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EMPIRIC VERIFICATION OF THE "SWATREZ" MODEL UNDER CONDITIONS AT THE "HAJDÓW' EXPERIMENTAL RESEARCH STATION

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A b s t r a c t. This article presents the initial results of field research conducted at the "Hajdów" experimental research station near Lublin.

Measurements show groundwater levels over a 1 month period, compared with the calculation results obtained by the "SWATREZ simulation model over the same period.

K e y w o r d s: soil physics, water movement simulation

INTRODUCTION

One of the methods for the prognosis of soil moisture conditions is the use of mathematical models. The simulation of phenomena occurring in a soil-plant-atmosphere system makes it possible to estimate the work of any improvement systems from the design stage alone, or as in this case, after the failure of the investment.

Many models can be used to improve design, but verification is still unsatisfactory. The "SWATREZ model was verified by Brandyk among others [1].

The present paper, although small in scope, continues verification of the work.

OBJECT OF THE RESEARCH

The "Hajdów" experimental research station is situated near the City of Lublin in the Bystrzyca River valley. The system of waste water purification integrated with the irrigation of industrial crops [3] was tested here. The melioration system installed together with stable moisture conditions played an important role. The research was conducted over 21 separate fields with various drainage system and

plants. For the purposes of this paper, only four of them were chosen – fields 6A, 6B, 7A and 7B, where grass was under cultivation. The drainage parameters are as follows: spacing 20 m, diameter 50 mm, deep 1.1 m (for field 6) and 1.5 (for field 7). The letter "A" signifies that this field was not irrigated. The letter "B" – that the fields were irrigated by waste water from the "Hajdów" treatment plant.

Soil at the "Hajdów station is organic in origin, mainly peat. The detailed soil parameterisation (pF curve, water conductivity etc.) was done based on archive data for MtI bc soil, received from the Lublin Institute of Land Reclamation and Grassland Farming. Using reference data in place of field experiments has a major bearing on the quality of the simulation results received.

Unfortunately, during the simulation work, the authors were not in possession of the results of these experiments.

Additionally, in the simulation process, the authors had used meteorological data, from the meteorological station installed at the experimental research station (temperature, rain, humidity, wind) and from the Lublin-Radawiec station (insulation).

The experimental object was equipped with net of observation wells and piezometers. The specifics of the mathematical model presented in this article, only need verification of the research wells in the middle of the drainage. Measurements indicate the levels of the groundwater table, taken daily at 9 a.m., during the 1st. month – May 1997.

SIMULATION MODEL

For moisture conditions and groundwater level simulation in selected soil profiles, the authors chose the "SWATREZ" model – as elaborated by Feddes, Kowalik and Zaradny [2] based on the Richard equation with source factor:

$$\frac{\partial h}{\partial t} = \frac{1}{C(h)} \frac{\partial}{\partial x}\left[k(h)\left(\frac{\partial h}{\partial z} + 1 \right)\right] - \frac{S(h)}{C(h)} \tag{1}$$

where: h – soil water potential, t – time, $C(h)$ – differential water capacity, $K(h)$ – water conductivity, z – vertical co-ordinate, $S(h)$ source factor (transpiration etc.).

A description of the entire model is included in the Feddes, Kowalik and Zaradny work [2]. Using this model makes it possible to simulate moisture change dynamics in the soil profile when considering parameters of the soil, the plants, meteorological conditions and the improvement system.

SIMULATION RESULTS

Figure 1 presents the ground water level obtained by simulation calculations and their comparison with measurement data. As can be seen, in spite of the inaccurate input of essential data (i.e., soil parameters), the calculation results are very similar to the measurement data. During the measurement period – on the 15^{th} and 16^{th} day – a failure of the irrigation system occurred. There was uncontrolled irrigation of field "A" by breaches in the dykes in field "B". Thus a correct estimation of irrigation amounts was impossible.

In order to better present the verification of the simulation results, the authors made a few minor statistical calculations, and minimised the standard error:

$$S = \frac{1}{n}\sqrt{\sum_{i=1}^{n}(h^i_{meas} - h^i_{calc})^2} \tag{2}$$

and average deviation:

$$\alpha = \frac{1}{n}\sum_{i=1}^{n}\left|h^i_{meas} - h^i_{calc}\right| \tag{3}$$

where: h^i_{meas} – measured groundwater level, h^i_{calc} – groundwater level calculated by simulation model, n – number of observations.

The results of the calculation are collected in Table 1.

Table 1. The standard error and average deviation, as measured and calculated by the "SWATREZ model, groundwater levels

Specification	Field			
	6A	6B	7A	7B
	(cm)			
Standard error	11.2	4.8	6.4	12.7
Average deviation	14.1	7.0	8.4	16.4

CONCLUSIONS

It seems that in spite of the inaccuracy of the soil parameterisation, the simulation results are quite a good approximation of the measurement data. If this is the case, the model can be used in practical applications in land reclamation. Of course, it is very necessary to continue the verification commenced. A single month of measurement, along with the irrigation failure, doesn't give sufficient

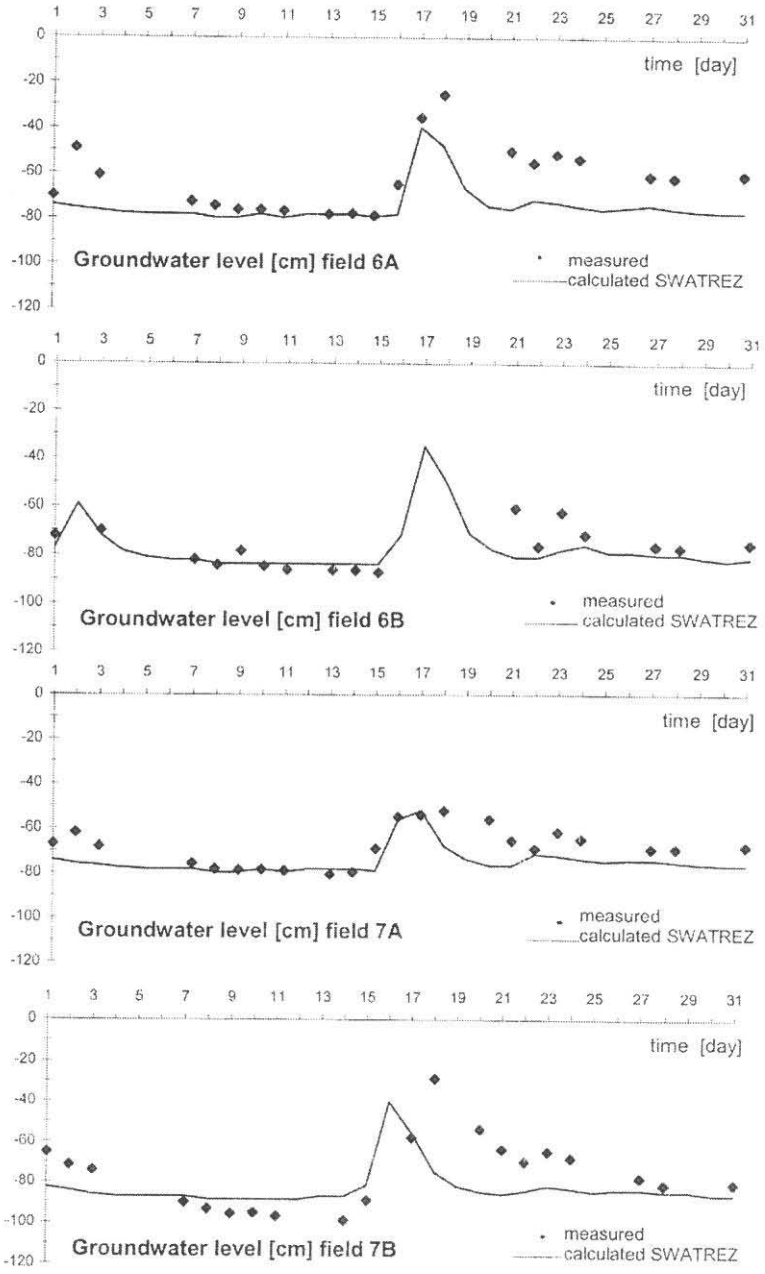

Fig. 1. Comparison of groundwater levels obtained by simulation and field measurements

verification material. It is also necessary to obtain proper soil parameterisation data. The "SWATREZ model also simulates plant growth. In future, the authors of this article would like to extend their verification work to this parameter.

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EMPIRYCZNA WERYFIKACJA MODELU "SWATREZ" W WARUNKACH OBIEKTU EKSPERYMENTALNEGO "HAJDÓW"

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S t r e s z c z e n i e. Artykuł prezentuje wstępną weryfikację modelu SWATREZ, w warunkach obiektu eksperymentalnego Hajdów, zlokalizowanego w okolicach Lublina. Weryfikacja obejmowała wyniki obliczeń symulacyjnych głębokości zwierciadła wody gruntowej, w okresie jednego miesiąca. Autorzy, wykazując dużą zgodność wyników symulacji z pomiarami polowymi, wskazują na konieczność szczegółowego rozpoznania własności fizyko-wodnych profilu glebowego.

S ł o w a k l u c z o w e. fizyka gleby, symulacja ruchu wody, model SWATREZ