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Research Article

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Factor Analysis of Influence of Parameters of Water Regime and Hydrological Changes on Pastures

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Abstract

According to basic tabular data (DEFRA-commissioned project BD1310. Final report to the Department for Environment, Food and Rural Affairs) steady regularities between biochemical substances of the soil of pastures and hydrological parameters of their water mode are revealed shows the ranking methodology affecting and dependent factors and identification of deterministic models of the relationship between the 10 factors according to the general equation consisting of the sum of two biotechnical laws.

Keywords: Pastures; Options, Rating; Mutual Influence; Factor, Analysis; Patterns

Introduction

Analysis of binary relations between the 10 factors conducted on the data [1] (Appendix C). Soil parameters used in the hydrological modelling). Statistical modeling was performed by identification of General algebraic formula containing the sum of two biotechnical laws [2-5].

Factor analysis is understood as the identification of stable patterns of changes of values of each of the plurality of parameters of the studied systems, as well as mathematical relations between the factors. In comparison with the approximation in the methodology of identifying the truth of stable laws is accepted as an axiom. So there is no need of using empirical formula it is set in advance.

Our method of factor analysis allows not only to establish a posteriori causality, but also to give them a quantitative characteristic, provides an assessment of the level of influence of factors (influence parameters) on the results of functioning (dependent parameters). This makes factor analysis accurate method, and conclusions quantitatively valid and meaningful in the identification of regularities.

The source data

Us, it is assumed that the factors the researcher selected and the corresponding tabular model (Table 1) was compiled. Then factor analysis is the identification of the algebraic relationships between the selected factors.

This will show a specific example [1]. It is clear that they received some kind of grouping. Most often the grouping is performed by calculating the arithmetic mean value (Table 1). If at our disposal were the primary measurement data, it would be possible to identify a more accurate statistical model on 10 indicators with consideration of the wave components. On average factors, there is a coarsening of the desired biotechnical regularities. Therefore, the wave functions do not identify and the only deterministic model binary relations between factors. Rank relationship is not detected, for a one-dimensional relationship; the correlation coefficient is equal to 1.

General biotechnical regularity

Inductively, on the basis of tens of thousands of examples of identification of statistical selections from various areas of science, two generalized mathematical models [2-5] were revealed:

a) The generalized determined (trend) model for identification on values of factors and communications between them (it is shown in this article).

b) The general wave function of oscillatory indignation of the studied system in the form of an asymmetric wavelet signal (it is offered according to primary not grouped data).

All tendencies are modelled by binomial regularity of a look

$$y=a_1 x^{a_2}\exp(-a_3 x^{a_4})+a_5 x^{a_6}\exp(-a_7 x^{a_8}) \qquad (1)$$

where, y: estimated parameter (parameter is an indicator of the studied system);

x: the influencing parameter, in an example of ref. [1] 10 measured factors on 20 values.

A rating of the influencing and dependent factors

The full correlation matrix (without rank distributions) binary (between couples of mutually influencing factors) communications between 10 factors is given in Table 2.

Follows from the concept of a correlative variation of Ch. Darwin that in other conditions of dwelling other combinations of values of factors of the soil can be stronger (Darwin calls factors hereditary evasion). Therefore, weak factorial communications can be stronger on other objects of research. You need to compare pastures from different regions of the Earth. In the end there is a mathematical tool to compare the environmental systems of pastures between them.

The coefficient of functional connectivity (in the wider biotechnological meaning - correlative variation) 10 factors equal $53.2089/10^2=0.5321$. This criterion is applied by comparison of different phytocenoses, in particular of pastures from different regions.

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Site name	Topsoil hydraulic conductivity (m day)	Subsoil hydraulic conductivity (m day)	Topsoil drainable porosity	Subsoil drainable porority	Unsaturated Hydraulic conductivity exponent	Rainfall (mm)	Potential transpiration (mm)	SMD (mm) (end July)	Drought threshold (cm)	Aeration threshold (cm)
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
Belaugh	3	3	0.3	0.3	8	575	531	107	49.4	35.7
Blackthorn	0.22	0.01	0.06	0.03	3	669	511	90	48.5	23.5
Broaddale	0.7	0.35	0.14	0.09	4	1663	375	0	47.7	30.4
Cricklade	0.24	3.5	0.12	0.12	7	726	503	82	44.6	34.1
Dancing Gate	_	_	_	_	_	1045	444	39	46.4	35.9
East Cottingwith	_	_	_	_	_	643	486	85	-	-
East Harnham	5.7	_	0.11	_	8	799	511	86	49.6	44.3
Moorlinch	0.6	0.6	0.16	0.16	8	865	523	85	46.8	27.3
Mottey Meadows	1	_	0.13	_	8	700	498	86	46.4	25.6
Nethercote	0.41	0.73	0.1	_	_	726	503	82	49.1	28.9
Portholme	0.2	3.5	0.12	0.1	7	574	523	103	48.3	38.7
Southlake	0.08	1	0.12	0.14	7	865	523	85	48.7	42
Stonygillfoot	2.3	2.3	0.1	0.1	11	1068	404	33	47.4	23.3
Tadham	2.5	1.75	0.15	0.15	8	865	523	85	48.8	35.6
Tadham ESA	2.5	1.75	0.15	0.15	8	865	523	85	48.8	35.6
Upton Ham	0.9	0.7	0.11	0.11	5	775	514	78	48.2	35.6
Upwood	0.22	0.01	0.06	0.02	3	574	523	103	48.5	23.5
Westhay ESA	2.5	1.75	0.15	0.15	8	865	523	85	48.8	35.6
West Sedgemoor	1.5	1.5	0.27	0.27	6.4	865	523	85	49.3	44.7
Wet Moor	0.1	3.35	0.06	0.15	8	865	523	85	49.3	42.7

Table 1: Soil parameters used in the hydrological modelling.

The influencing factors (parameters x)	Dependent factors (indicators y)					Parameters						Sum	Place
						X	Dependent factors (indicators y)					Σ_r	I_x
	x_1	x_2	x_3	x_4	x_5		X_6	x_7	x_8	x_9	x_{10}		
Topsoil hydraulic conductivity (m day) x_1	1	0.5382	0.6028	0.6337	0.6409	x_1	0.3702	0.3698	0.4575	0.5232	0.4469	5.5832	4
Subsoil hydraulic conductivity (m day) x_2	0.8652	1	0.4973	0.6772	0.8634	x_2	0.3517	0.379	0.6024	0.6294	0.8915	6.7571	1
Topsoil drainable porosity x_3	0.3666	0.2321	1	0.9079	0.4495	x_3	0.0033	0.3565	0.1194	0.4246	0.3474	4.2073	9
Subsoil drainable porosity x_4	0.591	0.5206	0.9293	1	0.7528	x_4	0.3726	0.6964	0.6342	0.4903	0.7067	6.6939	2
Unsaturated Hydraulic conductivity exponent x_5	0.6068	0.6989	0.4786	0.6994	1	x_5	0.2785	0.6658	0.5374	0.1581	0.7606	5.8841	3
Rainfall (mm) x_6	0.255	0.225	0.0739	0.2373	0.5864	$x6$	1	0.9021	0.9525	0.1825	0.4483	4.863	7
Potential transpiration (mm) x_7	0.0176	0.149	0.2092	0.3188	0.4963	x_7	0.8767	1	0.9514	0.5864	0.3902	4.9956	6
SMD (mm) (end July) x_8	0.0167	0.2099	0.1194	0.2223	0.6612	x_8	0.9363	0.9683	1	0.4164	0.9553	5.5058	5
Drought threshold (cm) x_9	0.5277	0.1634	0.1783	0.3824	0.0596	x_9	0.2545	0.5205	0.4263	1	0.6013	4.114	10
Aeration threshold (cm) x_{10}	0.3202	0.4632	0.3848	0.6131	0.2246	x_{10}	0.3716	0.3828	0.3417	0.5029	1	4.6049	8
Sum of coefficients of correlation S_r	4.5668	4.2003	4.4736	5.6921	5.7347	Σ_r	4.8154	6.2412	6.0228	4.9138	6.5482	53.2089	-
Indicator place I_y	8	10	9	5	4	**Place** I y	7	2	3	6	1	-	0.5321

Table 2: Correlation matrix of the full factorial analysis and rating of factors.

According to Table 2 among the influencing factors first place was won by a factor x_2 (Subsoil hydraulic conductivity), the second - x_4 (Subsoil drainable porosity) and the third - x_5 (Unsaturated Hydraulic conductivity exponent). Among dependent factors (indicators) in ranked first factor (Aeration threshold), and the second - (Potential transpiration) and the third - (SMD end July).

Correlation matrix of the binary relations

We will exclude a rating and cages with units on a diagonal Table 3 from data of Table 2. Then we will receive a set of coefficients of correlation at binary communications. The maximum adequacy 0.9683 is observed at dependence x_7=f (x_8). The minimum coefficient of correlation 0.0033 is equal for the relation x_6=f (x_3). Above the known level of adequacy 0.7 there are 15 binary communications (Table 4) that makes 100 × 15/(102–10)=16.67%. Thus the share of the strongest bi nary relations is very far from a gold proportion of 61.80%.

The grayed out the block from pair communications between three factors is allocated x_6, x_7 and x_8. In Table 5 compact records of values of parameters of model are given (1). In total three clusters of regularities were formed.

First cluster

It possesses good symmetry (Table 6). Here the strongest biotechnical regularities settle down. In fact three factors x_6 (Rainfall), x_7 (Potential transpiration) and x_8 (SMD end July) become a kernel for all set of factors. Schedules are shown in Figure 1.

Because of repetitions of values only 12 points were formed of 20 names of the sites. Apparently from Figure 1, these 12 points form a big cluster of basic data of nine points located closely to each other. Thus, the clustering occurs not only on regularities, but also on values of the factors entering these biotechnical regularities. As a result when using all primary data there will be also wave indignations.

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
x_1		0.5382	0.6028	0.6337	0.6409	0.3702	0.3698	0.4575	0.5232	0.4469
x_2	0.8652		0.4973	0.6772	0.8634	0.3517	0.379	0.6024	0.6294	0.8915
x_3	0.3666	0.2321		0.9079	0.4495	0.0033	0.3565	0.1194	0.4246	0.3474
x_4	0.591	0.5206	0.9293		0.7528	0.3726	0.6964	0.6342	0.4903	0.7067
x_5	0.6068	0.6989	0.4786	0.6994		0.2785	0.6658	0.5374	0.1581	0.7606
x_6	0.255	0.225	0.0739	0.2373	0.5864		0.9021	0.9525	0.1825	0.4483
x_7	0.0176	0.149	0.2092	0.3188	0.4963	0.8767		0.9514	0.5864	0.3902
x_8	0.0167	0.2099	0.1194	0.2223	0.6612	0.9363	0.9683		0.4164	0.9553
x_9	0.5277	0.1634	0.1783	0.3824	0.0596	0.2545	0.5205	0.4263		0.6013
x_{10}	0.3202	0.4632	0.3848	0.6131	0.2246	0.3716	0.3828	0.3417	0.5029	

Table 3: Correlation matrix of the binary relations between factors.

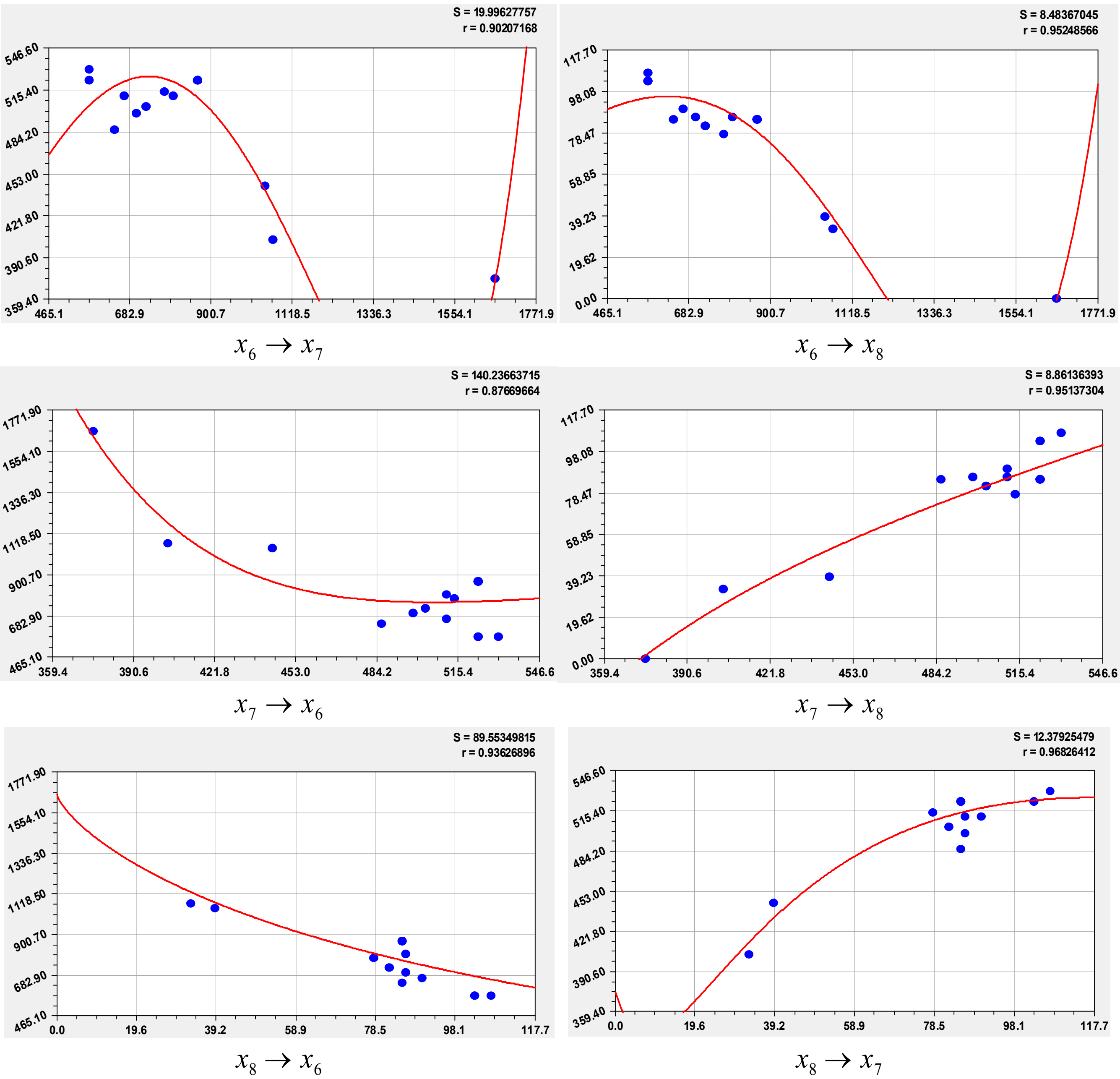

Figure 1: Schedules of the binary relations of the first cluster of regularities.

	x_1	x_3	x_4	x_5	x_6	x_7	x_8	x_{10}
x_2	0.8652			0.8634				0.8915
x_3			0.9079					
x_4		0.9293		0.7528				0.7067
x_5								0.7606
x_6						0.9021	0.9525	
x_7					0.8767		0.9514	
x_8					0.9363	0.9683		0.9553

Table 4: Correlation matrix of the binary relations at correlation r ≥ 0,7.

Factors		General law $y=a_1 x^{a_2}\exp(-a_3 x^{a_4})+a_5 x^{a_6}\exp(-a_7 x^{a_8})$								Correl. coef. r
		First component				Second component				
x	y	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	
x_8	x_7	374.7037	0	0.026208	1	6.51818e6	5.0856	16.64811	0.14794	0.9683
x_8	x_{10}	3.22802e7	8.18164	23.41995	0.17105	0	0	0	0	0.9553
x_6	x_8	40.23982	0	-0.00231	1	-4.55658e-8	3.29629	0	0	0.9525
x_7	x_8	-1.14232e7	0	1.53724	0.3491	0.004412	1.60871	0	0	0.9514
x_8	x_6	1652.688	0	0.028053	0.74615	0	0	0	0	0.9363
x_4	x_3	0.05782	0	-5.07272	0.92808	0	0	0	0	0.9293
x_3	x_4	0.033043	0	0	0	1.26462	1.28611	0	0	0.9079
x_6	x_7	227.6021	0	-0.00201	1	-5.09798e-7	3.12871	0	0	0.9021
$x2$	x_{10}	23.75135	0	-0.01731	2.67978	17.15156	1.95212	0.051754	6.18305	0.8915
x_7	x_6	386020.2	0	0.007819	0.94425	-6774.02	0.83325	0.014992	0.89617	0.8767
x_2	x_1	0.49583	0	0.45055	1	39.61873	12.39564	5.60147	1.00944	0.8652
x_2	x_5	3.02871	0	0.37467	1	7.85863	1.18715	0.47018	1	0.8634
x_5	x_{10}	4.28454	2.3827	0.27272	1.1259	0	0	0	0	0.7606
x_4	x_5	2.79236	0	-3.31653	18.59787	1.75307e8	4.77904	23.86727	0.55696	0.7528
x4	x10	23.48359	0	8.2251	1	996.423	1.43515	5.22215	1	0.7067

Table 5: Parameters of regularities of mutual influence of indicators.

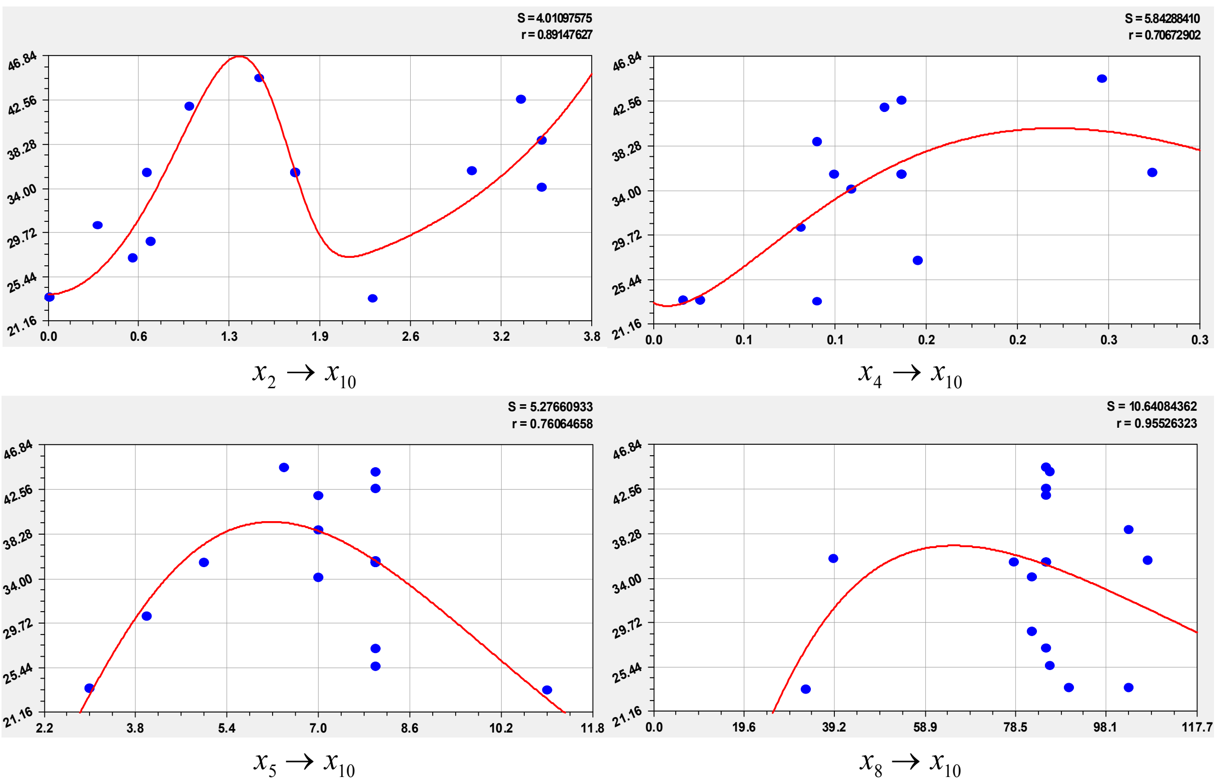

Figure 2: Schedules of the binary relations of the second cluster of regularities.

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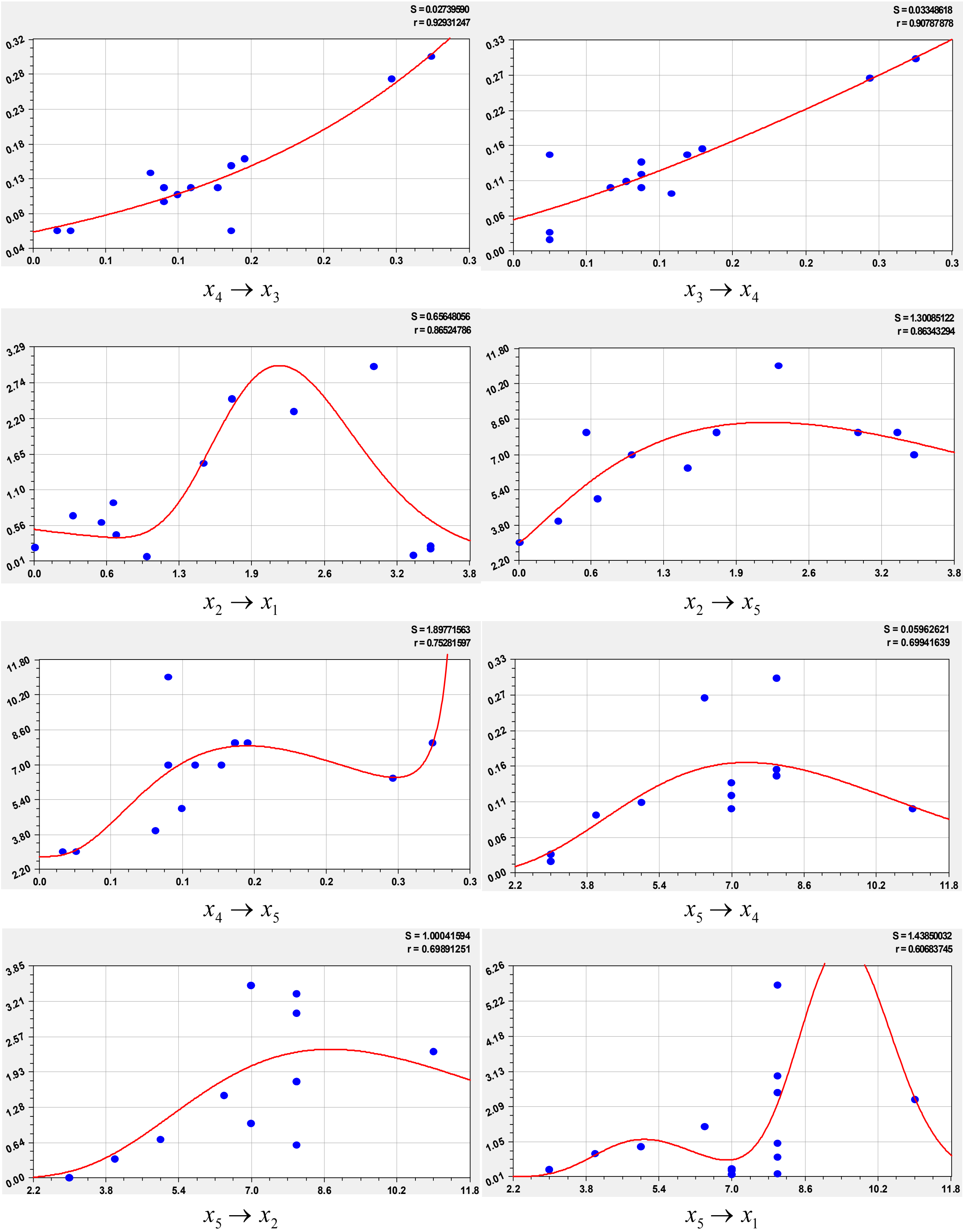

Figure 3: Schedules of the binary relations of the third cluster of regularities.

	x_6	x_7	x_8
x_6		0.9021	0.9525
x_7	0.8767		0.9514
x_8	0.9363	0.9683	

Table 6: First cluster of the strongest communications.

	x_{10}
x_2	0.8915
x_4	0.7067
x_5	0.7606
x_8	0.9553

Table 7: Second cluster of strong communications.

	x_1	x_2	x_3	x_4	x_5
x_2	0.8652				0.8634
x_3				0.9079	
x_4			0.9293		0.7528
x_5	0.6068	0.6989		0.6994	

Table 8: Third cluster of the binary relations.

Second cluster

It was defined (Table 7) influence on an indicator x_{10} (Aeration threshold) four influencing variable x_2 (Subsoil hydraulic conductivity), x_4 (Subsoil drainable pororsity), x_5 (Unsaturated Hydraulic conductivity exponent) and x_8 (SMD end July).

Figure 2 schedules of the binary relations are shown. The coefficient of correlation r is given in the right top corner of the schedule.

Third cluster

It (Table 8) is received by addition to the group of regularities of influence of x_5 which is available in Table 4 (Unsaturated Hydraulic conductivity exponent).

This influence on three indicators x_1 (Topsoil hydraulic conductivity), x_2 (Subsoil hydraulic conductivity) and x_4 (Subsoil drainable pororsity) happens to correlation coefficients less than 0,7.

Figure 3 schedules of eight binary relations are given. In addition to Table 5 influence happens on formulas:

$$x_4=0.00089702\,x_5^{5.30108}\exp(-0.72580x_5^{0.99904}) \qquad (2)$$

$$x_2=9.97568.10^{7}\,x_5^{18.18652}\exp(-28.52592x_5^{0.31926}) \qquad (3)$$

$$x_1=3.11204.10^{-6}x_5^{20.53199}\exp(-4.05046x)+1.55852.10^{-48}\,x_5^{89.91067}\exp(-9.51579x_5) \qquad (4)$$

When the same design of the general model (1) specific design patterns varies greatly, so get differing in complexity graphics.

Conclusion

Between biochemical substances of the soil of pastures and hydrological parameters of the water mode always there is a homeostasis. On the general tabular model [1], after identification of strong factorial communications, it is quite possible to define optimum or rational values at all 10 factors. And then on statistical models to predict the productivity of hayfields and pastures on the rational values of the factors. You can then proceed to parametric substantiation of measures for improvement of the water regime of riparian areas.

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