Comparing pipedrain and tubewell spacings in a deep and permable semi-confined aquifer

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Introduction

The “Revelle Report” states that subsurface drains (horizontal drains) are used in controlling the watertable and the build up of salinity in many regions of the world. In the Punjab, however, the report states that such horizontal drains are not only much more expensive than tubewells (vertical drains) for eliminating waterlogging and salinity, but they do not provide the advantages of regulation of the irrgation supply. (Ref. Gulam Mohmmad, 1965. *Waterlogging and Salinity in the Indus plain: A Critical Aanalysis of the Major Conclusions of the Revelle Report.* http://www.pide.org.pk/pdf/PDR/1964/Volume3/357-403.pdf).

Mohammad Valipur has felt the necessity to compare the required spacings of horizontal and vertical drains as a basis for cost comparison between the two drainage methods. His well spacings, however, are relatively small, because he did not use an aquifer with high hydraulic transmissivity (the product of hydraulic conductivity and thickness of the aquifer), while the use of tubewells only advisable when aquifers with high transmissivity are present, because in that situation the well spacing can be very wide making the constructing of a vertical drainage system relatively cheap. (Ref. Mohammad Valipour, 2012. *A Comparison between Horizontal and Vertical Drainage Systems in Anisotropic soils*. IOSR Journal of Mechanical and Civil Engineering, Vol. 4, Issue 1 (Nov.-Dec. 2012), PP 07-12. http://iosrjournals.org/iosr-jmce/papers/vol4-issue1/B0410712.pdf)

Below, a comparison will be made between the required spacing of drainpipes and tubewells in highly transmissive semiconfined aquifers (i.e. aquifers covered on top by relatively slowly soil layers), a condition that can often be found in the middle parts of large river systems like for example the Indus plains in Punjab.

Comparisons

For the calculation of the drain spacings use is made of the EnDrain calaculator (see: https://www.waterlog.info/endrain.htm). It uses the energy balance of groundwater flow that results in a somewhat deeper watertable than the traditional water balance method because the energy of the incoming percolation water is accounted for (Ref. https://www.waterlog.info/pdf/enerart.pdf).

For the calculation of the well spacings use is made the the WellDrain calculator (see: https://www.waterlog.info/pdf/wellspac.pdf).

In all cases it is assumed that the depth of the watertable midway between the drains and wells should not be shallower than 0.5 below soil the soil surface when the discharge reaches a value of 3 mm/day (0.003 m/day). Further, in all cases, the soil profile consists of a first layer of 5 m. thickness having a hydraulic conductivity of 0.5 m/day, underlain by a second layer, the aquifer, of 100 m. thickness having a hydraulic conductivity of 2 m/day.

Pipedrains with a diameter of 0.1 m will be placed at 1. 0, 1.2 and 1.4 m. depth. Tubewells, with a diameter of 0.2 m will be placed to reach a depth of 20, 40 and 60 m.

The results are shown in Table 1.

Table 1. Depth and spacing of drains and wells		Spacing	Drain length per ha
Drain depth	1.0 m	63 m	159 m
	1.2 m	97 m	103 m
	1.4 m	132 m	76 m
			Number of wells per ha
Well depth	20 m	254 m	0.155 (1 well per 6.5 ha)
	40 m	354 m	0.078 (1 well per 12.5 ha)
	60 m	420 m	0.057 (1 well per 17.6 ha)

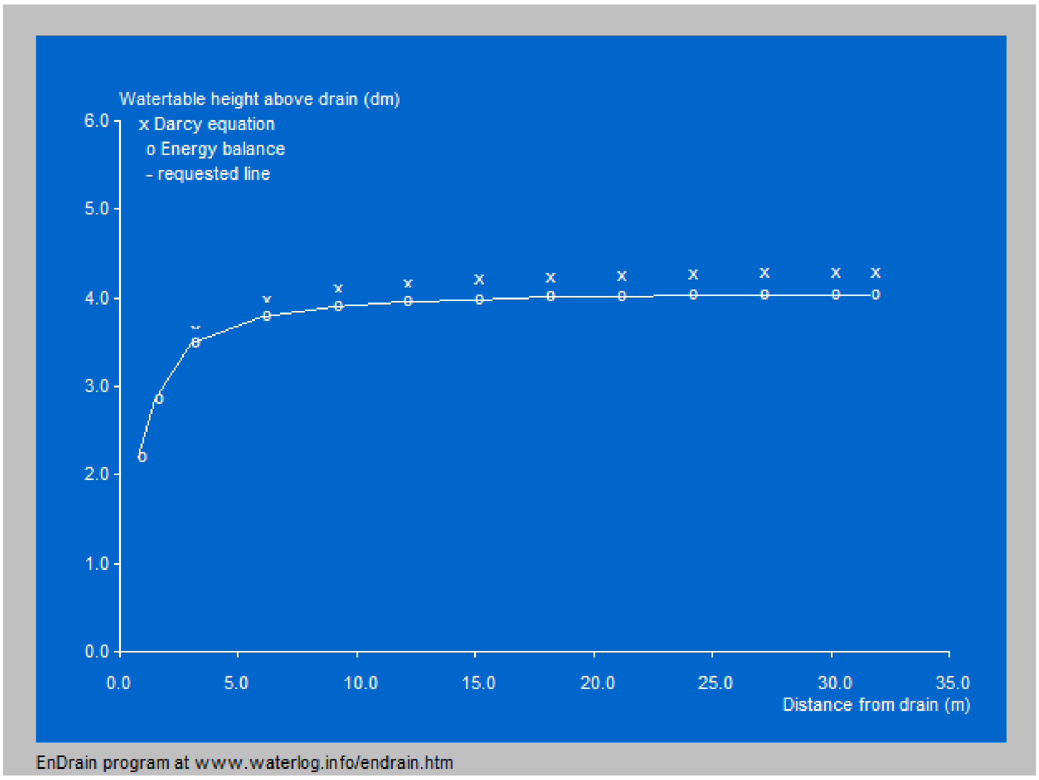
See also the figures on the next page.

Conclusion

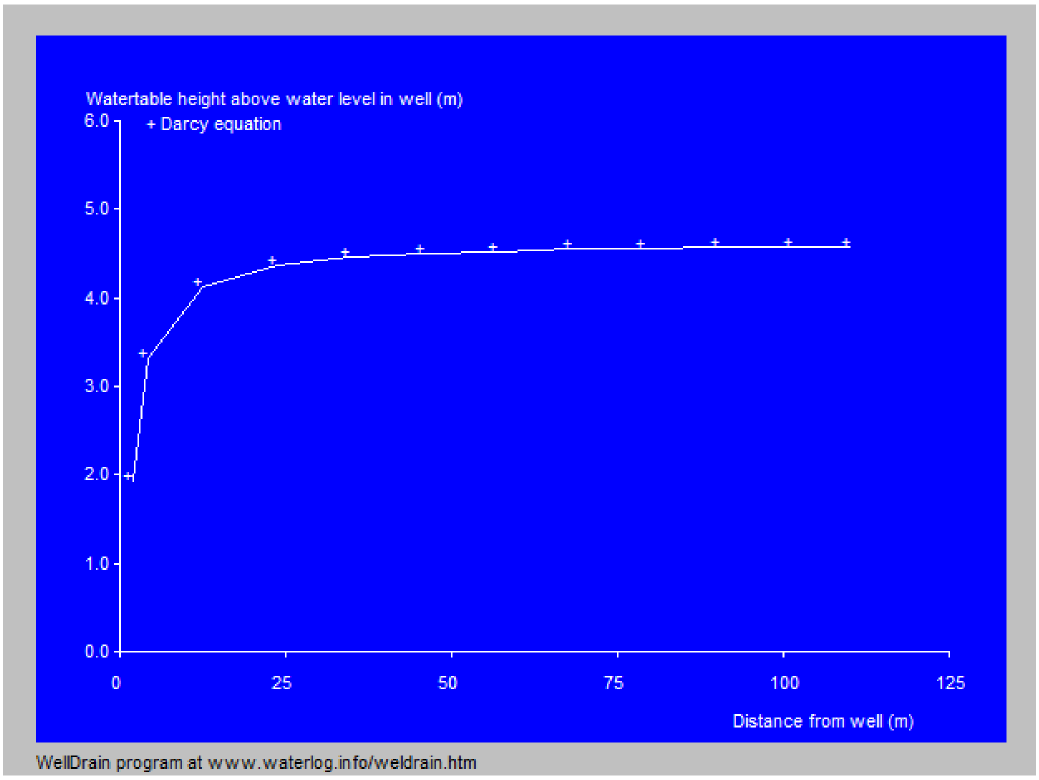
Although Table 1 is only an example for a certain situation, it clearly shows that one tubewell can span a large area (around 10 hectares or more). Tubewells possibly require a smaller initial investment per ha than pipedrains, even though they need a pump and the installation costs per m depth of the well is higher than those per m drainlength. However, tubewells need recurrent energy costs for pumping the water up, whereas pipedrains normally can evacuate the water by gravity. It requires a technical/economical analysis to determine which of the two methods deserves preference.

Note

The pump discharge, when the well depth is 20 m, is 6.5*10000*0.003 = 195 m3//day or 195/86.4 = 2.25 l/s. When the pump is a pressure pump with sufficient capacity, it might draw down the water level in the pump deeper than 5 m, say 10 m. In that case, the spacing could be 429 m (one well per 18.4 ha) instead of 254 m and the pump discharge becomes 6.37 l/s
It is normally feasible to place wells deeper than 20 m (say 60 m) and to lower the drawdown inside the well to more than 10 m (say 20 m) so that the area served by 1 well can go up to 60 ha while the discharge would then be 20.7 l/s.



Shape of the water table between drains placed at 1 m depth at a spacing of 63 m. (height in dm)



Shape of the water table between wells placed at 10 m depth at a spacing of 254 m. (height in m)