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STAGES OF MODELING THE FILTERING OF GROUND WATERS TO THE DRAINS OF THE RURAL DRAINAGE

Field studies of drainage systems operating in the over moistened zone of Ukraine show that a large part of them does not work as planned by the project and does not provide the necessary water-air regime of agricultural land soils [1]. As a result, we have unfavorable hydrological conditions for crop cultivation. In particular, the main consequences of untimely removal of excess soil moisture include:

- Untimely implementation of agrotechnical measures (plowing, sowing, application of fertilizers, etc.), in particular due to the impossibility of the equipment entering the field [2].
- Destruction of the soil structure, including mechanically, by agricultural machinery [3].
- Intensive development of pathogenic bacteria (Club Root in brassicas, Foot Rot of leguminous plants and other diseases also flourish on wet land), [4].
- Plants and their roots do not develop, and in a dry period the roots are not able to provide the plant with moisture [4].
- And also poor response to fertilizers, uneven crop growth, harvesting problems, restrictions on grazing, [4] etc.

In many cases, the incorrect operation of the drainage occurs as a result of failure to take into account during the design of certain conditions that were present, but were not detected, or these conditions arose from the time the drainage system began to be operated [1]. These unaccounted factors led to a change in the mode of filtering water to the drains, and the system gradually left the design mode of operation.

Modern studies of modes of filtration of groundwater to drains are developing in the following directions:

- Modeling of groundwater filtration to drains – use of mathematical models and computer programs to determine the parameters of groundwater filtration to drainage systems. This allows you to refine calculations and predict the behavior of the system in various conditions.
- Use of geographic information systems (GIS) to analyze groundwater filtration to drains. This allows for a more accurate analysis of soil properties and hydrological processes, which facilitates the design and operation of the drainage system.
- Study of the influence of climatic changes on filtration - temperature, precipitation and other climatic conditions that change the level of groundwater and the mode of its filtration in the direction of drains.
- Research of possible agrochemical pollution, to assess the risks of contamination of drainage waters and to develop measures to reduce them.
- Study of the impact of drainage systems on biological diversity and ecological sustainability to determine possible negative consequences for the environment and develop measures to reduce them.

Modeling of groundwater filtration to drainage systems should be carried out in several stages:

1. Collection and analysis of data on hydrology and hydrogeology: At this stage, data are collected on climatic factors (precipitation, evaporation, etc.), soil properties, geological features of the area and topography. These data are used to create a hydrogeological layer model. Service [5] can be useful.
2. Creating the geometry of the model: The geometry of the model is a three-dimensional representation of the hydrogeological layer. This geometry can be created using specialized modeling programs, such as [6].
3. Setting Boundary Conditions: Boundary conditions determine how the water will interact with the boundaries of the model. These conditions may include subsurface and surface runoff and catchments.
4. Purpose of filtration parameters: Filtration parameters determine how water will move through the soil. These parameters may include hydraulic conductivity, porosity, and aquifer boundaries.
5. Modeling the filtration process: At this stage, calculations are made to determine how water will move through the soil and reach drainage systems. These calculations are performed using numerical methods and simulation programs.
6. Analysis of results: The results of modeling of groundwater filtration into drainage systems should be analyzed and interpreted in order to draw conclusions about the effectiveness of the drainage system and suggest possible improvements.

Different mathematical models and computer programs are used to simulate groundwater filtration to drainage systems (stages 4 – 5). The modeling of groundwater filtration to drains may include the following stages:

1. Determination of soil characteristics – for modeling, it is necessary to know the characteristics of the soil, such as porosity, permeability and water resistance or sufosis.
2. Determination of hydrological conditions – modeling should take into account hydrological conditions, such as the level of groundwater, its direction of movement and filtration rate.
3. Creation of a mathematical model – based on data on the soil and hydrological conditions, a mathematical model is created that describes the movement of water in the soil and its filtration to the drainage system, for example, taking into account the placement of drains at different levels [7].
4. Selection of the appropriate or development of a new computer program – a computer program is created based on the mathematical model, which allows numerical modeling of groundwater filtration to the drainage system.

It is often used to simulate filtration processes in the soil Forchheimer equation. The Forchheimer equation describes the steady-state flow of fluid through a porous medium. There are many computer programs that use the Forchheimer equation to model fluid flow through porous media. Some examples include [8]:

1. COMSOL Multiphysics - a commercial software package that can simulate a wide range of physical phenomena, including fluid flow through porous media [9].
2. OpenFOAM (OpenCFD Ltd) - a free, open-source software package for computational fluid dynamics (CFD), which includes models for porous media flow that use the Forchheimer equation [10].

3. PHREEQC (USGS) - a geochemical modeling software package that includes capabilities for simulating groundwater flow through porous media using the Forchheimer equation [11].

4. TOUGH2 (Lawrence Berkeley National Laboratory) - a numerical simulation software for modeling fluid and heat flow through porous and fractured media, which includes models for Forchheimer flow [12].

5. MODFLOW (USGS) - a widely used software package for simulating groundwater flow and solute transport in porous media, which includes options for using the Forchheimer equation to model non-Darcy flow.

These are just a few examples of the many computer programs that use the Forchheimer equation.

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