SYSTEMS RESEARCH INSTITUTE
POLISH ACADEMY OF SCIENCES

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

CONTRACTED STUDY AGREEMENT REG / POL / 1

"CONCEPTS AND TOOLS FOR STRATEGIC REGIONAL SOCIO-ECONOMIC CHANGE POLICY"

STUDY REPORT

PART 2

POLISH CASE STUDY REPORT

COORDINATOR, IIASA: A. KOCHETKOV
COORDINATOR, SRI PAS: A. STRASZAK

ZTS/ZPZC/ZTSW 1-36/85

WARSAW 1986

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Consisting of 3 Parts

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V. CROSS-IMPACT STUDY OF THE REGIONAL CASE CONSIDERED

by Jan W.Owsiński, Andrzej Jakubowski and Andrzej Straszak

This chapter is devoted to description of the actual conduct and results of the case study undertaken with the cross-impact methods. First section presents the way in which this study was organized and conducted. Then, main portions of the study documentation are shown and commented upon. It should be emphasized here that only a part of this documentation is shown here, for reasons of clarity and space. The chapter ends with conclusions, referring both to the case, i.e. to the subject matter at hand and to the methodology applied. As to the latter, an outline is presented indicating feasible and, simultaneously, desirable structure of stages and approaches in performing such a study, as resulting from experiences up to date.

V.1. Organization of the study

Owing to previous contacts and experiences gained in cooperation with researchers and decision-makers of the region in question, see Owsiński and Hołubowicz (1985), it was possible both to carry out a deeper analysis of the case, on the basis of reliable data, and to consult central and local planners, designers and decision makers related to problems of this region.

The overall course of analysis was as follows:

1. Analysis of the general systemic framework for the analysis (see Chapter I of this part of the report).
2. Consideration of the technical aspects of the procedure undertaken (see Chapter II of Part 1 of this report).
3. Preparation of the basic information for the experts to be consulted, consisting, consecutively, in:
    a. problem areas to be looked in further analysis, see sections I.4 and I.5 of this part of the report,
    b. more precise formulation of issues to be addressed (as a follow-up to a., and sent a month later to the experts to further their preparation).

4. Cross-impact session itself, composed of the following stages:
   a. adoption of the issue list, together with
   b. determination of the thresholds (threshold values) for these issues (for both a. and b. see the following section of the report, section V.2.),
   c. adoption of the list of events, together with
   d. determination of the thresholds (threshold values) for these events (for both c. and d., see section V.3.),
   e. determination of the prior subjective probabilities of events,
   f. determination of the conditional subjective probabilities of events, in the simplified and full scale, and
   g. running of the computerized scenario-generating model, on the basis of data from points e. and f. (results of e., f. and g. stages are reported in section V.4.).
5. Analysis of the results obtained (section V.5) and conclusions thereof (section V.6).

The list of experts who took part in the session is contained in Table V.1. It should be emphasized that this list encompasses a large portion of these institutions and groups who should and/or can voice their opinions and interests in the development of this area, see Fig. V.1.1., as well as represent an important body of expertise. For Polish documentation of computer printouts see Urich et al. (1985). It should perhaps be noted that, according to Godet (1985), it is necessary to have at least approximately one year for a significant cross impact study.

V.2. Issues

On the basis of considerations reflected in Chapter I of Part 2 of the report a preliminary list of essential issues was put together and sent to the experts. An additional requirement,

besides those resulting from the significance of problems and the specifics of the cross-impact method, was placed upon the formulation of this list of issues, namely, that it should not exceed 12 items. This limitation is due to purely technical reasons. It must be noted, however, that a limitation of this kind usually serves well the focussing of attention and efficiency of the session. On the other hand it may force to consideration of more than one problem within one issue formulation.

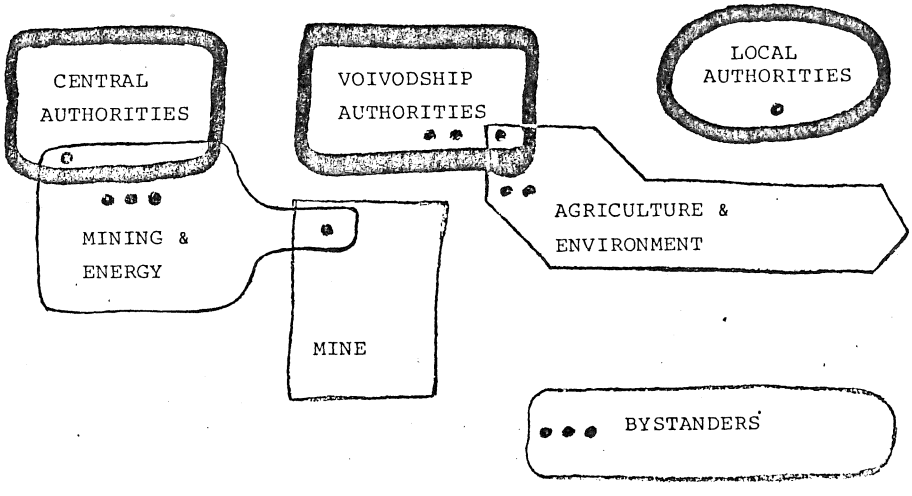


Fig. V.1.1. Covering of sectors and levels by participants of the study.

The list of finally adopted issues, given below, did not differ much from the one proposed to the experts. Each issue is accompanied by appropriate values. The values indicated by the experts in a mini-Delphi procedure are denoted with asterisks, Results of this procedure, carried out with simple terminals of Polish pocket calculators, are illustrated and commented along

Name	Institution	Position
1. Karol Bielikowski	Ministry of Mining and Energy	Director, Lignite Mining Division
2. Andrzej Dunalewicz	Institute of Organic Chemistry, Polish Academy of Sciences	Researcher
3. Stefan Gołaszewski	Voivodship Agricultural Investments Board, Piotrków Tryb. Voivodship	Director
4. Dr Kazimierz Łołubowicz	Field Research Station in Piotrków, Environmental Engineering Institute, Polish Academy of Sciences	Head of Station
5. Marek Jefriemenko	Polish TV, Economic affairs division	Journalist
6. Andrzej Klimiuk	Technical Assistance Department, Polish Academy of Sciences	Assistant
7. Professor Zbigniew Kozłowski	POLTEGOR: Geologicald Mining Design office	Chief Designer Head or project
8. Juliusz Krawczyk	Voivodship Planning Commission, Piotrków	Vice-President
9. Józef Kuszneruk	Lignite Mine	Engineer, Water Economy Division
10. Waldemar Kutera	as 4.	Researcher
11. Damazy Laudyn	ENERGOPROJEKT: Power Design office	Chief Designer Head of Project
12. Antoni Michalak	Voivodship Party Committee, Economic Department	Secretary, Head of Department
13. Ludwik Seweryn	POLTEGOR: Geological & Mining Design office	Designer
14. Andrzej Szczepocki	Head of a commune located in the region	
15. Professor Zygmunt Warsza	Institute of Industrial Chemistry	Head of group

TABLE V.1. List of experts participating in the cross-impact session, in the alphabetical order.

with other aspects of a given issue.

Before assessing the issues the experts convened adopted a set of basic assumptions.

First, assumptions A, through F. quoted in section I.5. were agreed upon as the basis of further consideration. Their correctness was assessed not only "for the forecast sake" and internal consistency, but also from the point of view of actual state and currently adopted premises for any planning exercise.

Thus, the following point discussed concerned determination of the starting point of the forecast. It was agreed that the forecast. i.e. working of the cross-impact model, shall not start at the present time moment, but rather at some well defined, decisive moment in the future. Such a time-point would be the moment when the mining-and-power-generation reaches its maximum capacity, which should occur some time between 1995 and 2000. From then on the basic processes enumerated in Chapter I shall proceed in a different manner (e.g. decreasing extraction, virtual extinction of labour force flow from agriculture to industry etc.). That is why the following set of "starting point" assumptions was agreed upon:

S1. Attainment of at least 95% of the maximum lignite extraction intensity.

S2. Attainment of at least 95% of the full envisaged power generation capacity.

S3. Decrease of the labour force flow intensity from agriculture to industry by 80%.

S4. Build-up period of approx. 15 years, i.e. starting point of the forecast located at around year 2000.

As to the terminal point of the forecast, it was largely determined by the existing production plans for the lignite mines, which assume practical termination of full-scale extraction at around the year 2030. Having in mind a possibility of prolongation of this extraction by eventual discoveries and developments of some neighbouring fields, as well as the "just after" perspective, participants of the session agreed to adopt year 2040 as the terminal point of the forecast. The overall period 2000 - 2040 was subdivided into four 10-year subperiods, (called scenes), as steps of the procedure, i.e.

as distances over which the first-order approximations are taken in the method as valid.

For the temporal structure of the analysis, see Fig. V.1.2.

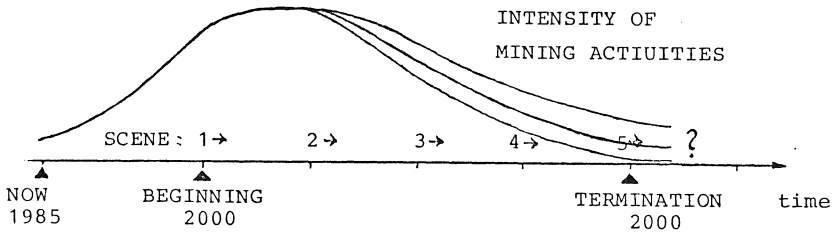


Fig. V.1.2. Specification of time scale of the forecast.

V.2.1. Attractiveness of work in the region

"This issue is evaluated by assessing the relative (as compared to national average) personal income in the region, taking into account the corrective factor accounting for the environmental (natural, health,...) and socio-cultural (housing, service, education, leisure,...) conditions."

Current values: a. for the country as a whole:
30 points, i.e. 100%,
b. for Upper Silesia:
37* points,i.e. 123%*,
c. for the region in question:
38* points,i.e. 127%*,

Forecasted values:
d. starting point: 39* points,i.e. 130%*,
e. terminal point: 34* points,i.e. 113%*.

The above text, with blanks where now asterisked numbers appear, was presented to the experts. It consists, for each issue, of issue measure quasi-definition (which was also discussed and adopted at the session) given in quotation marks, and of evaluation items. Because of technical reasons,

mentioned in Chapter II, Part 1, actual evaluations were expressed during the session by its participants on the scale of 1 to 99 and only then, where necessary, converted to some other scale. Numbers which are not asterisked here did appear on the original session sheets and served as basic, reference data.

Upper Silesia is an old, heavily industrialized region founded mainly on the anthracite mining and metal industries, enjoying high average earnings but also very serious environmental problems.

Asterisked values were obtained through a mini-Delphi sort of procedure. Figures V.2.1. through 4. show the final histograms of evaluations of individual items: 1b.,1c., 1d. and 1e. above. The histograms are produced by aggregating

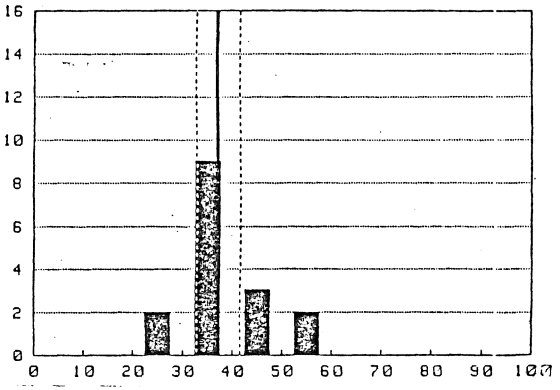


Fig. V.2.1. Final histogram of expert responses to issue 1b. (work attractiveness, current value for Upper Silesia). Modal value: 37.11, coefficient of variation, i.e. standard deviation divided by mean value:.18.

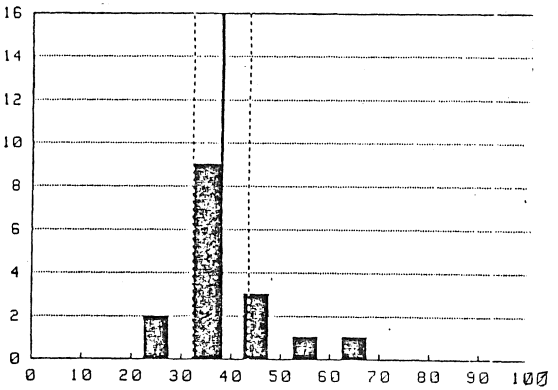


Fig. V.2.2. Histogram of expert responses to issue 1c. (work attractiveness, current for the region). Modal value: 37.91, coefficient of variation: .22.

the numbers of experts (axis 0y) whose estimates fall within consecutive ten-points interval (axis 0x). The number of experts in these mini-Delphi exercises is 16, since experts listed in Table V.1. were joined by a member of this team of authors,

One can easily see from the figures that there is a fair agreement among experts as to subpoints of issue 1. The conclusion which can be drawn from the results obtained is as follows: attractiveness of work in this newly developing region is already above that of Upper Silesia and shall continue to slowly grow until at least the initial point of the forecast, but then it will decrease reaching at the end of the forecasting period a level lower by some 13% than its maximum.

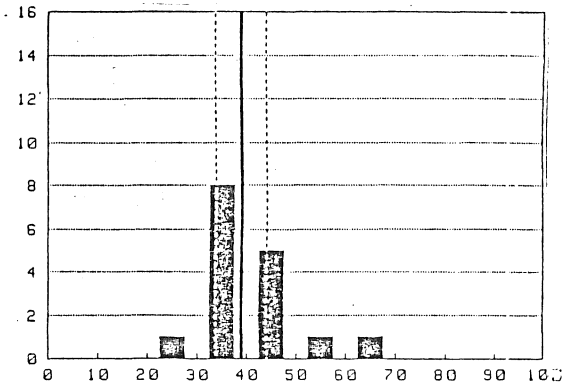


Fig. V.2.3. Histogram of expert responses to issue 1d. (work attractiveness, starting point value for the region). Modal value: 38.98, coefficient of variation: .20.

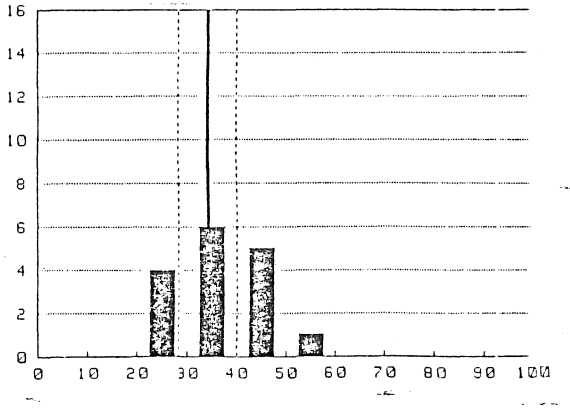


Fig. V.2.4. Histogram of expert responses to issue 1e. (work attractiveness, terminal point value for the region). Modal value: 34.20, coefficient of variation: .26.

V.2.2. Electric energy consumption in the region

"Evaluated by assessing the increase, from the present level, of the electric power consumption in the region, taking into account possibilities of development of various economic activities within the region".

Values: a. current: 30 points, i.e. 100% ,
b. starting point: 37* points, i.e. 123* ,
c. terminal point: 49* points. i.e. 163* .

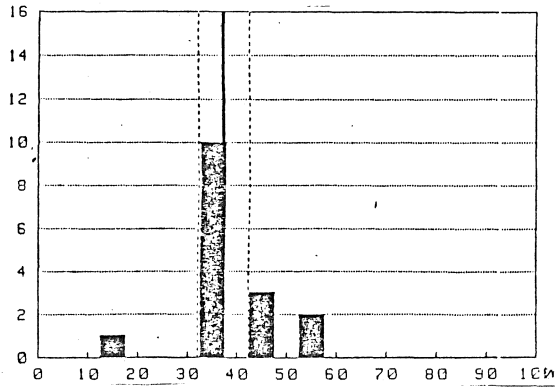


Fig. V.2.5. Histogram of expert responses to issue 2b. (electricity consumption, starting point value for the region). Modal value: 37.10, coefficient of variation: .21.

As all other issues, also this one involves a number of tacit assumptions or aspects to be considered. Thus, in this case, one should have in mind: energy economies to be made in view of increasing energy costs, general national economic trends, and local developments. In view of all that it seems that experts had agreed to a consumption growth which is slightly above the national average. Note, again a fair agreement of experts over this issue, with exception of just one outlier for item 2b.

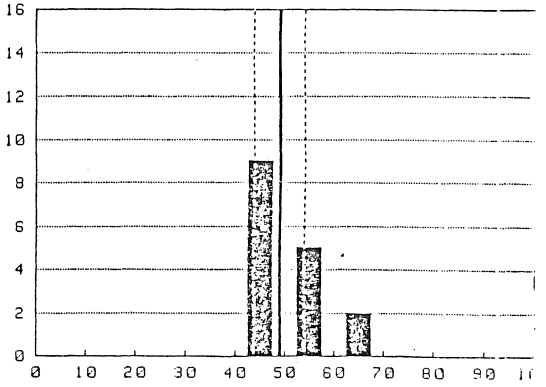


Fig. V.2.6. Histogram of expert responses to issue 2c. (electricity consumption, terminal point value for the region). Modal value: 48.91, coefficient of variation: .15.

V.2.3. Significance of agriculture in the regional (voivodship) economy

"Evaluated by assessing the agriculture's share in the total of voivodship production, in %, with due consideration of dynamics of both the agricultural and non-agricultural sectors in the region, with the dynamics of agricultural sector accounting for: changes in arable land resources and in labor force, state of environment, condition of the productive assets, technologies applied etc. on the one hand, and the demand and price levels of agricultural produce on the other".

Values: a. current, 17%, while the national average is 20%
b. starting point, 12%*,
c. terminal point, 13%*.

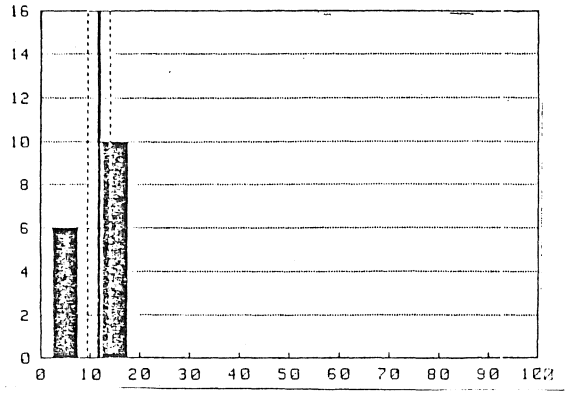


Fig. V.2.7. Histogram of expert responses to issue 3b. (agriculture in the region, starting point value for the region). Modal value: 11.73, coefficient of variation: .28.

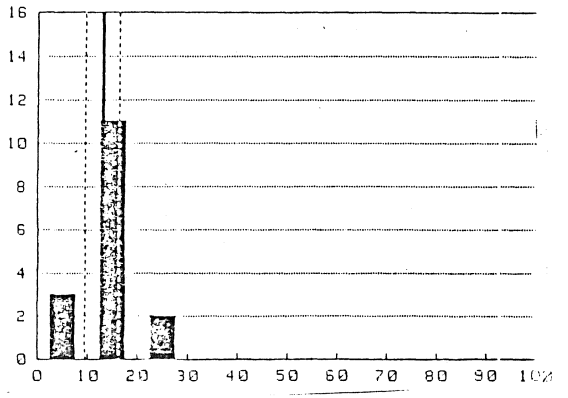


Fig. V.2.8. Histogram of expert responses to issue 3c. (agriculture in the region, terminal point value). Modal value: 12.89, coefficient of variation: .38.

Thus, experts thought that after the period of sharp decrease in the relative importance of agricultural activities, until 2000, there will be a stabilization of agricultural share or even a small increase, although with respect to this latter statement there is less agreement among experts.

V.2.4. Investment-intensity of non-agricultural jobs

"Evaluated by assessing the relative (% of the national average) value of fixed assets per workplace outside agriculture in the voivodship, taking into account general national and local trends (decapitalization, repayment, modernization, changes of technologies, new investments etc.), with the - moving - national average at 30 points".

Values: a.current, for industry, 30 points, i.e. exactly 100% of the national average
b. starting point, 41* points, i.e. 137%*,
c. terminal point, 40* points, i.e. 133%*.

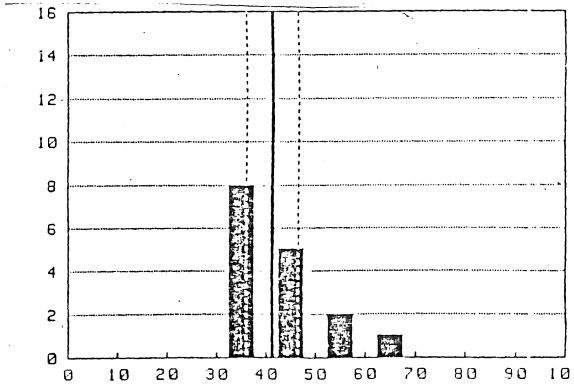


Fig. V.2.9. Histogram of expert responses to issue 4b. (investment-intensity of jobs outside agriculture, starting point value). Modal value: 41.15, coefficient of variation: .19.

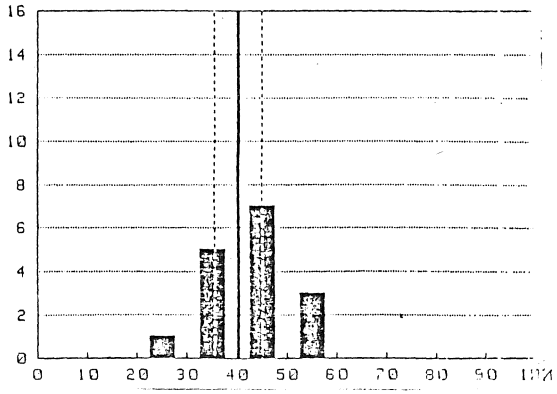


Fig. V.2.10. Histogram of expert responses to issue 4c. (investment-intensity of jobs outside agriculture, terminal point value). Modal value: 40.21, coefficient of variation: .16.

Apparently, experts have seen a relatively quick build-up coming, parallelling growth of extraction, followed by stabilization or perhaps a negligible decline, at about 135% of the national average. This is primarily an expression of belief as to the additional industrial development and as to its nature, i.e. to a large extent heavy industries. Note, yet again a significant agreement among experts.

V.2.5. Investment-intensity of agricultural jobs

Evaluated as in V.2.4. above, with particular attention to local changes of the capital intensity of agriculture.

Values: a. current: 30 points, i.e. exactly 100% of the national average,

b. starting point: 30* points, i.e. exactly 100%* of the national average,

c. terminal point: 35* points, i.e. 117%* of the national average.

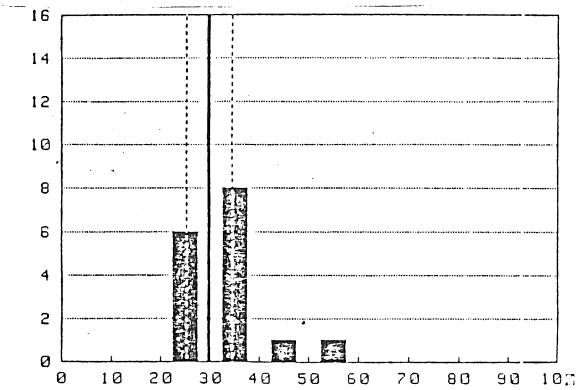


Fig. V.2.11. Histogram of expert responses to issue 5b. (investment intensity of agricultural jobs, starting point value). Modal value: 29.83, coefficient of variation: .23.

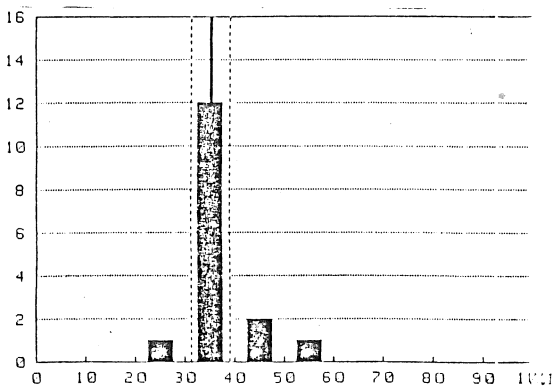


Fig. V.2.12. Histogram of expert responses to issue 5c. (investment intensity of agricultural jobs, terminal point value). Modal value: 35.18, coefficient of variation: .17.

The result presented corroborates the opinion as to issue 3. (section V.2.3.: significance of agriculture in regional economy). Thus, it is held by the experts that after a period of stagnation, leading to relative decline, local agriculture shall stabilize and even shall start to redress, as witnessed by higher than average (by 17%) per-job investment volume resulting from its growth over the period of forecast. Apparently, such a view was enhanced by the perspective of increasing income levels and urbanization of the region. This may lead to development of investment-intensive activities in local agriculture.

V.2.6. Attractiveness of the region for location of water - and generally resource-intensive industries

"Evaluated as a relative, in comparison with the national average, regional attractiveness for location of - additional - resource-intensive industries, from the viewpoint of water availability, construction materials, infrastructure, land and labour force (primarily energy industry, induding nuclear, chemical industries, heavy metal industries)".

Current values: a. national average: 30 points, i.e. 100%,
b. for the region: 22* points, i.e. 75%* ,

Forecasted values:
c. starting point: 20* points, i.e. 67%*,
d. terminal point: 33* points, i.e. 109%*.

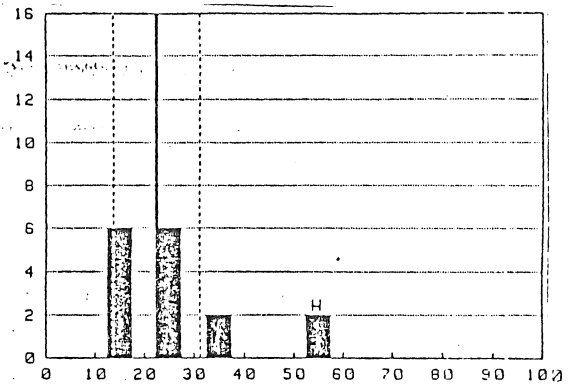


Fig. V.2.13. Histogram of expert responses to issue 6b. (attractiveness for resource-intensive industries, present). Modal value: 22.49, coefficient of variation: .59.

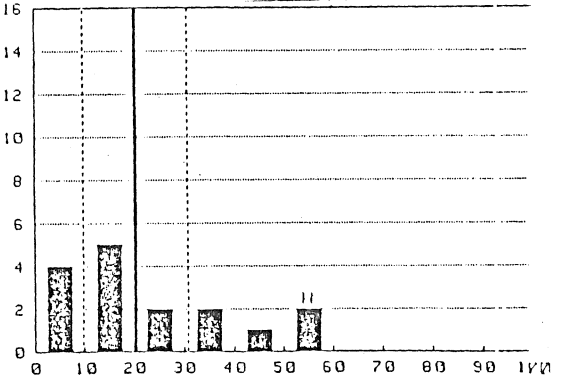


Fig. V.2.14. Histogram of expert responses to issue 6c. (attractiveness for resource-intensive industries, starting point). Modal value: 20.22, coefficient of variation:.78.

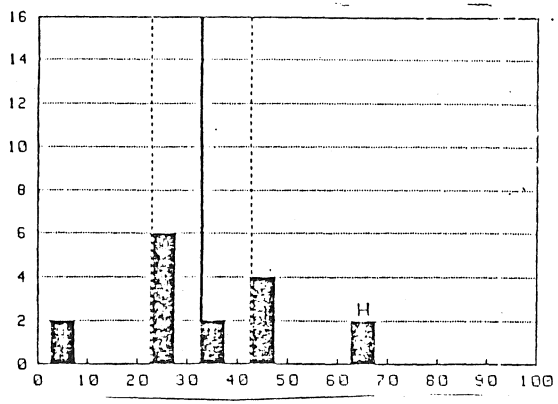


Fig. V.2.15. Histogram of expert responses to issue 6d. (attractiveness for resource-intensive industries, terminal point). Modal value: 32.79, coefficient of variation: .46.

Note first an obvious disagreement of experts, which persisted throughout the procedure. Since it was not the aim of this exercise to bring the experts into an, eventually, quasi-consensus, after a few steps there was no more effort into "homogeneization". Thus, it is clear that two experts (estimates denoted by H, for "high") steadily maintained their opinion of very high attractiveness of this area for heavy industries, notwithstanding water reserve difficulties and environmental problems. On the other hand there were two experts who maintained that terminal attractiveness for resource-intensive industries shall be lower than the present one.

Even, however, taking all these discrepancies into account, it can be concluded that experts envisage a drop in attractiveness from now till the starting point and an improvement thereafter. As to the levels, conclusions must be quite cautions, but it seems that the region may end up by having higher attractiveness than national average, in spite of water-preservation regulations

and potential environmental threats. The attractiveness level would result from the already existing, at that time, local infrastructure, technical and social.

V.2.7. Natural and recreational attractiveness of the region

"Evaluated as a relative, in comparison with the national average, attractiveness of the region for definite human groups an agglomerations, from the viewpoint of nature resources (water, forests, landscape), interesting landscape and cultural objects, their promotion and possibility of utilization".

Current values: a. national average: 30 points, i.e. 100%,
b. for Upper Silesia: 11* points, i.e. 37%*,
c. for the region: 25* points, i.e. 82%*,

Forecasted values:
d. starting point: 25* points, i.e. 83%*,
e. terminal point: 26* points, i.e. 88%*.

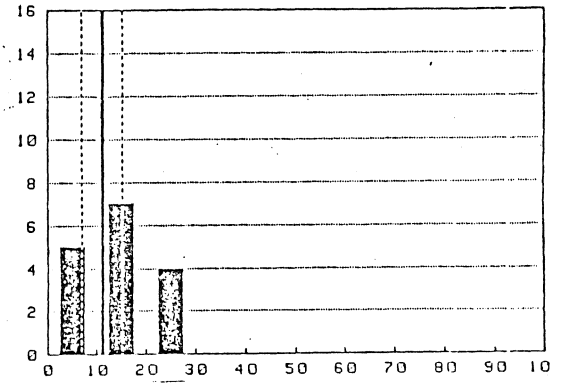


Fig. V.2.16. Histogram of expert responses to issue 7b. (current leisure-wise attractiveness of Upper Silesia). Modal value: 11.18, coefficient of variation: .56.

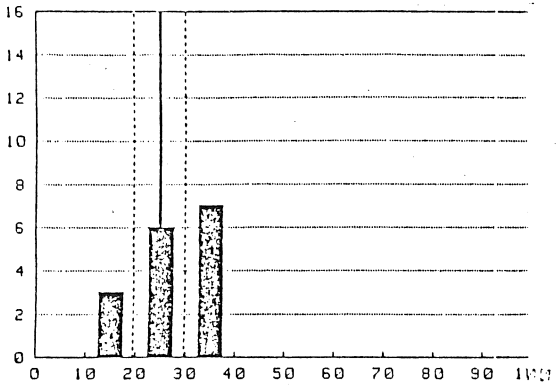


Fig. V.2.17. Histogram of expert responses to issue 7c. (current leisure-wise attractiveness of the region). Modal value: 24.67, coefficient of variation: .31.

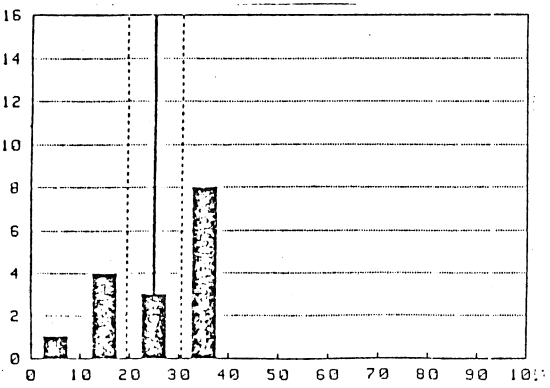


Fig. V.2.18. Histogram of expert responses to issue 7d. (leisure-wise attractiveness of the region at starting point of the forecast). Modal value: 25.02, coefficient of variation: .32.

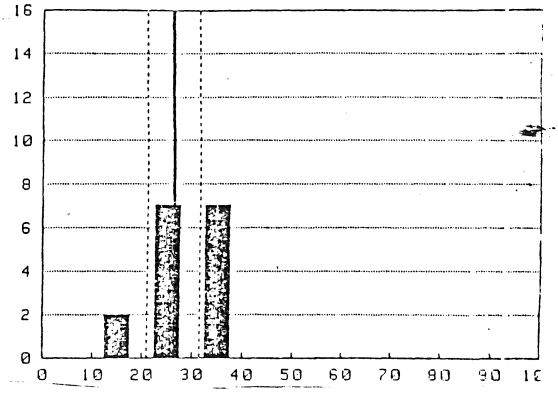


Fig. V.2.19. Histogram of expert responses to issue 7e. (leisure-wise attractiveness of the region at terminal point of the forecast). Modal value: 26.27, coefficient of variation: .29.

Here experts ostensibly regain their agreement. A somewhat higher value of the variability coefficient for issue item 7b. is of minor significance here, since this item was used only to set a scale for further estimates. In general, it can be said th. region's nature - and leisure-wise attractiveness shall remain stable, at some 80-90% of the national average. There is a small upswing at the end of the period, but of little importance in view of qualitative nature of the procedure (anyway, at least one expert thought there may rather be a decrease). The stability results from opposing influences of further anthropogenic changes: environmental and landscape deterioration on the one hand, and appearance of new objects as well as infrastructure on the other.

V.2.8. Value of agricultural production per 1 hectare

"Evaluated by assessing the relative, as compared to national average, value of agricultural net product per 1 hectare of arable land, with consideration of general national as well as local trends; in consideration of local trends account should be made of the technical condition of agriculture, its intensity, environmental conditions - in particular soil humidity and the possibility of decreasing the value of agricultural products by too high toxic or harmful contents, labour force, and potential technological changes".

Current values: a. national average: 30 points, i.e. 100%,
b. for Upper Silesia: 32 points, i.e. 107%,
c. for the region: 27 points, i.e. 90%,

Forecasted values:
d. starting point: 25* points, i.e. 83%*,
e. terminal point: 29* points, i.e. 97%*.

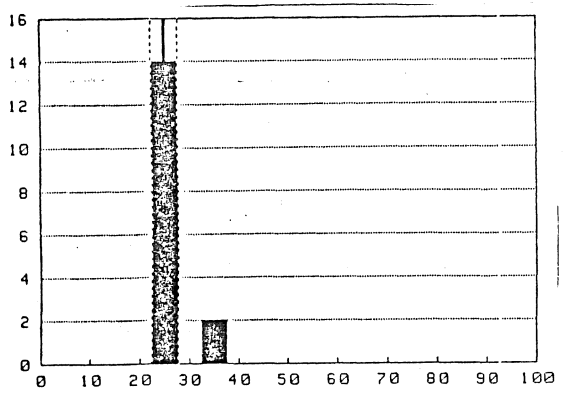


Fig. V.2.20. Histogram of expert responses to issue item 8d. (per hectare value of agricultural production in the region at starting point). Modal value: 25.03, coefficient of variability: .16.

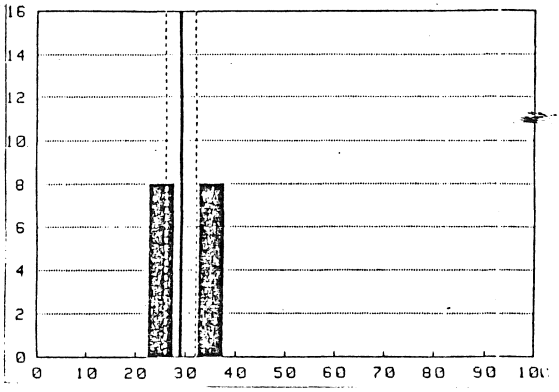


Fig. V.2.21. Histogram of expert responses to issue item 8e. (per hectare value of agricultural production in the region at terminal point). Modal value: 29.02, coefficient of variation: .15.

Responses to this issue item were to show consistency with the other ones concerning agriculture (issues 3 and 5) and also to distinguish more strongly the influence of potential price and demand increases for agricultural products.

The results are up to expectations: previously indicated trends are maintained (first a decline and then an improvement), and tend to even be sharper, which corroborates the demand and price increase hypothesis. Still, however, monetary intensity of agricultural production will have difficulties in reaching national average. Agreement among experts was very high with that respect.

V.2.9. Investments in the region outside mining and the economic stability

"Evaluated by assessing the portion, expressed in %, of additional investments made into the economic activities, other than mining, in the region, this total volume of additional investments being necessary for maintaining a persisting perspective of economic stability of the region".

Values: a. current : 59%*,
b. starting point : 55%*,
c. terminal point : 61%*,

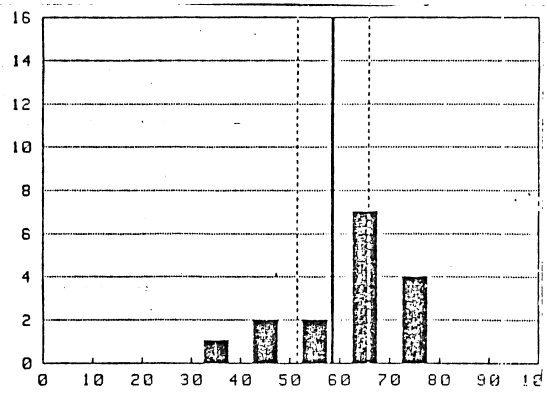


Fig. V.2.22. Histogram of expert responses to issue item 9a. (currently implemented portion of investments necessary for regional stability). Modal value: 58.56, coefficient of variation: .18.

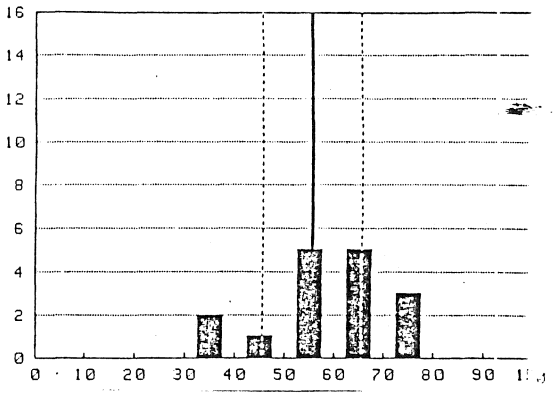


Fig. V.2.23. Histogram of expert responses to issue item 9b. (portion of investments necessary for regional stability implemented at starting point). Modal value: 55.42, coefficient of variation: .27.

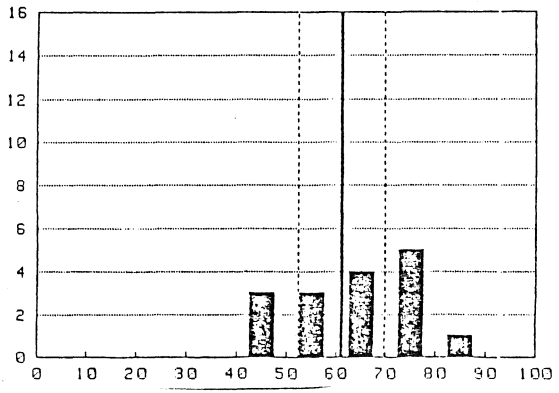


Fig. V.2.24. Histogram of expert responses to issue item 9c. (portion of investments necessary for regional stability implemented at terminal point). Modal value: 61.0, coefficient of variation: .21.

It should be emphasized that although this issue was defined in quite a fuzzy way, with practically no hard data to rely upon or at least to start with, there was, still, quite an agreement among experts, corroborated also by consecutive shapes of frequency histograms, Figs. V.2.22-24. Generally speaking, there is not much faith in stabilization of this regional economy through "naturally" made investments. Certainly, there shall be a growth of variety and infrastructure during the extraction period, by some 10%, in terms of relative volume, but of no major importance for the regional robustness.

V.2.10. Changes in utilization of lignite

"Evaluated as % share of lignite volume extracted, which, owing to new technological developments shall be directed not to electric power generation, but to other, economically and/or socially more profitable uses (chemicals, agriculture,...)".

Values: a. current: 1%,
b. starting point: 2%*,
c. terminal point: 23%*.

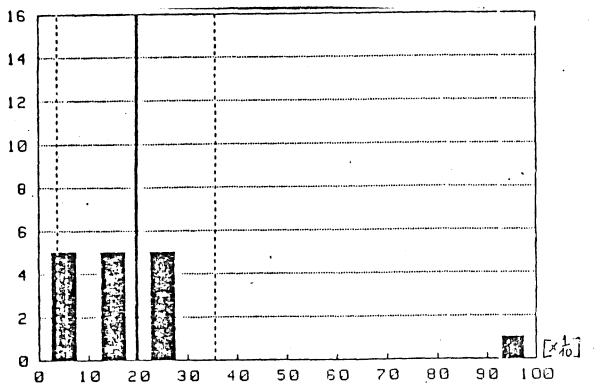


Fig. V.2.25. Histogram of expert responses to issue item 10b. (non-power share of lignite utilization at the starting point). Modal value: 1.973 (scale used was multiplied by 10)! , coefficient of variation: 1.20!.

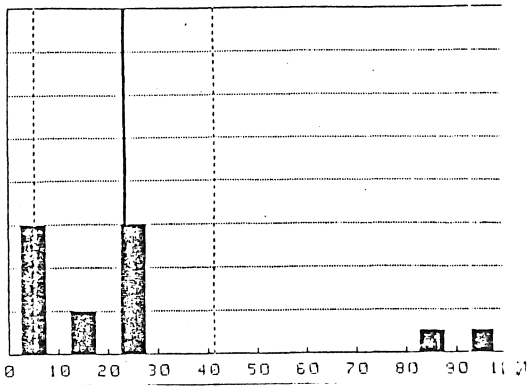


Fig. V.2.26. Histogram of expert responses to issue item 10c. (non-power share of lignite utilization at the terminal point). Modal value: 23.29, coefficient of variation: 1.15!

The very high degree of disagreement of experts as to this particular issue is a reflection of both their diverging views and their uncertainty in this quite hypothetical domain. It is interesting to see a minority (one expert for 10b. and two experts for 10c.) of very optimistic "outlying" views. In general, it can be stated that the non-power-generation use of lignite throughout and at the end of the forecast period will not have a major influence on power generation (which will anyway go down or switch to another fuel in the vicinity of the terminal point) but, at the same time, the diverted lignite may have an impact on regional economy.

V.2.11. Skills and education of labour force

"Evaluated by assessing the ratio of the available skilled and technical labour to the potential demand of an industry of highly processed products (hi-tech, eventually) that would have regional significance, taking into account education and employment processes in the region, educational infrastructure and potential

differentiation of demand, in %".

Values: a. current: 34%*,
b. starting point: 40%*,
c. terminal point: 75%*.

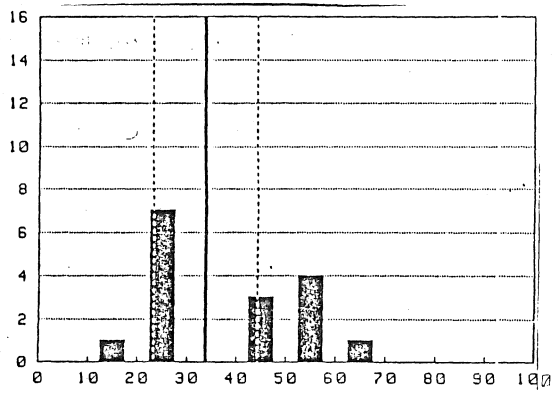


Fig. V.2.27. Histogram of expert responses to issue item 11a. (current skill preparation ratio). Modal value: 33.77, coefficient of variation: .46.

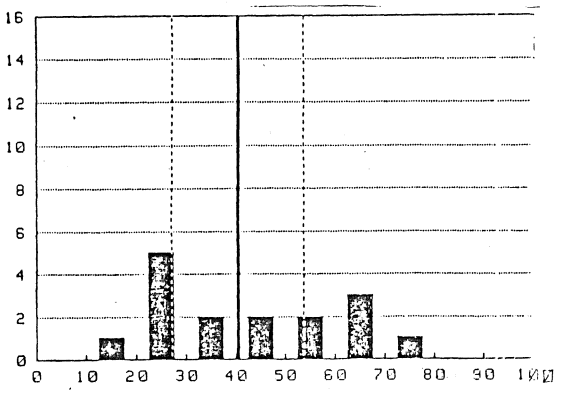


Fig. V.2.28. Histogram of expert responses to issue item 11b. (skill preparation ratio at starting point). Modal value: 40.46, coefficient of variation: .49.

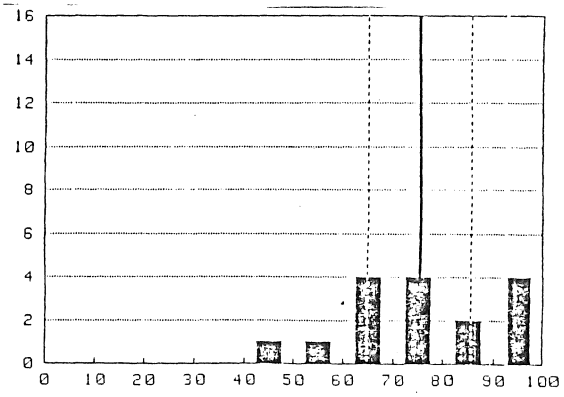


Fig. V.2.29. Histogram of expert responses to issue item 11c. (skill preparation ratio at terminal point). Modal value: 75.15, coefficient of variation: .21.

Note quite a "decent" agreement of experts for this issue, which is almost as hypothetical as issue 10. The result for the terminal point can be viewed as quite an optimistic one, though some experts, who anyway shift their assessments upwards, are of a far less optimistic opinion with regard to labour force skill conditions for more advanced industries to be located in the region.

V.2.12. Energy-wise national utility of the region

"Evaluated through the share of this region in the overall electric power balance of the country, in %".

Values: a. current: approx. 10%,
b. starting point: approx. 18%, according to plans,
c. terminal point: 8%*.

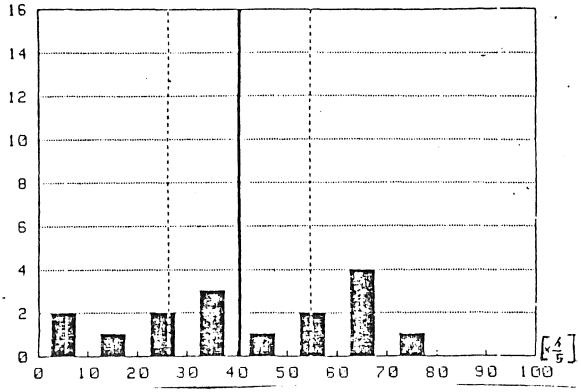


Fig. V.2.30. Histogram of expert responses to issue item 12c. (national energy share of the region at terminal point). Modal value 40.45 (scale multiplied by 5!).

This issue was meant to clarify what shall be the net energy export of this region in 2040's, i.e. whether power generation shall stop, shall be kept at the minimum level (only for regional purposes, e.g. from other, smaller neighbouring lignite reserves) or, shall be maintained at a higher level owing to either new resource discoveries or new technologies. The result, in spite of obvious disparity of opinions, points out that regional share in rational electric power generation shall not go down to zero, but rather be maintained at an inportant positive level, presumably by a technological change and/or by use of an alternative source, like nuclear.

V.3. Events

On the basis of results and formulations obtained for the regional development issues the subsequent step of the procedure could be carried out, namely (see section V.1): adoption of the list of events, together with determination of the threshold values for these events.

The experts participating in the session have already, through

its issue-oriented part, gained a broader recognition of the problem area, and especially of its more or less controversial domains. This, however, does not yet lead to actual recognition of importance and interrelations of these issues. Thus, for instance, some issues over which there was little agreement may turn out to be of foremost importance, while other may be quite insignificant. The subsequent step in the direction of better recognition of the actual structure and significance of issues is done in the procedure through formulation and subjective probability assessment of the events, directly related to the previously discussed issues. Then, first-order conditional subjective probabilities are assessed, constituting the basis for actual forecast runs of the computerized method. In fact, the straightforward, "direct", subjective probabilities together with the first-order conditional ones form a sort of a model of this system, results of this model being obtained in accordance with the relations given in Chapter II of Part 1 of the report.

Formulation of events

The list of events given here in Table III.2 relates directly to the list of issues of section V.2. In fact, every event is a reformulation of the corresponding issue so that on the basis of assessments given for the issue measure a significant threshold value is made to appear to which probability measure values can be attributed as to whether this threshold will be attained, exceeded or not attained over the forecast period or over its portion. Formulation of the events, as in the case of issues, was done by the project team, while threshold values were determined, on the basis of previous ratings, through appropriate mini-Delphi votings whose results, however, shall not be given here, because of their secondary significance.

1. Decrease of the relative attractiveness of work in the region shall be at least 13% over the period considered.
2. Relative electric power demand in the region shall increase over the period considered by at least 32%.
3. Agriculture's share in GRP shall be constant over the period considered, at the level of 63% of the national average.
4. Relative value of fixed assets per one non-agricultural workplace in the region shall be constant over the period considered, at the level of 140% of the national average.
5. Increase of the relative value of fixed assets per one argricultural workplace in the region shall be over the period considered not smaller than 17%.
6. Water and other natural resources of the region, available at the end of the period considered, shall attract water - and generally resource-intensive industries.
7. Social attractiveness of region's nature and recreational premises shall attain at least 90% of the national average at the end of the period considered.
8. Agricultural production value per 1 hectare shall approach the national average level at the end of the period considered.
9. Investments made in the regional sectors not related directly to mining shall attain at least 60% of those necessary for ensuring long-range regional economic stability at the end of the period considered.
10. Technological developments occurring over the period in question shall cause at least 23% of the lignite extracted in the region to go to purposes other than direct burning for energy generation, at the end of this period.
11. Availability of skilled labour will not create over the period in question obstacles to the development of industries of highly processed goods.
12. During the period considered additional or alternative energy sources shall be activated making it possible for the region to account for at least 8% share in the total national production of electric power.

TABLE V.2. The list of events.

V.4. The cross-impact model

According to considerations contained in section II.3. of Part 1 of this report, a "cross-impact" model of interrelations among various hypothetical events is determined by the equation (II.13), Part 1, the so-called cross-impact relationship, derived after Turoff, and by the following parameters:

(i) prior subjective probabilities of events, P_i^0, i=1,...,N;

(ii) conditional subjective probabilities of events, R_{ij}, S_{ij}, i,j=1,...,N, $i \neq j$;

(iii) cross-impact matrix $\underline{C}$, containing also the γ-coefficients;

(iv) effectiveness and sensitivity parameters, ψ_i^t, η_i^t, η_{ij}^t, i,j=1,...,N, $i \neq j$, where t=1,...,4 are indices of subsequent scenes (subperiods).

Since methodological significance of the above parameters was presented in Chapter II, Part 1, they will only be cited here and commented upon for substantial purposes, i.e. from the viewpoint of strategic futures of the region in question. Thus, Table V.3 recalls P_i^0 and R_{ij}, S_{ij}, while Table V.4. - values of C_{ij}.

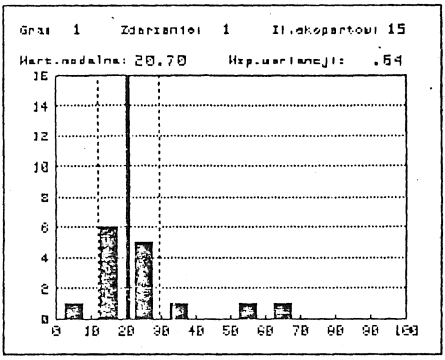
I	1	2	3	4	5	6	7	8	9	10	11	12
Po(I)	21	38	78	80	34	13	38	32	39	16	24	6

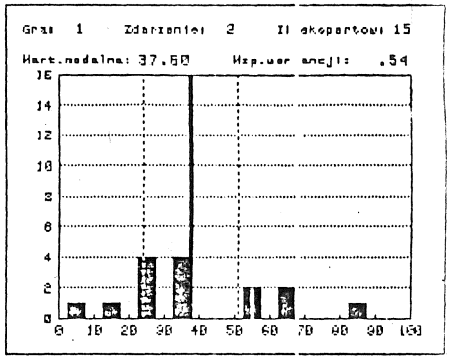
Table caption - see next page.

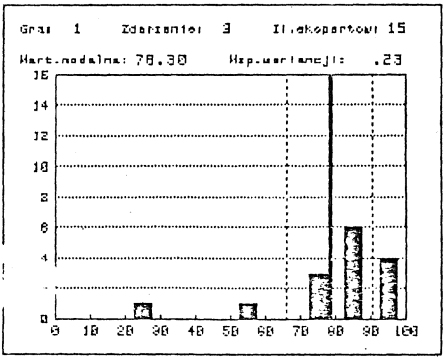
I	Po(I)	1	2	3	4	5	6	7	8	9	10	11	12
1	0.21	##	23	23	32	29	20	32	25	37	21	39	28
		##	20	15	3	18	21	16	19	14	21	17	21
2	0.38	35	##	43	56	48	55	43	45	52	47	51	46
		39	##	23	3	33	36	35	35	30	36	34	38
3	0.78	76	80	##	76	90	68	79	89	78	74	79	77
		79	77	##	85	69	79	77	71	78	79	78	78
4	0.80	75	82	80	##	78	82	81	79	84	82	79	84
		81	79	80	##	81	80	79	80	77	80	80	80
5	0.34	36	49	59	39	##	38	37	63	34	36	35	36
		33	26	1	18	##	33	32	23	34	34	34	34
6	0.13	13	16	14	14	14	##	24	13	26	20	24	11
		13	11	10	10	13	##	9	13	8	12	11	13
7	0.38	41	39	48	40	40	30	##	40	48	37	40	36
		37	37	13	30	37	39	##	37	32	38	37	38
8	0.32	36	44	71	33	72	30	36	##	38	33	35	32
		31	26	0	28	16	32	30	##	28	32	31	32
9	0.39	43	47	49	49	49	50	50	44	##	44	54	51
		38	34	13	11	34	37	33	37	##	38	35	38
10	0.16	17	21	19	19	19	33	19	16	25	##	22	40
		16	13	8	8	15	14	14	16	12	##	14	15
11	0.24	34	25	25	42	25	26	31	26	38	25	##	39
		22	23	21	1	23	24	20	23	19	24	##	23
12	0.06	7	23	7	12	6	10	6	6	13	9	12	##
		6	2	3	0	6	6	6	6	4	6	5	##

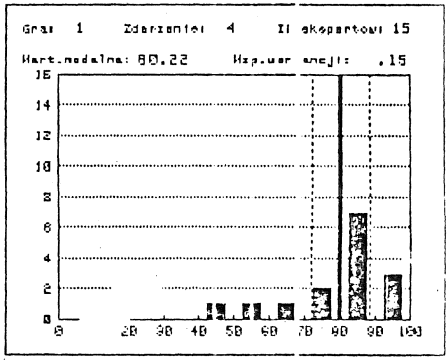
Table V.3. Values of P_i^0 and R_{ij}/S_{ij} in %. Rows: influenced events, columns: influencing events.

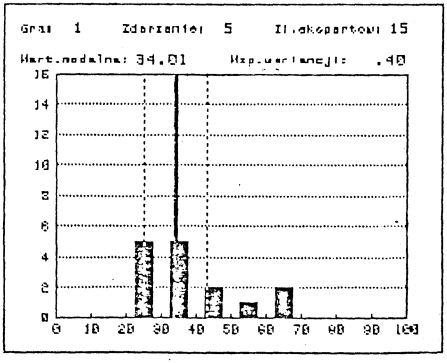
Table V.3. presents aggregate (weighted average) prior subjective probabilities, whose values could be determined via a series of mini-Delphi votings and discussions. In order to better illustrate this stage of the process, Fig. V.4.1. shows the outline of votes for these probabilities. It can easily be seen that in many cases experts' opinions, in spite of repeated votings, widely diverged. In fact, this collection of histograms might serve as educational exhibit, serving for illustrating various cases of group voting behaviours: a. more than one opinion group, events 1, 2 and 8; b. outliers: events 3,6 and 10; c. distributed opinion: events 7 and 11; d. unimodal opinion: events 4, 9, 11.











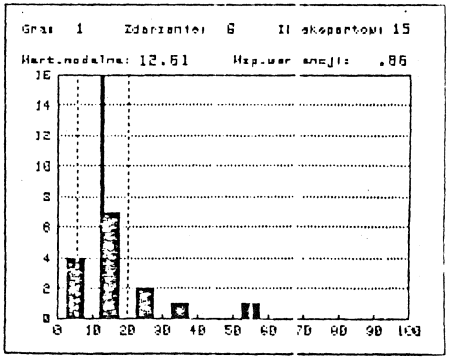
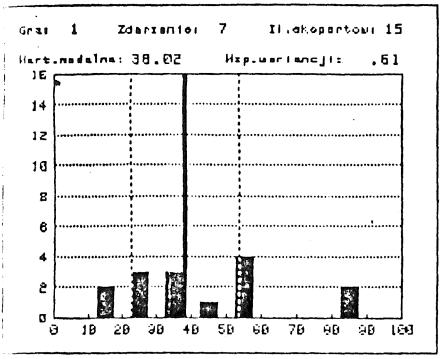
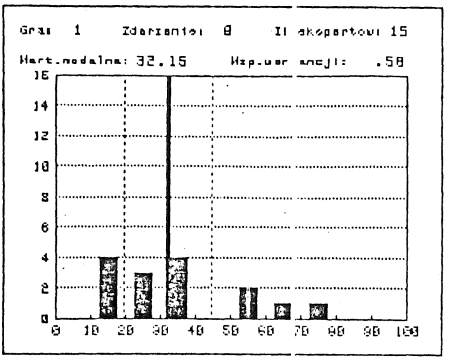
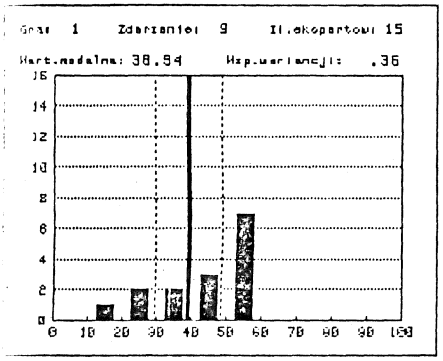
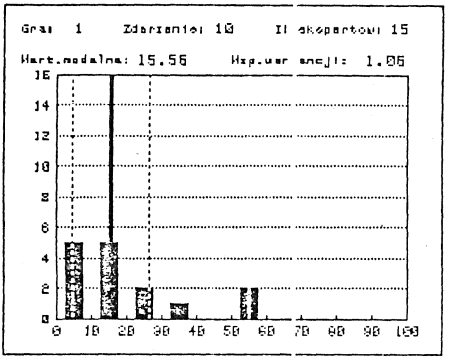


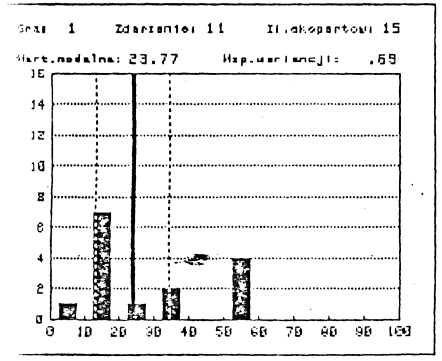
Fig. V.4.1.a. Histograms of mini-Delphi responses as to prior subjective probabilities of the first six events e_i, i=1,...,6.











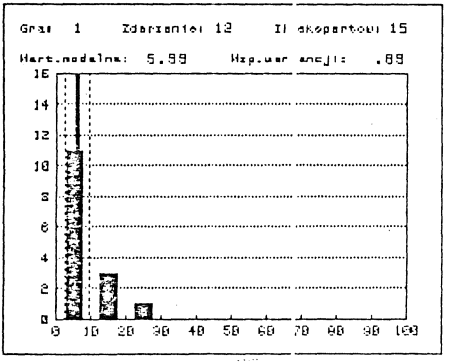


Fig. V.4.1.b. Histograms of mini-Delphi responses as to prior subjective probabilities of the last six events, e_i, i=7,...,12.

There was no further effort, though, meant at bringing the diverging opinions closer, since, first, identification of opinions was one of the goals of this study, and, secondly, it was anticipated that such a convergence would not change much the final results of the cross-impact model.

Note that because of the stage-wise temporal breakdown of the forecasting period the probabilities P_i^0 do also express the beliefs as to the dynamics of particular processes. Thus, it is obviously believed that the share of agriculture in regional product shall be kept at the constant relative level of 63% of national average throughout the whole period (event 3) and that the high investment intensity in industry shall also persist over the whole forecasting period (event 4). Simultaneously, low initial dynamics is assigned to events 6 (industrial attractiveness of region's resources) and 12 (8% of region's share in national electric power generation balance). Otherwise both dynamics and levels are not very well pronounced. The events as to which experts disagreed the most in giving subjective prior probabilities were: event 2: local energy demand, event 7: social attractiveness of region's endowment, event 8: value of agricultural production per hectare, event 10: non-energy use of lignite,and event 11: skills of labour force.

Although these observations, together with the results obtained for issues, constitute already a basis for substantial conclusions, they will be commented upon in a more in-depth manner at the end of result presentation.

V.4.2. Subjective conditional probabilities

As mentioned previously, the resulting conditional parameters R_{ij} and S_{ij}, contained in Table V.3., are calculated on the basis of subjective conditional probabilities, provided by the experts. In view of the fact that there are 12 events, each expert was asked to provide as many as 132 subjective probability assessments. In order to facilitate this task experts were asked first to give these probabilities via the "influence index" values. This index, whose values, denoted I_{ij}^k (k-th expert, influence of j-th event on i-th event) are integers -3,-2,-1,0,+1,+2,+3, shows the degree of change of P_i^0 resulting from previous occurrence of an event j.

Thus, e.g., when $I^k_{ij}=I^k_{ji}=0$, then, according to the k-th expert, events i and j are independent. An explanation of meaning attributed to particular values of I^k_{ij} is given in Table II.6. of Part 1.

Tables of $\{I^k_{ij}\}$ for various k are given in the Appendix A. to this Chapter. Values of I^k_{ij} were converted in a simple manner into numerical values of $\hat{P}^k_{i/j}$, i.e.

$$\hat{P}^k_{i/j} = P^0_i + \frac{|I^k_{ij}|}{4}\left(\frac{1}{2}\left(\frac{I^k_{ij}}{|I^k_{ij}|} + 1\right) - P^0_i\right)$$

then aggregated over k, that is, over all the experts, and then used to produce C_{ij}, Table V.4., and, further, working of the cross-impact model.

After I^k_{ij} were established, experts retained copies of their tables $\{I^k_{ij}\}$ of qualitative assessments of inter-event interactions and were asked to produce, at a delay of approximately one week, quantitative tables containing values of $P^k_{i/j}$ expressed in percentage points. These tables, together with appropriate results of the rest of the cross-impact procedure, are given in Appendix B. to this Chapter. As could be expected, in spite of more time given to the experts, tables $\{P^k_{i/j}\}$ not only contained inconsistencies with regard to $\{I^k_{ij}\}$, but, apparently, also internal inconsistencies. Apart from that, the final results thus obtained did either confirm the ones obtained with $\{I^k_{ij}\}$ or at least were not contradictory with them. Significantly, they also carried less information, as if, given more time, experts receded to "safer" opinions which ultimately can lead to "white noise" i.e. no information phenomenon. That is why further presentation shall primarily refer to the I^k_{ij} - based results of the cross-impact simulation and analysis.

V.5. Results of simulation

V.5.1. Probability values

Having determined the parameters of the cross impact model, as described in Chapter II of Part 1, these parameters defining interactions between the pairs of events and the event-proper features, one can pass over to the very simulation of the future event probabilities. This, in turn, can serve as a basis for development of the scenario, or scenarios, of future regional

system development. The scenario thus identified is referred to as "exploratory" or "warning". It precludes, namely, any decision feedback and, instead, assumes certain a priori, unchangeable conditions and policies. Such a simulation is sometimes referred to as "passive" in that it does not contain a possibility of inter--scene interventions, changing P_i^t, i=1,...,N; t=1,...,T-1, and motivated by the results observed for the scenes 1,...,t-1.

The direct result of simulation are the adjusted (updated) probabilities P_i^t of the events e_i, with the prior probabilities P_i^0 being "input" probability values for the first scene. Values of the temporal development of probabilities over the sequence of scenes are shown in Table V.5. Additionally, diagrams presenting these temporal developments, against definitions of events, are contained in the Appendix C of this Chapter.

I	2000	2010	2020	2030	2040
1	0.18	0.61	0.88	0.95	0.88
2	0.39	0.69	0.96	0.96	0.97
3	0.75	0.75	0.90	0.95	0.90
4	0.78	0.85	0.94	0.86	0.87
5	0.39	0.73	0.86	0.98	0.99
6	0.19	0.22	0.63	0.67	0.76
7	0.27	0.64	0.60	0.64	0.60
8	0.21	0.70	0.99	0.95	1.00
9	0.38	0.71	0.90	0.97	0.97
10	0.21	0.39	0.76	0.86	0.93
11	0.20	0.54	0.71	0.86	0.83
12	0.10	0.35	0.67	0.88	0.94

Table V.5. Values of adjusted probabilities P_i^t, for events e_i and scenes t.

Analysis of the results obtained shall first directly refer

I	Gamma	1	2	3	4	5	6
1	-5.57	****	.19	.53	2.86	.65	-.07
2	-5.31	-.16	****	.94	3.65	.62	.79
3	.87	-.14	.19	****	-.56	1.41	-.59
4	1.22	-.36	.21	0.00	****	-.18	.15
5	-6.28	.11	1.01	4.67	1.08	****	.20
6	-4.07	0.00	.39	.39	.43	.13	****
7	-2.64	.16	.07	1.86	.42	.13	-.41
8	-8.34	.23	.83	7.50	.23	2.57	-.11
9	-4.68	.21	.53	1.85	2.04	.62	.51
10	-4.39	.09	.54	.95	1.04	.32	1.09
11	-5.48	.62	.09	.25	4.15	.08	.12
12	-8.31	.21	2.49	.75	3.80	0.00	.64

...C(I,J) & Gamma(I) ctd.

I	Gamma	7	8	9	10	11	12
1	-5.57	.92	.33	1.30	0.00	1.15	.40
2	-5.31	.33	.42	.93	.44	.70	.35
3	.87	.10	1.21	0.00	-.26	.08	-.06
4	1.22	.10	-.09	.45	.15	-.08	.29
5	-6.28	.21	1.76	0.00	.10	.06	.09
6	-4.07	1.21	0.00	1.40	.61	.98	-.20
7	-2.64	****	.12	.67	-.05	.11	-.09
8	-8.34	.29	****	.43	.05	.18	0.00
9	-4.68	.72	.30	****	.25	.80	.52
10	-4.39	.34	0.00	.92	****	.52	1.33
11	-5.48	.57	.16	.73	.06	****	.75
12	-8.31	0.00	0.00	1.39	.52	1.00	****

Table V.4. Values of C_{ij} and of γ_i obtained for qualitative assessments of interactions between events.

to P_i^t, their values and shapes displayed in temporal diagrams of the Appendix C, and then to the effectiveness and sensitivity parameters of particular events. Most of the conclusions shall be presented in the following section, devoted to substantial and also to methodological conclusions derived from the case study.

When assessing the P_i^t, one might refer to the so called pattern curves, which are representations of awaited standard behaviour of probability values over time. Naturally, there are infinitely many possible temporal evolutions of probability values. Quite an important class of such evolutions is, though, ruled out a priori as meaningful solutions (e.g. bang-bang type of probability changes changes). In most cases, in fact, and under quite mild assumptions, one may await monotone behaviour of P_i^t for t=1,...,T-1. Thus, pattern curves of Fig. 5.1, taken and compared for pregiven end--levels, can be also used to assess the results.

Let us first note that the only two events, whose occurrence over the period in question can be considered doubtful are 6. and 7., i.e. resource-wise industrial attractiveness of the region, and resource and cultural social attractiveness of the region. Thus, when considering future, long-range development of this area, two main scenarios should be taken into account: *)

Scenario S_1: All the events e_i, i=1,...,12, take place at the end of the period.

Scenario S_2: Events e_i, i=1,...,5,8,9,...,12, take place at the end of the period, while events e_i, i=6,7 do not take place at all.

Yet, additional dimension must be added, resulting from the temporal dynamics of P_i^t. Namely, even if S_1 is accepted as the "proper" vision of the after-lignite future, it cannot be disregarded that various events are seen as occurring at different stages (scenes) which has important significance for interpretation of the future image put together at the session. Furthermore, since this image is an approximation of what may really happen, policy conclusions should be drawn therefrom. Table V.6. presents occurrence stages (scenes) for assumed S_1 and S_2. For scenario S_2 the adjusted probabilities P_i^t are modified, so that

*) On the basis of results derived from P_i^k, see Appendix B, the third scenario, S_3 can be formulated in which e_i, i=6,7,10,11 and 12 do not take place, see also Table V.6.

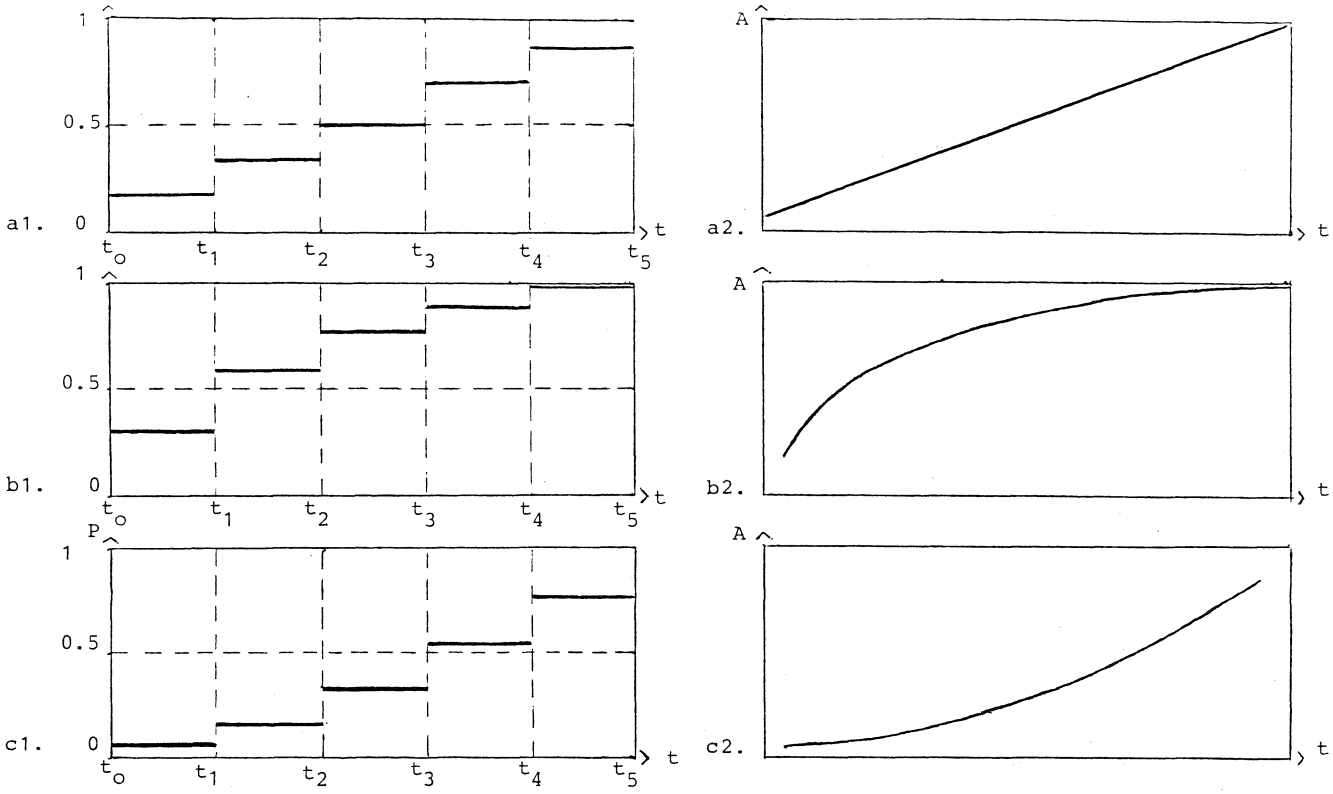


Fig. V.5.1. Pattern curves of temporal probability evolution:

a1, a2: normal development

b1, b2: optimistic case

c1, c2: pessimistic case

P : probability

A : intensity of process

Assumed scenario	Event numbers											
	1	2	3	4	5	6	7	8	9	10	11	12
S_1	2	2	1	1	2	3	2	2	2	3	2	3
S_2	3	2	1	1	2	-	-	2	2	3	3	4
$S_3^{\S}$	3	2	1	1	2	-	-	3	2	-	-	-

Table V.6. Sequential numbers of stages (scenes) at which events e_i, i=1,...,12 occur (P_i^t or $P_i^{*t}>0.5$).
§: according to values of $P_{i/j}^k$.

$$P_i^{*t} = \frac{0.5}{\max P_6^t, P_7^t} P_i^t.$$

In the Table V.6., which simplifies the diagrams given in the Appendix C, one can easily see that events numbered 3 and 4, i.e. agriculture's share and high industrial investment level, persist irrespective of time with high degree of robustness. Furthermore, events 2,5,8 and 9 tend to occur relatively early in all scenarios. These events refer, respectively, to: increase of relative electric power demand in the region, increase of relative investment into one agricultural job, per hectare agricultural production value, investment into stabilizing activities.

Events 6 and 7, besides having the lowest end probabilities, relatively early reach their respective probability plateaus and do not progress much beyond them.

V.5.2. Effectiveness and sensitivity parameters

Additional information, of great subtantial value, can be gained from calculation and analysis of values of the so called effectiveness parameters. The following parameters can be calculated:

- values of effectiveness Ψ_i of influence exerted by the event e_i on all the other events,
- sensitivities η_i of the individual events e_i with regard to the influence exerted by all the other events,
- sensitivities η_{ij} of the individual events e_i with regard to the influence exerted by the individual events e_j.

Mathematical definitions of these magnitudes are given in Part 1,

Chapter II, formulae II.24-II.26. Having their values one can determine the classes of events according to effectiveness-vs.-sensitivity classification. Thereby also the set of "control events" (usually containing just one element), i.e. the events having possibly high effectiveness of influence and low sensitivity to influence can be determined.

Table V.7. presents the values of the effectiveness parameters ψ_i^t for the scenes t=1,2,3,4, and for the verifying after-end scene, t=5. Values of the inter-event sensitivity parameters for the consecutive scenes, η_{ij}^t, are given in Appendix D to this Chapter. Finally, Table V.8. presents the global sensitivity parameter values, η_i, for all the events e_i, i=1,...,12, and the

2000	4 15.8	3 14.8	9 3.1	5 2.6	2 2.5	7 1.3	11 1.1	8 .9	6 .9	10 .5	1 .4	12 .4
2010	4 17.2	3 14.8	9 5.8	5 4.9	2 4.5	8 3.1	7 3.1	11 3.1	12 1.4	1 1.4	6 1.0	10 1.0
2020	4 19.0	3 17.7	9 7.4	2 6.3	5 5.8	8 4.4	11 4.0	6 3.0	7 2.9	12 2.7	1 2.0	10 1.9
2030	3 18.7	4 17.4	9 8.0	5 6.6	2 6.3	11 4.9	8 4.2	12 3.6	6 3.1	7 3.1	1 2.2	10 2.2
2040	3 17.7	4 17.6	9 8.0	5 6.6	2 6.3	11 4.7	8 4.4	12 3.8	6 3.6	7 2.9	10 2.3	1 2.0

Table V.7. Values of the effectiveness parameters ψ_1^t, i=1,...,12, t=1,...,5.

i	1	2	3	4	5	6	7	8	9	10	11	12
η_i	.51	.68	1.39	.37	.74	.34	.71	.90	.44	.30	.76	.46
j_i^*	2	4	5	9	3	9	3	3	4	12	4	4

Table V.8. Values of the overall (global) sensitivity prameters η_i. The extreme parameter values are indicated. Indices j_i^* point out these events j, which influence the events i with the greatest strength.

indices j_i^* of the corresponding most influencing event. Following Godet, Godet (1985), the values of η_i and $\bar{\psi}_i$, i.e. averages of ψ_i^t for t=1,...,4, are plotted in Fig. V.5.2, so as to visualise the control and dependence features of individual events. This figure makes it obvious that the control events set of this case consists

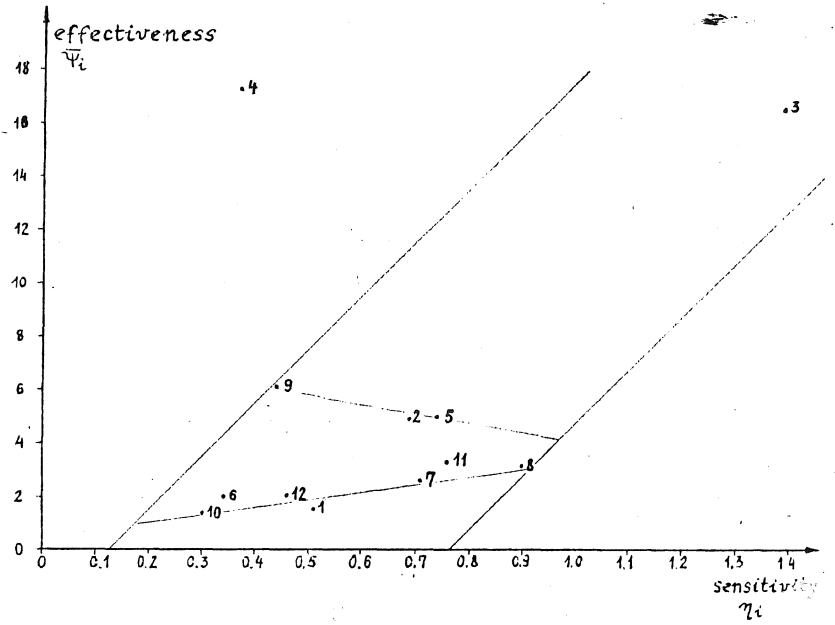


Fig. V.5.2. Effectiveness vs. sensitivity diagram of events e_i, i=1,...,12.

of just one event i.e. event no. 4, namely continuation of the high level of per-job capital investments in industry. Recall that this event, together with event no. 3 (agriculture's relative share in GRP slightly below the national average), had high, quasi-insensitive probability values P_i^t throughout the whole period in question. Fig. V.5.2. shows also event no. 3 as the main "transumitting" event: highly sensitive and highly effective. Other events do form, as compared with events 3 and 4, one triangular cluster, at whose extremes (vertices) there are: event 9 (most effective of those in the cluster): investment

outlays shall constitute at best 60% of those necessary for securing region's long-term stability, event 8 (most sensitive of those in the cluster): per hectare value of agricultural production at the country's average level, and event 10 (least effective and least sensitive of all the events): at least 23% of local lignite directed to non-energy purposes. This event is, obviously, independent of the others, but, apparently, not only this event. Thus, e_6: attraction of resource-intensive industries by local resources, is the most akin to e_{10} in its effectiveness-sensitivity characteristic, while e_{12} (at least 8% of nation's electric power shall come from this region at the end of the forecasting period due to new, alternative energy sources), and e_1 (relative attractiveness of work in this area shall drop by at least 13% over the period in question) have somewhat higher sensitivity.

After this overview and short presentation of results, contained in this section and in the Appendices to this chapter, a number of conclusions shall be forwarded and justified, concerning the very regional subject matter, both in the contents of the forecast itself and in the actor-based conditioning, as well as the conduct of this study.

V.6. Conclusions

V.6.1. Future regional development: the experts' view

Results of the cross-impact study form an image of the region's strategic future. Since it has already been indicated which would be the most probable scenarios of regional development, S_1,S_2, S_3, they will just be commented upon here, basing upon P_i^t and effectiveness-sensitivity characteristics.

1. The region shall continue throughout the forecasting period the heavy investment path, opened up by mining and energy and accompanying investments, as it is indicated by the events no. 4, 2 and 9.
2. The path indicated shall be enhanced by the increase in local manpower skills, event no. 11.
3. Heavy investment path (either power, metal industries or chemical industries) shall be followed notwithstanding a drop in the work attractiveness of the region, event no. 1, and its very doubtful resource situation, events. no. 6

and 7.

4. Resulting from this type of development there shall be a slight improvement in the economic position of agriculture, related mainly to agricultural investments, event no. 5, so that in some indices national average shall be attained, event no. 8, but the share of agriculture in regional economy shall continue to be rather low, event no. 3.
5. Two important technological and investment developments may take place later on in the forecasting period:
   a. an important part of lignite production to be used for non-energy purposes, event no. 10, and
   b. alternative - to the existing ones - sources of energy could be made operational within the region, making it possible to maintain the region's relatively high share of national electric power production, event no. 12.

It is especially interesting to note that the experts convened assumed the heavily invested development path to continue, in spite of the obvious decrease in the attractiveness of this area: once certain investments made, others shall of necessity follow, as if in the "growth pole" or "territorial complex" thought framework where, from a certain point onwards, infrastructure is the decisive factor, although other factors do not only decrease their contribution, but even start to act negatively on the region's development.

Now let us turn to interrelations among the events forming the image presented.

As it has been pointed out, industrial investments, event no. 4, are the crucial control factor within the system at hand. Hence, the whole development outlined would look entirely differently, had this event failed to occur. This indicates the dependence of region's development on the outside (central) forces, economic and political.

On the other hand, event no., 3, indicating agriculture's share in GRP, displays simultaneously high effectiveness and high sensitivity. Since it cannot, in fact, directly influence events related e.g. to industrial development, it has to influence them indirectly, and the main scope of its direct influence is limited to events connected with agriculture. This is corroborated by the data from Table V,8. where it can easily be seem that event no. 3

influences the most the other two "agricultural" events, i.e. no. 5 and 8, and also no. 7, that is, social resource attractiveness of the region. Another question related to this subsystem, namely that the event no. 3 has more the nature of effect than of cause, is easily answered by looking at the results contained in Table V.8. It can be seen that there exists a positive feedback loop between the events no. 3 and 5, obviously starting at 5, i.e. investment level. Simultaneously, there seemed to exist among the experts a belief that event no. 3 would just be a "policy flag" indicating whether agriculture would be considered important and to what degree.

Experts do perceive a competition for resources between agriculture and industry, but, judging upon event probabilities and levels, as well as other parameters, this competition is easily won by industry, again in the line with anticipated general tendency: once started, development no matter what.

Two technology- and development-bound events, no. 10 and 12, and also 11, form a relatively isolated subsystem, depending, as a whole, again upon the event no. 4, i.e. industrial investments. It is also worth noticing that although event no. 10 has the lowest overall efficiency, it scores far better for some particular events, e.g. it ranks fourth in influencing the event no. 6. Besides that, event no. 11, i.e. manpower skills, ranks sixth in influencing event no. 10. Thus, it seems, advanced technology appears as related to the environment-and-resources subsystem.

All that brings us closer to identification of the basic questions which face currently all those involved in planning and decision making for this region, and which should be answered and not avoided, if long-term development is to go on sufficiently smoothly:

A. How to ensure that probability higher than just 0.6 could be obtained for region's economic long-term stability? It seems obvious that an extra effort is needed for that, in terms of technoactivity choice and investment, as well as research and development.

B. What to do with region's resources: water, land, infrastructure? This problem calls for additional in-depth studies of both supply and demand, with particular emphasis on water, its volumes, various

technologies with regard to water use intensity and role in the ecosystem.

C. How to reallocate manpower and ensure adequate technological transition in agriculture?

These questions could be addressed, and partly answered, if an active cross-impact simulation exercise, centered mainly around event no. 4 was performed, not undertaken yet in this study (see section II.4.3, Part 1). It would, though, be necessary, prior to such an exercise, to further the knowledge in the crucial areas indicated already by the passive simulation.

Some possibilities of answers to these questions were, however, already outlined in Chapter I of this part of Report. It is the proper choice among these possiblities that should be made. Some remarks on this subject shall be forwarded in the following subsection. Presently, short comments shall be offered with regard to the "scenarios" outlined in Chapter I, section I.5:

- with regard to choices available, in view of just 60% of long-term stability probability, there is no room for wait and see attitude,
- with regard to potential technoactivities: activity F. (recreation) seems very doubtful on a larger than just local scale; activity A. (agriculture) cannot be treated as leading activity; activities B. (nuclear power generation), and C. (fossil-fueled power generation) are in a way competitive, see Chapter II in this volume, the outcome of this competition depending upon the potential further lignite resources in the area, water and capital availability; there is a high probability of activities of type D. (energy intensive) coming into the region; activity E. (skill-intensive) may find advantageous conditions in the area.

V.6.2. Experts' conditioning

The image of future development, together with accompanying questions, provided by the cross-impact study, is also informative as to the stances that various actors, represented by experts involved, would take in influencing or at least reacting to the course of events. Since anonymity of responses

was one of the basic assumptions in the study, it was only possible to make certain general assessments with respect to the actor--attitude issue. Some aspects of this issue are obvious, some were also illustrated in Fig. I.3. in this part of the Report. Table V.9. summarizes both actor types (see, e.g. Fischer et al. (1981), Godet (1985)), and their interrelations. It is by confronting this knowledge with the results of the study that one can formulate a number of conclusions as to the end-result of inter-actor relations with regard to attitudes expressed during the study. These conclusions can be summarized in the following statements:

1. Mining and evergy is not only in fact a very powerful sector (and a lobby), but, also, this situation is widely recognized and treated with a sort of fatalism (in an opinion, expressed by a mining expert, even legal mechanism may turn out to be insufficient in e.g. safeguarding local resources from industrial overuse). This results as much from the objective significance of the sector as from its actual quasi-formal position among the actors.

2. It is held that agriculture, although continuing its low profile, resulting from the first tide of development, shall not go under, but rather, on the unitary level (per hectare, per employee), shall keep up with the - moving - national average. This view results inasmuch from the hopes as to the increased demand (through both prices and volume) and, perhaps, additional investments and restructuration, as it is an expression of the upper hand taken by those who prefer to maintain that "agriculture shall rather profit than lose".

3. There is a hope that the present and further investments might introduce and speed up technological innovation and change. Throughout the period in question, though, an important feedback, in economic terms, from these innovations and, potential, new activities, to the whole of the regional economy, is not yet anticipated. Such a view should certainly be attributed to relative conservatism of the majority of experts with regard to development and impacts of basic technologies, justified by their life-long experience.

Impacted actors / Impacting actors	Mining and energy, central administration	Central financial and economic bodies	Environmental protection institutions, local and national	Regional authorities	Regional agriculture	Local authorities
Mining and energy, central administration	Energy balance, short and long term	Losses from lack of proper balance	Payments of reparatory dues,	Activity location, cooperation	Reparatory dues, cooperation	Activity location, cooperation
Central financial and economic bodies	Location, zoning, financial obligations	Overall financial and economic soundness	Zoning, reparatory payment obligations	Location of activities, budget disbursements	Reparatory payment obligations, disbursements	Inspection
Environmental protection institutions, local and national	Observation of obligations and guidelines, inspection.	Long-term losses from environmental disruption	Preservation of ecological viability of the area	Observation of guidelines	Cooperation, monitoring, studies	Monitoring
Regional authorities	Observation of obligations and guidelines	Cost-and-benefit based demands	Cost-and-benefit-based location and allocation decisions	"Regional development"	Disbursements, resource allocations	Disbursements, resource allocations
Regional agriculture	Observation of obligations and guidelines	Losses from environmental changes	Losses from environmental changes	Resource requirements	Satisfaction of basic needs	Allocation of activities and resources
Local authorities	Coperation, facilities	-	-	Demands for resources	Demands for resources	Functional

Table V.9. Objectives, persuasion and control means within the inter-actor system centered around the opencast lignite mining and power generation area.

It should be stressed that experts did not only voluntarily contribute to the study, but did also very freely discuss most of the issues which were either formulated beforehand or emerged

during the cross-impact session. As previously indicated, there was no effort made at bringing together views and opinions expressed, since recognition of actor groups and their stances was one of the aims of this study. Anticipations, related to expert classification and known actor situation (see Fig. V.1.1 and Table V.9), were corroborated by the course of the study. It is interesting to note that the inter-expert, viz. inter-actor relations get more complicated (a greater variety of coalitions is formed) when dealing with current or not-too-distant in time problems, while they are rather issue-wise stable and simpler, although more vaguely defined for strategic questions. This, apparently, is both a handicap and an advantage for formulation of strategies within the inter-actor system: handicap in that the responses and suggestions may not be sufficiently to the point, and advantage in that the conflicts and coalitions are yet simple enough to grasp and resolve.

Seeing the above, and the crucial role of external funding and local resources the following alternative imposes itself:

Either

the local infrastructure and lignite resources (and electric power therefrom) are valuable enough for central planners, and they anticipate the resource and financial situation sufficiently favourable so that environmental and agricultural actors, allied with regional authorities, could take a hard line and put high price on local resources, thus forcing their sparing use, technological innovations and promoting diversification, boosting long-term stability of the regional socio-economic and ecological setting,

or

some of the above conditions do(es) not hold, i.e. there may be not enough capacities for the non-power activities or for long-range R+D and investments, so that taking an allied hard line would lead to abandonment, overall losses, or, notwithstanding this hard line, to overuse of resources with a shorter-time effectiveness in mind.

In the second case a coalition of central mining and energy agents with regional authorities is more likely. (Directions of the above alternative are sketched in Fig. V.6.1.) With regard to the first case a number of activities related to the "optimum" pressure of

both strategic coalitions can be sited:

- search for best utilization of lignite,
- search for new lignite deposits in the area, even if smaller and less economically efficient,
- search for alternative, cleaner and more resource - efficient energy options for the region,
- investments into accompanying and complementary activities in order to enhance the long-term sustainability of the given development path.

All that would require technological research and know-how, and skill upgrading. Simultaneously, it will lead to, and also necessitate, by feedback, through a multiplier effect, improvement and diversification of other activities, including agriculture. Further insight into this question would require, though, more in-depth studies and modelling for each of the subproblems (subsectors) involved.

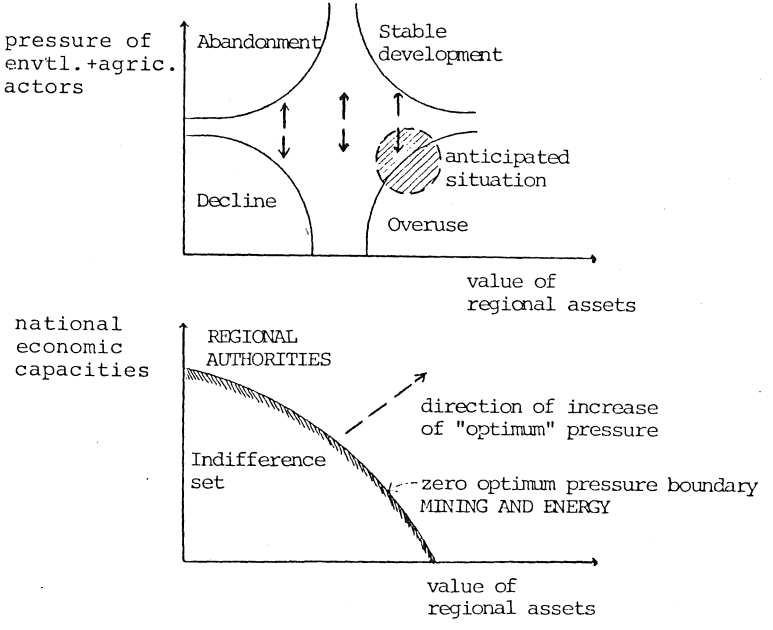


Fig. V.6.1. Illustration to the strategic stance alternative (← →), indicating main development proponents in the extreme cases of conditions.

V.6.3. Methodology of the study

Results here presented prove usefulness of the method in regional strategic analysis. The method allows construction of a simplified model, enabling representation of a regional system within its systemic environment and generation of its development scenarios. Thus, both exploratory (warning, passive) scenarios of regional development can be obtained with the method and normative ones, when certain definite goals are being aimed at.

It should, though, be emphasized, that the cross-impact approach whether in the form implemented here or in any other one, adequately effective, can be applied to other systemic entities. In particular, cross-impact analyses can be performed for cases of technological innovation or introduction of new technologies, where assessment ("technology assessment") of economic and social effects of these innovations is sought.

In order, however, for any technique from this family of exploratory analysis methods to be applied effectively, the following conditions must be satisfied:

- list of events should represent the processes decisive for the given system's development,
- software should be possibly user-friendly, allowing not only smooth running of interactions with operator, session manager and the experts, but also substantially adequate processing of resulting information,
- the above should involve maximum use of simple and robust procedures such as e.g. outlined in Chapter I of Part 1,
- the model obtained must be regarded as a limited-power forecasting tool, whose purpose is as much to yield forecasts as to gain insight into the decision making mechanism, the scope of potential outcomes etc.

It is of paramount importance to have experts properly informed, avoiding unnecessary lengthy "learning periods" as well as overly aboundant information. Information provided, questions formulated and composition of the study would lead to fruitful discussion accompanying the disclosure of structures of the future development via the model and its results. Concrete numbers are, of course, of less importance, since they are anyway always just rough approximations, whose range of uncertainty can rarely be adequately established.

V.6.4. Summary

The method used, constituting a portion of the procedure outlined in Chapter I, Part 1, proved to be effective. Other variants of the method could, of course, also be tried out. Results obtained are of high practical value. Although they confirm some intuitive "suspicions", they do form a more complex, coherent, wholesome image of the future, which calls for, however, further strategic action in order to attain desirable state or, rather, development path. These results do also reveal certain opinion shaping mechanisms behind the scenarios obtained, and the ways these mechanisms can evolve over time.

APPENDIX A:

Values of influence indices I_{ij}^{k}, given by experts k, k=1,...,15 for events i, i=1,...,12, whose probabilities of occurrence are influenced by events j, j=1,...,12, to the degree I_{ij}^{k}, $I_{ij}^{k} \in [-3,-2,-1,0,+1,+2,+3]$.
Experts no. 1,2 and 3:

EKSPERT NR 1

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	+2	-1	+3	-1	+1	+2	-1	+1	-1	+2	-1
2	-1	.	+1	-1	+1	-1	+1	-1	-1	-1	+1	+2
3	-1	+1	.	+1	+2	-2	+1	+2	+1	0	+1	-1
4	0	+1	+1	.	-1	+2	+2	+1	+2	0	+1	+1
5	0	-1	+2	+1	.	+3	+2	+3	+1	+1	-1	+1
6	-1	+1	-1	-1	-2	.	+3	-2	-1	+1	-1	-1
7	+1	-1	+3	+1	+2	-3	.	+2	+1	+1	+1	+1
8	+1	+1	+2	+1	+2	-2	+2	.	+2	+1	+2	-1
9	-1	+1	-1	-1	+1	-2	+3	+2	.	+1	+1	+1
10	-2	+1	+1	+1	+1	+2	+2	0	+1	.	+1	+2
11	-2	-1	-1	+2	0	-2	-1	-1	+1	-1	.	-1
12	+2	+1	+1	+2	+1	-3	-1	+1	-1	+2	+1	

EKSPERT NR 2

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	0	+1	+2	+2	0	-1	+1	+1	0	-1	0
2	0	.	+1	+1	+1	0	+1	+1	+1	0	0	0
3	+1	+1	.	+2	+3	-2	0	+3	+1	0	0	0
4	-1	-1	0	.	0	0	0	+1	+1	0	+1	0
5	-1	+1	+1	+1	.	-1	0	+2	+1	+1	+1	+1
6	0	0	+1	0	0	.	+2	0	0	-1	0	0
7	0	0	+2	0	0	-1	.	+1	+2	0	0	0
8	-1	+1	+3	+1	+3	-2	0	.	+1	0	0	0
9	-1	-1	+1	+3	0	-2	0	0	.	0	0	+2
10	0	0	0	0	0	0	0	0	+1	.	-1	+3
11	-2	0	0	+2	0	0	+1	0	0	0	.	+1
12	0	+1	0	+1	0	-3	0	0	+2	0	0	

EKSPERT NR 3

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	-1	0	0	0	+1	+2	0	+2	-2	+2	+2
2	-1	.	0	0	+1	-1	+1	+1	+2	-2	+2	+1
3	-1	-1	.	0	+1	0	0	+1	+1	-1	+2	0
4	+2	+2	0	.	0	0	+1	-1	+2	+2	-1	+3
5	0	+3	0	0	.	0	0	+2	-2	-1	-1	-3
6	0	0	0	0	0	.	+2	0	0	0	0	-2
7	+1	0	0	0	0	-2	.	0	+2	0	0	-1
8	+1	-1	0	0	+1	-2	0	.	+2	-2	-2	-2
9	+2	0	0	0	0	0	+1	+1	.	-3	+3	-3
10	+1	-1	0	0	+1	-1	0	0	+1	.	+2	+3
11	+1	+1	0	0	0	0	0	0	-2	-3	.	+2
12	+1	+1	0	0	0	0	0	0	0	0	+3	

Experts no. 4,5 and 6

EKSPERT NR 4

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	0	-1	+1	-1	-1	+1	0	+2	0	+2	-1
2	-2	.	+1	+1	+1	+1	0	+1	+2	+1	+1	0
3	-2	+1	.	0	+2	-2	0	+2	+2	-1	-1	0
4	+1	+1	0	.	0	+1	+1	0	+1	+1	+1	+1
5	-1	+2	+2	+1	.	-1	0	+2	0	-1	-1	0
6	0	0	-1	0	0	.	0	0	0	0	0	-3
7	+1	0	0	0	0	-3	.	0	+1	0	0	-2
8	-1	+1	+2	0	+3	-2	0	.	+1	0	-1	0
9	0	+1	+1	+1	+2	+2	+1	+1	.	+2	0	+1
10	0	0	0	0	0	+1	0	0	0	.	0	-2
11	+2	0	-1	+2	-1	-1	-1	0	+2	-1	.	0
12	0	+1	0	+1	0	+1	0	0	0	0	+1	

EKSPERT NR 5

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	-1	-1	+1	+1	-1	-2	-1	+3	0	+1	-1
2	0	.	+1	+1	+2	+2	+1	+2	-2	0	0	0
3	+1	+1	.	-1	+3	0	+1	+3	-2	0	0	0
4	-1	0	0	.	0	0	0	0	0	0	0	0
5	+1	+2	+2	0	.	0	+1	+3	-2	0	0	0
6	0	+3	0	0	0	.	+1	+1	-2	+1	+2	0
7	0	0	+1	+1	+1	+1	.	0	-2	0	0	0
8	+1	+2	+3	0	+3	0	+1	.	-2	0	0	0
9	-2	-2	+2	-1	+2	0	-2	-2	.	-2	+2	0
10	0	+1	0	0	0	0	0	0	+2	.	0	0
11	0	0	0	+2	0	+3	+1	0	0	0	.	0
12	0	0	0	0	0	+1	0	0	-1	0	0	

EKSPERT NR 6

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	0	+2	-2	+1	0	0	+2	0	0	0	0
2	0	.	0	0	0	+1	0	0	0	+1	-1	+1
3	-1	-1	.	-1	+2	0	0	0	+1	0	0	0
4	+2	0	+2	.	+1	0	0	+1	0	+1	0	0
5	+2	0	+2	+1	.	0	0	+2	0	0	0	0
6	0	-1	0	0	0	.	0	0	+1	-1	0	0
7	0	0	0	0	0	-2	.	0	0	0	0	0
8	-1	0	+2	+2	+1	0	0	.	0	0	0	0
9	0	0	0	0	0	+2	0	+1	.	+1	0	+1
10	0	-2	0	0	0	+2	0	0	0	.	+1	+1
11	+1	-1	0	0	+1	0	0	0	+1	-1	.	0
12	0	+2	0	0	0	+1	0	0	0	+1	0	

Experts no. 7,8 and 9

EKSPERT NR 7

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	+1	-1	+3	+3	-2	+3	+2	+3	0	+2	+3
2	+1	.	+2	+3	+1	+3	0	+1	+1	0	+2	0
3	0	0	.	0	+3	+2	0	+3	+2	0	0	0
4	-1	+1	0	.	0	+3	0	0	+2	0	+2	+1
5	-2	+2	+3	+3	.	+1	0	+3	+1	+1	+1	0
6	-3	0	0	+2	0	.	+2	0	+3	0	+2	0
7	0	0	+1	0	0	0	.	+1	+3	0	0	0
8	0	+1	+3	0	+3	+2	+1	.	+1	+1	0	0
9	+2	0	+2	+1	0	+1	+2	+1	.	0	+3	+2
10	0	-2	+1	0	+1	+2	+2	0	0	.	0	0
11	-3	0	+2	+2	0	+3	+3	+2	0	0	.	+3
12	0	+3	+2	+3	0	-1	0	0	0	0	0	.

EKSPERT NR 8

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	+1	+1	-2	-2	-1	+1	+1	-1	-1	-1	+1
2	+1	.	+1	+3	+2	0	+1	+3	-1	+3	+1	+1
3	0	0	.	+2	+3	+3	+1	+3	+1	0	+1	0
4	+1	+2	0	.	0	+1	+1	0	+1	+1	0	+1
5	0	+1	+3	+2	.	+1	+1	+2	+1	+1	0	0
6	0	0	+1	+3	+1	.	+1	+1	+2	+1	+2	+3
7	0	+2	+1	+1	0	+1	.	0	0	-1	-1	-1
8	0	+3	+3	0	+3	+3	0	.	0	+1	+1	0
9	+2	+2	+1	+3	+3	+1	0	+1	.	-2	-2	-1
10	+1	+3	+3	+3	+1	+2	0	0	0	.	+1	+3
11	+3	0	-1	+3	+1	+1	+2	+1	+1	+2	.	+3
12	0	+1	0	0	0	0	0	0	0	+1	+1	

EKSPERT NR 9

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	-1	0	-1	-1	-2	-2	0	-3	-1	-3	-2
2	-1	.	+1	+1	+1	+2	+1	+1	+3	+2	+3	+3
3	+1	+1	.	+1	+1	-1	+1	+2	-2	-1	-1	-1
4	-1	+1	+1	.	-1	+1	-3	0	+3	+2	+3	+3
5	-1	+1	+1	+1	.	-1	+1	+1	-2	-1	+1	+1
6	-1	+1	0	-1	-1	.	-3	-1	+2	+3	+1	-3
7	+1	+1	+1	-1	+1	-3	.	-1	-3	-3	0	-3
8	+1	+1	+1	-1	+1	-3	-3	.	-2	-1	-1	+1
9	-1	+1	+2	-1	0	+3	+2	-1	.	+3	+3	+3
10	-1	0	0	+1	0	+3	0	0	+2	.	+1	-3
11	-3	+1	0	+1	0	+1	+1	0	+3	+1	.	+2
12	0	0	0	+1	0	-3	0	0	+3	-3	-3	

Experts no. 10,11 and 12

EKSPERT NR 10

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	-1	0	-1	-2	-3	-1	0	+2	+2	+3	+3
2	-2	.	+1	+3	+1	+3	0	+1	+2	+2	+3	+1
3	+3	0	.	-2	+3	-3	0	+3	+3	-1	+3	0
4	-1	+1	0	.	-1	+2	0	-1	+2	+2	-1	+3
5	+2	+1	+3	-3	.	-3	0	+2	+2	-2	-1	-3
6	0	0	0	0	0	.	-3	0	0	0	0	-3
7	-1	0	+2	+1	0	-3	.	0	+2	0	0	-1
8	+2	+1	+3	-2	+3	-3	0	.	+2	-2	+3	-3
9	0	+2	+3	+1	+3	+1	+1	+1	.	+3	+3	+3
10	0	-3	+2	-1	0	0	0	0	+1	.	+3	+3
11	+2	0	0	+3	-2	-3	0	0	-2	-3	.	+3
12	0	+3	0	0	0	+2	0	0	+3	0	+3	

EKSPERT NR 11

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	0	0	+1	+1	0	+2	+1	+1	-1	+1	0
2	-1	.	-1	+2	0	+1	+1	0	+2	0	+1	0
3	0	+1	.	-1	0	0	0	+3	0	0	0	0
4	0	0	0	.	0	0	0	0	0	0	0	+1
5	0	+2	0	0	.	+1	+1	+2	0	0	0	+2
6	0	0	0	0	+1	.	0	0	0	+1	0	0
7	0	0	+2	0	0	+1	.	0	+1	0	+1	0
8	+1	+2	+3	0	+1	0	0	.	0	0	0	0
9	0	0	+1	+1	0	-1	+2	0	.	0	0	+1
10	0	+1	0	0	0	0	+1	0	0	.	0	0
11	+2	0	0	0	0	-1	0	-1	0	0	.	0
12	0	0	0	0	0	0	+1	0	0	0	0	

EKSPERT NR 12

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	+2	-1	0	0	0	+1	0	+1	+1	+3	+2
2	+1	.	0	+2	+1	+2	0	+1	+2	+2	-1	+2
3	0	0	.	0	+2	+1	0	-1	0	0	+1	0
4	-2	-1	0	.	0	0	0	-1	-1	-1	-2	-1
5	-1	-1	+1	0	.	+1	0	-3	-1	0	-1	0
6	+1	+3	-1	+1	0	.	-1	-2	+2	+1	-2	+1
7	+3	0	-1	0	0	-1	.	+1	0	0	+1	0
8	+1	+1	-1	0	+2	+1	+1	.	0	0	+1	0
9	+1	+2	-1	+3	+1	+2	-1	+1	.	+1	-1	+1
10	+1	+1	0	0	0	+1	+1	0	+2	.	-1	+3
11	+1	+1	+1	-1	-1	+1	+1	+2	+2	+1	.	+1
12	+1	-1	-1	+1	0	-1	-1	-1	+1	+1	-1	

Experts no. 13,14 and 15

EKSPERT NR 13

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	0	0	+1	0	0	0	0	-2	0	0	0
2	0	.	0	+1	+1	0	0	0	-2	0	0	0
3	+1	0	.	0	0	+1	0	0	-2	0	+1	0
4	0	0	0	.	0	+1	0	0	-1	0	0	0
5	0	+1	+1	0	.	+1	0	-1	-3	0	+1	0
6	0	0	+1	0	0	.	0	0	+3	0	0	0
7	0	0	0	0	0	+1	.	0	-1	0	+1	0
8	0	0	0	0	+1	+2	+1	.	-2	-1	+1	0
9	+1	0	0	0	0	+1	+2	-1	.	0	0	0
10	0	0	0	0	0	+1	0	0	0	.	0	0
11	+2	0	0	0	0	0	0	0	0	+1	.	0
12	0	0	0	0	0	0	0	0	0	0	0	

EKSPERT NR 14

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	0	+1	+2	+1	-1	+1	0	-1	-1	0	-1
2	0	.	0	+2	+1	+2	0	+1	+1	+1	+1	+1
3	0	+1	.	0	+2	-1	0	+1	0	-1	0	0
4	-1	0	0	.	0	+1	0	0	+1	+1	+1	+1
5	0	+1	+1	0	.	0	0	+1	0	0	0	0
6	0	0	0	0	0	.	0	0	0	+1	+3	0
7	0	0	+1	0	0	-1	.	0	+1	-1	-1	-1
8	-1	+1	+3	0	+3	-1	0	.	0	0	0	0
9	0	0	0	+1	0	+1	0	0	.	+1	+1	+1
10	0	+1	0	+1	0	0	0	0	0	.	+1	0
11	-2	0	0	0	0	-1	+1	0	+1	-1	.	0
12	0	+2	0	0	0	+1	0	0	+1	0	0	

EKSPERT NR 15

	1	2	3	4	5	6	7	8	9	10	11	12
1	.	0	0	-1	+2	+1	-2	0	+1	+1	+1	-1
2	-2	.	0	-1	+1	+2	+1	0	+1	+1	+2	+1
3	-1	+1	.	0	+2	-1	+1	+2	+1	+1	0	-1
4	+1	+1	0	.	-1	-1	-1	0	+1	+1	-1	+2
5	+2	0	+2	-3	.	+2	-1	+1	+2	+1	+1	0
6	0	0	0	0	+1	.	0	0	0	0	+1	0
7	-2	+1	0	-1	+1	+2	.	0	+1	0	0	+1
8	-1	+1	+2	-2	+3	0	+1	.	+1	+1	0	0
9	0	+2	-1	+1	+2	+1	0	0	.	0	+1	+1
10	0	+1	0	0	0	+1	0	0	-1	.	0	0
11	-2	0	+2	-1	+2	-1	+1	+1	+1	0	.	-1
12	0	+1	+1	0	0	0	-1	+1	0	0	+1	

APPENDIX B:

Qvantitative matrices $P^{k}_{i/j}$ for experts k, k=1,...,12 of subjective probabilities, expressed in % points.

Experts no. 1,2 and 3:

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	16	21	30	40	30	10	21	30	16	30	28
2	15	X	48	38	50	60	50	38	25	45	60	45
3	65	85	X	78	95	85	85	95	85	90	78	70
4	85	90	80	X	70	90	80	90	90	90	65	95
5	60	40	60	20	X	45	28	40	40	38	38	35
6	10	13	13	13	20	X	13	13	13	13	20	15
7	15	45	38	25	45	45	X	38	25	38	38	48
8	25	40	60	20	70	40	40	X	40	42	35	35
9	39	60	45	39	45	45	45	39	X	48	50	45
10	16	25	16	16	16	25	16	16	10	X	20	18
11	5	24	35	15	35	15	35	30	30	24	X	20
12	4	10	10	6	6	6	4	10	3	6	10	X

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	21	30	12	25	21	21	30	21	21	21	21
2	38	X	38	38	38	45	38	38	38	45	30	45
3	60	60	X	60	90	78	78	78	80	78	78	78
4	90	80	90	X	85	80	80	85	80	85	80	80
5	50	34	50	32	X	34	34	50	34	34	34	34
6	13	10	13	13	13	X	13	13	16	13	13	13
7	38	38	38	38	38	20	X	38	38	38	38	38
8	25	32	40	40	40	32	32	X	32	32	32	32
9	39	39	39	39	39	50	39	45	X	45	39	45
10	16	5	16	16	16	25	16	16	16	X	20	45
11	30	15	24	24	30	24	24	24	30	20	X	24
12	6	10	6	6	6	8	6	6	6	8	6	X

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	21	30	40	30	15	30	20	15	15	20	15
2	38	X	38	55	45	55	38	45	45	45	45	45
3	78	85	X	78	90	70	78	85	78	70	78	78
4	70	80	80	X	80	90	80	80	90	90	90	90
5	34	45	45	34	X	34	34	45	34	34	34	34
6	13	13	13	13	13	X	13	13	13	20	40	13
7	38	38	50	38	38	30	X	38	50	30	30	30
8	20	40	60	32	60	20	30	X	32	32	32	32
9	39	39	39	50	39	50	39	39	X	50	50	50
10	16	25	16	25	16	16	16	16	16	X	25	16
11	10	24	24	24	24	20	30	24	30	20	X	24
12	6	20	6	6	6	15	6	6	15	6	6	X

Experts no. 4,5 and 6

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	19	21	21	21	14	19	21	24	25	24	25
2	34	X	38	38	37	37	38	42	46	45	45	42
3	85	78	X	78	86	78	78	85	85	86	92	78
4	64	88	80	X	80	80	80	72	88	88	72	90
5	34	37	34	34	X	34	34	40	41	37	30	27
6	13	13	13	13	13	X	9	13	13	13	13	9
7	34	38	38	38	38	30	X	38	45	38	38	34
8	35	35	32	32	48	28	32	X	38	35	38	25
9	30	39	39	39	39	39	43	43	X	43	51	50
10	13	14	16	16	19	13	16	16	18	X	20	20
11	25	24	24	24	24	24	24	24	29	17	X	30
12	6	9	6	6	6	6	6	6	6	6	10	X

	1	2	3	4	5	6	7	8	9	10	11	11
1	X	19	21	18	15	12	19	21	25	27	25	30
2	32	X	40	47	41	47	38	40	42	44	44	41
3	87	78	X	72	87	72	78	84	84	45	84	78
4	77	82	80	X	77	84	80	78	84	84	78	89
5	40	36	40	25	X	28	34	38	38	28	32	25
6	13	13	13	13	13	X	7	13	13	13	13	4
7	35	38	42	41	38	32	X	38	42	38	38	35
8	38	34	38	26	41	26	32	X	36	26	38	23
9	39	43	45	42	48	41	41	41	X	48	45	48
10	16	10	20	13	16	16	16	16	18	X	22	25
11	30	24	24	31	18	18	24	24	20	15	X	33
12	6	12	6	6	6	10	6	6	12	6	12	X

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	30	30	10	10	15	30	30	15	15	15	30
2	50	X	65	80	65	50	50	80	30	80	50	50
3	85	85	X	90	95	95	85	95	85	78	85	78
4	85	90	80	X	80	85	85	80	85	85	80	85
5	40	40	50	45	X	40	40	45	40	40	34	34
6	5	13	20	30	20	X	20	20	25	20	25	30
7	30	50	45	45	38	45	X	38	38	30	30	30
8	32	50	50	32	50	50	32	X	32	40	40	32
9	60	60	50	70	70	50	39	50	X	20	20	30
10	20	30	30	30	20	25	16	16	16	X	20	30
11	40	24	20	40	30	30	35	30	30	35	X	40
12	4	10	6	6	6	6	6	6	6	8	8	X

Experts no. 7,8 and 9

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	38	25	30	17	21	17	30	30	21	21	21
2	38	X	45	45	45	38	45	45	45	38	38	38
3	78	85	X	78	95	85	78	95	85	38	78	78
4	70	85	80	X	80	80	80	80	95	80	85	80
5	30	40	30	40	X	30	34	45	34	40	40	40
6	13	13	17	13	13	X	20	13	13	9	13	13
7	38	38	50	38	38	32	X	45	45	38	38	38
8	25	35	45	25	45	32	32	X	35	32	32	32
9	30	45	45	60	39	30	39	39	X	39	39	20
10	16	16	16	16	16	16	16	16	20	X	12	28
11	16	24	24	35	24	24	30	20	24	24	X	20
12	6	8	6	8	6	2	6	6	10	6	6	X

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	30	30	99	99	80	75	99	20	20	75	99
2	40	X	60	99	30	99	30	40	40	30	75	30
3	75	75	X	75	99	75	75	99	75	75	75	75
4	10	80	80	X	80	99	80	80	85	80	85	80
5	10	50	99	99	X	40	30	99	40	40	40	30
6	2	10	10	50	10	X	50	10	99	10	50	10
7	40	40	50	40	40	40	X	50	99	40	40	40
8	30	40	90	30	99	50	50	X	50	50	40	40
9	75	40	75	50	40	40	75	50	X	40	99	75
10	15	2	30	15	30	40	40	15	15	X	15	14
11	2	25	50	50	25	99	99	50	25	25	X	99
12	5	30	20	30	5	2	5	5	5	5	5	X

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	21	21	21	21	45	45	21	35	21	30	45
2	38	X	45	45	50	50	38	50	35	38	38	38
3	90	90	X	65	95	78	85	95	60	78	78	78
4	80	85	85	X	80	85	80	85	80	80	80	80
5	34	45	45	34	X	34	40	50	25	34	34	34
6	13	20	13	13	13	X	15	15	5	13	13	13
7	38	38	45	45	45	45	X	38	30	38	38	38
8	35	40	45	32	50	32	32	X	20	32	32	32
9	30	35	50	39	30	39	39	30	X	30	39	39
10	16	20	20	16	16	20	16	16	25	X	16	16
11	24	24	24	30	24	35	25	24	24	24	X	24
12	6	6	6	6	6	10	10	6	1	6	6	X

Experts no. 10, 11 and 12

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	21	15	25	15	15	25	21	30	21	30	15
2	30	X	40	45	40	40	38	45	45	40	40	38
3	70	80	X	78	85	70	78	85	85	75	75	78
4	85	85	80	X	80	85	85	80	85	85	85	85
5	30	40	40	35	X	30	34	40	34	30	30	34
6	13	13	10	13	13	X	13	13	13	13	13	5
7	40	38	38	38	38	25	X	38	40	38	38	30
8	30	35	40	32	45	25	32	X	35	32	30	32
9	39	42	45	45	45	50	40	40	X	45	39	40
10	16	16	16	16	16	20	16	16	16	X	16	10
11	30	24	20	30	20	20	20	24	35	20	X	24
12	6	10	6	10	6	10	6	6	6	6	10	X

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	40	12	85	10	15	40	15	20	10	42	10
2	10	X	16	10	15	12	20	10	10	14	20	45
3			X		60	50	20	60	20	10	20	15
4	10	20	20	X	10	50	50	15	40	10	12	17
5	10	15	55	15	X	70	55	80	20	15	10	20
6	12	20	15	10	50	X	80	55	17	20	12	15
7	15	18	75	20	50	75	X	45	20	15	20	20
8	15	20	45	20	50	70	45	X	40	20	45	10
9	12	20	14	18	20	50	85	50	X	17	20	20
10	45	20	15	20	20	40	40	10	20	X	20	55
11	50	13	10	50	24	50	15	16	20	15	X	15
12	45	20	20	45	20	80	20	20	15	55	6	X

	1	2	3	4	5	6	7	8	9	10	11	12
1	X	47	68	81	34	13	44	32	45	18	35	8
2	24	X	78	99	40	17	38	37	51	20	20	8
3	21	37	X	80	45	15	38	28	39	16	30	6
4	15	32	78	X	34	13	38	27	33	14	18	7
5	18	31	90	80	X	15	38	16	32	16	21	6
6	24	54	66	90	34	X	32	22	50	15	19	8
7	30	37	67	80	34	11	X	39	39	16	27	6
8	24	42	65	80	45	15	42	X	38	16	28	5
9	25	48	67	99	40	18	32	40	X	18	20	7
10	24	42	78	80	34	16	44	32	50	X	21	10
11	23	43	90	70	30	15	43	42	52	20	X	8
12	25	43	68	90	34	12	31	28	45	19	20	X

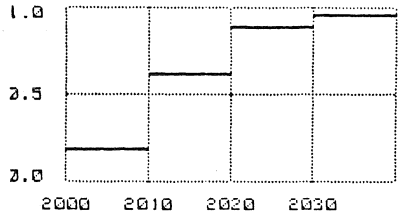
Simulation results for data defined by matrices contained in Appendix B: P_i^t for events i, i=1,...,12.

I	2000	2010	2020	2030	2040
1	0.20	0.49	0.53	0.60	0.50
2	0.38	0.55	0.60	0.63	0.63
3	0.77	0.79	0.81	0.90	0.86
4	0.82	0.82	0.82	0.76	0.88
5	0.41	0.56	0.48	0.66	0.60
6	0.16	0.17	0.22	0.20	0.25
7	0.26	0.56	0.46	0.46	0.37
8	0.30	0.39	0.64	0.52	0.65
9	0.36	0.54	0.58	0.63	0.50
10	0.21	0.24	0.31	0.38	0.23
11	0.18	0.43	0.41	0.29	0.37
12	0.11	0.22	0.31	0.34	0.45

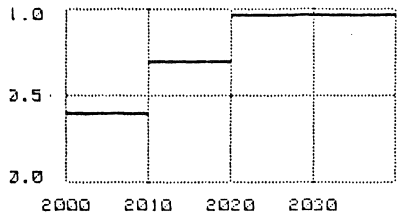
APPENDIX C:

Simulation results, i.e. P_i^t for data defined by I_{ij}^k, see Appendix A., extended version.

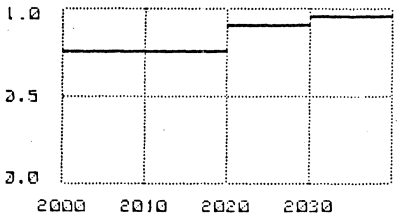
Events 1,2,3 and 4.



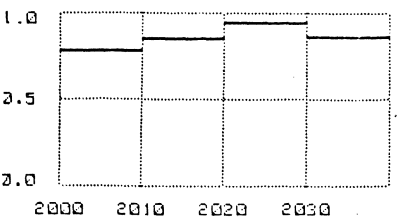
Attractiveness of work - decrease by at least 13%



Relative demand for electric power - increase by at least 32%

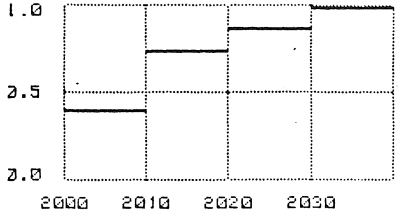


Agriculture's share in GRP - - constant at 93% of national average

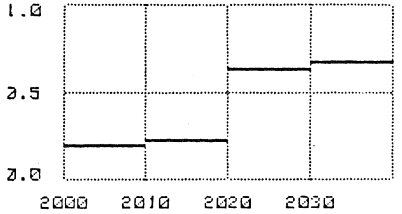


Capital intensity of non-agricultural jobs - constant at 140% of national average

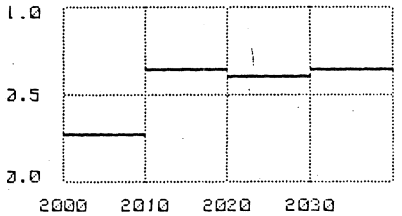
Events 5,6,7 and 8



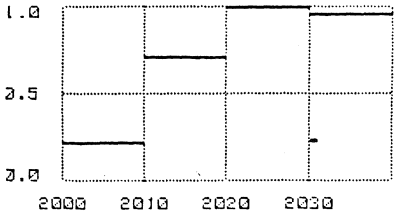
Capital intensity of agricultural jobs - increase by at least 17%



Resource attractiveness for heavy industries - sufficient

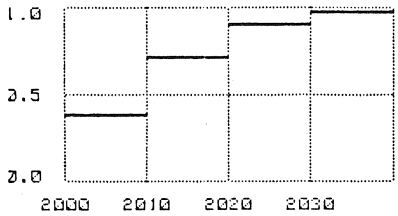


Leisure-wise attractiveness for social groups - not less than 90% national average

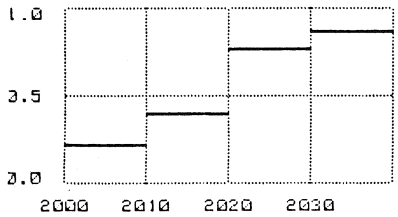


Value of agricultural produce per 1 hectare - around national average

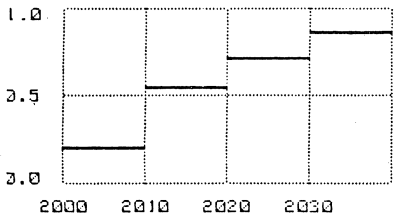
Events 9,10,11 and 12



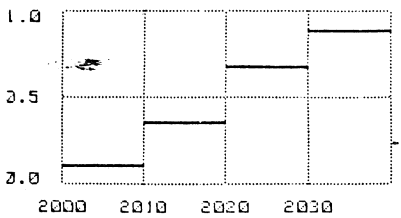
Implemented portion of investments volume necessary for maintenance of long-term stability - at 60%



Change of lignite utilization from energy to other uses - at least 23% of lignite extracted



Skilled labour availability- sufficient -for development of advanced manufacturing industries.



Other sources of energy - shall provide not less than 8% of national electric supply from this region

APPENDIX D:

Sensitivity coefficients n_{ij}^{t} for consecutive scenes t
Rows: influenced events i, columns: orderings of influencing events according to $|n_{ij}^{t}|$.
Scene 1: 2000-2010.

1	4 1.86	6 -.38	1 -.37	10 -.37	12 -.33	8 -.30	2 -.29
2	4 2.42	1 -.46	2 -.43	12 -.39	8 -.34	7 -.34	10 -.34
3	5 .52	4 -.47	8 .23	6 -.14	10 -.08	1 -.05	2 .05
4	9 .15	5 -.09	1 -.08	2 .06	8 -.04	11 -.03	4 -.02
5	3 3.02	5 -.48	9 -.48	12 -.47	11 -.47	1 -.46	10 -.46
6	9 .35	12 -.20	1 -.18	6 -.18	8 -.18	4 .15	7 .14
7	3 1.21	6 -.26	10 -.20	12 -.19	7 -.18	11 -.16	8 -.16
8	3 4.95	6 -.70	8 -.68	12 -.68	10 -.66	11 -.64	1 -.64
9	4 1.22	3 1.02	9 -.37	1 -.33	10 -.32	12 -.32	8 -.31
10	4 .56	3 .46	10 -.25	8 -.25	1 -.23	7 -.16	11 -.15
11	4 2.86	11 -.38	10 -.37	6 -.36	5 -.35	8 -.35	2 -.35
12	4 2.46	5 -.50	7 -.50	8 -.50	12 -.50	2 .47	1 -.46

Scene 2: 2010-2020

1	4 1.89	6 -.55	1 -.54	10 -.54	2 -.41	12 -.40	9 .38
2	4 2.54	1 -.66	2 -.56	12 -.44	10 -.39	6 -.39	7 -.35
3	5 .91	8 .73	4 -.60	6 -.25	10 -.22	1 -.21	12 -.14
4	9 .29	1 -.25	5 -.16	2 .12	8 -.09	12 .08	11 -.07
5	3 2.89	8 .62	5 -.61	9 -.61	11 -.58	12 -.58	10 -.57
6	9 .68	7 .46	12 -.39	6 -.32	1 -.32	8 -.32	5 -.22
7	3 1.17	6 -.32	12 -.26	9 .25	10 -.24	7 -.22	2 -.18
8	3 4.81	5 1.06	6 -.84	8 -.82	12 -.82	10 -.80	11 -.72
9	4 1.23	3 .88	9 -.51	10 -.41	6 -.39	1 -.38	12 -.32
10	4 .51	10 -.37	8 -.37	3 .34	1 -.32	9 .28	7 -.16
11	4 3.03	11 -.50	10 -.48	6 -.47	5 -.44	2 -.44	8 -.39
12	4 2.54	2 1.04	5 -.68	7 -.68	8 -.68	12 -.68	1 -.56

Scene 3: 2020-2030.

1	4 2.05	6 -.68	1 -.64	10 -.64	9 .53	2 -.46	12 -.37
2	4 2.73	1 -.84	2 -.70	7 -.50	12 -.47	10 -.37	8 -.28
3	5 1.08	8 1.07	4 -.66	6 -.50	10 -.33	1 -.26	12 -.17
4	1 -.36	9 .36	5 -.20	2 .16	12 .15	8 -.13	11 -.10
5	3 3.43	8 .97	5 -.77	9 -.77	11 -.73	12 -.71	10 -.69
6	9 .87	12 -.52	1 -.39	6 -.39	8 -.39	7 .34	11 .31
7	3 1.42	6 -.52	9 .35	12 -.32	10 -.30	7 -.26	2 -.19
8	3 5.76	5 1.23	6 -1.05	8 -.98	12 -.98	10 -.94	11 -.86
9	4 1.28	3 1.03	9 -.63	1 -.45	10 -.45	8 -.33	6 -.31
10	10 -.52	8 -.52	4 .46	1 -.43	12 .38	3 .34	7 -.31
11	4 3.30	11 -.60	10 -.55	5 -.53	6 -.52	2 -.52	8 -.44
12	4 2.70	2 1.52	5 -.87	7 -.87	8 -.87	12 -.87	1 -.69

Scene 4: 2030-2040

1	4 1.80	6 -.71	1 -.66	10 -.66	9 .60	2 -.48	8 -.34
2	4 2.43	1 -.87	2 -.71	7 -.50	12 -.40	10 -.33	8 -.31
3	5 1.24	8 1.01	4 -.63	6 -.54	10 -.37	1 -.28	12 -.20
4	1 -.39	9 .39	5 -.23	12 .21	2 .16	8 -.13	11 -.12
5	3 3.65	8 .89	5 -.78	9 -.78	11 -.73	12 -.70	10 -.69
6	9 .94	12 -.59	11 .43	6 -.42	1 -.42	8 -.42	7 .36
7	3 1.50	6 -.54	9 .38	12 -.35	10 -.31	7 -.27	2 -.20
8	3 6.07	5 1.47	6 -1.12	8 -1.05	12 -1.05	10 -1.01	11 -.90
9	3 1.10	4 1.09	9 -.66	1 -.46	10 -.45	8 -.37	6 -.32
10	12 .61	10 -.56	8 -.56	1 -.47	7 -.35	3 .34	4 .34
11	4 2.97	11 -.60	10 -.54	5 -.52	6 -.52	2 -.51	8 -.45
12	4 2.39	2 1.51	5 -.88	7 -.88	8 -.88	12 -.88	1 -.68

Scene 5, run for testing purposes: 2040-2050

1	4 1.83	6 -.71	1 -.66	10 -.66	9 .60	2 -.47	8 -.32
2	4 2.46	1 -.87	2 -.72	7 -.52	12 -.39	10 -.31	8 -.30
3	5 1.26	8 1.07	4 -.63	6 -.59	10 -.38	1 -.27	12 -.20
4	9 .38	1 -.37	5 -.23	12 .22	2 .15	8 -.14	11 -.12
5	3 3.43	8 .99	5 -.77	9 -.77	11 -.72	12 -.68	10 -.67
6	9 .95	12 -.60	1 -.41	6 -.41	8 -.41	11 .41	7 .31
7	3 1.42	6 -.57	9 .40	12 -.34	10 -.30	7 -.25	2 -.19
8	3 5.73	5 1.53	6 -1.10	8 -1.02	12 -1.02	10 -.97	11 -.87
9	4 1.11	3 1.01	9 -.66	1 -.47	10 -.43	8 -.36	6 -.27
10	12 .68	10 -.57	8 -.57	1 -.49	7 -.37	4 .34	9 .32
11	4 3.01	11 -.60	10 -.54	5 -.52	2 -.52	6 -.51	8 -.44
12	4 2.42	2 1.53	5 -.88	7 -.88	8 -.88	12 -.88	1 -.70

V.7. References to chapters I, III and V:

Fischer, D., Ikeda, S., Owsiński, J. and von Winterfeldt, D. (1981): North Sea Oil - An Environment Interface. Univesitetsforlaget, Bergen.

Godet, M. (1985): Prospective et planification stratégique. Economica, Paris.

List of 500 biggest Polish manufacturing enterprises (1985), in Polish. Zarządzanie, Warszawa.

Owsiński, J.W. and K.Hołubowicz (1985): A case of energy-related development in an agricultural region. In: A Straszak and J.Owsiński, eds.: Strategic Regional Development. System Research Institute, Warsaw.

Owsiński, J.W. (1985): Time factor and technoactivity choice in the case of a regional undertaking with a finite time horizon. In: Proceedings of the IIASA Seminar "Time Factor in Regional Development", Tbilisi, USSR, May 1985.

Manne, A.S. and Schrattenholzer, L. (1985): International Energy Workshop. RR-85-5. IIASA, Laxenburg, Austria.

Jakubowski, A. (1985): Cross-impact Method for Regional Development. Scenario generation. A draft, (in Polish). Internal report, Systems Research Institute, Warsaw.

Turoff, M. (1972): An alternative approach to cross-impact analysis. Technological Forecasting and Social Change, Vol. 3, No. 3, pp. 309-339.

Urich, R. et al. (1985): Expertise concerning leading problems of socio-economic development within the reach of influence of the Bełchatów Industrial Center in the period 2000-2040. Documentation of computer-aided session. (In Polish). Mimeograph, SEP, 365/6/85/OW, Warsaw.

Yao-Chi Lu (1979): Technological Innovation and Productivity Growth in U.S. Agriculture. Paper presented at the Workshop on Innovation Policy and Firm Strategy, Dec. 4-6, 1979, IIASA, Laxenburg, Austria.

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STUDY REPORT

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