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SEA of the Planned Network of Motorways and Expressways in Poland

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STRATEGIC ENVIRONMENTAL ASSESSMENT OF THE PLANNED NETWORK OF MOTORWAYS AND EXPRESSWAYS IN POLAND

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1. Introduction

Poland's political and economic opening for Europe, resulting in dynamic growth of motorisation and road traffic, put in front of the Polish road network a number of new requirements, which the existing network is not able to satisfy. In particular there is still lack of a system of high standard roads. Construction of a motorway system of about 2600 km supplemented in a future by a network of expressways, should give the Polish road network expected efficiency with regards to capacity, safety and traffic economy. The motorway construction programme and network of planned motorways in Poland was accepted by the government in 1993 and revised in 1996. The last plan was preceded by earlier plans from 1938, 1963, 1972 and 1985. Thanks these former plans the majority of motorway corridors were provided in local land use plans.

Since the 1996 revision, several new sections of motorways and expressways were proposed and new traffic surveys were conducted. Prof.W.Suchorzewski team from Warsaw University of Technology made a comprehensive study of several development alternatives of the planned network for the General Directorate of Public Roads. The author of paper was asked to make a strategic environmental assessment (SEA) of four development scenarios of the network of motorways and expressways, including the "do nothing alternative". Considered were the following networks and traffic:

- "do nothing alternative" (with about 300 km of motorways) with 1996 traffic - WO96,
- "do nothing alternative" with 2025 traffic - WO25,
- "governmental" alternative (1996 motorway network) with 2025 traffic - WA25,
- new alternative of the motorway network with 2025 traffic - WK25.

Multimodal scenarios were not considered in the study at that stage.

2. Aims of the SEA of the planned network of motorways and expressways in Poland

In Poland the EIA process is compulsory for all larger road investments. According to the departmental directive [5] all road investments are classified into three groups [3,4,5]: particularly harmful for an environment (motorways and expressways), those which can deteriorate a state of environment (other national and provincial roads, large parkings and several other investments) and other (small works). The

EIA process in practice can include one to two assessments at the project levels and one at the operation stage.

In Poland no statutory form of the SEA exists at the national level. The Land Use Act (1995), Building Law (1995) and the new Environmental Protection Law (1997) state that sustainable development is to be the basis for all land-use decisions. The Acts stipulate that a forecast of environmental consequences regarding biological environment should be performed for local land use plans. The guidelines [3,4] recently published by the road administration [4] recommend SEA for strategic actions like plans, programmes and policies. With regards to the SEA, general aims and contents of the guidelines are based on recommendations of the OECD [1] and the CEMT [2] reports.

SEA for the proposed developments of the network of motorways and expressways was seen by the road administration as a complementary measure, improving the EIA system and also as an instrument for promoting of sustainable development and promoting some environmental advantages of the motorway programme implementation. Expected were also answers to some questions related to environmental impacts asked often too late, i.e. in the EIA at the project level, concerning for example impacts on the air pollution, on an agriculture production and on road safety or a modal choice between a fast train and a motorway. Several myths regarding negative impacts of the motorway construction programs were also taken into account.

In general a problem of the SEA were reduced to three basic questions:

1) what is an assessment of environmental impacts of the proposed (by the network study team) network alternatives of network of motorways and expressways including the "do nothing" alternative at predicted traffic flows?
2) does the reference to the do nothing alternative show majority of benefits or negative impacts on an environment?
3) is the general balance of all of the considered in the SEA impacts, i.e.:
   - total area of land required for building the motorways and expressways and changes in agricultural production,
   - collisions with protected areas (sanctuaries, national and landscape parks, habitats etc.)
   - air pollution,
   - noise impact,
   - impact on traffic safety

   evaluated as positive or negative?

In evaluating the aims and range of the SEA also time and funds provided for it should be taken into account.

3. Contents of the SEA according to OECD and ECMT recommendations

The authors of the SEA considered several factors to be used in the assessment, including all those suggested in the 1994 OECD Report [1], World Bank Report (1994) and the 1998 ECMT Report [2]. In this analysis several aspects were considered including: available data, access to data, need of time consuming data processing and analysis etc. and also potential sensitivity of the assessment factors in relation to the evaluated alternatives. This analysis has showed that in practice list of suggested factors is mainly affected by the availability of data and by sensitivity of factors in conducted comparisons. SEA process and involved techniques can vary depending on its aims and type of comparisons to be made and they seem very decisive

in selection of evaluated factors. For example strongly recommended CO2 emission for its global effects is not very practical in comparison of various alternatives of road networks, whereas it is very important in multimodal comparisons. On the other side CO and NOx recommended for local EIA were much more sensitive and useful in the SEA comparisons of alternatives.

Available time, funds and data have resulted in selection of the following issues for the conducted SEA of the motorway and expressway network alternatives:

a. identification of all of the possible positive and negative environmental impacts in relation to all considered elements of an environment, including also cumulative and secondary impacts and general evaluation of their impacts,

b. determination of the area of land that will be taken for construction of motorways and resulting changes in agricultural production expressed by production of grain, including also impact on employment in the agriculture sector,

c. determination of emissions of pollution to air related to traffic conditions, driving speed and traffic composition - including CO2, CO, CxHy, NOx and equivalent emissions {Mg/year], [Mg_e/year], [Mg/mln veh km/year] and comparisons,

d. noise impacts along the road network sections including changes in the considered alternatives of three types of impacts of noise (affected sections, affected housing areas and affected areas),

e. impacts of the planned alternatives on road safety expressed by the numbers of accidents, killed and injured and a exposure risk to hazardous chemicals (during hazardous goods transport),

f. conflicts with protected areas of natural environment (lengths and types of collisions).

Available time and money have not allowed for including several factors or even considering other important issues for example:

- analysis of development of alternative modes of transport (networks, modes), alternative transportation policy (distribution of available resources and tax policy, use of energy) and standards,
- cohesion of the proposed road network development with trends in transport development neighbouring countries,
- long-term macro-environmental issues,
- other aims of the motorways network development, linkage to other types of development plans, its possible impact on mobility and impact of motorways on traffic generation and induced traffic,
- impacts on regional development (employment, relocation of activities etc., changes in land use patterns and cost of land),
- cumulative impacts and synergistic impacts,
- technical and economic problems of protection of environment and compensations,
- socio-economic effects including: lifestyle, housing, changes in land use, social services, community cohesion)

Initial analysis of available databases have showed several gaps in data and lack of methodologies and tools for including in the SEA most of these issues and factors.

4. Methodological aspects of the SEA

The SEA process and techniques that can be used depend on the scope and type of SEA, i.e. type of problem (multimodal or monomodal, multialternative or one alternative) and on type of strategic actions that has to be assessed (policies, plans or programmes). Therefore it is not possible to formulate one general SEA process and its objectives, goals and set of environmental factors which can have quantitative or qualitative character. SEA should cover effects on human health (including road safety), natural and cultural environment. Socio- economic effects should also be assessed but these may be very difficult in practice. Anyway all impacts and concerns should be identified and taken into account. So recommendations regarding impacts and indicators that should be assessed in transport SEA given in [1] and [2] should be treated only as a checking list.

At the SEA stage it is possible to make a numerical estimation in an approximate manner only for some elementary impacts on components of the environment. Quantitative assessments of environmental effects use variables that can be expressed in numerical values (for example monetary units, km, km2, tonnes, number of affected objects or people). Multicriteria analyses may include weights of options. In case of other impacts such numerical analyses are not possible without more precise recognition of environment or more precise determination of vertical and horizontal alignment of the network links.

It should be noted that the considered environmental impacts can be divided into three groups, i.e. those which:

a) can decide on purposefulness of the whole network realisation or on the motorway programme reduction, as:
   - total area of required agricultural land, that can have impact on food production in national or regional scale,
   - emissions of pollutants to the atmospheric air, that together with other pollution, can decide about significant deterioration of living conditions (impact on health) in the global, national, regional or local scale,
   - number and cost of road accidents,

b) decide on possibilities of building of particular links (or their changes) in the network, i.e. collisions with:
   - protected areas national and landscape parks, habitats (fauna, flora),
   - areas of very high cultural, historical or archaeological value,
   - valuable recreational or agricultural areas,
   - water-supply areas.

c) decide on deterioration of living conditions of people and fauna and flora. They also have decisive impacts on costs of the motorway network realisation,
   - impact of noise and costs of noise reduction,
   - pollution of air, water and earth,
   - accidents in road traffic.

The SEA should give clear answers to questions related to the first group and if possible reasonably clear answers in relation to the second group. Both groups of impacts should be evaluated also in comparison with "do nothing" alternative. The third group, that does not decide about acceptance of the construction of the network of motorways and expressways and its elements should show environmental costs and benefits from the programme implementation in comparison to the "do nothing" alternatives (WK25, WA25).

The SEA should also give recommendations with regards to screening and scoping of the EIA at the project level (contents of EIA).

5. Methodological assumptions for assessment of some impacts

5.1. Impacts on changes in agriculture production and on employment in the agriculture sector

For the assessment of impacts the following data were required:

- areas of agricultural land required for each of alternatives of road network development on the basis of determined widths of the road corridor for each type of motorway and expressway cross sections on the basis of already completed designs or guidelines and characteristics of terrain,

- agricultural structure of areas covered by motorways, expressways (including interchanges and service areas) and impact of covering and fragmentation on structure of agricultural production, productivity and loss of labour places including determination of:

  - structure of land use,
  - areas of complexes of soils and their use,
  - loss in annual agricultural production caused by construction of motorways and expressways. The estimations showed that for realisation of the WK25 alternative, required is total area of 51 thousands of hectares for construction 2x2 lanes motorways, 2x2 lanes expressways, 1x2 lanes expressways and service areas and interchanges.

On the basis of supplementary analysis of data from 16 districts determined was average structure of use of areas in the motorway and expressway corridors. Then the division of agricultural lands on complexes of agricultural usefulness (taking into account the land capability taxation) was made in order to calculate the agricultural production. This stage of analysis was time consuming as the determined rates differ in various regions of Poland. Poland is in the stage of transformation also in the agricultural production sector and therefore these results should be verified in the future.

The synthesis of assessment is given in Table 1. They show that a myth that the motorway programme will have great impact on agricultural production was not proved. Realisation of the motorway programme will not bring noticeable loss in agriculture production and in employment. Of course possible are local problems in surroundings of motorways.

5.2. Impacts on the acoustic climate

Impact on the acoustic climate is majority of case studies conducted in the OECD countries [1, 2] not listed among the evaluation indicators. There is also lack of information how this impact can be included in SEA.

In the described SEA the assessment of the impacts of noise was conducted on the basis of rates determined by the authors from available maps from a few parts of Poland. The following assumptions were made:

a) Evaluated is only impact of noise from road traffic on marked on maps areas with a development (individual buildings or groups of buildings). It was also assumed that this impact is related to people and other indirect impact on people due to affected recreational areas (or areas of protected landscape) are not taken into account at this stage of evaluation. This assumption is linked with two indicators used for the network assessment, i.e. a **length of harmful** (affected by noise) **sections** and an **area of affected**

development (by noise) (Fig. 1). The third indicator, i.e. an **affected area** does not take into account development in zones along the motorway.

b) Negative impact of noise on the development is calculated for zones with noise L_{Aeq} = 60 dB for the day period (6.00-22.00) and average hourly traffic volume in this period. Treatment of development in the motorway surroundings as a common receiver required assuming of average common permitted noise level L_{Aeq}.

c) The **harmful road section** is defined as section along which there is a development in the range of noise L_{Aeq} = 60 dB.

d) The **affected development** is defined as development located in zone of L_{Aeq} = 60 dB.

e) The **affected area** is defined as limited by isolines of L_{Aeq} = 60 dB on both sides of motorways.

The strategic level of assessment to some extent determined the method of evaluation with use of the defined indicators. Assumed was concept of the "rate of casing" for the selected groups of districts and groups of road categories. For these groups on the basis of maps determined were lengths of sections with development in their surroundings and a distance to this development. Thus the rate of casing of the road section can be defined as the ratio of the total of lengths of sections with development (within the distance of 1000 m from the road axis) to the total length of the analysed road (Fig.1).
As assessment indicators and for comparisons of the alternatives of the motorway and expressway networks were taken:

- the percentage of the harmful road sections in the total length of the road network,
- area of affected development,
- affected area.

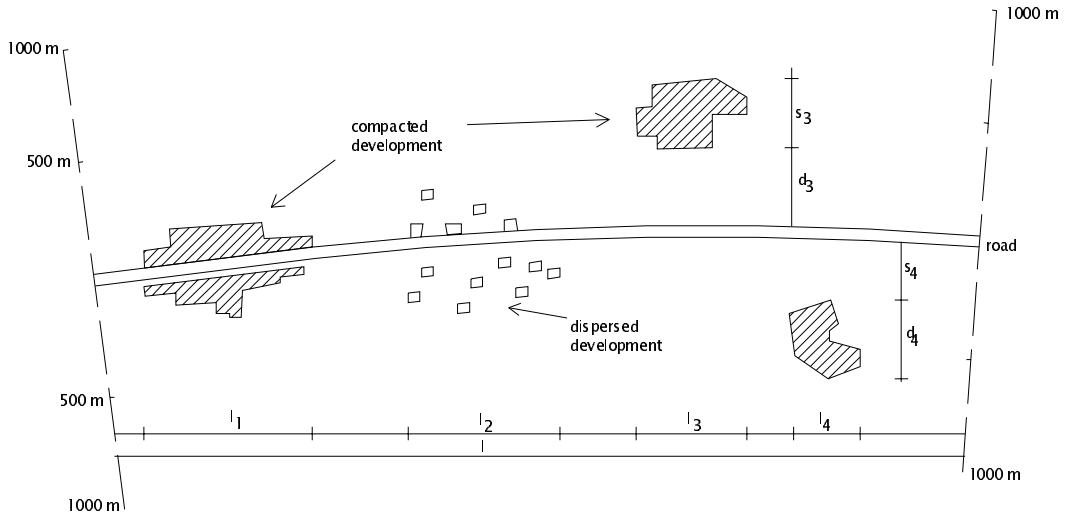

Fig. 1. Development in the road surroundings. The illustration of the definitions of indicators

The assessment method. The assumed concept and including a few stages assessment were developed especially for the SEA. For example in Figure 1:

$$\text{rate of casing} = (l_1 + l_2 + l_3 + l_4)/l$$

where: l_1, l_2, l_3, l_4 are lengths of sections along which there is located development and l is the total length of the analysed stretch.

As the development treated were marked on maps in scales 1:100 000 or 1:25 000 area of compacted of scattered buildings, two-sided or one-sided. It was not possible to determine use of the development.

In calculations related to the rate of casing, included were:

- distance of development from a road "d" (Fig.1) and the width of buildings area "s". The rate determine shares of development in several distances from a road with a step of 100 m from 100 to 1000 m. If the development is located in direct environment of a road d = 10 m.
- three groups of road categories - group of categories Z and G, A and S and GP, urban sections (U)
- group of districts for which the common values of the rate of casting can be taken.

The method of noise prediction developed by S.Radosz and calibrated by J.Bohatkiewicz was used for noise calculations. In these calculations the reduction of noise of 3.0 dB for 2025 was included. The distances of the permitted noise range from 30-50 meters from the roads categories Z and G, to 150-300 for the roads A (motorways), S (expressways) and GP (dual carriageway roads).

Synthesis of results is presented in Table 1. Two examples of comparisons are presented in Figures 2 and 3.

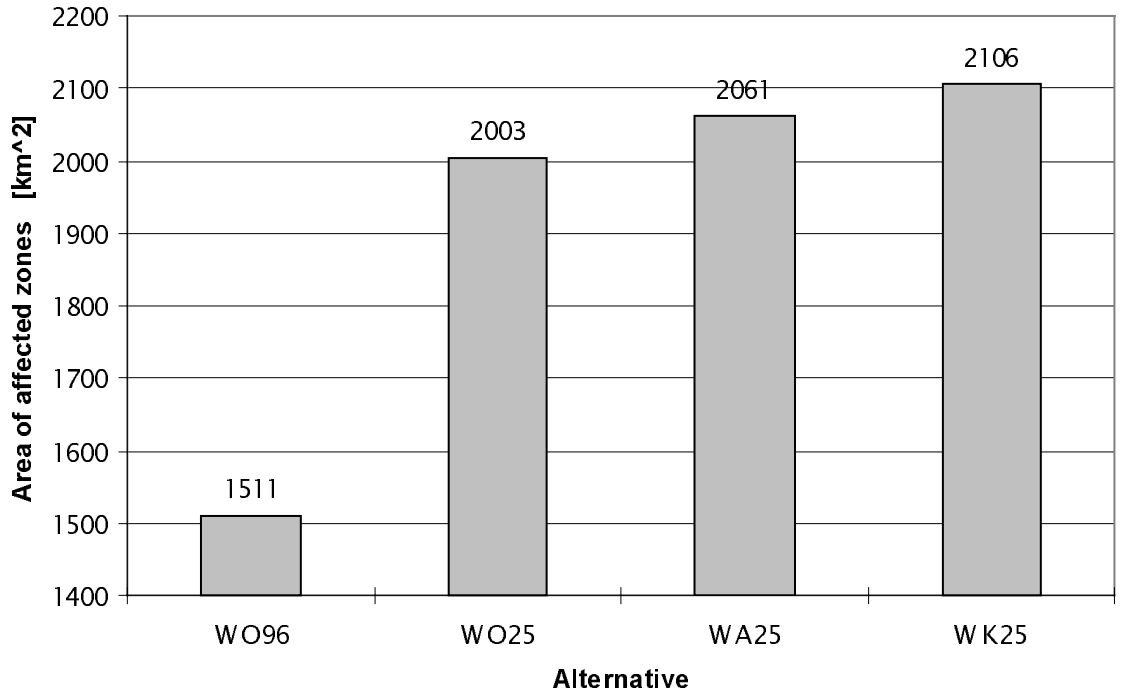

Figure 2. Comparison of areas of zones affected by traffic noise for evaluated alternatives of networks

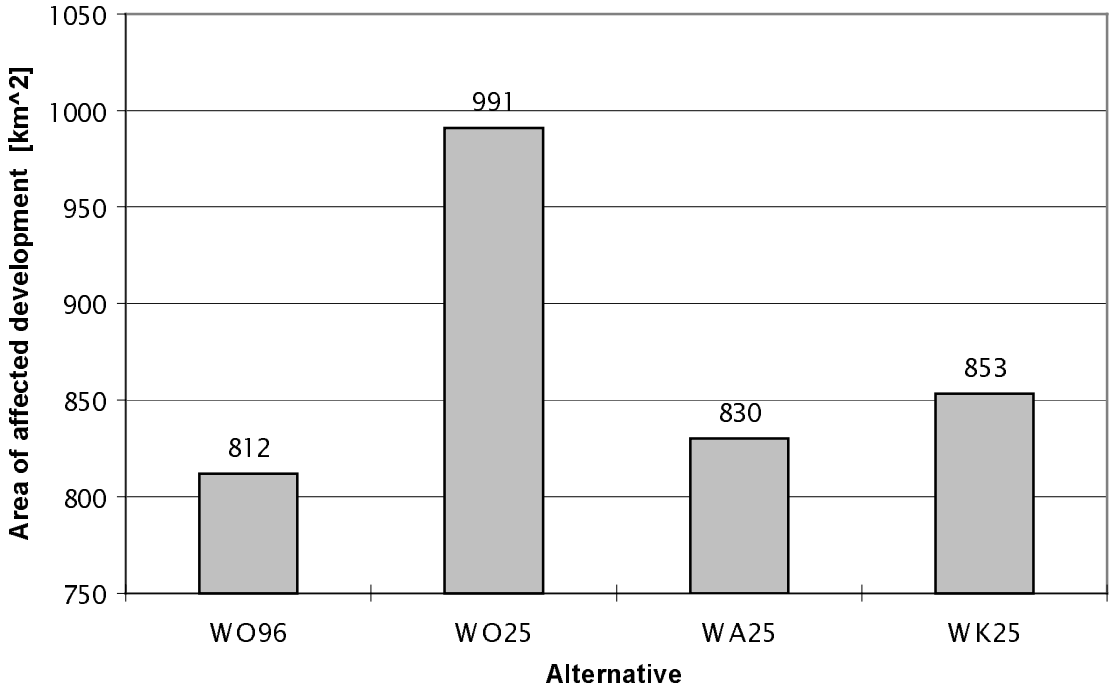

Figure 3. Comparison of areas of development affected by traffic noise for the evaluated alternatives of networks

5.3. Impacts on air pollution

For road traffic emission several air pollutant were considered, despite on orientation in references [1, 2] mainly on the carbon dioxide. It seems useful in intermodal transport SEA and also in assessment of the absolute emissions. However it has occurred that CO2 is not very useful in evaluation of alternatives of the road networks, as CO2 was not very sensitive to changes in traffic conditions in the evaluated networks. Therefore other air pollutants were involved too; i.e. CO, NOx, CxHy and the equivalent emission. These air pollution indicators made possible comparisons of the motorway network alternatives WA25 and WK25 with the "do nothing" alternatives.

For estimation of the air pollution indicators the methods used in Poland and also the German method – recommended for planning analyses were considered. Analysis of the considered methods, their characteristics, input and output data, possibilities of use of available traffic and geometric data for the evaluated networks, characteristics of Polish fleet of motor vehicles and also aims of the SEA, the German method were chosen. This method in the estimation of emissions for motorways and expressways make possible to take into account:

- ADT traffic volumes [veh/24 h],
- ratio of heavy vehicles in traffic flows {%],
- average speed of cars and heavy vehicles [km/h].

Values of unitary emission indicators are calculated on the basis of the estimated speed and fixed values of parameters from empirical forms. In calculations of emissions the estimation model taking into account eight various traffic conditions characteristics (moduses) was adapted. Tabular values of unitary emissions for the considered pollutants for cars and heavy vehicles for 1985 were used. The correction factors for the

unitary emissions for various types of vehicles and various time horizons were used. Application of the German method in the SEA required additional assumptions and decisions concerning:

- determination of the unitary emission rates for 1996 horizon (in the German method emission rates for the 1985 horizon constitute the calculation basis),
- assumptions regarding the driving models and average speeds determining the emission rates (available data included only information related to the total flow),
- determination of the values of correction factors for emissions of the analysed pollutants in relation to national conditions.

On the basis of comparisons of statistical data, the authors recognised that there is good similarity between the development and changes in Polish and German fleet of motor vehicles, if the delay of 10 years for Poland is assumed.

In order to include the impact of lower speed on road sections through small towns and villages, analysis of selected parts of the Polish road network was made. Determined were lengths of road sections through urban areas, small towns and villages and rural sections for all national roads. This stage of determination of rates required for calculations was very time consuming as sections with speed limits were significantly extended in last years.

Synthesis of results of assessment of air pollution is given in Table 1. Examples of comparisons are presented in Figures 4 and 5.

Alternatives of network WA25 and WK25 are almost equivalent, alternative WK25 is slightly better. It should be expected (in the time horizon of 25 years) that assumed 3.5 increase of traffic, will produce 2 times higher equivalent emission of pollutants from road traffic. Implementation of the motorway programme will reduce this emission 6.3-8.7%.

Impact of emission of pollutants will be lower in case of realisation of the programme than at "do nothing" alternative, thanks transferring of significant part of emissions from urban sections (share of emission on urban sections will decrease by 39%) on rural sections.

In case of continuation of the current transportation policy in the perspective period about 50% of pollution will be produced by heavy vehicles. **Implementation of the motorway programme** (WK25 or WA25) **is better than “do nothing” alternative.**

The motorway construction programme will have a marginal impact on emission of CO2.

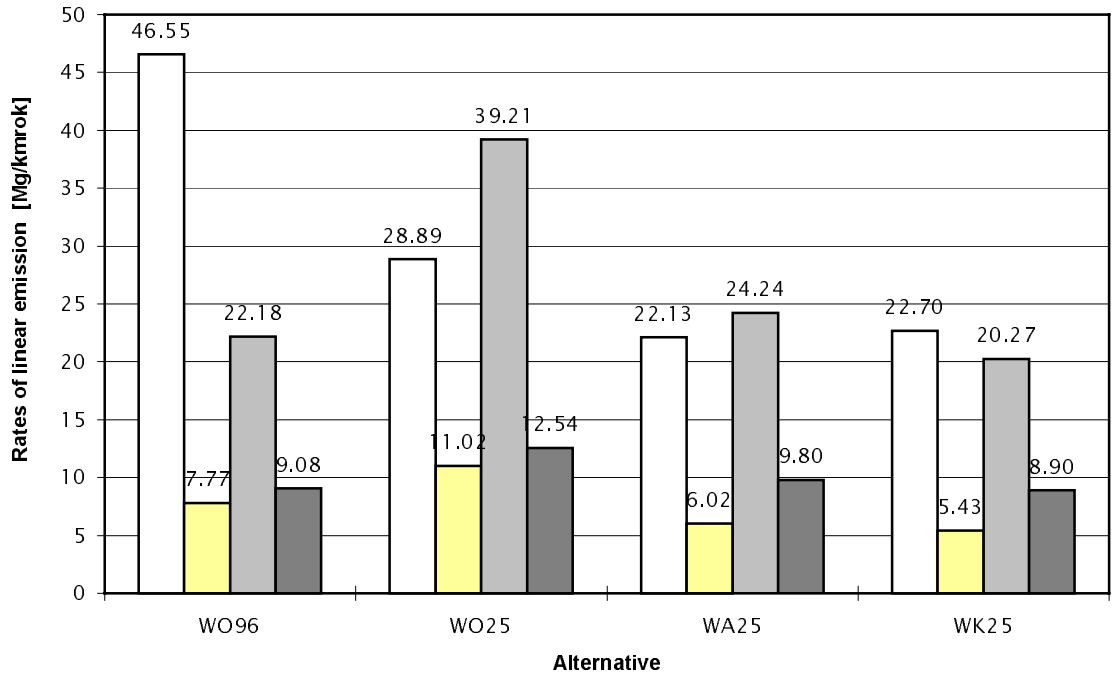

Fig. 4. Rates of linear emissions of CO [Mg/km/year] for three groups of road categories (First column,– roads A, S and GP, second column – other roads G, Z, L and D, third column – urban roads, fourth column – average values) and evaluated alternatives of networks

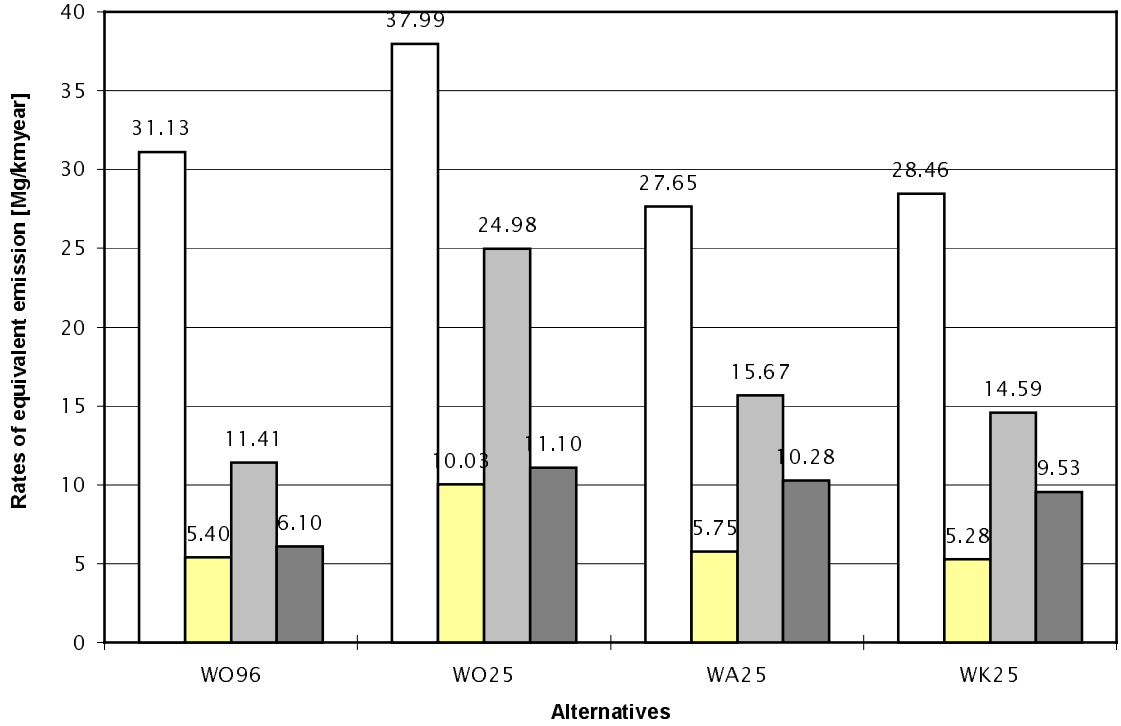

Figure 5. Rates of linear equivalent emissions [Mg_e/km/year] for three groups of road and evaluated alternatives of networks (columns as in Figure 4)

Table 1. Synthesis of the SEA results

Impacts on elements of environment	Results of assessment
1. Area required and effects of its covering – expressed by decrease in: **agricultural area, number of farms** and **employment in agriculture**	Within period of 15 years loss of ~51.000 hectares of arable lands, loss in production ~122.000 tons of grain -0.5% of annual production in Poland in 1996 (at assumed rate of productivity 1.5- -2.0%. Loss of 4.5-11.000 working places and decrease in the number of farms of about 6.000 (0.3%). Realisation of the motorway programme (alternatives WA25 or WK25) and associated loss of agricultural land will not bring noticeable loss in agriculture production and in employment. Possible local problems in surroundings of motorways.
2. Impact on air pollution expressed by emissions of **CO, NOx, CxHy, CO2** and equivalent emission	Alternatives of network WA25 and WK25 are almost equivalent, alternative WK25 is slightly better. It should be expected (in the perspective of 25 years) that assumed 3.5 increase of traffic, will produce 2 times higher equivalent emission of pollutants from road traffic. Implementation of the motorway programme will reduce this emission 6.3-8.7%. Impact of emission of pollutants will be lower in case of realisation of the programme than at "do nothing" alternative, thanks transferring of significant part of emissions from urban sections (share of emission on urban sections will decrease by 39%) on rural sections. In case of continuation of the current transportation policy in the perspective period about 50% of pollution will be produced by heavy vehicles. **Implementation of the motorway programme (WK25 or WA25) is better than do nothing alternative.** The motorway construction programme will have a marginal impact on emission of CO_2.
3. Impact of noise in relation to "do nothing" alternative expressed by: - length of harmful sections of motorways - area of deteriorated development - deteriorated area	Transferring of part of increasing traffic from the existing network (WO96, WO25) on the network of motorways and expressways will result in: - decrease of the percentage of the harmful road sections from 38% (WO25) to 34% (WA25, WK25). The difference is equivalent to 700 km of road sections. - decrease of the area of affected development from 991 km2 (WO25) to 830 km2 (WA25 - 16.2%) or to 853 km2 (WK25 - 13.9%), - small increase of affected areas (2.9-5.1%) at simultaneous increase of traffic and development of network Realisation of the programme (networks WK25 or WA25) at traffic increase, will not result in noticeable increase of deteriorated areas, but can decrease area of affected development and length of harmful road sections. It means the positive total effect in relation to noise pollution in relation to "do nothing alternative. The positive effect can be much better at use of noise reduction measures.
4. Impact on road safety is expressed by numbers of: accidents, killed, injured and costs of accidents.	Transferring a large part of the veh.xkms on motorways and expressways, i.e. roads with lower accident rates will decrease number of accidents. According to moderately optimistic prediction for only one year 2025 - the number of accidents will be reduced by 17.000, number of injured by 22.000 persons and killed by 360-380 persons, at reduction in costs of about 3.6-3.9 billions nzl. In relation to incidents involving transport of dangerous chemicals very positive effects can be expected - difficult to predict. The total **effect very positive**
5. Impacts on protected areas expressed by lengths of conflict sections.	In the assessment the number of kilometres of sections through protected areas of a few types were estimated. General expected **effect – negative**. There are some sections through new landscape parks and their direct surroundings. Valuation of collisions in EIA is required.

5.4. Impact on protected areas

The estimation of the lengths (kilometres) of sections through protected areas of a few types was made. However the scale of available numerical maps made this estimation very inaccurate. General expected effect is of course negative. There are some sections of motorways passing through new landscape parks and their direct surroundings. It is a result of establishment of several new landscape parks since establishing the motorways' corridors in land use plans.

More precise analysis of conflicts with protected areas, together with weighting of collisions, is recommended in the next EIA.

5.5. Impact on road safety

Impact traffic safety is very important criterion in environmental impact assessment of several network alternatives including the "do nothing" alternative. This impact is often left out of account in EIA by environmental experts, because of focus on natural environment, lack of knowledge, need of special data and their relation to the road traffic and road users. Evaluation of impacts of new networks in relation to "do nothing alternative" does not create too many problems. The predicted numbers of accidents, injured and killed as well as cost of accidents were assumed as the impact indicators.

Numbers of accidents and victims were predicted on the basis of accident frequency rates AC (accidents/10^6 veh kms) for evaluated road classes and cross-sections. Eight categories of roads were taken into account; A – motorways, S – expressways, GP – dual carriageway roads, G, Z, L, D – other roads (with and without paved shoulders) and urban roads as one category. For these roads values of accident rates were determined for 2025 time horizon. The Polish road network within the coming period should reach the Western European standards regarding the road network hierarchisation, signing and marking and quality of pavements. Also behaviour of road users, particularly pedestrians will change and accident risk will be lower on Polish roads. Therefore the authors decided to base accident rates on the foreign references, mainly German and Dutch (BASt and the Dutch SVOW papers and reports) and on own research results from the Polish network. The determined accident rates include the impact of intersections on road safety and are in general lower than currently recorded in Poland. In determination of the accident rates special care was focused on proportions of rates in categories.

Two scenarios regarding the development of situation in road safety were considered; pessimistic and moderately optimistic. Costs of accidents for compared alternatives were calculated with use of the German method: "Richtlinien fur die Anlage von Strassen – Teil: Querschnitte –RAS-Q96 – modified for the analysis.

Results of analysis and comparison are given in Table 1. Transferring a large part of the veh.x kms on motorways and expressways, i.e. roads with lower accident rates will decrease number of accidents and victims. Lack of data has not allowed making assessment of impact of new network in relation to incidents involving transport of dangerous chemicals very positive effects can be expected - difficult to predict. Expected can be significant improvement due to transferring of significant part of this dangerous transport from urbanised areas on roads in rural areas with good protection.

6. Results of the SEA and concluding remarks

Some selected results of the SEA are presented in the table 1. There are positive and negative global impacts. Positive evaluation of noise and air pollution impacts of the realisation alternatives in comparison with do nothing alternative was rather unexpected.

In works at the described SEA the authors met several methodological problems in the areas of impacts of noise, air pollution and conflicts with protected areas. There is great gap in data, numerical thematic maps and rates needed for such SEA. In general it is impossible to conduct a total evaluations including all the criteria together with application of the weighting system.

Lack of numerical data and time did not allow including a fragmentation issue in the SEA.

References

[1] OECD Scientific Research Group: Environmental Impact Assessment of Roads, Road Transport Research, OECD, Paris 1994.

[2] ECMT: Strategic Environmental Impact Assessment in the Transport Sector, Paris 1998.

[3] Tracz, M. et al: Environmental impact assessment of road investments - guidelines, General Directorate of Public Roads, Warsaw 1997.

[4] Tracz, M. et al: Guidelines for environmental impact assessment of motorways, Agency for Motorways Construction and Operation, Warsaw 1998.

[5] Types of investments particularly harmful for an environment or those which can deteriorate a state of environment, and requirements concerning their EIA, Directive of the Minister of Environmental Protection, Natural Resources and Forestry, Warsaw 1998 (Dz.U.nr 93, poz.589)

[6] Liro A. i inni: Koncepcja krajowej sieci ekologicznej ECONET-POLSKA. Fundacja IUCN Poland, Warszawa 1995.