Calculation of release time of water in soil layer

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Abstract. This article discusses the importance and principles of drainage system design in irrigated land. Weather and the type of cultivated crop are analyzed as the main factors for the drainage system. Also, since there is no single empirical formula for determining the duration of groundwater discharge through ditches for designing efficient and sustainable drainage systems in areas where water-saving irrigation technologies are introduced, a certain new method for determining this time is presented as a recommendation.

1 Introduction

Designing drainage systems requires considering the area's climatic and weather conditions. It is important to base the project on the system, taking into account the amount and intensity of the rainfall and the likelihood of extreme weather events such as storms or flooding.

To prevent flooding in areas with a lot of precipitation, drainage systems should be designed to serve as a large-scale water account. This includes installing larger pipes, digging deeper debris collectors, or building ponds for storing freshwater after irrigation.

In areas with frequent extreme weather conditions, drainage systems must withstand heavy loads and high water speeds. To increase the resistance of the system to flood or external natural forces, iron-concrete or steel pipe structures will be needed.

Additionally, drainage systems must be built from materials resistant to ultraviolet radiation and thermal expansion in regions with high temperatures and strong solar radiation. Failure to consider these factors will damage the system over time, leading to expensive maintenance and repair.

In general, climate and weather conditions play a crucial role in the design of effective drainage systems. Considering these factors will help ensure that the system works well and efficiently throughout its lifespan.

The type of crops grown in the design of the drainage system in agricultural areas is important. The water requirements and dehydration resistance of various crops vary, and a drainage system is developed as a system that serves to maintain soil moisture in the required amount to ensure the optimal growth of crops.

The design and installation of an effective drainage system on irrigated agricultural land are crucial in ensuring the optimal growth and yield of crops. The drainage system helps prevent anaerobic conditions in the soil, damage to the roots, and, as a result, the degradation of the crop.

Previous research on the design of drainage systems focuses on various aspects, including the evaluation of various drainage systems[4], their installation and operation[5,9], as well as the impact of land management methods on the operation of the drainage system[8]. The research also examined the impact of drainage systems on irrigated agricultural stability [1,2,6], water management, and soil quality [7,10,12].

Generally speaking, designing and installing modern technologies, such as geographic information systems (GIS) and remote bonding, helps work optimally in the design and planning of drainage systems[3,13].

In conclusion, the literature supports the importance of designing and installing effective drainage systems on irrigated land to achieve optimal crop growth and yield, water management, and soil stability. Simultaneously, further research is required in various regions to examine the exact factors that will also affect the design and implementation of optimal drainage systems.

Despite numerous scientific research and research in this area, it is the only one to determine the time when groundwater produced by saline washing will leave through debris. There is no analytical expression, which is calculated only by the ratio of the saline washing mechanism to the reseal module. Theoretically, such time determination sets the stage for bypassing several factors affecting groundwater flow movement.

In areas where resource-efficient technologies are introduced, we will consider a method to evaluate the dynamics of water levels.

Problem statement: One of the largest hydroelectric activities in agricultural areas is shoe washing activities. Shoe washing activities are carried out mainly during the novegetation period. When determining the amount of freshwater used to wash, you should consider the level of soil degradation, climate, and other factors. Water is known to be 2,500 to 3,000 square feet [2,500 to 3,000 m2]. Full water can be absorbed into the soil layer for 3-5 days. The issues surrounding how long the water absorbed into the earth's soil layer goes out through the drainage systems have not been adequately studied.

2 Methods

When the waterproof layer is horizontal, the water flow is parallel to it, and the comparative cost of unpressed grunt water entering the closed drainage pipe is determined by the Dyupi formula:

$$q = k_f \frac{H_1^2 - H_2^2}{2l}, \ \mathrm{m^2/day}; \tag{1}$$

where: q=Q/b; b is the length of a single drainage pipe network, m;
The distance between sections I, II, and the level of water level i,m;
l-I,II, compared to the H_1,H_2 comparison alignment;
k_f is filtration coefficient, m/day.

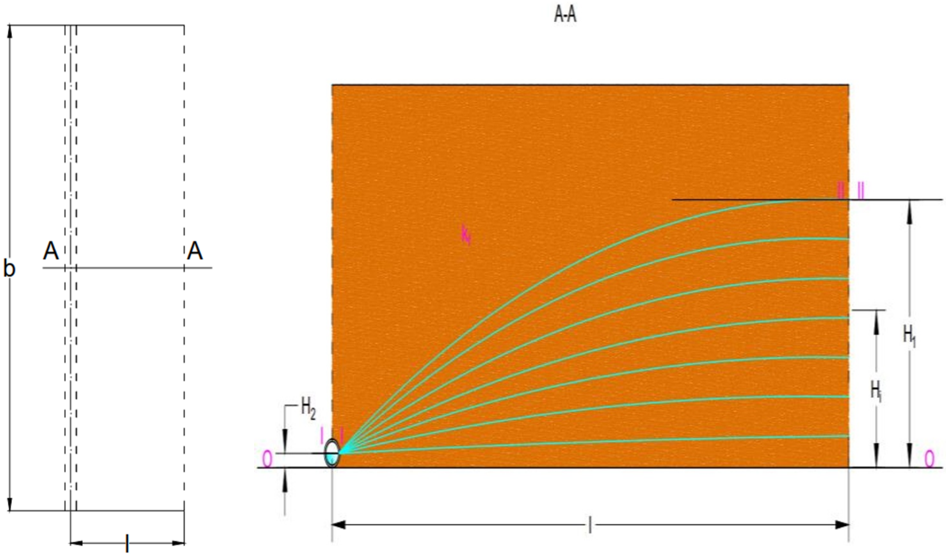

Fig. 1. Scheme explaining Dyupi formula

If we write down the flowrate of entering the drainage pipe by determining Q in a volume way:

$$Q = \frac{W}{t} = k_f \frac{H_1^2 - H_2^2}{2l} b, \text{ m}^2/\text{day}; \quad (2)$$

In each separate layer taken, we find the following private time that has gone to reduce the level of your water:

$$t_i = \frac{W_i 2l}{b k_f (H_i^2 - H_2^2)}, \text{ days}; \quad (3)$$

where: W i is separately obtained layers of water in soil pores:

$$W_i = (S_i - S_{i+1}) n b, \text{ m}^3; \quad (4)$$

H_i is the optional height between the two I,II sections, and the following are satisfied with inequality:

$$H_2 < H_i < H_1$$

n is soil pore;

$S_i = \int_0^{100} H_i = \sqrt[2]{\frac{l_i + C_i}{k_i}} dl$ is the surface of the aqueous layer that matches H i compared to the comparison alignment, m^2;

li=f(Hi)=$l_i = k_i {H_i}^2 - C_i$ is depression line equation, m;

$k_i = \frac{l}{H_i^2 - H_2^2}$ is equation coefficient, m^{-1};

$C_i = kH_2^2$ i-equation release hadi or unchanged number, m.

And the total time is found as follows:

$$T = \sum_{i=1}^{n} t_i, \text{ days}; \quad (5)$$

3 Results and Discussion

When the maximum depth of the depression ch trace is Hi=2.8 m Hi=1.6 m Hi=0.4 m, you are presented with a change in the level of your water between sections I and II, l=100 meters, and is selected for the chart listed in Figure 1 because of the calculations A graph of the change in the line of depression between sections I and II is provided. Table 4 provides depression line equations that match H max depths, so Table 5 shows that the reverse function of the depression line equation corresponding to each H max is clearly integrated from 0 to 100 meters. Table 6 determines the volume of sizot water between soil pores in sections I and II using formula 4, taking into account soil porousness, the surface of the water layer, and the length of a drainage pipe system, and the results are listed in the table. Table 7 calculated the private time taken for the decrease in sizot water level in each separate layer based on Formula 3. The results of the calculation are in the table, And the graph and scheme explaining the tables are given in Figures 3 and 4.

Table 1. Changing level of your water between Sections I and II when maximum depth of depression line is Hi=2.8 m

No.	**H i,m**	**k i,m-1**	**ki(H2)2,m**	**l i,m**
1	2,8	12,8	0,29	100,06
2	2,6	12,8	0,29	86,24
3	2,4	12,8	0,29	73,44
4	2,2	12,8	0,29	61,66
5	2	12,8	0,29	50,91
6	1,8	12,8	0,29	41,18
7	1,6	12,8	0,29	32,48
8	1,4	12,8	0,29	24,80
9	1,2	12,8	0,29	18,14
10	1	12,8	0,29	12,51
11	0,8	12,8	0,29	7,90
12	0,6	12,8	0,29	4,32
13	0,4	12,8	0,29	1,76
14	0,2	12,8	0,29	0,22
15	0,15	12,8	0,29	0,00
Hi=2.8 m				

Table 2. Changing level of your water between Sections I and II when maximum depth of depression line is Hi=1.6 m

No.	**H_i,m**	**k_i,m^{-1}**	**$k_i(H_2)^2$,m**	**l_i,m**
1	1,6	39,5	0,89	100,23
2	1,4	39,5	0,89	76,53
3	1,2	39,5	0,89	55,99
4	1	39,5	0,89	38,61
5	0,8	39,5	0,89	24,39
6	0,6	39,5	0,89	13,33
7	0,4	39,5	0,89	5,43
8	0,2	39,5	0,89	0,69
9	0,15	39,5	0,89	0,00
Hi=1.6 m				

Table 3. Changing level of your water between sections I and II when maximum depth of depression line is Hi=0.4 m

No.	**H_i,m**	**k_i,m^{-1}**	**$k_i(H_2)^2$,m**	**l_i,m**
1	1,6	39,5	0,89	100,23
2	1,4	39,5	0,89	76,53
3	1,2	39,5	0,89	55,99
Hi=0.4 m				

Table 4. Depression line Hmax depth matching depression line equations

No.	Depression Line Equation	H max,m
1	$l_i = 12.8H_i^2 - 0.29$	2.8
2	$l_i = 17.43H_i^2 - 0.39$	2.4
3	$l_i = 25.14H_i^2 - 0.56$	2.0
4	$l_i = 39.5H_i^2 - 0.89$	1.6
5	$l_i = 70.55H_i^2 - 1.59$	1.2
6	$l_i = 161.94H_i^2 - 3.64$	0.8
7	$l_i = 727.27H_i^2 - 16.36$	0.4

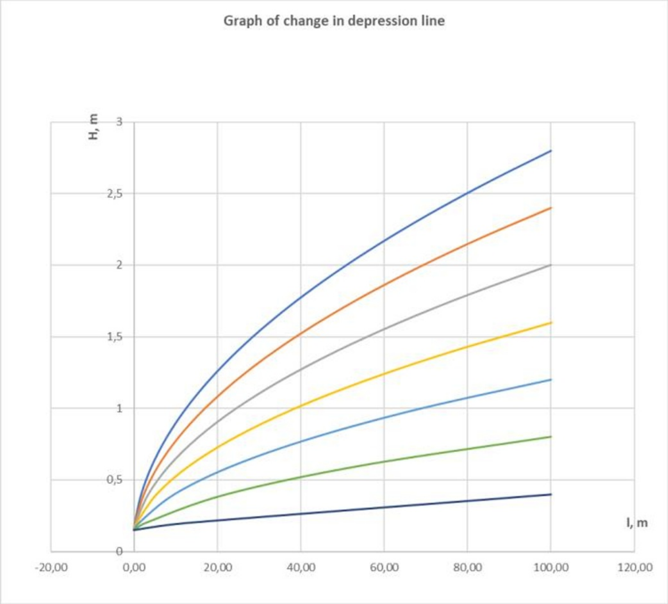

Figure 2. Graph of change in depression line between sections I and II

Table 5. Determination of surface of aqueous layer S i between sections I and II using depression equations

No.	Depression Line Equation	Hmax,m	The surface of the aqueous layer that matches Hmax compared to the comparison alignment—S_im2
1	$l_i = 12.8H_i^2 - 0.29$	2.8	$S_i = \int_0^{100} \sqrt{\frac{l_i + 0.29}{12.8}} dl = 187.21$
2	$l_i = 17.43H_i^2 - 0.39$	2.4	$S_i = \int_0^{100} \sqrt{\frac{l_i + 0.39}{17.43}} dl = 160.58$
3	$l_i = 25.14H_i^2 - 0.56$	2.0	$S_i = \int_0^{100} \sqrt{\frac{l_i + 0.56}{25.14}} dl = 134.02$
4	$l_i = 39.5H_i^2 - 0.89$	1.6	$S_i = \int_0^{100} \sqrt{\frac{l_i + 0.89}{39.5}} dl = 107.4$
5	$l_i = 70.55H_i^2 - 1.59$	1.2	$S_i = \int_0^{100} \sqrt{\frac{l_i + 1.59}{70.55}} dl = 81.11$

6	$l_i = 161.94H_i^2 - 3.64$	0.8	$S_i = \int_0^{100} \sqrt{\frac{l_i + 3.64}{161.94}} dl = 54.91$
7	$l_i = 727.27H_i^2 - 16.36$	0.4	$S_i = \int_0^{100} \sqrt{\frac{l_i + 16.36}{727.27}} dl = 29.39$

Table 6. Determine volume of sizot water between soil pores in Sections I and II

No.	S_i, m^2	n	b, m	W_i, m^3
1	187.21	0.261	400	2780.172
2	160.58	0.261	400	2772.864
3	134.02	0.261	400	2779.128
4	107.4	0.261	400	2744.676
5	81.11	0.261	400	2735.28

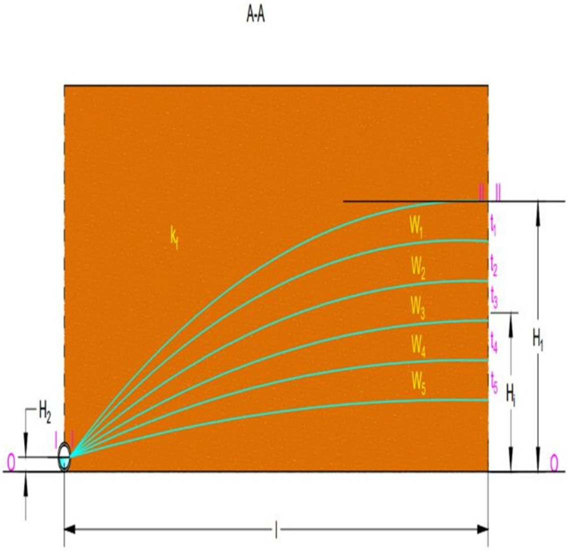

Figure 3. Scheme explaining calculation results in Tables 6 and 7

Table 7. Determine volume of sizot water between soil pores in Sections I and II

No.	Wi, m3	Hi, m	H2, m	l, m	b, m	kf, m/day	ti, days
1	2780.17	2.8	0.15	100	400	15	11.85
2	2772.86	2.4	0.15	100	400	15	16.11
3	2779.13	2	0.15	100	400	15	23.29
4	2744.68	1.6	0.15	100	400	15	36.05
5	2735.28	1.2	0.15	100	400	15	64.32
Total: $T = \sum_{i=1}^{n} t_i$							151.62

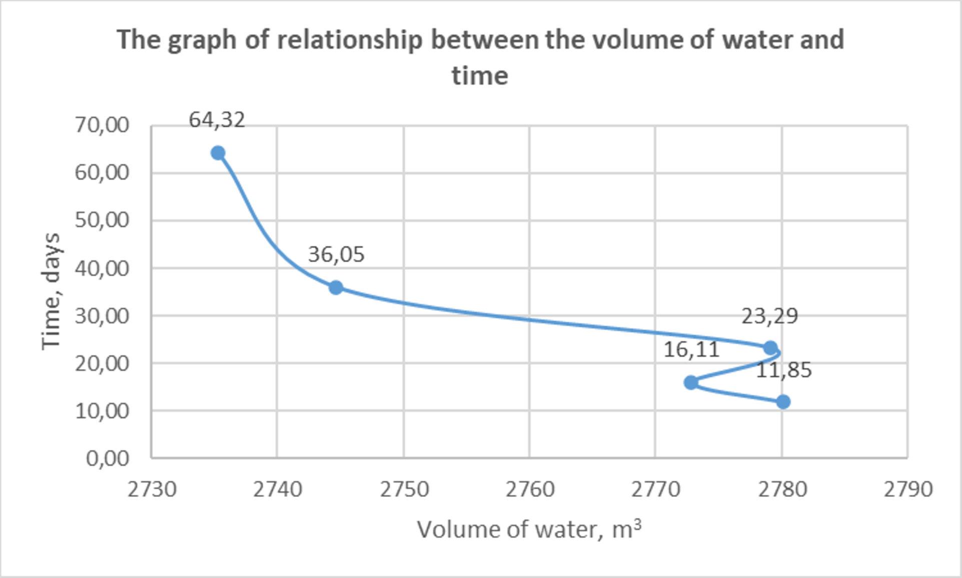

Figure 4. Graph of relationship between volume of water and time

4 Conclusions

As a rule, in diesel engines, with stable operation of fuel equipment and a sufficient reserve The article emphasizes the importance of climate and weather conditions in designing efficient drainage systems that can prevent flooding, withstand heavy loads and high water speeds, and resist natural forces. Drainage systems should be designed based on factors such as rainfall intensity, extreme weather events, soil types, land relief, water sources, and crop types. Effective drainage systems are necessary on irrigated land to ensure optimal crop growth and yield, water management, and soil stability. Although there are existing research and scientific studies, more research is necessary to examine the various factors affecting optimal drainage systems' design and implementation. Finally, in areas with resource-efficient technologies, it is essential to evaluate the dynamics of water levels to determine the optimal drainage system.

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