COMPARATIVE VULNERABILITY ASSESSMENT

Based on National Vulnerabiliy Assessments

Version 1
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A. Introduction

Air pollution is one of the particular challenges that human civilization is currently facing and probably it will remain a major concern for the future generations. The changes in the concentration of air pollutants over the past decades are well-documented in the literature for outdoor locations over almost the entire world due to the existing regulations, while less information is available on the indoor microenvironments. However, the relevance of indoor air quality is high and cannot be overlooked since people usually spend about 80-90% of their time indoors. The climatic conditions, the ambient concentration of air pollutants, the protective functions of the building envelope as well as the sources and sinks of indoor air pollutants all have an influence on the indoor air quality. The complexity of this environmental issue poses the question of how a healthy indoor environment can be achieved and maintained. It is a crucial question in the case of primary school buildings since children between the ages of 6 and 14 are one of the most vulnerable populations. Future generations will be responsible to take over several global environmental problems, thus they deserve the best possible indoor environment during their education.

The InAirQ project is dedicated, among others, to assess the indoor air quality in primary school buildings and to take actions to ensure children`s health and well-being at school in Central Europe. In this light, national vulnerability assessments were prepared to review the quantitative and qualitative aspects of the primary school domain in the participating countries (Czech Republic, Hungary, Italy, Poland and Slovenia), the existing policies, i.e. officially adopted documents on indoor environment, as well as the previous experiences in the health risk assessment of the school environment. All project partners prepared a substantial vulnerability assessment worth reading one by one. Their main findings are summarized and compared in this report.

B. Facts and figures

B.1. Number of primary schools

Due to the different sizes of the countries and their participating regions it is not possible to compare the given numbers directly. However, it can be seen that, in spite of the fact that Czech Republic and Hungary have similar population size (10.5 and 9.8 million inhabitants respectively), there are considerable differences in the number of primary school buildings; approximately 1.8 times more primary school buildings are located in the Czech Republic compared to Hungary. Accordingly, the Czech pupils are more dispersed among more primary school buildings than the Hungarians. Limited data is available about the number of the classrooms. The average class size is similar in the Czech Republic than in Hungary with 19.5 and 20 pupils in each classroom on average respectively. It is interesting to note that although in Poland the law maximizes class size at 25 pupils, still 7% of classes accommodate even more than 30 children. The maximum class size is 25 pupils in Italy as well. In Slovenia, there are 16 (minimum) - 28 (maximum) pupils in classes (if there is a kid with special needs, the maximum number is reduced).

B.2. 2.Types of school buildings

In general, it is difficult to compare the average age of the school building stock in the different countries because construction year statistics cover different ranges of years determined by the differences in the countries' history or for other reasons. The highest proportion of old school buildings (built before 1900) can be found in the Czech Republic (22%). Brick was the main material used in the case of old buildings. Concrete was mainly used as building material between 1970 and 1990. Approximately 40% of the school buildings in the Municipality of Ljubljana (Slovenia) were built in the latter period, while in other countries this proportion was only about 21-28%. New constructions built after 1990 range from 1.2% (Lodz; Poland) to 8% (Hungary). It is clear that the school building activity was more active at beginning and the middle of the 20th century compared to the past two decades in all countries.

Most of the primary schools are run by the state either directly or indirectly by the district authorities. Hungary has the lowest proportion in this respect (81%), while 94% of the primary schools in the Czech Republic are maintained by the state.

B.3. State of the school buildings

In most countries the state of the school buildings varies considerably. In general, non-public school buildings are in a better condition than public schools. Renovation works (windows, insulation, heating, light, etc.) started after 2000 in the Czech Republic and Hungary, while they started 5 or 3 years ago in Poland and Italy, respectively. Partial

renovation was performed in almost all primary schools included in the present survey in Slovenia. In some countries asbestos may also cause some concern as between 1950 and 1990 asbestos was frequently used in the Czech Republic, Italy and Hungary. In Lodz only 1 school is affected by the asbestos problem.

B.4. Legal measures related to the management

There are no health-based indoor air quality standards or guidelines for chemical pollutants which are applicable to primary schools in most of the Central European countries. Only in the Czech Republic has legislation (since 2003) defining hygienic limit values of chemical, physical and biological indicators of residential rooms, which was accompanied by decrees on the requirements for educational establishments. National policies exist on some parameters related to indoor air quality (e.g. temperature, relative humidity, CO_2 concentration, formaldehyde emissions and ventilation) in the other Central European countries. Besides the international bodies, there is a big effort to establish indoor air quality guidelines at the national level in all Central European countries.

B.5. Monitoring of indoor environment

There are no special guidelines or rules on monitoring indoor air quality in schools in either of the partner countries.

B.6. Results of the indoor air quality field campaigns

Since 1994 in the Czech Republic 280 flats, 20 kindergartens, 25 nursery schools and 200 classrooms of 39 elementary schools have been monitored in the frame of the Environmental Health Monitoring System.

The Czech Republic, Hungary, Italy and Poland participated in the SINPHONIE project between 2011 and 2013. The concentration of $PM_{2.5}$ mass, NO_2, formaldehyde, benzene, naphthalene, limonene, radon, CO_2, trichloroethylene and tetrachloroethylene were measured in classrooms and outdoors simultaneously. Physical parameters (temperature and relative humidity) as well as biological agents were also investigated. Hungary and Italy also participated in the SEARCH project between 2006 and 2013. The investigated parameters were the temperature, relative humidity and the concentration of PM_{10} mass, NO2, formaldehyde, benzene, xylenes, toluene, CO and CO_2. Italian schools were also monitored in some other international studies (INDOOR, HESE, INDEX and EXPAH) including the determination of the concentration of PM_{10} mass, NO_2, formaldehyde, toluene, ethylbenzene, benzene and xylenes. There has not been a field campaign for monitoring indoor air quality in school buildings in Slovenia yet.

The comparison of the indoor air quality results obtained in the frame of international project (SEARCH, SINPHONIE) revealed that, in general, the measured values were in line with other European countries for all investigated parameters, except for formaldehyde,

being much higher in Italy. The mass concentration of PM_{10} and $PM_{2.5}$ was high in most of the countries and the microclimatic conditions were also inappropriate (e.g., insufficient air exchange rate, inappropriate temperature and relative humidity in the classrooms). In Lublin (Poland) the measured radon values also exceeded the recommended (WHO) levels in schools and especially in kindergartens.

B.7. Monthly ambient air quality data for 12 months

All five countries have an air quality monitoring network consisting of several stations across each country. Air quality is regularly monitored for most health-relevant pollutants such as NO_2, PM_{10}, $PM_{2.5}$, As, Cd, Ni, Pb, benzene and benzo(a)pirene in the Czech Republic; SO_2, NO_2, CO, O_3, NO_X, PM_{10}, and $PM_{2.5}$ in Hungary and Poland; PM_{10}, $PM_{2.5}$, NO_2, O_3, benzene in Italy; PM_{10}, NO_2, SO_2, CO, O_3, benzene, toluene, ethylbenzene and xylenes in Slovenia.

In all countries, the PM10 mass concentration values often exceeded the 24-h limit value in winter. In several areas the PM10 mass concentration and NO2 concentration were higher than the corresponding limit values also in other seasons due to the higher traffic density, geographical location and the unfavourable meteorological conditions. This situation was especially problematic in Turin (Piedmont, Italy) where 5 out of the measured 12 pollutants exceeded the corresponding limit values in 2015 throughout the regional territory, mainly due to high traffic intensity and the geographical location of Turin, as the city is situated in a valley protected from winds.

C. Conclusions

In the participating countries children spend 7 to 9 hours in primary school buildings where healthy indoor air is not yet guaranteed by law. With the exception of the Czech Republic there is no appropriate legal regulation on the indoor air quality in schools and there are no guidelines or rules on monitoring indoor air quality in these microenvironments. There is an urgent need to perform studies on indoor air pollutants in a school environment and to trigger establishing indoor air quality guidelines/regulations at the national and EU level.

Annex 1. Brief summary of the main findings of the national vulnerability assessments

	Czech Republic	Hungary	Italy (Piedmont)	Poland (Lodz)	Slovenia (Ljubljana)
Population	10.5 million	9.8 million	60.7 million (4.6 million)	38.5 million (2.5 million)	2.1 million (289,000)
Number of primary school buildings and pupils	4,658 primary schools; 6,500 school buildings; 42,300 classrooms; 827,000 pupils; average class size: 19.5	2,300 primary schools; 3,600 school buildings; 36,500 classrooms; 748,000 pupils; average class size: 20.2	16,995 primary schools; 2,799,553 pupils; (in the Piedmont Region: 1,364 primary schools; 11,399 pupils)	13,563 school buildings; 2,481,800 pupils; (in the region of Lodz: 845 schools; 151,776 pupils) By law: max. 25 pupils/class (in 7% of classes >30 pupils)	452 primary schools (375 schools are included in Slovenian Network of Health Promoting Schools); (in the health region of Ljubljana 116 schools; 50 schools in municipality of Ljubljana, which were included in the present survey) 170,067 pupils in Slovenia 22,469 pupils in municipality of Ljubljana.

	Czech Republic	Hungary	Italy (Piedmont)	Poland (Lodz)	Slovenia (Ljubljana)
Types of school buildings	94% of schools maintained by the state Construction year: <1900: 22% 1900-1945: 32% 1946-1970: 18% 1971-1990: 21% 1991-2000: 5% 2001-2014: 2% Mostly low level buildings and mostly brick buildings	81% of schools maintained by the state (directly or indirectly) Construction year: <1900: 12% 1900-1950: 27% 1951-1970: 27% 1971-1990: 26% 1991-2002: 6% >2002: 2% 2- or 3-storey buildings with regular or U shape	Construction year: <1900: 6.5% 1900-1940: 14.8% 1941-1974: 43.7% 1975-1990: 27.9% 1991-2012: 7.1% 87.4% of schools were originally built as school, Only 10.14% was built according to seismic criteria	89.8% of the primary schools are run by the district authorities Construction year (for 83 public schools in Lodz): 1900-1945: 12.0% 1946-1979: 78.4% 1980-1989: 8.4% From 1990: 1.2% 61.4% brick building, 62.6% 2-storey, 26.5% 3 or more storied buildings, 38.5% with regular shape, 32.5% with L-shape and 12% with U shape	Construction year: 1889-1913: 16% 1913-1950: 2% 1951-1960: 16% 1961-1970: 20% 1971-1980: 34% 1981-1990: 8% 1991-2000: 2% 2000-2017: 2% Older buildings (26%) were built from bricks, the new ones from reinforced concrete
State of the school buildings	The state of primary school buildings varies considerably. Renovation works (windows, insulation,	Renovation works (windows, insulation, heating, light, etc.) started after 2000 Church and foundation	Big national re-construction programs in the last 3 years (asbestos and barrier removal, works of seismic and energy	The state of primary school buildings in Poland does not vary considerably. In the last 5 years	Partial renovation (roof – 78%; windows replaced – 70%; plumbing and/or electrical installations – 40%; thermal

	Czech Republic	Hungary	Italy (Piedmont)	Poland (Lodz)	Slovenia (Ljubljana)
	heating, light, etc.) started after 2000. Between 1950 and 1990 asbestos was frequently used. Forced ventilation has been started to be installed due to pressure by commercial entities.	schools are in a better condition. Natural ventilation is applied only.	adapting)	renovation works started including replacement of windows and/or insulation, modernization of heating, lighting and sanitary installations (31.7%). In general, non-public school buildings are in a better condition than public schools. Only 27.7% are in a low traffic area, 40% in medium and 33% in high traffic density area. Asbestos only in 1 school.	insulation – 36%) was performed in almost all of the 50 school buildings included in the survey.
Legal measures related to the management	Act 258/2000 – General requirements Decree 6/2003 - defined hygienic limits of chemical, physical and biological indicators for indoor environment of	No regulation of indoor air quality in schools, except for some parameters (e.g., temperature, concentration of CO_2) which are regulated by national policy	Since 1975: 1.8m^2/child in the classroom, max. 25 children/classroom; temperature and relative humidity are also regulated but only for winter	There are no legal regulations on the indoor air quality (except temperature and relative humidity, and reference values for harmful biological agents).	There is a lack of laws for designing school buildings in Slovenia. Guidelines for building a primary school were issued in 2007.

	Czech Republic	Hungary	Italy (Piedmont)	Poland (Lodz)	Slovenia (Ljubljana)
	residential rooms Decree 343/2009 (amending Decree 410/2005) – requirements for educational establishments		No regulation on chemicals at country level, except formaldehyde since 1983 (0.123 mg/m^3), otherwise since 2010 WHO indoor air guidelines are referred to		
Monitoring of indoor environment	No regular IAQ monitoring Windows are frequently closed even during breaks – due to energy saving or safety reasons. 26% of schools report outdoor air pollution in the neighbourhood due to traffic, heating or industry.	No regular IAQ monitoring	There are no enforcement authorities at national level responsible of monitoring air quality in schools, there are no standards to be met at regulatory level and there is no obligation to conduct monitoring campaigns.	No regular IAQ monitoring	There are no special guidelines or rules on monitoring indoor air quality in schools.
National and international field campaigns	SINPHONIE In the frame of the Environmental Health Monitoring System, since 1994 280 flats, 20 kindergartens, 25	SEARCH SINPHONIE	SEARCH INDOOR SINPHONIE HESE	SINPHONIE	Field campaigns have not been carried out yet.

	Czech Republic	Hungary	Italy (Piedmont)	Poland (Lodz)	Slovenia (Ljubljana)
	nursery schools and 39 elementary schools with about 200 classrooms have been monitored.		INDEX EXPAH		
Monthly ambient air quality data for 12 months	Air quality in the different types of locations is evaluated for the most health-relevant pollutants such as NO_2, PM_{10}, $PM_{2.5}$, As, Cd, Ni, Pb, benzene and BaP. NIPH runs the Oracle database, where the data are being processed and every year an annual report is worked out, which includes both basic evaluation and interpretation of the measured values and evaluation of health risks from outdoor air. This assessment of health risks from outdoor air is also included in the report	The annual mean values measured in 2016 in Hungary were below the limit values set by the EC Due to higher traffic density, PM_{10} and NO_2 concentrations were higher in the capital city than in other cities and towns of the country. In winter, PM_{10} values often exceeded the 24-h limit value	Environmental data, collected in the last decade by measuring stations operating in the Piedmont Region and managed by ARPA Piemonte (Regional Agency for the Protection of Environment, which is responsible for the official environmental monitoring in the whole regional territory), show an overall trend towards improvements in air quality.	According to the Voivodship Inspectorate of Environmental Protection in Lodz, within monitoring system of air quality currently automatic (10), manual (21) and passive measurements of SO_2, NO_2, CO, O_3, NO_X, PM_{10}, and $PM_{2.5}$ are taken. Both NO_2 as well as NO_X present in the atmospheric air in the city of Lodz are in higher concentrations than in the rest of the region. It is caused by high intensity of traffic. During the winter period, the levels of	The values of ambient air quality data in Ljubljana (PM_{10}, NO_2, SO_2, CO, O_3, benzene, toluene, etilbenzen, xylens) were collected at the measuring site Ljubljana Bežigrad. PM_{10} data was collected also at the measuring site at Biotechnical faculty in Ljubljana. The main findings showed that exceeded daily PM_{10} limit values are exclusively reported in the cold part of the year.

	Czech Republic	Hungary	Italy (Piedmont)	Poland (Lodz)	Slovenia (Ljubljana)
	for the Czech Government.			almost all measured agents often exceeded the 24-h limit values. The annual mean values for $PM_{2.5}$ measured in 2016 in Lodz exceeded the year limit value set by the EC.	