THE VULNERABILITY TO WATER HAZARDS OF URBAN AREA TURDA– CÂMPIA TURZII

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ABSTRACT: **The vulnerability to water hazards of urban area Turda–Câmpia Turzii.** The risk was defined as a social object whose primary component is vulnerability. This paper examines the way in which vulnerability was defined by highlighting its three aspects: physical, technical and social. The vulnerability involves a complex systematic approach especially when cities are analyzed. The economic, social heritage, the environmental elements can all become factors of vulnerability. In this paper the urban areas vulnerable to waterborne hazards, especially floods were mentioned. The means to reduce urban vulnerability were analyzed, highlighting the measures taken by the local communities to mitigate the crisis.

Keywords: vulnerability, risk retention, floods, urban areas, risk mitigation.

1. General observations

The hazard, as a social object, is defined as the perception of a danger, of a possible catastrophe, more or less predictable to a social group or an individual who are exposed to it. Hazard concept includes 3 terms: danger, vulnerability and exposure. The danger represents the phenomenon or the process of certain intensity that causes losses to people, activities or environment (Sorocovschi, 2007). The vulnerability expresses more or less the sensibility of an element to danger and the level of damages caused by it.

The vulnerability was the object of studies from many authors, cu various aspects. In 1990, year declared by UN as the year for risks attenuation, was confirmed the *hazard paradigm*, that considers hazard as a *alteration* in analyzing the risk a social construction, with an accent over vulnerability (Pigeon, 2002, p. 457). It is expressed by exposed systems *resistance* and by resilience, the system's capacity to assimilate changes (Dauphiné, 2001, p. 17-20). In Dauphiné's acception, the vulnerability is expressed by predictible consequences level of a natural phenomenon with elements at risk (people, goods, and environment). There exist human, socio-economical and environmental vulnerability. Vulnerability is

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first a physical exposure, even though a still potential one, to a certain hazard, after that a sort of fragility in regard to this kind of phenomenon, and finally a poor knowledge of how to act in case of a catastrophe (Veyret, 2003. p.31). There appears an agreement in separating risk from hazards, the appearance probability of a dangerous phenomenon. Risk definition as a conjunction between a hazard and a vulnerability is condemned as functionally, but this approach is more operative through its spatial repartition (November, 2000, p.206).

The analyze of vulnerability factors determined various research methods, framing solutions to risk attenuation and people's response improvement (D'Ercole and colab., 1994, p. 94). American and Japanese risk management institutions suggest a quantifiable vulnerability approach. It is analyzed according to the predictable costs of people, facilities and goods exposure to a hazard, and to the relation between costs and benefits of protection measures. Here appears the confusion between exposure and vulnerability, people and facilities becoming a "stake". International institutions (World Bank, UN) analyze vulnerability through its social dimension. Their studies begin with hazards evaluation in territory, followed by the analyze of exposed systems fragility and, finally, by system's adaptation capacity and espouse to operative behaviors

2. Urban vulnerability

Risk attenuation represents danger's attenuation, but also of land's vulnerability. In the second half of XXth century, urban growth and industrial development had as consequence the growth of dangerous phenomena and damages, the city exposure becoming higher and higher to major risks. Vulnerability implies a systemic approach, compulsory but also complex, in a city analyze. We can talk about society's resilience to such a natural "crisis" (Veyret, 2001). The city amplifies, multiplies and diversifies vulnerability factors that have their own origin in city's activity, in spatial organization principles and in land dynamics.

A vulnerability factor can be represented by economical, social and organizing aspects, heritage and environment. Veyret (2001) suggested a factor's classification that transforms a city into a vulnerable space:

Population density, built space extension,

Technical factors:

- Low building quality, insufficient water control
- Under sizing evacuation development and waste water treatment

Social-economical factors:

- They refer to land utilization, social segregation and space fragmentation

Danger acceptance:

- Danger is often accepted for having a house or a job; poverty appears as vulnerability factor

Psychological factors:

- Danger's neglecting, the absence of risk acknowledge
- Religious aspects of risk acceptance

Political and social history factors; institutional and political-administrative factors:

- The absence of warning programs
- The absence of meditation over an urban planning program
- The absence of a risk culture in the social group
- Administrative carving: the existence of risk territories, of multiple decision makers, responsibility disclaimer

Structural factors:

- Certain impact location and moment
- Unpredictable technical malfunctions

Functional factors:

- Poor crisis management, deficient technical and human resources organization
- The absence of warning systems
- The absence of operative predictions

After analyzing urban vulnerability, Guezo and Verrhiest (2006) suggest vulnerability territorial and social approach. Urban vulnerability manifests itself over humans and also over environment. Its "spectrum" develops after two directions: land and society.

Territorial vulnerability

Territorial vulnerability can approached from a geographical and structural point of view, shaping the objects in their physical environment.

Geographical vulnerability

It represents land's exposure to a natural or technological dangerous hazard. Dangerous hazards with geographical localization of sources and consequences (river flooding) can be territorially defined through risk exposure of some potential parameters. Not all exposed elements have the same geographical vulnerability to the same hazards; so, the constructions in flooding area don't have the same risk exposure level as the other urban area constructions. Geographical vulnerability result from land's physical characteristics that are in resonance with hazards characteristics. For a flood, the damages are determined by river's discharge conditions, concentration time, current's velocity, submersion time – in a strong connection with land's topography and with land's occupancy.

Structural vulnerability

It refers to the degree of goods, humans and activities protection through technical or architectural planning actions. And so, in case of flooding, upper building floors are out of water danger zones.

Social vulnerability

Organizational vulnerability

It refers to organizations' influence (communities, companies, strategical centers) over the consequences of a catastrophical phenomenon. For a company exposed to flooding, a proper interior improvement may reduce considerably the losses. If the goods are located into flooding area, with no possibility of exist in case of need, makes it an organizational vulnerability.

On the other hand, we ask ourselves if some organizations are prepared to reduce the effects of catastrophic phenomena using surveying equipments and warning procedures according predefined regulations.

Individual vulnerability

This refers to ones fragility in front of a major phenomenon, using the intrinsic vulnerability, but also individual's exposure to a dangerous phenomenon. The vulnerability of an individual shows the capacity of a person to stand in the face of danger, and also the way to react to a catastrophe. The situation an individual confronts in the moment of a catastrophe makes the vulnerability big or small: this way, the individual faces a dangerous situation if he is in traffic in time of flooding.

Dependence vulnerability

More than a territorial or a social approach, dependence vulnerability represents the essence of urban vulnerability. It results from the relations established between land use, intern possessions and activities of the urban system, also from the relations between them and the urban system. The failure of the electricity supply can determine even the interruption of water supplies and, through its effects, can damage the whole urban system. The security of a town indirectly depends on security management in risk units. A city must know the different aspects of its vulnerability to integrate risk into its own function and to take the appropriate actions in reducing it.

3. The identification of vulnerable urban areas to water hazards

Outlining areas with different land vulnerability degrees took into account the presence and way of manifestation of many factors: flooded territories, high waterproofing and deep slopes territories, sectors with beds active dynamic, moisture excess and low underground waters depth, water gathering markets, low drainage slopes of sewage network or undersized sewage networks.

The floods from Arieş River drainage regime represent a big fase of flooding effects over environment. The historical drainage maximum is of 950 mc/s appeared at Turda in 03/07/1975, an year with big floods that affected 2/3 from town's population. The social, economical and ecological flooding effects vary from a flood to another.

Studies made by Sorocovschi, V., Şerban, Gh. and Bătinaş, R.(2002) reveals the flooding characteristics problems from lower Arieş basin and the risks that meadows got through. So, for the flood from March 1981, the water source from Cornești that supplied with water Turda, was put temporally out of service, and the riverbed recorded many modifications materialized into erosions, sedimentations, bank consolidations destruction. The discharges from the 1995 flood maintained over the defense level; in Turda, the attention level was exceeded for more than 120 hours and at the entrance of Arieş River was damped up. The flood from December, 1995, affected the catchment of Turda cement Enterprise and a dam of 500m long.

The flood from the spring of 2000 determined the degradation of a bottom crossing near Turda's water supplies (Moldovenești-Cornești), making necessary a bank consolidation. The modification of channel aspect is an important aspect tat appears after a flood. So, together with the floods from the spring of 2000, the river talweg decended 1 m at the Turda hydrometric station, and the bed slowly moved towards the left bank, amplifing the river's asymmetric characteristic. In Decembre, 2009, the river strongly eroded the left bank, and temporarely changed it course, leaving Mechel enterprise with no water supplies (Fig.1).

Figure.1. Arieş River diversion for the December 2009 flooding and damage to water mains from Mechel enterprise.

Using previous experiences from the vulnerable zones, a few have been presented into the Local Defense Plan against Floods in Turda town:

- No drainage area – aroud Clujului Str., Cuza Str., Ştefan cel Mare Str., 22 Decembrie Str., Câmpiei Str.;
- Moisture excess and/or ponds area – Băilor and Durgăului Alleys;
- Undersized sewage network areas or undersized bridges and platforms areas, locations with objectives affected by heavy rains –at the intersection between the streets: Clujului – Furtună; Cocoşului – Bariţiu; Clujului - Hotarului; Călăraşi - Dorobanţi; Vânători - Agriculturii; Sirenei - P. Maior; Castanilor - Barbu Lăutaru and Viilor - Avram Iancu.

There have been revealed all flood areas all over the town determined by river's overflow and also from torrential slope drainage:

- Poştarât District Area
- Turda Nouă – Valea Racilor Brook District Area
- Turda Nouă - Fâneața Vacilor Brook District Area
- Central District Area – Valea Racilor Brook downstream the confluence between Fâneața Vacilor Brook and Arieş
- Sănduleşti Street – Sănduleşti Brook
- Pordei Brook – Cheii Street
- Letf bank of Arieş River at Central Park
- Oprişani District, right bank of Arieş River

Big floods appeared Arieş River overflow in the years 1970, 1975 and smaller in the years 1981, 1984, 1995. Floods of the tributaries Valea Racilor, Fâneața Vacilor, Sănduleşti, Pordei, with low amplitude, appeared in the years 1984, 1995, 2005, 2007 and 2009. In June, 2010, took place an overflow of Valea Racilor Brook, together with street flooding after heavy rainfalls, affecting many households in Turda Nouă District (Fig.2).

Figure. 2. Valea Racilor Brook overflows, together with pluvial flooding in June 2010

In Câmpia Turzii, together with the floods from Arieş River, some objectives have been affected by heavy rainfalls in areas with no drainage, with excess of moisture (Şarât District), in areas with undersized sewage network. In June, 2006, after some heavy rainfalls, there appeared slope flows in the Călăraşi Area, flooding Călăraşi and Bogata villages, with an underground water level rising that determined the flooding of Şarât and some part of Sâncrai Districts. In July, 2011, a 20 minutes heavy rainfall was enough to flood the whole central area, because of many big impervious areas and because of the sewage network incapacity to evacuate pluvial waters (Fig. 3).

Figure. 3. Floods in Câmpia Turzii after flash floods and underground waters level rising.

3.1. Remedial proposals of critical situations

Vulnerability diagnostic procedure can be made at various scales (town, district, structure), according to the pursued objectives. It means elements of different nature (houses, institutions, activities, and networks), taking human, technical, material, economical or functional approaches (Guezo, Verrhiest, 2006).

Geographical vulnerability reduction can be accomplished through urban spatial planning, through the introduction of risk prevention plans and operational development plans. The spatial development plan is very important in risk prevention. Once the town grows, some problems appear the problem of urbanization methods for the risk exposed peripheral areas. The territorial planning scheme may define risk administration principles, giving development; it may encourage the displacement of risk industries from urban areas to more favorable ones. Also, risk prevention plans may present spaces less exposed to risks that are favorable to sustainable development. Sustainable development projects define the urbanism and development orientation, protecting environmental balance.

Structural vulnerability reduction may be obtained taking into account buildings architectural and structural conception. It often determines the behavior of a construction under risk and defines the exposure ways and future vulnerability factors. A strong influence over potential water overflows consequences it may have the buildings characteristics, the used material types, the location of electric installations and sensitive equipment. Choosing the right architectural and constructive directives taking risk into account, is the guarantee for a final minimal vulnerability.

Organizational vulnerability reduction

Those responsible with crisis management take into account the operational helping, intervention and security plans that have to mobilize human and technical resources in crisis times. The plans are made at different

organizational levels. There must be made some exercises from time to time to guarantee their efficiency in time. In the industrial areas, an important role comes to security management in supplementing intervention plans.

Individual vulnerability reduction

To accomplish this thing it is necessary that the citizen understand the risks perception and that each of them:

- Understand the risk nature and components
- Accept or not the risk; decide knowingly if they remain or not exposed
- Understand and assimilate risk inventory instruments
- Take the right actins in crisis time
- Know how to apply at his level the prevention, protection and vulnerability reduction methods
- Send risk information to other people
- Take part into local action programs and to communicate with local responsible and organization

Different instruments may contribute to risk culture development. First, it refers to preventive information, followed by the need of awareness and information actions: publications, exhibitions, videos, radio and public announcements, etc.

Dependence vulnerability reduction

There exists no instrument in dependence vulnerability reduction. It starts with hazards identification, with urban system analyze and with the consequences determined by its function. This diagnostic must reveal the functional territorial relations, the vital elements, the induced effects and the catastrophes "domino effects". Once the predictable dysfunctions have been identified, the dependence vulnerability reduction consists in enhancing strategic networks and alternative procedures for minimal crisis functioning.

The *Local Committees for Emergency Situations* from the urban area of Turda and Câmpia Turzii are brought into existence and they function to prevent and handle emergency situations, to coordinate human, material and financial resources necessary in coming back to a normal situation. In a few hours, a volunteer service for emergency situations is formed for protecting life, goods and environment against disasters, and also to take protective and intervention measures in case of risk generating situations.

Town halls are in charge with risk mapping in case of localities flooding from water overflow or from slope and pluvial flow, and with including them into Local Urbanism Planning (Fig.4). They are also in charge with implementing construction regulations in flood areas according to Law No. 575/2001 about approving national territory development plan.

The role of committees is to organize the information services and the training exercises on civil protection. They inform, alert and prepare the population

to take the right measures in case of flooding. According to local floods defense plans, there are organized some flood effects limitation actions that include population evacuation, distressed housing and their supplying with food and medical assistance. There are provide necessary funds for flood defense operative actions, for maintain and repairing hydro technical constructions and for maintaining the water courses from affected area (Table 1).

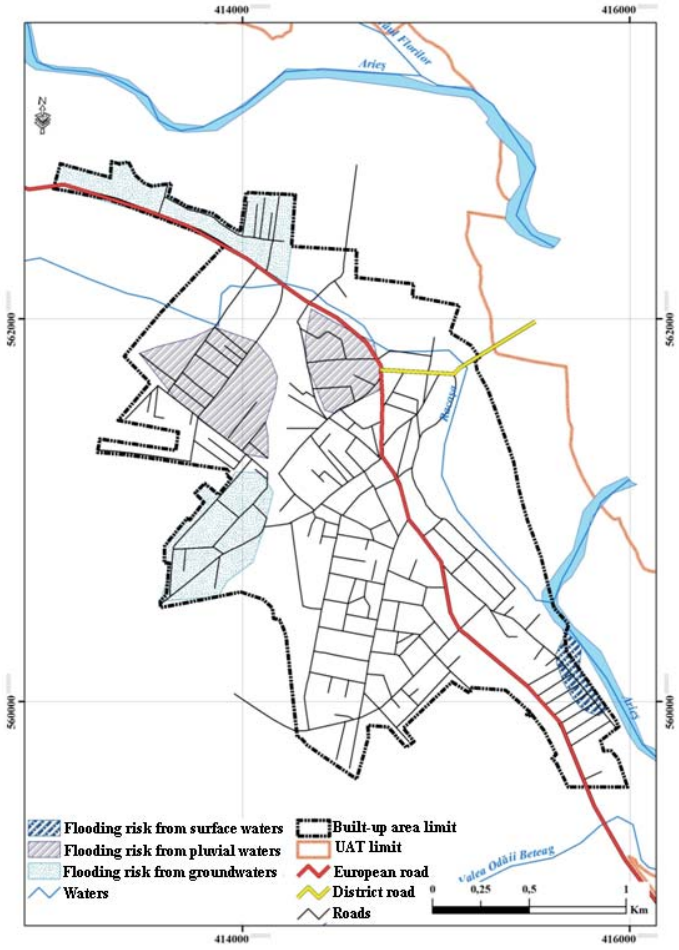

Figure.4. Flooding risk areas map Câmpia Turzii Town.

To reduce flood risk on lower Arieş Basin, there have been made some watercourses planning works. An important role in diminishing flood risk it has Mihoieşti reservoir, even though it is not settled into lower Arieş basin. To reduce flood risks in urban areas in lower Arieş basin, some small non-permanent storage

basins have been made into the drainage basin (Sorocovschi, V., 2002). Tureni reservoir on Valea Racilor Brook, left side Arieş tributary, helps flood defense for Tureni, Copăceni and Turda localities. Fâneața Vacilor and Tăul Ceanului reservoirs from Fâneața Vacilor basin also help the protection against floods of Turda town.

Table 1. Defense characteristics data of flooding targets in the urban area of Turda-Câmpia Turzii

No	Water course / Flooding risk sources	Targets within range of risk	Existing hydrometric defence systems	Account insurance of existing hydrometric constructions
1.	R. Arieş – Poştarât District	102 households, 2 econ. ag., 2 km roads, 50 ha agricultural lands		Q asig.5% = 640 mc/s
2.	Valea Racilor Brook (till confluence)	540 households, 20 econ. ag., 9,2 km roads, 6 bridges	Tureni Accumulation Vol.Tot=10,5 mil. mc; Brook regulation L=2 km	V coresp. asig. level 1% = 3.9 mil. mc;
3.	Fâneața Vacilor Brook	1100 households, 10 economical ag., 3,3 km roads, 3 bridges	Fâneața Vacilor Accumulation Vol.tot.=8,3 mil.mc; Brook regulation L=3 km	V coresp. asig. level 1% = 3.9 mil. mc;
4.	Valea Racilor Brook (after confluence)	170 households, 5 economical ag. 5 km roads, 6bridges	Brook regulation L=3 km	
5.	Sănduleşti Brook – Sandulesti street	20 households, 2km roads, 10 ha agricultural land, 2 bridges	Brook regulation L=2 km	
6.	Pordei Brook - Cheii Street	30 households, 1 km roads, 4 ha agricultural land, 1 bridge		
7.	Arieş River – the left bank near the Park	15 households, 0,5 km roads	Banking Mihai Viteazu-Turda-Câmpia Turzii; Arieş Dam left bank L=600m, l ridge =3m	III imp.class Q1%=640mc/s From1987
8.	Arieş River – right bank (Oprisani, Poiana)	7800 aparts., 30 economical ag., 41,6 km roads, 20 km sewerage, 2 bridges	Banking Râul Arieş right bank L=3798 m l ridge =4m	II imp.class, Q1%=1100mc/s From 1988
9.	Arieş River at Câmpia Turzi	Wastewater treatment plant	Arieş earth dam, L=3 Km	Q1%=1100mc/s From 1982

River banking is another protection way for flood areas. There are dikes on Arieş River between Turda and Câmpia Turzii, on a length of 21 km, between the road bridge heading Cheia village (upstream) and at the confluence between Racoşa Brook and Arieş River at Câmpia Turzii (downstream). The main negative aspects in case of flooding are dike's erosion, and also dike infiltrations and even breaches.

Table 2. Characteristic data for operative actions of Local Emergency Committee

No	**Water course/ flooding risk sources**	**Local hydro metric stations**	**Local defense measures**			**Warning hydro metric stations**	**Defense – warning measures**		
			CA*	CI*	CP*		CA*	CI*	CP*
			Cod G*	Cod P*	Cod R*		Cod G*	Cod P*	Cod R*
							Rainfalls critical thresholds		
							25 l/mp/h	35 l/mp/h	50 l/mp/h
							45l/mp/3h	60 l/mp/3h	80 l/mp/3h
1.	Arieş River	SH Turda	370 cm	425 cm	475 cm	SH Baia de Arieş	250 cm	300 cm	400 cm
						SH Buru	250 cm	350 cm	450 cm
						SH Turda	300 cm	350 cm	500 cm
2.	Valea Racilor Brook					Tureni Dam	522,7 Md M=12,2 m/rod	523,7 Md M=13,2 m/rod	524,7 Md M=14,25 m/rod
3.	Fâneaţa Vacilor Brook					Fâneaţa Vacilor Dam	354,5 Md M=14 m/rod	355,5 Md M=15 m/rod	356,2 Md M=15,75 m/rod

* Code G -Yellow code warning ; * CA – Level of attention to flood; * Code P - Orange code warning; * CI – Level of flood; * Code R – Red code warn; * CP – Level of flood risk

When national weather and hydrological warnings are issued, Local Committees have to initiate population notification – warning systems (Table 2). Once the attention level is exceeded, the alarm is started (flood alarm). Emergency Committee takes operative measures to reduce the phenomenon and to prepare everybody for probable dangerous situations. In case of danger, it takes the measures to limit floods effects.

Local Emergency Committee has to analyze all data for right operative actions in case of flooding: local defense measures, warning measures, objectives with flood risk, the existence of hydro-technical constructions.

5. Conclusions

Taking into account the space employment density, there appear interactions between people, activities and goods. This density may bring opportunities, but also vulnerability. It represents more than the sum of individual elements vulnerability. Dependence vulnerability, even though it is not the only urban vulnerability, expresses the reality of this concept. The multitude of available instruments for urban vulnerability reduction shows the fact that it must not be seen as an isolated action or an assembly with no interconnections. It is an important part of the urban risk management plan. This global strategy must reflect over territorial evolution. It also represents a set of decisions from the local authority's part. Only following this global plan, with a partnership between all actors involved into urban risk management, the town may be on sustainable development trend.

REFERENCES

1. Bălteanu, D., Costache, Andra (2006), *Conceptul de vulnerabilitate. Aplicații în geografie*. Rev. Geogr. XII/2005
2. Bătinaș, R., Sorocovschi, V., Șerban, Gh. (2002), *Fenomene hidrologice de risc induse de viituri în Bazinul inferior al Arieşului*, Seminarul Geografic "Dimitrie Cantemir", nr 21-22, Iaşi
3. Dauphiné, A., (2001), *Risques et catastrophes*, Armand Colin, Paris
4. D'Ercole, R.,(1994), *La vulnerabilité des sociétés et des espaces urbanises: concepts, typologie, mode d'analyse*, Revue de géographie alpine, no.4, Grenoble
5. Grecu, Florina (2006), *Hazarde şi riscuri naturale*, Edit. Universității, Bucureşti
6. Guezo, B., Verrhiest, G.(2006), *Reduire la vulnerabilité urbaine aux risques majeurs*, Revue Techni.Cites, Dossier CERTU, no.108
7. Pigeon, P. (2005), *Géographie critique des risques*, Economica Anthropos, Paris
8. Sorocovschi, V., (2007), *Vulnerabilitatea componentă a riscului. Concept, variabile de control, tipuri şi modele de evaluare*, în "Riscuri şi Catastrofe", Editor Victor Sorocovschi, an VI, nr.4, Edit. Casa Cărții de Stiință, Cluj-Napoca