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A Dynamic Model for Regional Analysis

The present study is an experiment of dynamic modelling of a complex social system. The main economic, social and political levels which characterize the dynamic framework of the development of the territory are followed. The main utilizations of the dynamic model achieved with the aid of the Forrester type techniques are pointed out.

Today there is increasing recognition among scientists that the system approach is required for understanding and resolving many problems related to social development. Our inability to determine and implement "the best" policies that would steer the social systems from their present states to more ideal future states, have led some scientists to invent what has come to be called "systems dynamics" modelling, which includes such factors as population, technology, and the natural environment. The concept sprang essentially from the preoccupation of scholars in recent years with the interactions of the above major factors rather than with the sum of the system's isolated parts. The major premise of these technique is that it is often possible to understand and to express the properties of the components of a large social system in mathematical terms and by so doing to describe and predict the total system behaviour.

The basic notion of system dynamics has been used extensively in economics for decades. Unfortunately, the dynamic model of a social system is construided only upon assumption which are intuitively plausible to the model-builder.

The behaviour of the model is examined by calculating the dynamic paths of the variables. The difficulty of validation-by testing predictions against empirical evidence or intuitive judgement-is probably the essence of the dispute about the value of "systems dynamics" modelling. There have been, a great number of recent publications, attempts to invalidate or otherwise demonstrate the advantages of these techniques [5] — [7].

There are two ways to use a dynamic model. The first way is simulation. Computer simulation is often put forward as an attractive possibility for analysing complex problems such as occur in the analysis of the dynamics of regional systems. Simulation is a powerful tool, but there are a number of difficulties to be overcome before it can be applied with confidence in socially relevant situations.

These difficulties are not only computational but also philosofic.

The second way is to make explicit use of analytical methods for understanding and controlling the dynamical behaviour of a model.

The model is a computerized abstraction of a county obtained by employing a modelling philosophy developed by Forrester [2], [3] which characterizes a system as continuous flows of time-ranging objects interrelated by complex feedback and coupling mechanisms. The model consistes of a set of equations that describe the interactions among major sectors as:

— population
— labor
— public health
— housing
— industry
— agriculture
— education

These subsystems were chosen because they appear to be the dynamic framework of regional structure. The changes in agriculture, population and industry are the central processes involved in growth.

A model is build with an end in mind.

Our end was to demonstate the applicability of optimisation techniques to the generation of alternative policies for control of a regional system.

The answer to this question requires an assesment of the political, economic and technological state of the region factors which relate directly to controllability.

The expertise of systems and control engineering is potentially relevant to the problems of contemporany urban society. But the way in which this potential can be most fruitfully realized is less obvious.

The planer is faced with the task of devising a set of inputs (or policies) to an exceedingly complex dynamic environment which will alter that environment in desired direction.

The mechanisms available for performing the task are complex human organizations which must be designed, modified or manipulated. But only rarely is the policy maker given the opportunity to derive appropriate and efficient control inputs de novo. Instead his options are tightley constrained by the organizational mechanisms which already exist.

We are quick to admit that many of the topics discussed here have been incompletely, even superficially, elaborated.

Hopefulley some of these gaps will be filled by research in which we are presently engaged.

In this way, the present study — first in a serie — is rather an invitation to criticism than recommendation.

The first step in elaborating a model is the establishment of the variables of condition (levels) and of the decision points (rates) which we shall, in the following, call indicators.

For example, for a model made up of 8 submodels (population, labour force, health protection, housing, industry, agriculture, education, social-political), the indicators might be:

1. **Population**

1.1. The number and structure of the population
1.2. The average annual birth-rate
1.3. The average annual death-rate
1.4. Internal and external migration
1.5. Fertility

2. **Labour force**

2.1. The number of unskilled workers
2.2. The number of skilled workers
2.3. Managerial staff, specialists
2.4. The number of cooperative members

3. **Health protection**

3.1. The number of hospital beds
3.2. The growth rate of hospital beds
3.3. The obsolescence rate of hospital beds

4. **Housing**

4.1. Floor space area in use
4.2. The area of houses to be demolished
4.3. The rate of house building
4.4. The rate of house depreciation
4.5. The rate of house demolition

5. **Industry**

5.1. The level of capital goods
5.2. The rate of industrial investments
5.3. Discard of capital goods in industry
5.4. Industrial output
5.5. Productivity in industry

6. **Agriculture**

6.1. The level of capital goods in agriculture
6.2. The investment rate in agriculture

6.3. Dscard of capital goods in agriculture
6.4. The productivity of capital goods in agriculture
6.5. The surface of poorly productive land
6.6. The surface of arable land
6.7. The surface of urban-industrial grounds
6.8. The rate of ground lay out
6.9. The rate of the occupation of land

7. **Education**

7.1. The number and structure of the school-aged population
7.2. The rate of enrollings for training schools
7.3. The rate of enrollings for specialization schools
7.4. The rate of graduation from training schools
7.5. The rate of graduation from specialization schools
7.6. Proportions to the total

8. **Social political**

8.1. The quality of life
8.2. Crowding
8.3. Expectation of life
8.4. The number of party members and their proportion to the total population
8.5. The average number of trade-union members and their proportion to the total number of the population.

It is noticed that each submodel comprises besides the indicators specific of the respective field a number of other indicators.

Thus, besides the indicators of demographic structure (number, means, etc.) the population is also characterized by a number of indicators in which it is regarded both in its capacity of a producer and a consumer of the production of social services.

In the exemplifying references, we do not aim to explain in detail or to justify the necessity for such structures nor to motivate the relations between the indicators which belong to different models.

We must underline a fact which is already known, namely that the representation on submodels of the basic structures of the territorial system implies, in the last analysis, a certain degree of convention.

It is important that the main social-economic aspects should find their concrete illustration in one of the submodels and the respective indicators should result in an explicite way from the association and correlation of the other indicators in the territorial system.

3. THE MODELLING TECHNIQUE

In the attempt to answer the tasks of the model, we must have a guiding line which should schedule the activity of establishing the relations between the desired indicators. This line is offered by a modern modelling technique which considerably facilitates work.

The modelling technique used was described at length in [2] — [6].

The most important flows are mainly followed, flows which circulate the content of some of the levels, in our case the state variables of the model.

The growth and decrease rates of the levels are, in fact, decision functions. Generally, they have an equation of the form:

$$R \cdot KL = N \cdot K * RN * M \cdot K$$

The rate in the quantified time interval (K, L) is equal to a certain level of system $N.K$, multiplied by a normal rate RN and by a multiplier $M.K$ which depends on the time moment K and expresses the conditions different from the normal ones of moment K. Generally, $M.K$ nonlinearily depends on the values of some other levels of the system.

The level equations have the general form:

$$N \cdot K = N \cdot J + (DT)(RI \cdot JK - RE \cdot JK)$$

that is the level at moment K is equal to the level at moment J, plus the variation of the level in the period (J,K).

The establishment of the factors on which depend the rates, in fact, implies the closing of positive or negative feedback loops. The complex social systems, the category of which includes the territory as well, are characterized by a big number of levels and of feedback loops whose interaction leads to a counterintuitive behaviour of the system.

4. DESCRIPTION OF THE MODEL

The model comprises the following submodels:

a) — population;
b) — labour force;
c) — health protection;
d) — housing;
e) — industry;
f) — agriculture;
g) — education;
h) — social-political.

a) *The population submodel*

Two levels have been observed in this sector: urban and rural population with the flows town-village and village-town, immigration and emigration.

Fig. 1 represents the levels and rates in this sector.

The birth rate in urban RNUR appears depending on the multiplier fertility in urban FERU which is determined by the expectation of life in urban, ASVU, by a maximum biological rate of births, RNBBU, by health services NLPCL, and by the industrial production per capita of the population which influences the birth rate by a delay of the third order, which has the constant value of 10 years.

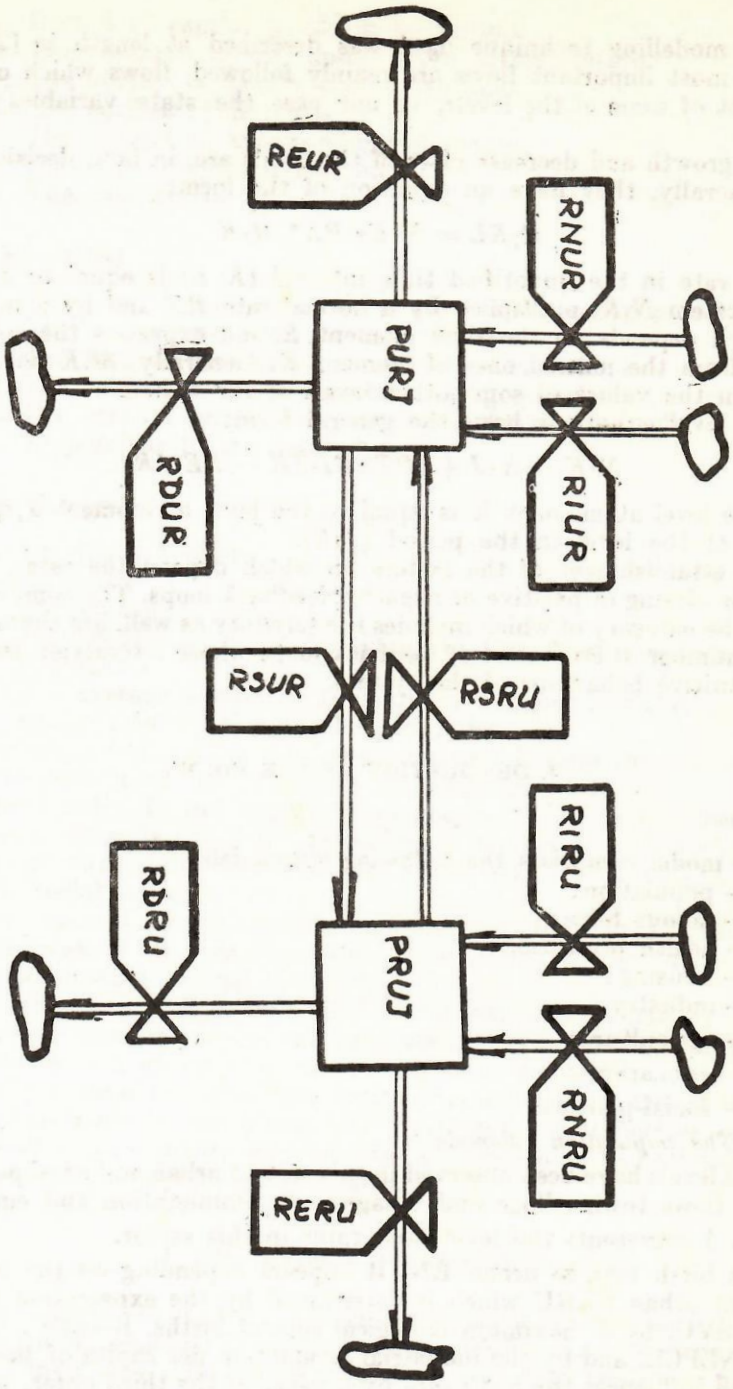

Fig. 1. Levels and Rates in the Population Submodel

The immigration rate into urban, RIUR, appears as determined by the atractiveness of the town ATRO, which acts with a delay in perception calculated with the aid of the delay of the third order which has the constant value of five years.

The atractivenss of the town ATRO depends on the jobs available MALO, on housing MAL, on health services MAOSS, on the possibilities of improving professional skill through various schools MAOI. The death rate in urban RDUR mainly depends on the multiplier the expectation of life ASVU which depends on the agglomeration on the territory AGLO, on health services per capita of the population NRPCL and on the food per capita produced on the territory ALIMCL.

The emigration rate REUR depends on the multiplier departures which is small when the attractiveness of territory ATRO is great.

The rate of rural-urban settle down RSRU depends on the attractiveness of towns ATRO, perceived with a delay of the first order having the constant value of 3 years and on the labour force available due to the mechanization of agriculture.

The rate of urban-rural settle down RSUR is taken in this model as a constant fraction of the urban population.

The flows and rates concerning the urban population are duplicated for the rural population.

Naturally, with regard to towns there are certain differences which have been included in the model. Thus, the influence of jobs in industry no longer appears in the multiplier of attractiveness of villages ATRS, but, appearing is the influence of the multiplier NLMAS the number of work places in the state agriculture of the county.

b) *The Labour Force Sub-model*

The following indicators are calculated in this submodel:

— the number of unskilled workers MNECI

— the number of skilled workers MCALI

— the number of specialists, managerial staff SCCIN

— the number of cooperative members NRPCJ

These indicators are calculated with the aid of the following levels in the informational flow: F R M N C — fraction of unskilled workers, F R M C A — fraction of skilled workers, FRSCC-fraction of specialists, managerial staff and FRCOP-fraction of cooperative members.

These four levels have the same type of equations:

$$FR{\cdot}K = FR{\cdot}J + (DT)(FN{\cdot}J - FR{\cdot}J)/TA$$

where $FR.J$ is the fraction at moment, $FN.J$ is the fraction necessary at moment J, DT the time interval (J, K), TA the adjustment time in which it is desired to pass from the existent fraction to the necessary fraction.

At each of these levels, the necessary fraction appears from the necessary work places.

The necessary labour force for each type of qualification was calculated in the model with the aid of fractions indicating the need for that type of labour per unit of capital goods.

The adjustment time, that is the time necessary for covering the work places with personnel appears as dependent on the possibilities of improving qualification and on the housing available.

The number of work places in agriculture, NLMA appears in the model as dependent on the arable land existing in the county and on the level of mechanization of agriculture.

c) *The Health Protection Submodel*

This sector is extremely important. It is an indicator of the entire sphere of services. Since, generally, services in the county are difficult to measure and

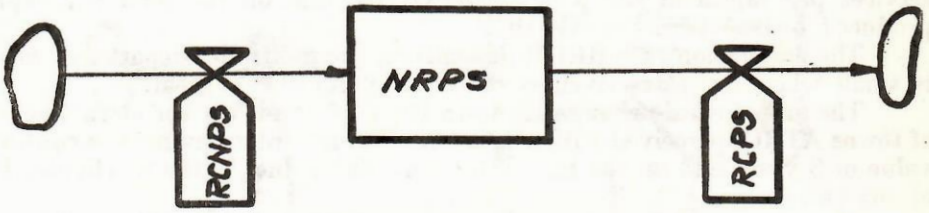

Fig. 2 Flow Diagram of the Symbol. Health Protection

the sphere of services interferes in many directions with other sectors, we preferred to follow in the model a well known indicator which appears in almost all statistics, the number of hospital beds (Fig. 2).

This level increases with RCNPS, the rate of building of new hospital beds and decreases with RCPS, the obsolescence rate of hospital beds. RCNPS depends on a normal rate RNCNPS, on the growth of population MCNPSP and on the multiplier building of new beds from the industrial production MCNPPI. RCPS is calculated with the aid of a constant obsolescence rate RNDPS.

Indicator NRPCL, the number of beds per capita is used in other sectors influencing the attractiveness of the county, the average length of life, the quality of life.

d) *The Housing Sector*

We have noticed two levels in the housing flow: houses in use LOCF and houses which are to be demolished LOCD and four rates: the rate of house building RCONL, the rate of demolition of houses in use, due to town planning work RDS, the rate of deterioration of houses RUZL and the rate of demolition of houses RDEML (Fig. 3).

The rate of house building appears in the model as dependent on a normal rate of house building RNCONL, on the house building plan MPCL and on the ground available MCLT. MCPL is considered to be a simulation factor.

RDS is considered a constant fraction of LOCF.

RUZL — the rate of deterioration of houses appears in the model as depending on the average of life of the houses.

RDEML — the rate of house demolition is calculated with the aid of a normal demolition rate RNDCML and with the aid of a demolition multiplier resulting from a delay of the third order, with the time constant value

of 60 years, which reflects the fact that any new house must be demolished after a certain time intervel.

MALT is also a multiplier influencing the demolition rate, expressing the demolitions which are taking place for building grounds.

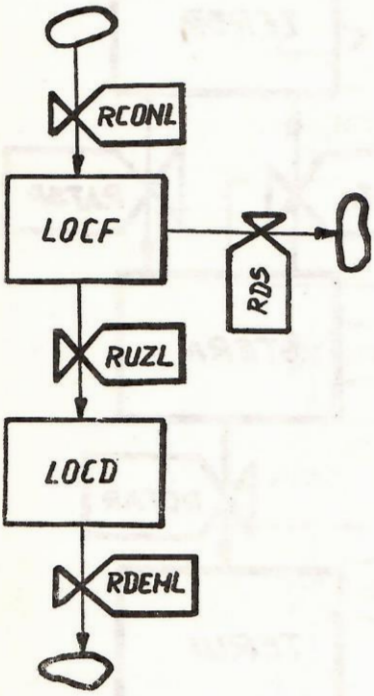

Fig. 3

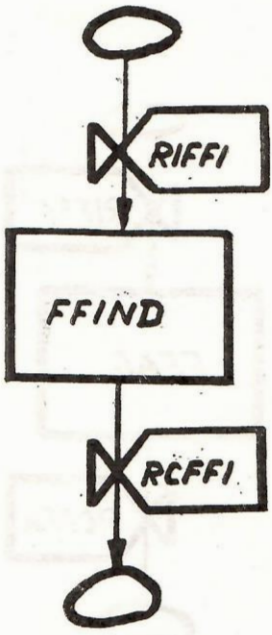

Fig. 4

e) *The Industry Submodel*

The level followed in this sector is FFIND, the capital goods in industry, comprising both the all-country, local industry and that of the craftsmen's co-operative society.

RIFFI is the investment rate in industry (Fig. 4).

It depends on a normal rate RNIFFI, on the skilled labour force available RAPCLM and on the necessary land MDTIJ.

The industrial development plan appears through MPDIJ.

RCFFI is the discard of production capacities. It depends on their average length of life and on a factor MCFFIPT which expresses the discard due to the moral wear implied by the technical-scientific revolution characteristic of our time.

f) *The Agriculture Submodel*

This sector is similar to the industry sector. It contains a level — capital goods in agriculture FFAG and two rates: RIFFA — the rate of investments in agriculture and RCFFA — the rate of annulments in agriculture (Fig. 5). The investment rate RIFFA depends on a normal rate RNIFFA, on a factor

representing the existence of the plans for the development of agriculture MPDAJ and on the increase in the arable land MCIAT which requires more fixed assets.

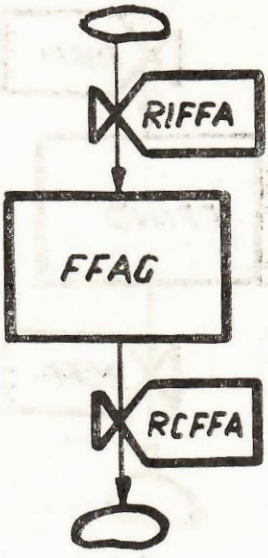

Fig. 5

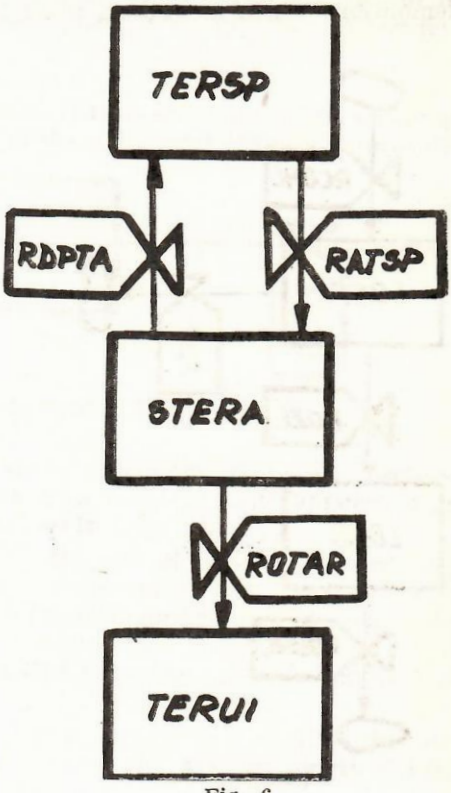

Fig. 6

We calculate: the productivity of arable land PRTAR, the necessary labour force per hectare NLMAHA, the foodstuff production per head of the population produced in the county ALIMCL.A subsector is that of land.

The levels followed are: the unproductive grounds TERSP, the arable land STERA, urban-industrial land TERUI (Fig. 6).

The main level is STERA which increases through the laying out of unproductive land RDPTA and decreases through the weathering of arable land RATSP and through the occupation of the land for industrial purposes and for house building ROTAR. The rate of laying out of the grounds depends on the cost of the laying out of a hectare of unproductive land. The funds which are alloted must be the bigger the more one wishes to attain a higher level of land productivity. The cost of the laying out of hectare of unproductive land is the bigger the fewer are the unproductive grounds.

The rate of weathering of the arable land depends on the average length of life which is calculated from the agricultural investments made on the territory(irrigation, fertilizers, etc.).

The rate of occupation of the arable land depends on the demand for grounds implied by the growth of the urban population and the necessary ground required by the development of industry.

g) *The Education Submodel*

This sector comprises the forms of education for improving qualification and the forms of education for specialization in a certain field.

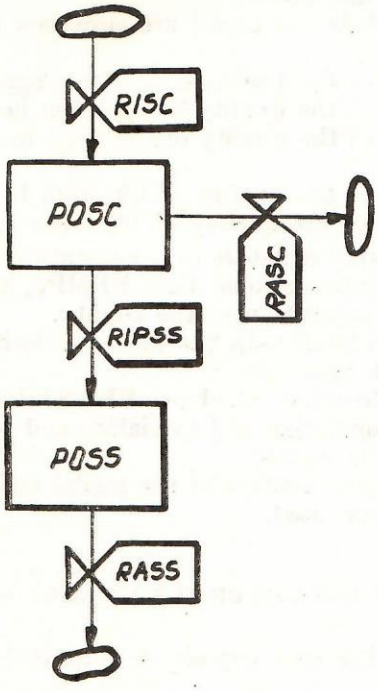

Fig. 7

Thus, the flow of qualification appears, comprising two levels: POSC population attending training schools and POSS population in specialization schools. (Fig. 7).

POSC comprises those forms of education which ensure a qualification: vocational schools, lyceums, training at the job, short term schools, etc.

POSS comprises the technical schools for foremen, forms of postlyceum education, faculties, etc.

The rates which appear as guiding the evolution of these levels are: RISC the rate of enrolling for training schools, RASC the rate of graduation from training schools, RIPSS the rate of enrolling for specialization schools, RASS the rate of graduation from specialization schools.

RISC, RIPSS depend on the necessary qualified persons, respectively specialists resulting in the Labour Force sector.

The rate of graduation from schools depends on the constant values which express the length of these forms of education.

h) *Social-political Submodel*

As part of this submodel we tried to quantify a complex indicator, the quality of life CV. We also followed two political indicators: the number of party members NRMPJ and the number of trade-union members NRMSJ.

The quality of life CV is expressed as a size with no dimension, indicating in relation to a given moment, the standard of the quality of life SCV=1, the evolution of this indicator.

The factors which in the model are supposed to influence the quality of life are:

— the multiplier of the quality of life from agglomeration MCVA;

— the multiplier of the quality of life from health services MCVS;

— the multiplier of the quality of life from foodstuffs produced in the county MCVALI;

— the multiplier of the quality of life from housing MCVL;

— the multiplier of the quality of life from investments MCVSV:

The number of party members in the county is calculated with the aid of a level within the informational flow FRMPJ, the proportion of party members to the total population of the county.

This ratio is calculated with the aid of a desired proportion FRDMP and of an adjustment time TA.

The fraction-trade-union members, FRMSJ is calculated by totalling the unskilled, skilled population and specialists and by reporting them to the entire population of the county.

We present a general scheme of the model and the appendix the key explaining the notations used.

5. ON THE USE OF THE DYNAMIC MODEL

The model, as it has been conceived, is an instrument allowing a wide range of simulations.

The decisions adopted by the decision-making human factor by choosing a variant from the set of admissibles are, in fact possible by changing the control variables of the system. The existence of the model allows, before the real system being applied, the validation of the decision by an adequate change in the parameters.

Management by simulation thus reduces subjectivism and brings information about the behaviour of the system.

In this respect, we have made experiments on the computer on a simplified variant of this model, for validating the model with real data. Evolution curves have been obtained which represent forecasts of the respective indicators in the followed time interval.

In Buzău, Bacău, Dolj and Cluj counties, preoccupations exist for experimenting such a model for simulation.

Another direction of using the dynamic model besides simulation is the optimal control.

In this connection, we have identified the input (control) variables and have introduced a performance function (the maximization of the indicator "Quality of life").

In this way, we have come to the field of optimization in which there are many perfected techniques for determining the input variables.

In order to avoid some very long calculations, we have used an optimizing technique in steps which, benefitting from the linear form in which the control variables appear resorts to the linear programming method.

In the following research stages, we think of applying to this model a number of techniques appearing from the study of fuzzy sets in order to find out the nondeterministic elements of a nonstochastic character.

APPENDIX

1. Normal rate of investments for industrial capital goods
2. Investment rate of industrial capital goods
3. Industrial capital goods
4. Annulment rate of industrial capital goods
5. Normal annulment rate of industrial capital goods
6. Area occupied by a floor space unit
7. Area occupied by a unit of industrial capital goods
8. Degree of occupation of the urban-industrial ground
9. Multiplier of the quality of life from food
10. Foodstuffs produced per head of the population in the county
11. Population in specialization schools reported to the entire population
12. Population in training schools reported to the entire population
13. Normal graduation rate in specialization schools
14. Graduation rate in specialization schools
15. Population in specialization schools
16. Rate of enrolling of the population for specialization schools
17. Rate of graduation from training schools
18. Normal rate of graduation from training schools
19. Rate of enrollings for training schools
20. Normal rate of enrollings for training schools
21. Rate of house demolition
22. Normal rate of house demolition
23. Houses to be demolished
24. Wear rate of houses
25. Demolition rate through town planning
26. Normal wear rate of houses
27. Houses in use
28. House building rate
29. Normal house building rate
30. Total houses in the county
31. Houses per head of the population
32. Rate of hospital beds depreciation
33. Normal rate of bed depreciation
34. Number of hospital beds
35. Building rate of hospital beds
36. Normal building rate of beds
37. Number of beds per thousand of inhabitants
38. Initial number of beds per thousand of inhabitants
39. Attractiveness of villages from housing
40. Multiplier of the increase in the number of hospital beds
41. Attractiveness of villages in the county
42. Attractiveness of towns from education
43. Atractiveness of towns from health services
44. Attractiveness of towns from housing
45. Attractiveness of towns
46. Attractiveness of towns from work places
47. Expectation of life in urban

48. Delay in perceiving the length of life
49. The desired birth-rate in urban
50. Delay in the effect of changes in industry on birth-rate
51. Fertility in urban
52. Maximum biological birth-rate in urban
53. Industrial production per capita
54. Proportion unskilled workers
55. Jobs for unskilled workers
56. Jobs for unskilled workers per unit of capital goods
57. Multiplier of industrial development from plan
58. Multiplier of industrial development from land
59. Multiplier of industrial development from labour force
60. Volume of productive investments
61. Volume of productive investments par capita of the population
62. Multiplier of the quality of life from living standards
63. Multiplier of the quality of life from housing
64. Multiplier of the quality of life from crowding
65. Normal annulment rate of agricultural capital goods
66. Annulment rate of agricultural capital goods
67. Multiplier of capital goods annulment in agriculture from the industrial progress
68. Average length of life of agricultural land
69. Weathering rate of agricultural land
70. Area of agricultural land
71. Rate of occupation of agricultural land
72. Surface of urban-industrial land
73. Normal occupation rate of agricultural land
74. Necessary urban-industrial ground
75. Urban-industrial ground per capita
76. Multiplier of enrollings for specialization schools from the need for specialists
77. Normal rate of enrollings for specialization schools
78. Multiplier of enrollings for training schools from the need of skilled workers
79. Agricultural production per capita
80. Multiplier of house demolition
81. Delay in house demolition
82. Proportion of party members to the total population
83. Desired proportion of party members
84. Proportion of party members in the county
85. The county population over 18 years of age
86. Fraction of population over 18 years of age
87. Adjustment time
88. Number of party members in the county
89. Multiplier of the building of new beds
90. Delay in the effect of health services on the length of life
91. Expectation of life in rural settlements
92. Multiplier of length of life from agglomeration in rural settlement
93. Total population of the county
94. Total area of the county
95. Crowding in the county
96. Multiplier of length of life from crowding in urban
97. Delay in the attractiveness of urban zones
98. Delay in perceiving attractiveness in rural areas
99. Delay in attractiveness of towns, of county, of rural settlements
100. Birth-rate in urban
101. Urban population of the county
102. Emigration rate from urban zones
103. Normal emigration rate from urban
104. Death-rate in urban
105. Emigration rate from urban zones
106. Unskilled workers in industry
107. Adjustement time
108. Adjustement time of the need for skilled workers

109. Multiplier of adjustment time of unskilled workers in industry
110. Number of skilled workers reported to jobs
111. Number of specialists, managerial staff reported to jobs
112. Jobs for skilled workers in industry
113. Jobs for skilled workers per unit of capital goods
114. Jobs for specialists, managerial staff per unit of capital goods
115. Industrial capital goods per head of the population
116. Multiplier of quality of life from health services
117. Quality of life
118. Multiplier of capital investment growth in agriculture from grounds
119. Initial area of agricultural land
120. Capital goods in agriculture
121. Rate of investments for capital goods in agriculture
122. Multiplier of plans for developing the county agriculture
123. Normal rate of investments for agricultural capital goods
124. Share of agricultural land cultivated with cereals
125. Value of foodstuffs produced in the county
126. Multiplier of length of life of land from agricultural capital goods
127. Unproductive land
128. Multiplier of cost of layings out
129. Initial level of unproductive land
130. Rate of laying out unproductive land
131. Normal rate of laying out
132. Multiplier of unproductive land laying out from productivity per hectare
133. Total agricultural production
134. Delay in perceiving the expectation of life in villages
135. Desired rate of births in villages
136. Maximum biological birth-rate in villages
137. Fertility in rural settlements
138. Emigration rate from villages
139. Birth rate in villages
140. Emigration rate to the rural areas of the county
141. Normal emigration rate in villages
142. Normal rate of settle down from rural into urban areas
143. Rate of rural-urban settle down
144. Normal immigration rate in urban zones
145. Immigration rate in urban zones
146. Skilled workers in industry
147. Fraction of skilled workers
148. Adjustment time of the need for skilled workers in industry
149. Multiplier of adjustment time of the need for unskilled workers from housing.
150. Multiplier of adjustment time of the need for skilled workers from education
151. Adjustment time
152. Multiplier of adjustment time of skilled workers from housing
153. Jobs for specialists
154. Industrial production of the county
155. Productivity per unit of capital goods in industry
156. Volume of total capital goods in the county
157. Standard of quality of life
158. Number of agricultural jobs in the county
159. Need for agricultural jobs per hectare
160. Capital goods per hectare
161. Productivity of agricultural land
162. Fraction of cooperative members population
163. Multiplier of emigration from rural zones
164. Normal emigration rate in rural zones
165. Rural population of the county
166. Death-rate in rural zones
167. Rate of urban settle down in rural zones
168. Normal rate of urban-rural settle down
169. Multiplier of settle down in urban from the labour force available in agriculture

170. Death-rate in urban areas
171. Specialists — managerial staff
172. Fraction of specialists — managerial staff
173. Adjustment time
174. Adjustment time of the need for specialists
175. Multiplier of adjustment time of specialists from housing
176. Number of cooperative members in the county
177. Death-rate in rural zones
178. Multiplier of expectation of life in urban zones from housing
179. Multiplier of annulment of industrial capital goods from technical progress
180. Normal demolition rate from town planning
181. Number of workers and specialists in the county
182. Fraction of trade-union members in the county
183. Multiplier of length of life in urban areas from health services

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CONSIDERATIONS CONCERNANT L'ELABORATION D'UN MODELE DYNAMIQUE AU NIVEAU TERRITORIAL

Le présent ouvrage constitue un essai de modelage dynamique d'un système social complexe. Les auteurs observent les principaux indicateurs économiques, sociaux et politiques qui caractérisent le cadre dynamique de l'évolution du territoire. Y sont indiquées les principales utilisations du modèle dynamique, réalisé à l'aide des techniques du type Forrester.

СООБРАЖЕНИЯ О РАЗРАБОТКЕ ДИНАМИЧЕСКОЙ МОДЕЛИ В ТЕРРИТОРИАЛЬНОМ РАЗРЕЗЕ

Настоящая статья представляет собой попытку динамического моделирования комплексной социальной системы. Ведется наблюдение за важнейшими экономическими, социальными и политическими показателями, характеризующими динамические рамки развития территории. Указываются основные виды использования динамической модели, осуществленной при помощи техники типа Форрестер.

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