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Influence of Parameters of Water Regime and Hydrological Changes on the Pasture

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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 modeling). Statistical modeling was performed by identification of General algebraic formula containing the sum of two biotechnical laws [2-6]. 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 was compiled (Table 1). Then factor analysis is the identification of the algebraic relationships between the selected factors.

Table 1: Soil parameters used in the hydrological modeling.

Site Name	Topsoil Hydraulic Conductivity (m day)	Subsoil Hydraulic Conductivity (m day)	Topsoil Drainable Porosity	Subsoil Drainable Pororsity	Unsaturated Hydraulic Conductivity Exponent
	x_1	x_2	x_3	x_4	x_5
1. Belaugh	3	3	0.3	0.3	8
2. Blackthorn	0.22	0.01	0.06	0.03	3
3. Broaddale	0.7	0.35	0.14	0.09	4
4. Cricklade	0.24	3.5	0.12	0.12	7
5. Dancing Gate	_	_	_	_	_
6. East Cottingwith	_	_	_	_	_
7. East Harnham	5.7	_	0.11	_	8

8. Moorlinch	0.6	0.6	0.16	0.16	8
9. Mottey Meadows	1	_	0.13	_	8
10. Nethercote	0.41	0.73	0.1	_	_
11. Portholme	0.2	3.5	0.12	0.1	7
12. Southlake	0.08	1	0.12	0.14	7
13. Stonygillfoot	2.3	2.3	0.1	0.1	11
14. Tadham	2.5	1.75	0.15	0.15	8
15. Tadham ESA	2.5	1.75	0.15	0.15	8
16. Upton Ham	0.9	0.7	0.11	0.11	5
17. Upwood	0.22	0.01	0.06	0.02	3
18. Westhay ESA	2.5	1.75	0.15	0.15	8
19. West Sedgemoor	1.5	1.5	0.27	0.27	6.4
20. Wet Moor	0.1	3.35	0.06	0.15	8
Site Name	**Rainfall (mm)**	**Potential transpiration (mm)**	**SMD (mm) (end July)**	**Drought threshold (cm)**	**Aeration threshold (cm)**
	x_6	x_7	x_8	x_9	x_{10}
1. Belaugh	575	531	107	49.4	35.7
2. Blackthorn	669	511	90	48.5	23.5
3. Broaddale	1663	375	0	47.7	30.4
4. Cricklade	726	503	82	44.6	34.1
5. Dancing Gate	1045	444	39	46.4	35.9
6. East Cotting with	643	486	85	-	-
7. East Harnham	799	511	86	49.6	44.3
8. Moorlinch	865	523	85	46.8	27.3
9. Mottey Meadows	700	498	86	46.4	25.6
10. Nethercote	726	503	82	49.1	28.9
11. Portholme	574	523	103	48.3	38.7
12. Southlake	865	523	85	48.7	42
13. Stonygillfoot	1068	404	33	47.4	23.3
14. Tadham	865	523	85	48.8	35.6
15. Tadham ESA	865	523	85	48.8	35.6
16. Upton Ham	775	514	78	48.2	35.6
17. Upwood	574	523	103	48.5	23.5
18. Westhay ESA	865	523	85	48.8	35.6
19. West Sedgemoor	865	523	85	49.3	44.7
20. Wet Moor	865	523	85	49.3	42.7

This will show a specific example [1]. From Table 1 it is clear that they received some kind of grouping. Most often the grouping is performed by calculating the arithmetic mean value. 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 [2-6] 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).

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All tendencies are modeled by binomial regularity of a look

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

Where,

y - Estimated parameter (parameter is an indicator of the studied system),

x - The influencing parameter, in an example of [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 53.2089/102= 0.5321. This criterion is applied by comparison of different phytocenoses, in particular, of pastures from different regions. 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 prorosity) 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 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 $x_6 = f(x_3)$ (Table 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 binary 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.

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

The Influencing Factors (Parameters x)	Dependent Factors (Indicators y)						
	x_1	x_2	x_3	x_4	x_5		
Topsoil hydraulic conductivity (m day) x_1	1	0.5382	0.6028	0.6337	0.6409		
Subsoil hydraulic conductivity (m day) x_2	0.8652	1	0.4973	0.6772	0.8634		
Topsoil drainable porosity x_3	0.3666	0.2321	1	0.9079	0.4495		
Subsoil drainable prorsity x_4	0.591	0.5206	0.9293	1	0.7528		
Unsaturated Hydraulic conductivity exponent x_5	0.6068	0.6989	0.4786	0.6994	1		
Rainfall (mm) x_6	0.255	0.225	0.0739	0.2373	0.5864		
Potential transpiration (mm) x_7	0.0176	0.149	0.2092	0.3188	0.4963		
SMD (mm) (end July) x_8	0.0167	0.2099	0.1194	0.2223	0.6612		
Drought threshold (cm) x_9	0.5277	0.1634	0.1783	0.3824	0.0596		
Aeration threshold (cm) x_{10}	0.3202	0.4632	0.3848	0.6131	0.2246		
Sum of coefficients of correlation Σr	4.5668	4.2003	4.4736	5.6921	5.7347		
Indicator place I_y	8	10	9	5	4		
Parameters x	Dependent factors (indicators y)					Sum	Place
	x_6	x_7	x_8	x_9	x_{10}	Σr	I_y
x_1	0.3702	0.3698	0.4575	0.5232	0.4469	5.5832	4
x_2	0.3517	0.379	0.6024	0.6294	0.8915	6.7571	1
x_3	0.0033	0.3565	0.1194	0.4246	0.3474	4.2073	9
x_4	0.3726	0.6964	0.6342	0.4903	0.7067	6.6939	2
x_5	0.2785	0.6658	0.5374	0.1581	0.7606	5.8841	3
x_6	1	0.9021	0.9525	0.1825	0.4483	4.863	7

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x_7	0.8767	1	0.9514	0.5864	0.3902	4.9956	6
x_8	0.9363	0.9683	1	0.4164	0.9553	5.5058	5
x_9	0.2545	0.5205	0.4263	1	0.6013	4.114	10
x_{10}	0.3716	0.3828	0.3417	0.5029	1	4.6049	8
Σr	4.8154	6.2412	6.0228	4.9138	6.5482	53.2089	-
Place I_y	7	2	3	6	1	-	0.5321

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

	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 4: Correlation matrix of the binary relations at correlation $r \geq 0,7$.

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

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

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	374.70374	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	-0.0023136	1	-4.55658e-8	3.29629	0	0	0.9525
x_7	x_8	-1.14232e7	0	1.53724	0.3491	0.0044124	1.60871	0	0	0.9514
x_8	x_6	1652.6879	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	227.60211	0	-0.0020124	1	-5.09798e-7	3.12871	0	0	0.9021
x_2	x_{10}	23.75135	0	-0.017314	2.67978	17.15156	1.95212	0.051754	6.18305	0.8915

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x_7	x_6	386020.2	0	0.0078186	0.94425	-6774.0186	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
x_4	x_{10}	23.48359	0	8.2251	1	996.42298	1.43515	5.22215	1	0.7067

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.

Table 6: Parameters of regularities of mutual influence of indicators.

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

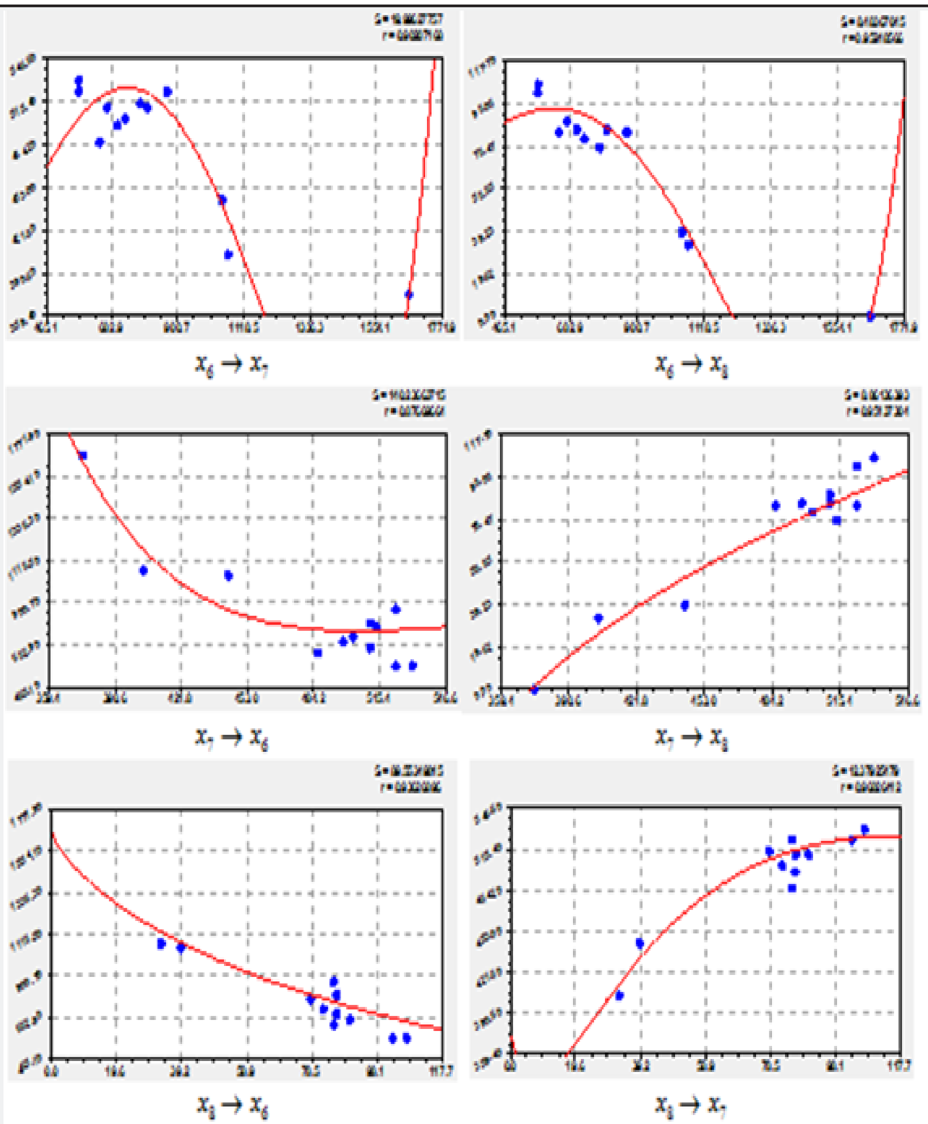

Figure 1: Schedules of the binary relations of the first cluster of regularities.

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Table 7: Parameters of regularities of mutual influence of indicators.

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

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 porority), x_5 (Unsaturated Hydraulic conductivity exponent) and x_{10} (SMD end July). In Figure 2 schedules of the binary relations are shown. The coefficient of correlation is given in the right top corner of the schedule.

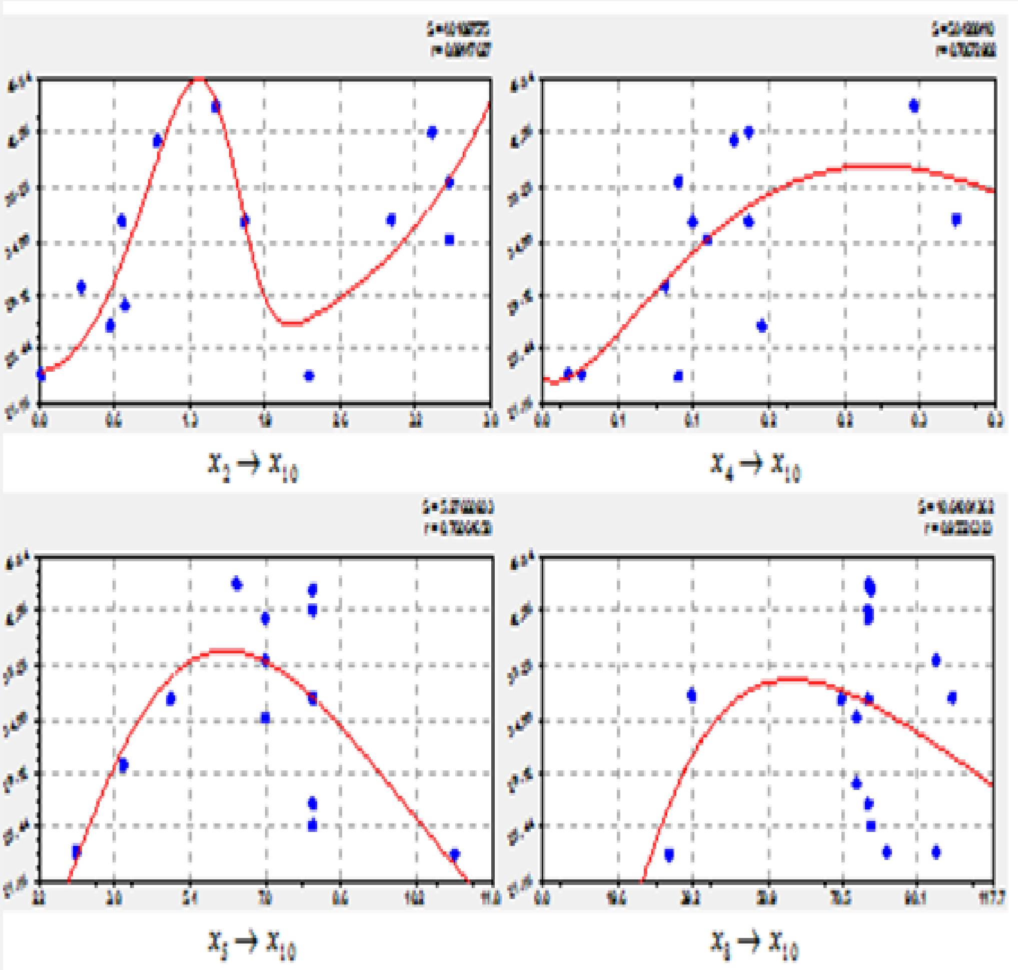

Figure 2: Schedules of the binary relations of the second cluster of regularities

Table 8: Third cluster of the binary relations.

	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	

Third cluster: It is received by addition to the group of regularities of influence of which is available in the Table 4 (Unsaturated Hydraulic conductivity exponent) (Tablet 8). This influence on three indicators x_1 (Topsoil hydraulic conductivity), x_2 (Subsoil hydraulic conductivity) and x_5 (Subsoil drainable porority) happens to correlation coefficients less than 0.7. In Figure 3 schedules of eight binary relations are given. In addition to the Table 5 influence happens on formulas:

$$x_4 = 0.00089702 x_5^{5.30108} \exp\left(-0.72580 x_5^{0.99904}\right) \quad (2)$$

$$x_2 = 9.97568 \cdot 10^7 x_5^{18.18652} \exp\left(-28.52592 x_5^{0.31926}\right) \quad (3)$$

$$x_1 = 3.11204 \cdot 10^{-6} x_5^{20.53199} \exp\left(-4.05046 x_5\right) + 1.55852 \cdot 10^{-48} x_5^{89.91067} \exp\left(-9.51579 x_5\right) \quad (4)$$

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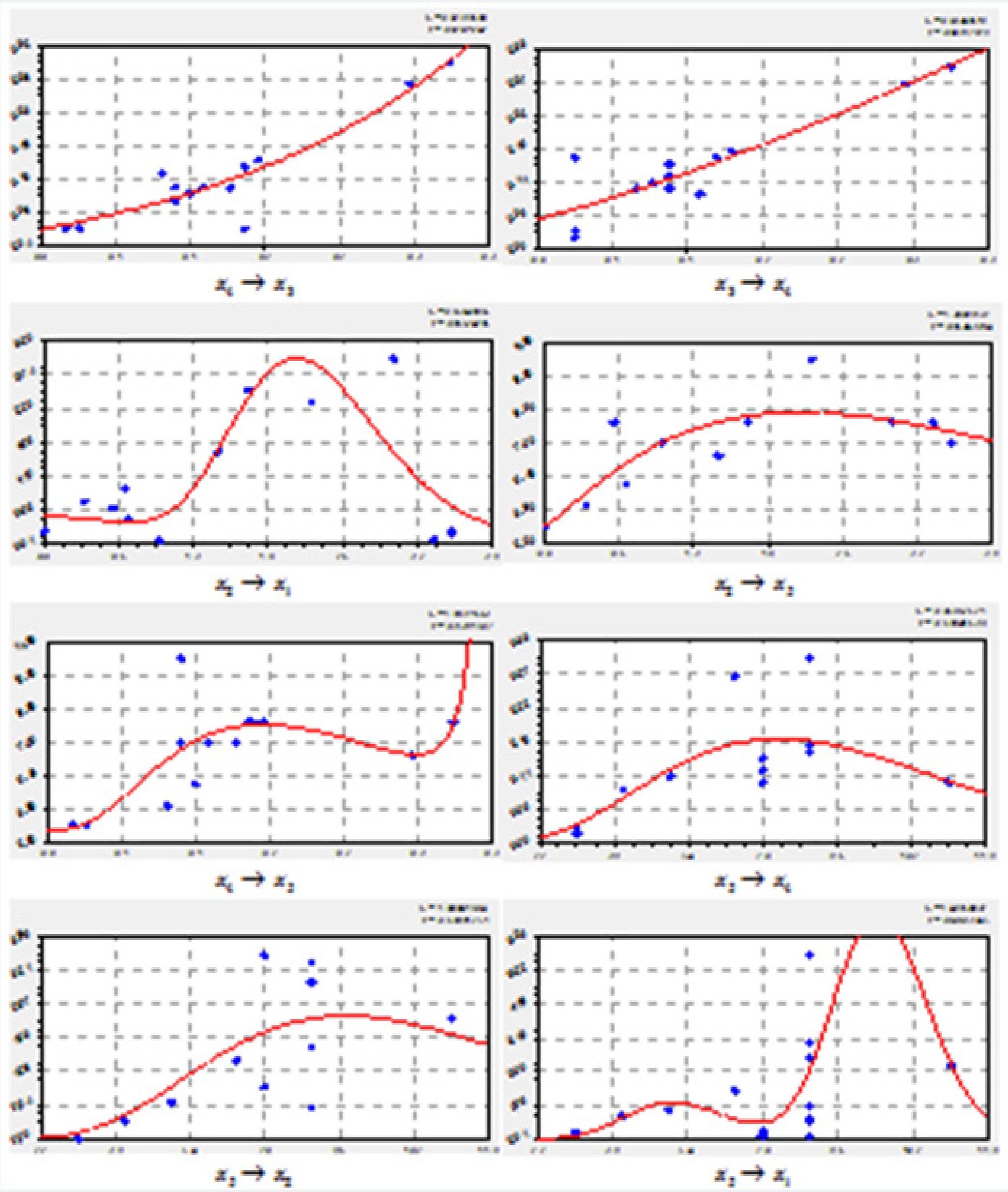

Figure 3: : Schedules of the binary relations of the third cluster of regularities.

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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