VULNERABILITY EVALUATION OF THE URBAN ENVIRONMENT OF PIATRA NEAMT TOWN

Dumitru LETOS

Keywords: urban environment, hazard, vulnerability, risk, matrix, indicators, favourability.
Cuvinte cheie: mediu urban, hazard, vulnerabilitate, risc, matrice, indicatori, favorabilitate.

ABSTRACT:

As privileged space of living, creation and manifestation of actual society values, town represents the emblem of modern civilization, with all its successes, oportunities, but also with its failures, risks and threats. Modern town is a place of fast, complex and multilevels transformations of substance, energy and information as forms of matter, which enter the system but also transforming even its existence as: space, structures, activities and especially the life of its inhabitants. The present urban environment of Piatra Neamt town carries on the powerful mark of the evolution in time and space of the urban teritorial system, strengthfully linked by the information, experience and knowledge levels of population that determined the kind of interventions and the quality leaps bringing many consequences, some positive as the favorability of the environment for a comfortable life and other negative as starting its vulnerability.

I. Some considerations about present natural environment of Piatra Neamt town and the generating risk factors

Piatra Neamt town appeared and has been developing into a very favourable natural environment for inhabitance and economy, turning to good account the sit of valley (the junction of Bistrita River with Cuejdi, its main tributary river) and the contact position (Subcarpathian hills and Eastern Carpathians) at the cross of access and trade ways from the mountains and from the hills and plateau, at the exit from mountains of Bistrita River and the entrance into the large Cracau-Bistrita depression.

The geological and geomorphological considerations certify the fact that the position of the town at the contact of Easten limit of mountains and Westen limit of hills offers various and complementary conditions for inhabitance. The very large valley of Bistrita at a junction position, having plateaus and terraces about 350 – 400 m and being sorrounded by small mountains about 500 – 850 m offers favourable conditions for inhabitance and different economic activities too. A geomorphological risk is that on the sides over 30^{o} can appear sliding ground processes.

In the climatic point of view, Piatra Neamt town is a double contact zone among the mountain climate and the hill climate on one hand and among exccesive continental climate and dim oceanic climate, generally offering good conditions for living but there existing the possibility to appear short periods with climatic excesses. The climatic risks are linked about: short periods of drought in the summer, some thermic inversions in the winter or some invasions of polar air especially in the winter, some froggy days in winter or in the transition seasons (due to both, depression character and urban micro-climate), some torrential rains in the summer (often with hail-stone) because the thermic convection, a high air wet for a long time in the year which affects people who has breathing problems. The torrential rains in the summer joint with high sides of the mountains can provoke local floods due to leakage on the sides.

The hydrography network in the area of Piatra Neamt town is formed of Bistrita River situeted in the South part and its tributary rivers, the most as brooks with continuous flow or temporary flow while there are torrential rains. The main tributary river is Cuejdi that even if in ordinary conditions it has a small flow, sometime, while there are raining a lot its flow rises of 50 times up, so that it would provoke floods unexpectedly. At the present time this risk is much diminueted because its bed in the town is damed up avoiding the most floods. There are still some brooks as Borzoghian and Sarata which present some risk of floods due to the particular conditions of flow and the lack of protecting works.

The two lakes in the town area, both on the Bistrita River, Batca Doamnei Lake in the Western part and Valeni Lake in the Southern part have hydroenergetic character but even for control and regulating the flow of river. The big areas fo the two lakes, 235 ha and 150 ha, asociated with the two big water volumes, 5,2 milions m^3 and respectiv 1,5 milions m^3 there are favourable conditions to rise up the air wet in the town area.

The present vegetation in the town’s area is formed of secundary forest, with a small domination of coniferous forest, mainly been planted after 1950 while a large campaign of afforestation because some ravaging fires and big deforestations in the second part of 20th century.

The native vegetation can be found on the peaks of Cernegura and Bahrin mountains, composed maily of beech trees. The degree of afforestation of the small mountains surrounding the town has the average of 70%, with small differences from a peak to another. The ample interventions of the man on vegetation composition have generated the change of biodiversity, that having further effects on the soil. The soil in the town area has big differences from a place to another depending on the kind of man’s interventons, so that even today the soil bears continuous quality changes.

The surface of parks and green spaces into the town of Piatra Neamt are on the decrease in last years, from 1,72 km^2 meaning 16,1 m^2/person in 2002 to 1,71 km^2, meaning cca. 15,9 m^2/person in 2008, (according to the data provided by County Statistical Center) due to extension of the urban buildings surface to the prejudice of parks and green spaces, that affects the ecological safety of the town, opposite to the European standards which stipulate the extension of these to 20 m^2/person untill 2010 and 26 m^2/person untill 2013. This surface somehow small is made up for the big surface of forest which surrounds the town as a green belt.

II. Some considerations about the present built environment of Piatra Neamt town and the generating risk factors

The built area of Piatra Neamt town lies on an area of 2135 ha (21,35 km^2) in 2008 being larger than in 2002, when that was only 1982,35 ha. (19,82 km^2). That built area spreads on 27,5 % from the whole administrative area of the town (7747 ha respectivly 77,47 km^2).

The height level of the buildings especially of blocks of flats associated with the old age of these and their degree of seismic resistence, the zone of the town presents a high seismic risk, because the whole zone is integrated with E class for Romania, meaning an account potential of 7 degree intensisty on Mercali scale. The quality of traditional urban infrastructure is a good one refering to the roadways and railways but a modest one refering to water pipes and sewerage. The water network of pipes and the sewerage system, evem though are partialy rehabilitated în the last years, part of them are old and have sub-sized dimensions, they have been lasting since ’60 and ’70 in the most part and therefore they present a huge risk of damage. The gas pipes, electric network and telecommunication system work in good conditions because of recent rehabilitation and extension. Even there is a good quality for town roadways they are too busy in the crossways at the top hours because of sub-sized dimensions.

Industrial societies in the town area and in its neighbourhood present different degrees of risk to technological accidents. The present industrial societies in town area (wood, paper, mecanics, ready-made clothes) have a low risk to technological accidents while some industrial sections that work on The Platform of Savinesti (Fibrex S.A., S.C. Melana S.A., S.C. Rifil SRL, S.C. ICFS S.A) present a high risk to technological accidents even they are to 10 km far-off.

The degree of pollution in the urban environment of Piatra Neamt town has been decreasing after the closing of some factories with high degree of pollution as: „Pergodur” (cellulose and paper) and „Zorile Noi” (bricks), or renew their technology as „Petrocart” (paper) or relocate them as: I.M. „Ceahlaul” (mecanics) and „Bistrita” (wood). In the present time, the main sourse of pollution is the traffic on the roads which exceeds the CMA in 24 hours with 0,54% for dust and gas pollution at the top hours, even for sonic pollution the limit is more overtaken.

In spite of significant decreasing of pollution there is persisting the phenomenon of degradation of urban landscape because of industrial residual structures as „Pergodur”, I.M. „Ceahlaul”, „Bistrita”, „Montana” etc. which stand in the middle of the town or in some residential districts, spreading on 3,2% of urban surface maiming the urban landscape of a touristic town.

The frequency of fire accidents in the town is almost big as number of events (58 fires in 2008) but the majority of small intensity, indicating a small risk to that kind of accidents. The most number of fires had as causes: smoking, uncleaned or out of work chimneys, electric installations, or even deliberate actions.

A major risk had mainly been put in evidence in the last years is that of uncontroled and chaotic spreading of the building space and an irrational usage of the lands in the same time, equally into the urban area and in its neighbourhood.

The present population of the town is estimated about 107 000 inhabitants in 2008 (105 499 inhabitants in 2002) generating an average density into the town of 53,21 persons/ha meaning 5321 persons/km^2, resulting 187,21 m^2 built space for every person.

The risks refering to the demographic factors take into account the negative values of natural balance and migratory balance of population in the perspective of demographic growing old.

Social risk situations are linked on the profesional and educational level of some population categories that associated to the phenomenon of economical restructure (closing or reshaping of some plants) or to the economic crisis which can lead to increasing the rate of unemployment, a phenomenon specific mainly to some districts with many families of Rroms.

The instruction level of population for risky situations can determin the degree of safety for the citizen and the capacity of responsable intitutions for promoting and making population aware of proper behaviour in those situations.

III. Relating risky situations to types of hazard and degrees of vulnerability

The risky situations come into being in relation with types of hazards and degrees of vulnerability. A potential hazard comes into being and provokes a risky situation when there are high vulnerability conditions on its action zone. The more the degree of vulnerability is lower the more reduced is the risky situation generated by a potential hazard which is coming into being.

In the speciality literature there is a formula which relates in a mathematic way the three elements:

$$\mathbf{R = H \cdot V}$$

where, **R** means risky coefficient, **H** means potential hazard and **V** means degree of vulnerability.

IV. Identification of types of potential hazards for Piatra Neamt town

Taking into account the phisico-geographic conditions which are specific to urban environment of Piatra Neamt town, together with the human, economical and thrifty-town characteristics which are tightly linked with types and actual conditions of organization and of administrative policy, on the town area there are coming into being different types and forms of potential hazard.

V. Defining vulnerable elements

Vulnerable elements in the urban environment of Piatra Neamt town are:

- Buildings and infrastructure;
- Human life, health and safety;
- Socio-economic activities.

VI. Specific indicators for vulnerability evaluation

The indicators for vulnerability evaluation are devided into five categories: environmental, technical, socio-economic, demographic, educational and organizational, all of them being quatified according to numerical values and qualitative estimations being characteristic to Piatra Neamt town.

Table 1. Types and forms of hazard for Piatra Neamt town.

TYPES OF HAZARD	FORMS OF HAZARD
Teluric hazards	Seisms
Geomorphological hazards	Slides of ground, erosion processes
Floods	Overflows of Cuejdi River and the brooks in the zone of town
	Leakage on the sides
Climatic hazards	Torrential rains
	Rain with hail-stones
	Drought
Ecological hazards	Deforestations
	Decreasing green spaces
	Defective management of waste
Epidemiological hazards	Virosis, epidemics, breathing affections
Urban pollution	Sonic pollution
	Noxes pollution (dust and gases)
Technological hazards	Technological accidents
	Fires
	Damage of public utilities (water pipes and sewerage)
Social and economic hazards	Unemployment
	Economic crisis
Demographic hazards	Demographic decreasing
	Demographic growing old
Organizational hazards	Degradation of urban landscape
	Inadequate administration of the lands
	Inadequate instruction of population for risky situations (disasters)

Table 2. Quantification of the indicators to determine vulnerability degrees.

Indicators	Vulnerability degrees (Frequency and intensity of phenomena)				
	Very big	Big	Average	Little	Very little
ENVIRONMENTAL INDICATORS					
Seismic frequency	yearly	1/ 2 yaers	1/ 3 years	1/ 5 years	1/10years
Seismic intensity	>7degrees Mercali scale	5-7 deg. Mercali scale	3-5 deg. Mercali scale	1-3 deg. Mercali scale	< 1 deg. Mercali scale

Proximity in comparison with the place of ground slides	<50 m	50-100 m	100-150m	150-200m	>200 m
Proximity in comparison with the place of floods (as overflows)	<1 m relat. altit.	1-1,5m relat.altit.	1,5-2m relat.altit.	2-2,5m relat.altit.	>2,5m relat.altit.
Flood coefficient as leakage on the sides for the urban areas near the sides	>80%	60-80%	40-60%	20-40%	< 20%
Frequency of floods following torrential rains and overflows of tributary brooks	2/1year	1/1year	1/3 years	1/5 years	1/10years
Frequency of rains with hail-stones	4/year	3/year	2/year	1/year	0/year
Frequency of droughts	2/year	1/ year	1/ 2 years	1/ 5 years	1/10years
Length of droughts	35 days	30 days	25 days	20 days	15 days
Degree of deforestations	Very big	Big	Average	Little	VeryLittle
Area of green space for every person	<10 m^2/pers.	10-15 m^2/pers.	15-20 m^2/pers.	20 -25 m^2/pers.	>26 m^2/pers.
Implementation degree of waste management	Very little	Little	Average	Good	Very Good
TECHNICAL INDICATORS					
Strenthening degree of slides	Very little	Little	Average	good	VeryGood
Urban pollution degree (exceed CMA % in 24 hours, dust and gases)	>2 %	1,5-2 %	1-1,5 %	0,5-1 %	0-0,5 %
Sonic pollution degree	>70 decibels	65-70 deicbels	60-65 decibels	55-60 decibels	<55 decibels
Frequency of technological accidents	>5/year	4-5/year	3-4/year	1-2/year	<1/year
Proximity in comparison with zones for producing of technological accidents	<1 km	1-5 km	5-10 km	10-15 km	>15 km
Frequency of producing damages of public utilities	Very big	Big	Average	Little	Very little
Quality of buildings	Veryweak	Weak	Average	Good	VeryGood
Degree of exposure for buildings against seisms at 7 degrees on Mercali scale	Very big	Big	Average	Little	Very little
Quality of roadways	VeryWeak	Weak	Average	Good	VeryGood
Quality of lands for building	VeryWeak	Weak	Average	Good	VeryGood
Frequency of fires	>60/year	50-60/ year	40-50/ year	30-40/ year	<30/ year
Intensity of fires	Very big	Big	Average	Weak	VeryWeak
SOCIO-ECONOMIC INDICATORS					
Average level for gains (RON)	< 700	700-1000	1000-1500	1500-2000	> 2000

Assurance degree for goods	VeryWeak	Weak	Average	High	Very High
Number of beds in hospital (beds/1000 inhabitants)	< 8	8 – 10	10 – 12	12 – 14	> 14
Number of doctors to 1000 inhabitants	< 1	1 – 2	2 – 3	3 – 4	> 4
Percentage of patients in the cold season (%)	>25 %	20-25 %	15-20 %	10-15 %	<10 %
Unemployment rate	>8 %	6-8 %	4-6 %	2-4 %	<2 %
DEMOGRAPHIC INDICATORS					
Natural balance level	< -2 ‰	-2 şi 0 ‰	0 şi 2 ‰	2 şi 4 ‰	> 4 ‰
Migratory balance level	< -7 ‰	-5 şi -7‰	-3 şi -5‰	-1 şi -3‰	0 şi -1 ‰
Average urban density (pers/km^2)	> 7000	6000-7000	5000-6000	4000-5000	< 4000
Growing old degree	> 110	100 –110	90 – 100	80 – 90	< 80
Percentage of feminine population (%)	> 54%	53-54%	52-53%	51-52%	50–51%
EDUCATIONAL AND ORGANIZATIONAL INDICATORS					
Presence of local institutions (%)	< 60 %	60-70 %	70-80%	80-90 %	90-100 %
Degradation degree of urban landscape due to the presence of rezidual industrial structures	Very big	Big	Average	Weak	Very weak
Degree of proper administration of urban land	Very good	Good	Average	Weak	Very weak
Educational level of population (percentage for superior and middle education)	< 35 %	35-40 %	40-45 %	45-50 %	> 50 %
Degree of population perception about risks	< 60 %	60-70 %	70-80%	80-90 %	> 90 %
Degree of population instraction for disasters	< 50 %	50-60 %	60-70 %	70-80 %	> 80%

Overlapping statistical data which show the concret reality at the town level with the types of technical indicators as in Table 2 there can be determined the vulnerability degrees on the specific quantifying indicators. Attributing bonitation marks for vulnerability degrees there is building the evaluation matrix for urban environment vulnerability according to quantifying indicators. The bonitation marks are established from 0 to 4, 0 means a very weak vulnerability and 4 means a very high vulnerability.

Associating some specific indicators for some potential situations there can be estimated different levels of risk for vulnerable elements in the urban environement of Piatra Neamt according to some degrees of vulnerability. The progressive classes for vulnerability, V1, V2 and V3 express degrees of vulnerability according to every potential situation emphasizing some specific levels of risk: Rmaj = Major Risk, Rave = Average Risk and Rmin = Minor Risk.

Table 3. Matrix for vulnerability evaluation of Piatra Neamt town.

Indicators	Marks (from 0 to 4)				
	4 mark	3 mark	2 mark	1 mark	0 mark
ENVIRONMENTAL INDICATORS					
Seismic frequency			2		
Seismic intensity		3			
Proximity in comparison with the place of ground slides			2		
Proximity in comparison with the place of floods (as overflows)			2		
Flood coefficient as leakage on the sides for the urban areas near the sides			2		
Frequency of floods following torrential rains and overflows of tributary brooks		3			
Frequency of rains with hail-stones				1	
Frequency of droughts			2		
Length of droughts				1	
Degree of deforestations				1	
Area of green space for every person			2		
Implementation degree of waste management				1	
TECHNICAL INDICATORS					
Strenthening degree of slides				1	
Urban pollution degree (exceed CMA % in 24 hours, dust and gases)				1	
Sonic pollution degree		3			
Frequency of technological accidents					0
Proximity in comparison with zones for producing of technological accidents				1	
Frequency of producing damages of public utilities		3			
Quality of buildings			2		
Degree of exposure for buildings in front of seisms at 7 degrees on Mercali scale		3			
Quality of roadways				1	
Quality of lands for building				1	
Frequency of fires		3			
Intensity of fires				1	

SOCIO-ECONOMIC INDICATORS					
Average level for gains (RON)			2		
Assurance degree for goods		3			
Number of beds in hospital (beds/1000 inhabitants)			2		
Number of doctors to 1000 inhabitants				1	
Percentage of patients in the cold season %	4				
Unemployment rate				1	
DEMOGRAPHIC INDICATORS					
Natural balance level			2		
Migratory balance level	4				
Average urban density (pers/km^2)			2		
Growing old degree			2		
Percentage of feminine population (%)			2		
EDUCATIONAL AND ORGANIZATIONAL INDICATORS					
Presence of local institutions (%)					0
Degradation degree of urban landscape due to the presence of rezidual industrial structures	4				
Degree of proper administration of urban land			2		
Educational level of population (percentage for superior and middle education)			2		
Degree of population perception about risks		3			
Degree of population instraction for disasters		3			

Table 4. Sinthetic-matrix concerning the vulnerability evaluation according to the average values for different types of specific indicators.

Indicators	**Marks (from 0 to 4)**				
	4 mark	**3 mark**	**2 mark**	**1 mark**	**0 mark**
Environmental Indicators			**2**		
Technical Indicators			**2**		
Socio-economic Indicators			**2**		
Demographic Indicators		**3**			
Educational and Organizational Indicators			**2**		

Table 5. Correspondence between vulnerability degrees and risk levels based on the association of technical indicators (potential situations).

POTENTIAL SITUATIONS	VULNERABILITY DEGREES	RISK LEVELS
Seismic potential + exposure degree of buildings	**V3**	• **Rmaj** for buildings and infra-structure • **Rmaj** for human life, health and safety • **Rmaj** for socio-economic activities
Potential ground slides + Strengthen degree for sides	**V1**	• **Rmin** for buildings and infra-structure • **Rmin** for human life, health and safety • **Rmin** for socio-economic activities
Potential floods (proximity + frequency + coefficient)	**V2**	• **Rmed** for buildings and infra-structure • **Rmed** for human life, health and safety • **Rmed** for socio-economic activities
Climatic potential excesses (droughts + torrentiality + hail-stones rains)	**V2**	• **Rmed** for buildings and infra-structure • **Rmed** for human life, health and safety • **Rmed** for socio-economic activities
Ecological potential damages (green spaces + defo-restations + waste)	**V1**	• **Rmin** for human life, health and safety • **Rmin** for socio-economic activities
Exposure to epidemics (patients + medical services)	**V3**	• **Rmaj** for human life, health and safety • **Rmaj** for socio-economic activities
Urban pollution (sonic + CMA values: dust, gas)	**V2**	• **Rmed** for human life, health and safety
Technological potential damages (networks damages + fires)	**V3**	• **Rmaj** for buildings and infra-structure • **Rmaj** for human life, health and safety • **Rmaj** for socio-economic activities

Exposure to socio-economic hazards (goods assurance + gains + unemploy-ment)	**V2**	• **Rmed** for material goods • **Rmed** for human life, health and safety • **Rmed** for socio-economic activities
Exposure to demographic hazards (decreasing inhabitants + growing old)	**V3**	• **Rmaj** for human life, health and safety • **Rmaj** for socio-economic activities
Exposure to organi-zational hazards (degradation landscape + administration lands + instruction population)	**V3**	• **Rmaj** for landscape, lands, infra-structure • **Rmaj** for human life, health and safety • **Rmaj** for socio-economic activities

VII. Diminishing the level of risk through decreasing the vulnerability degree into the urban environment of Piatra Neamt town

The main categories of hazards: environmental, technical, socio-economic, demographical and organizational are and come into being when there are touched some potential thresholds, but their transformation for generating of risk factors depends on vulnerability degree of proper environment. A conscious man intervention in order to diminish the vulnerability degree of environment in front of some potential or manifested hazards has the effect of deceasing the level of risk for vulnerable elements.

Table 6. Proposals for diminishing the vulnerability degrees linking on risk categories.

Risk categories of urban environament	Proposals for diminishing vulnerability
1.Major risk to seisms	**a**. Instruction of population for an adequate behaviour in case of seismic events **b**. Strenthening and rehabilitation of old buildings
2.Minor risk against slides of ground	**a**. Monitoring the zones with proper risk for producing slides of ground **b**. Project and implementation of a local strategy concerning to struggle against the slides of ground, including also the adequate manner to use the land
3.Average risk to floods	**a**. Training population for an adequate behaviour in case of floods **b**. Project and implementation of a local strategy to manage the floods
4.Average risk to climatic excesses	**a**. Make aware the local decision factors and the population concerning the manifestation of climatic excesses **b.** Project a local strategy to react adequately in case of some climatic excesses

5.Minor risk to ecological hazards	**a**. The extension of green spaces inner the town to **26 m^2/person (2010)** **b.** Achieving the full management of waste
6.Major risk to epidemics	**a**. A periodical and complete report for population **b**. Monitoring those persons predisposed to breathing affections **c.** Supporting and implementation the programs for developing infrastructures of medical unities
7.Average risk to urban pollution	**a**. Cooperation between local authorities and specialized institutions for a strict, periodical and corect monitoring and report about the degree of urban pollution **b**. Promoting and supporting the unpolluting technologies **c**. Application of a longtime strategy for a gradual diminishing of urban pollution
8.Major risk to some technological accidents	**a**. Rehabilitation of public utilities network for decreasing technological damages **b**. Project a local longtime strategy to struggle against the causes of fires
9.Average risk to socio-economic hazards	**a**. All time monitoring of unemployers and social cases **b**. Periodical implementation of programs of professional reconversion for unemployers **c**. Making periodical reports for monitoring the standard of living and social risks **d**. Monitoring the social disadvantaged groups and implementing proper supporting programs **e**. Supporting local firms for developing production and creating new work places **f.** Project and implementing the longtime strategy for monitoring, preserving and promoting the population safety **g**. Developing and making easy accessible the recreation and amusement base in the town area for preserving psychic and phisical health of population
10.Major risk to demographic hazards	**a.** Initiating and supporting of projects of investment for houses and new work places for young people in order to stop their emigration **b.** Creating of multiple facilities for young people for drawing and settling them down in the town
11.Major risk to organizational hazards	**a.** Desaffectation the rezidual industrial structures for stopping the degradation of urban landscape **b.** Project a strategy for adequate administration of the lands **c.** Implementing some programes concerning to train and make aware whole population for developing and adopting an adequate behaviour in risky situations

VIII. Conclusions

The urban environment of Piatra Neamt town has generally an average degree of vulnerability to risky factors (potential hazards) but particularlly, some of them exceed the average having big values as: epidemics, seisms, fires, damages of public utilities, demographic hazards and organizational hazards. When the big degree of vulnerability depends on natural factors (epidemics in cold season, seisms) man implication has to counteract the potential action for diminishing the future effects, while the big degree of vulnerability depends on administrative management, technological or organizational factors that require an increasing of awareness and responsability degree for all local responsabale institutions concerning those changes for anticipating and preventing, for cooperating and reporting properly but even for thinking and projecting strategically in longtime terms. Where the local institutions have already made some firm steps, as ecological area, there is a little degree of vulnerability and a big favourability. A viable solution for future is that of thinking and implementing an integrated strategy for sustainable development of the urban system concerning the remodelling structural components and functional relations in the whole system based on universal priciples that centred on man as in himself value but also the beneficiary of all goods.

REFERENCES

Alexander D. (2006), *The Geography of Social Vulnerability: Race, Class, and Catastrophe*, South Caroline.

Apostol L, (2004), *Clima Subcarpaților Moldovei,* Editura Universității Suceava.

Grozavu A. (2009), *Vulnerabilitate Teritorială: Diagnoză, Prognoză şi Intervenție*, curs didactic, Facultatea de Geografie şi Geologie, Iaşi.

Letos D. (2004), *Extinderea recentă a habitatului municipiului Piatra Neamț şi a ariei sale periurbane*, teză gradul I, Piatra Neamț.

******* Agenția de Mediu a Județului Neamț, (2008), *Raport Anual*.

******* Direcția Județeană de Statistică, (2009), *Fişa Localității Piatra Neamț*

******* Inspectoratul pentru Situații de Urgență „Petrodava" al Județului Neamț, (2008), *Plan de analiză şi acoperire a riscurilor de pe teritoriul Județului Neamț*.

******* Institutul Național de Statistică, (2008), *Indicatori statistici de dezvoltare durabilă*.

******* Primăria municipiului Piatra Neamț, (2007), *Strategia de Dezvoltare Durabilă a Municipiului Piatra Neamț 2025*.

******* site Județul Neamț, http://www.neamt.ro

******* site Agenția de Mediu a Județului Neamț, http://www.apmnt.ro/

Dumitru LETOS
Univ. „Al. I. Cuza" Iaşi
Email: dumitruletos@yahoo.com