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SANITATION AND WATER FOR ALL

Sustainable groundwater exploitation of the Lei-Basin

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THE INFILTRATION SURFACE is being sealed off. This is creating further flood problems in Rawalpindi. After the drought year of 1994, groundwater is being privately exploited without any legal central control of quality and quantity. Measures to increase the amount of groundwater recharge would improve drinking water both qualitatively and quantitatively and reduce loss through uncontrolled runoff. The stored groundwater would not only be a reliable reserve in times of drought but also compensate for the anthropogenic influences in the south and the geogenic burden of gypsum layers in the west. To cut losses due to evaporation in the dry period, methods of groundwater recharge could be restricted to those involving little exposure to sun and wind. At other time periods surface spreading could be used. All in all the chessboard regional city planning of Islamabad, as laid down in the Master Plan, has to be re-planned interdisciplinarily according to the modern environmental aspects.

The Lei-basin

The Lei catchment area lies in the cities and suburbs of Islamabad and Rawalpindi between 33° 00' and 34° 00' North and 72° 45' and 73° 30' East. The stream Lei and its tributaries rise in the Margalla Hills bordering Islamabad to the north. It is a fairly typical mountain river or hill torrent producing dendritic patterns of steep gradient in limestone in the northern parts and meandering designs of gentle gradient in its southern alluvial filled parts in the heart of Rawalpindi after being joined by its main tributaries. The Study Area is surrounded from the two main river basins, the Haro in the north and the Soan in the south. The catchment is bounded to the north by the Margalla Hills, to the east by the Kurang-Basin and to the west by a low ridge bearing the Pakistan Railway Track. After draining Islamabad the Lei flows to the flatter area of Rawalpindi. It drains an area of about 211 km2, of which 55 per cent are lying in Islamabad up to the Khyaban-i-Sir Syed and the remaining 45 per cent in Rawalpindi City and Cantonment. The Lei-Basin is connected with the neighbouring basin of the Kurang River underground. The drainage divide on the northern and north-eastern is functioning partially as compared to its western divide, which is dividing the surface and groundwater.

Four small streams - Saidpur Kas, Kanitanwali Kas, Tenawali Kas and Bedranwali Kas - rise in the Margalla Hills, cross Islamabad, come together upstream of Khyaban-I-Sir Syed and constitute the main Lei. Another tributary known as Nikki Lei joins it from the west about 3.2 km downstream of the above mentioned confluence. About 20 other streams draining the city join it from both sides. Finally it falls into the Soan River after crossing the G. T. Road, where it approaches Rawalpindi from the Lahore side near the building of the Fauji Foundation. The Lei-Basin lies in a semiarid to subhumid climatic zone, showing large seasonal fluctuations in temperature, evaporation, rel. air humidity and precipitation values. It has hot summers and cold winters. The water-table was lying about 19.8 m in Islamabad and about 22.8 m in Rawalpindi in the year 1995. In the period between 1988 and 1995, the mean annual water-level drop was 1.40 m. Groundwater covered about 30-40 per cent of the need for drinking water in the year 1988 for Islamabad and Rawalpindi. Yet if present trends towards overpumping and urbanization (sealing) of the infiltration surface continue, this percentage is bound to fall. Ground and surface waters are threatened by planned or present industry, by erosion, herds of domesticated animals and uncontrolled runoff. The quantity and quality of surface water vary from January to December and interannually, specially the flood waters of the monsoon and winter periods carry a lot of sediment load with them.

The insufficiency of sewage treatment plants and disposal network impose a great burden on the water naturally available. The waste water load increases in the dry period proportionally. The population of the cities Islamabad and Rawalpindi increased from 1.1 (1981) to 3.7 mil. (1995), with a mean of 185 l/d water consumption per head (Islamabad with 415 l/d). About 0.46 mil. m3 waste water, partially mechanically treated is being released per day in the Lei stream.

After the drought period of 1994, each private groundwater exploitation has been allowed irrespective of the exploitation intensity. The infiltration surface is being sealed off, and the city of Islamabad is growing. This creates further flood problems in Rawalpindi. The chessboard regional city planning of Islamabad, as laid down in the Master Plan (1960), has to be corrected interdisciplinarily according to the hydrogeological conditions.

The Margalla Hills are responsible for the long term natural groundwater recharge of the Lei-Basin. But unfortunately about 56 quarries are eroding up 107 ha of the area. The 34 villages in and around the National Park with over 26,000 inhabitants make unauthorised use of wood for cooking and heating. The domestic cattle herds are also endangering the environment by overgrazing and erosion.

According to the estimates, about 68 per cent (70 km2) of the total unsealed infiltration area of Islamabad in the year 1981 was providing about 16 mil. m3/a (100 per cent) of groundwater. Thus the remaining 30 per cent of the total unsealed infiltration area of Islamabad in the year 2030 will be producing only about 6 mil. m3/a (38 per cent), the prognostic value of groundwater production. As also discussed by Todd, D. K., 1980, the process of urbanization causes decreased recharge and increased discharge (withdrawal) of the groundwater.

A scheme of partial diversion of the Lei stream to the Kurang River would be an attractive solution according to the CDA. This would imply a diversion of all four tributaries with a partial maximum discharge of about 114 m3/sec into the eastern lying river Kurang, but it will deprive the low precipitation western areas even with their original amount of groundwater recharge through surface water. Unfortunately, the local authorities are also considering to allow to dig the Lei bed deeper to compensate the flood damages in the densely populated areas in the City of Rawalpindi. With these practices, the problem of erosion and groundwater depletion will increase.

In the drinking water in Rawalpindi, 90 per cent of the samples were polluted with coliform bacteria. In almost all the private open dug wells in Rawalpini (Rural) bacterial contamination was found (Tahir, M. A., et al., 1994). About 0.18 and 0.29 mil. m3 waste water is being released per day in the Lei stream partially mechanically treated in Islamabad and untreated in Rawalpindi respectively. According to the current studies, it can be said that the tested wells along the Lei stream was biologically unfit for human consumption (Chandio, B. A., 1995).

According to the analysis of the available data, it would be favourable to have groundwater recharge in the Lei-Basin to compensate the already sealed-off infiltration surface, to compensate the pollution and contamination due to urban development and geogenic salinity of groundwater in the western parts of the area and the dearth of emergency water supplies. This study suggests various low-cost, appropriate and applied methods of artificial recharge for the specific suitable areas of the Lei-Basin. The Study Area, specially the area of Islamabad, has a greater chance of a revision of the regional planning because building and construction work is being done since 1960 and is still in progress. With the revision of the Master Plan of Islamabad, 1959, of the area according to the hydrogeological and environmental aspects of the regional city planning, mistakes already made can be corrected or compensated with different techniques and methods of land use and groundwater recharge.

Recommendations

According to Chandio, B. A., (1995) and Jica-Cda (1988), the water-table has dropped from 12.5 to 22.9 m in Rawalpindi and from 10 to 19.8 m in Islamabad. Due to these drops of the water-table, there is space available for groundwater recharge. But to recharge these significant water-table gaps, the chances for evaporation losses are high. The freedom of groundwater exploitation, since 1994 and the over-mining of the Lei-Basin as a whole are the main causes. The Lei-Basin groundwater reservoir has a total deficit of at least 10 m water depth. Assuming the porosity of the aquifer to be about 15 per cent, the reservoir must be able to store about 317 mil. m3 water in these 10 m (the total water requirement of Islamabad and Rawalpindi was about 249 mil. m3/a in 1995, Chandio, B. A. 1995; Jica-Cda, 1988 & Ahmad, N., 1995.). The height which infiltrates into the Lei-Basin (211 km2) ground surface is about 171 mm, producing about 1.14 m groundwater depth. This is equal to an amount of about 36 mil. m3/a. Moreover, about 35 mil. m3 is being fed as inter-basin flow from the Kurang-Basin underground, making the total aquifer capacity of the Lei-Basin about 71 mil. m3/a. But the average aquifer exploitation of the last 7 years was about 115 mil. m3/a. This indicates a deficit of about 44 mil. m3/a. It would take many years for the water-table to return to the level of 1988, even if groundwater exploitation were completely stopped.

The dangers of land subsidence and aquifer depletion of the Study Area are continuously increasing. Thus the central control of quality and quantity to ensure the sustainable groundwater development of the local aquifer has been lost. This law has to be revoked at once, and the groundwater control and management have to be transferred again to a central groundwater administration. Otherwise the ongoing rate of depletion and pollution and thus also land subsidence will be accelerated. A regional groundwater management and planning authority must be established, not only to collect the groundwater concerning long term data, but also to implement projects concerned with the environment generally and ground and surface water specially. An emergency plan has to be put into force at once to stop further aquifer depletion. Broadly conceived measures including groundwater recharge for increasing the amount of available groundwater in the Study Area would improve drinking water both qualitatively and quantitatively, reduce loss through uncontrolled runoff and aquifer depletion. The stored groundwater would be a reliable reserve in times of droughts and emergencies. This could also compensate for the anthropogenous influences in the south and the geogeneous burden of gypsum layers in the Northwest. The remaining village irrigation settlements and natural infiltration areas ought to be protected as a contribution towards recharge.

Water with sediment load from the monsoon and winter periods high rains could be used to raise the level of groundwater for groundwater recharge along the geologically suitable sites after having been treated through established sedimentation and filtration plants in times of low consumption of drinking water. Since losses due to evaporation in the dry period would be too high, methods of groundwater recharge would at this time be restricted to those involving little exposure to sun and wind. A supplementary measure would consist of leading surface water via gravity flow from the NE rainy areas to dry ones in the west and south where it would contribute to recharge, especially at times of less evaporation. Because of the undulating topographical situation of the Study Area, and to reduce the risk of wetness in the cellar and ground floor of the houses, the water-table should be lying under 5 m from the ground surface. In the consulted literature from various scientists, these depths vary from 2 to 3 metres, according to the geological, hydrogeological local conditions. These limits must be investigated for a specific model area to avoid undesired side effects, salinity or waterlogging. Groundwater recharge with a combination of appropriate methods, like trenches or basins with pits and ditches, could use the old left wells for groundwater recharge. The best use of groundwater reservoirs is to manage and exploit them for the whole year with precautionary measures of having enough water reserved storage for the coming dry periods. Each field of wells should not only be supported by artificial recharge structures and installations but also be secured from polluting insecurities. It is best to build groundwater recharge installations near the raw water i.e. not far from the lakes and dams, to save the cost of transportation infrastructure and of damage to pipelines during transport due to salt precipitation.

According to the studies done by the Jica-Cda, 1988, about 34 mil. m3/a groundwater of the Lei-Basin is being lost, unused, into the River Soan. In this loss of groundwater, the factors of erosion and pollution play an important role. The stream Lei is deepening its river bed. Due to increasing pollution of the stream, the plume (cone) encroachment of groundwater contamination is moving further upward and laterally landward. This means that, to get the same quality of groundwater, wells have to be dug deeper and must be located further away from the polluted Lei stream. So the old stream wells along the lower part of the Lei have to be left abandoned due to bad water quality, and thus also leaving the quantity of groundwater unused flow into the Soan River. That is why there are three urgent priorities, which should be applied, first is to free the Lei stream from the waste water and pollution to allow it to regenerate itself, second is to apply the watershed & soil conservation measures and management to counteract the erosion damages, and the third one is to control the aquifer depletion. There should be measures against the mining of limestone, sandstone, gravel, boulders, sand, clay and loess (for example for the brick kiln industry).

The Rawalpindi Lei flood problems are being discussed to be solved by deep digging, straight forwarding through lined (cemented) canals and the diversion of the Lei towards the rainy eastern part. It is rather advisable to divert the surface water through unlined canals in the opposite direction to increase the artificial and natural groundwater recharge of the western areas to compensate for the scarcity of precipitation and thus also to accelerate the groundwater infiltration quantity. In the monsoon season it could also be very difficult to deliver the overflow water from the Lei stream to the Kurang River, because of the increased intensity of rainfall and runoff along the whole northern and eastern mountainous areas. Thus the diversion of the Lei towards the Kurang River cannot fulfil its aimed goals. The naturally sealed areas can be used for the construction of houses, etc., but the other natural infiltration areas must be integrated into the future planning as pollution-free groundwater recharge areas. Because of the unavailability of groundwater recharge structures already in the Study Area, it is advisable to start with a small project for the sake of experience, and to choose groundwater recharge sites selected in a rational manner by carrying out detailed geological, hydrological and hydrogeological investigations. It is further recommended that the processing capacity of the filtration plants for drinking water and sewage treatment plants of Rawalpindi and Islamabad be enlarged to cover the whole urban and rural areas, integrating also the groundwater recharge facilities.

As a measure of watershed management, soil and water conservation and soil-erosion control the dike-structure technique should be applied, beginning from the north-eastern rainy areas and continuing towards the southern and south-western less rainy areas, according to the precipitation depths and intensity and the drainage network density and runoff depths to reduce the risks of soil erosion, damage of the dikes and bridges and loss of groundwater along the southern part of the Soan River. These measures are already practised but only to protect the local bridges from floods. Construction measures of these dikes have to be expanded vertically and horizontally along the streams according to the geological and hydrogeological conditions of the area, which would also influence positively the groundwater recharge situation. With the development of these installations, the infra-structure for groundwater monitoring must be integrated. Instead of planting imported trees and plants, it is advisable to use the local potential of autochthonous vegetation. It is essential to develop a system and plan for the geological survey of Islamabad, for the continuous geological mapping work, since the construction work is continuously in progress. After the construction has been completed, it will not be possible to reconstruct these essential basic information for a final geological map of the Study Area. The local scientists and the local traditional methods and techniques were not always involved in long-term planning for the natural sources development schemes, which might otherwise have spared the environment from degradation. The chessboard regional city planning of Islamabad, as laid down in the Master Plan (1960), has to be corrected interdisciplinarily according to the hydrogeological conditions. Long-term sustainable ecological solutions ought not be sacrificed to political short sighted expedience.

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