

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

Mazurkin PM\*

Doctor of Engineering, Academician of Russian Academy of Natural History Russian, Russia

## 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

$$y = a_1 x^a \exp(-a_3 x^a) + a_2 x^{a6} \exp(-a_7 x^{a8}) \quad (1)$$

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.

\*Corresponding author: Mazurkin PM, Academy of Natural Sciences, Member of the European Academy of Natural Sciences, Volga State University of Technology, Russia, Tel: 7 836 245-53-44; E-mail: [kaf\\_po@mail.ru](mailto:kaf_po@mail.ru)

Received November 14, 2016; Accepted March 29, 2017; Published March 31, 2017

Citation: Mazurkin PM (2017) Factor Analysis of Influence of Parameters of Water Regime and Hydrological Changes on Pastures. J Phys Math 8: 220. doi: 10.4172/2090-0902.1000220

Copyright: © 2017 Mazurkin PM. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Site name	Topsoil hydraulic conductivity (m day)	Subsoil hydraulic conductivity (m day)	Topsoil drainable porosity	Subsoil drainable porosity	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
Motley 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	Dependent factors (indicators y)					Sum	Place
							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	$x_6$	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	$\sum_r$	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  $100 \times 15/(102-10)=16.67\%$ . 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.

### 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.

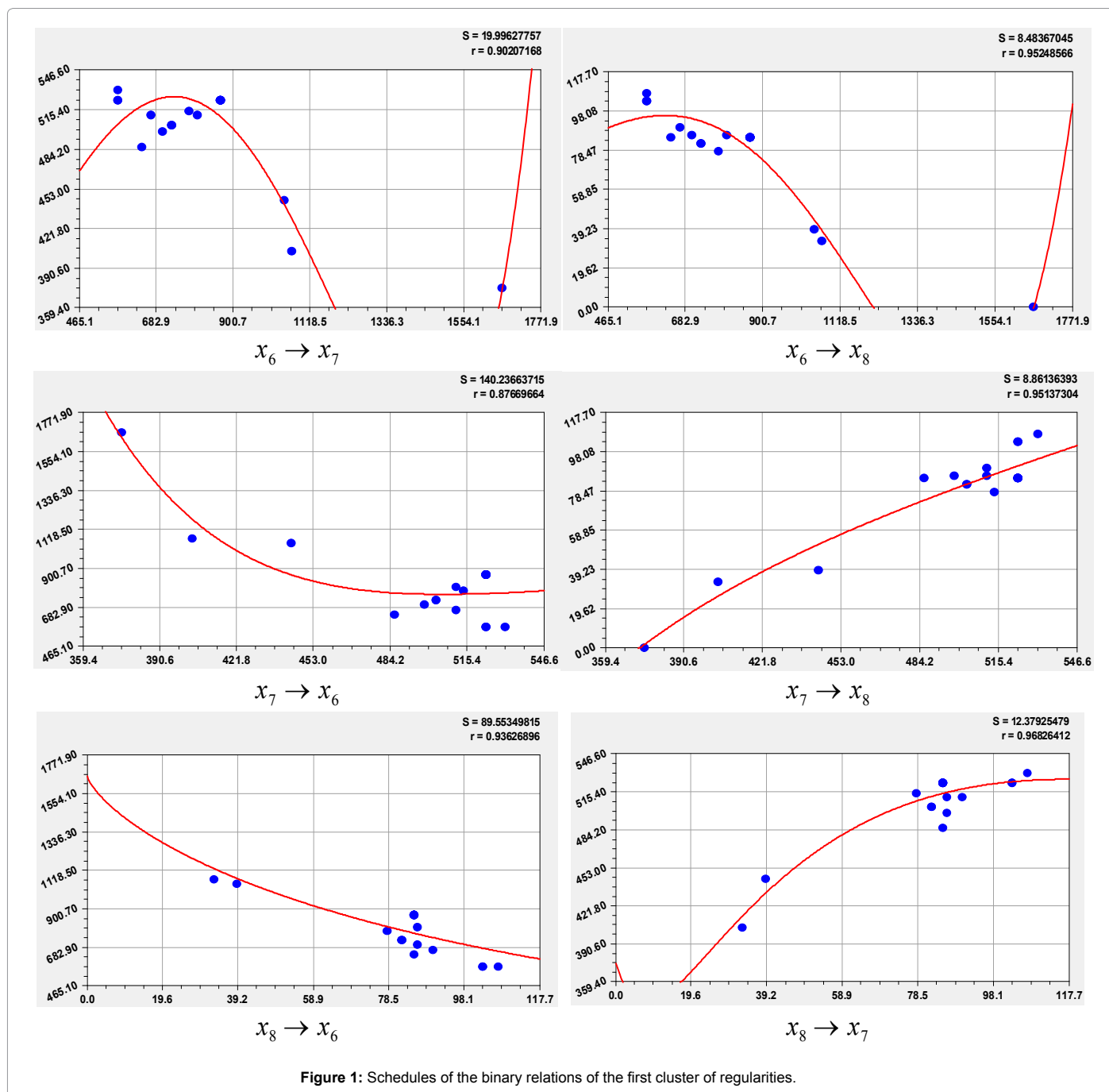


Figure 1: Schedules of the binary relations of the first cluster of regularities.

	$x_1$	$x_3$	$x_4$	$x_5$	$x_6$	$x_7$	$x_8$	$x_{10}$
$x_2$	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  $r \geq 0,7$ .

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. $r$
$x$	$y$	First component				Second component				
		$a_1$	$a_2$	$a_3$	$a_4$	$a_5$	$a_6$	$a_7$	$a_8$	
$x_3$	$x_7$	374.7037	0	0.026208	1	6.51818e6	5.0856	16.64811	0.14794	0.9683
$x_3$	$x_{10}$	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
$x_2$	$x_{10}$	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
$x_4$	$x_{10}$	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.

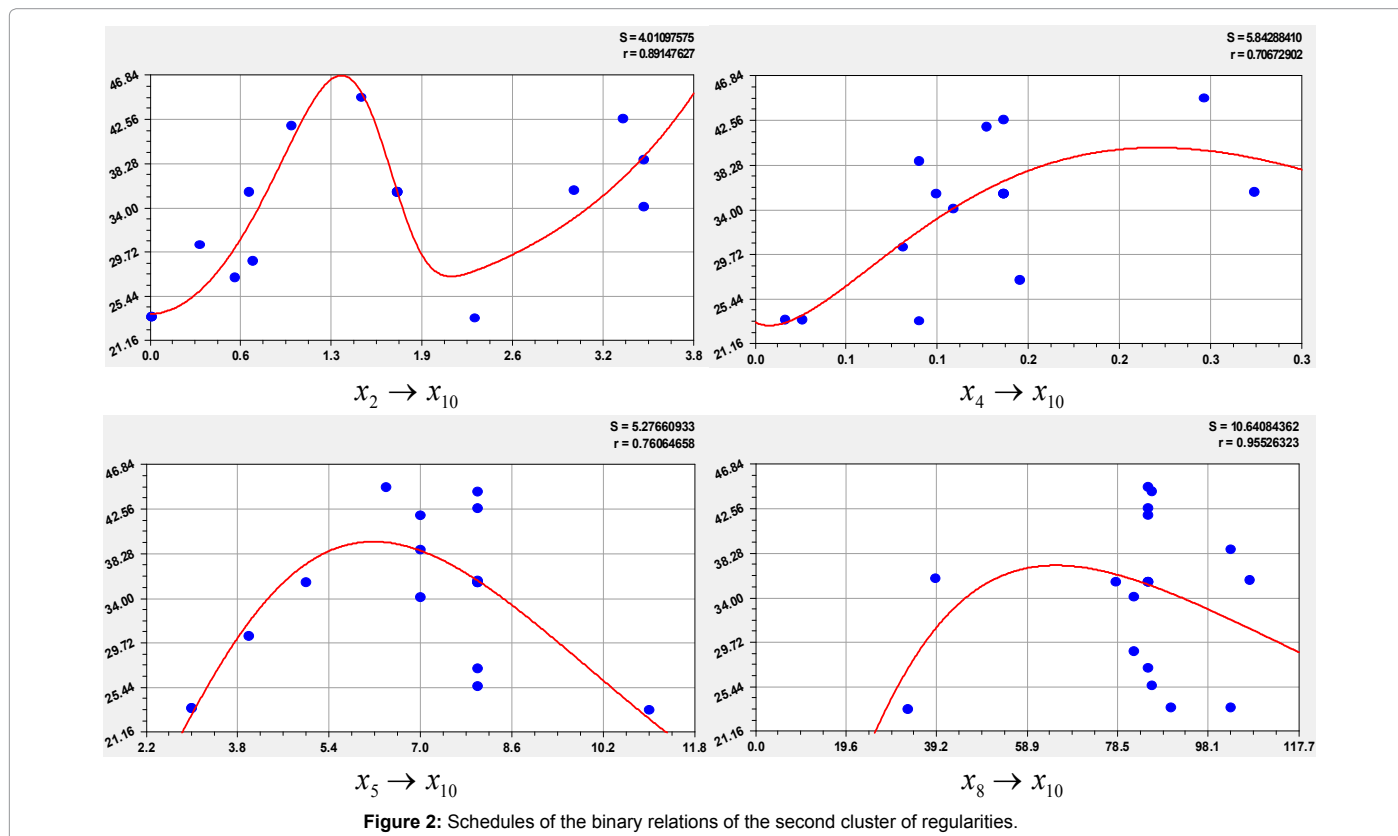


Figure 2: Schedules of the binary relations of the second cluster of regularities.

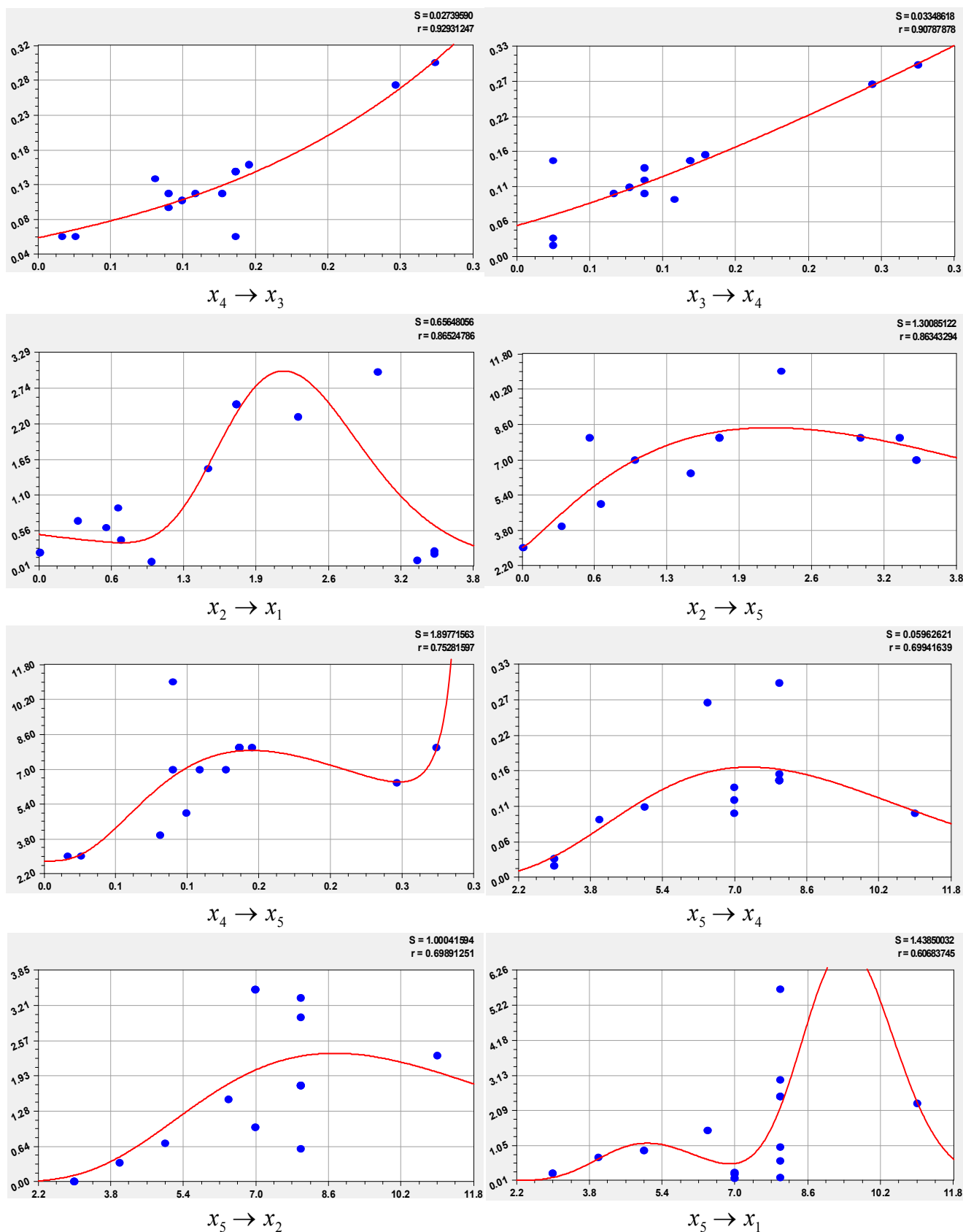


Figure 3: Schedules of the binary relations of the third cluster of regularities.

	$x_6$	$x_7$	$x_8$
$x_6$		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 porosity),  $x_3$  (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 porosity) 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:

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

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

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

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.

### References

1. Gowing DJG, Lawson CS, Youngs EG, Rodwell JS, Prosser MV, et al. (2002) The Water Regime Requirements and the Response to Hydrological Change of Grassland Plant Communities. DEFRA-commissioned project BD1310, Final report to the Department for Environment, Food and Rural Affairs, Institute of Water and Environment, Silsoe Bedford 98.
2. Mazurkin PM (2014) Method of identification 14<sup>th</sup> International multidisciplinary scientific geoconferent & SGEM2014, Geo Conference in Nano, Bio and Green-Technologies for a Sustainable Future. Conference proceedings 1: 17-26.
3. Mazurkin PM (2014) Factor analysis of the technical level of single-bucket hydraulic excavators. International Journal of Engineering and Innovative Technology 3: 84-92.
4. Mazurkin PM (2014) Statistical modeling of entire prime numbers. International Journal of Engineering and Technical Research (IJETR) 2: 148-158.
5. Mazurkin PM, Tishin DV (2015) Wave dynamics of tree-ring width of Oak. Integrated Journal of British 2: 55-67.