

## SOME PROPERTIES OF DAGAN'S METHOD FOR DRAIN SPACING DETERMINATION IN MARSHY - GLEY SOIL

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**Abstract:** Dagan's method as well as Kirkham's one belong to the group of methods for drain spacing determination in steady state water flow conditions. Both methods are based on the assumption that drainage spacing ( $L$ ) is linear function of water table depth and drainage discharge ( $h/q$ ). The only difference can be distinguished in the values of coefficients. To dry out eugley type of soil, drain spacing is better determined by Dagan's method in all treatments, as compared with Kirkham's one. Advantage of this method is especially marked on the drainage system with narrower drain spacing.

**Key words:** steady state water flow, drain spacing, Dagan's method.

### **I n t r o d u c t i o n**

Dagan's method is one of the methods for drain spacing determination in steady state water flow conditions. Mutual characteristic of both Dagan's and Kirkham's methods is the assumption that drain spacing ( $L$ ) is linear function of water table depth and drain discharge ( $h/q$ ) (FAO, 1976). The only difference can be distinguished in the values of coefficients. The aim of this work is to show comparison of methods and to test their reliability for main purpose such as to be applied for drain spacing determination in eugley type of soil and to represent their advantages and disadvantages.

### **M a t e r i a l a n d M e t h o d s**

Dagan (1964) used the results of Hooghout's analysis to derive a very simple solution for the drainage problem. (cit. Wesseling 1974). For this purpose, he

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divided the flow region in a region with radial flow and one with horizontal flow and expressed by equation:

$$h = \frac{qL}{K} F_D \quad (1)$$

where

$$F_D = \frac{1}{4} \left( \frac{L}{2D} - \beta \right) \quad (2)$$

$$\beta = \frac{2}{\pi} \ln \left( 2 \cosh \frac{\pi r_0}{D} - 2 \right) \quad (3)$$

The term  $\beta$  has been presented as a function of  $\frac{\pi \cdot r_a}{D}$ , and its value can be obtained from the diagram (Dagan, 1964, cit. Wesseling, 1974)

For the analysis of the Dagan's method for drain spacing determination, the experimental data of drainage discharge and water table depth measurements in steady state water flow was taken from the previous article (Djurović, 2003, Djurović, 1999).

The values of  $\beta$  and Dagan's coefficient ( $F_d$ ) for all drainage treatments are presented in table 1.

T a b. 1. - Parameters of Dagan's equations

L (m)	$\beta$	$F_d$
10	-1.4	2.623
20	-2.4	2.053
30	-3	2.203

## Results and Discussion

Results of drain spacing estimation by applying Dagan's equation for treatment I (L=10 m) are shown in figures 1 and 2. Similar trend of data series can be observed when Kirkham's equation is applied. Namely, data series can be divided into two segments. First segment considers the values of  $k < 28$  and second one the values  $> 28$ . Curve of drain spacing estimation for the first drainage treatment has the same shape as with Kirkham's method, but the values are slightly different. That is somehow expectable regarding the similar assumption upon which methods are based. However, Dagan's method better estimates drain spacing for treatment I, having mean value of error  $-0.7066$  m,

median  $-1.699$  m and mode of error  $-4.577$  m. The value of standard deviation of error is  $3.661$  m and it is presented in Table 2. Histogram of error (fig. 2) has very irregular trend as well as by applying Kirkham's method, with maximal concentration of data in the range of  $5$  m.

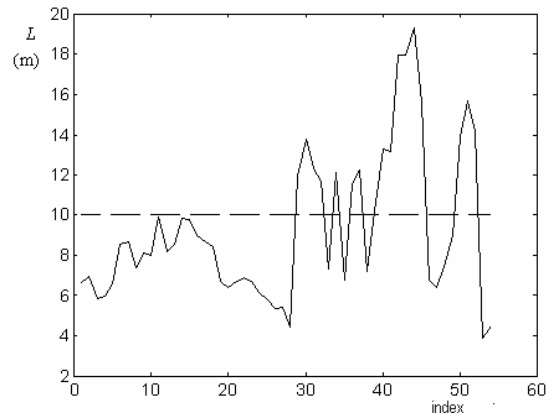


Fig. 1.- Drain spacing estimation by Dagan's method, treatment I ( $L=10$  m)

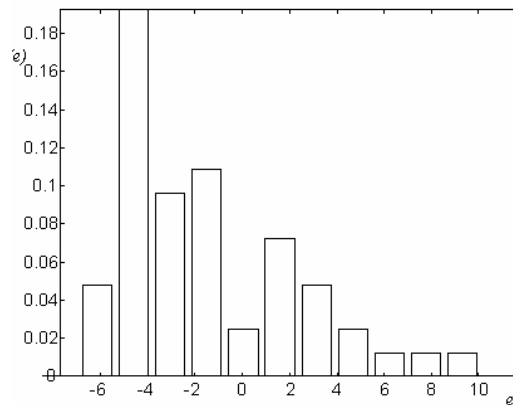


Fig. 2.- Histogram of error of estimation, treatment I ( $L=10$  m)

The results of drain spacing estimation for treatment II ( $L=20$  m) are shown in figures 3 and 4. The trend of data is very similar to treatment I. In this treatment Dagan's method is more precise than Kirkam's one, too. Nevertheless, drain spacing estimation is moved toward negative value illustrated through the

negative value of mean error of estimation which is lesser ( $-4.765$ ), then through the median, mode and standard deviation of error  $-6.205$  m,  $-6.57$  m and  $4.224$  m, respectively. Histogram of error (fig. 4) refers to negative value of error with the maximal concentration of data in range of  $-6$  m.

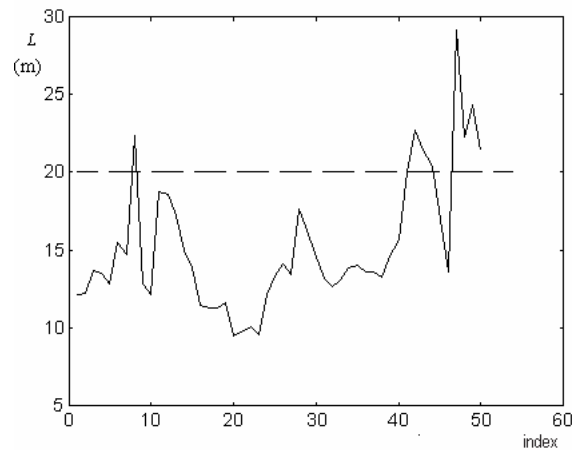


Fig. 3.- Drain spacing estimation by Dagan's method, treatment II ( $L=20$  m)

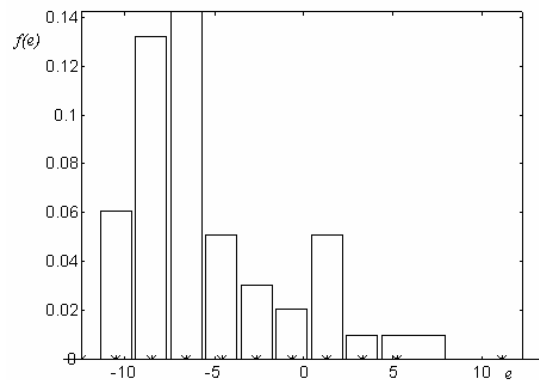


Fig. 4.- Histogram of error of estimation, treatment II ( $L=20$  m)

The advantage of Dagan's method with regard to Kirkham's one has minor importance when drain spacing is wider, which confirms obtained data from treatment III ( $L = 30$  m). Like in treatment II, error is negative, but much higher. Results of the drain spacing estimation analysis are shown in figures 5 and

6. Mean value of error increased by absolute value till  $-9.44$  m, median till  $-9.36$  m and value of mode (Table 2) highly increased ( $18.88$  m). In this treatment two segments of data series can be observed. They are influenced by different water table depth. Histogram of error shows two peak values, therefore the value of mode is under question (Fig.6). In all treatments Dagan's method better-estimated drain spacing in comparison with Kirkham's one, eventhough less precise in the case of wider drain spacing. Both methods give better results in the second segments of data when water table depth is shallower or with higher water head.

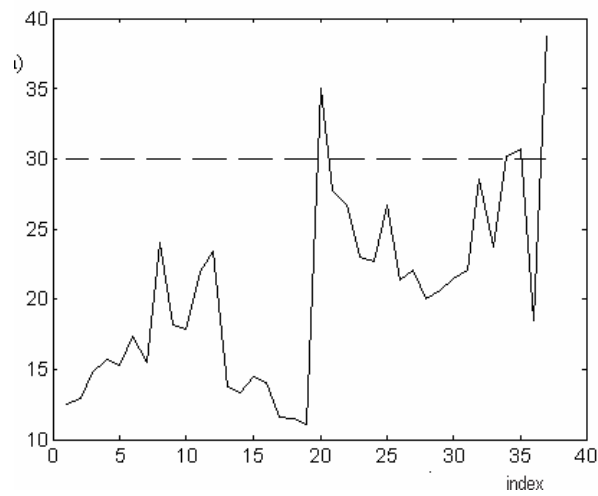


Fig. 5.- Drain spacing estimation by Dagan's method, treatment III ( $L=30$  m)

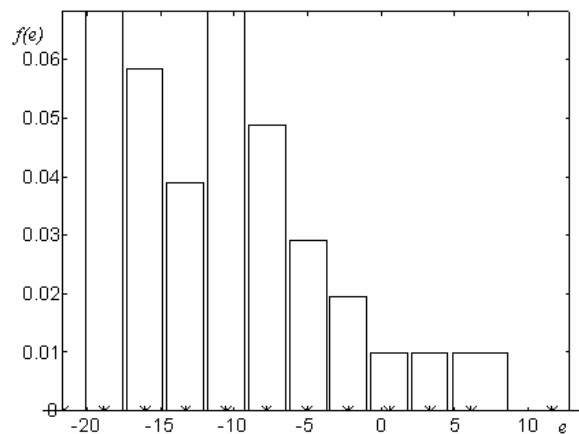


Fig. 6.- Histogram of error of estimation, treatment III ( $L=30$  m)

Statistical parameters of error obtained by estimating drain spacing in drainage treatments I, II and III by Dagan's and Kirkham's methods are presented in Table 2. According to the values of all parameters it comes out that Dagan's method better estimates drain spacing in all drainage treatments. The advantage of Dagan's method is especially meaningful in treatment I, hence narrower drain spacing.

T a b. 2. - Statistical parameters of error of estimation in all drainage treatments

Method	Mean error of estimation (m)	Median of error (m)	Mode of error (m)	Standard deviation of error (m)
Kirkham (treatment I)	-1.518	-2.424	-5.05	3.36
Dagan (treatment I)	-0.7066	-1.699	-4.577	3.681
Kirkham (treatment II)	-7.165	-8.378	-8.687	3.559
Dagan (treatment II)	-4.765	-6.205	-6.572	4.224
Kirkham (treatment III)	-12.18	-12.09	-20.35	5.906
Dagan (treatment III)	-9.46	-9.359	-18.88	6.807

## Conclusion

Dagan's and Kirkham's methods belong to the group of method for drain spacing determination in steady state water flow condition. Mutual characteristic of both methods is the assumption that drain spacing ( $L$ ) is linear function of water table depth and drain discharge ( $h/q$ ). The only difference can be distinguished in the values of  $F_k$  (Kirkham) and  $F_d$  (Dagan) coefficients. For estimation of drain spacing to dry out eugley type of soil better results have been obtained by Dagan's method in all treatments. The advantages of Dagan's method are shown through lower values of mean error estimation, median and mode. The advantage is marked when applied in over wetted soil when narrower drain spacing is needed.

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NEKE OSOBINE METODE DAGANA ZA ODREĐIVANJE  
RASTOJANJA IZMEDJU DRENOVA NA  
MOČVARNO-GLEJNOM ZEMLJIŠTU

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R e z i m e

Metod Dagan-a, kao i metod Kirkham-a spada u metode za određivanje rastojanja između drenova u uslovima stacionarnog režima filtracije. Obe ove metode zavisnost rastojanja između drenova, dubine podzemne vode i drenažnog isticanja prikazuju kao linearnu, pri čemu se razlikuju samo vrednosti koeficijenata. I jedna i druga metoda pokazuju tačnije procene u uslovima većih dubina podzemnih voda. Pri određivanju rastojanja između drenova u uslovima odvodnjavanja močvarno-glejnog zemljišta metoda Dagan-a pokazala je bolje rezultate na svim varijantama oglada. Prednosti metode Dagan-a se pokazuju kroz manje vrednosti srednje greške procene, medijane i mode greške. Prednosti metode Dagan-a naročito su izražene na drenažnom sistemu sa manjim rastojanjem između drenova.

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