Software Principles for Mapping the Relative State of Groundwater

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Annotation: The article begins with an acquaintance with the modern level of drinking water supply in the world, determining the hydrogeological parameters of the hydrosphere of groundwater in single and double layers, creating algorithms for forecasting and monitoring the dynamics of underground aquifers, and integrating hydrogeological modelling processes. Monitoring issues, statistics and information on research institutions working in this area. The article describes the creation of information and forecast maps of groundwater, comparison of relative level coefficients only on the basis of chronological homogeneous series of observations, monitoring of source consumption for regime characteristics and development of software for determining groundwater levels as average long-term maximum and minimum levels. and its results are presented.

Keywords: Algorithm, software, groundwater, mathematical modelling, prediction maps.

Introduction.

The groundwater regime should reflect the main regional groundwater level laws in order to compile information and forecast maps. These requirements are met by the indicator of the relative state of groundwater levels, which is determined by the formula for each point: the longer the observation, the more accurate the coefficient. Therefore, long-term computational work on carrying out short-term observations for drawing up information and forecast maps of the regime is of great importance.

Algorithmic part of the program. Besides, λ_H it is advisable to determine the observation coefficient for the period, since the groundwater regime is characterized by a long-term rhythm. Comparison of the coefficients of the relative position of the level is quite effective only when they are calculated from a chronologically homogeneous series of observations.

$$\lambda_f = \frac{H_i - H_{\min}}{H_{\max} - H_{\min}} \tag{1}$$

here Hi – average annual level of the current year;

Hmax, Hmin – maximum and minimum annual levels for the entire observation period.

To characterize the mode, observation of the flow of springs is used, in this case

$$\lambda_Q = \frac{Q_i - Q_{\min}}{Q_{\max} - Q_{\min}} \tag{2}$$

here Qi – spring spending for this year;

Qmax, Qmin – maximum and minimum average annual expenditures for the observation period.

In these equations Hmax – Hmin and Qmax-Qmin – perennial amplitudes. The latter serves as a measure of the variability of surface vibration or groundwater flow. Therefore it is normalized (perennial amplitude shares) coefficients λ_H (or λ_Q) shows that, what part of the multiyear amplitude. This year represents the minimum value of the water table this year (spring run off) or observation period. When creating forecast maps λ_H calculated predictive level, *H*max *and H*min while - values observed over many years. In long-term observations λ_H the coefficient can be calculated as a percentage of the standard deviation.

In this case, (1) the formula looks like this, λ_H from 0 till 1 changes. The coefficient λ_H equal to zero ($H_i = H_{min}$). This year's level is the lowest in many years of the situation, $\lambda_H=1(H_i = H_{max})$ its value is approaching a multi-year maximum.

The coefficient λ_H reliability largely depends on the duration of observations at each point as a characteristic of the state of the level: the longer the observation, the greater the value of the coefficient.

Algorithm for creating maps. Computational work based on long-term observations or short-term observations is of great importance for the creation of information and forecast maps.

In addition, the coefficient λ_H is advisable to determine according to observations relating only to one period, since the regime of groundwater is characterized by long-term rhythm, i.e. the duration of observations should be a homogeneous series (20, 30 years, etc.).

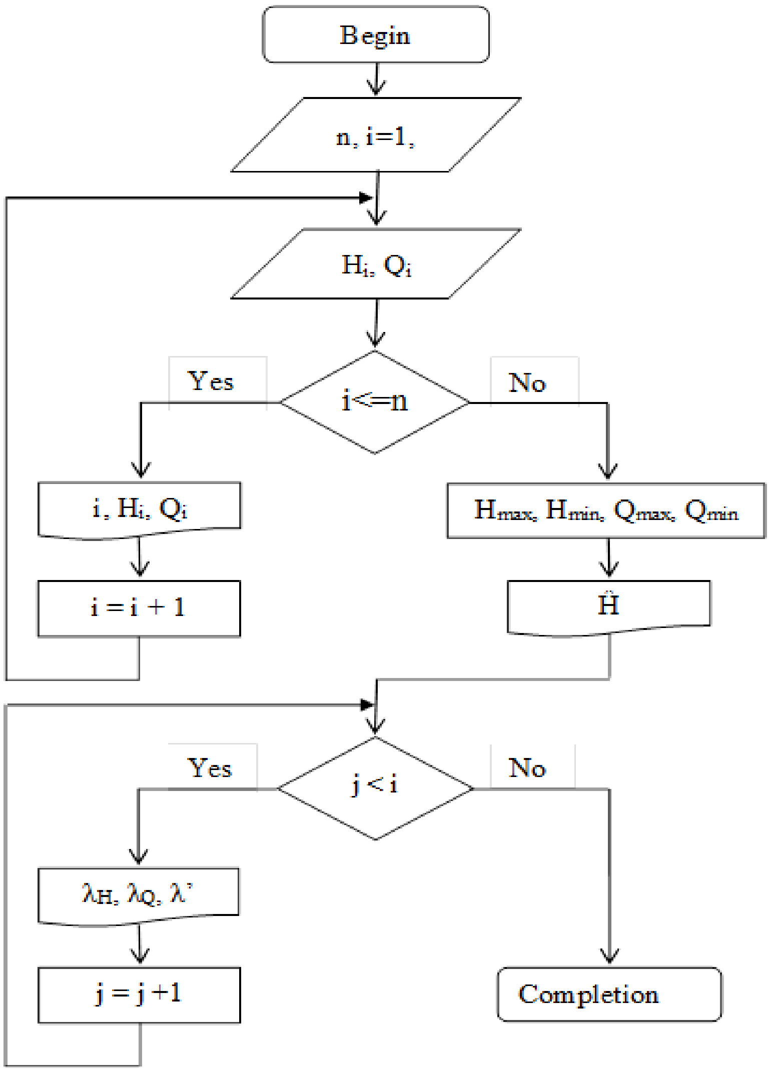
Thus, the groundwater levels from formula (1) are determined as the average value of the long-term maximum and minimum levels. Such a permutation is valid only for signs that obey the normal distribution law. In other cases, the coefficient λ_H The relative position of the sum and the average corresponds to multi-year levels $\lambda_{i}^{'}$ Having calculated the coefficient, it will be possible to control it using the formula below

$$\lambda_{i}^{'} = \frac{H_i - \overline{H}}{H_{\max} - H_{\min}}, \qquad (3)$$

here $\overline{H}$ - Average long-term volume (norm) of the groundwater level as the average of all values of the chronological series.

The coefficient $\lambda_{i}^{'}$ what fraction of the multiyear amplitude t.This year shows that the level of this year will deviate from the average level of the observation period. $\lambda_{i}^{'}$ = 0 depending on the level of groundwater in a year, it is at a long-term mark.

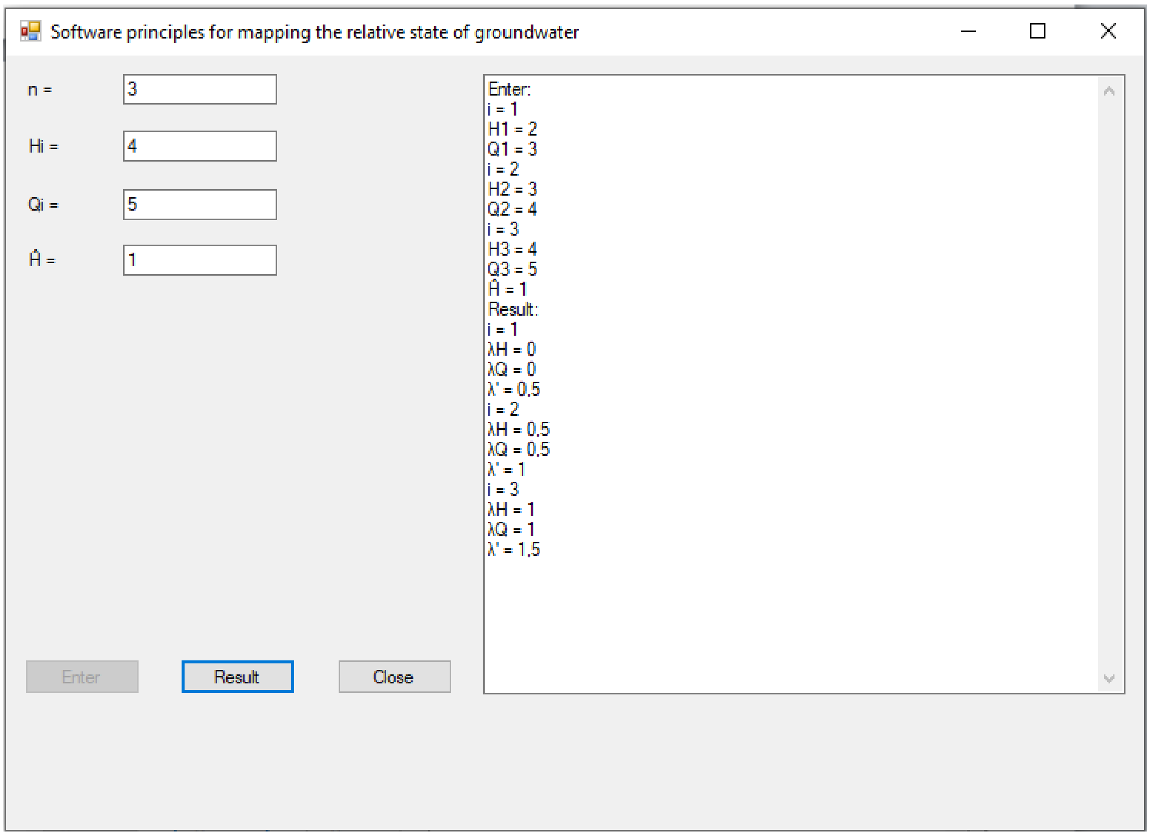
So if $\lambda_H = 0{,}5$, $\lambda_{i}^{'} = 0$ depending on the level of groundwater, the average long-term depth per year. Based on the algorithms described above, the block diagram of the program looks like this (1.Picture.):



1.Picture. ***Block diagram of the principles of constructing a map of the mutual arrangement of groundwater.***

The flowchart algorithm makes it possible to compile maps of the relative state of groundwater based on the average annual level for the year, the maximum and minimum average annual levels for the entire observation period, spring discharge per year, maximum and minimum average annual discharge for the observation period.

Result. n some cases, fluctuations in the groundwater surface do not obey the normal distribution law. However, histograms often have relatively minor skewness that λ_H limits the value. Experimental work shows that for practical purposes, the calculation of this coefficient according to (1) is completely expedient, since when constructing maps of the relative levels of the situation λ_H in a wide range, for example, 0.2–0.4 or 0.4–0.6, and h. turns out (Picture.2.).



2.Picture. Program window of the results of mapping trends in the relative state of groundwater.

Conclusion

The creation of software for the results of the principles of mapping the relative state of groundwater was carried out on the basis of the following algorithms**:**

• Comparison of the coefficients of the relative position of the groundwater level only by calculating them from chronologically homogeneous series of observations;

• Algorithm for tracking the flow of springs according to the characteristics of the groundwater regime;

• Determination of the groundwater level as the average long-term maximum and minimum levels.

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