Statement of the Problem (Task) of Optimization of Mode Irrigation

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Abstract

At first, planning the development of the separate areas of Georgia is necessary, alongside with other factors, to consider the opportunity to receive the needed quantity and quality of water. The task of water distribution is formulated so: at the presence of a deficiency of water in a pool from the examined river, it is necessary to find the optimum size deficiency waters paid to consumers within a given pool, and the optimality is understood at least the sums of economic damages at the set size of deficiency.

A new approach to answer the question of water-distribution should determine the tendencies in designing and creating the automated irrigation system by factors of the life of the plants providing reception of stable high crops of agricultural crops, close to their biological potential. It is necessary to note, that research on the technical perfection of ameliorative systems is being done continuously. In the process of developing a science there is improvement in the design of the system as a whole, and its separate elements. One of the major problems for the operation of irrigation systems it is the organization of the optimum control of distribution of deficient water resources. Such management can be carried out as soon as the automated control systems for water distribution are created.

The production function reflects the dependence of a crop's size on the volume of water allocated for its irrigation, which varies from year to year and from field to field—as it is related to soil fertility and meteorological conditions. Besides this, even under fixed conditions of an environment with the presence of a deficiency of water resources for crops, essential influence renders a mode of an irrigation. Terms and rates enamel that cause statement and decisions for the task of optimizing the mode of irrigation with a deficiency of water resources.

მორწყვის რეჟიმის ოპტიმიზაციის ამოცანის დადგენა და განხილვა

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საქართველოს უნივერსიტეტი

საქართველოს ცალკეული რაიონების და რეგიონების განვითარების პერსპექტიული დაგეგმარების მიზნით აუცილებელია სხვა ფაქტორების გვერდით გათვალისწინებული იქნეს წყლის საჭირო რაოდენობისა და ხარისხის მიღების შესაძლებლობები.

წყლის რესურსების განაწილების ამოცანა ფორმულირდება შემდეგი სახით: განსახილველი მდინარის აუზში წყლის დეფიციტის არსებობის დროს აუცილებელია მოცემულ აუზში მდებარე მომხმარებლებისათვის წყლის მიუწოდებლობის ოპტიმალური ზომის მოძებნა, თანაც ოპტიმალურობა გაგებულ უნდა იყოს როგორც სახალხო სამეურნეო დანაკარგების ჯამის მინიმუმი, მოცემული დეფიციტის სიდიდის პირობებში.

წყალგანაწილების საკითხების მიმართ ახალი მიდგომა უნდა იყოს პროექტირებაში ტენდენციების და მცენარეთა სიცოცხლის ფაქტორების ავტომატიზირებული სარწყავი სისტემების კომპლექსური მართვის შექმნის განმსაზღვრელი, რომელიც უზრუნველყოფს სასოფლო-სამეურნეო კულტურების მათ ბიოლოგიურ პოტენციალთან ახლოს მდგომ, სტაბილურად მაღალი მოსავლიანობის მიღებას.

უნდა აღინიშნოს, რომ კვლევები მელიორაციული სისტემების ტექნიკური სრულყოფისათვის ტარდება განუწყვეტლივ. მეცნიერების განვითარებასთან ერთად ხორციელდება კონსტრუქციების გაუმჯობესება როგორც სისტემებისა მთლიანობაში, ასევე მათი ცალკეული ელემენტების.

სარწყავი სისტემების ექსპლუატაციის ერთ-ერთ უმნიშვნელო-ვანეს ამოცანას წყლის რესურსების განაწილებისას წარმოადგენს ოპტიმალური მართვის ორგანიზაცია მათი დეფიციტის დროს. ასეთი მართვა შესაძლოა განხორციელდეს მხოლოდ წყალგანაწილების მართვის ავტომატიზირებული სისტემების შექმნით.

საწარმოო ფუნქცია, რომელიც ასახავს სასოფლო-სამეურნეო კულტურის მოსავლიანობის სიდიდის დამოკიდებულებას მის სარწყავად გამოყოფილი წყლის მოცულობაზე, იცვლება წლიდან წლამდე და მინდვრიდან მინდორზე, რადგან ის დაკავშირებულია ნიადაგის მოსავლიანობაზე და მეტეოროლოგიურ პირობებზე. გარდა ამისა, გარემოს წინასწარ ფიქსირებული პირობების და წყლის რესურსების დეფიციტის არსებობის დროსაც კი მოსავალზე არსებით გავლენას ახდენს მორწყვის რეჟიმი, ანუ მორწყვის ვადები და ნორმები, რაც წყლის რესურსების დეფიციტის დროს მორწყვის რეჟიმის ოპტიმიზაციის ამოცანის დაყენების და გადაწყვეტის აუცილებლობას იწვევს.

Considering, that the purpose of cultivating agricultural fields is the reception of a quantity of a biomass of one or several bodies of a plant, the description growth process – accumulation of a biomass – is the major component of the formation of a crop.

The process of accumulation of a biomass of an agricultural crop is described by system residual the equations (I) with discrete time.

$$\left.\begin{aligned}
&M^*(\tau+1)=M^*(\tau)+\alpha^*\sum_{j=1}^{l}m_j+\sum_{i=1}^{n-1}b_i\hat{M}_i(\tau),\\
&\hat{M}_i(\tau+1)=(1-b_i-v_i)\hat{M}_i(\tau)+\alpha_i\sum_{j=1}^{l}m_j,\\
&M_i(\tau+1)=(1-\omega_i)M_i(\tau)+\alpha_i\sum_{j=1}^{l}m_j-b_i\hat{M}_i(\tau),\\
&L_j(\tau+1)=(1-g_j)L_j(\tau)+\beta_j\sum_{j=1}^{l}m_j,
\end{aligned}\right\} \qquad (I)$$

$$i\in I,\quad |I|=n,\quad j\in J,\quad |J|=l,\quad J\subset I,$$

$$\alpha^*+\sum_{i=1}^{n-1}\alpha_i\equiv 1,\quad (\alpha^*,\alpha_i,\beta_j,b_i,v_i,g_j,\omega_i)\ge 0.$$

Thus factors entering into the equations – parameters of the efficiency, being are known for functions of time and conditions of an environment. Parameters of efficiency $S=(\alpha_i,\alpha^*,\beta_j,b_i,v_i,g_j,\rho)$ have sizes which are distinct from zero on the limited interval of time:

$$S=\begin{cases}0, & \tau\le\tau_i \ \text{და} \ \tau\ge\bar{\tau}_i,\\ S_{(\tau),} & \tau_i<\tau<\bar{\tau}_{i,}\end{cases} \qquad (II)$$

Where the moments of time τ_i and $\bar{\tau}_i$ also correspond to the beginning and end of the growth of i-that body and are defined by means of model of development.

The behavior of an object of management – an agricultural crop agrocoenosis, connected with the formation of a crop—is described by its(his) mathematical model.

“All biological blocks of model consider dependence of process of accumulation of a biomass of crops on factors of an environment. Into number of these factors enter: photosynthetic the active radiation Q coming on a surface of crop, average daily temperature of air in crop t, humidity root-inhabited a layer of ground ω, fertility of ground

η_{Π}, additional fertility due to application of fertilizers η".

Formally, the task of optimizating a mode of irrigation with one operating parameter – daily volume of the water φ submitted on the irrigated site—can be formulated as follows:

To define the determined discrete function $\varphi(\tau),\ \tau \in [\underline{\tau}, \overline{\tau}]$, satisfying to restrictions

$$\sum_{\underline{\tau}}^{\overline{\tau}} \varphi(\tau) \leq \Phi, \qquad 0 \leq \varphi(\tau) \leq \varphi^0, \qquad (III)$$

So that at the decision

$$x(\tau) = \left\{M^*(\tau);\ M_1(\tau),\ldots,M_n(\tau);\ \hat{M}_1(\tau),\ldots,\hat{M}_n(\tau);\ L_1(\tau),\ldots,L_n(\tau);\ w(\tau)\right\}$$

Systems difference, the equations (I) and models of the geophysical blocks, meeting entry conditions

$$x(\underline{\tau}) = \underline{x}, \qquad (IV)$$

The population mean $R[M^*(\overline{\tau})]$ of a biomass $M^*(\overline{\tau})$ of economic-useful body in the end of the vegetative period $\tau = \overline{\tau}$ was maximal, i.e.

$$R[M^*(\overline{\tau})] \to \max \qquad (V)$$

Here Φ – size of irrigating norm (rate), $\Phi = V/\omega$. V – total volume of water which it is necessary to submit for a time interval $\overline{\tau} - \underline{\tau}$ on an irrigated field; ω – the area of an irrigated field; j^O – the maximal daily volume of submitted water on a floor(field); $\overline{\tau}$ - the moment of sowing.

One of the basic features of agricultural production is that when predicting the results of its functioning, the degree of uncertainty is high. This uncertainty has an objective character. Such feature of a branch demands application of specific principles and forms of planning and management.

Record of criterion of efficiency in the form of (V) assumes, that in a problem (task) of definition of "optimum strategy all uncontrollable factors have the stochastic nature". First of all it is total radiation $Q(\tau)$, temperature of air $t(\tau)$, total evaporation $E(\tau)$, the atmospheric $\theta(\tau)$, precipitation modeled by discrete casual processes; in second the turn is uncertainty of a vector of entry conditions of a condition of object of management.

The information on factors of an environment can be set doubly: in the determined form – in the form of the realization of casual processes and in the stochastic form – and in the form of casual processes with the set laws of distribution.

However, information on the weather, in any form makes it impossible to depend on good prospects for weather to really be carried out.

In connection with that that in the entrance information the source of significant mistakes (errors) is covered, there is a necessity regularly, in process of receipt of the new entrance information to correct (adjust) the plan, differently in other words, realizing operational planning of a mode of an irrigation.

Operational planning of a mode of an irrigation during the moment of time $\tau = \tau_0,\ \underline{\tau} \le \tau_0 < \overline{\tau}$ represents the decision of a problem (task) (III) – (V) optimization of a mode of the irrigation, meeting the entry condition

$$x(\tau_0) = x_0 \qquad (VI)$$

Measurement a component of a vector x_0 during the moment of time $\tau = \tau_0$ represents a labor-consuming problem. As a rule, "The accuracy of such measurement low, that forces to consider x_0 as a casual vector with, Gaussian distribution." To simplify the process of measurement, in particular for its automation, it is of interest to determine lightly measuring parameters of plants and an environment. Having connected their functional connections with phase coordinates, so that the measured values of these parameters received by the moment of time τ, have formulated an estimation of values of a vector of phase coordinates during the moment of time τ .

Statement of and a decision about the problem of supervision, filtration and optimization of the program of irrigation allow the construction actually optimum mode of an irrigation $\varphi_\Phi(\tau),\ \tau_0 \le \tau < \overline{\tau}$ and dependence

From size of irrigating norm (rate) F, $0 \le \Phi < \infty$ and actually optimum mode of the irrigation $\varphi_{\Phi}(\tau)$ corresponding(meeting) fixed value of parameter F, to an allocated field for the period $\overline{\tau}-\tau_0$.

Sizes y and F are the specific characteristics carried to unit of the area of the irrigated field. Having defined (determined) a quantity of pairs their values $\Phi(\tau_0)\to y$ for the moment τ_0 , it is possible to construct function of communication (connection) of total gathering of production Y from all irrigated field ω_0 the area with volume of the water $V(\tau_0)$ submitted on a floor(field) for the period $\tau_0 \div \overline{\tau}$:

$$y=\max R[M^*(\tau)]=y(\Phi) \qquad (VII)$$

Thus

$$Y=Y[V(\tau_0)] \qquad (VIII)$$

$$Y=y^{\omega_0} \qquad (IX)$$

$$V(\tau_0)=\Phi(\tau_0)\omega_0 \qquad (X)$$

Function (VIII) represents for fixed τ_0 and at absence of sources of natural humidifying, the concave-convex curve certain in an interval $0\le V<V_0$.

“Depending on a zone in which the agricultural crop and consequently, from a degree of natural humidifying function can be *Y = Y (V) t*ransformed is grown up”.

Considering, that the system, by which process of formation of a crop is described, is dynamic, the finding of optimum control of it is challenging enough. It becomes necessary to estimate available approaches for its decision and to choose the most comprehensible.

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