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Hydrological Interaction between Surface Water and Ground Water in Vavuniya District of Sri Lanka

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Abstract

Irrigation tanks are the only surface water resource in Vavuniya district. Households in this district are dependent on ground water sources to satisfy their domestic water needs. It has been experienced and reported by the households that the wells during the dry season especially during the months of June, July, and August became dry without water while there was little water in the irrigation tanks in this district. Hence, this study was carried out to understand the hydrological relationship between surface water and ground water. Three tanks namely Vavuniya tank, Pandarikulam tank and Paddanichchepuliyankulam tank were purposively selected as surface water source. 21 wells were selected from each Vavuniya tank and Padanichchepuliyankulam tank command area and 23 wells were selected from Pandarikulam tank command area as ground water source. The measurements of water level of tanks and wells were taken once in two weeks for six months from August 2013 to January 2014. The correlation coefficients of respective tank water levels Vs well water levels were estimated using Minitab 16 and found that the average correlation coefficient of the same of Vavuniya tank, Pandarikulam tank and Paddanichchepuliyankulam tanks were 0.88, 0.72 and 0.69 respectively. The strong positive correlation between the tank water level and well water level in the selected tanks confirmed that the increased tank water level would ensure the well water level. Any action taken towards tank maintenance and rehabilitation would ensure the sustainable water availability in the wells. Therefore maintaining sufficient water level in the tank would help to minimize water scarcity issues in Vavuniya.

Keywords: Correlation coefficient, irrigation tank water level, water scarcity, well water level.

Introduction

Ground water resources and recharge rates shows variation across Sri Lanka locally and regionally. Different geologic formations retain water differently. Vavuniya district falls in the metamorphic hard rock region of the dry zone of Sri Lanka. The groundwater present in this region made up of the shallow 'Regolith Aquifer' and the deeper fracture zone aquifer[1]. This ground water found in an irregular pattern in crevices and fractures within rocks with distinct water table. In Vavuniya, the ground water system is controlled by the small tank cascade system designed for increasing surface water availability. Vavuniya is mainly an agricultural district where people use surface and ground water for cultivation. Ground water sources satisfy the domestic needs of the households in this district. Vavuniya district experiences an acute shortage of drinking water during the dry season and the water supply to the region was not sufficient to meet the demand.

There are one major, 21 medium tanks and 674 minor irrigation tanks including 26 anicuts distributed in Vavuniya district. The water resources mainly depend on rainfall as there are no perennial rivers. Out of the 674 Minor Irrigation Schemes, 41 abandoned tanks, 64 breached and nearly 208 tanks to be renovated[3]

During some periods in a year, the wells in some residential area are dried completely. Thus, the determination of hydrological interaction between surface water level and ground water level in Vavuniya district was considered important for determination of well water recharge by surface water in regolith aquifer. The objective of this study was to find out the correlation between tank water and well water.

Methodology

Among 674 tanks found in Vavuniya district, three tanks were purposively selected; *Vavuniya* tank, *Pandarikulam* tank and *Paddanichchepuliyankulam* tank which are closer to each other to ensure similar topographic and climatic conditions. The sample wells were selected sequentially along the water flow path using Google earth pro. To ensure maximum coverage of tank water flow number of wells were chosen sequentially each side of the water flow in the command area. The details of sample tanks and number of wells selected for each tanks were given in table-1.

Wells and tanks were mapped in Google earth pro with coordinates obtained from GPS.

Well water level and tank water level were measured once in

two weeks from first week of August 2013 to the last week of January in 2014. *Vavuniya* tank water level data were periodically collected from the provincial irrigation department. Other two tank water levels were measured periodically in sluice. Rain fall data were collected from the Meteorological department. Minitab 16 was used to estimate the correlation coefficient between tank water level and the corresponding well water level for the selected three tanks separately. Correlation coefficient r was used to find out the correlation between the tank water and well water level in Vavuniya district.

The water spread area for each tanks were calculated by the equation given below [4].

$$\text{Capacity} = 0.4 * d * a$$

d- FSL (Full Supply Level) a - Water spread area

Table-1
Sample tank and wells

Tanks	No of Sample wells	No of wells in right Paddy land area	No of wells in left Paddy land area
Vavuniya Tank	21	12	9
Pandarikulam Tank	23	6	17
Paddanichchepuliyankulam Tank	21	11	10

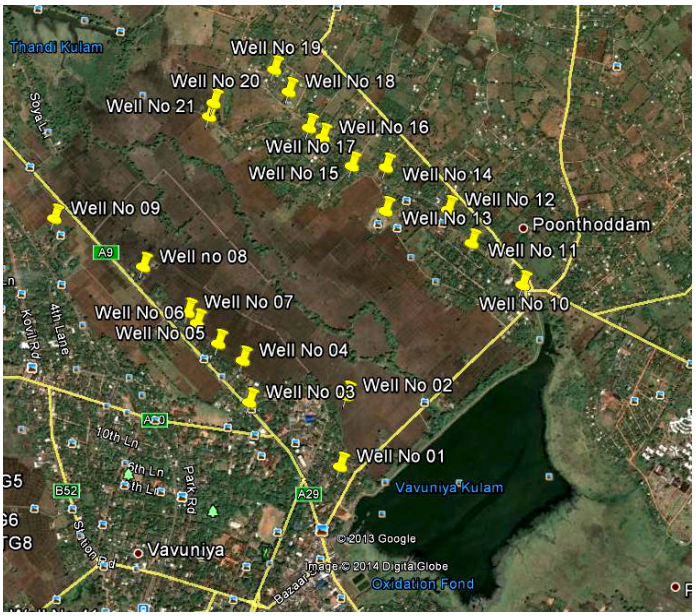

Figure-1
Location of selected wells in *Vavuniya* tank basin

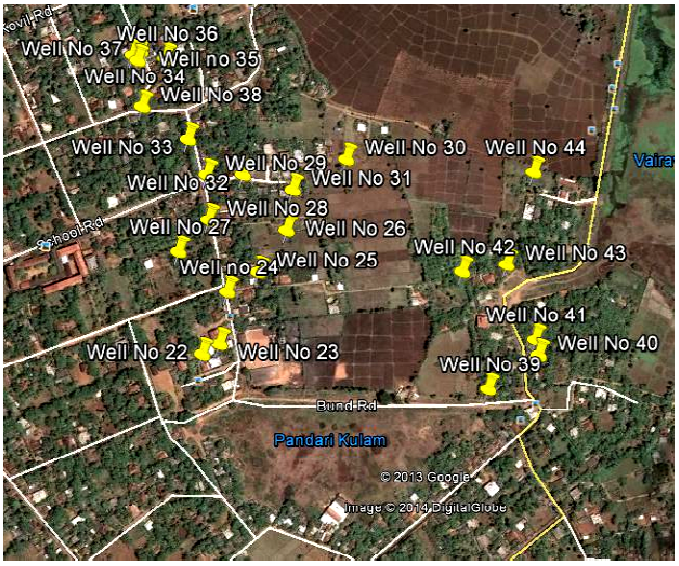

Figure-2
Location of selected wells in *Pandarikulam* tank basin

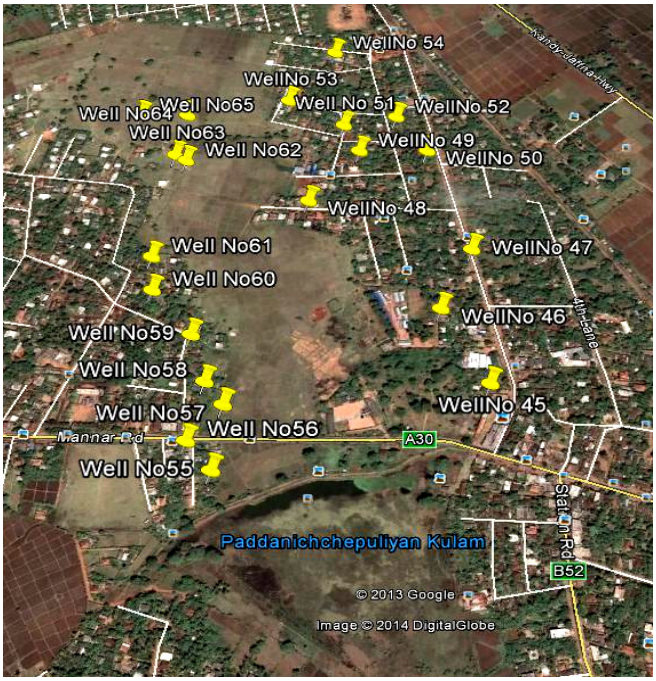

Figure-3
Location of selected wells in *Paddanichchepuliyankulam* tank basin

Results and Discussion

With the heavy rain (240mm) experienced during the first week of January, 2014 sudden increase of tank water level observed in the three selected tanks and in the wells located in the respective command area (figures-4, 6, 8).

Figure 4 demonstrates that the majority of well water level followed the path of *Vavuniya* tank water level.

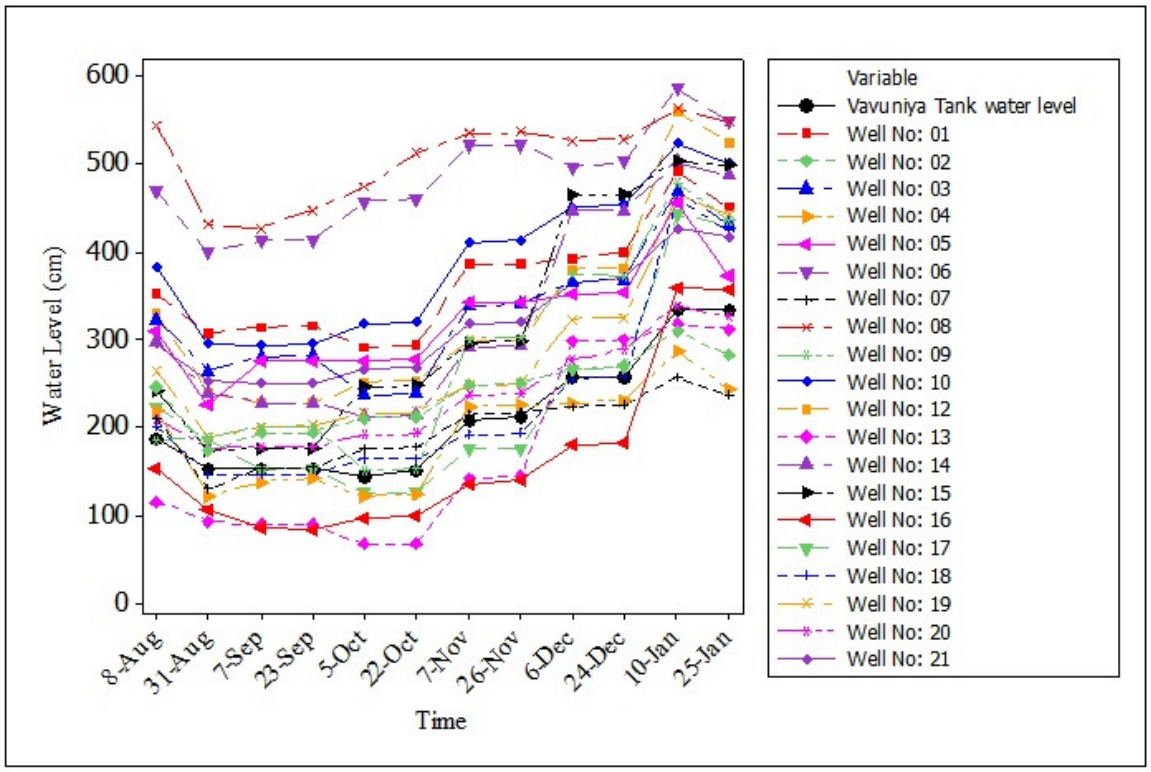

Figure-4
Tank water level and Well water levels at *Vavuniya* tank

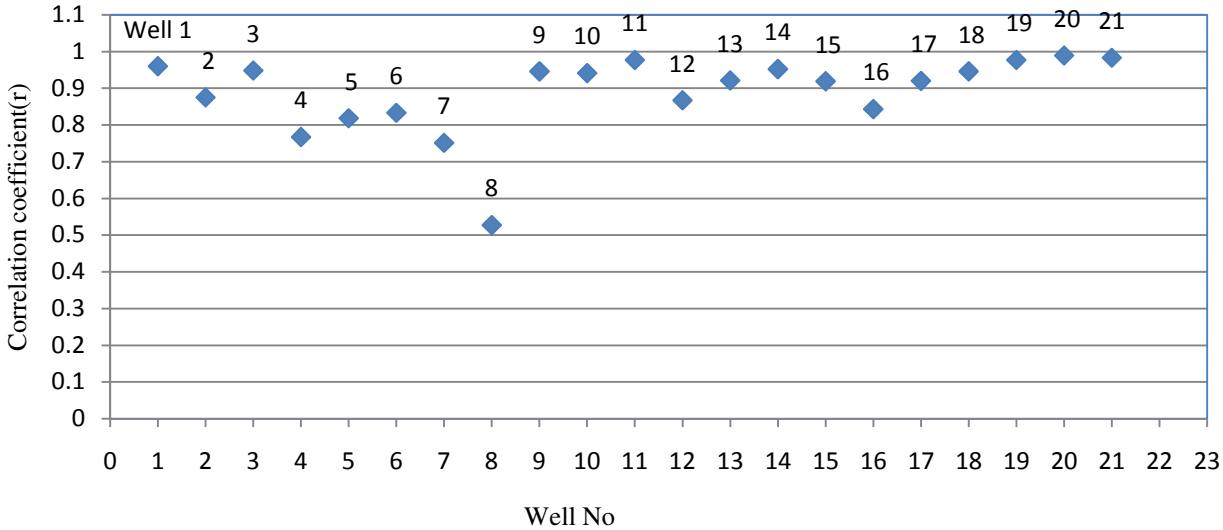

Figure-5
Distribution pattern of correlation coefficient values of selected wells in *Vavuniya* tank basin

The mean value of overall correlation co-efficient (r) of *Vavuniya* tank was 0.88. This reveals that there was a significant strong positive correlation between *Vavuniya* tank water level and the water level of the wells situated in its command area. Distribution pattern of r values of 21 tanks in the *Vavuniya* tank command area in figure-5 illustrates that most of the correlation values laid in between 0.7 to 1 and about 86% of the sampled wells showed correlation coefficient greater than 0.8. Therefore, it could be inferred that there must be a strong positive correlation between *Vavuniya* tank water level and the water level of the wells located in its command area.

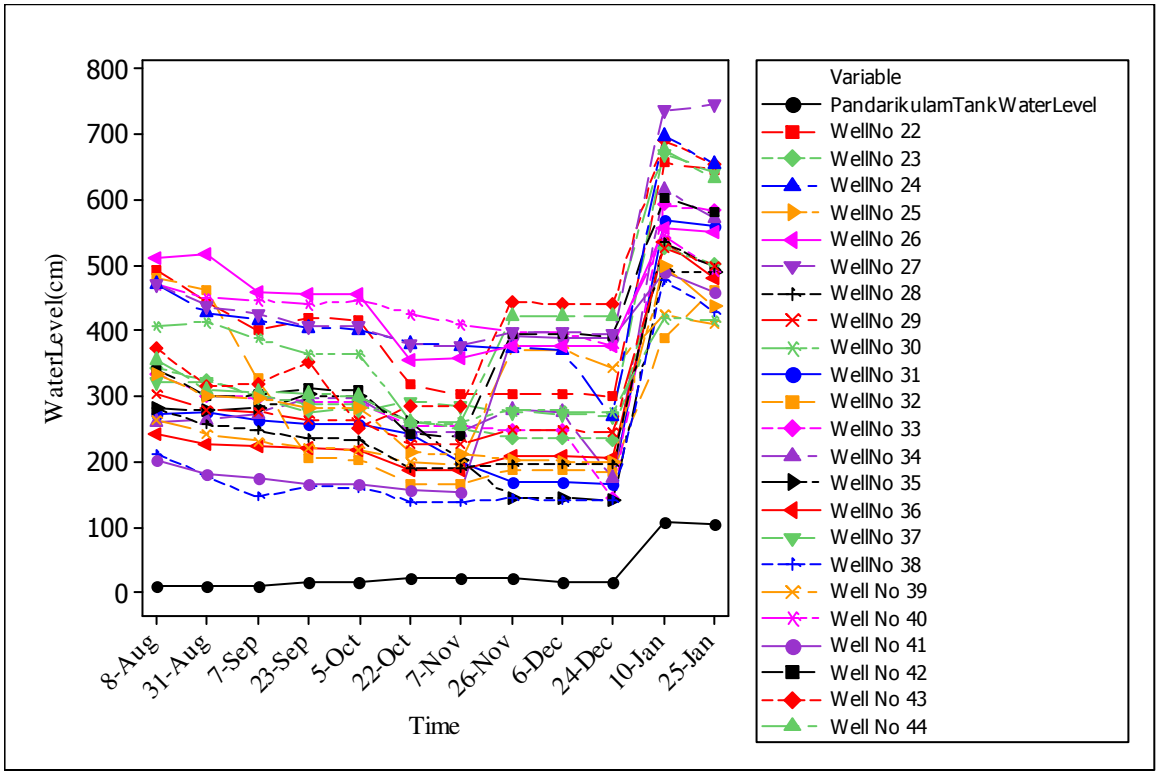

Figure-6
***Pandarikulam* tank water level and well water levels**

Figure-6 illustrates that from November 1st week to last week, an increasing trend of water level observed in majority of the wells with tank water level. Further in some wells (Well No 41, 42, 43, 44) a drastic increment was observed. It may be due to the influence of the nearby tank which is located comparatively closer to the particular wells.

The mean value of overall correlation co-efficient (r) of *Pandarikulam* tank was 0.72. About 52% wells showed greater than 0.8, hence it could be inferred that there must be a strong positive correlation between the water level at *Pandarikulam* tank and the water level of the wells in its command area.

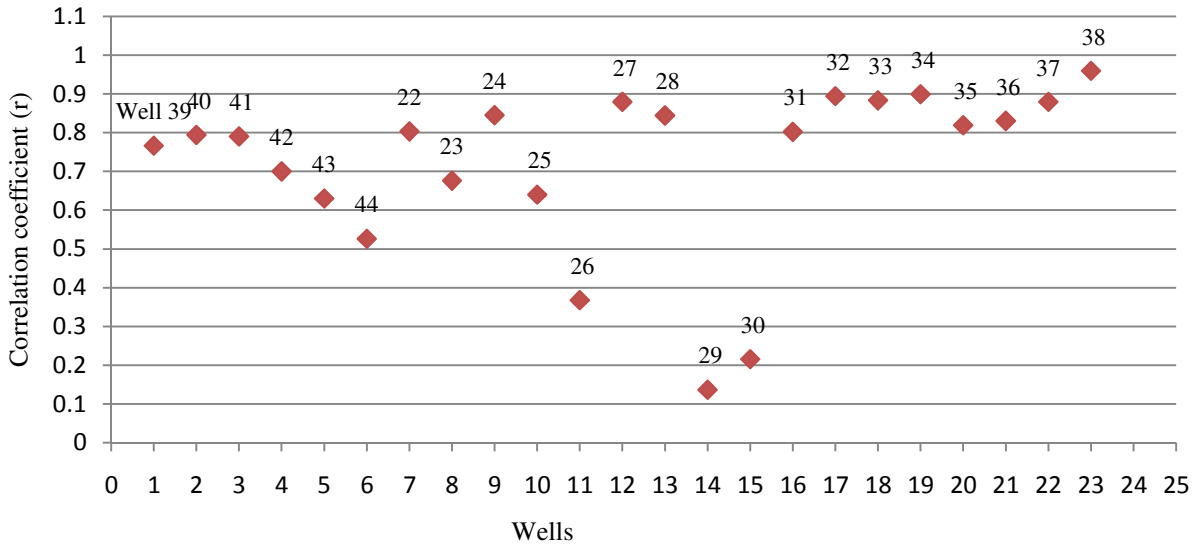

Figure-7
Distribution pattern of correlation coefficient values of selected wells in *Pandarikulam* tank basin

Figure-8 clearly indicates that the majority of well water level followed the pattern of tank water level with time.

The Mean value of overall correlation co-efficient (r) of *Paddanichchepuliyankulam* tank is 0.69 while about 50% wells showed more than 0.7. This reveals a moderate positive correlation between tank water level and the water level of wells situated in its command area.

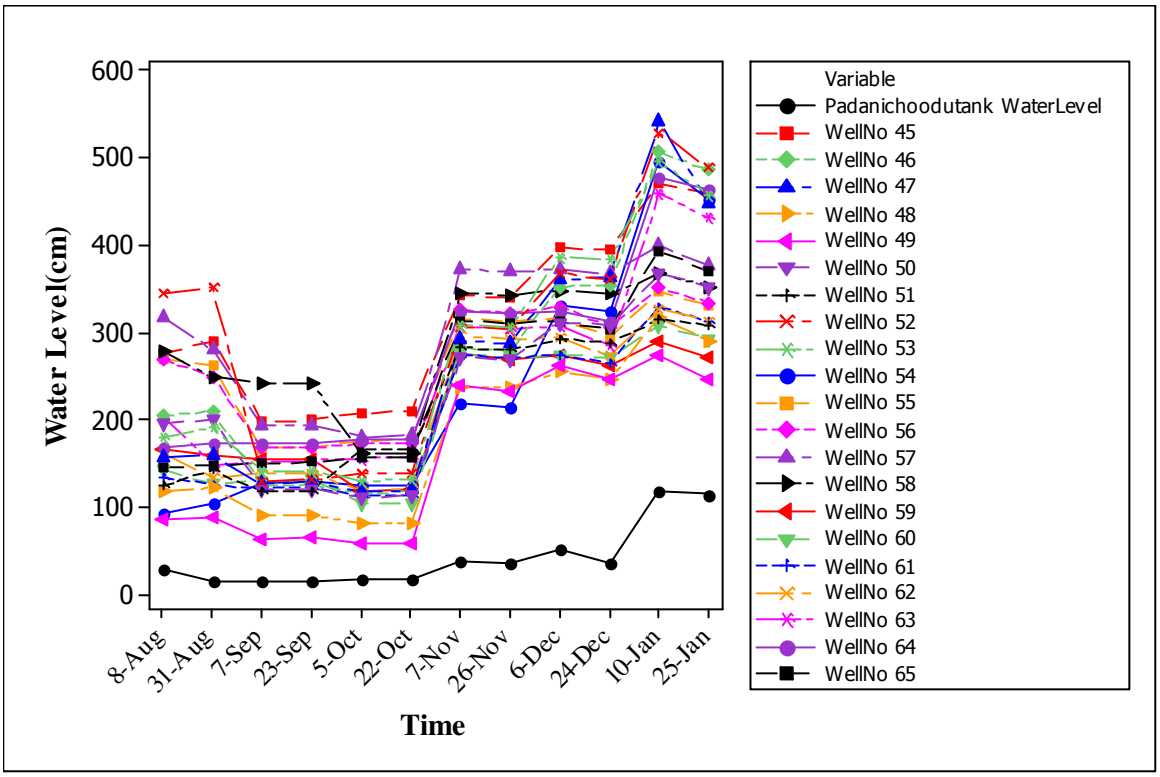

Figure-8
***Padanichchepuliyankulam* tank water level and well water levels**

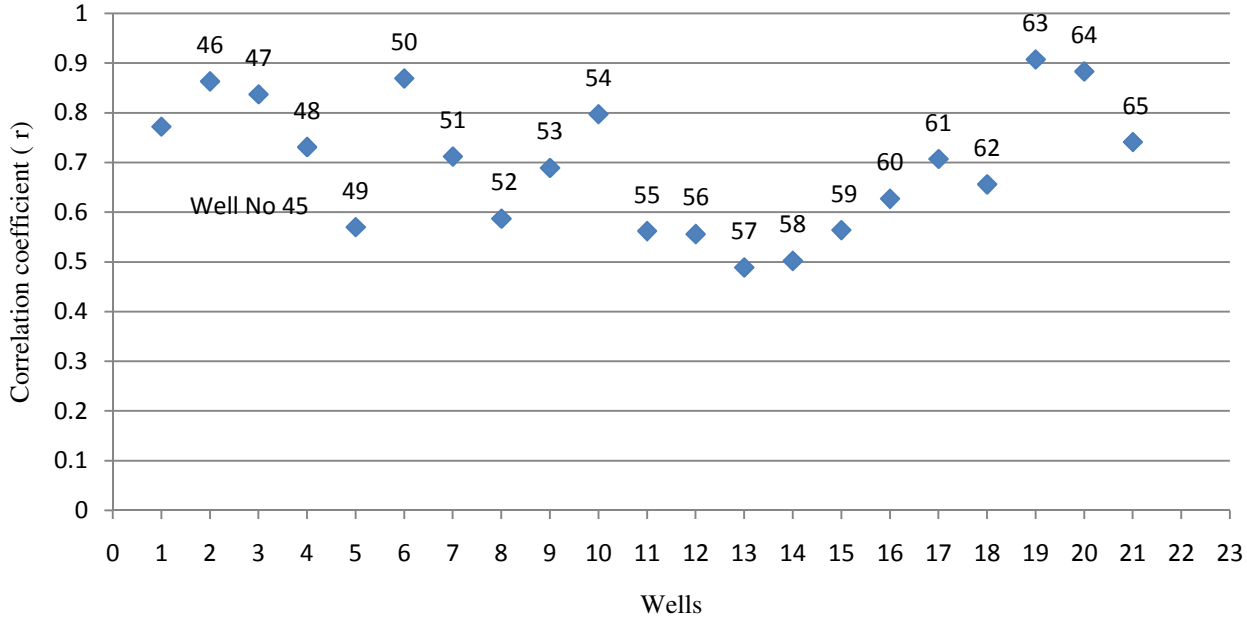

Figure-9
Distribution pattern of r values of selected wells in *Vavuniya* tank basin

Table-2
Selected hydrological parameters of each selected tank

Tank	Capacity (Ha.m)	Command area (Sq.mile)	Mean correlation coefficient	FSL(Full Supply Level,)(m)	Water Spread Area (ha)
Vavuniya tank	243	10.5	0.878	3.96	153.4091
Pandari kulam tank	8	0.19	0.720	3.35	5.970149
Paddanichchepuliyan kulam tank	18	1	0.669	2.44	18.44262

Source: Field survey, 2013 and secondary data

The encroachment in tank water spread area could reduce the supply to tank storage[2]. The water spread area of selected tanks was shown in table-2. Though the water spread area of *Paddanichchepuliyankulam* (18.44) tank was higher than that of *Pandarikulam* tank (5.97), the correlation coefficient of *Paddanichchepuliyankulam* tank (0.669) was lower than that of *Pandarikulam* (0.720). This may be due to the dense tank encroachment in the water spread area *Paddanichchepuliyankulam* tank.

Conclusion

The strong positive correlation between Tank water level and the water level of the wells in the selected tanks located in the regolith aquifer in Vavuniya district was found. It could be inferred that there was significant degree of well water recharge taking place from surface water (irrigation tanks). Therefore maintaining sufficient water level in the tank would help to avoid water scarcity issues in Vavuniya. The encroachment of tanks in tank command areas and unplanned urbanization activities were interfering the well water recharge from tanks. This could be overcome by taking measures to prevent tank encroachment and implementing a well planned urbanization and tank rehabilitation which enhance the water storage in the irrigation tanks and thereby in the wells.

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