SYSTEMS RESEARCH INSTITUTE,
POLISH ACADEMY OF SCIENCES, SZCZECIN DEPARTMENT
AGRICULTURAL UNIVERSITY OF SZCZECIN
FACULTY OF ECONOMICS AND ORGANIZATION OF FOOD ECONOMY

MODELLING OF ECONOMY IN SPECIALLY PROTECTED REGIONS

Proceedings of the international conference held on 9-11 june 1994 in Drawno, Poland

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Editor: Bogdan Krawiec

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Reviewed by:
prof. dr hab. Stanisław STACHAK

Edition of this publication was financially supported by:

1. Komitet Badań Naukowych, Warsaw,
2. Samodzielny Zespół Edukacji Ekologicznej Ministerstwa Ochrony Środowiska, Zasobów Naturalnych i Leśnictwa, Warsaw.

ISBN 83-85847-40-5

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VISUALIZATION IN MODELLING AND MONITORING OF THE NATURAL ENVIRONMENT

Jerzy Sołdek

Technical University of Szczecin

1. Global visualization of the environment state in a form of image.

Economical management in especially protected areas requires a great care and should base on a full analysis of the state of environment, both current and expected, resulting from the economical and protecting activities.

Present-day technological means provide opportunities for global processing and analysis of the state of natural processes within the area under consideration.

Fig. 1 presents the space distribution of a certain physical parameter, whose value is represented by a gamut of colours and degrees of greyness. As measurement sensors, the electromagnetic sensors of artificial Earth's satellites, for example multi spectral radiometers in regard to the area of land, and multi spectral sonic depth finders in regard to the area of sea and ocean bottom, were used. .

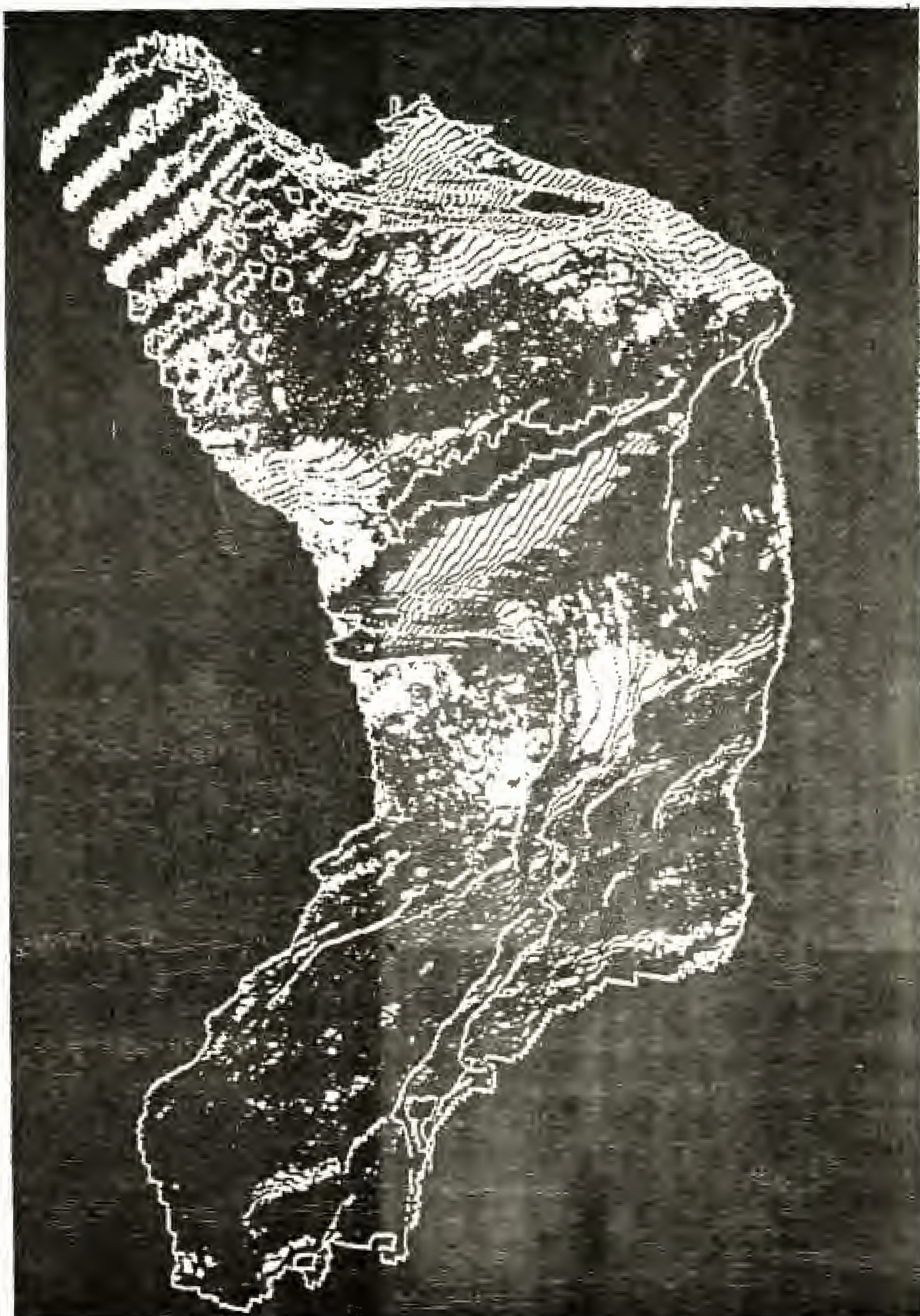


Fig. 1. A space plot of physical field values distribution.

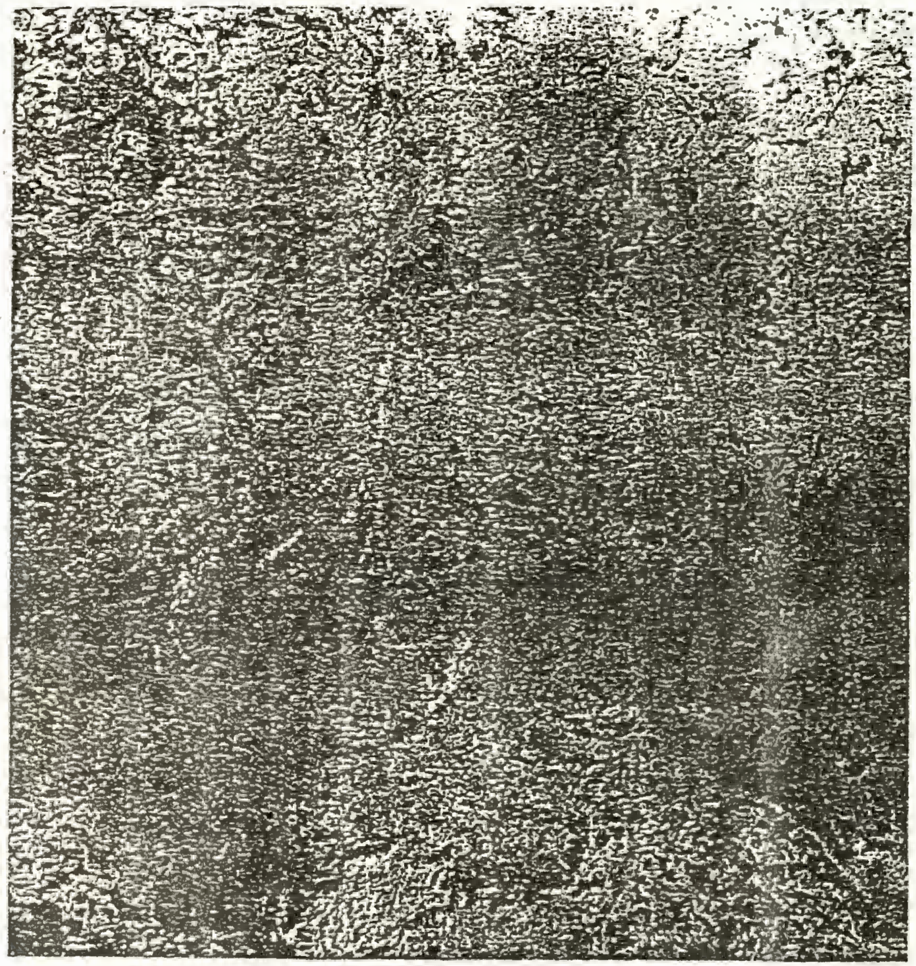


Fig. 2. Imission of dusts from Turoszów and neighbouring East-German electric power stations, visualized by Landsat satellite on 2nd March, 1979 [1].

The image obtained with the help of such sensors can characterize the state of natural environment in the considered region, allowing, for instance, to detect forest fires, devastation of plants by pests etc.

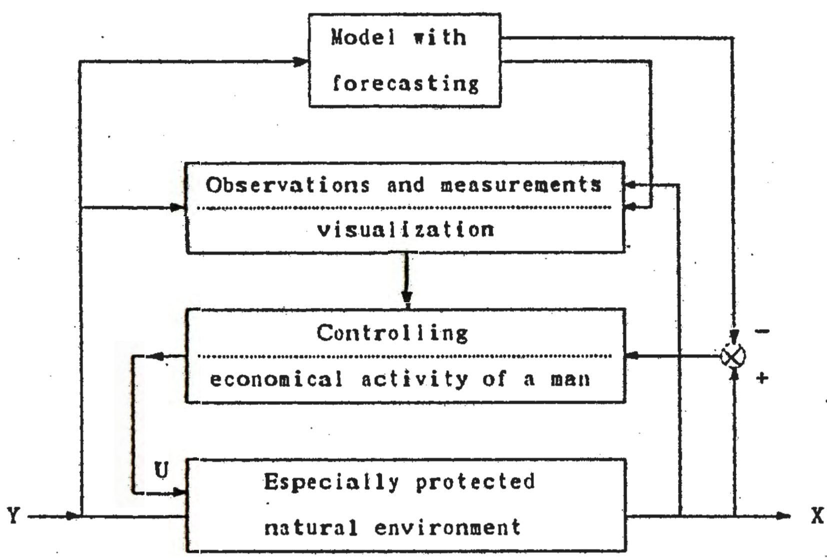
Fig. 2 presents a simple, non-processed in a monitoring system, satellite image of emission of dusts from Turoszów electric power station and neighbouring to it East-German power plants [1]. (Six days before the satellite passage the whole area had been covered by a several-centimeters-thick layer of snow. For the period of these six days the electric power stations had thrown up such an amount of dusts, that, after they had fallen, the dusts covered with a black layer the area of some hundreds square kilometers, indicating the range of influence of these power plants on the environment).

It is essential for the area monitoring to present the state of environment in the region in a form of image, and to determine the differences in this state by comparing the images from the same area at different instans of time.

Since the image is recorded by means of a large number of colour dots, e.g. a million, distributed uniformly over the area considered, the afore-mentioned comparison means comparing one million dots with one another. This is where the great variety of information from the image analysis comes from.

It is important to operate on the image described by a large number of regularly distributed points. And it is of secondary significance how this image was obtained; whether it was obtained automatically from the satellite, or the image was created on the basis of results of many point observations, loaded manually into a computer.

There is a need for such an economical activity in especially protected regions, so that the relations between the environment and the economy are presented in a global way, as shown in Fig. 3.



Notation:
X - vector of the environment state
Y - vector of natural influences onto the environment
U - vector of controlled influences

Fig. 3. A scheme of basic dependencies in the system: environment - state visualization - control

The man's activity is controllable and should mean rational economical activities, leading to the long-term protection of natural environment by:

- minimization of the wear (raw mineral materials, water, space);
- minimization of pollution emission;
- maximization of waste products utilization;
- influence on natural processes, reactivation of natural resources by, e.g., proper selection of agricultural cultures, underwater vegetation, etc.

One can distinguish the following three kinds of the man's activity controlling, differing from one another by the time horizon:

1. controlling and limitation of pollution emission to the environment through current influence on technological processes and cleaning devices, e.g. by controlling power boilers and filters in thermal power stations.
2. planning for economical activity, e.g. agricultural cultures and regulation of the economical activity by means of definition of admissible consumption of the environment resources, as well as admissible values of contamination parameters.
3. active influence on the natural processes, leading to the improvement of the environment state quality, e.g. by appropriate choice of agricultural cultures, flora in water reservoirs, etc.

In order to carry on the controlling activities, it is necessary to possess information on the state of environment and its pollution (emission, imission, wastes), as well as the knowledge of mathematical models of natural processes. The mathematical models, necessary for controlling (making decisions), have different forms, depending on their purpose: from very extended ones, enabling simulation of processes and the forecast of effects of particular activities, causing the environment pollution, to the extremely simple ones, determining only an admissible value of the controlled contamination parameter.

A permissible degree of simplification of the models depends on their purpose - on the one hand, and on a possibility to mathematically describe the process considered as well as to determine empirically the coefficients of the model - on the other hand.

Information needed for controlling the man's activity in the natural environment comes from measurements and observations. Nowadays they are organized on the basis of data processing systems.

In the system one should distinguish the following three characteristic parts:

1. information subsystem of collecting the data on the environment and putting them into the information system;

2. subsystem of data processing, storage and exchange (with other regions);

3. subsystem of rendering the results accessible to the users (decision makers and supervisors), along with respective documentation.

The data on the environment and its pollution for needs of the monitoring information system will be gained by:

1. real-time measurements of process parameters (determination of parameters and choice of sensors types, design of measurement stations, e.g. floating measurement platforms and measurement networks, principles of deploying measurement points and data collection);

2. periodical *in situ* measurements of the water environment by the use of a vessel, provided with a set of equipment for current measurements and preliminary processing of measurement results (measurements of physical, chemical and biological quantities of waters, e.g. the Odra Estuary);

3. air teledetection: aerial photographs, presenting sea area contamination, dumping grounds, etc., and the results of teledetection tests of radiation and other sources of pollution (aerial images, wireless measurement signals);

4. satellite teledetection: introduction to a system of satellite photographs;

5. preparation and input into a computer (with the help of scanners or a keyboard) the off line data, coming from measurements and observations, as well as the earlier stored thematic data (along with their verification).

The data processing subsystem should fulfil the following functions, regarded as *basic programs of processing and elaboration of measurements*:

- data acquisition, correction, re-scaling, filtration, archivization, storage, as well as output of basic reports on measurements realized on line;

- conversion and transmission of data from and to other systems;
- simple operations, typical for integrated data bases, among others: data sorting, protection and updating, as well as data aggregation and searching in various sections, along with adequate control of data access;
- computation of environment state characteristics in various layouts and sections;
- computation of trends and predictions of the environment state, as well as statistical characteristics of this state;
- simulation computations in a scope of trends, predictions and characteristics of the environment state;
- visualization of the results of measurements as well as basic and simulation computations in a form most convenient for the user.

On the basis of the data stored, a regional environment information system should be furnished with forecast and simulation models. Construction of these models has to be preceded by recording data files of sufficiently large capacity. Forecasting the environment state also requires theoretical verification and a choice of appropriate methods of forecast building.

The subsystem of rendering the results accessible to the users based on the visualization of the results of measurements and computations in the forms, chosen every time by the user:

- tables,
- reports,

- circle and bar charts,
- thematic maps.

The most demonstrative form of visualization of the measurements and environment states are maps of the area of interest with marked measurement points and illustration of current, simulated or predicted situation. The visualization can be realized through displaying the pollution or the environment state in a form of adopted symbols or point characteristics (e.g. visualization of quantity of observed pollution in a form of circle of diameter adequate to the quantity of this pollution), or by means of maps with marked contour lines or layers. The data visualization should, apart from a choice of visualization form, enable the choice of:

- domain of visualization (aspects of the environment state, e.g. whether the visualization concerns the pollution, or points of localization of monuments of nature, a state of ground water pollution, localization of dumping grounds, etc.);
- a measurement point or points;
- a kind of pollution;
- a kind of data for computations (averaged monthly or annually data, a mean twenty-four hours' measurement, data from the last measurements, etc.);
- a period, from which the data for visualization are chosen.

The idea of integrated information system for needs of the environment protection in an economical region is presented in Fig. 4.

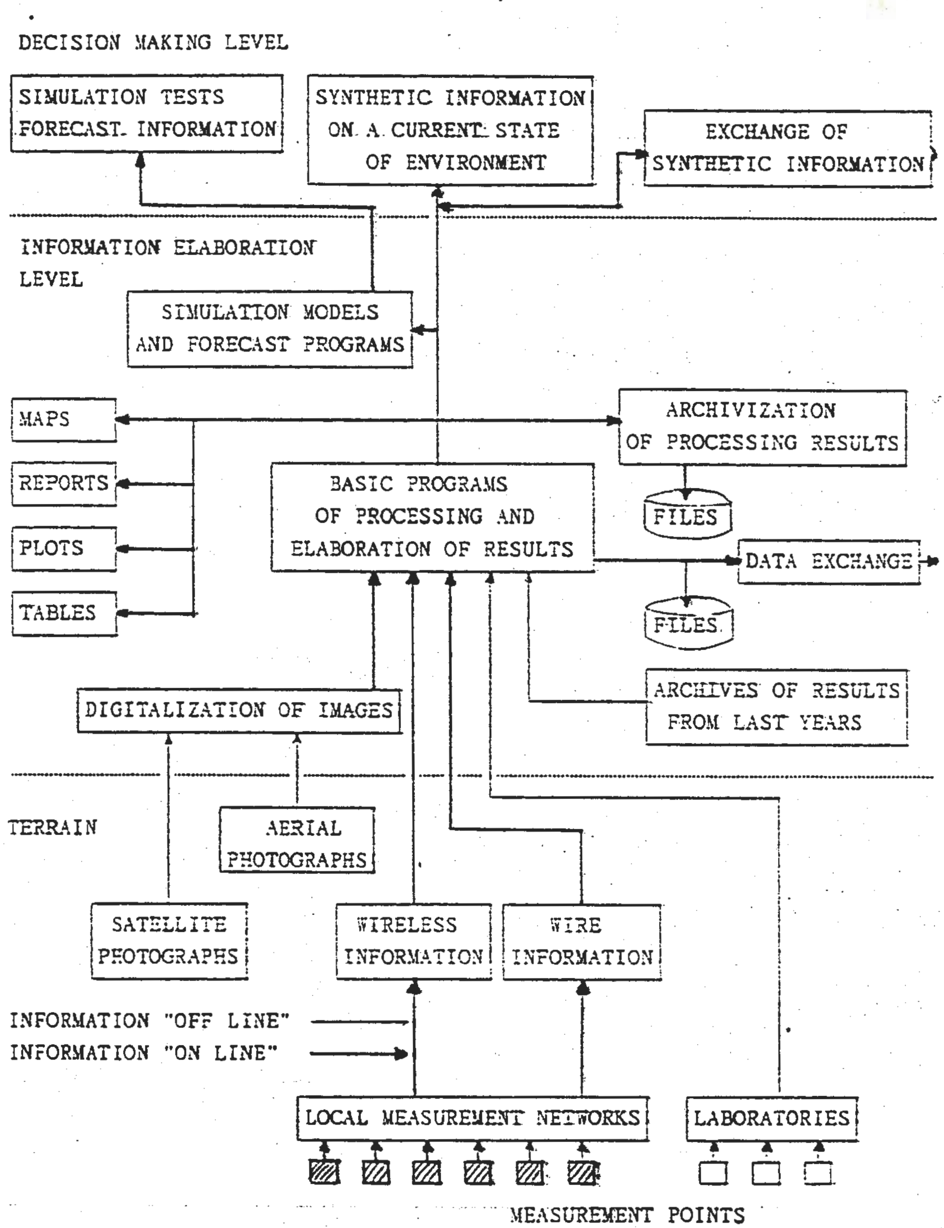


Fig. 4. A scheme of integrated information system of natural environment protection in an economical region.

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