Assessm e nt of the Environmental Risk of Cultural Heritage Objects in Poland

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1. ASSESSMENT OF THE ATMOSPHERE CORROSIVITY ON AREA OF POLAND

1.1 Assessment of atmospheric pollution

On area of Poland routine measurements of main air and precipitation pollutants are carried out at a few institutions. There are two main networks of measurements stations: National Network of Basic Stations (95 sites) supervised by the National Inspection of Environment Protection and network of the State Sanitary Inspectorate (about 400 sites).

In addition the observations are carried out at the research institutes (8 sites) and local urban network stations.

Every two years the National Inspection of Environment Protection and the State Sanitary Inspectorate publish a report " Pollution of Air in Poland" containing data concerning main environment pollutants emission and concentration on several sites, analysis of the trends their changes and maps of geographic distribution. Number of measurement sites of main atmospheric pollutants is contained in table 1 [1].

Table 1. Number of measurement sites of main atmospheric pollutants [1]

Parameter	Meteorological parameters	SO_2	NO_2	O_3	Suspended particulates	Precipitation
Number of sites	234	365	315	19	341	17

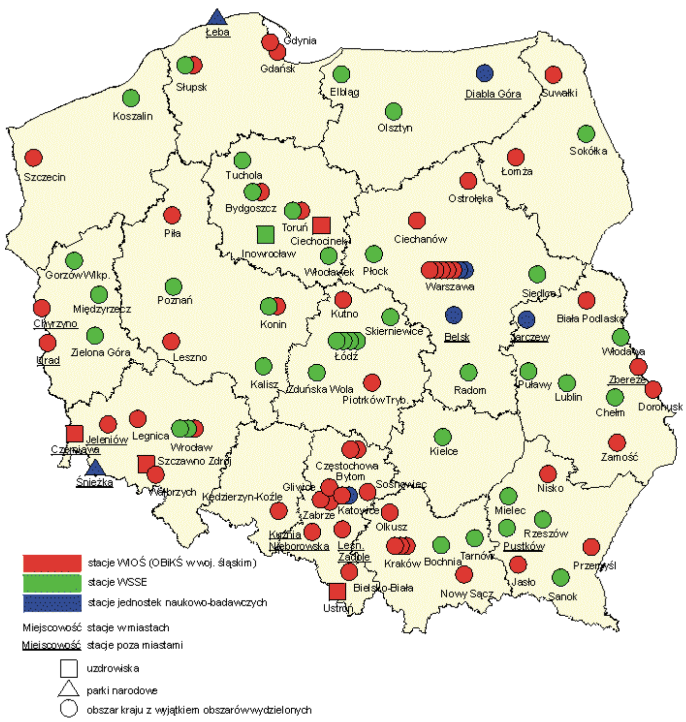


Fig. 1. Location of the National Network of Basic Stations

Some of research institutes take part in international programmes within the scope of the UN ECE Convention on Long-range Transboundary Air Pollution: ICP on Assessment and Monitoring of Air Pollution Effects on Forests, ICP on Assessment and Monitoring of Acidification of Rivers and Laces, ICP of Air Pollution on Materials and Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollution in Europe (EMEP).

1.2 Trends in atmospheric pollution in Poland

From 1989 on the area of Poland there is observed a downward trend in the emission of industrial and transport pollutants. The greatest reduction of SO_2 emission, about 35%, was noted in 1998-1992, which was due to political and economical changes in Poland. From 1993 to 1995 a decrease of about 7% yearly was noticed and from 1996 to 2000 SO_2 concentration stayed on the same level.

In contrast to the observed reduction of SO_2 emission, no trend of reduction of NO_2 emission can be noticed.

The very high emission of suspended particulates in 1988 degreased two times in the period 1989-1990, in next years a slow gradual reduction was observed (fig. 2) [1].

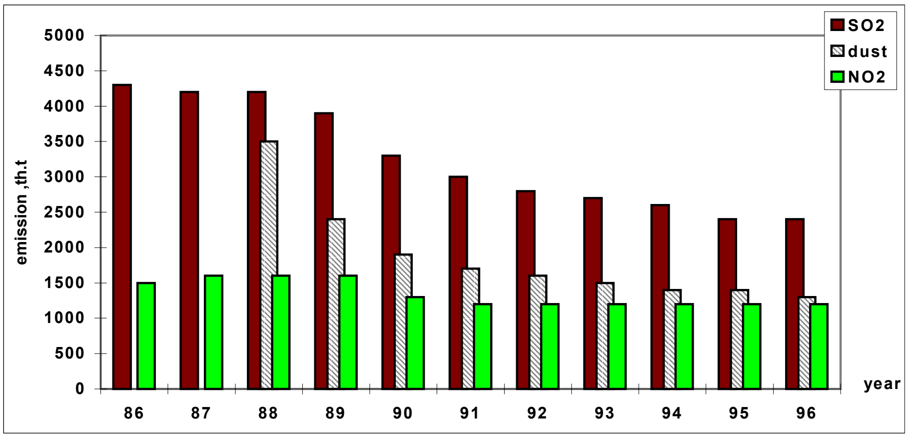


Fig. 2. Average SO_2 and NO_2 emission from 1986 to 1998 on the area of Poland [1]

The main sources of SO_2 and suspended particulates emission are located in south, south-western and central part of Poland. Economical changes and project for the restructurisation of the area of the ” black triangle” with Poland, Czech Republic and Germany share result in reduction of the number of the emission sources and its intensity in south-western Poland. In figure 3 there are presented trends of the changes in the concentration of main contaminants in air and in precipitation on the area of towns, outside towns and also the maximum and average value from 1993 to 2000.

The average yearly SO_2 concentration slightly decreased from 1993 both on the urban and on the rural areas. But on the selected industrial areas, after the reduction in 1994-1996, there began the increase in SO_2 air concentration due to economical animation in 1996-1997.

Practically nearly no reduction of NO_2 air concentration can be found, on the contrary increasing in selected towns can be observed due to the increase in transport intensity. In main part of Polish towns international and local transit transport leads through centre of the cities. Differences in NO_2 concentration between rural and urban areas of about 100% are found.

Ozone concentration is relatively high in Poland, the highest, about 30% higher in rural areas than in urban/industrial agglomeration areas. This is due to high concentration of ozone precursors typical for areas with high vehicle exhaust and VOC emission. From 1994 to 2000 average ozone concentration increased about 25%, mainly in the period 1998-1999.

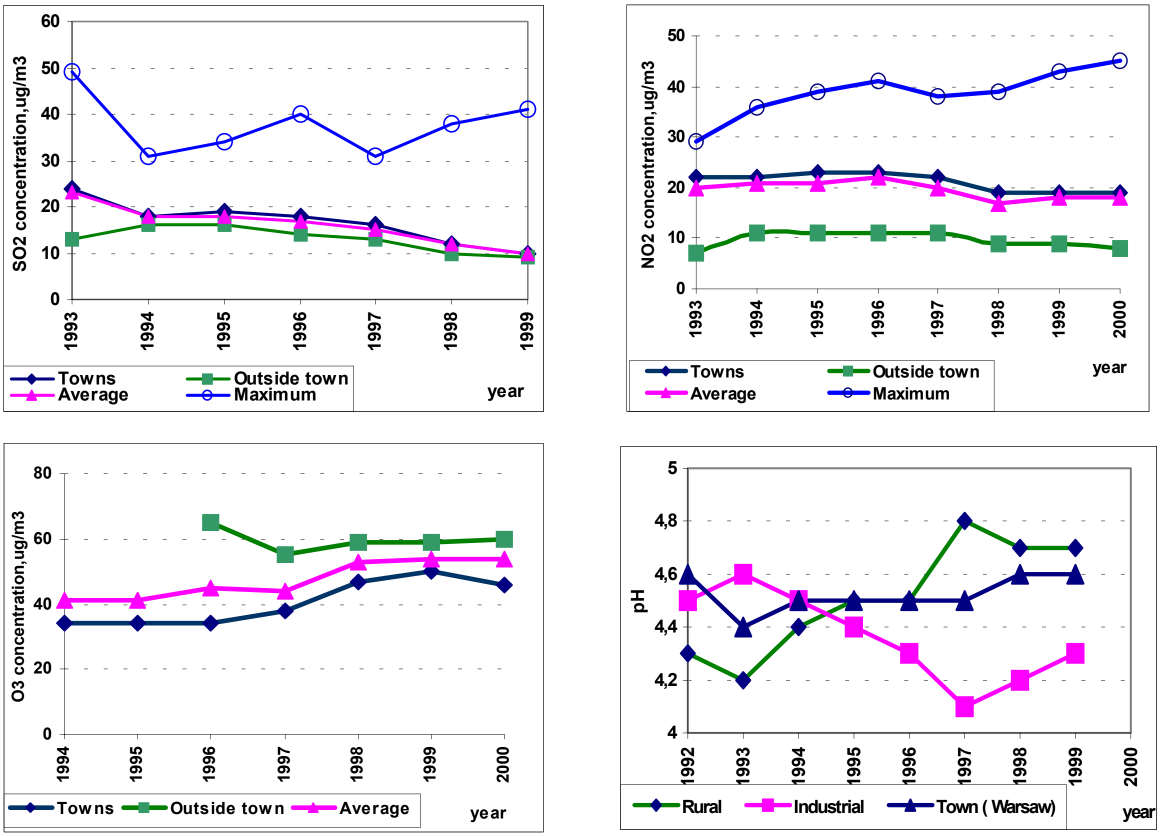


Fig. 3. Trends of the changes in the SO_2, NO_2, O_3 concentration in air and pH of precipitation on the area of towns, outside towns and also the maximum and average value from 1993 to 2000 [1]

The differences in the trend of the average pH-value (wet deposition) in rural and in industrial areas was noticed. In rural areas from 1993 an increase in the pH-value (about 0,6 unit) was found. In the industrial areas, at the same time, reduction of the pH-value was observed due to a big reduction of suspended particulates emission. In towns pH-value keeps from 1992 to on the same low level 4,5, with differences ±0,1 units.

1.3 Trends in air pollution in towns

Networks of the monitoring of air pollution exist in the bigger towns for the registration industrial and transport contaminants concentration in air.

Data in fig. 4 show the level of SO_2 and NO_2 concentration in 1997 in main towns where there are located major group of cultural heritage objects [1].

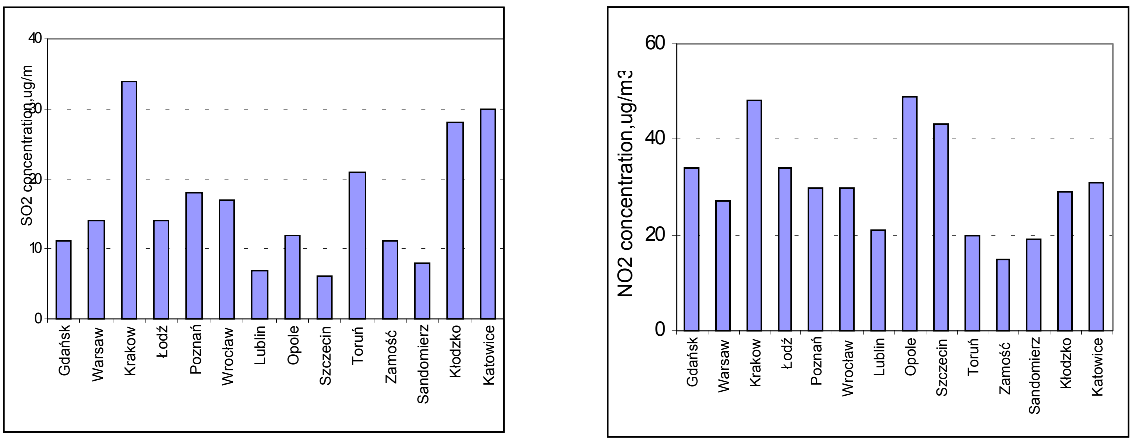


Fig. 4. Level of SO_2 and NO_2 concentration in 1997 in main towns with group of main cultural heritage objects [1]

On the examples of two towns: Warsaw and Krakow we can characterise trends of the changes in air pollution in urban areas in Poland.

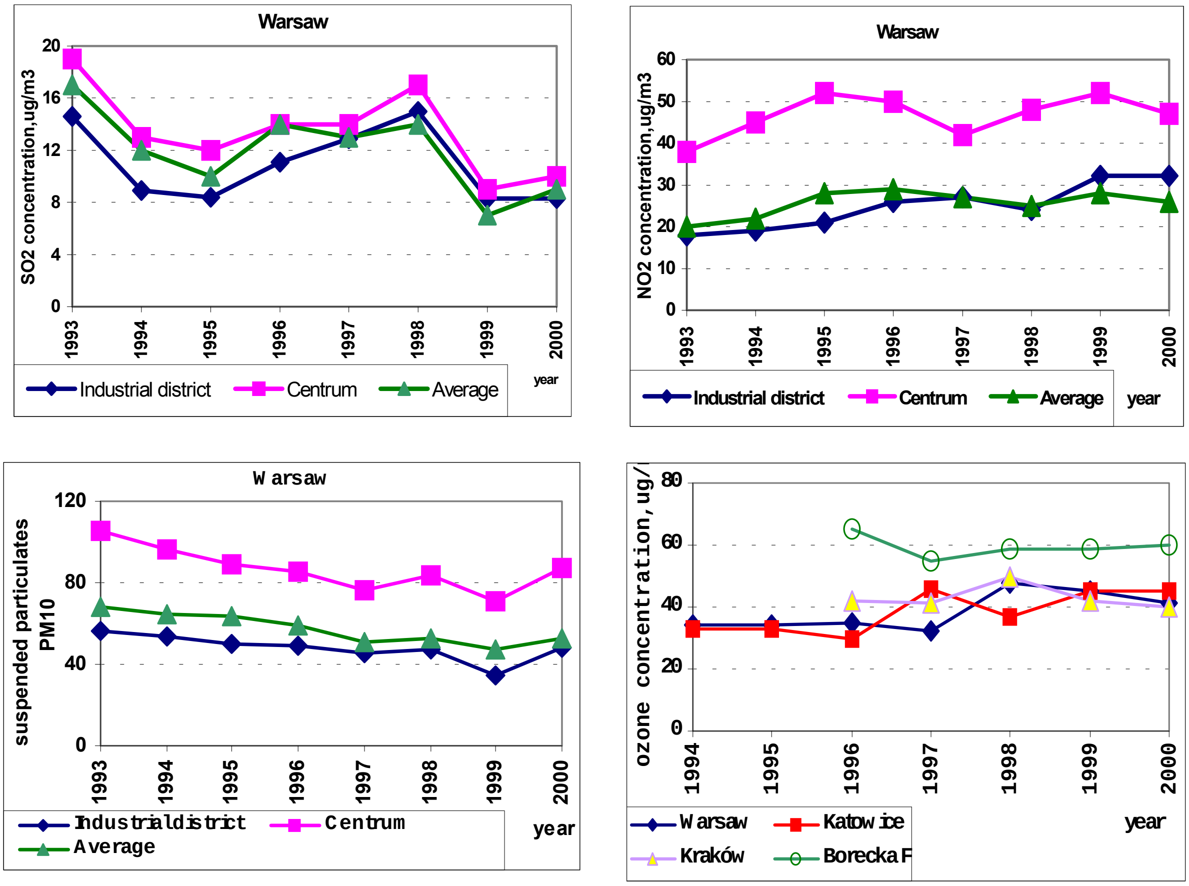
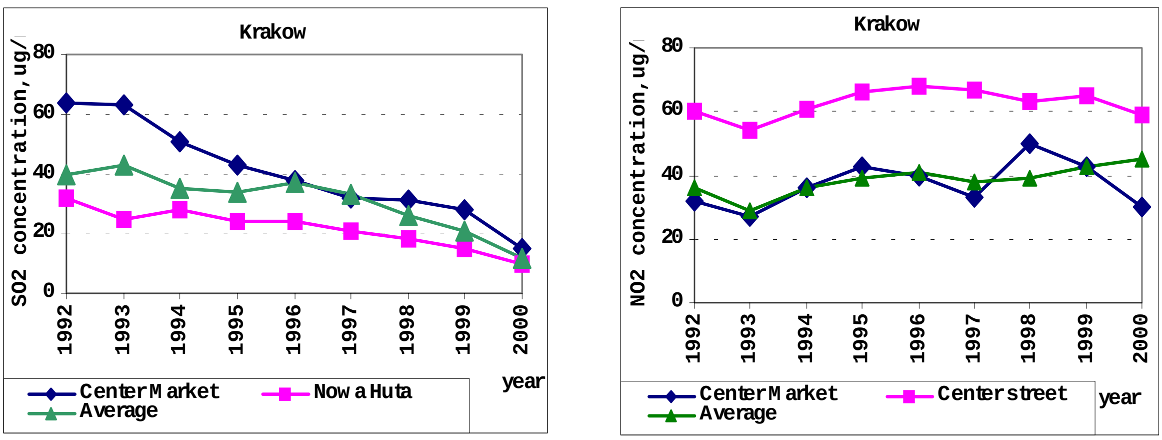


Fig. 5. Trends in air pollution from 1993 to 2000 in Warsaw [2]

In fig. 5 trends in the air pollution from 1993 to 2000 in Warsaw are presented [2]. Regarding SO_2 no general trend can be observed in any districts of the town. After the fall in 1994-1995, the increase in 1996-1998 and repeated reduction in 1999 were noticed.

In Warsaw the increase of NO_2 concentration from year to year is detected. In the central district nitrogen dioxide concentration is about twice bigger than in industrial areas and than the average value for all town. In contrast a small reduction of suspended particulates is noticed. Ozone concentration in the towns in Poland from 1997 was detected to be on stable level 40-45 $\mu g/m^3$ when on the rural areas it was about 30% higher.



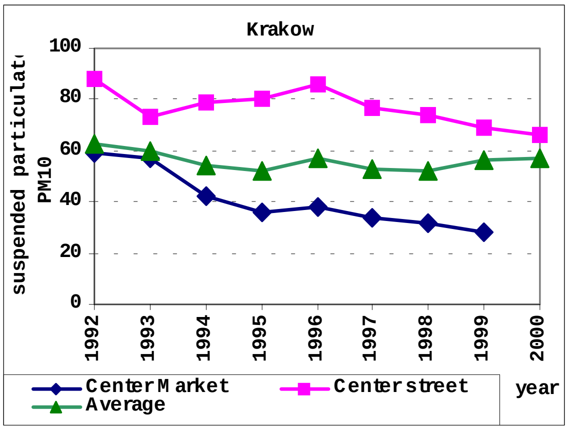


Fig. 6. Trends of the changes in air pollution from 1992 to 2000 in two Krakow district and average value for all town [3]

Krakow is an exceptional city on account of a very valuable big historical centre on the one hand and proximity of industrial plants agglomeration (mills and power plants in the town and 60 km in north-western direction) on the other hand.

In fig. 6 trends in the changes in air pollution from 1992 to 2000 in two Krakow districts and the average values for all town are presented [2].

From 1992 to 2000 average sulphur dioxide concentration falls down about four times in all town but in Centre Market even five times. Unfortunately we can not say that about nitrogen dioxide concentration, but from 1998 small diminish (about 10%) was observed. Suspended particulates PM10 concentration from 1992 have decreased continuously in centre from year to year to about of 50 % this value in 2000, but average value for all town was in 2000 on the same level as in 1993.

1.4 Corrosivity of the atmosphere

In Poland investigations of the atmosphere corrosivity have been performed systematically according to the standard ISO 9223:1992 from 1991 at 6 corrosion stations situated in several regions with different type of the atmosphere pollution range: industrial, urban, marine and rural.

Table 2. Average correlation coefficients between average annual atmospheric parameters and corrosion rates from 1993 to 1999 on corrosion sites in industrial, urban and rural atmosphere

Atmosphere	Meteorological parameters		Air pollutants			Precipitation pollutants				
	Temp	RH	SO2	NO2	O3	sum	pH	SO42-	Cl-	NO3-
Carbon steel										
Industrial	**0,57**	0,45	**0,70**	0,38	0,23	0,07	**- 0,59**	**0,72**	**0,93**	0,32
Rural	**0,56**	**0,67**	**0,83**	0,10	**0,58**	0,21	- 0,40	**0,52**	0,19	0,10
Urban	0,10	0,38	**0,76**	**0,85**	**0,63**	0,36	**- 0,70**	**0,96**	0,13	-
Zinc										
Industrial	0,31	0,10	**0,62**	0,33	**0,52**	**- 0,53**	**- 0,51**	0,27	**0,76**	0,15
Rural	**0,82**	**0,88**	**0,70**	0,24	0,42	0,06	**- 0,51**	0,37	**0,70**	0,31
Urban	**0,58**	**0,63**	**0,50**	**0,74**	0,37	**- 0,91**	**- 0,55**	**0,50**	0,28	-
Copper										
Industrial	0,30	0,29	**0,85**	- 0,35	**0,72**	- 0,48	**- 0,54**	**0,56**	0,29	0,16
Rural	**0,64**	**0,79**	0,41	0,10	**0,79**	0,10	- 0,29	0,41	0,10	0,24
Urban	**0,70**	0,43	0,39	**- 0,80**	**0,78**	- 0,39	- 0,44	**0,50**	**0,70**	-
Aluminium										
Industrial	**0,52**	0,21	**0,87**	- 0,42	**0,53**	- 0,04	**-0,76**	**0,80**	**0,64**	0,48
Rural	**0,59**	**0,93**	**0,96**	0,47	**0,92**	0,13	**-0,79**	**0,91**	**0,62**	0,35
Urban	0,10	0,20	0,46	**0,63**	**0,59**	- 0,12	**-0,65**	**0,73**	0,30	-

Results of the correlation analysis presented in table 2 show that aggressive corrosion agents in the area of Poland are: sulphur dioxide and ozone in the air, air relative humidity, temperature and acid rains. For particular metals and sites there can be distinguished especially aggressive agents like:

- for carbon steel – sulphur dioxide , ozone, temperature and acid rains,
- for zinc – humidity, sulphur dioxide, temperature and acid rains,
- for copper – ozone and temperature,
- for aluminium – ozone, sulphur dioxide, temperature and chloride ions.

The same parameters are obtained for the sites participating in the project UN/ECE ICP Materials.

Comparison of the function of the corrosion losses *versus* SO_2 or O_3 concentration on the area of Poland in the period 1993-2000 and the same data for ICP Materials sites in 1997-1998 can indicate the differences in the effect of the mentioned contaminants on corrosion losses on different areas of Europe.

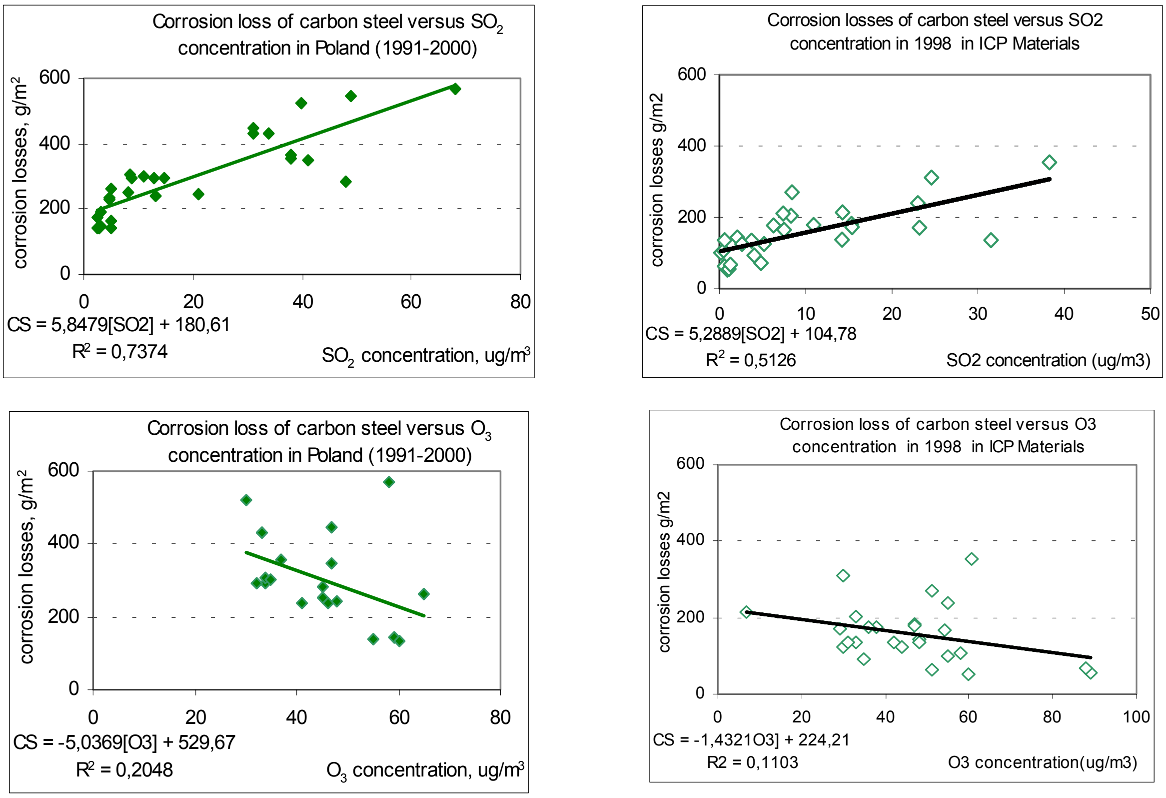
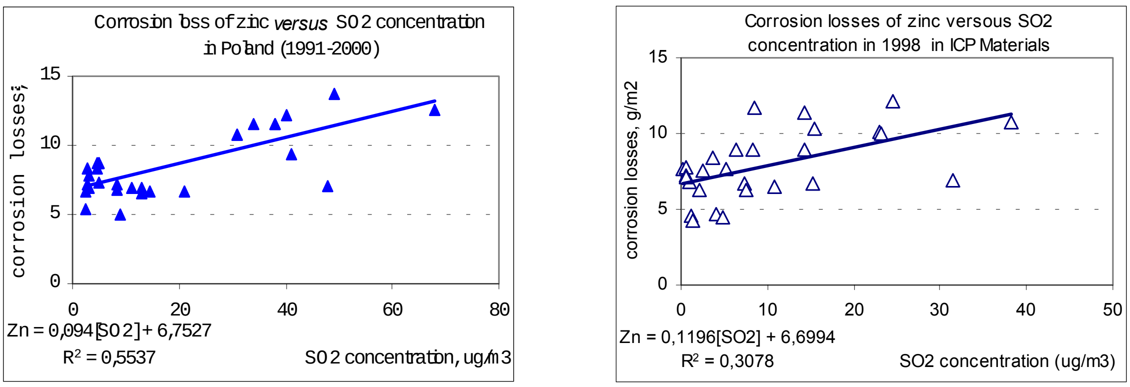


Fig. 7. Average 1-year exposure corrosion losses of carbon steel versus *SO_2 and O_3 concentration in area of Poland in period 1991-2000 (left) and ICP Materials sites in period 1997-1998 (right)*



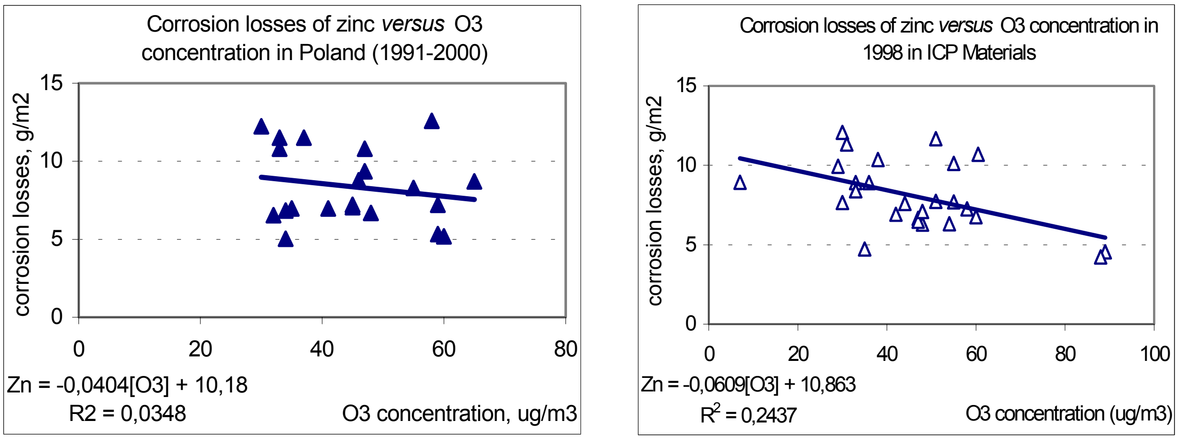


Fig. 8. Average 1-year exposure corrosion losses of zinc versus *SO_2 and O_3 concentration in area of Poland in period 1991-2000 (left) and ICP Materials sites in period 1997-1998 (right)*

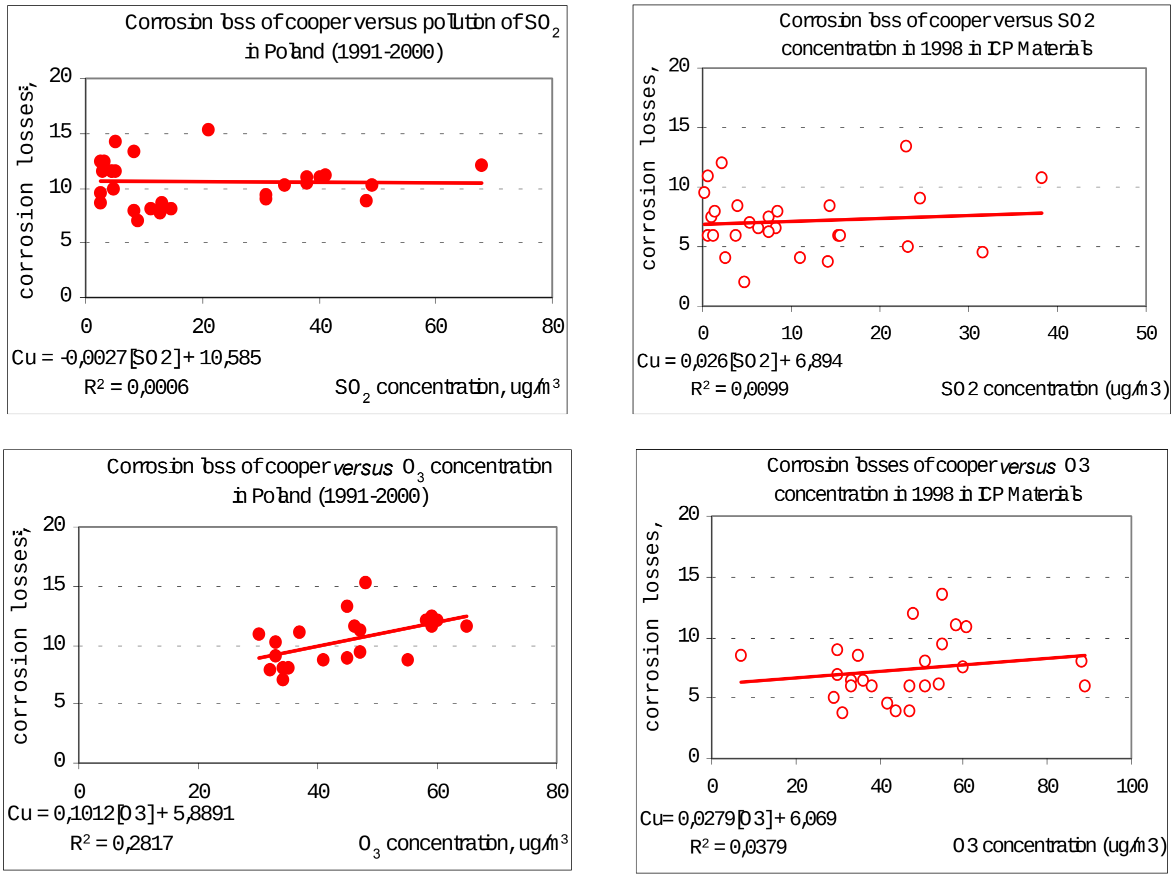


Fig. 9. Average 1-year exposure corrosion losses of copper versus *SO_2 and O_3 concentration in area of Poland in period 1991-2000 (left) and ICP Materials sites in period 1997-1998 (right)*

For three presented metals: carbon steel, zinc and copper exposed in Poland and ICP Materials sites a similar effect of SO_2 concentration on the corrosion losses is observed.

In particular we can show distinctly similarity in effect of SO_2 concentration to corrosion rates of carbon steel and zinc.

For the same concentration of ozone bigger corrosion losses of carbon steel and copper appeared on the sites in Poland than in ICP Materials Programme sites.

With regard to the presented similarity the dose-response functions from the UN/ECE ICP Materials [4] were used to compare calculated and observed corrosion losses.

Table 3. Dose-response functions from ICP Materials Programme [4]

Material	Dose-response function
Steel	$ML = 34[SO_2]^{0,33} \exp\{0,20RH + 0,059(T-10)\}t^{0,33}$
Zinc	$ML = 6,5-0,0023[SO_2][O_3] + 0,0003[SO_2]RH\ T$
Copper	$ML = 0,083[SO_2]^{0,32} [O_3]^{0,79} RH \exp\{0,083(T-10)\}t^{0,78} + 0,050\ Rain[Cl^-]t$
Aluminium	$ML = 0,0021[SO_2]^{0,23} RH \exp\{0,031(T-10)\}t^{1,2} + 0,000023\ Rain[Cl^-]t$
Bronze	$ML = 0,026[SO_2]^{0,44} RH \exp\{0,060(T-11)\}t^{0,86} + 0,029Rain[H^+]t^{0,76} + 0,00043Rain[Cl^-]t^{0,76}$
Limestone	$R = 2,7[SO_2]^{0,48} \exp\{-0,018T\}t^{0,96} + 0,019Rain[H^+]t^{0,96}$
Sandstone	$R = 2,0[SO_2]^{052}t^{0,91} + 0,028Rain[H^=]t^{0,91}$

Results of the calculations for carbon steel, zinc, copper and aluminium were presented on fig. 10.

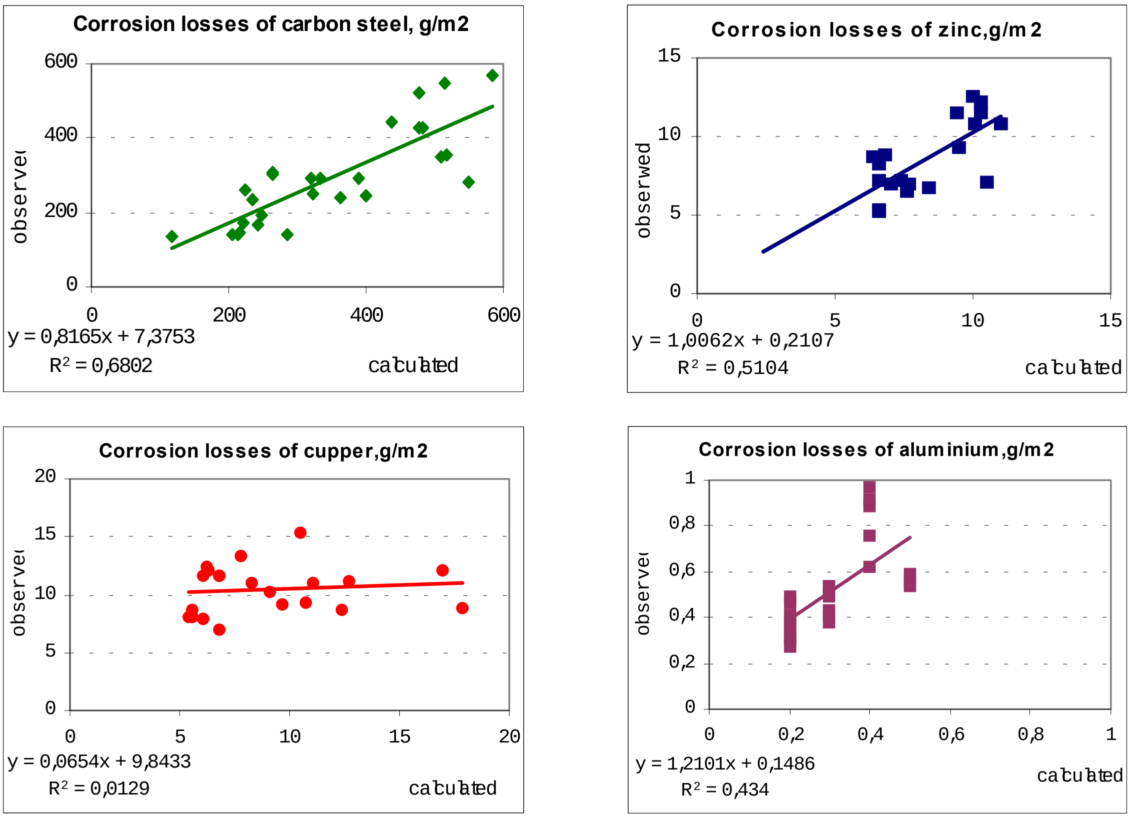


Fig. 10. Calculated from dose-response equation and observed value of corrosion losses of carbon steel, zinc, copper and aluminium

For steel calculated value of corrosion losses appeared to be about 20% bigger than the measured value after 1-year exposition on corrosion stations in Poland. For aluminium the situation was opposite, the observed corrosion losses were found about 20% bigger than calculated.

In respect to corrosion losses of zinc just the same value were obtained from dose-response function and after natural exposition.

In the case of copper, the lack of compability between the calculated and the observed data of corrosion losses was noticed. The analysis of the data for following corrosion sites in Poland shown that the biggest differences appeared for the corrosion station in rural atmosphere with a low level of SO_2 and high O_3 concentration, the smallest differences in the industrial areas with opposite proportion in the concentration of these contaminants.

In Poland environment expositions of stone materials and bronze were not carried out.

By using dose-response equations corrosion losses of stone materials and bronze for rural, urban and industrial area in Poland were calculated. From 1992 to 2000 average corrosion losses of limestone, sandstone remain on the same level depending strongly on SO_2 concentration.

On the base of ICP Materials directions the background corrosion rates value were calculated. Background corrosion rates mark natural share of corrosion processes to materials. Within ICP Materials it was decided to use the lower 10-percentile of all corrosion rates observed during the materials exposure programme. For area of Poland experimental data for period 1993-2000 for carbon steel, zinc, copper and aluminium was used. For limestone, sandstone and bronze data calculated from dose-response function was used.

In the table 4 there is presented a comparison of background corrosion rates values for ICP Materials Programme sites and the data for area of Poland in reference to two exposure periods.

Table 4. Background corrosion rates for area of Poland

Material	Background corrosion rates			
	Poland 8-year exposure (1993-2000)	Poland 4-year exposure (1997-2000)	ICP Materials 4-year exposure	Propose ICP Materials 1 year exposure (1997-1998)
Carbon steel	143,5 g/m^2	140,6 g/m^2	204 g/m^2	72 g/m^2
Zinc	5,3 g/m^2	5,2 g/m^2	17,1 g/m^2	3,3 g/m^2
Copper	8,1 g/m^2	8,7 g/m^2	14,0 g/m^2	3,0 g/m^2
Bronze*	2,8 g/m^2	3,7 g/m^2	11,6 g/m^2	2,1 g/m^2
Aluminium	0,34 g/m^2	0,30 g/m^2	0,67 g/m^2	0,09 g/m^2
Sandstone*	3,95 μm.	3,22 μm.	15,9 μm.	2,8 μm
Limestone*	3,45μm	3,72 μm	15,9 μm	3,2 μm

* calculated with use dose-response function from ICP Materials Programme

Background corrosion rates for three metals: carbon steel, zinc, copper calculated with the use of corrosion rates data for the area of Poland in period 1997-2000 there are about two times bigger than value proposed in ICP Materials Programme [4].

By using data about background corrosion rates for the area of Poland based on dose-response equations average acceptable SO_2 concentrations for different values of " n" ratio have been calculated. Three values of ratio "n": 1,5, 2 and 3 in consideration of different technical and economic facts were chosen. The results of the calculations are presented in table 5.

Table 5. Average acceptable SO_2 concentration for area of Poland

Material	Acceptable SO_2 concentration, $\mu g/m^3$				
	Poland 4-year exposure (1997-2000)			ICP Materials 1 year exposure (1997-1998)	
	n = 1,5	n = 2	n = 3	n = 1,5	n = 2
Carbon steel	2,5	6	21	5	45
Zinc	15	47	109	12	49
Copper	37	92	330	7	33
Aluminium	92	324	-	10	39
Bronze	11	23	59	5	12
Sandstone	5,4	9,4	20,6	6	14
Limestone	3,1	5,8	13,6	7	112

For each metals average acceptable SO_2 concentrations for area of Poland there are higher than for ICP Materials Programme sites.

2. PROTECTION OF THE CULTURAL HERITAGE OBJECTS

2.1 Organisation of the cultural heritage objects protection

Protection of the cultural heritage monuments in Poland is the sphere of activity of some institutions with different organisational and legal status, scope and aims of the works and financial possibilities.

There are some main groups of institutions. The national administration are represented by the Ministry of Culture and Cultural Heritage to which subjected is the Office of General Conservator of Historic Monuments as well as Offices of the Provincial Conservators of Historic Monuments.

The General Conservator of Historic Monuments proposes departure programmes of specific activities and issues and gives his opinion about individual groups of historic monuments.

The General Conservator of Historic Monuments is entitled to issue permits for conservation treatment.

The Service of Monuments Protection was engaged in organising all types of activities connected with the process of cultural heritage objects protection. It is aided by some organisations with different activity range, in particular: documentation, research, preparation of the conservation programmes, training, verification of conservators and the controlling of protection and preservation works.

Research activities connected with cultural heritage objects protection is performed by research institutes, artistic academies and architecture faculties of universities in particular: Intercollegiate Institute of Conservation and Restoration of Cultural Objects, Academy of Fine Arts in Krakow and Warsaw, M. Kopernik University in Torun, Faculties of Architecture of Technical University in Krakow and Warsaw.

The characteristic of Polish conservation with its 50 year-long tradition is a high level of university conservation education both in theoretical and practical subjects. Education in the Polish model of conservation-restoration is based on M.A. courses that combine the interdisciplinary humanities and the science with parallel artistic and technical preparation in individual specialities.

Besides education academies and institutes activities are research in historic, materials, chemical as well as law and economical subjects. They are supported by research centres which have at their disposal required equipment and competent specialists.

Realisation of conservation and renovation works is the scope of the activity of conservation firms both private and national (e.g. in museums).

Although such an extended network of institutions and big resources of knowledge there is the lack of co-ordination and co-operation, uniform programmes of activity in protection and conservation, procedures of the conservation processes regulation at all stages of activities.

Programmes of investigation concerning cultural monuments protection are dependent in most cases on financial power of the teams and their activity in the participation in international programmes e.g. 5th Framework Programme of the European Community for Research, technological development and demonstration activities.

The main part of the investigations depends on the expertises before conservation or renovation works, like: identification of materials, type of damage, specification of the techniques and materials earlier used for conservation. In the analysis of the damage there is a lack of the quantitative dependence between the destructive factors, parameters and range of the losses.

In the scope of the preservation of the cultural heritage monuments little works are done. Monitoring of the selected stone materials was carried out in Krakow and Toruń but it was limited by time and financial possibilities.

Investigations concerned with monitoring of air inside the National Museum in Krakow at present time are perform as a part of 5th Framework Programme of the European Community for Research, technological development and demonstration activities.

Despite in Poland there is dense network of the atmosphere parameters measuring stations, especially in the areas with high level of air pollution, so use for the aim of heritage objects protection was occasional. In Krakow the programme of the cultural monuments and stone materials damage monitoring was started about 15 years ago, but it was given up in 1999 on account financial problems.

2.2 Characterisation of the cultural heritage objects and conditions of their exposition

In Poland major cultural heritage objects including historic cities are conglomerated in a few big cities like Krakow, Gdańsk, Warsaw, Toruń, Wrocław, Lublin as well as in smaller country towns like Malbork, Sandomierz, Zamość. The Second World War left huge, unreparable damage, not only in national consciousness but in material heritage too.

From the mentioned towns only in Krakow, Zamość and Toruń the historic parts are remained after war in an almost untouched original form. The last of the mentioned cities have been in almost entirely destroyed.

After war historic centres of these towns were reconstructed and restored in different ways: with the use of almost the same materials (e.g. Gdańsk and Lublin), with the use of materials partly recovered from ruins of other towns (e.g. Warsaw, Wrocław) or using modern materials (Warsaw, Elbląg, Gdańsk).

Krakow is biggest historic gothic-renaissance city in Poland with great historic and cultural importance for Polish people. It was for 470 years (from 1139 to 1609) the capital city of Poland and it was " golden age" of cultural, academic and politic progress.

After the Second World War Krakow was endangered with destruction due to activity of great industrial objects located in the area – two mills (iron and aluminium) which had been build as a form of political restrictions directed against community of the town, unfavourable to Government.

The liquidation in the end of 1980-ies of the aluminium mill and a restructurisation of the iron mill closed the period of biggest devastation. The restoration in last 10 years was carried out in part with the use of the national capital and owing to external capital (American Express Foundation, Project TEMPUS). Now the greatest menace for cultural heritage objects located in towns are: increasing road transport intensity, traffic transport air pollution, ozone precursors and particulates emission as well as the vibrations.

The objects located in the country in the area with rural atmosphere are in better situation due to small atmosphere pollution but it often depends on their owners. High class monuments are in keeping of national or provincial conservators' offices. Many objects have private owners which take care of the maintenance, restoration, renovation and proper conditions of the use their under specialised surveillance of the conservators. But there is a group of smaller class objects, used by different institutions e.g. schools, factories devoid of conservators' care due to lack of finance.

In this situation there are small wooden churches located all over the area of Poland which are a part of European cultural heritage. There are in danger of microbiological destruction and fire.

On the International Conference on Fire Protection of Cultural Heritage in 2000 in Thessaloniki it was proposed to set up an international coalition for the protection of wooden architecture in Central Europe with participation of the Czech Republic and Hungary and with consultation of Norwegian specialist [5].

Most of indoors cultural heritage monuments are subjected to damage due to lack of equipment secured requiring conditions. It concern objects exhibited for example in church, some museums also libraries and historical buildings used by different institutions.

2.3 Characterisation of the structural materials and scope of investigations of cultural monuments.

Over the centuries the following main structural materials were used in Poland: bare brickwork, rendered brickwork, stones and wood.

Bare brickwork with connection of stones were used in Poland first of all in Middle ages to XVI century. The biggest city centres built with use of brickwork are located in Northern Poland e.g. Gdańsk, Toruń, Malbork and in the medieval part of Krakow. Bare brickwork were applied in Poland in industrial architecture at the beginning of XIX century; each typical example can be found in Łódź, greatest textile industry centre in Poland.

Rendered brickwork was used in Poland from Renaissance, in particular in Baroque till half of XIX century, but now the original render can not be found. Historic objects are located all over the area of Poland: historic centres of renaissance towns Zamość, Sandomierz, Lublin and baroque buildings e.g. in Warsaw, Poznań, Krakow as well as big number of palaces and churches in the whole area of Poland.

An interesting example of rendered brickwork architecture is Old Town in Warsaw reconstructed after the Second World War with the use of traditional technology and materials (brickwork and lime render). After 50 years of exposition in polluted urban atmosphere (thoroughly researched and documented) it make a good research material for investigation and evaluation of the maintenance methods and forecasting the durability of used materials.

Stone architecture is abundantly represented in Poland, but main structural materials were local stones: limestone and sandstone, not resistant to industrial atmosphere except the kinds containing silica. There is big amount of data concerning the stock of stone materials at risk but they arise from different sources, for different objects and were investigated with the use various physical and chemical methods. Most accurate data can be found for cultural monuments in Krakow due to the installed in the beginning of 1990-ies municipal atmosphere monitoring system, an extensive programme of the cultural monuments renovation and investigations carried out by academic institutions with the use of present-day methods and instruments.

Some of these studies concern the relationship between the level of air pollution and the stock of materials lost but greater part concern identification of degradation products and methods of the renovation and preservation of the objects

Wood was used on the area of all Poland in various types of architecture. Particularly important part of these objects is formed by wooden churches dating from XV to XX century which represent a unique architecture heritage. Noteworthy are polychromed wooden objects, which are a unique expression of cultural values and the document of the development of the art of decoration [6].

A large number of old wooden churches are abandoned, neglected, dismantled, demolished and sometimes even deliberately destroyed due to lack of uniform protection policy [6].

Investigations of the metal degradation in polluted environment are carried out in Poland in several fields: degradation of the structural metals and protection organic and non-organic layers in natural conditions as well as corrosion of silver and properties of the protection layers in natural outdoor and laboratory conditions.

Investigations concerning the effects of the metal exposition indoors are connected with degradation of the natural metal pigments, gold and silver, in various type of the paintings.

To the metal and glass degradation processes include problems of stained glass corrosion and protection because they refer not only to glass but to a number of metals used in construction and composition e.g. tin, lead and steel.

In the years 1993-1997 there were carried out investigations of the effects of environmental conditions on degradation of the medieval stained glass windows of St. Mary's Church in Krakow. The scope of the tests concerns: the designation of the glass and painting layers composition, grade of its destruction, parameters effecting degradation (humidity and temperature) and methods of conservation and protection [7].

3. CONCLUSIONS

1. Routine measurements of main air and precipitation pollutants carried out on area of Poland can form the base used to create a system of assessment of degradation of different kinds of materials and evaluation of the risk map of the cultural heritage objects.
2. It is necessary to verify dose-response function for the stone materials from ICP Materials Programme for the area of Poland by their exposition on selected sites with architecture monuments exposed to high polluted atmosphere.
3. Despite the extended network of institutions and big resources of knowledge existing in Poland there is a lack of co-ordination and co-operation, uniform programmes of activity in protection and conservation, procedures of the conservation processes regulation at all stages of activities.
4. There is a lack of the quantitative dependence between the destructive factors, parameters and range of the losses in the analysis of the damage. In the scope of the preservation of the cultural heritage monuments little works is are done. Monitoring of the selected stone materials was carried out but it was limited by time and financial possibilities.
5. In Poland necessity of merging the data on the location culture monuments with that on all degradation factors (atmospheric pollutants, physical stress, tourism intensity and anthropic danger) effects on their degradation, in order to create the Risk Map is acknowledged by all institutions responsible for protection of cultural heritage object. Completion of this programme is hardly possible due to lack of the financial resources.
6. Polish research institutions can join international programmes in following scopes of investigations:
   - exposition of the samples on the area of Poland on the sites with monitoring atmosphere conditions,
   - investigation of the degradation of the following materials and objects: architecture (stones, brickwork, render), wood and wooden sculpture, mural and easel paintings, paper and tissue.

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