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Assessment of Climate Evolution Trends and Updating Water Requirements in Fântânele-Şagu-Arad Irrigation Systems,in order to Rehabilitate - Refurbishment

Man T. E.[1], Gabor A[2], Orlescu M.C.[1], Coput F[3] , Meriu D[4]

Abstract - **This paper addresses the following issues: assessment of climate evolution trends and also updating water requirements in Fântânele Şagu Arad irrigation systems.**

The paper shows dynamic agri zoning after Berbecel in the parameters, positive temperature sum as annual multi-values and average annual rainfall amount, the area fits in moderate humid area, while the work indicates the MAI concept (Moisture Adequacy Index) by G. Hargreaves highlighting the gradually effect of water shortage on agricultural production depending on rainfall to provide 75% and reference evapotranspiration.

In the second part of the work shown recalculation reveals water to the irrigation system, according to the methodology [7], ensuring climate deficit by E. Manole by assessing the net irrigation rate and consumption by evapotranspiration during the growing season.

The paper ends with a case study for Fântânele-Sagu-Arad irrigation system, respectively irrigation water needs updating for irrigation from the base station of the arrangements with data obtained by calculations of the case study.

Keywords: irrigation systems, climate evolution, climatic shortage, irrigation rate, rehabilitation.

1. INTRODUCTION

Fântânele-Sagu-Arad irrigation system, is located in south east, respectively south of Arad city, south of the Mures river. The area is characterized by an half arid climate, or humid, subject to desertification and is included in the surface of 40% of the agricultural area of Romania.

In terms of aridity index (α), the perimeter fall within the area of the dry and moderate dry humidity type (by Donciu) where the ratio of precipitation (P) and potential evapotranspiration (PET).

The complex of factors that gave rise to the infrastructure of this improvemenet, after about 50 years from commissioning, while the drought has intensified in the area, winds were intensified, so the increasing aridity index indicate a higher moisture deficit of the Fântânele-Sagu-Arad area. However land improvement surface at macro level is part of the Pannonian Plain, respectively south - east of this plain.

Drought presence and ariditation area are determined both by natural causes, that small amounts of rainfall or lack of rainfall for long periods of time, or lack of rainfall in critical periods for crop development.

Also likely anthropogenic factors, such as irrational deforestation plus programs ill-conceived to increase arable, ultimately increasing deforestation, together with the effects of global warming have led to accelerating ariditation and desertification.

In the past 20 years meteorological situation due global climate change, drought in Romania has become normal, imposing the application of irrigation.

Therefore all across the country may be affected by drought, in varying degrees of intensity and for longer periods or shorter, situation in which is Fântânele-Sagu-Arad irrigation improvement.

Dry years are years when rainfall is deficient, that the total rainfall is below average multi considered normal and rainfall distribution during the growing season is poor, insufficient compared with agricultural requirements.

Changes in climate regime of Romania within the global context and not shown to be good changes for the western country surfaces future, respectively territory on which is located Fântânele-Sagu-Arad improvement, area that we study.

These changes in time require recalculation of climate evaluation and so updating water quantity for irrigation application for the rehabilitation and refurbishment of this irrigation system.

2. ASSESSMENT OF CLIMATE TREND - THEORETICAL CALCULATION ISSUES [6.7]

[1]"Politehnica" University of Timisoara, Faculty of Hydrotechnical Engineering, George Enescu Street, no.1A, Zip cod 300022, Timisoara, Romania, e-mail: eugentman@gmail.com

Fântânele Şagu Arad irrigation system from climatic point of view fall in the temperate zone where the temperature is 6-9 months per year over 10°C and type of climate is moderately dry where α=0,51-0,92 is calculated using the formula [7]:

α= P/Etp (1.1.)

where: α- aridity index

ETp- reference evapotranspiration

P – rainfall

Another way of expressing the clime quality, in relation to requirements for agricrop in Romania is agrodinamic zoning desing by Berbecel in 1983 on the basis of two parameters: ∑t = sum of positive temperatures that average annual values (°C/ year) and ∑P = average annual rainfall (mm /year). From this point of view Fântânele Şagu Arad irrigation system fall in the moderate - humid with ∑t = 3400-4000 °C/ year and ∑P = 550-650mm/year. Irrigation is needed in this area and covers the most part of the area with furnished potential for irrigation.

In half arid - wet areas irrigation is a temporary character or or addition of soil water deficit.

Globally lately appeared another index, denoted by the symbol MAI (Moisture Adequacy Index) proposed by G. Hargreaves [7]. By this index show highlight gradual effect of water deficiency on agricultural production for a given climate and expressed as the ratio between fallen precipitation value ensuring 75% (P_{75}) and the reference evapotranspiration (ETp):

$$\text{MAI}=\frac{P_{75}}{ETp} \quad (1.2)$$

The author of this index recommends for parameter calculation P_{75} relationship:

P_{75} = Pm - 0,74 x SD

(1.2.1)

In the event that Pm > 0,3 x ETp, where:

Pm – represent arithmetic mean of recorded values range;

SD - standard deviation (deviation) calculated for the range of values of recorded rainfall.

These classification criteria have been established on the basis of several researches conducted for different crops, according to empirical equation:

$$y= 0,8 \cdot x + 1,3 \cdot x^2 - 1,1 \cdot x^3 \quad (1.3)$$

where:

$$y= \frac{y_1}{y_{max}} \quad \text{si } x = \text{MAI}$$

yi = agricultural production value corresponding to one value of the index (x = MAI);

ymax = maximum value of agricultural production of one crop.

It is interesting to follow relationship behavior 1.3 compared with values (x) which resulting the limits.

For x=0 → P_{75}= 0 and production yi=0;

For x=0,3 →

$$y=\frac{y_i}{y_{max}} = 0,327 \rightarrow y_i \cong \frac{1}{3} y_{max};$$

For =1 → P_{75}=Etp and y=1, which means that production is maximum (y_i=y_{max});

For x=1,33 →

$$y=\frac{y_i}{y_{max}} = 0,77 \rightarrow y_i \cong 0,77 \cdot y_{max};$$

Noted that the usefulness of presented indices is to evaluate the degree of necessity of introducing irrigation in a particular climate zone and its nature (continuous or temporary). These indices can not substitute the setting of irrigation water requirements at different levels of insurance.

By Manole E. [7], resulting the following conclusions:

- in warm-season, there is an increasing trend of climatic deficit (Δ=P-ET_p) in time, exceeding the annual average of around Decade V - VI of the past century. This can be taken as a confirmation of the fact that in the area is a widening trend of global drought during the irrigation season.

- climate deficit development is different in the months of the warm period, result that biggest growth trend in the deficit occurs in July, then in June and September. The calculation is made for case study of Fântânele Şagu Arad irrigation system.

2.1. Methods for recalculation water needs for irrigation

The exploatation phase of the irrigation system, appealing to standard assessment net irrigation (M_o) and consumption by evapotranspiration (ET_r) for each calendar month from vegetation period of each crop (period April-September).

Evapotranspiration process complexity and coverage sources (in the atmosphere, soil, and irrigation), requires that methods of calculation (based on probabilistic models) to be based on multiannual research for every crop and pedoclimatic zone.

To this objective, a Romanian school was done for scientific research of water consumption after the Second World War. Based on these results were substantiated technical solutions for sizing our irrigation systems. Who founded this school is Mark Botzan academician, having famous successors, namely Nicolae Grumeza, Oleg Merculiev, Cornel Tuşa, Klepş Cristian, etc.

Water balance equation in an open circuit (Af=O), used by research institutions in the network of experimental fields for a given crop and during a calendar month is after Manole E. [7]

$$ETR_o=\Delta R + P + M \quad (1.4)$$

where:

ETR_o is actually optimal consumption through evapotranspiration of a crop, obtained by equation (1.4) from direct measurements of parameters ΔR, P and M:

$\Delta R = R_i - R_f$ is the variation of water reserve of soil in balance;

R_i - is the initial reserve of water in the soil, determined by gravimetric method, at the beginning of the calculation month;

R_f - is the final reserve of water in the soil, at the end of the calculation month;

P – represent the gross monthly rainfall, fallen and recorded at a weather station or research field;

M – is gross monthly norm of irrigation, volumetric measured and applied in experimental fields.

It is recognized that both monthly irrigation rates (M) and gross monthly precipitation (P) can not be fully used by plants, that leading to an overstatement of monthly water consumption (ETR_o) determined with the relationship 1.4. Therefore, it is necessary to correct the relationship 1.4 by acceptance and use of two parameters: irrigation net rate (M_o) and useful rainfall (P_u), defined:

M_o - net irrigation monthly rate, entirely consumed by evapotranspiration

P_u - useful monthly precipitation, entirely consumed by the evapotranspiration process

If we consider that the efficiency with which irrigation monthly rate (M) was applied in the experimental fields is (η_a), then the first correction of the equation is:

$$\eta_a = \frac{M_0}{M} \Rightarrow M = \frac{M_0}{\eta_a}, \eta_a < 1$$

where: η_a – efficiency with which irrigation monthly norm (M) was applied in experimental fields

M- monthly irrigation rate

M_o- monthly net irrigation rate

The second correction is the recovery coefficient introduction of recorded monthly rainfall, namely:

$$c_v = \frac{P_u}{P} \Rightarrow P = \frac{P_u}{c_v}, c_v < 1$$

where: c_v- recovery coefficient of rainfall

P- gross monthly rainfall

P_u- useful monthly rainfall

By introducing the coefficients (c_v) and (η_a) is obtain the correct form of balance equations:

$$ETr = \Delta R + C_v \cdot P + \eta_a \cdot M \qquad (1.5)$$

In which ETr, is the real monthly consumption through evapotranspiration of a crop < ETRo.

Relationship has reason to improve the accuracy of evaluation calculations of actual monthly consumption (ETr) and implicitly of the net irrigation rate (Mo), because together, present the research parameter values in the professional literature for the past 50 years.

Since the meteorological data used to climatic potential evapotranspiration calculation are recorded in much higher periods, through mean values that connecting real with climatic parameters (measured during the research period) it is extrapolate the range of sequence data throughout weather station. In this respect it increases the accuracy of fixing the Mo or ETr value.

Thus, for a crop, ETRo obtained from equation in the (j) month of the(n) year related to potential evapotranspiration (ETp) calculated for the same month (j) of the same year (n) by weighting of the crop (dc) :

$$dc = \frac{ETR_0}{ET_p} \qquad (1.6)$$

again indicating that ETp is the potential or reference evapotranspiration, calculated on climate data recorded at the same time (month and year) to the execution of direct measurements on actual consumption ETRo.

From relations of the calculation of (ETp) are using climatic parameters in Romania, has adapted Thornthwaite equation (which using the mean values of monthly temperature and latitude weather station). Relationship (ETp) adapted to calculate the coefficient (dc), gains the name of climate reference potential evapotranspiration. At the end of a research cycle (10-25 years) for a crop, resulting a correction coefficient (dc) specific to this crop and to the calculation month by the arithmetic mean of multi-string values. These values are published in our professional literature. With this coefficient can extrapolate the actual monthly consumption values (ETRo) throughout data of the influence meteorological station.

To determine the relationship between soil water reserves (ΔR) and reference potential evapotranspiration (ETp) is introduced the coefficient of soil (ds) as a coefficient indicating the contribution rate of water from soil to cover consumption by evapotranspiration calculated in experimental fields (ETRo):

$$ds = \frac{\Delta R}{ETR_0} \text{ sau } ds = \frac{\Delta R}{dc \cdot ETp}$$

The coefficient values (dc) and (ds) are or may result from special publications.

Knowing these coefficients the two relations become:

$$dc \cdot ETp = ds \cdot dc \cdot ETp + P + M \qquad (1.4')$$

$$ETr = ds \cdot dc \cdot ETp + c_v P + \eta_a M \qquad (1.5')$$

From the equation, results:

$$dc \cdot Etp = ds \cdot d \cdot Etp + P + \frac{M}{\eta_a} \qquad (1.6')$$

which, costum for a crop and calculation month (j) becomes:

$$(Mo)_j = \eta_a[dc \cdot Etp_j\ (1\text{-}ds) - P_j] \qquad (1.6'')$$

From equation (1.6) determine the net monthly irrigation norm (Mo).

To determine the level of assurance of this rate (Mo) is used chronologically balance method which involves:

- calculation is made separately for each crop;
- using equation (1.6.) Mo is calculated for each month of years of analysis (N), resulting ETp;
- net monthly rates totals for each year (i) of string (N) (sum of the Mo values from the months IV - IX);

- obtained values are descending orders after summation ;

- year is identified for each sum of ordered column;

- unsurpassed providing is calculated with the formula of Cegodaev:

$$An_i \cong 100 \cdot \frac{N - i + 0{,}7}{N + 0{,}4} (\%)$$

- sum values are determined to calculation insurance and corresponding to that year are considered the values of monthly net rates at the level of such insurance;

- likewise, one can determine the net monthly norm at a certain level of insurance for a month (July) in the range of years.

Manole E. [7] proposed a new method for calculating climate deficit insurance, which will cover the following issues and methodology:

-Since the sequence of years (N> 25) there are data from the meteorological station of influence area over the irrigation system to be analyzed, it was called the "climate deficit" (Δ=ETp-P) for calculation of two parameters (Mo and ETr). The relationship between irrigation net monthly rate and climate deficit is:

$M_0 = k(ETp - P) = k \cdot \Delta$

And for the actual monthly consumption ETr: ETR:

$Etr = \lambda \cdot (ETp - P) = \lambda \cdot \Delta$

- Ariditation or moisture index (α), by Manole E.[7]:

$$\alpha = \frac{P}{ETp}$$

- the factor (k), determined by Manole E.[7]:

$$k = \eta_a \frac{dc(1 - ds) - \alpha}{1 - \alpha}$$

- the coefficien (λ) determined by Manole E. [7] as:

$$\lambda = k + \frac{ds \cdot dc + c_v \alpha}{1 - \alpha} \qquad (1.7.)$$

Atmospheric (climatic) factors governing the consumption through evapotranspiration are integrated into climate deficit Δ=ETp-P, which monthly varies throughout the number of years (N). But, at the same climate state deficit (Δ), each crop is influenced differently so as consumption rate (ETr) and such through irrigation required rate (Mo), influence expressed by the two parameters (k) and (λ).

Therefore, ensuring calculation applies only to determine the value Δ=ETp-P at two levels of insurance:

- insurance of not exceeding the deficit, by 80%, with values distributed over the months IV-IX, required hydraulic and structural sizing of the system for the month with a maximum consumption of irrigation water (in July) and check the volume to the source;

- insurance of not exceeding the deficit, by 50%, with values distributed over the months IV-IX required calculation base fof technical and economic efficiency, of system construction and equipment, and multi exploitation parameters: the net irrigation water consumption, average energy consumption for pumping water, average annual expenditure for maintenance and repairs, etc.

The advantage of this method is that it determines the level of insurance for climate deficit (Δ) then the net irrigation rate is calculated for each crop.

Manole E. [7] introduced a coefficient (dc') like this form:

$$dc' = \eta_a[dc(1 - ds) - \alpha] + ds \cdot dc + c_v \alpha \qquad (1.8)$$

If ds ≈ 0 (texture N) →

$dc' = \eta_a[dc - \alpha] + c_v \alpha \rightarrow$

$$dc' = \eta_a \left[dc - \alpha \left(1 - \frac{c_v}{\eta_a} \right) \right] \qquad (1.8')$$

By Manole E. [7] to assess the recovery coefficients of precipitation fallen recommended equation (1.9).

$$1 > c_v > \eta_a - dc \frac{(1 - ds) \cdot \eta_a + ds}{\alpha} \qquad (1.9)$$

Relation (1.9) allow the evaluation of precipitation fallen recovery rate if known: dc, ds, η_a and α.

From the difference of the two correction coefficients (dc - dc ') results:

$$dc \cdot ETp = \Delta R + P + \frac{M_0}{\eta_a}$$

$$dc' \cdot ETp = \Delta R + c_v P + M_0 \big|_{-1}$$

$$(dc - dc') \cdot ETp = (1 - c_v)P + M_0 \left(\frac{1}{\eta_a} - 1\right) \text{ or}$$

$$dc - dc' = (1 - c_v)\alpha + \frac{M_0}{ETp} \cdot \left(\frac{1}{\eta_a} - 1 \right) \qquad (1.10)$$

Appealing to the formula: $M_o = k(ETp - P) = k \cdot \Delta$ and substituting the value (k) of equation (1.10) will result this form of expression:

$$dc - dc' = (1 - c_v)\alpha + k(1 - \alpha) \cdot \left(\frac{1}{\eta_a} - 1 \right) \qquad (1.10.1)$$

If knowledge of all parameters of equation (1.10.1.), net irrigation norm (Mo) by Manole E. [7] can be evaluated by chronological balance method, too, based on the following relationship:

$$M_0 = \frac{(dc - dc') - (1 - c_v)\alpha}{\left(\frac{1}{\eta_a} - 1 \right)} \cdot ETp \qquad (1.11)$$

To recalculate the required water for irrigation, of the climate evolution trend appear the problem of determining the difference between designed irrigation rates by chronological balance method (based on equation 1.4) and that addressed according to equation 1.5.

Through method based on equation (1.4.), ΔR canceled between successive two months whereas the final reserve (R_f) of the calculation month become the initial reserve (R_i) of the month following, so this method does not appeal to the coefficient (ds).

$$M=ETRo-P$$
$$M=dc \cdot Etp-P$$
$$M=dc \cdot ETp(1-\alpha) \quad (1.12)$$
$$Mo=k\Delta=k(Etp-P)$$
$$Mo=k(1-\alpha)ETp \quad (1.13)$$

Note the difference (δ) expressed as a percentage of the rate (M) as follows:

$$\delta = \frac{M - M_0}{M} \cdot 100 \rightarrow \delta = \left(1 - \frac{M_0}{M}\right) \cdot 100 \quad ,(1.14)$$

where M_o and M replacing the above relations we obtain:

$$\delta = \left[1 - \frac{k(1-\alpha)}{dc(1-\alpha)}\right] \cdot 100 \rightarrow \delta = \left(1 - \frac{k}{dc}\right) \cdot 100$$

$$sau: \delta = \left(1 - \eta_a \frac{dc(1-ds)-\alpha}{dc(1-\alpha)}\right) \cdot 100$$

$$\delta = \left(1 - \eta_a \frac{1 - \left(ds + \frac{\alpha}{dc}\right)}{1-\alpha}\right) \cdot 100, (\% \text{ din M}) \quad (1.15)$$

2.2. Case study for Fântânele Şagu Arad irrigation system - data determined in experimental field Arad on the study of climate evolution figure (1.1) [5]

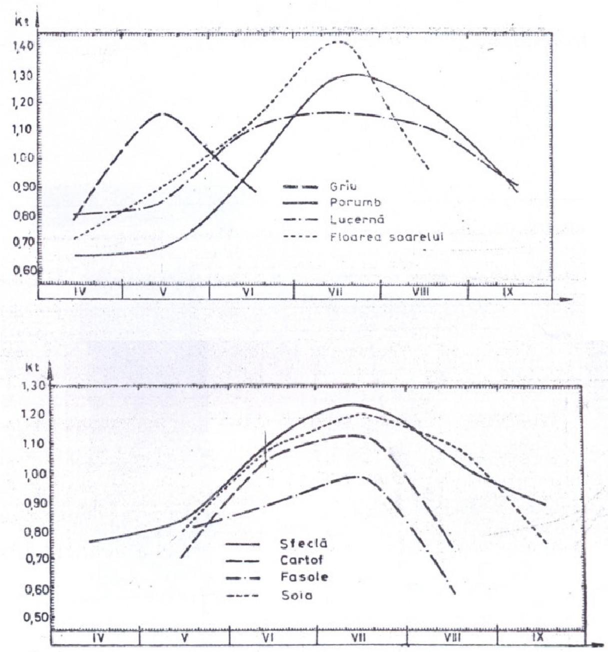

Fig.1.1. Graphs of transformation coefficients (K_t) determined in the experimental field of Arad

Example of calculation of monthly irrigation rates for the Fântânele Şagu Arad irrigation system .

Values, crop correction coefficient (dc), the coefficient of soil (ds), coefficient indicating the water of soil contribution rate to cover consumption by evapotranspiration calculated in experimental fields, the index of aridity function the type of clime (α) and performance that irrigation monthly rate was applied (M_o) in experimental fields (η_a), resulting by Manole E. [7], so:

dc=1,26 α=0,51

ds=0,05 ηa=70%

$$\delta = \left(1 - 0.7 \frac{1 - \left(0.05 + \frac{0.51}{1.26}\right)}{1-0.51}\right) \cdot 100 = 23\%$$

δ=23%

Means that by chronological balance is over sized the net irrigation water needs up to 23%.

For updating irrigation water needs to SP Floating Fântânele the obtained results represent water consumption in the main irrigated crops in the area.

Results of calculating irrigation water requirements are presented in Tables No. 1 and No. 2 and include monthly irrigation rates for the Fântânele Şagu Arad irrigation system in 2002, respectively in 2009.

Analyzing the data in Tables No. 1 and No. 2 is established that:

- annual irrigation rate for total crop plan is 2040 cubic meters per hectare in 2002 and 1050 cubic meters per hectare in 2009 compared to thevalue used in STE (1967) equal to 3600 cubic meters per hectare, the difference is justified by the lack of research data in hydrological balance equation and climate data used in Etp calculating.
- irrigation norm in month with maximum consumption (in July) in 2002 is 800 cubic meters per ha compared to data used in the sizing system, equal to 1200 cubic meters per hectare. There appears a substantial difference between the specific flow updated to 0.3l/s/ha compared to the original debit. Since the work of system sizing was performed with a gross rate of 0.8l/s/ha, results that they are appropriate in July to a minimum efficiency of water use is equal to 38%.

Irrigation norm in month with maximum consumption (June) in 2009 is 425 cubic meters per ha compared to used value in the sizing system, equal to 1200 cubic meters per hectare. There appears a substantial difference between the specific flow updated of 0.4l/s/ha compared to the original flow. Since the work of system sizing was performed with a gross rate of 0.8 l/s/ha, results that they are appropriate in June to a minimum efficiency of water use equal to 50%.

Crop	P %	April				May				June			
		ETp	P	α	Δ	ETp	P	α	Δ	ETp	P	α	Δ
		30.38	24.3	0.8	6.08	40	22	0.55	18	92.45	49	0.53	43.45
		dc	ds	k	Mo	dc	ds	k	Mo	dc	ds	k	Mo
Corn	29	0.81	0.2	0.66	4.01	0.75	0.15	0.68	12.24	0.85	0.10	0.9	39.11
Grain	50.98	1.88	0.2	0.82	4.99	1.85	0.2	1.15	20.7	1.05	0.15	0.85	36.93
Sunflower	10	1.13	0.18	0.75	4.56	0.83	0.18	0.9	16.2	1.35	0.18	1.05	45.62
Soya	10	1	0.17	0.65	3.95	0.76	0.17	0.75	13.5	0.85	0.17	1.7	73.87
Vegetables	0.02					1.23	0.05	0.7	12.6	1.27	0.025	1	43.45
Mo weighted average (mm)		4.38				15.05				47.80			
Specific flow (l/s/ha)		0.017				0.059				0.186			

Crop	P %	July				August				September				
		ETp	P	α	Δ	ETp	P	α	Δ	ETp	P	α	Δ	ΣMo mm
		129.61	66.1	0.51	63.51	141.76	72.3	0.51	69.46	90.74	49	0.54	41.74	
		dc	ds	K	Mo	dc	ds	k	Mo	dc	ds	k	Mo	
Corn	29	1.33	0.05	1.3	82.56	1.26	0.05	1.2	83.35	0.77	0.05	0.9	37.57	258.84
Grain	50.98													62.62
Sunflower	10	1.44	0.18	1.42	90.18	0.77	0.18	0.8	55.57	0.65	0.18	0.7	29.22	241.35
Soya	10	1.23	0.17	1.2	76.21	1.13	0.17	1.1	76.41	0.85	0.17	6.78	32.56	276.50
Vegetables	0.02	1.1	0.05	1.12	71.13	0.7	0.05	0.75	52.1					179.28
Mo weighted average (mm)		80.02				66.86				33.12				204
Specific flow (l/s/ha)		0.311				0.261				0.129				

Table no. 1. Monthly irrigation rates for the Fântânele Şagu Arad irrigation system in 2002.

Crop	P %	April				May				June			
		ETp	P	α	Δ	ETp	P	α	Δ	ETp	P	α	Δ
		4.5	3.6	0.8	0.9	84	46.2q	0.55	37.8	147.92	78.4	0.53	69.52
		dc	ds	k	Mo	dc	ds	k	Mo	dc	ds	K	Mo
Corn	36	0.81	0.2	-0.53	0	0.75	0.15	0.14	5.29	0.85	0.10	0.35	24.33
Grain	17	1.88	0.2	2.46	2.21	1.85	0.2	1.45	54.81	1.05	0.15	0.54	37.54
Sunflower	16	1.13	0.18	0.44	0.40	0.83	0.18	0.20	7.56	1.35	0.18	0.86	59.79
Soya	20	1	0.17	0.11	0.09	0.76	0.17	0.13	4.91	0.85	0.17	0.26	18.07
Vegetables	11					1.23	0.05	0.96	36.29	1.27	0.025	1.05	73.00
Mo weighted average (mm)		0.9				21.77				42.55			
Specific flow (l/s/ha)		0.009				0.207				0.405			

Crop	P %	July				August				September				
		ETp	P	α	Δ	ETp	P	α	Δ	ETp	P	α	Δ	ΣMo mm
		72.94	37.2	0.51	35.74	58.43	29.8	0.51	28.63	61.48	33.2	0.54	28.28	
		dc	ds	K	Mo	dc	ds	k	Mo	dc	ds	k	Mo	
Corn	29	1.33	0.05	1.08	38.6	1.26	0.05	0.98	28.06	0.77	0.05	0.29	8.20	104.48
Grain	50.98													94.56
Sunflower	10	1.44	0.18	0.96	34.31	0.77	0.18	0.17	4.87	0.65	0.18	0	0	106.93
Soya	10	1.23	0.17	0.73	26.09	1.13	0.17	0.61	17.46	0.85	0.17	0.25	7.07	73.69
Vegetables	0.02	1.1	0.05	0.76	27.16	0.7	0.05	0.22	6.30					142.75
Mo weighted average (mm)		31.54				14.17				7.64				105
Specific flow (l/s/ha)		0.300				0.135				0.073				

Table no. 2. Monthly irrigation rates for the Fântânele Şagu Arad irrigation system in 2009

3. RESULTS AND CONCLUSIONS

Therefore the need of water for Fântânele Şagu Arad irrigation system, according to the methodology [7], ensuring climate deficit by Manole E, results the following conclusions:

- Annual irrigation rates, rates of watering and compared water deficit for 2002 and 2009 compared to the situation from initial project of improvement is presented synthetic (Table No. 3) as follows:

Table No.3

	Annual Irrigation Rate (mc/ha)	Watering Rate (mc/ha)	Specific flow (l/s/ha)	Deficit
Projection	3600	600	0.8	
2002	2040	600	0.3	635
2009	1050	600	0.4	695

- Application of the methodology [7] by Manole is recommended that it be taken into account in evaluation calculating of the climate trend assessment, additional elements.
- Climate deficit is most pronounced in the following order: July, August, June, September, respectively months that the stages of plant growth requires the largest quantities of water.
- Relations calculation based on climatic parameters of ETp is Thornwaithe equation (using monthly averages of temperature and altitude weather station), potential evapotranspiration reference climate.
- Months order of irrigation season requiring irrigation application as follows: July, August, June, September, May and April.
- At the same condition of climatic deficit each crop is differently influenced such cosumption rate and through required irrigation rate.
- Consequently, this new approach to calculating the irrigation system and crop irrigation by water supply of the improvement with volumes closest to the plant needs, in the irrigation season water savings will be substantial and the current situation of general crisis, these actions will be welcomed and will be reflected in the price of production with the observation that decisive element in determining the amount of water needed for irrigation is rainfall fell during the growing season in particular.

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