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Living with floods in towns and cities

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Abstract: Urbanization is facing now a dramatic challenge being at a point when this process must select between regeneration and new approaches to alleviating poverty and supporting communities. As a fundamental feature of world-wide civilization, the urbanization process based only on economical and population growth, in the absence of policy reform, stronger institutions, and enlightened political leadership, may lead to a deterioration of the urban environment, both physical and social (with an increased risk in developing countries). Two of the issues which are emerging are particularly critical are based on water management in general terms and especially on urban flood management. All the countries involved in urban regeneration process understand the necessity of adopting a common policy based on the following paradigm: a beautiful city is an efficient city. Urban areas must find the direction guided by environmental principles (free way for water), aesthetical principles as well as economical sustainable principles. Objective: The main idea of this paper is that urban flood management and the sustainability of urban structural and non-structural measures for an integrated flooding management can meets the needs and aspirations of the present urban generation without compromising the ability of future generations to meet their own needs.

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Keywords: floods, water management, structural, non-structural

1. INTRODUCTION

Even all ancient great civilizations developed on river banks, mankind has always wanted safety from natural hazards. A total protection against flood is very hardly to be achieved that is why we must understand that we will have to live with them by using the tools which we have so far including between them the structural measures as are land drainage and urban drainage and the non-structural measure which can consist in efficient specific policies and strategies.

Literary speaking, drainage means the removal of a liquid. According to Oosterbaan (1991), an example of ambiguous definition for drainage can be: "the removal of water excess from field as fastest as possible". This type of drainage is required to change the land hydrological characteristics for a specific purpose. The fast removal of water is often seen by the hydrologist (and the practitioners in environment protection) as menace higher than flooding. This fast process can be a source of drought phenomenon occurrence (it prevents the water storage in soil – storage which can prove to be useful during drought periods). Meanwhile, water is carrying pollutants with a high negative impact. The term of water excess, from hydrological point of view have a much more harmful meaning because suppose high values of water flows which are requesting expensive drainage systems and can lead to environment problems. As a conclusion, we need to design drainage systems which are able, in a relative short time, to remove the water excess with a low cautious flow. These definitions are general but they can be adapted for the specific conditions of urban areas [1].

The continuous migration of people towards towns and cities caused an encroachment of built-up areas in their peripheries. In the same time, this migration process is producing changes in agricultural areas. In both cases, the major impact will be on land use and furthermore on the hydrological processes.

With a supplementary pressure created by climatic changes, the role of land drainage and especially of urban drainage and urban flood management will increase as complexity and will have to deal not only with their main purposes but mainly with the necessity of applying a new philosophy in drainage infrastructure design and the principles of sustainable urban drainage systems.

2. HISTORICAL ASPECTS OF LAND DRAINAGE AND URBAN DRAINAGE

Urban drainage and urban flood management had a long history. Etruscans succeeded in draining lakes and swamps, an example being the Valley of Chiana River. In his study about antic civilizations from Meridian Italy, Professor Adamesteanu, in 1983, reports here about important surface drainage arrangements, dating from the 5th century and submitted under protection of demigod Achelaos, which had the gift of land purification and amelioration. In the ancient Rome dominated perishable construction materials as wood but the Etruscans brought in this city materials as rocks and

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bricks which were used for urban sewers, drainage arrangements, evolved communication roads.

Etruscans had strong knowledge of hydrology and hydraulics. Large low areas of Rome, as it was the one between Capitoliu and Velia, were swampy areas. The development of this areas and the creation of settlements weren't possible without a very good hydraulics technique. The first data about the availability of drainage canals, on actual Romania's territory, is dating from the Neolithic period. A group of houses near a water source formed a hamlet, which in the plain Neolithic settlements was surrounded by a ditch with fence function and for collecting the inside waters, a forerunner of the later drainage channels. These trenches - fossatum - were characteristic for Dacian villages Dacian-Roman [2, 3].

Archaeological excavations on the territory of our country show that the Geto-Dacian settlements were surrounded by collection and disposal ditches of water from precipitation, land resulting from the excavations being placed outdoors in the form of a dam. In fact, the word dyke is of Geto-Dacian "dhejgh", the same word used and understood today ("dig"). Dacians from Cris and Beretaului Valley, residents of a marshy area, could not be conquered by Romans due to their mastery in building dams against floods, dams also used for defense against invaders [4].

At the former capital of Dacia, Sarmizegetusa Regia, homes disposed of systems for water intake and water transport but also drainage systems for pluvial water. In order to evacuate the water from precipitations (which seems that were significant as volumes in antiquity) and for avoiding water infiltration in different constructions, were used drainage channels, most of them presented as small ditches (see figure below). In the sacred area were channels realized from carved limestone elements. Such a channel consisted in carved limestone blocks (with U section), perfectly linked and covered by limestone slabs. After a while, when the channel had a proper depth, it was covered by elements identical with the one from inferior part [5].

As it can be seen, in the ancient period, drainage had a complex role, both hydroameliorative and sanitary. According to Butler and Davies (2011), the English word *sewer* is derived from an Old French word, *essever*, meaning 'to drain off', related to the Latin *ex-* (out) and *aqua* (water). The Oxford English Dictionary gives the earliest meaning as 'an artificial watercourse for draining marshy land and carrying off surface water into a river or the sea'. Before 1600, the word was not associated with wastewater [6].

Middle Age is a period when role of drainage is almost inexistent for several centuries. Many swampy areas were kept as they were for military purposes, as strategic defensive positions against different invaders. We can say that the migrations of different tribes from East and especially the Huns attack on Middle and Western Europe contribute to large black holes in drainage history. After 1600 the role of drainage increased in importance and knew a continuous development in terms of surfaces covered and in technique.

3. URBAN FLOOD MANAGEMENT

According to a recently EEA report, flooding is, along with storms, the most important natural hazard in Europe in terms of economic losses. The floods that caused the largest economic losses occurred in the Elbe Basin in 2002 (over EUR 20 billion), in Italy, France and the Swiss Alps in 2000 (around EUR 12 billion), and a series of those in the United Kingdom during the summer of 2007 (accumulated losses exceeded EUR 4 billion). The events causing the highest number of fatalities were the floods in Romania in 2005 (85 fatalities) and the 1998 disaster in Slovakia (54 fatalities) [7].

The last floods which affected large surfaces in Europe had many causes as:

- dam damage as a result of very high flows, which exceeded the de flows used in designed process of dams, and the extremely high time of their action on dams (over 20 days);
- deforestation;
- lack of gutters and storm water drainage ditches or a poor maintenance of the existing in many rural areas;
- clogging, low capacity of transport or a poor maintenance of sewage networks, which are inadequate for actual torrential rainfall regimes;
- placement of unauthorized items (houses, household, etc.) on flood plains;
- building homes in flood plains, on inadequate foundations and with poor quality materials;
- exceeded carrying capacity of bridges and footbridges sections, both because underflow and blocking drainage sections with timber, household waste or technological waste, stored in riverbeds or involved from slopes;
- failure by owners to ensure the flow in the bridges sections in accordance with legal provisions in force;
- lack of or insufficient inventories of materials and means of intervention at the level of local emergency committees;
- lack in securing a permanency in some rural municipalities, which interrupt the operation of informational flow for population alarming-alerting;
- lack of awareness by local government and the public of functions and measures necessary to be taken in emergency situations caused by floods and hazardous weather phenomena.

Flooding of cities and towns can have two major groups of causes: anthropic (severe urbanization – flooding which involves small watersheds) and natural (climatic changes – flooding which involves large watersheds).

Urbanization, with respect for flood management and urban drainage, means changing green to grey, causing high and dramatic changes regarding the hydrologic and geomorphic systems where rural land is converted, sometimes only in a first phase, to suburban. Urban development can also create obstructions to runoff, such as sanitary landfills, bridges, inadequate drainage, obstructions of runoff

and conduits, and clogging. The increase of impervious areas which prevents the infiltration process will lead to high peak flows which will increase the pressure on sewer systems. Current urban flood management practice includes a non-quantified safety factor. In comparison with land drainage and the hydrology of land drainage, is rather difficult to measure data and to establish statistics in a very complex space as is urban space. The high number of factors which are involved in urban space hydrology slows the possibilities and capacities of predicting the frequencies of peak flows occurrence as well as the features of urban runoff phenomenon [8].

In urban area, unlike open rural space, it prevail impervious surfaces which are strongly affecting the runoff process and the infiltration process. A comparison regarding the rates of infiltration and runoff in different environments is presented in the following picture:

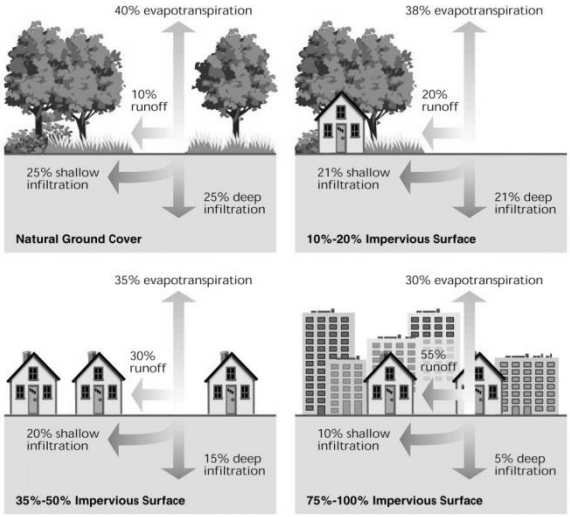

Figure 2. The influence of impervious surface size on runoff and deep infiltration [9] (Source: Stream Corridor Restoration: Principles, Processes, and Practices. Federal Interagency Stream Restoration Working Group, 1998.)

However, in urban space we have enough conditions to determine accurately relevant data concerning precipitation and even runoff. Flood management policies should be basically founded on mathematical modeling and sound engineering practice rather than on statistic and probabilistic analyses.

In many countries, the defense plans for flood management are established at river-basin levels. All the structural measures were designed and engineered at this level, protection both rural and urban spaces. The last decades proved that this conventional approach is no longer sufficient enough to provide an acceptable protection against flooding. An urban flood management system must cover not only structural measures (focused especially on economic and social protection) but also non-structural measures and environmental measures. Flood related pollution issues, such as hazard to health, due to water borne diseases, and large cleanup costs, deserve the same attention as traditionally favored flood related physical destruction themes.

Some authors propose to replace conventional structure measures by an alternative, contemporary set of structural measures, by adding an important objective of reducing water pollution through non-point source pollution control, combined sewer overflow control, recovery of wetlands and erosion control. In addition, traditional flood modifying and against-flood protecting measures need to be amended with two new measures characteristic only for urban settings: small near-to-source detention structures and low cost protection techniques. On the other side, rural areas suffered because thinking, valuing and planning the countryside is done mainly by urbanites and future rural development is mainly focused upon the urban needs [8].

Traditional flood defense measures in urban areas are generally based on non-friendly environmental solutions [10]. Green areas were replaced in time by grey areas in order to resolve the immediate necessities: economical and social protection. In order to increase cities and towns flood resilience capacities we must adopt the strategies to the following terms: Living with Floods, Space for Water, Room for the River.

These strategies will imply structural measures (which are engineering works) and non-structural measures (consisting in Flood preparedness measures and Emergency response measures). The structural measures can be classified in watershed impact measures (with role in decreasing the flood peaks) and river bed impact measures consisting in: construction of dykes and polders, attenuation reservoirs and basins, diversion canals. For urban areas flooding protection may include the following structural measures: green parking areas; green roofs; urban wetlands; dykes repositioning; correction and recalibration of adjusted river beds.

Some of the advantages gained after applying these measures are: space for water in case of high flows by developing the main river bed; biodiversity development; creation of wetlands; a significant increase of water course remediation; landscaping improvement.

Difficulties may appear from the investments value point of view. The investments can be high but they will prove their efficiency in time if they will be properly managed. Areas improved from landscaping point of view can be used in commercial purposes, tourism and other economic sectors.

All the structural measures must be completed by non-structural measures as are: creation of a flood preparedness plan, media campaigns for population training in case of flooding etc. Flood preparedness plan is a series of sub-plans, including emergency response planning and training, raising public awareness, flood forecasting and warning, setting development policy, land use regulation, flood proofing, setting alternative plans, and local social structure strengthening. Emergency response can be considered as a series of sub-plans that address communication and public information management, search and rescue co-ordination, shelter management, stockpiling and distributing of food and supplies, contacting and requesting additional support, debris

management, financial management, volunteers co-ordination and donations management [8].

4. DISCUSSIONS: PRINCIPLES OF PLANNING FOR 21ST CENTURY

An Urban Flood Management (UFM) plan must be adapted at the requirements of 21st century. UFM should cover, in a sustainable manner, the two parts of a flood event: prevention and restoration. According to ASCE/UNESCO (1998), sustainable water systems are 'those systems designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental and hydrological integrity' [12].

A sustainable urban flood management plan must wear the mark of public participation, individual responsibility and be focused on measures that are environmentally friendly, socially acceptable and financially viable. Only the combination of the contemporary analytical approaches and empirical techniques may lead to an integrated, environmentally sustainable and economically feasible management plan.

A sustainable urban flood management plan must be characterize by 7 factors:

- scientific aspect, because of research and deductive reasoning being used
- artistic aspect, because of creativity needed
- technical aspect, because of approximations needed due to shortage of reliable measured data
- legal aspect, because of legislature needed to enforce the proposed measures
- political aspect, because of priority issues and necessary trade-off between the calculated risk and the proposed protection level
- social aspect, because of the importance of public participation and the involvement of public-private partnerships
- financial aspects, because of the necessity of applying a healthy investment program and sustainable insurance system [8].

From scientific and technical point of view, the structural measures included in this plan must be based on urban drainage criteria and urban flood management criteria. Generally speaking, criteria are specific operational, performance oriented, requirements relative to construction, operation and maintenance of stormwater drainage and flood control facilities. They should be reviewed periodically and revised in the light of new knowledge and changing urban circumstances. Unless otherwise required, reviews of criteria should be made at time intervals ranging from five to ten years [8].

In the same time, these criteria must fulfill the requirements of urban regeneration mechanism. The criteria which are defining an urban flood management plan can be divided in five categories:

- Economic: private investments in urban flood protection, private investments retired due to flood events, rate of unemployment because of flood events, the level of urban economic declining due to flood events, the level of entrepreneurship as result of increasing flooding defense system or as results of a flooding etc.;
- Social: the potential impact of flooding on poverty, the potential impact of flooding on services system and infrastructure, etc.;
- Spatial: economic losses because of illegal residential development affected by flooding, the impact of flooding on high-residential areas etc.;
- Environmental: the impact of loss of green spaces on flooding development, the degradation of urban landscape because of flooding, destruction of cultural sites and monuments, etc.;
- Institutional: complex and outdated urban flooding management framework, poor implementation of flood protection system, overlapping responsibilities, number of partnerships created for urban flooding system development and implementation.

Regarding the social aspect, some relevant examples of partnerships involved in urban flood management (urban drainage) are coming from UK. The UK Government's strategy for flood and coastal erosion risk management, Making Space for Water (MSfW), set out a portfolio of approaches to ensure that flood risks are managed more effectively in the future by adopting an holistic, joined-up, and integrated approach. An area of particular concern in MSfW was flooding in urban areas from surface water due to inadequacies in drainage systems; the need for integrated urban drainage management (IUDM) approaches was identified [13]. In MSfW the Government recognised that the physical and institutional complexities of urban drainage systems make it difficult to plan and deliver systems with reduced flood risk. Most pilot projects had the local authority, the water company or the Environment Agency in a lead role. Others tested the leadership of an internal drainage board, a regeneration company or a technical consultant acting on behalf of the stakeholder partnership. The overall experience was that any organisation can contain individuals with the skills and drive to lead integrated urban drainage work. The critical success factors in the pilots were the people rather than the institutions leading; a reflection that IUDM is a new approaches where there is currently little embedded experience within stakeholder groups [13]. As anticipated, water companies were effective in leading where surface water management issues were dominated by the operation of the public sewers system in highly urbanised city areas but even here they required input from other stakeholders to understand interactions with water courses and areas contributing runoff from the urban fringe.

The financial protection and the insurance system for an urban flooding management must be strongly linked with the other aspects and must we well explained and understand by public. Urban space is a result of transforming rural space generally with private investments which increased the land value. a community that obtained the capital increment resulting from land use change can apply a levy to any ratable land that had increased in value by belonging to the flood protection scheme. The

proceeds of the levy should be directed towards the costs of further capital improvement. A levy is imposed only on flood-affected properties and its collection ceases on completion of the project. User charges still remain after completion of the capital improvement to cover the costs of operation and maintenance [8].

From political and legislative point of view, in order to improve the response capacity of local authorities, in Romania have been developed two important documents: the Prefect's Manual for emergency management in case of flooding and the Mayor's Manual for emergency management in case of flooding. The Romanian Government launched a finance program for development of natural hazard mapping (flood and landslides) in every county. In the cities, towns and villages will be set up local emergency committees, consisting of a president (mayor), vice president (a deputy), and members: the secretary of the village, city or municipal sector; representatives of key public services and institutions and businesses of the administrative-territorial unit, as well as managers and leaders of economic operators, affiliates, subsidiaries or local working points, which, through specific activities, are potential risk factors generators of emergency situations.

Emergency meetings of committees shall be conducted in the presence of a majority of members or designated replacements. Emergency committee decisions shall be adopted by a vote of two thirds of the members present, except for implementing the evacuation plan, which is based on the decision of the President of the Committee. In the cities, towns, municipalities, public institutions and economic operators involved in the classification in terms of civil protection, must be employed personal specialist in the field of civil protection duties. Local authorities ensure the establishment and integration of civil protection measures in plans and economic and social development programs that are developed locally and follow their achievement.

Preventive measures and action plans of civil protection are priority planned and implemented by all local authorities according to their skills. Local authorities bear full responsibility for ensuring the conditions for survival of the population affected by the consequences of emergency situations.

Ensuring compliance is achieved through emergency services, municipal public services, institutions and businesses, including the using, under the law, of supplies from state reserves and goods and services provided by the non-governmental organizations, local communities and the unaffected population, state and foreign organizations or international nature.

The mayor should have at least the following main tasks: propose to local council the organizational structure for civil protection; brings out the decisions of the local council in civil protection; approves the operational plans, training exercises and planning specialist; proposes the carrying out civil protection measures; participates in exercises, applications and activities training on civil protection; coordinates the activity of volunteer emergency services; approves the plans for cooperation with neighbouring municipalities and NGO; takes measures and controls the maintenance of collective accommodation spaces by their administrator; seeks the development, maintenance and operation of alarming systems in case of Civil Protection; is responsible for alarm, protecting and preparing the population for cases of civil protection; requests assistance and support for civil protection management situations; controls the implementation of civil protection measures at local level; provide assessment and centralize requests for assistance and compensation in case of civil protection as well as the distribution of incoming; coordinates evacuation of people from areas directly affected by civil defense situations; determine appropriate measures to ensure the feeding, accommodation and water supply of the evacuated population; takes measures to ensure public order in the affected area; cooperates with mayors of neighbouring sectors; manage, store, maintain and preserve the technique, equipment and materials for civil protection through subordinate professional services [14].

Mayors have the following specific tasks for the management of emergencies arising from floods, hazardous weather, accidents and accidental pollution from hydraulic structures:

- ensure consistent operating conditions in town halls, post offices and police stations;
- provide the means to notice and alarm the population from areas at risk that may be affected by flooding, hazardous weather, accidents and accidental pollution from hydraulic structures;
- coordinate the preparation of the population to achieve protection and intervention measures in case of floods, hazardous weather, accidents and accidental pollution from hydraulic structures;
- ensure the establishment plan for defense against floods, ice and spill;
- organizes actions to limit and removing the effects of floods and accidental pollution, hazardous weather, to save people, animals and material goods, first aid, evacuation and transportation of victims, victims accommodation, water and food, medical assistance for affected people, withdraw from consumption of contaminated supplies;
- establish, together with operators and specialized units, actions and operational measures for the identification and burial of deceased persons, restoration of running municipal services and utilities, transportation, telecommunications and water supply, electricity and natural gas;
- collect the data on the consequences of floods, hazardous weather and accidental pollution and prepare operational reports and summaries foreseen in annexes and send them to Inspectorate for Emergency Situations and to the Operative Center for Water Management System;
- provide the necessary funds for setting up and completing inventories of materials and means of defense, for defense operative actions against flooding, maintenance and repair the hydraulic construction and maintenance of watercourses beds in the localities;

- ensure the achievement and proper maintenance of drainage ditches and gutters for rain water, wood and waste removal from the watercourses major bed, drainage sections of bridges and footbridges [15].

The Counties Councils have also a lot of attributions represented by preventing actions, actions which must be deployed during the event and actions after phenomenon. Among preventing actions can be mentioned:

- identification of flood plains situated in the county under their jurisdiction;
- realization of operational county plans for flood protection in accordance with the existing specific legislation on emergency management;
- realization of flood protection strategy at county level based on real data about the physical, economic, cultural and value system vulnerability;
- developing a book on the flood risk, for municipalities, human communities and the establishment of a county-level continuous service monitoring of flood events and their consequences;
- coordination of activities focused on the elaboration of hazards maps identification, hazard maps and flood risk maps at district level and coordinate the preparation of these documents to the territorial administrative units under their jurisdiction;
- organization of activities focused on human communities consultation regarding regional development strategy and taking into account the national flood management strategy and appropriate investigations;
- consultation before any decision of the association structures of local authorities provided by law in all matters that concern them directly under the law and taking appropriate views in the content of draft normative acts;
- take action for informing, educating and training people on how to behave before, during and after the occurrence and the role of individual protection [16].

The actions foreseen to be deployed during the event and after event are generally similar and in concordance with Mayoralties responsibilities but at county level.

5. CONCLUSIONS

Rivers have always played an important role in towns and cities development. A river is not just a water supplier but also, maybe more important, a dynamic ecosystem with frequent changes and specific characteristics influenced by many factors as local climate, geology etc. Human society, being in a continuous development and with high needs in new territories, finds in rivers a redoubtable adversary. The interference led, in centuries, to a radical alteration of rivers watercourses and major beds which had responded by flooding properties and livelihoods.

The result was an arms race, humanity with higher and stronger dikes, and other flood defence, rivers with higher flow peaks with a strong destructive force. An armistice was signed once with the appearance of Water Framework Directive 2000/60/EC but in order to be "peace", humanity must work with nature and stop fighting against it. Regional and local authorities must develop integrated management plans for rivers in order to recreate their natural floodplains. Flood control can be introduced with the following tools: the urban flooding management master plan, municipal/provincial legislation and the urban drainage manual. The first sets out the main policies, the second controls implementation and the third offers guidance.

The origins and consequences of flooding have to be fully understood, particularly in developing countries, in order to propose and justify adequate institutional strengthening (regulatory agencies, conservation authorities) which should overcome existing institutional and political barriers.

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