while the western world is now trying to bring back the nature to their cities.

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