STATUS OF GROUNDWATER EXPLOITATION AND INVESTIGATION IN TERAI AND INNER TERAI REGION OF NEPAL

Dinesh Pathak

Central Department of Geology, Tribhuvan University, Kirtipur, Kathmandu
(Email: dpathaktu@gmail.com)

ABSTRACT

Terai and Inner Terai region of Nepal are considered to be rich in groundwater resources and it has been utilized to meet the domestic, agriculture and industrial demand. Large number of wells is drilled and vertical electrical sounding have been carried out for groundwater exploration. The available secondary data have been analyzed to evaluate the status of groundwater exploitation through deep tubewells and status of groundwater investigation in the region. The deep tubewells are drilled as deep as 300 m and VES has been carried out by the government agency in many districts. The well yield shows very high aquifer performance in Rupandehi district and average in many district with the exception of Morang and Dang district that are having low yield in comparison to other districts. The well depth and yield shows very high positive correlation. It is realised that deep wells are still not well distributed in the districts and VES survey need to cover significant areas.

INTRODUCTION

Groundwater is considered as vital natural resources to meet various demands of human beings. However, the overexploitation of groundwater to meet the increasing demand and utilization due to the growing population has caused this natural resource heavily stressed.

Though several rivers are draining through the Terai and Inner Terai region of Nepal, the people residing at these areas have to suffer from the water scarcity for drinking and significant areas of the limited agricultural land available in the area has to depend only on rain-fed irrigation because of lack of proper water management, especially in the Bhabar zone. Furthermore, the population along the foothill areas has been increasing in the recent time. In this regard, it is extremely necessary to explore and exploit groundwater resources in the region and assessment of present status is essential component.

There are several literatures available on the studies on the groundwater exploitation in the Terai and Inner Terai region (Pathak 2017, 2016; Rao and Pathak 1996). However, it is necessary to holistically evaluate the present situation of the existing groundwater exploitation in the entire Terai and Inner Terai. An assessment of the groundwater exploration and exploitation has been carried out through considering the deep tube well data and area covered by geophysical exploration so as to identify the existing knowledge so far achieved on the groundwater condition in the region.

The present study is expected to provide insight on the present knowledge on deep aquifer and the areas covered by geophysical investigation for further exploitation of groundwater. The management of groundwater resources is possible through the detailed analysis of subsurface geological condition and understanding of aquifer parameters. It is possible only through the proper understanding of the hydrogeological knowledge in the area.

The Study Area

The data of deep tubewells were used from 20 Terai districts of Nepal, namely, Jhapa, Morang, Sunsari, Saptari, Siraha, Dhanusa, Mahottari, Sarlahi, Rautahat, Bara, Parsa, Chitawan, nawalparasi, Rupandehi, Kapilvastu, Dang, Banke, Bardiya, Kailali and Kanchanpur. Likewise, the area covered by VES survey in 17 districts, namely Jhapa, Morang, Sunsari, Saptari, Siraha, Sindhuli, Mahottari, Sarlahi, Rautahat, Bara, Parsa, Makwanpur, Chitawan, Kapilbastu, Dang, Banke, and Surkhet districts were evaluated.

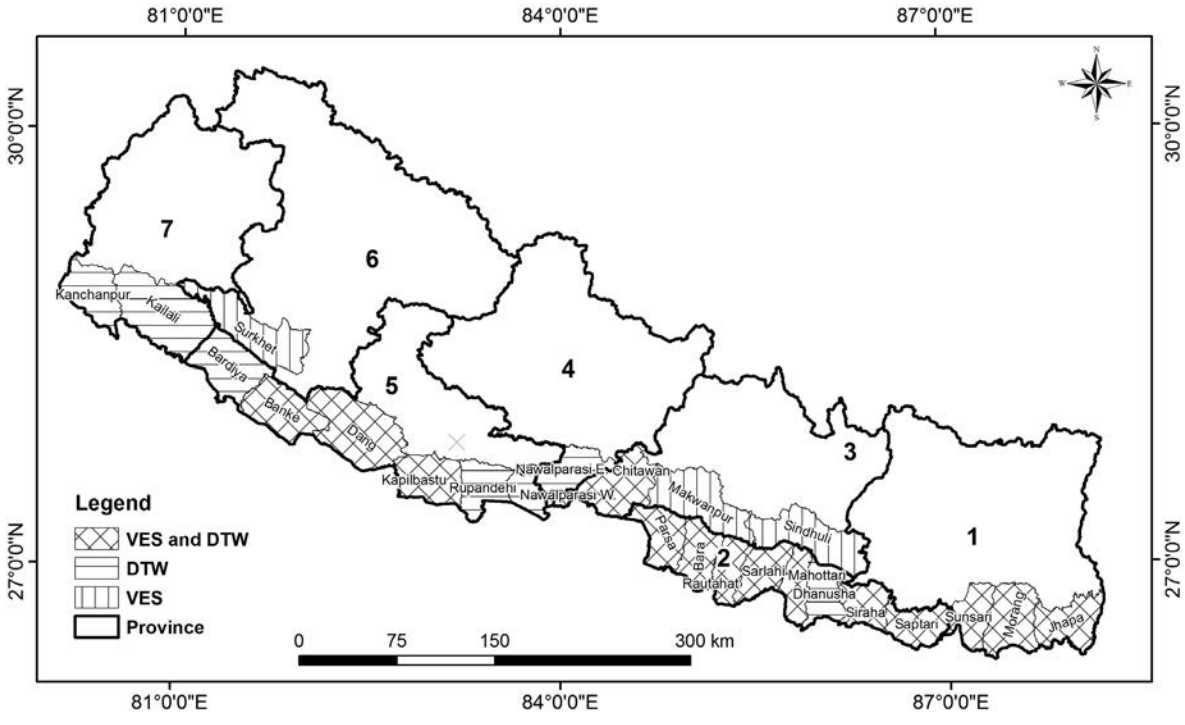

Fig. 1: Location map of study area showing the districts covered by DTW and VES survey

Province-wise, the study area covers almost all provinces of Nepal, however, only Surkhet district is the only one district lying in the Province Number 6. As far as the Province Number 4 is concerned, the new district, i. e. Nawalparasi east lies in the province. For the present analysis, the older boundary of the district is considered. Fourteen districts have both the deep tubewell and VES survey data, seven districts have only DTW data and three districts have only VES survey data.

MATERIALS AND METHODS

The main source of information for the present study is the secondary information available in various reports of the Department of Irrigation and Groundwater Resources Development Board, Government of Nepal (DOI 2014, 2015). The data represents information that existed till 2013. The data was put in GIS to develop a hydrogeological database, which was undergone careful screening to ensure reliability of the data. The location points of deep tubewell and VES survey were plotted on the map and the areal coverage has been described. Likewise, the distribution of the well depth and yield in the study districts has been analysed. Based on the data analysis, the relationship between yield and the well depth have been clarified and the areas requiring more investigation have been identified.

RESULTS AND DISCUSSION

Deep Tubewells

There are all together 1,190 DTW within the study districts in which, Rupandehi district having of highest number of DTW whereas Sarlahi district has lowest number of DTW (Fig. 2). The deep tubewells are distributed in five provinces, namely 1, 2, 3, 5 and 7. Few wells falling in Nawalparasi East district of Province number 4 has been excluded in the present analysis and the wells lying in Surkhet district of Province number six is not considered in the present study. Likewise, Chitawan district is the only one district falling in Province number 3.

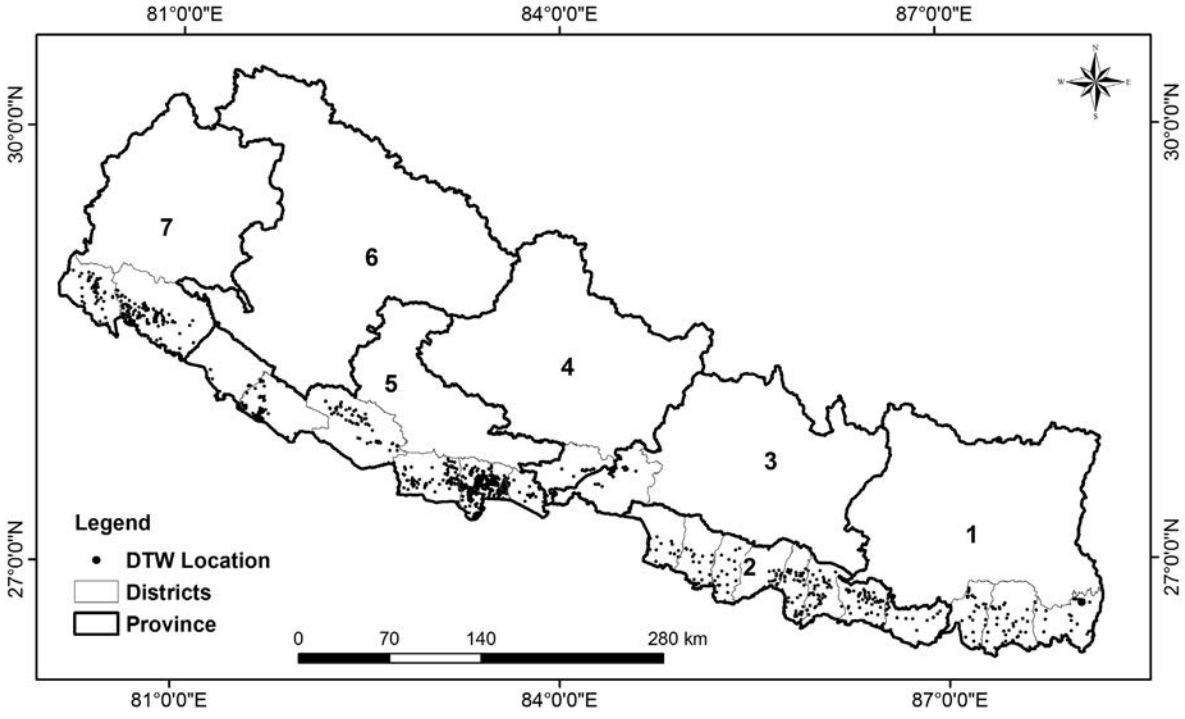

Fig. 2: Location map of the deep tubewell distribution in study districts

The distribution of deep tubewell in the study districts shows that highest number of wells lie in Rupandehi district followed by Kailali district (Fig. 3). Saptari, Sarlahi, Rautahat, Bara and Parsa districts have comparatively few numbers of deep tubewells in comparison to other districts. The wells with the depth more than 50 m have been considered in present analysis.

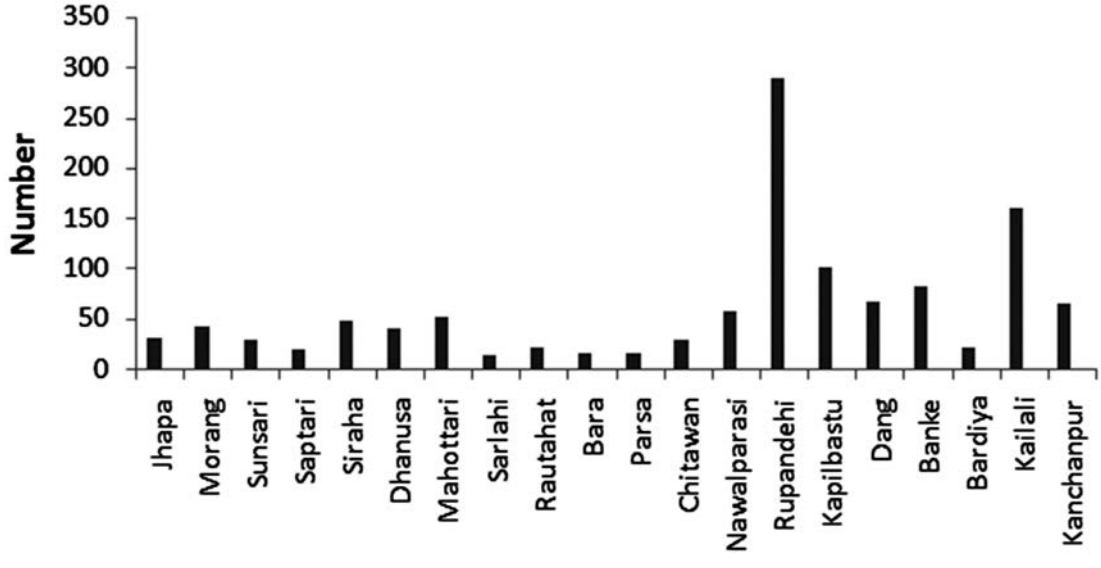

Fig. 3: Distribution of deep tubewells in study districts

The depth of the well is important from the groundwater abstraction perspective. In order to analyze the maximum depth of the aquifer exploited in each district, the maximum well depths have been plotted (Fig. 4). It is observed that the deep wells in Rupandehi and Dang districts have been exploiting the deepest aquifers (more than 250 m deep), while the wells in Saptari, Sarlahi and Chitawan districts exploits aquifers from relatively shallower depths (i.e. less than 125 m deep). In most of the districts, the maximum depth of exploited aquifers is around 150 m.

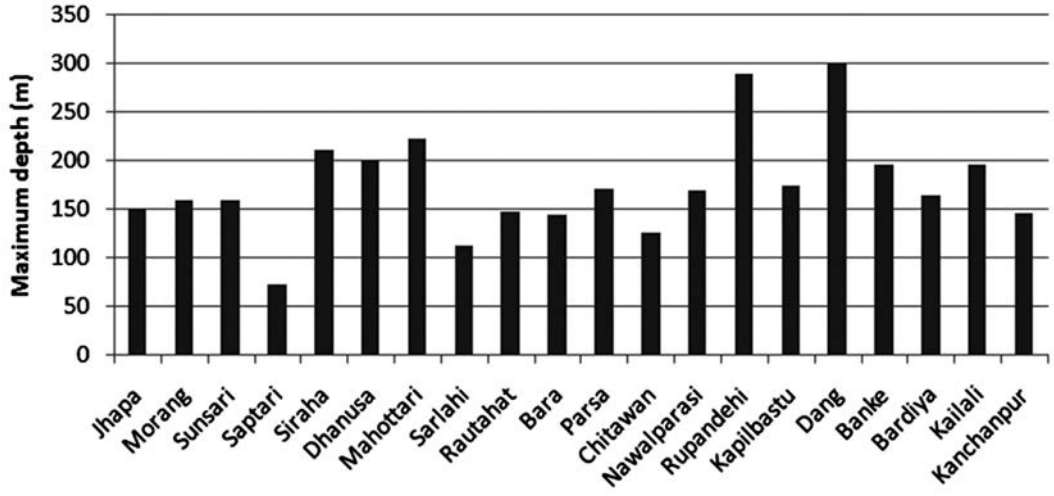

Fig. 4: Maximum well depths in the study districts

The average yield of the wells in each districts have been analyzed (Fig. 5). This is indicative of the aquifer characteristics. It is observed that the aquifers in Rupandehi district with the average yield of 84 liter per second (lps) are most productive while that of Morang and Dang districts shows comparatively less productive with the average yield value less than 15 lps. Rupandehi district is characterized by yield values more than 25 lps even for shallow wells (Pathak 2017).

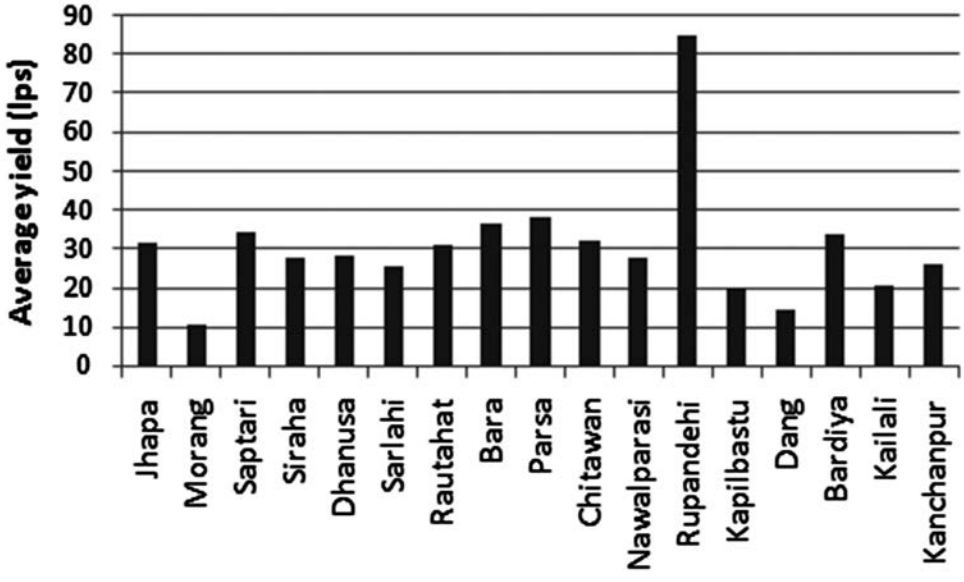

Fig. 5: Average yield of wells in the study districts

The analysis showed an interesting result that deeper the depth of the well, higher the yield (Fig. 6). This is indicative that the deeper well had higher possibility to tap multi-aquifers and the permeable confined aquifer is the cause of high production wells. The wells between 50 and 75 m deep has the lowest yield, i. e. 19.26 lps while it gradually increases to 90.5 lps for the well between 175 and 200 m deep. There is good correlation (R^2 = 0.974) between the well depth and average well yield.

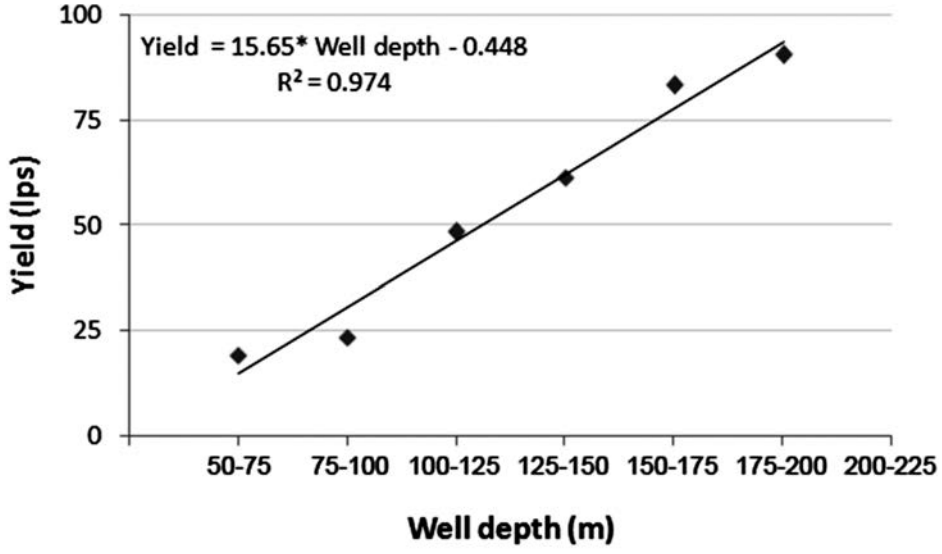

Fig. 6: Relationship between well depth and average yield

Vertical Electrical Sounding (VES) Survey

Groundwater Resources Development Board (GWRDB) carried out vertical electrical sounding (VES) survey in 17 districts of Terai and Inner Terai (Fig. 7). The surveyed districts belong to Province numbers 1, 2, 3 and 5. Makwanpur, Chitawan and Sindhuli districts represents the districts of Province number 3.

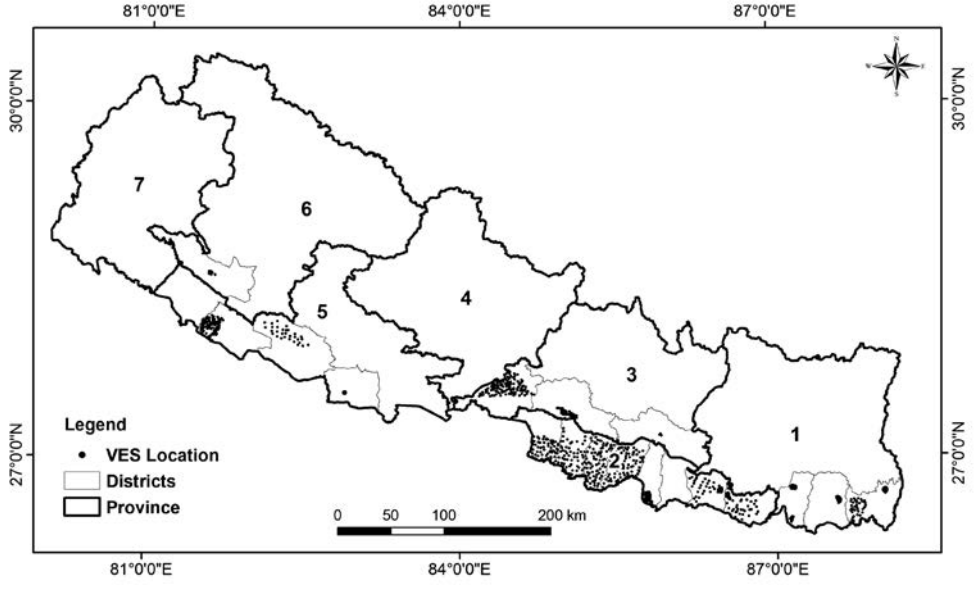

Fig. 7: Districts with VES survey

The number of survey points and area covered varies from district to district (Fig. 8). It is observed that Chitawan and Banke districts have highest number of surveyed points while Sindhuli and Surkhet districts have the lowest numbers. The survey was carried out only in northern central and western part of the Jhapa district. In Morang and districts, only small area is covered, while in Sunsari district, small areas in northern and southern parts are covered. In Province number 2, the VES survey is well distributed except in Mahottari district where it is clustered in southern part. Likewise in Sindhuli and Makwanpur districts, the survey covers very local area, respectively in Kamalamai Municipality and Hetauda Municipality, while in Chitawan district the survey points are uniformly distributed. In Dang district the survey points are uniformly distributed while the survey areas are localized in Kapilbastu, Banke and Surkhet districts.

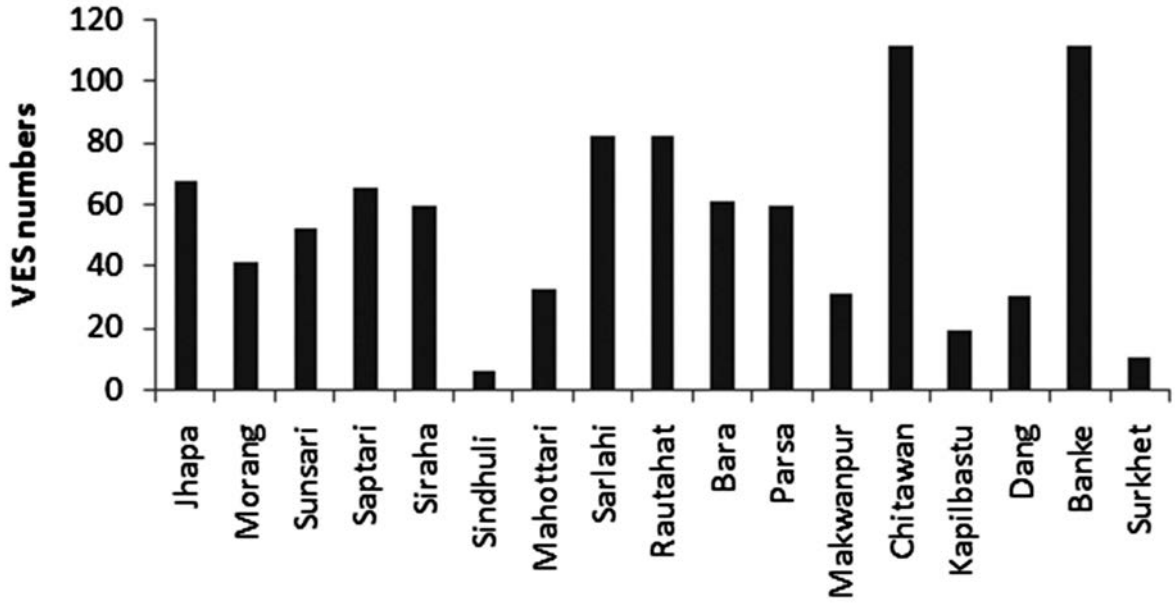

Fig. 8: Distribution of VES survey points in the districts

The data shows that VES survey need to be carried out in some more districts of Terai and Inner Terai, even in the districts covered by survey, the survey points are not uniformly distributed covering the entire area of the districts. VES survey provides good information regarding subsurface electrical properties which enables us to interpret the subsurface lithology and depth to water table. Such information is important in groundwater exploration leading to exploitation where the lithologs of tubewells are not available.

CONCLUSIONS

The deep tubewell data of the districts considered in present study shows that large number of deep tubewells is drilled in the Terai and Inner Terai region of Nepal. Rupandehi, Kapilbastu and Kailali districts have highest number of deep tubewells. In most of the districts, the wells are drilled to around 150 m deep in an average, Rupandehi and Dang districts having deepest wells. Most of the districts have 25 lps average well yield, Rupandehi district having the highest while Morang and Dang districts have the least. There is very good correlation between the well depth and well yield. This gives a rough idea that the increased depth of the well, we can expect greater yield in the Terai and Inner Terai regions of Nepal. It is praiseworthy that the Government of Nepal has been carrying out vertical electrical sounding (VES) for groundwater exploration. However, the data distribution shows that some of the districts are not well covered by the survey while some are totally not surveyed. The present understanding of the status of groundwater exploitation and exploration would be better understood with the inclusion of data after 2013.

REFERENCES

DOI, 2014. Collection, compilation and report preparation of geophysical data in Terai and Inner Terai districts of Nepal. Department of Irrigation (DOI), Groundwater Division, Jawalakhel, Kathmandu, 76 p.

DOI, 2015. Collection, compilation, GIS based plotting & report preparation of deep tube wells. Department of Irrigation (DOI), Groundwater Division, Jawalakhel, Kathmandu, 103 p.

Pathak, D., 2016. Water availability and hydrogeological condition in the Siwalik Foothill of eastern Nepal. Nepal Journal of Science and Technology, vol. 17(1), pp. 31-38

Pathak, D., 2017. Delineation of groundwater potential zone in the Indo-Gangetic Plain through GIS analysis. Journal of Institute of Science and Technology, vol. 22(1), pp. 104-109.

Rao, G. K., Pathak, D., 1996. Hydro geological conditions in the Terai plain of Nawalparasi district, Lumbini Zone, Nepal with special reference to groundwater recharges. Journal of Applied Hydrology, vol. 9, pp. 69-75.