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Cottbus, Germany – Dnipro, Ukraine

Brandenburg University of Technology Cottbus - Senftenberg

DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service

DNIPRO UNIVERSITY of TECHNOLOGY 1899

«Modeling the Management of the Ecological and Economic System»

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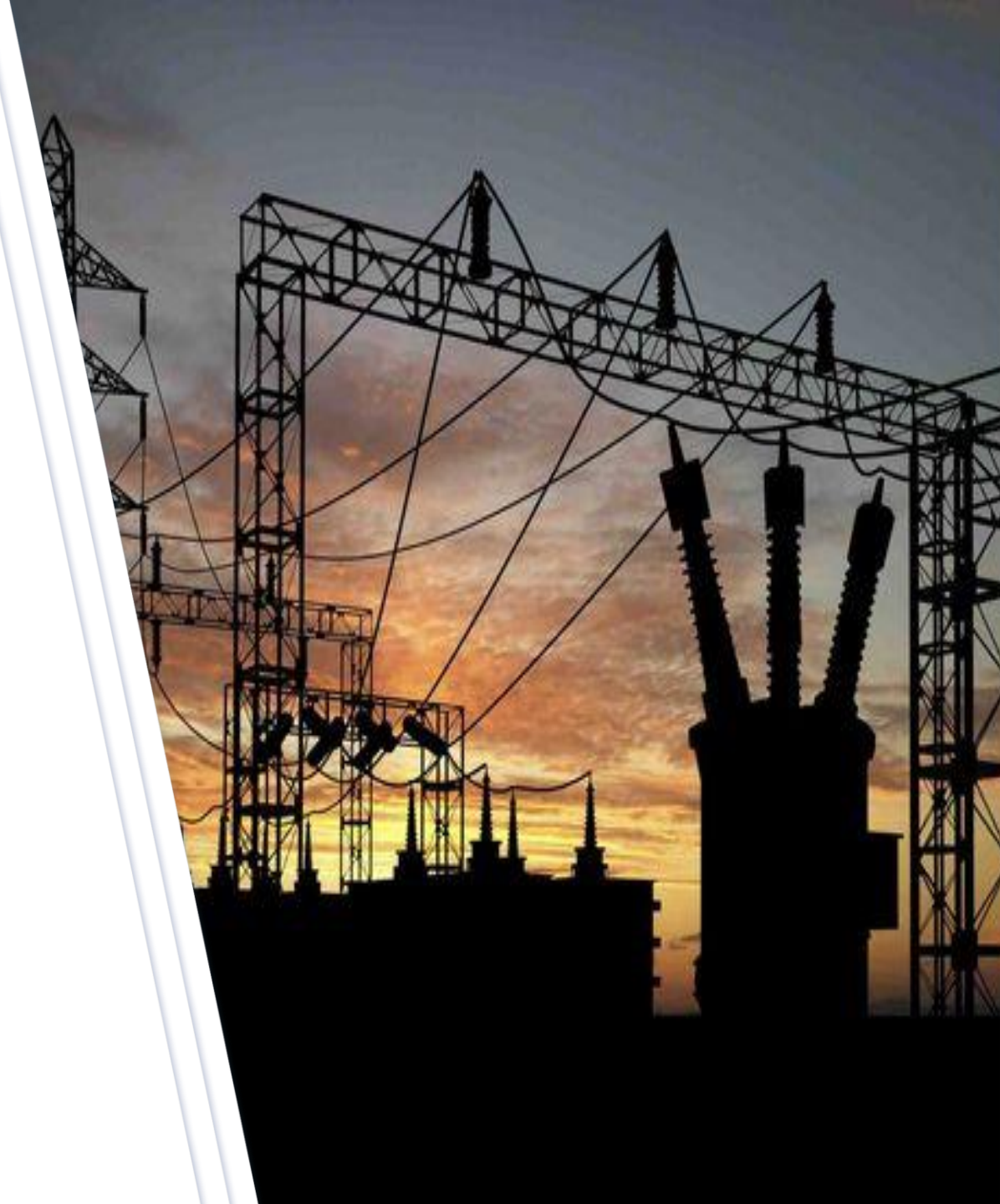
Co-authors:

Questions for discussion

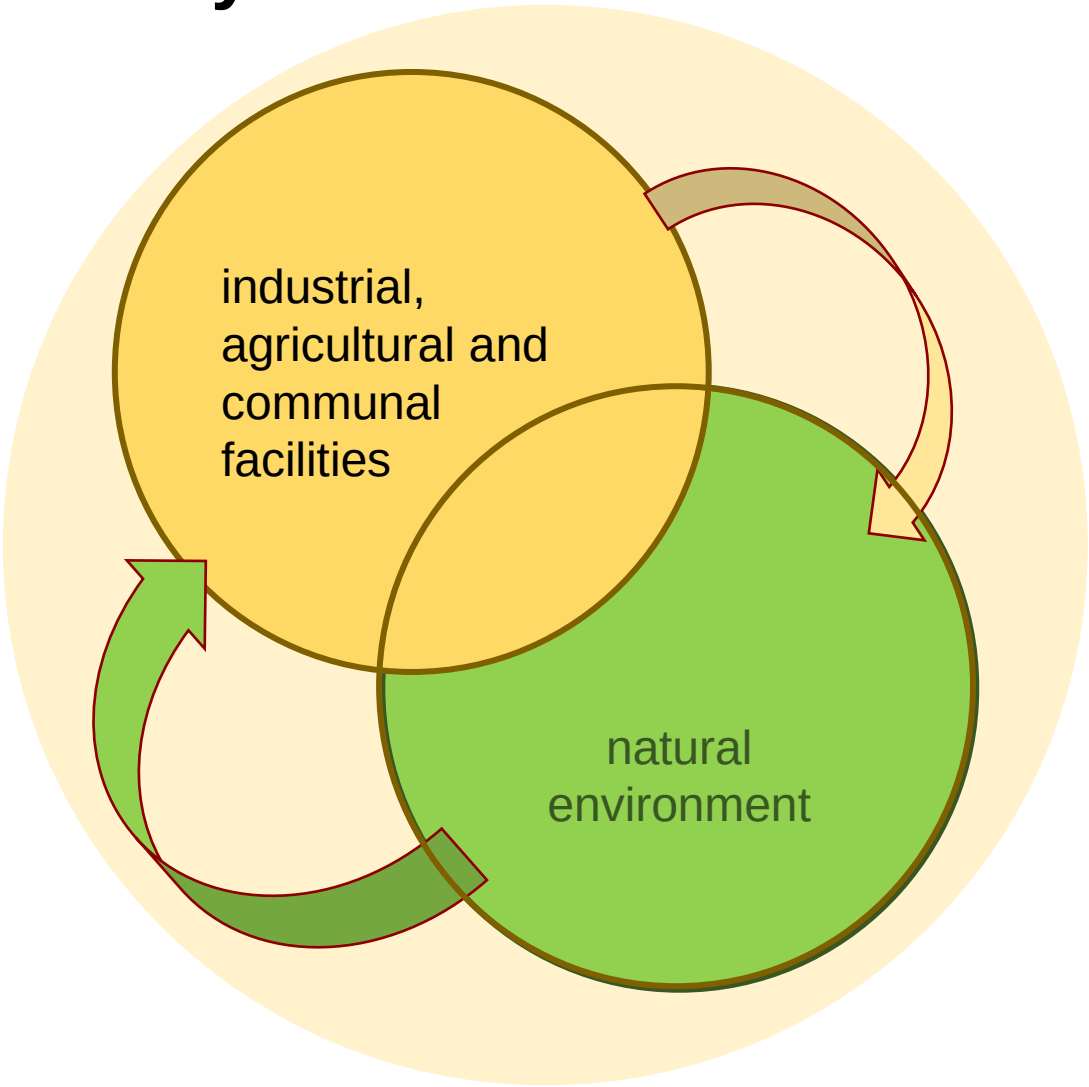
- Problems of modeling of ecological and economic systems.
- The concept of model and modeling.
- Classification of models and stages of modeling.
- Using cognitive analysis to model ecological and economic systems.



Ecological and economic system

The essence of the ecological-economic system consists in the system-organized interaction of the economy and nature with the use of interrelated organizational, economic and social activities.

Its goals include the formation, distribution, redistribution of the means of production at the level of the production system and the creation of conditions for the rational use of natural resources in order to ensure the sustainable and efficient functioning of the enterprise and environmentally friendly safe working conditions.



Features of ecological and economic systems

1. They are characterized by a certain mismatch between economic development and environmental requirements, which causes their significant man-made load on the environment.

2. They are poorly structured, namely

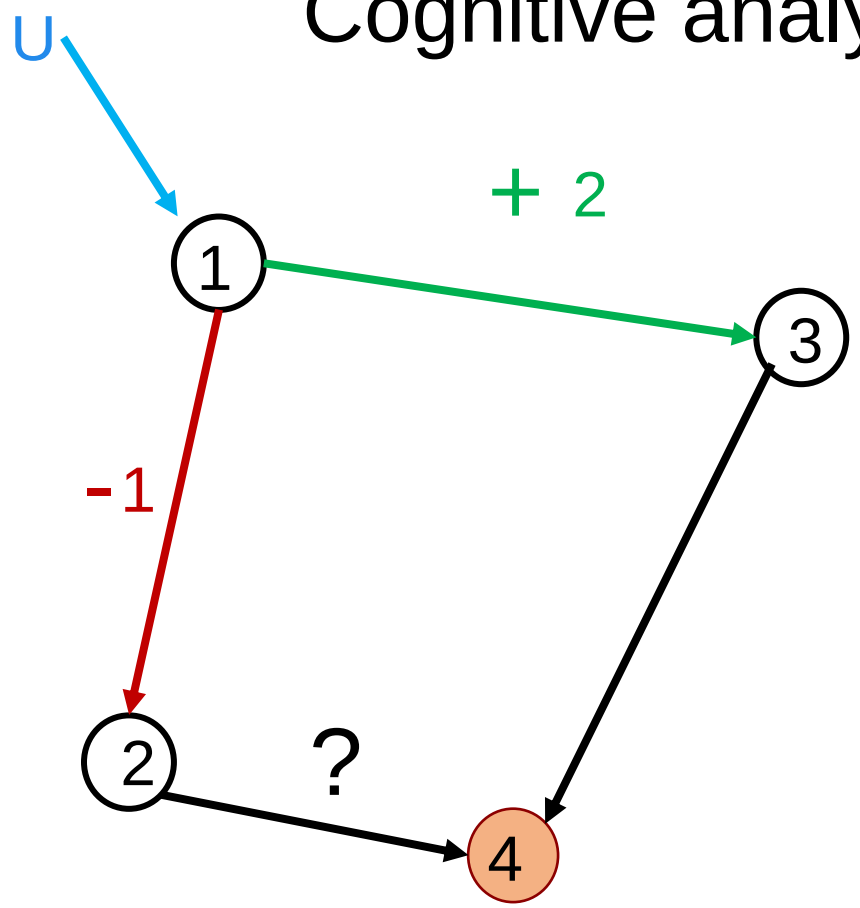
The system of concepts (factors) and connections between them is not defined with sufficient completeness.

The main parameters of the situation (values of factors, the degree of influence of some factors on others) - are not quantitative but qualitative,

The values of the parameters of the situation are often their subjective assessments.

There are no pre-formulated alternatives in such situations; they arise in the process of their analysis.

Cognitive analysis and cognitive modeling



$$Y_i(k+1) = Y_i(k) + \sum_{j=1}^{n} a_{ij} P_j(k) \qquad (1)$$

$$P_i(k+1) = \sum_{j=1}^{n} w(v_j, v_i) P_j(k) \qquad (2)$$

Cognitive modeling allows static analysis, or impact analysis - is the analysis of the situation by studying the structure of mutual influences of the elements of the cognitive map and dynamic analysis, which is to generate possible scenarios for the situation over time.

The main directions

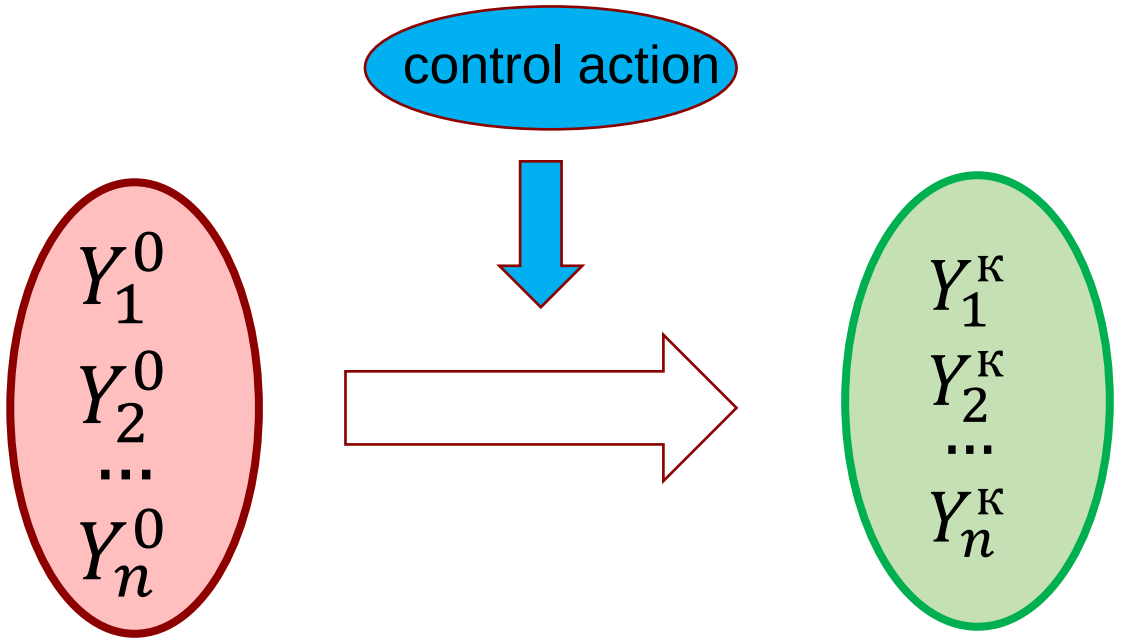
- impact analysis;
- analysis of the dynamics of change of state (forecast of the situation);
- stability analysis;
- scenario analysis;
- search for managerial influences;
- assessment and interpretation of forecasts of the situation

Problems that can be solved using cognitive models

1. It is known the initial state of the system and the principles and conditions of its operation, to determine the state in which the system will be after a certain period, if the conditions remain constant.

2. It is known the initial state of the system and the control to be applied, to determine the state of the system after a certain period, if this control is applied.

3. The initial state of the system and its desired state after a given period of time is known. You must define the controls that must be applied to bring the system to the specified state.



The initial state of the system

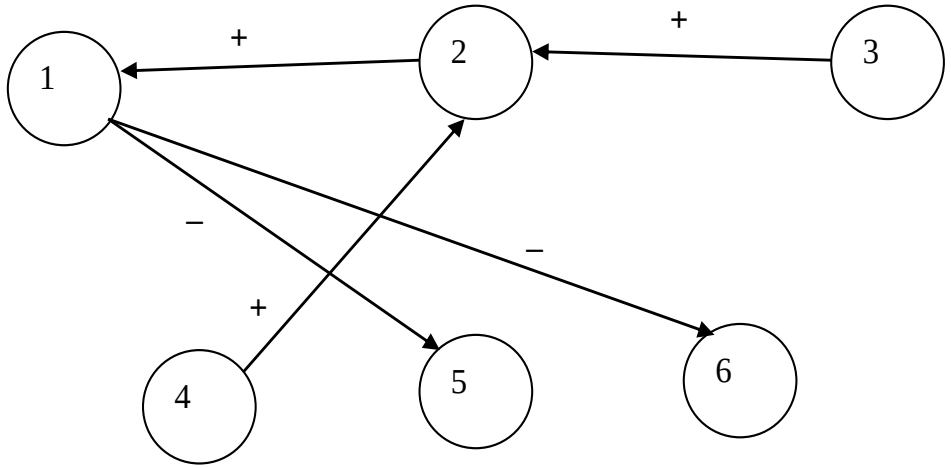
The final (desired) state of the system

The problem statement

The state of the enterprise at each point in time is assessed by a set of indicators. The initial values of these indicators are known,
it is necessary:

- Predict the value of these indicators for the next 5 years;
- Identify management influences that achieve the desired performents of the company over a period of time;
- Identify the influence under which a given ratio is achieved between the company's performance and investment in nature protection

Construction of a cognitive map



ВЫВОД ИТОГОВ

Регрессионная статистика	
Множественный R	0,957310667
R-квадрат	0,916443712
Нормированный R-квадрат	0,716443712
Стандартная ошибка	231,7329123
Наблюдения	6

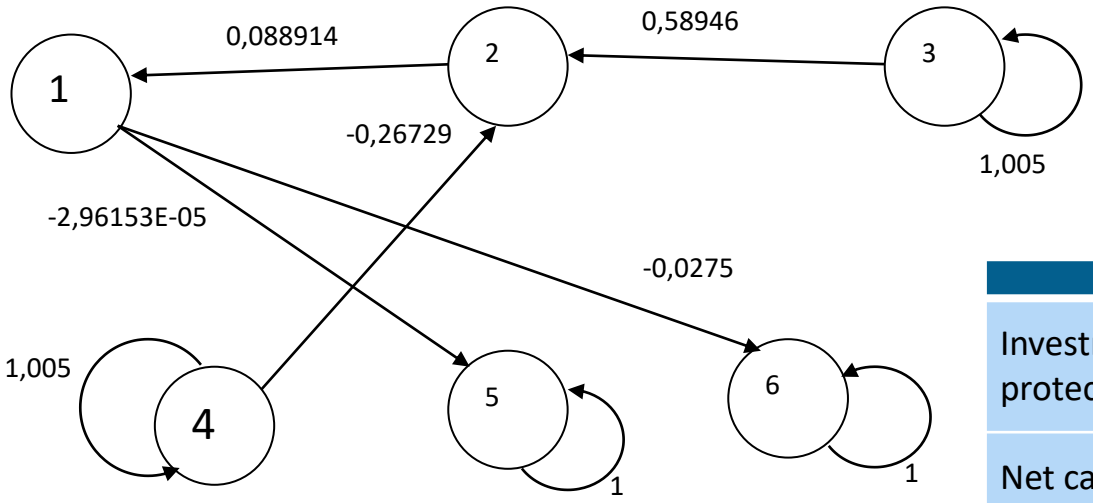
Дисперсионный анализ

	df	*SS*	*MS*	*F*	*Значимость F*
Регрессия	1	2944910,517	2944910,517	54,8399012	0,00177388
Остаток	5	268500,7132	53700,14264		
Итого	6	3213411,23			

	Коэффициенты	*Стандартная ошибка*	*t-статистика*	*P-Значение*	*Нижние 95%*	*Верхние 95%*	*Нижние 95,0%*	*Верхние 95,0%*
Y-пересечение	0	#Н/Д	#Н/Д	#Н/Д	#Н/Д	#Н/Д	#Н/Д	#Н/Д
Переменная X 1	0,088914442	0,012006709	7,405396762	0,00070672	0,058050214	0,119778669	0,058050214	0,119778669

1 - investments in environmental protection, mln. UAH
2- net cash flow, mln. UAH
3 - coal production, thousand tone.
4 - electricity generation, million kWh
5 - specific emissions into the atmosphere thousand tons / thousand tons
6 - specific discharges of wastewater, million cubic meters. m / mln kWh

Model analysis

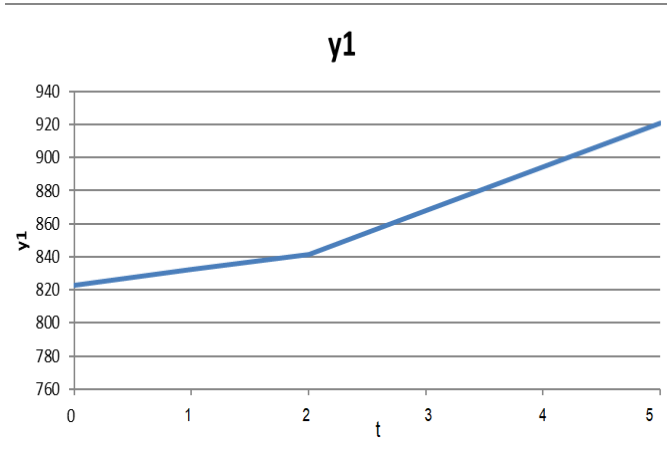


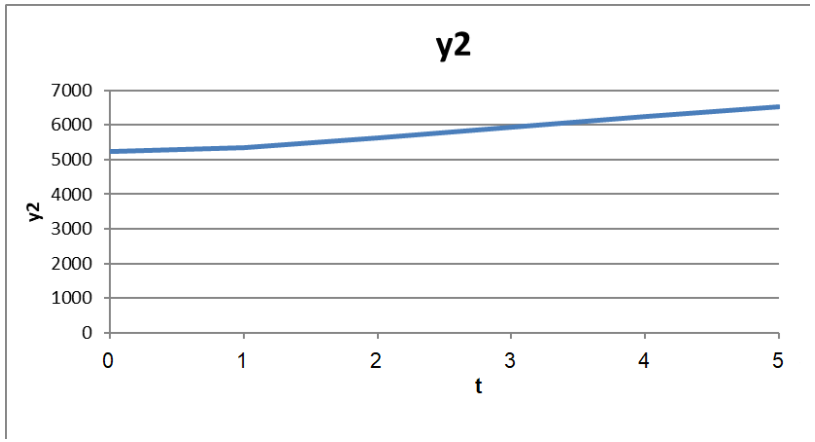
$$Y_i(k+1) = Y_i(k) + \sum_{j=1}^{n} a_{ij} P_j(k) \qquad (1)$$

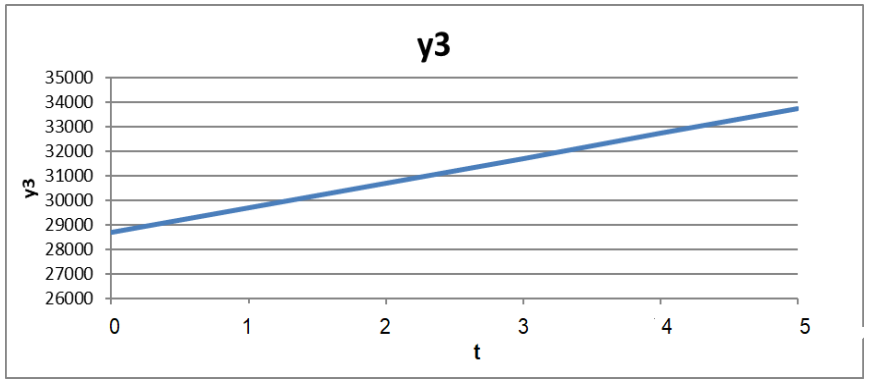
Projected changes in the company's performance over 5 years

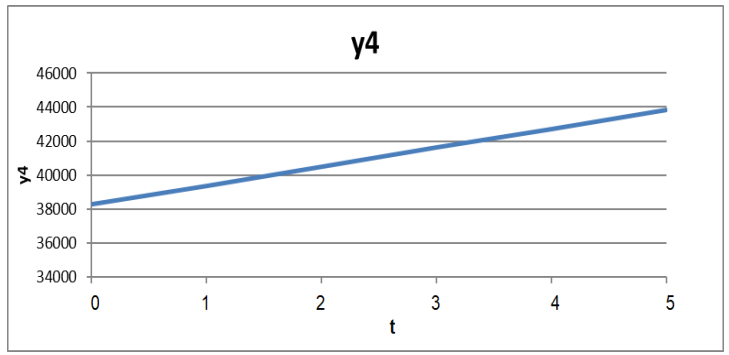
Indicator / year	1	2	3	4	5
Investments in environmental protection, mln. Uah	10	8,891444	26,268755	26,4001	26,5321
Net cash flow, mln. Uah	100	295,4386	296,91576	298,4003	299,8923
Coal production, thousand tone.	1000	1005	1010,025	1015,075	1020,151
Electricity generation, million kwh	1100	1105,5	1111,0275	1116,583	1122,166
Specific emissions into the atmosphere thousand tons / thousand tons	0	-0,0003	-0,000559	-0,00134	-0,00212
Specific discharges of wastewater, million cubic meters. M / mln kwh	0	-0,27531	-0,520092	-1,24329	-1,9701

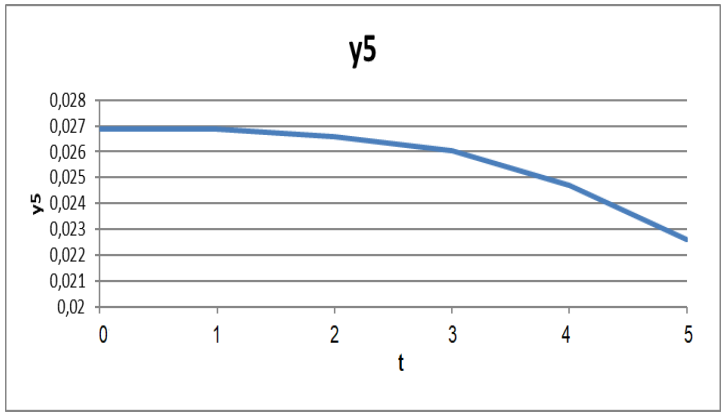
Projected changes in the company's performance over 5 years

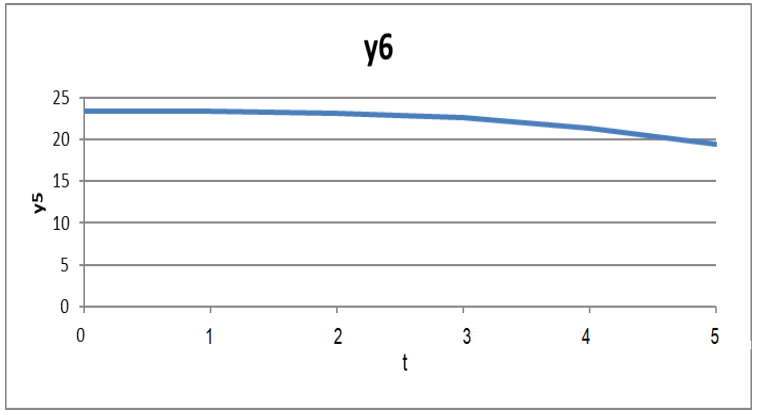












Y1 - investments in environmental protection, mln. UAH; Y2- net cash flow, mln. UAH; Y3 - coal production, thousand tone; Y4 - electricity generation, million kWh; Y5 - specific emissions into the atmosphere thousand tons / thousand tons; Y6 - specific discharges of wastewater, million cubic meters. m / mln kWh

The problem of finding management influence that allows you to achieve the desired indicators of the company.

$$\bar{u}(k) = (I + A + A_{M1} + (A_{M2} - A)q^{-1})[\bar{G} - \bar{y}(k)] \quad (6)$$

$$\bar{y}(k) = -A_{M1}\bar{y}(k-1) - A_{M2}\bar{y}(k-2) + (\mathrm{I} + A_{M1} + A_{M2})\bar{G} \quad (7)$$

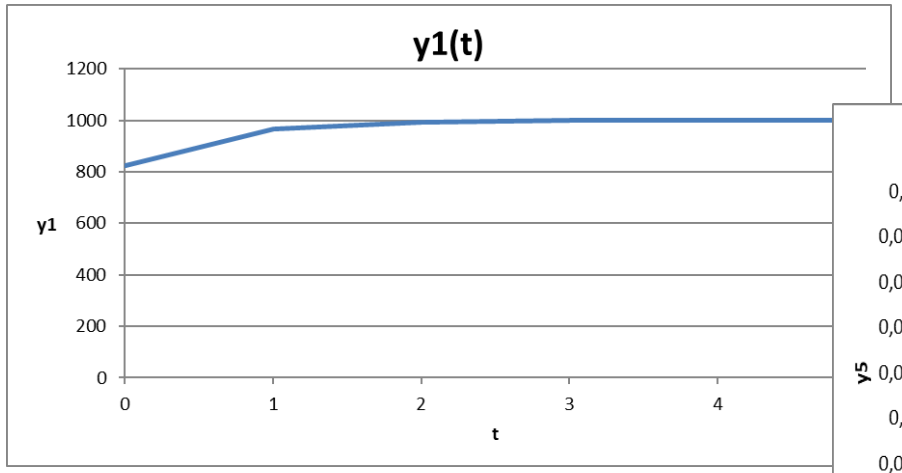


Figure -1 Graph of changes in the indicator "investment in environmental protection"

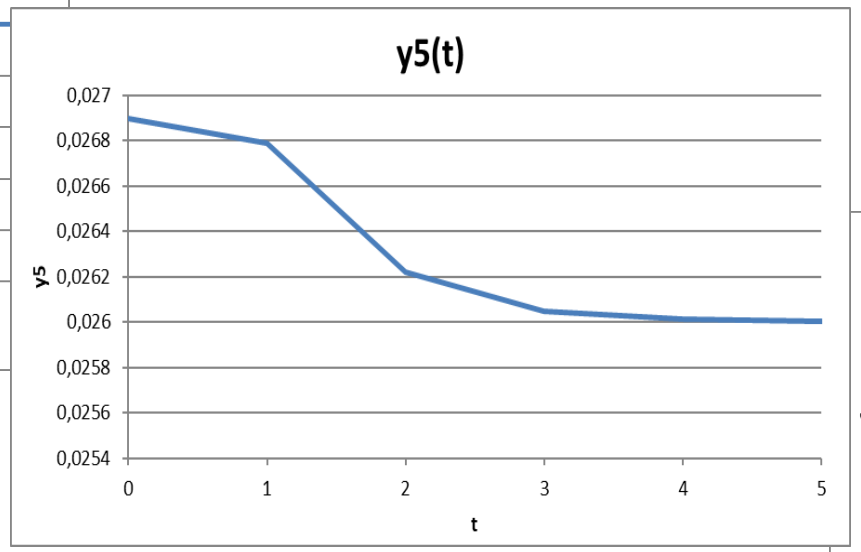


Figure -2 Graph of changes in the indicator of specific emissions into the atmosphere

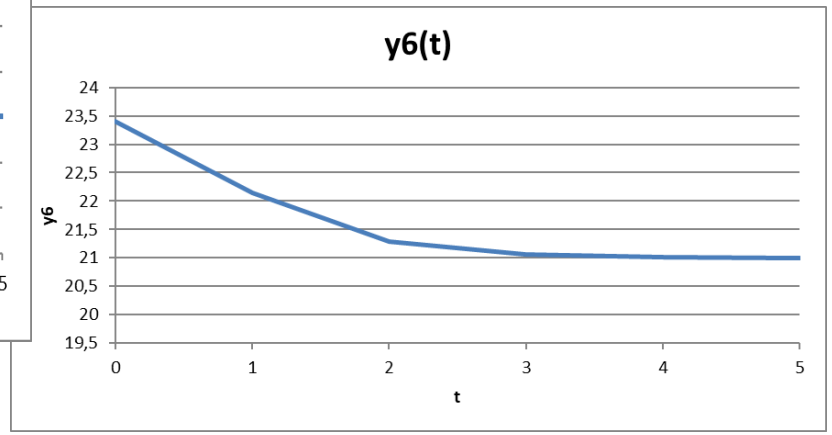
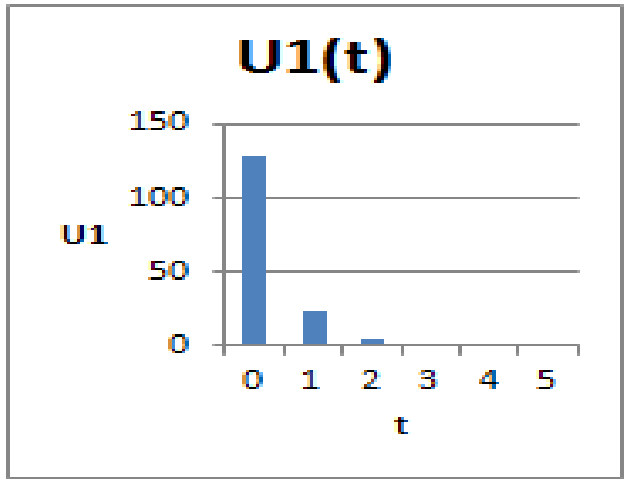
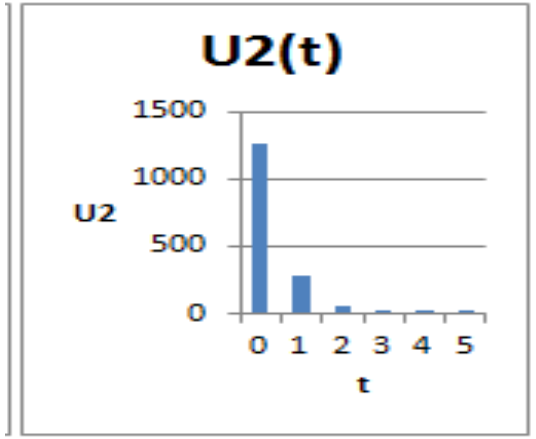
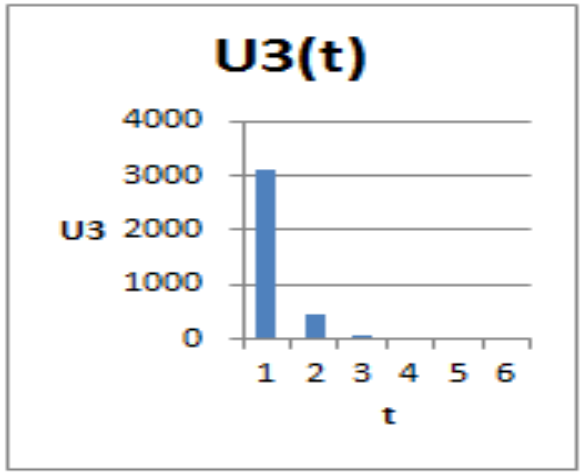


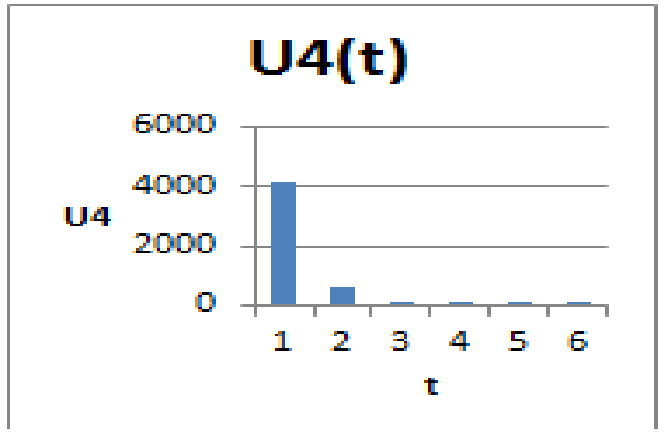
Figure -3 Graph of changes in the indicator of specific wastewater discharges

The received control influences



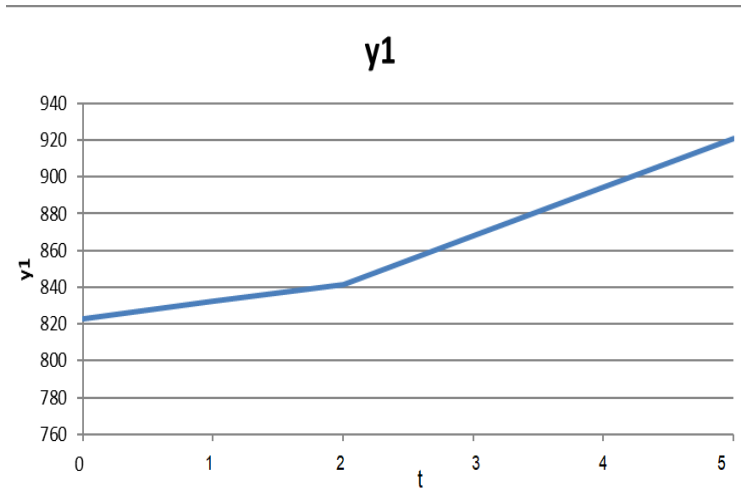


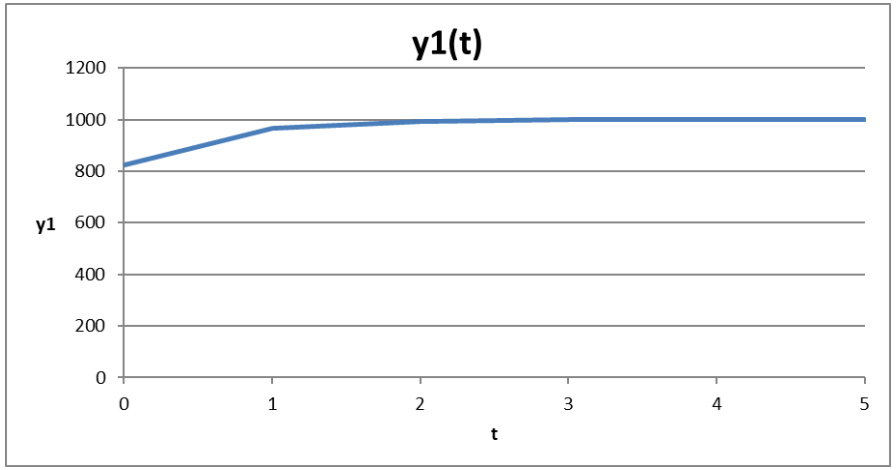


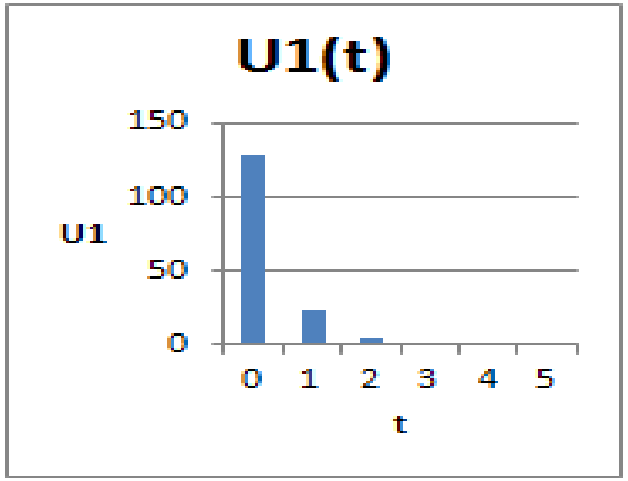


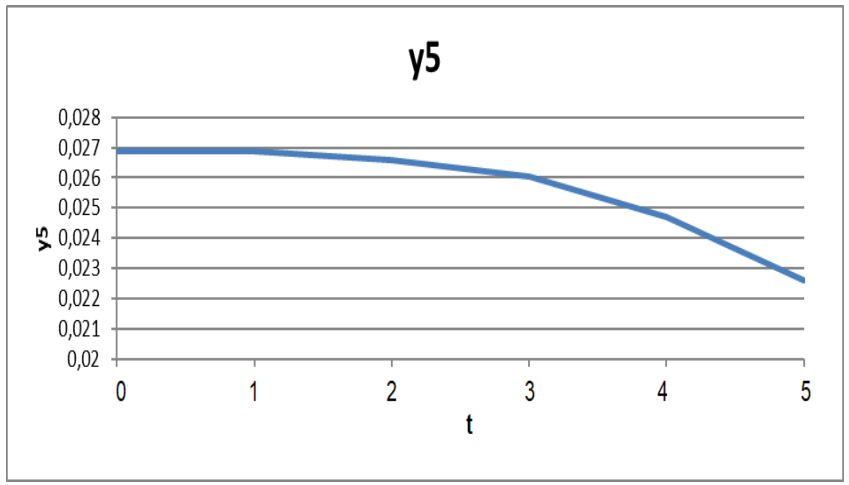
Management influence for indicators: Y1 - investments in environmental protection; Y2- net cash flow; Y3 - coal production; Y4 - electricity generation

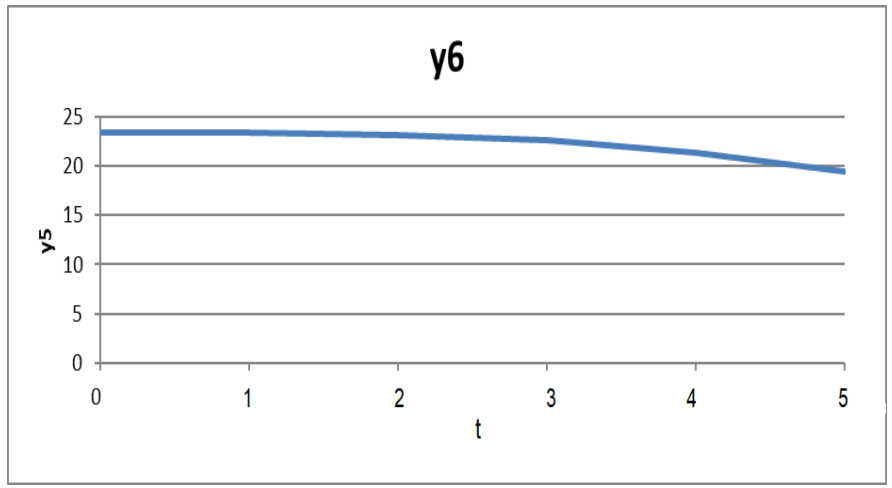
Graphs of changes in the indicator «investment in environmental protection»

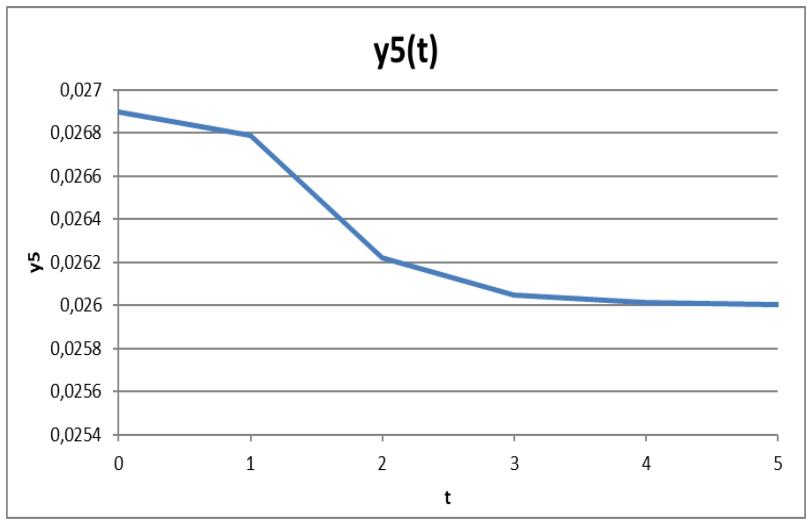


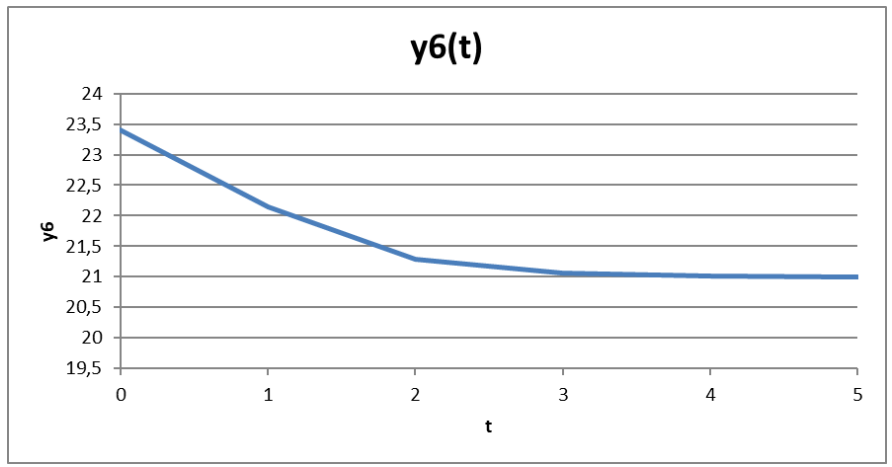




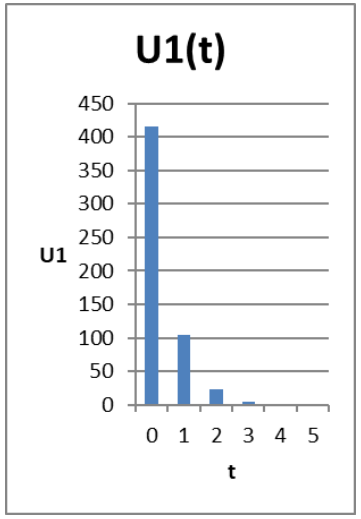

y5
0,028
0,027
0,026
0,025
0,024
0,023
0,022
0,021
0,02
y5
0
1
2
3
4
5
t

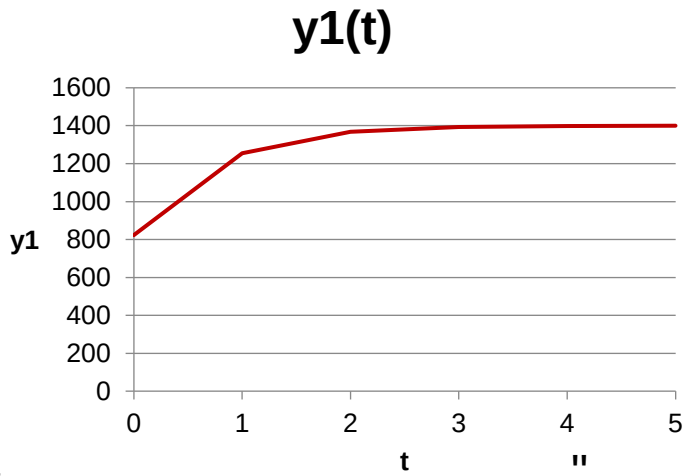

y6
25
20
15
10
5
0
y5
0
1
2
3
4
5
t


y5(t)
0,027
0,0268
0,0266
0,0264
0,0262
0,026
0,0258
0,0256
0,0254
y5
0
1
2
3
4
5
t

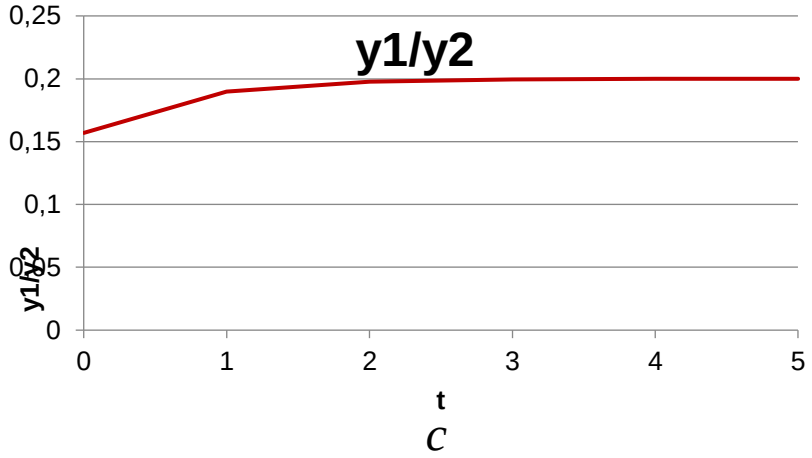

y6(t)
24
23,5
23
22,5
22
21,5
21
20,5
20
19,5
y6
0
1
2
3
4
5
t

The problem of finding management that achieves a given ratio between the performance of the company and investments in environmental protection





a



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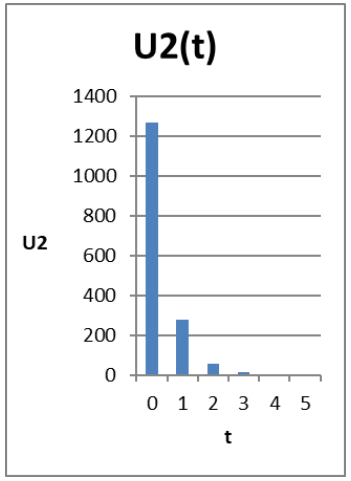

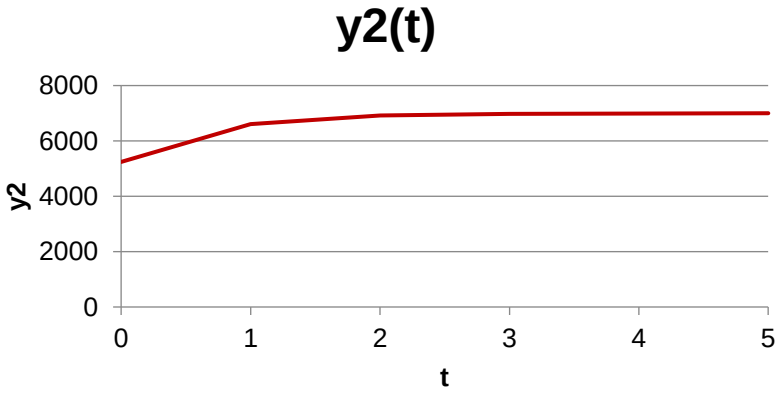

b

a- management influence and graph of changes the indicator Y1 - investments in environmental protection, mln. UAH;

b - management influence Graph of changes the indicator Y2- net cash flow, mln. UAH;

c - graph of changes the ratio of indicators Y1 and Y2

Conclution

It is advisable to apply cognitive modeling to increase the validity of management decisions when developing a scenario for achieving the desired state of the ecological and economic system.

For a deeper analysis of the model described in the form of a weighted cognitive map, it is necessary to establish special assumptions about the influence of the values of the characteristics of one factors on the characteristics of the remaining factors.

The choice of such a rule has a significant impact on the conclusions that will be obtained when applying the model.

Thank you for your attention