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Hydrogeological Conditions of the "Dhunge Dharas" in the Kathmandu Valley

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Abstract

Groundwater has been tapped in the Kathmandu valley since ancient times through the traditional stone-carved water-spouts called **Dhunge Dharas** and dug wells. Present study deals with hydrogeological situation of dug wells and **Dhunge Dharas**. Quality of groundwater is evaluated on the basis of pH versus topography. The Dharas are classified into natural types on slopes and artificial ones in the valley floor. Depth of water table is observed to be between nearly at ground surface to 6m below the sloping ground and exceptionally up to 12.25m below ground level (bgl) on the terraces. Chemical quality of groundwater is found to be good except at a few places.

Introduction

Groundwater has been under exploitation in the Kathmandu valley since ancient times through Dhunge Dharas constructed during Lichhabi and Malla periods and dug wells (Fig 1). In general, water from these sources can be used for domestic purposes though they are suitable even for drinking purpose at some places. High rainfall, centripetal type of drainage system and nature of sediments in the valley are favorable for a dependable shallow groundwater resources. Most of the Dhunge Dharas have been abandoned, however some are still in use.

Historical Background

Most of the traditional Dhunge Dharas in the Kathmandu valley have historic value as they were constructed during Lichhabi and Malla periods. Some of the localities got their names from these historical Dhunge Dharas, such as Bhotahiti, Maruhiti, Thahity, Sundhara (Patan) etc. In Newari language "hiti" means water spout. In the ancient and medieval periods, dug wells and Dhunge Dharas were well maintained through people's participation. Most of the Dharas used to be renovated from time to time during Rana periods. Vast growth in population and urbanization of the Kathmandu valley left no room for the traditional community

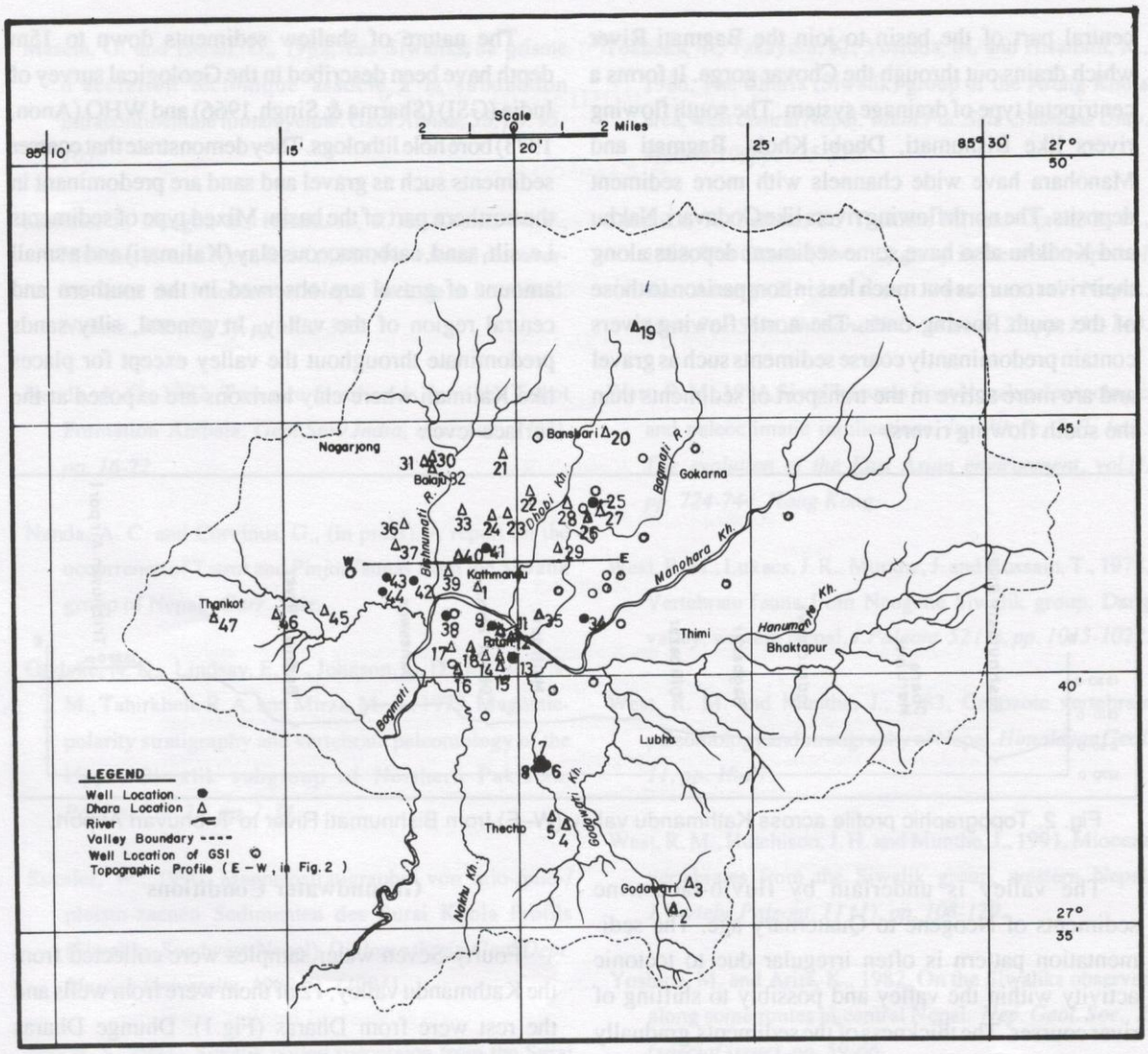

Fig. 1. Location map of **Dhunge Dharas** and wells of the Kathmandu valley.

works, thereby greatly influencing the maintenance of these Dhunge Dharas. These Dharas began to be less and less used because of modern water supply system introduced into the valley not more than seven decade ago (Anon, 1973). However rapid urbanization and increase in population led to scarcity of water supply. So, once again people are resorting to the Dhunge Dharas for meeting their water needs at some place.

Physiography and Geology

The valley is characterised by a number of terraces formed by the erosion by streams. Some of the important terraces are Baneswar, Airport, Gaushala, Patan, Chapagaon, Pyangaon etc. These terraces are formed at intervals of about 10m in elevation (Fig.2). The highest terrace is at an altitude of 1350m above msl while the lowest altitude of the valley is at 1280m. Rivers flowing from all around the valley meet in the

central part of the basin to join the Bagmati River which drains out through the Chovar gorge. It forms a centripetal type of drainage system. The south flowing rivers like Bisnumati, Dhobi Khola, Bagmati and Manohara have wide channels with more sediment deposits. The north flowing rivers like Godavari, Nakhu and Kodkhu also have some sediment deposits along their river courses but much less in comparison to those of the south flowing ones. The north flowing rivers contain predominantly coarse sediments such as gravel and are more active in the transport of sediments than the south flowing rivers.

The nature of shallow sediments down to 15m depth have been described in the Geological survey of India (GSI) (Sharma & Singh,1966) and WHO (Anon, 1973) bore hole lithologs. They demonstrate that coarser sediments such as gravel and sand are predominant in the northern part of the basin. Mixed type of sediments i.e. silt, sand, carbonaceous clay (Kalimati) and a small amount of gravel are observed in the southern and central region of the valley. In general, silty sands predominate throughout the valley except for places like Kalimati where clay horizons are exposed at the surface level.

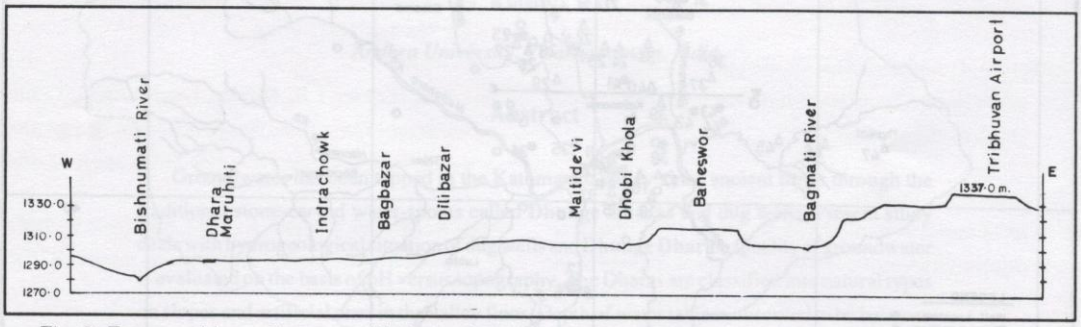

Fig. 2. Topographic profile across Kathmandu valley (W–E) from Bishnumati River to Tribhuvan Airport.

The valley is underlain by fluvio-lacustrine sediments of Neogene to Quaternary age. The sedimentation pattern is often irregular due to tectonic activity within the valley and possibly to shifting of river courses. The thickness of the sediments gradually increases from north and northeastern part of the valley towards the south. Granular beds are more frequent towards the north and northeastern part and decrease towards the south and southwestern part of the valley. In the northern part at the food of the Sheopuri range, the granular sediments alternate with clay layers and the clays including black type occur at deeper levels. Clays are predominant on the eastern part also close to the hills (Gautam and Rao, 1991). The sediments of the Kathmandu valley are considered to be of Pliocene age and are divided into eight stratigraphic units (Yoshida and Igarashi, 1984). Fan deposits are common all along the valley margins.

Groundwater Conditions

Fourty-Seven water samples were collected from the Kathmandu valley, 12 of them were from wells and the rest were from Dharas (Fig.1). Dhunge Dharas situated along the periphery of the valley and the slope of the terraces are of natural type as they intercept the water table across its gradient. On the other hand, in the valley part, Dharas are mostly artificial in nature as they are located below ground level. The depth of artificial Dharas ranges from nearly at surface to 6m bgl. Natural seepages are near the surface to 3m below the ground except at Swayambhu which is at 5.5m below the sloping ground. Discharge from these Dharas ranges from 1 to 224 litre per minute (lpm) and it is reported to be nearly double during post-monsoon period. The total discharge from the Dharas observed is estimated to be about 1.0 Mm^3/year. Higher dis-

charges occur in the Dharas situated on the hill slopes such as at Godavari (86.4 lpm), Dhobighat (66.5 lpm) and Matatirtha (224 lpm). The Dharas which have several seepage channels have higher discharge for instance at Ekhachhe (77.3 lpm), Naxal (85 lpm). Generally, low discharge occurs in the Dharas situated on the terraces, lowlands and at the locations where the number of channels are less, like those at Panipokhari (1.2 lpm), Minbhawan (3.8 lpm) and Teen Dhara at Naikap (1 lpm).

Dug wells were constructed at some places with brick lining. Most of these dug wells are situated on terraces and a few of them lie in the lowland (Fig. 1). At the slopes of the terraces, they are practically absent. The water table is found in between 0.4 m and 5.4 m bgl.

Singh and Sharma (op. cit) conducted a hydrogeological survey of the dug wells in the entire valley during 1961-1965 (Fig.1). They found that the depth to water table (observed between November and May) varies from 0.63 m bgl to 12.25m bgl, and that deep water tables are confined to terraces.

Quality of groundwater

The physical quality of the waters from almost all **Dhunge Dharas** is good except at a few places such as at Nayabazar, Naxal and Balaju where they are turbid. Dhara water is still used for drinking, domestic and irrigation purposes. Temperature of the Dhara water ranges from 16°-23°C which is less than the air temperature by 3°-10°C. Water from some dug wells is turbid and pale yellowish in colour. This is found to be related to the clay zones or iron oxides in those areas. In some wells like at Rajtirtha, Patandhoka and Kumveswar, the water is clear and potable. However, well water in the Kathmandu is used mainly for irrigation and cleaning purposes.

Some chemical parameters of the dug well and Dhara water representative of the different topographic setting and their distribution are shown in histograms (Fig.3). The pH of the groundwater ranges from 8.0 to 9.0 in the Dharas and 7.5 to 8.7 in the wells. But the histograms indicate a common mode at 8.0 to 8.5 for both wells and Dharas on terraces and on the low lands while Dharas on the slopes possess a mode at 8.5 to 9.0. High pH on the slopes may be attributed to the presence of limestone in their vicinity such as at Godavari, Matatirtha, Balaju and Pulchok. Carbonates are nil in the ground water while bi-carbonates range from 30-

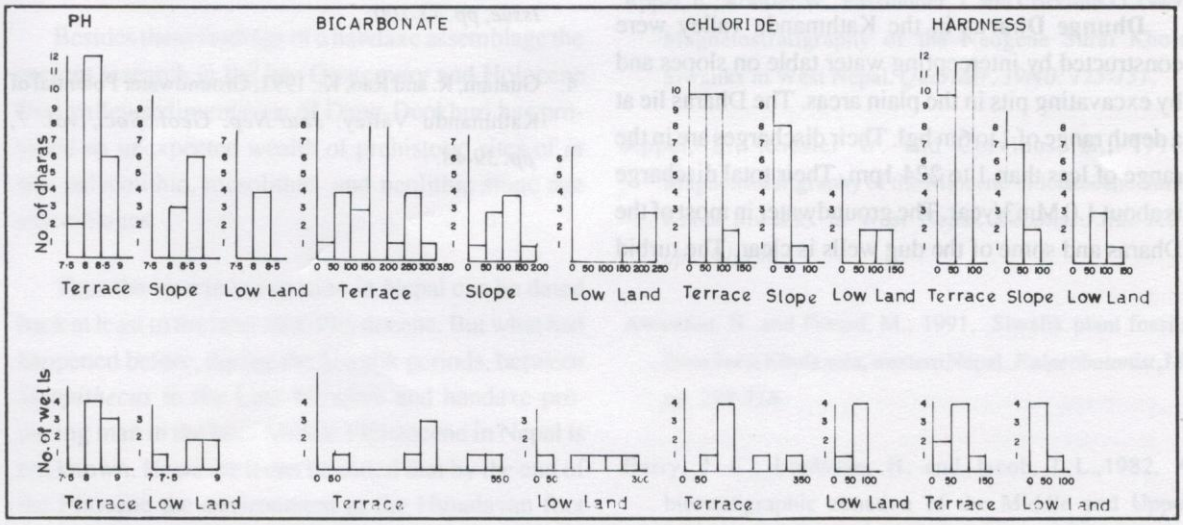

Fig. 3. Histograms of chemical parametres of **Dhunge Dharas** and wells.

502 mg/1. Bicarbonate content in the wells of terraces is higher than that in Dhara water. The histograms reveal that bicarbonate has a wide range in the well water in general without any prominent mode. The Dhara water has a relatively broad range of bicarbonate on the terraces with a prominent mode at 150-200 mg/1. The modes on the slope and lowland are 100-150 mg/1 and 200-250 mg/1 respectively. The bicarbonate is found to be higher at terraces both in Dharas and wells. On the slopes, it is quite low (50-200 mg/1). The chloride content ranges from 10-150 mg/1 in the Dhara water and 50-310 mg/1 in the dug wells. In the Dharas of terraces, its range is 30 to 150 mg/1 but mostly it falls under 100 mg/1, while on the slope it shows a mode at 0-50 mg/1. The wells on the terraces also have a wide range from 50-310 mg/1 and in the low land it has a mode of 50-100 mg/1. High concentration of chlorides in dug well and particularly on terraces reflect pollution as they are situated in the midst of residential areas. The total hardness ranges from 20-130 mg/1 in general. The histograms reveal that it is generally low in the dug wells of low land and slopes of Dharas. The prominent mode is at 50-100 mg/1 for both Dharas and wells on terraces.

Conclusion

Dhunge Dharas in the Kathmandu valley were constructed by intercepting water table on slopes and by excavating pits in the plain areas. The Dharas lie at a depth range of 1 to 6m bgl. Their discharges are in the range of less than 1 to 224 1pm. Their total discharge is about 1.0 Mm3/year. The groundwater in most of the Dharas and some of the dug wells is clear. The turbid water observed in a few wells is related to the clay or iron oxide content. Some of these waters are potable but mostly can be used for other domestic purposes. Generally the chemical constituents increase on the terraces due to high density of population and pollution around those areas. However, to confirm their potability and determine the level of pollution, bacteriological tests and chemical analyses for specific chemical parameters are desired. This groundwater resource, if tapped through dugwells can meet a considerable share of the domestic needs and mitigate the water problem of the Kathmandu valley to a certain extent.

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