Journal of Environmental Protection and Ecology 4, No 1, 234–247 (2003)

Environmental education

PEDESTRIAN WAY DESIGN FOR THE ROAD SAFETY OF SCHOOL STUDENTS

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Abstract. The years of school enrollment represent a crucial period of a person's life. The schooling experience forms the foundations of human evolution. The school day represents 30% of each school child's everyday activity experienced. Additionally, another important dimension that should be taken into account is that of time – space – school access safety. The pluralistic essence of the educational process is described as the sum total of actions exercised by various factors (family, school, state, the church, profession, society, etc.) aiming at the appropriate mental, physical and moral development as well as the culture and shaping of a country's citizens. The objective is to equip these persons in their effort for a harmonious adaptation to their physical, social and cultural environment. A relation between students and the environment is created, to be examined at three levels: student – school spaces, student – access means – safety and student – road traffic education and environment. The application of a Geographical System of Information (GIS) contributes to the qualitative improvement of the study, offers the potential for data updating and control over time, assists decision-making processes. In the areas where problems appear, political decisions and the related increased fund allocations result in the implementation of the necessary projects and activities aiming at upgrading the student – environment relationship. The supply of a pleasant and safe environment for walking is a necessary condition in order for the city to be friendly toward its student population and persons with special needs (the disadvantaged).

Keywords: student – school graund areas, student – acces-safety, surface of influence of school group, student – traffic education and environment, Network of pedestrian ways – decision-making with GIS.

AIMS AND BACKGROUND

The transfer of competences to the Local Authority Organisations (LAOs) in the fields of maintenance, repairs and management of school building complexes, allocates responsibility and underlines the role of the LAO as the agency directly

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responsible for the "**student – environment**" relationship. A corresponding transfer of data and information on the qualitative and quantitative figures for each school has not accompanied such transfer of competences to the Serres LAO. Responsibility for this transfer has simply been conveyed and vested in the City's Department of City Planning and Land Registry, where the authors of the present article are employed.

In the "City Planning Standards"[1] published by the Ministry of the Environment, Physical Planning and Public Works in 1983 within the framework of the City Planning Restructuring Enterprise, reference is made to the service radius (800 m maximum) as a **key criterion** for the spatial location of elementary schools. The minimum viable unit is considered to be a 6-teacher elementary school with an enrollment of 180 students, while the maximum size of a schooling unit is a 12-teacher school with an enrollment of 360 students (Table 1).

A differentiation as regards service radius (500 m) and the relationship available school surface area/student (17-20 m^2) is proposed in Ref. 2.

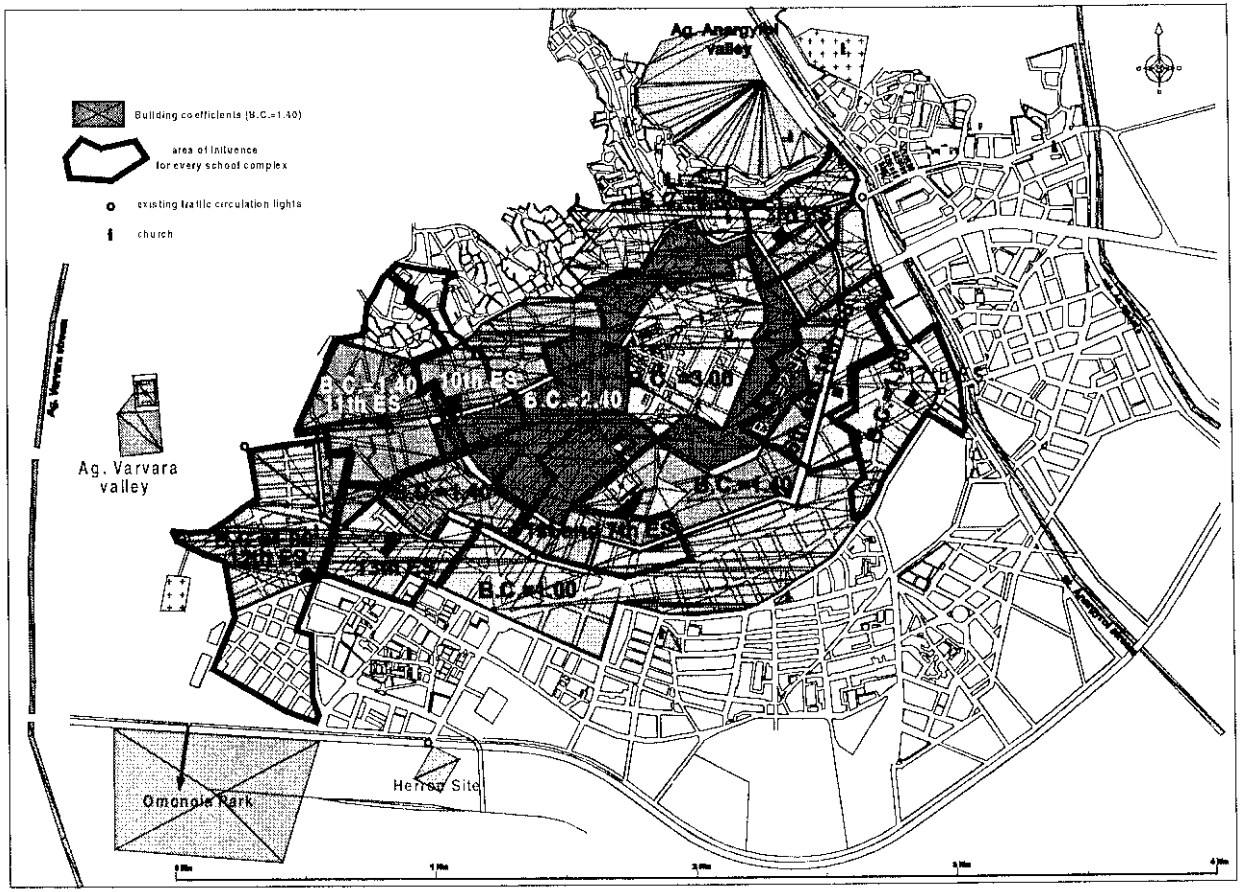
The present study encompasses 8 school building complexes, out of a total of 17 operating in the city of Serres. Their selection was conducted so that at least some them are located on main urban road axes.

EXPERIMENTAL

Each school complex has in its files a document showing a list of streets where students must have their permanent residence in order to be eligible for enrollment in the particular school. Using this street name list we created spatial data and proceeded to the production of a thematic map showing the area of influence for every school complex under study (Map 1).

Based on teaching staff (Table 2), we proceeded to:

- recording of the historical development of school complexes (building construction, additions, repairs);
- classification of the uses of classrooms, auxiliary spaces, athletic installations;
- location of fire safety means;
- localisation of dangerous pedestrian street crossing points around the school complexes during student arrival and departure;
- descriptive definition of routes that school students follow in school excursions;
- reporting on means and methods of traffic related student safety.



Map 1. City of Serres

Table 1. Standards for spatial location of elementary schools

Education ages	% of age groups in total population	% of age group participation	% of users in total population	Students/ classroom or section (maximum)	Service radius (maximum)	Units				Population
						viable (V) usual (U) optimum (O) maximum(M)	size (students)	usable surface (m^2/student)	school grounds (m^2/student)	
Kindergarten 4-5 years old	2.5	80	2	20-30	400	V	20-30	6-9	25-40	800-1200
						M, O	40-60	4-6	15-24	1600-2400
Elementary school	6-11 10	100	10	30	800	V, U	30-90	5-8	13-21	300
						O	180	4.5-7	9-15	1800
						M	360	4-6	7-11	3600

Table 2. School groups

Elementary schools (ES)	1st and 7th	3rd ES	6th and 16th ES	10th ES
Year of construction	1928 and 1982	1996	1914	1967 and 1975
Plot surface area	4545.72	1990.91	1371.06	3532.87
BC	0.00	0.80	1.00	1.40
Built coverage allowed	0.00	1592.73	1371.06	4946.02
Classroom surface area per floor	758.56	509.50	277.65	845.38
Total classroom surface area	1517.12	1528.50	555.30	1690.76
Kindergarten	157.71	***	***	176.28
Chapel	***	60.00	***	
Canteen	26.42	***	11.96	***
Storage space	28.15	5.52	***	***
Toilets (WC)	29.90	5.24	22.86	67.36
Semi-covered area	***	19.59	14.67	55.39
School yard surface area	3544.98	1391.06	1043.92	2388.46
Classroom uses	teaching lectures	teaching lectures, chemistry, music, projections, P/C	teaching lectures, art, music	teaching lectures
School yard uses	20th kindergarten, canteen, toilets	toilets	toilets	28th kindergarten, canteen, toilets
Fire fighting equipment	fire extinguishers	fire extinguishers	ceiling and boiler sprinklers, 5 fire extinguishers	15 fire extinguishers
Sport installations	basketball, volleyball	basketball, volleyball	basketball, volleyball	basketball, volleyball, gymnasium
Excursion routes	Heroon site, Omonoia park	Ag. Anargyroi valley, Omonoia park	Ag. Anargyroi valley, Omonoia park	Ag. Varvara valley, Omonoia park
Comments	***	***	***	***

Elementary schools (ES)	11th ES	12th ES	13th ES	17th ES
1	2	3	4	5
Year of construction	1904	1928	1970	1964
Plot surface area	2996.60	2695.63	3669.03	2513.22
BC	1.40	1.00	1.00	1.00
Built coverage allowed	4195.24	2695.63	3669.03	2513.22

to be continued

Continuation of Table 2

1	2	3	4	5
Classroom surface area per floor	496.89	468.33	734.67	817.75
Total classroom surface area	993.78	936.66	1110.14	1270.18
Kindergarten	***	***	***	***
Chapel	***	***	***	***
Canteen	***	***	***	***
Storage space	57.07	43.12	***	***
Toilets (WC)	25.12	26.53	***	***
Semi-covered area	***	5.07	17.72	6.20
School yard surface area	2417.52	2152.58	2916.64	1689.27
Classroom uses	teaching lectures, projections	***	***	teaching lectures, library
School yard uses	toilets, storage space	toilets, storage space	***	***
Fire fighting equipment	6 fire extinguishers	6 fire extinguishers	6 fire extinguishers	4 fire extinguishers
Sport installations	basketball, volleyball	basketball, volleyball	basketball, volleyball	***
Excursion routes	Ag. Varvara valley, Omonoia park	Ag. Varvara valley, Ag. Anargyroi valley, Omonoia park, Heroon site	Omonoia park, Heroon site	Ag. Varvara valley, Ag. Anargyroi valley, Omonoia park
Comments	9th kindergarten housed in the building	5th kindergarten housed in the building	17th kindergarten housed in the building	***

Based on the student records of every school, we acquired information concerning student enrollment numbers for the last ten years (Table 3). This information was not available for all schools. From this data we derived the average number of students per school (column 2). For those schools that are housed and function in the same buildings with other schools, student numbers has been summed up (column 3).

We then proceeded to the creation of a city of Serres mapping background.

• Digitalisation with analytical values (axes coordinates) of the city's street lay out and, depending on the breadth of streets and alleys, creation of respective building blocks.

• Digitalisation of extensions with the use of a digitiser, and creation of building blocks.

Spatial rendering of building coefficients (BC) in each building blocks and creation of a thematic map for each building coefficient (Map 1).

Table 3. Students per year adn school group

	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	Average	Average number of students/school complex
1st ES housed jointly with 7th ES	294	328	321	273	253	238	222	254	248	261	258	256	*
7th ES housed jointly with1st ES	***	***	***	***	***	***	***	***	133	132	143	136	392
3rd ES	***	***	***	***	***	***	***	272	250	238	244	251	251
6th ES housed jointly with 16th ES	***	***	***	***	***	203	194	180	158	136	119	148	*
16th ES housed jointly with 6th ES	***	***	***	***	***	***	***	92	95	89	91	92	240
10th ES	***	***	307	280	305	327	344	354	343	355	342	331	331
11th ES	160	158	148	154	143	131	127	135	148	146	157	145	145
12th ES	154	149	138	131	136	132	128	144	151	153	159	142	142
13th ES	145	155	167	183	198	201	198	200	204	221	225	195	195
17th ES	***	***	***	282	291	299	279	288	292	301	310	294	294

Note: ES – elementary school.

From the reference on the Serres Master City Plan[3] on traffic issues, the findings of the traffic study[4] and the traffic noise map[5], we proceeded to the selection of road axes characterised by heavy traffic load, high circulation speeds and high levels of noise. Simultaneously, the existing traffic circulation lights were localised.

A spatial rendering based on the description of excursion routes followed.

At the same time, we proceeded to a dependent land surveying recording of school grounds and their correlation with the city's tissue. The results of these surface area measurements produced quantitative figures (of school grounds, classrooms, etc.).

RESULTS AND DISCUSSION

The relationship **student – school ground areas** is created by correlating Table 2 and Table 3 data, and is given in Table 4, along with accompanying comparative diagrams showing which school building complexes fall short of specifications and which exceed given specifications (Figs 1-3).

Table 4. Relationship of students with the school spaces

	1st and 7th ES	3rd ES	6th and 16th ES	10th ES	11th ES	12th ES	13th ES	17th ES
Average number of students	392	246	240	331	145	142	195	294
Plot surface area	4545.72	1990.91	1371.06	3532.87	2996.60	2695.63	3669.03	2513.22
Classroom surface area	1517.12	1528.50	555.30	1690.76	993.78	936.66	1110.14	1270.18
School yard surface area	3544.98	1391.06	1043.92	2388.46	2417.52	2152.58	2916.64	1689.27
Student reception surface area	190907	125478	207442	124142	273415	354607	269344	172089
Conversion in surface area with a BC of 1.0	332000	135000	288000	183000	349000	362000	347000	164000
School surface area (m^2/student)	11.60	8.09	5.71	10.67	20.67	18.98	18.82	8.55
Classroom surface area (m^2/ student)	3.87	6.21	2.31	5.11	6.85	6.60	5.69	4.32
School yard surface area (m^2/ student)	9.04	5.65	4.35	7.22	16.67	15.16	14.96	5.75
School area of influence (m^2/student)	846.94	548.78	1200.00	552.87	2406.90	2549.30	1779.49	557.82

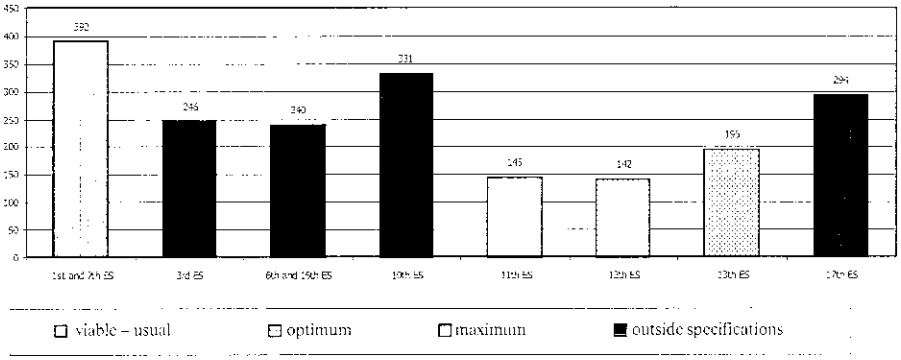


Fig. 1. Students/school complex

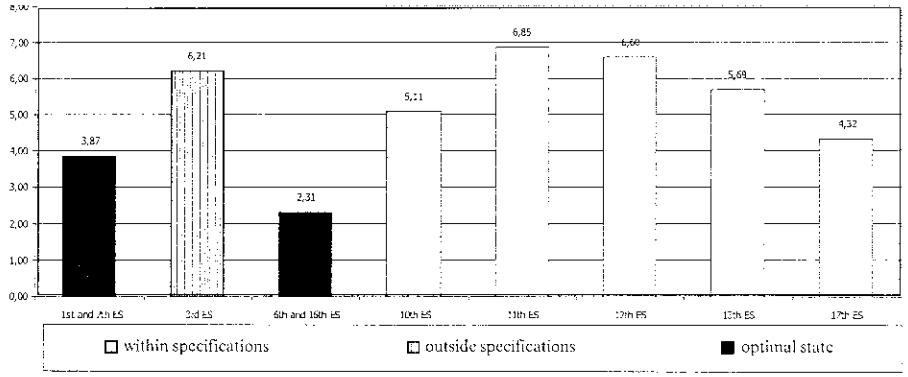


Fig. 2. Usable surface area (m^2/student)

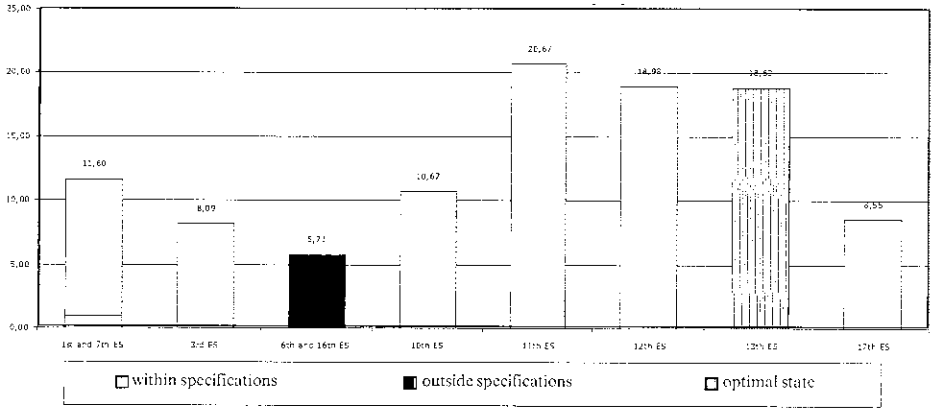


Fig. 3. School compex surface area (m^2/student)

Proposals:

• A linkage of spatial information (city map) with data coming from the city's population registry office allows for the possibility of automated updating of data concerning citizens whose children are about to be enrolled in the first grade of elementary school. A confirmation of the result of this linkage provides an estimate of the real number of new students about to enroll in the next academic period. Combining this information with the number of students already enrolled in the remaining grades, we arrive at an estimate of the total number of students for the academic year. If the area of influence of a school undergoes changes due to the proposals that follow, then the citizens affected are informed about the location of the school in which they are to enroll their children going to school for the first time (1st grade). No automatic school change is foreseen for students in grades other than the 1st. Such changes shall only be effected following a related petition on the part of the interested parent and its acceptance by the school. In such instances, the system database (GIS) should also be updated.

• When the number of students in a school exceeds specifications, the school's area of influence should be decreased.

• When the ratio of student/usable surface area falls under specifications, an investigation should be conducted aiming at:

- a decrease in the number of students through a reduction of the school's area of influence;
- an increase of usable space, taking into consideration the student/school grounds surface area ratio and the area's BC. This will result in a building extension, either horizontally or vertically;
- a search to find an appropriate area for the construction of new school buildings.

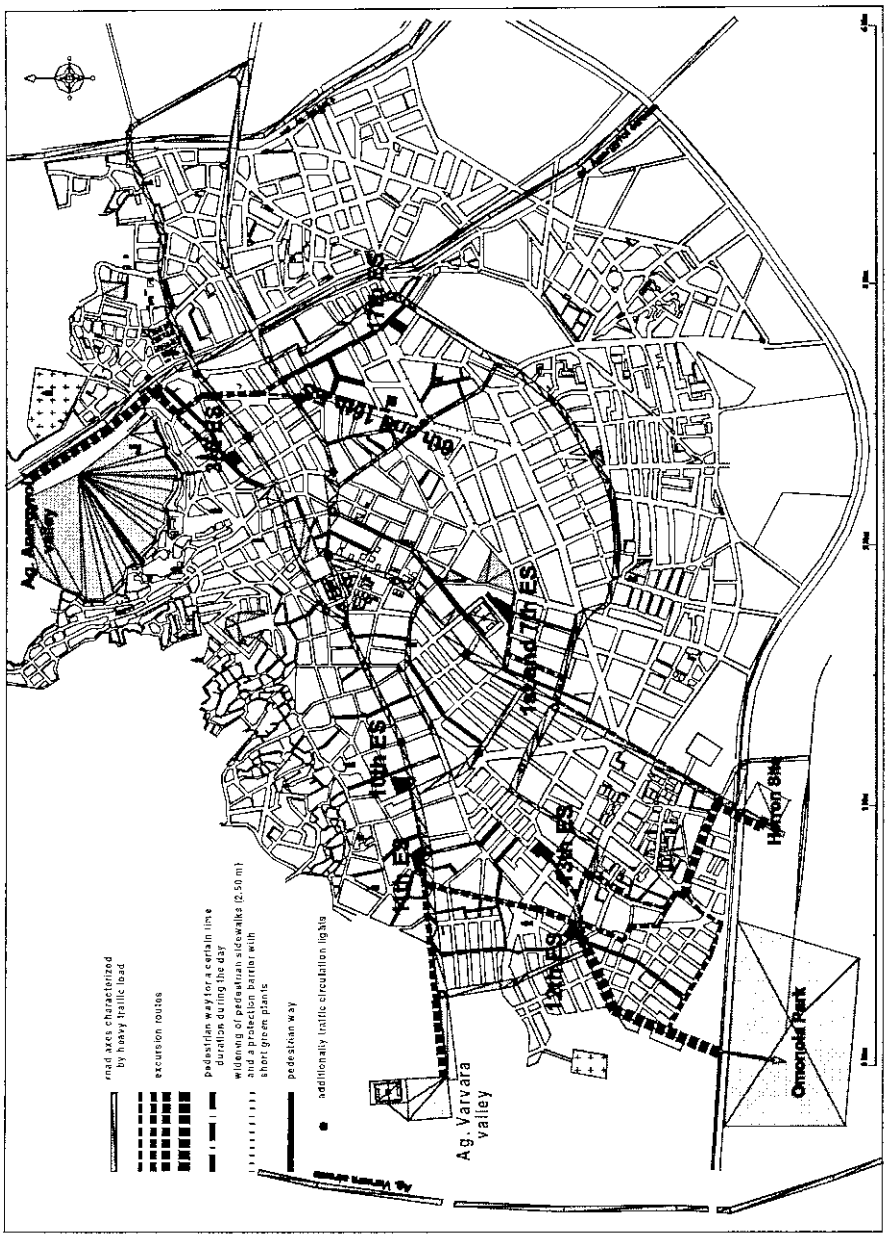
• When the ratio of student/school ground surface area falls under specifications, an investigation should be conducted aiming at:

- a decrease in the number of students through a reduction of the school's area of influence;
- an increase of the school grounds surface area, through the expropriation of some neighbouring property, if such property is not built upon and the required funds for compensation are available or can be obtained;
- a search to find an appropriate area for the construction of new school buildings.

• When building uses do not meet current requirements (e.g. lack of personal computer laboratories, physics and chemistry laboratories, music rooms, library), the problem hinges on:

- redistribution of classroom uses;
- increases in the usable school surface area.

The relationship **student – access means – safety** is created by correlating (Map 2):



Map 2. City of Serres

• School entrance to traffic load – speed of the road axis:

– existence of safety barriers on school gates, blocking direct access onto the street;
– existence of traffic lights in periodical or continuous operation;
– stationing of traffic policemen (regular or school-assigned) during student arrival and departure;
– existence of pedestrian crossing zones and of special arrangements allowing the free and unhindered passage of wheelchairs;
– existence of warning signs visible to passing drivers.

• The passage of road axes through the areas of influence of each school complex:

– accident analysis results;
– existence of pedestrian crossing zones and their relation to parked vehicles[6];
– existence of traffic lights in periodical or continuous operation;
– existence of pedestrian sidewalks.

• Network of pedestrian ways[7]:

– network structure;
– safety measures applied at pedestrian way intersections.

• Fire safety measures, especially at most dangerous sites (boiler rooms).

Proposals:

• Flower stands with green plants, to be used as safety barriers at school complex exit points, instead of the usual antiaesthetic metal railings. They also contribute to environmental education.

• No stopping – no vehicle parking zones (they hinder clear visibility) at school complex entrances.

• Widening of pedestrian sidewalks at intersections.

• Interventions in the common segments of student excursion routes, such as:

– avoiding central roads when planning excursion routes;
– provision of special uniforms and high driver visibility signs (fluorescent) for student escorts at intersections;
– traffic police briefings;
– preference to pedestrian ways, whenever possible.

• If the crossing of a major street is necessary while on an excursion route or in order to access a school complex, then one sidewalk should be asymetrically widened by 2.5 m at the point of crossing, and a protection barrier with short green plants should be positioned at the crossing area (Map 2).

• Connection of the existing network of pedestrian ways to school building complexes and expansion of this existing network. Function of certain streets as pedestrian ways, for a certain time duration during the day (Map 2), and prohi-

bition of any automobile circulation there, with the exception of emergency vehicles.

• Application of the "megablock" concept, referred to in an article included in the proceedings of this congress, entitled "urban upgrading through the unification of building blocks" and written by the same authors. Regarding unbuilt areas shortly to be included in a city planning project, the application of proposals made in another article included in the proceedings of this congress, entitled "network design and impact reduction in unbuilt areas to be included in a city plan" and also written by the same authors, will assist in the creation of pedestrian ways inside the building blocks.

The relationship **student – traffic education and environment** is created by correlating:

• Reporting and analysis conducted within the framework of teaching.

• Method adopted by educational staff for absorption by students during excursions[8].

Proposals:

• Creation of a traffic education and good practice park, intended for students as well as drivers.

• Selection of related material and equipment of pedestrian ways aiming at providing information to students and their escorts.

• Selection of alternative routes of school excursions and recording of environment related views and opinions of the students (relation of noise, exhaust fumes, accidents) (Map 2).

CONCLUSIONS

Spatial information will link the location of school complexes to the city planning tissue. Descriptive information shall serve as these data which describe phenomena that exist or occur in space and alternate through time (number of students, building block uses, accident sites, excursion routes, classroom uses).

The process of linking of spatial-mapping information with descriptive-statistical information, produces the area of influence (AI) of every school complex. It is then possible to proceed to pairing, i.e. residents per school, student per classroom, accidents per AI and accidents per excursion route, students per athletic installation.

Decision taking for:

• A.I. modification.

• Unifications of building blocks, based on AIs.

• Designation of streets as pedestrian ways for specific time durations.

• Prevention and protection measures.

• The contribution of the creation and existence of pedestrian ways is required, as it is positive.

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Received 20 October 2001
Revised 15 August 2002