BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi" din Iaşi
Tomul LV (LIX), Fasc. 3, 2009
Secţia
HIDROTEHNICĂ

THE IDENTIFICATION OF PRECIPITATIONS DISTRIBUTION'S REGIONAL PARTICULARITIES USING INFORMATIONAL TECHNOLOGIES

BY

TATIANA CONSTANTINOV, VALENTIN RĂILEANU and OLGA CRIVOVA

Abstract. Using the database of monthly precipitations registered at 15 meteorological stations in Republic of Moldova in 1961–2005, and these stations characteristics, there were obtained the regression equations of precipitations with relief and geographical location as parameters. On the basis of these equations and Digital Terrain Model we have obtained annual, seasonal and warm period's precipitations' digital maps using GIS technologies.

Key words: .

1. Introduction

The quantity of precipitations conditions cultural plants development. Republic of Moldova, being mostly an agricultural country, needs concrete data on precipitations distribution in multiyear aspect for the whole territory. But data registered at meteorological stations does not reflect real situation on the areas situated between these stations. Traditional methods of spatial interpolation have an insufficient accuracy. Together with appearance of high calculation technologies and Geographical Information Systems (GIS) [1], the possibility for modeling the distribution of various climatic indexes for the vast areas, considering relief's influence on them, geographical position and data registered on meteorological stations, also appeared. One of the well-known methods of spatial interpolation uses regression equations that can be obtained using data registered on meteorological stations, relief's particularities and station's geographical position. The goal was to obtain digital maps showing precipitation's spatial distribution for the whole Republic's territory for various time periods.

2. Materials and Methods

The most progressive methods of study known in the country and abroad were used for investigations, including new technologies of data processing such as STATGRAPHICS software and Geographic Information System ArcView.

The whole database that was meant to be used for creating these maps was actualized by being supplemented with data not only for the basic time period (yeas 1961–1990 according to WMO), but also with information for years 1991–2005, so that climatical indexes' ranges (of precipitations) include an interval of 45 years. From the dataset for 17 meteorological stations situated on Republic of Moldova's territory, we have selected 15 stations, keeping in mind that some them do not have complete data range, or where situated in different places in the period in question. Meteorological stations particularities are shown in Table 1.

Table 1

Meteorological Stations Particularities

Meteorological stations	Absolute altitude	Relative altitude	Slope	Aspect	*X* coordinates	*Y* coordinates
Bălțata	79.0	37.0	1.5	135	654700	5213401
Bălți	102.0	12.0	0.5	180	571323	5291731
Bravicea	78.0	12.0	5.5	225	608561	5247618
Briceni	242.0	14.8	1.0	135	505111	5356205
Cahul	196.0	116.0	0.0	0	597743	5078597
Camenca	154.0	0.0	0.0	0	626697	5322811
Chișinău	173.0	103.0	0.5	0	641189	5203169
Comrat	133.0	88.0	0.5	135	625678	5129008
Corneşti	232.0	132.0	5.5	225	575117	5247096
Dubăsari	41.7	26.9	4.0	225	661081	5238591
Făleşti	161.5	80.0	0.5	180	553239	5270086
Leova	156.0	136.8	0.5	0	598545	5149071
Rîbnița	119.0	79.0	1.5	90	653221	5292762
Soroca	173.0	129.4	1.0	135	597565	5339252
Tiraspol	20.9	16.0	0.0	225	701873	5189675

Precipitations sums registered at meteorological stations are shown in Table 2.

Table 2
Mean Values of Precipitations Registered at Meteorological Stations

Meteorological stations	Annual	Spring	Summer	Autumn	Winter
Bălţata	519.41	116.95	192.00	115.91	94.54
Bălţi	526.47	119.02	211.23	111.17	85.04
Bravicea	600.13	138.41	220.21	131.78	109.71
Briceni	621.97	150.04	238.45	126.52	106.95
Cahul	543.32	125.80	194.95	120.50	102.06
Camenca	545.47	121.65	216.26	115.93	91.63
Chişinău	555.19	126.69	189.69	127.67	111.13
Comrat	513.37	121.89	176.82	113.15	101.50
Corneşti	651.82	153.95	238.26	143.08	116.52
Dubăsari	526.32	119.58	186.02	115.82	104.89
Făleşti	577.45	130.91	223.71	127.02	95.80
Leova	532.06	125.06	186.17	123.97	96.84
Ribniţa	525.43	116.39	201.39	114.97	92.67
Soroca	574.56	128.91	218.00	123.65	104.00
Tiraspol	508.39	112.19	182.58	113.04	100.56

General model of multiple regressions can be expressed by formula [2]:

$$y = a + \sum_{i=1}^{n} b_i x_i \pm \varepsilon, \tag{1}$$

where y is dependent variable, x_i – independent variables, n – number of independent variables, a – constant term, b_i – coefficients of partial regression. Standard error dependent variable estimation ε represents residuals' standard deviation and is expressed by formula

$$\varepsilon = S_y \sqrt{1 - R^2}, \tag{2}$$

where S_y is standard deviation of the variable y. $R^2 = r^2 * 100\%$ is coefficient of multiple determination, and r – multiple correlation coefficient. The other parameters that characterize regressional model are P value and mean absolute error MAE. *P* value is a measure of model's significance. For $P < 0.01$ the confidence level is $d > 99\%$, for $P < 0.05$ the confidence level is $d > 95\%$, and for $P < 0.1$ the confidence level is $d > 90\%$.

3. Obtained Results

The results of regressional analysis are shown in Tables 3 and 4.

Table 3

Regression Equation Parameters $P = Ah{*}H + A\Delta h{*}\Delta H + Au{*}S + Ay{*}Y + C$ of Mean Precipitations

Time period	Coefficients of partial regression for independent variables *P* value				
	Ah	*AΔh*	*As*	*Ay*	Constant *C*
Winter	–	0.0689175 0.0808	2.54403 0.0224	0.0000176724 0.0000	–
Spring	0.138469 0.0000	–	3.56955 0.0002	0.0000196215 0.0000	–
Summer		–	3.4059 0.0302	0.000147148 0.0010	–593.006 0.0055
Autumn	0.0842893 0.0020	–	2.84434 0.0020	0.0000201859 0.0000	–
Warm period	0.389581 0.0001	–	9.97834 0.0010	0.00015146 0.0175	–408.235 0.1760
Annual	0.450879 0.0000	–	13.1234 0.0001	0.0000903321 0.0000	–

Note: *h* – absolute altitude, [m]; Δ*h* – relative altitude, [m]; *s* – slope, [degree]; *y* – latitude, expressed in meters in Transverse Mercator WGS84 projection with Central Meridian equal to 27^0 and False Esting equal to 500000m.

Table 4

Statistical Parameters Showing the Verisimilitude of Mean Precipitations' Regressional Models

Time period	Model's *P* value	*R*, [%]	*R* adjusted %	Standard error of estimation, [%]	Mean absolute error, [%]
Winter	0.0000	99.6	99.6	6.9	5.1
Spring	0.0000	99.9	99.9	4.9	3.4
Summer	0.0002	82.2	77.4	9.6	7.1
Autumn	0.0000	99.9	99.8	5.1	4.1
Warm period	0.0000	86.2	82.4	15.7	10.8
Annual	0.0000	99.9	99.9	17.0	12.0

Precipitations' regressional models for summer and warm period have as independent variables absolute altitude *h*, slope *s*, latitude *y* and constant term; for spring, autumn and annual – *h*, *s*, and *y*; for winter relative altitude Δ*h*, *s* and *y*. *P* values for independent variables vary within the limits of 0.0000 and 0.0302, which corresponds to the confidence level no less than 95% (Table 3). In all time periods *P* values of all models are no bigger than 0.0002, which corresponds to the confidence level bigger than 99% (Table 3).

Precipitations digital maps for various time periods were elaborated by GIS ArcGIS, using digital terrain model and corresponding regressional models (Figs. 1,…,6).

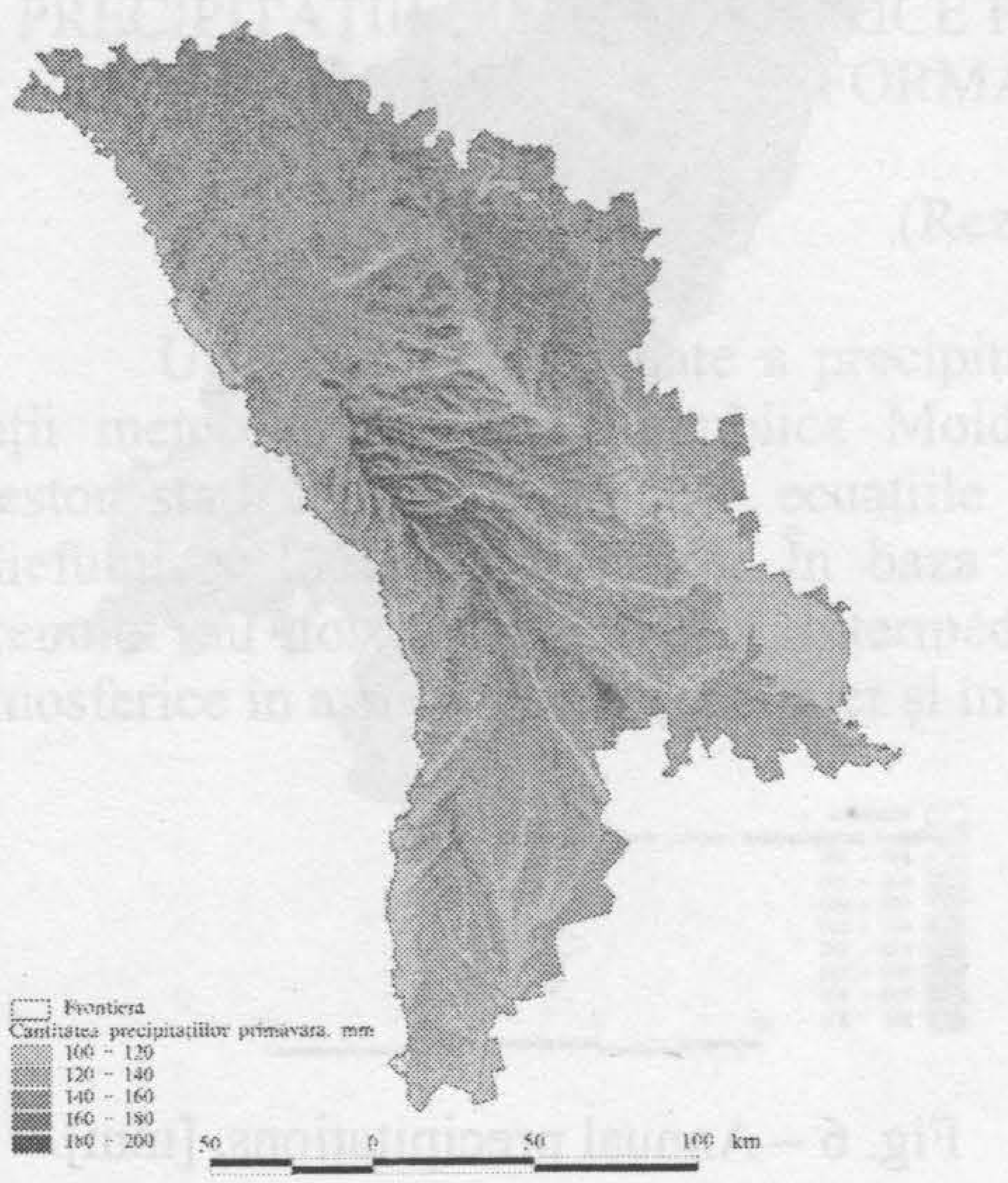

Fig. 1 – Spring precipitations, [mm].

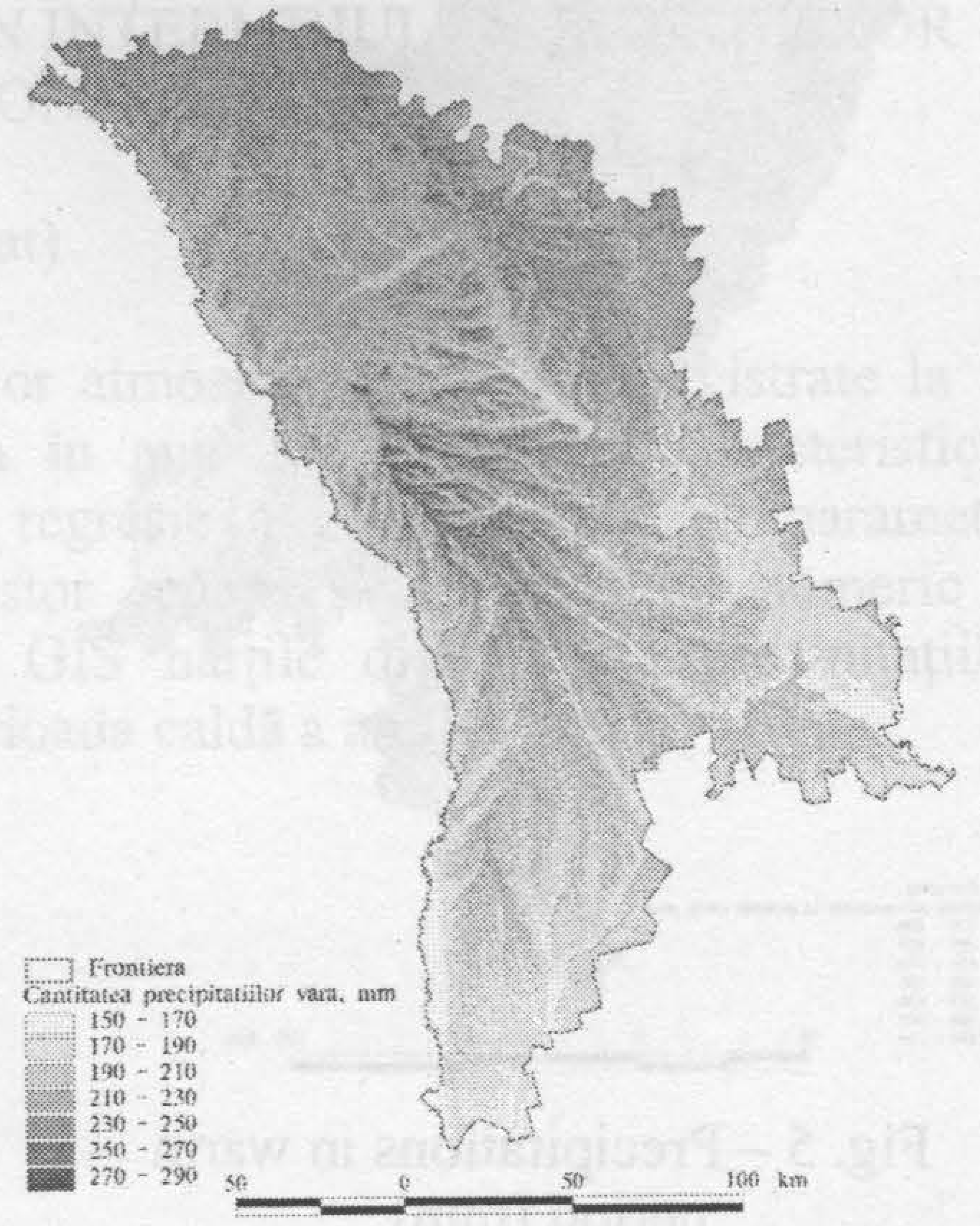

Fig 2. – Summer precipitations, [mm].

Fig. 3 – Autummn precipitations, [mm].

Fig. 4 – Winter precipitations, [mm].

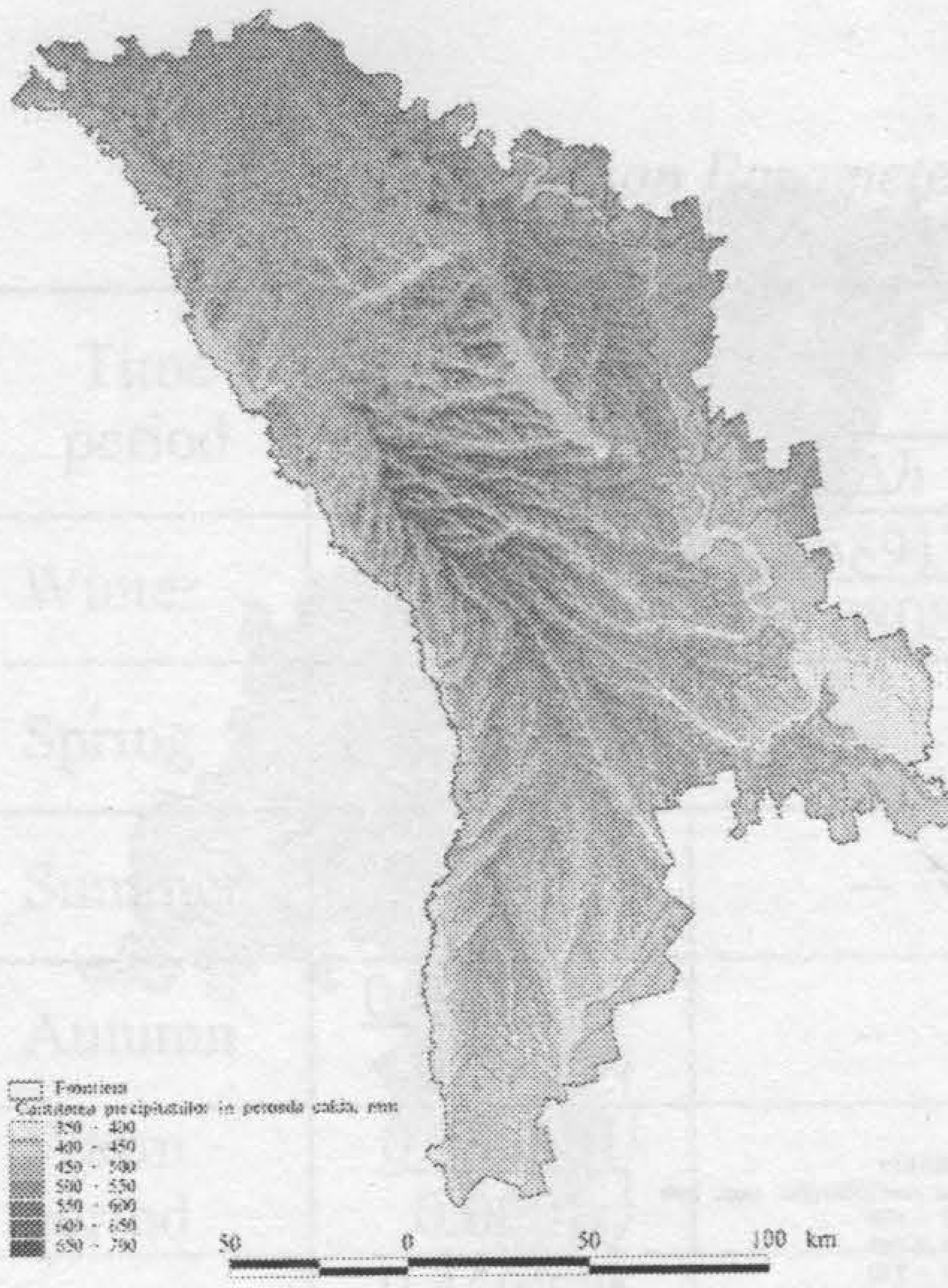

Fig. 5 – Precipitations in warm period,[mm].

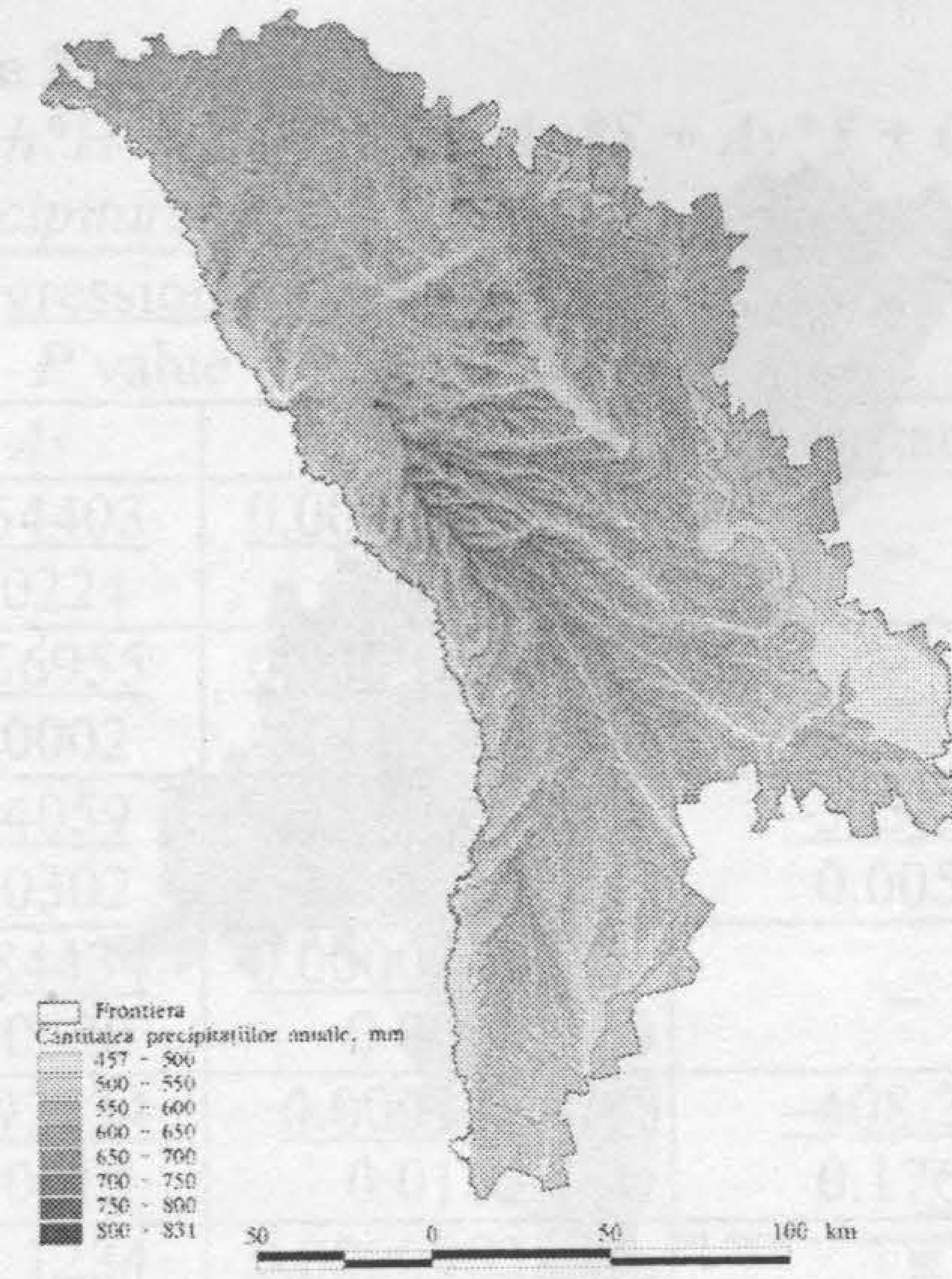

Fig. 6 – Annual precipitations, [mm].

3. Conclusions

1. Regressional models and Informational Geographical Systems usage allowed elaborating digital maps of precipitations distribution for the whole Republic's territory with a high accuracy;

2. Atmospherical precipitations quantity varies in various time periods and in different landscape regions: spring – within the limits of 100 and 200 mm, summer – within the limits of 150 and 290 mm, autumn – within the limits of 100 and 180 mm, winter – within the limits of 85 and 185 mm, warm period – within the limits of 350 and 700 mm, and annual within the limits of 460 and 830 mm;

3. The highest quantity of precipitations falls on Central Moldavian Plateau, Northern Moldavian Plateau, Dniester Plateau and less on Tigheci Hills.

Received: December 12, 2009

Institute of Ecology and Geography
Academy of Sciences of Moldova
email: valentin_rln@yahoo.com

REFERENCES

1. Popovici N., Biali G. *Sisteme Geoinformaţionale.* Edit. „Gh. Asachi", Iaşi, 154, 2000.
2. Patriche C.-V., *Evaluarea biofizică şi tehnică a terenurilor agricole.* Edit. „Terra Nostra", Iaşi, 151, 2003.

EVIDENŢIEREA PARTICULARITĂŢILOR REGIONALE DE DISTRIBUŢIE A PRECIPITAŢIILOR ATMOSFERICE PRIN INTERMDIUL TEHNOLOGIILOR INFORMAŢIONALE

(Rezumat)

Utilizând baza de date a precipitaţiilor atmosferice lunare, înregistrate la 15 staţii meteorologice din Republica Moldova în anii 1961–2005, şi caracteristicile acestor staţii, au fost obţinute ecuaţiile de regresie a precipitaţiilor cu parametrii reliefului şi locaţia geografică. În baza acestor ecuaţii şi a modelului numeric al terenului au fost obţinute prin intermediul GIS hărţile digitale ale precipitaţiilor atmosferice în aspect anual şi sezonier şi în perioada caldă a anului.