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MODELS AND THEIR GEOGRAPHICAL APPLICATIONS

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There might be as many definitions of models as models themselves. In other words there are many. Hardisty et al (1993) wrote about it sarcasticly in their book, though for them there is but one model that can be precisely described by a mathematic equation or system of equations. It happens frequently that one cannot arrive at stating the relations in a purely quantitative form being necessarrily the best way to build a model. Therefore a survey of the different model-building schools and model conceptions can be useful. ***Models*** are mostly used today to ***describe, explain and analyze the operation of a system.*** They are often present in theoretical geography, helping to understand systems, as well as in applied geography where they are integrated parts of regional planning, environmental impact statement and predecision-making. The following three examples represent the various fields of model application.

1. Map (Figure 1)
2. Model-model by Chorley (Figure 2)
3. Simulation (Figure 3)

Both the ***graphic and the mathematical representation of reality*** can be considered as models. In general models can be referred to as ***special projections or idealized pictures of reality.*** Every field of science can elaborate a model-definition of its own aspect. In case of a non-natural scientific approach, a model can be essentially a theory, law or a structuralized conception. In Chorley, R.J. - Hagget, P. (1967) and Kirkby, J. et al (1987) there are several model-definitions; the former being considered as a principal work on geographical models and the latter a representative of the Leeds School.

System is a concept often mentioned with models. System and model are in fact very closely related to each other like property to its owner. What is more, a model always ***belong to a concrete system,*** if the most general definition of the system is accepted, according to which it is a group of interrelated things. It is a question of aspect whether a landscape, a road network, a decision making management, a machine, a law or a map is a system or not. They ought to be considered or at least handled and analyzed as systems, however. There may be systems that are more difficult to scope with in society e.g. and they are still found to be real systems in recent research. There are, however, great differences between systems if their compounds and levels of hierarchy are considered. The concept of system is, however, an accepted and widely used category.

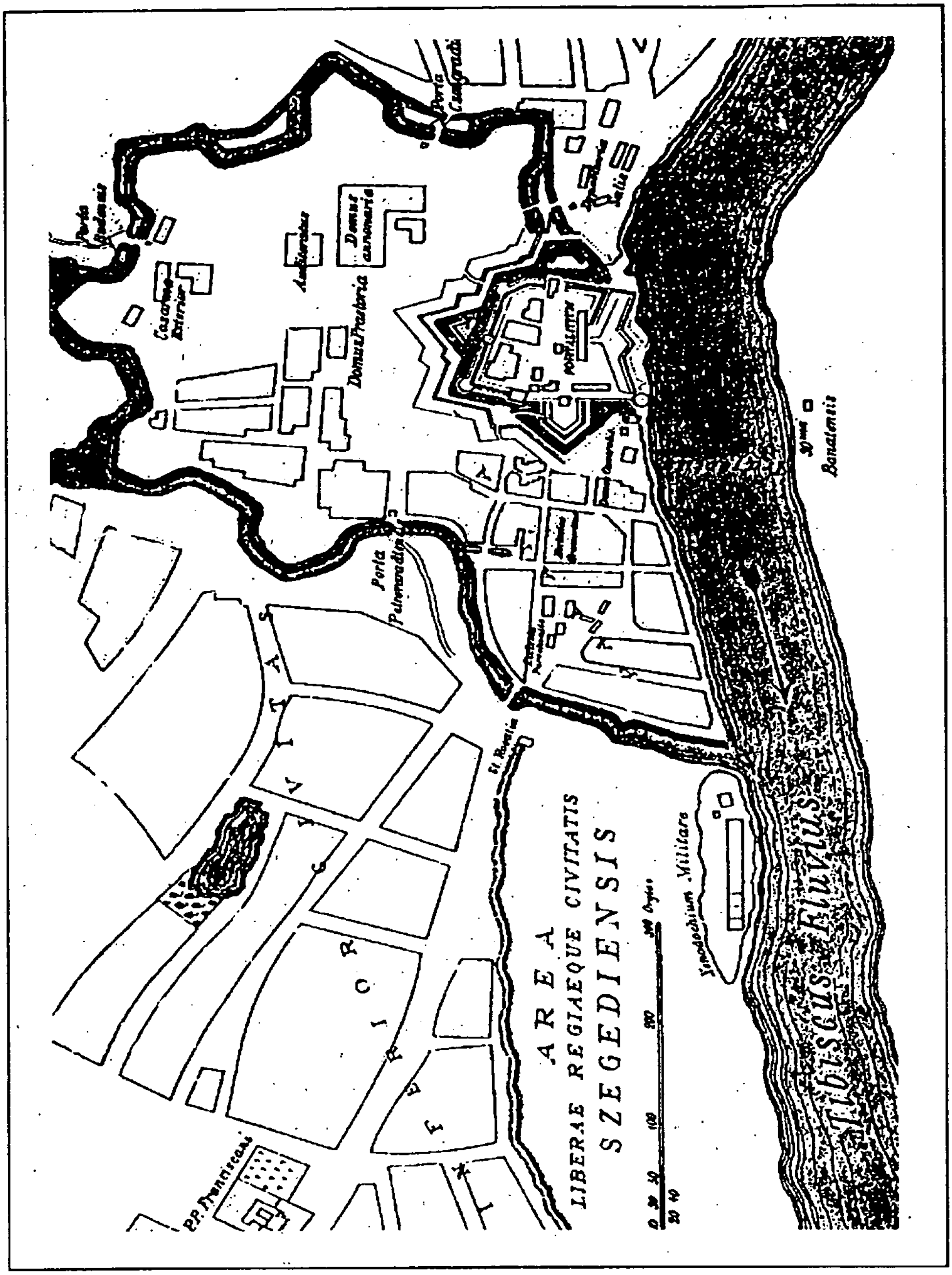

Figure 1. *Example No 1. The map as a model.* A map is a suitable model to represent reality and it is a theoretical model as well with all properties of generalization, which is suitable for the analization of the reality from different point of view

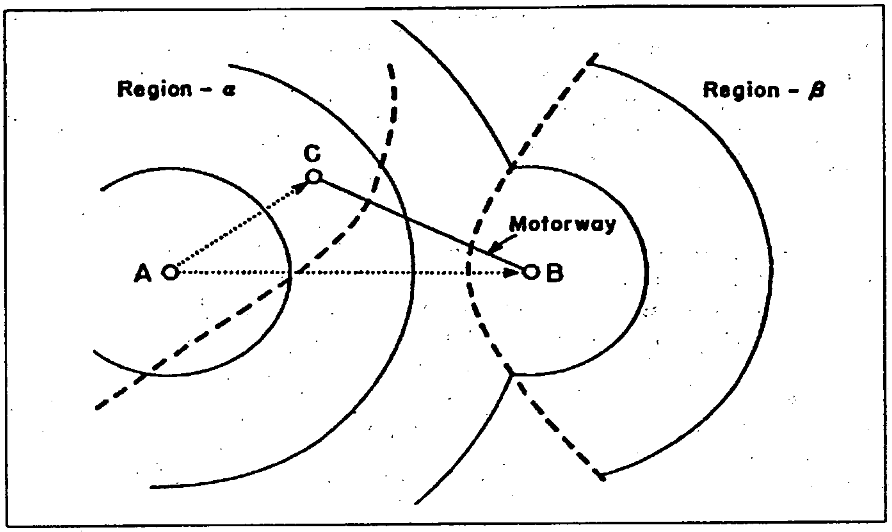

Figure 2. *Example No 2. The network model.* Within the ABC network, the shortest way is AB. If a motor way is built between B and C the road of the lowest cost will be ACB and the shape of regions a and b will be modified too.

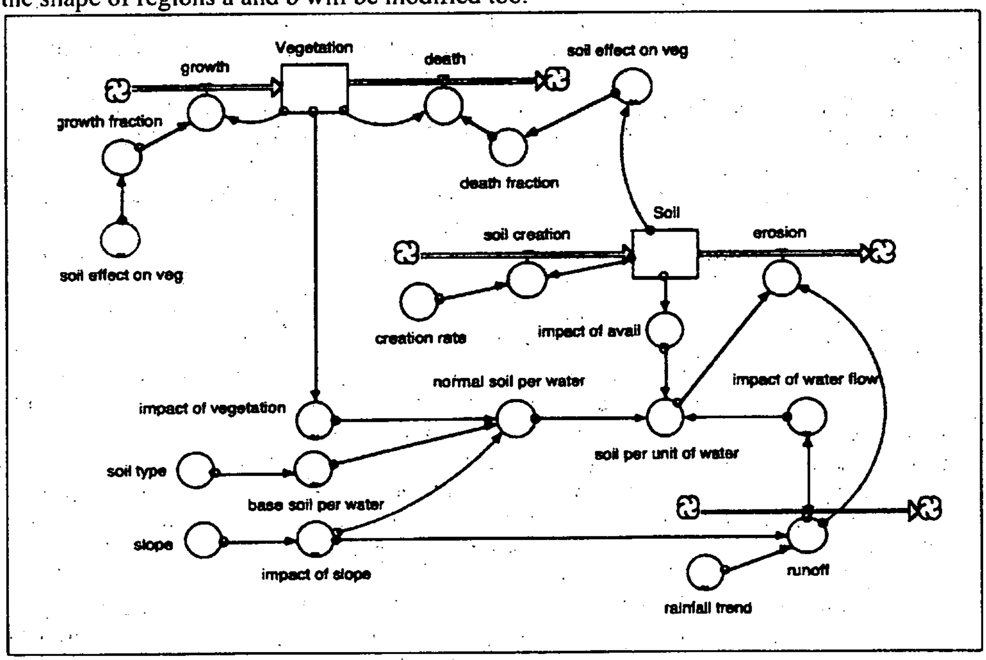

Figure 3. *Example No 3. A simulation network in the Stella II system.* The figure contains the different types of the variables with the run off scheme and the water budget of the soil.

Systems can be studied ***independently from their contents*** (see the general system theory of Bertalanffy), they have characteristic and ***common and specific features*** that show regularities and can be transferred from one to another.

When studying the relationship between models and systems, the phases of system-analyses by Hugget, R. (1980) ought to be mentioned. According to his finding in the system-analysis there are the following four phases built upon one another:

-- ***lexical phase***, when the boundaries, the contents (variables) the values of the constant variables etc of the system are tried to be understood.

-- ***describing phase***, when the relations between the variables of the system are tried to be defined in mathematically, physically or verbally.

-- ***modelling phase***, when the system is reconstructed and 'operated'.

-- ***analyzing phase***, when the validity of the model is analyzed.

The above does not mean,however, the model to be found only in the third and fourth phases. There are a lot of models helping comprehension in the lexical phase e.g. the schemes and patterns in text books can well be called models. The describing phase can often be left out, because its factors are difficult to be quantified. The steps of modelling can be put into a relevant order:

-- ***model building*** which uses the regulations of simplification, generalization and abstraction, taking the specific parametres of the model into consideration

-- ***model application*** which brings about new information through simulation devices e.g.

-- ***model assessment*** (the communicative part of modelling) which analyzes the validity of the model with its output results and examines different scenarios and alternatives.

From the above the advantages of the models can be seen in their geographical application. Models mean one of the easiest ways of professional *communication*, because the *information, theories and opinions* are displayed concentrated in them. When they are applied, problems of different nature can be compared, regularities can be adapted (Figure 4).

General characteristics of models

Aim and functions of model application. There are two large aim-groups considered in model applications. One of them contains the models used in practice (e.g. planning, prognoses, impact statements). They are used for calculations, prognoses, evaluations etc. The other group contains models helping comprehension. This frequently used grouppping is not precise enough, because the models used in practice and planning also help the comprehension of how the system works and because the so called models of comprehension sometimes do not have the full phases of model building owing to the troublesome quantifying (examples for this can be found in social geography, in the model representing the development of the financial sphere).

On the basis of the idea of Nijkamp, P (1978) the objective of modelling can be set as the *problem solving = aim + the structure of aims*. Nijkamp of course approaches this issue from regional planning, but in general and especially on the fields of social and environmental geography, there are several objectives to be realized together. This approach does belong to the natural sciences as well. Following this path the *functions* of

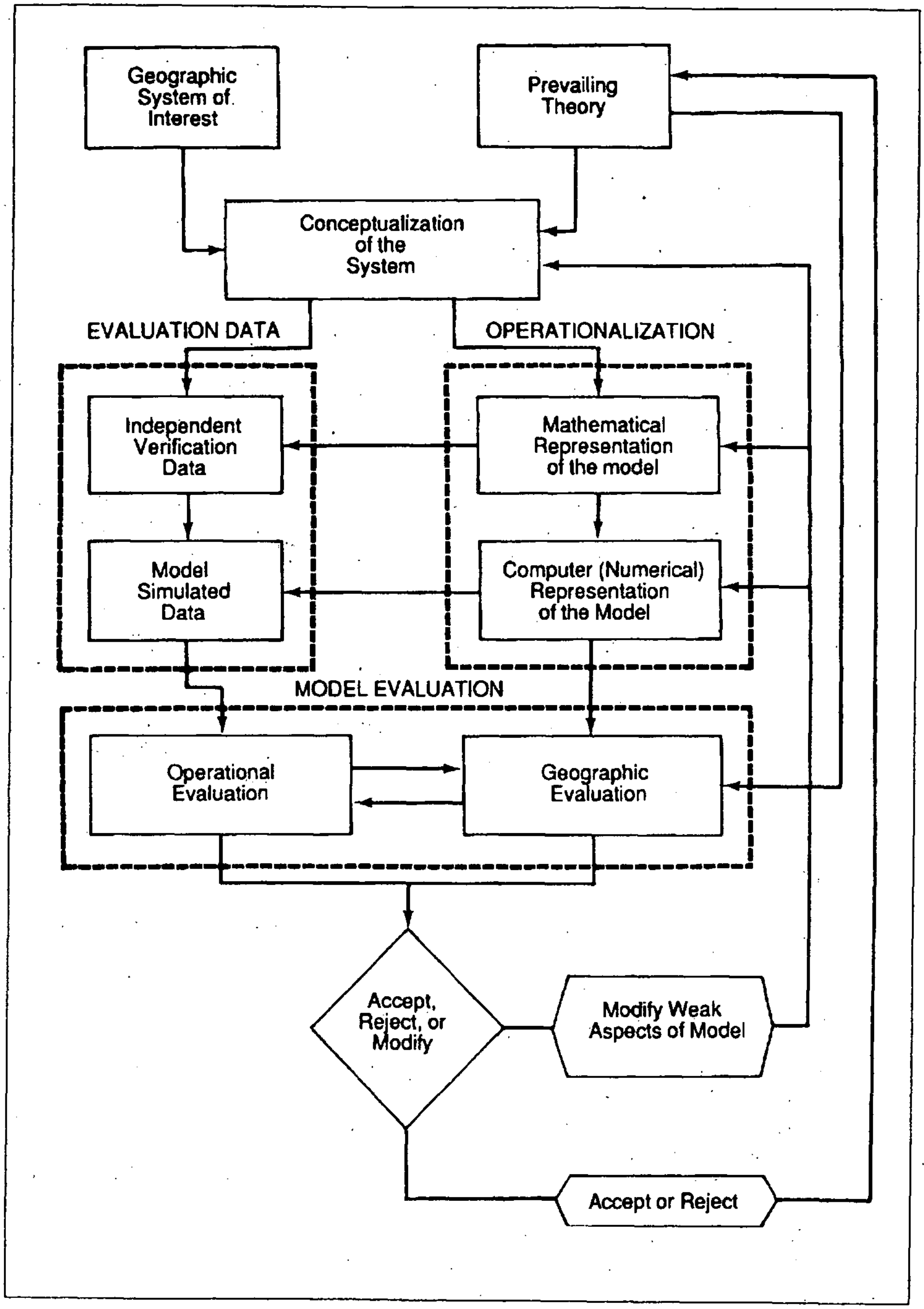

Figure 4. *Scheme of geographical modelling* (Abler et al 1992)

the models can be manifested easily, such as *revealing and displaying complex relationships*, shedding light onto the operation of the systems (e.g. through analyzing a process or an impact), or taking the simple ones: the collecting-categorizing function (because factors have to be listed) and the logical-psychological function (because relationships have to be interpreted and understood) etc.

One of the most complicated questions of models is probably the *relation between simplification and generalization (idealization)* and the *role of the scale* in connection with them. The success of model application is depending on the abstraction as it is put in every book on model building. There is, however, very little information on how to carry out this simplification. The map in Figure 5 helps to understand the relation between simplification and generalization. Both generalization and simplification cause information loss. If the scale is getting smaller from 1 : 10 000 to 1 : 100 000 e.g. there will be too much information to map and if it is getting the other way round, there will be too little information to map. In such cases generalization with the aggregated units should stick to the strip labelled with the row of dots when shifting from S1 to S2 and I2' is recommended instead of I2.

In the practice of modelling or (dynamic) simulation simplification is recommended to be performed first and then generalization (the so called 'upper way') according to Powersim (1993); those, choosing the 'lower way' should 'give up all hope' (see Figure 6).

The problem of simplification and generalization can manifest itself in quite different ways in different scales. With a global problem one cannot use a local model, like the global MIAMI Model cannot be applied to local, biological production schemes (NPP) to obtain a reliable result. In such cases the structure of the model is changing. The opinion formed in the 60s, according to which the models differ only in their style and they can be mutually transferred from one scientific field to another, is not true. Though transfer is an essential element of model application, it has got its limits to be observed.

Characteristics of models

The characteristics of models are summed up by Chorley, R.J. and Hagget, P. (1967) as follows:

-- they should be approximative i.e. simple enough to aid users, to help intelligibility, but it should not result in a loss of complexity;

-- they should be suggestive i.e. a sphere ought to be ouylined in which they are relevant. (This is especially important in geography because of the scale.) Their ability for prediction should also be stated etc.

-- They should be selective i.e. they should contain only the 'important' factors through elimination where necessary.

-- They should be structurized to reflect both the taxonomic and the relational structure of the system.

-- They differ from reality exept for analogy.

-- Models should be applicable for the above mentioned objectives and this is their most debated feature.

Types of models

The grouping of model types are presented to show how versatile they are. According to the categories drawn by Chorley, R (1967) they can be:

1 Systems based on analogy:

a/ historic analogy ('present is a key to past' as applied by Lyell in geology and landscape evolution and by the chronology of denudation;

b/ spatial analogy (this category has been worth being criticized, because the theory of global warming up by Budiko e.g. can be applied to future only in a very limited extent).

2 Physical models:

a/ hardware models (they are mainly made or built from some natural material, but in a wider sense, the modelling of soil erosion also belongs here e.g.);

b/ mathematical models. They can be determined (like linear equation systems and differential equations) and stochastic (like statistical devices).

3 General systems (they are mostly theoretical models bearing the problems of resolution and detailednedd as it has been mentioned earlier):

a/ synthetic models are mainly homomorphic containing only a few elements (white box -- where all relations and processes are known);

b/ partial models (grey box -- where the relations between the factors van be expressed in terms pf mathematics, but the processes cannot);

c/ black box models (where only the input and output information is known like in the isomorphic models containing every element).

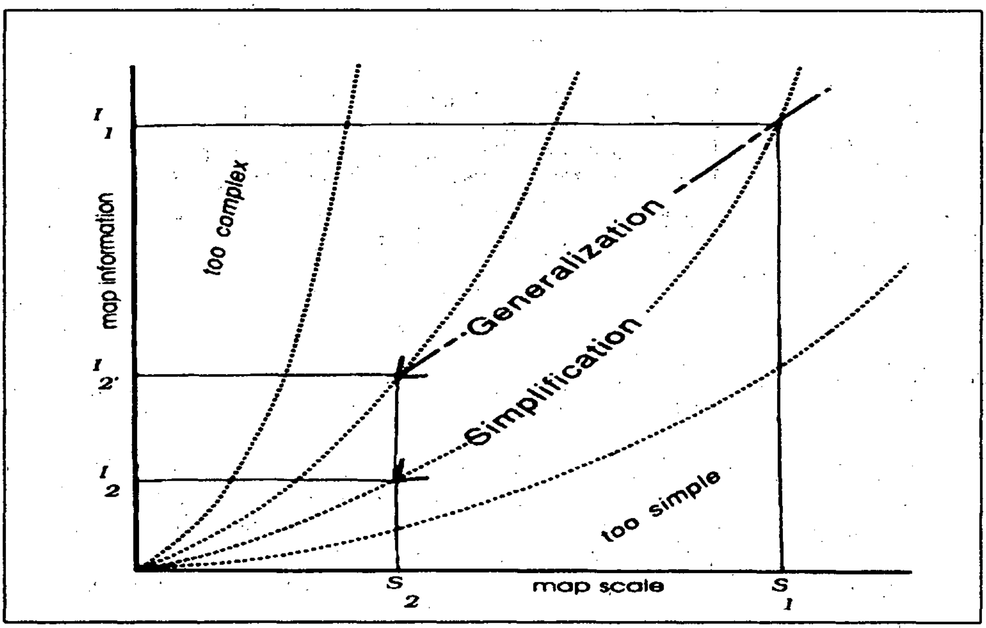

Figure 5. *The relation between simplification and generalization in cartographic model application (Abler et al 1992)*

Another approach is that of the descriptive models (aimed to put emphasis on the balance and process in the static and dynamic subtypes) and the normative ones (spatial or predictive). They are categorized by Güssefeldt, J. (1979) as follow:

model			
Layout	**physical entity**	**relations**	**way of expression**
iconic	'paper'	descriptive	determined
analogous	'hardware'	normative	likelihood type
symbolic	'software'	hypothetic	stochastic

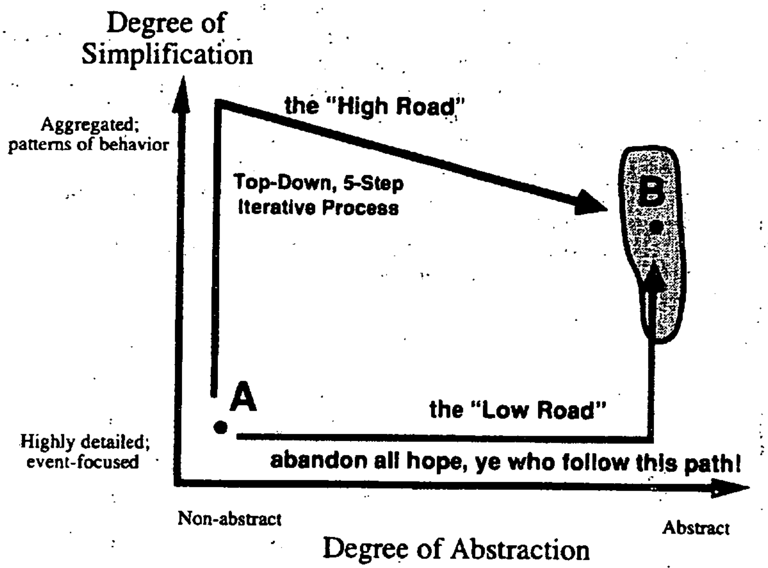

Figure 6. *The relation between simplification and generalization in simulating model application (Powersim 1993)*

This classification does reflect the chaos regarding models in the geography of the 80s. The critics of this classification like Köck, H. e.g. among others, had reasons that can hardly be accepted today. E.g. if models are representing things, they should be classified on the basis of their representational or non-representational contents.

When approaching model categorizing from the viewpoint of planning, it is a geographical classification as seen with Nijkamp, P. (1978, Figure 7).

For those, fond of definitions, let us define what models are: they are the representation of reality with simplified structure, showing relations thought to be important in a generalized form.

Geographical models?

In our opinion geographical models can be specificonly as far as their **topics** or perhaps aspects are concerned. Transferability is an essential feature of model application, securing their thematic independence. One might remember the polarized definition saying: the model is the 'picture' of the system which exists only virtually. The quality of this 'picture' depends on the available and obtained knowledge about its system.

There are some aspects giving specific features to geographical models, however. One such feature may be the *scale* related to the Greek idea of models. In geography it is especially important how a micro level construction can be tranferred into meso or macro levels. Another feature may be the model's evaluation that is a specific geographical feedback.

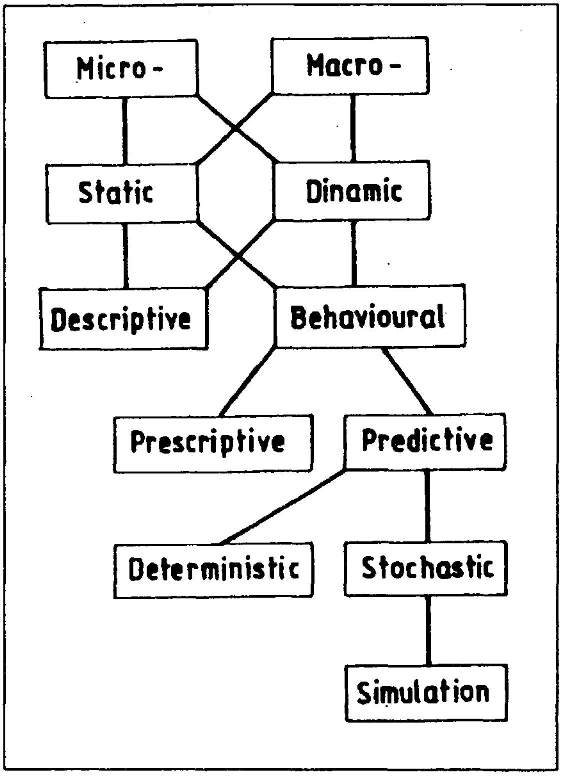

Figure 7. *Model types and their relations (Nijkamp 1978)*

References

CHORLEY, R.J. - HAGGETT, P. 1967. Models in geography. Methuen, London p. 816.
HARDISTY, J. et al. 1993. Computerized Environmental Modelling. Wiley, Chischester p. 204.
HUGGETT, R. 1980. System analysis in Geography. Calderon Press, Oxford p. 210.
KIRKBY, M.L. et al. 1987. Computer simulation in Physical geography. Wiley, Chischester p. 227.
NIJKAMP, P. 1978 The system view of planning, Pergamon Press Ltd. Oxford, p. 431.
POWERSIM 1993 Reference Guide Ver. 1.1, Bergen p. 278.
GÜßEFELDT, J. 1979. Die Bedeutung von Modellen in Forschung und Lehre der Geographie. GR. 1979.31.8. pp. 323-331.

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