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# SOME PROPERTIES OF GUYON'S METHOD FOR DRAIN SPACING DETERMINATION ON THE MARSHY GLEY SOIL

**Nevenka Djurović[1] and Ružica Stričević[1]**

**Abstract:** The aim of this work is to show out some properties of Guyon's method for drain spacing determination in unstaedy state of flow. The analysis has been carried out in the marshy gley soil of the experimental field with drain spacing of 10 m, 20 m and 30 m. The method assumed modeled dynamics of water recharge, which hasn't been observed during the experimental trial. Therefore, its application is limited.

**Key words:** drainage, tile system, drain spacing, unsteady state of flow, water discharge.

## Introduction

Methods for drain spacing determination in unsteady state of flow assume that water inflow to the drains is very variable in time, as well as water pressure by which variable water discharge from the drains occurred. Water table depth is oscillating in time as a consequence of water loss (drain discharge, evaporation) and irregular water inflow (rainfall occurrence). In such unsteady state of water flow, variable velocity of water flow at any point of cross section causes variable drain discharge. Depletion of groundwater table depth to the desirable level is an agronomical criterion, depending on crop tolerance to the soil water saturation. Intensity of drainage is determined according to the number of days needed to complete water depletion process (water depletion from the level $ho_{(max)}$ to the $ht_{(min)}$ in time *t*. The aim of this work is to show out some properties of one method among others used for drain spacing determination in unsteady state of flow in marshy gley soil.

[1] Nevenka Djurović, PhD., Assistant Professor, Ružica Stričević, PhD., Associate Professor, Faculty of Agriculture, 11081 Belgrade-Zemun, Nemanjina 6, Serbia and Montenegro

## Materials and Methods

Drain discharge and groundwater table depth were measured at the drainage experimental field Radmilovac, near Belgrade. The drainage treatments I, II and III were set up on the marshy-gley soil type, on the total area of 1.5 ha, with 10 m, 20 m, and 30 m, respectively. The average drain depth was 0.9 m. The mean value of hydraulic conductivity was 0.6 m·day$^{-1}$, and equivalent drain depth on the treatments I, II and III were $d_1$=0.45m $d_2$=1.06m $d_3$=1.51m. Measured data have been analysed by the equation given by Guyon (Wesseling, ILRI III,IV)

$$L^2 = \frac{32Kdt}{\pi\mu}\left[\ln\frac{(2d+h_t)h_0}{(2d+h_0)h_t}\right]^{-1} \qquad (1)$$

where: $K$ – soil permeability (m/dan); $d$ – equivalent drain depth (m); $t$ – time of drainage (days); $\mu$ - drainage porosity (.); $h_0$ – maximal groundwater table depth; $h_t$- minimal level of depresion curve at the end of depletion process (m)

Using the Guyon's equation (1), it is not possible to calculate drainage spacing as an explicit function *L(q,K,h)*, therefore iteration has been applied.

## Results and Discussion

The results of the drain discharge and ground water table depth measurements from the three drainage treatments, selected by the previous analysis (Djurović, 1999) for the unsteady state of flow, are shown in Table 1. Chosen data fulfilled the assumed criterion of method such as: groundwater table depth oscillated during the period free of rainfall. The Guyion's method analysis has been based on these measurements.

Estimation of drain spacing on the treatment I is moved toward a higher value (Fig. 1) obtaining the mean value of error even 12.06 m, median of error 10.19 m and standard deviation 11.73. It can be explained that method for drain spacing estimation in unsteady state conditions assumes that the only rainfall and irrigation recharges the groundwater. Regarding that marshy gley soil contents abound in the amount of groundwater, there are some other underground water sources which have been neither measured nor taken into consideration.

Guyion's method explains groundwater depletion by fictive, wider drain spacing. The obtained value of mod of error is zero, which can be related to the phenomenon of very small value of estimation error that appeared most frequently in the series of estimation (Fig. 2). These results are very similar to those obtained by Glover Dumm's method, which was expected, being basically very similar. Yet, Glover'Dumm's method shows better results manifested by lower values of mean and median of estimation error in all three drainage (Djurović et al. 2000).

T a b.1. - Measurements in unsteady state of flow

| No | Date | $h_1$ (m) | $q_1$ (m/dan) | $h_2$ (m) | $q_2$ (m/dan) | $h_3$ (m) | $q_3$ (m/dan) |
|---|---|---|---|---|---|---|---|
| | January 13, 95 | 0.66 | 0.02461 | 0.76 | 0.2231 | 0.83 | 0.02142 |
| 1 | January 17, 95 | 0.47 | 0.01721 | 0.64 | 0.01636 | 0.60 | 0.01403 |
| 2 | January 21, 95 | 0.32 | 0.00801 | 0.41 | 0.00641 | 0.50 | 0.00643 |
| 3 | January 24, 95 | 0.27 | 0.00681 | 0.32 | 0.00422 | 0.39 | 0.00396 |
| | November 22, 95 | 0.47 | 0.01749 | 0.64 | 0.01602 | 0.69 | 0.01164 |
| 4 | November 26, 95 | 0.42 | 0.01146 | 0.5 | 0.00983 | 0.53 | 0.00844 |
| | January 8, 96 | 0.56 | 0.02047 | 0.71 | 0.02086 | 0.79 | 0.01871 |
| 5 | January 11, 96 | 0.51 | 0.02006 | 0.66 | 0.01815 | 0.76 | 0.01525 |
| 6 | January 15, 96 | 0.43 | 0.01279 | 0.51 | 0.01144 | 0,62 | 0.01003 |
| 7 | January 18, 96 | 0.15 | 0.01001 | 0.25 | 0.0317 | 0.36 | 0.00811 |
| | March 5, 96 | 0.43 | 0.01515 | 0.54 | 0.01079 | 0.56 | 0.01166 |
| 8 | March 8, 96 | 0.30 | 0.01397 | 0.49 | 0.00822 | 0.48 | 0.00764 |
| 9 | March 12, 96 | 0.11 | 0.01144 | 0.38 | 0.00401 | 0.40 | 0.00535 |
| | March 21, 96 | 0.15 | 0.00612 | 0.19 | 0.00235 | 0.25 | 0.00209 |
| 10 | March 25, 96 | 0.11 | 0.00343 | 0.11 | 0.0004 | 0.15 | 0.00218 |
| | November 2, 96 | 0.11 | 0.0031 | 0.09 | 0.00052 | 0.07 | 0.00091 |
| 11 | November 5, 96 | 0.09 | 0.0019 | 0.02 | 0.00011 | 0.03 | 0.00042 |
| 12 | November 9, 96 | 0.09 | 0.00098 | 0.02 | 0.00009 | 0 | 0.00009 |
| 13 | November 16, 96 | 0.02 | 0.00081 | 0 | 0.00003 | 0 | 0.00001 |
| | February 22, 97 | 0.52 | 0.00699 | | | 0.44 | 0.00631 |
| 14 | February 26, 97 | 0.41 | 0.00844 | 0.50 | 0.00906 | 0.41 | 0.00398 |
| 15 | March 2, 97 | 0.15 | 0.00413 | 0.46 | 0.00712 | 0.33 | 0.00419 |
| 16 | March 8, 97 | 0.14 | 0.00407 | 0.23 | 0.00261 | 0.15 | 0 |
| 17 | March 11, 97 | 0.10 | 0.00161 | 0.12 | 0.00091 | 0.01 | 0.00009 |
| 18 | March 14, 97 | 0.05 | 0.00099 | 0.05 | 0,00011 | 0 | 0.00001 |

Remarks: $h_{1,2,3}$- groundwater table depth measured above the axes of drain on the treatment I, II and III, $q_{1,2,3}$ – drainage discharge on the treatment I, II and III

Figures 1,3 and 5 show the estimation of drain spacing, obtained by Guyon's method, on the treatments I, II and III.

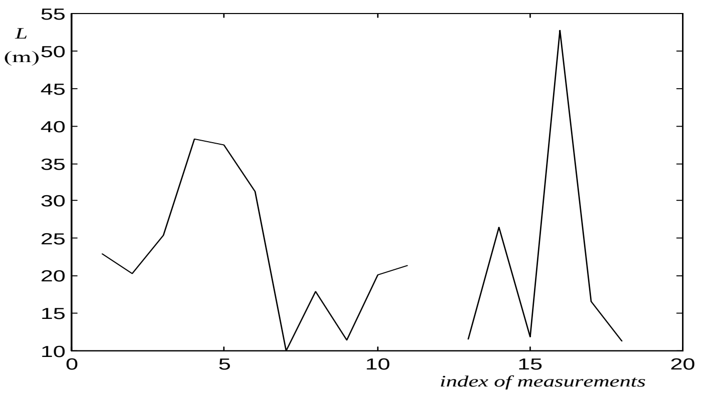


Fig. 1.- Drain spacing estimation by Guyon's method ($L$=10 m)

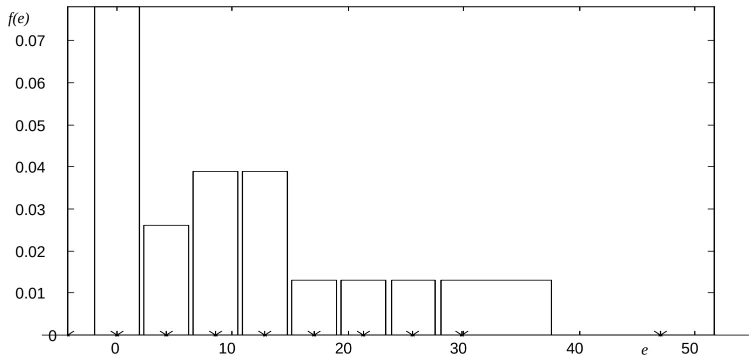


Fig. 2.- Histogram of estimation error by Guyon's method (*L*=10 m)

Note: *f*(e)-probability density function of *e*; *e* – error of drain spacing estimation

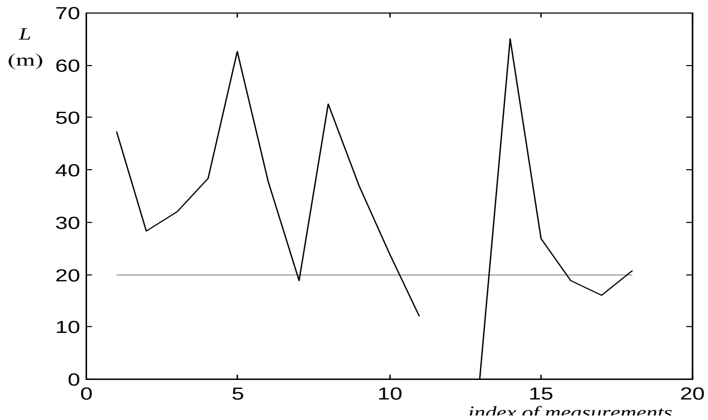


Fig. 3.- Drain spacing estimation by Guyon's method (*L*=20 m)

Similar explanation could be given for the drain spacing estimation on the drainage treatment II (Fig. 3). The value of mean estimation error is 11 m, median 7.6 m mode 6.9 m and standard deviation 17.42 m.

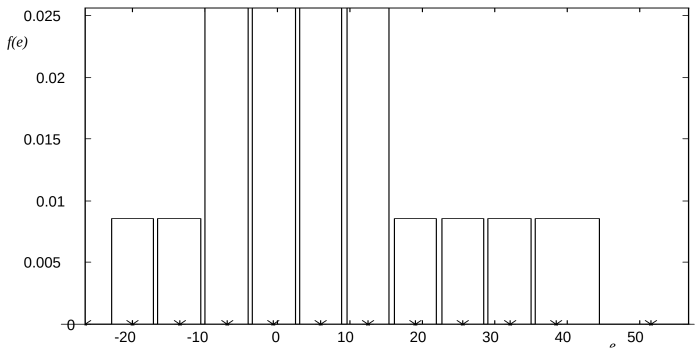


Fig. 4.- Histogram of estimation error by Guyon’s method (*L*=20m)

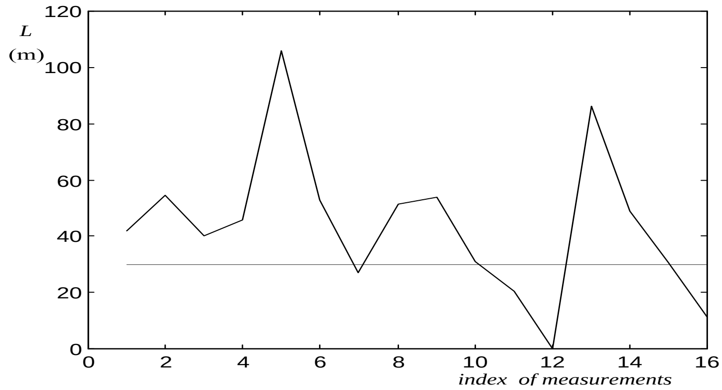


Fig. 5.- Drain spacing estimation by Guyon’s method (*L*=30 m)

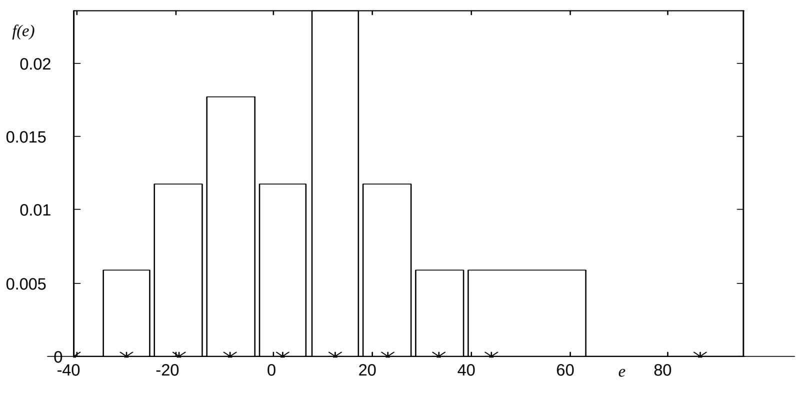


Fig. 6 .- Histogram of estimation error by Guyon’s method (*L*=30 m)

On the drainage treatment III (Fig.5), the value of mean estimation error and median is 13.9 m, and standard deviation reaches the value of 26.09 m. Histogram of error (Fig. 6) does not show the concentration toward value zero. Water inflow can be considered uncontrolled. Regarding that soil contents abound in the amount of groundwater, there are some effects that the model does not assume. Depletion of groundwater table level in the interval free of rainfall is much slower than it should be without extra ground water inflow. These results are in concordance with those obtained in different regions. (Murashima and Ogino, 1991), where priority was given to the methods of steady flow water assumption.

## Conclusion

Applicable methods for drain spacing determination in unsteady state of flow assume only water inflow from the rainfall or irrigation. Regarding that marshy-gley soil contents abound in the amount of water, it means that there are some extra groundwater inflows besides rainfall or irrigation. Guyon's method explains water table depletion by fictive, wider drain spacing, but it is less precise compared with Glover'Dumm's, eventhough they are basically similar. This property of Guyon's method limits its application. The obtained results show weak drain spacing estimation, which leads to the conclusion that this method should not be used in unsteady state of flow in marshy-gley soil.

## REFERENCES

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1. ILRI III (1980): Drainage principles and Application Vol. III: Surveys and investigation. Wageningen, The Netherlands.
2. ILRI IV (1980): Drainage principles and Application Vol. IV: Design and management of drainage systems. Wageningen, The Netherlands.
3. Murashima, K., Ogino, Y. (1992): Comparative Study on Steady and Non-Steady state Formulae of Subsurface Drain Spacing. Bulletin of the University of Osaka Prefecture, Series B, Vol. 44, pp 41-48.
4. Wesselng, J. (1974): Drainage Principles and Practices, Vol. II ILRI Wageningen. The Netherlands.
5. Djurović, N., Stričević, R., Gajić, B. (2004): Some constraints on the application of methods for drain spacing determination in unsteady-state of flow in eugley soil, Journal of Agricultural Sciences Vol. 45, No 2, 2000, pp 83-91.

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# NEKE OSOBINE METODE GUYON-A ZA ODREDJIVANJE RASTOJANJA IZMEDJU DRENOVA NA MOČVARNO-GLEJNOM ZEMLJIŠTU

**Nevenka Djurović[1] i Ružica Stričević[1]**


## R e z i m e

Cilj ovog rada je da prikaže neke osobine primene metode Guyon-a za odredjivanje rastojanja izmedju drenova u nestacionarnom režimu filtracije. Analiza je izvedena na primeru močvarno-glejnog zemljišta, na drenažnom sistemu sa rastojanjima izmedju drenova 10, 20 i 30 metara.

Metode primenljive u uslovima nestacionarnog režima filtracije podrazumevaju da doticaja osim merenog, dakle padavina ili navodnjavanja, nema. S obzirom da močvarno-glejno zemljište obiluje podzemnim vodama, postoje doticaji koji nisu obuhvaćeni niti kroz padavine, niti kroz navodnjavanje. Metoda Guyon-a smanjenje dubine podzemnih voda pokušava da obrazloži fiktivnim, većim rastojanjem izmedju drenova, i manje je uspešna nego metoda Glover-Duma, sa kojom ima velike sličnosti. Ova osobina metode Guyon-a je veoma veliko ograničenje u primeni, te se konačno može zaključiti da na močvarno-glejnim zemljištima ova metoda ne daje zadovoljavajuće rezultate.


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[1] Dr Nevenka Djurović, docent, dr Ružica Stričević, vanredni profesor, Poljoprivredni fakultet , 11081 Beograd-Zemun, Nemanjina 6, Srbija i Crna Gora