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TOWARDS A SPECIFIC APPROACH OF URBAN HYDROLOGY IN AFRICA

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Abstract

Fast urban growing in Africa leads to serious urban drainage problems that cannot always be solved by means of simple technical transfers from developed countries. A specific approach of urban hydrology in Africa is urgently needed. However, such an approach cannot be efficiently performed by only studying some specific aspects of African hydrological processes. It must also involved proposals for technical solutions which could be well adapted to local socio-economic conditions, and it must consider that urban storm drainage is one of the major factor when designing the land uses in African cities. Are given some comparative elements related to urban drainage in developed and developing countries, so are proposed elements for a specific approach of urban hydrology in Africa, including technical solutions and research axis on urban storm drainage. Most of these elements given there have been already presented by the authors in a recent French conference (Water, City and Development, june 86, Marseille, Institut for Science and Technic of Equipment and Environment for Development).

Hydrology and urban growth in Africa

One of the major consequences of industrial and economic development has been, till now, the growth of urban populations, mainly due to

mechanization of agricultural productions.

The migration of people from rural space to urban areas has begun at the end of 19th century in most of the developed countries. The migration is still existing but at low rates. Some opposite movments have even been observed in some French cities.

In developing countries, the rates of urban population growth are high. These rates are often amplified by the worldwide economic crisis and sometimes by natural disasters (severe drought in the Sahel areas for example). In 1979, some estimates from UNESCO concluded that urban population of Africa would have been multiplied by 4 from 1970 to 2000 (Table 1)(Lindh, 1985).

Table 1. Growth factor of urban population for the 1970-2000 period

Europe	1.5	East Asia	2.7
North America	1.7	Latin America	3.1
USSR	1.8	South Asia	3.3
South Sea Islands	1.9	Africa	4.2

Such a value indicates that urban population would increase by 5% a year on a mean basis, with probably increases higher than 10% a year in some cities. Such urban growths lead to strong changes in natural space, with some damages to the water cycle components (quantity and quality) and some bad consequences for people health. The solutions adopted in developed countries for urban drainage cannot be always well adapted to the technical and socio-economic conditions encountered in African countries.

If a lot of studies on waste waters disposal have been already done in these countries, similar studies related to storm drainage must be performed in order to detect some specific aspects of African cities and to lead to well adapted technical solutions;

Urban drainage in developed countries

Based on sanitary concepts, the technical solutions adopted in developed

countries, from 19th century to now, consist of a fast transport of polluted waters to treatment plants or to receiving waters. This is usually done by underground sewer systems. Such concepts, associated with the separation of wastewater and storwater in some countries (France for example), and with high protection levels against stormwater flooding lead to costly solutions regarding construction and maintenance of the adopted systems.

For approximatively fifteen years have been developed some new concepts based on storm runoff delay over urban catchments leading to technical solutions such as detention ponds, porous pavements, infiltration facilities of various size. Such solutions may have interesting effects in reducing stormwater discharges and volumes and also pollutants loads which are discharged in receiving waters. However, they are not yet frequently chosen, mainly due to the historical development of sewer systems which cannot be often quickly adapted to these new solutions.

However, one must notice that choosing a new technical facility does not necessarily mean a less expensive solution, mainly if management and maintenance problems have been uderestimated. For that reason, for example, according to Fujita (1984), the infiltration facilities recently developed in Japan, have been designed at the same time as the technic and tools for the maintenance of these facilities. In developed countries the new concepts for urban storm drainage are resulting not only from the ever growing costs of drainage equipments but also from a big research effort in urban hydrology.

Urban drainage in West and Center Africa

Most of the cities in West and Center Africa show undeveloped drainage equipments. This situation is made worse by high population growth and unadvised urbanization. Even with lower growth rates, classical sewer systems would lead to very expensive solutions with difficult maintenance problems (mainly due to sediment transport) and sanitary disorders.

New technical solutions are necessary which should be much more suitable

to growth rates of African cities and to their socio-economic conditions According to the experience of developed countries, one should propose technical solutions controling rather small areas and which can fit the urbanization growth. However, the new equipments which can be encountered in developed countries and which have been mentioned above may not be directly transfered to developing ones, without a careful study of local climatic and socio-economic conditions. In our opinion, a good solution must have the following characteristics:

- it must not induce strong constrains for the users;
- it must be easily and quickly constructed: in that way it may be quickly adapted to a changing socio-economic environment;
- it must not induce new disorders and nuisances, especially in the sanitary domain;
- it must not need costly importing of materials or equipments, and, on the contrary, it may to local economic developments;
- it must not be regarded as a poor cheap technic but as a specific solution better adapted than others which have been designed for very different climatic and socio-economic conditions.

Regarding urban storm drainage, one would already make some proposals. The European experience has shown that stormwater removal leads to high investments and maintenance costs when using classical sewer systems which have been designed after land use planing. For some socio-economic conditions, stormwater drainage may be a major factor of urban land planing. For example, urban streets and raods may be considered as a major component of storm drainage sytem. Such a concept leads to a "minor" system which is a classical sewer system designed for frequent rainfalls (2 years return period fof example), and a "major" system consisting of streets themselves, designed for large storm events (50 years return period or more).

Heberling (1985) has described three different ways for the design of such streets. For the most interesting one, streets carry off the runoff laterally from the area to be protected. In this case, streets design becomes the first srep of land planing.

In the same way, Schulz-Ehlbeck and Maikibi (1985), in a study related to the drainage of the city of Tahoua (Niger), have proposed paved streets for storm drainage. If compared to a classical sewer system, such a technic has a lot of advantages:

- no specialized staff nor heavy earthwork equipments are necessary;
- maintenance works are limited to pavement repairing;
- construction materials are not imported;
- workmen can be locally engaged;
- it is less expensive than classical asphalt streets and classical drainage systems using open channels (which generally lead to serious sanitary problems due to some misunderstanding of their function from people living along the channels) or classical sewer system, in the socio-economic context of the city of Tahoua.

Such a technic is in agreement with the characteristics previously mentioned. in particular, it must not be considered as a poor technic. On the contrary, it would be an interesting solution for some urban land uses in developed countries. Unfortunately, it cannot be generally used there because it leads to costly investments due to socio-economic conditions in these countries (mainly dealing with cost of labour). In the same way, detention ponds and infiltration facilities have been studied by Herz (1985) in the Sahel zone, considering three types of areas to be controled: a housing parcel, a group of housing parcels, and large catchments outside the cities. Herz and Heberling (1981) have previously proposed a system of stormwater detention ponds for the city of Zinder (Niger) which should not only reduce the investments for collectors (lower discharges) but also limit the damages resulting from runoff (erosion) and flooding. Here again, such solutions appear as major components of land planing because detention ponds sites must be chosen before urbanization, in order to be efficient. At the same time as looking for specific technical solutions, an approach of flooding risk should be developed. In France, for example, as probably in many other developed countries, we today know that the "classical" 10 years return period for the design of storm drainage systems is rather resulting from a juridical tradition than from a technico-economic approach. Such administrative rules must not be transfered to countries having different climatic and socio-economic conditions. Specific researches must be performed in these countries.

Finally, intensive educative programs dealing with storm drainage and drainage control equipments (detention ponds, channels, infiltration facilities...), similar to those developed for sanitary purposes, would give to new urban populations a better knowledge of urban storm

drainage problems and runoff dangers. These programs would contribute in reducing storm damages but also, in an indirect manner, but also in organizing uncontroled housing in a way that would help future equipments design in these areas. One must notice that such remarks should be taken into account in developed countries where housing is sometimes authorized in flooding areas!...

Conclusions

Urban hydrology and above all urban storm drainage should be a major factorof urban planing in Africa. Sewer systems are frequently not well adapted to fast urban growth. New drainage facilities which are now used in developed countries should be taken as references, but specific researches must be performed in order to choose those which should be in agreement with socio-economic conditions in African cities. Such researches need experimental "observatories" in order to get a better knowledge of the hydrological processes in African cities and of their socio-economic consequences. For this reason, we are developing, with the Interafrican Center for Hydraulics Studies (CIEH), in Ouagadougou (Burkina Faso), a research program related to urban storm drainage. The first works are dealing with the modeling of hydrological processes as observed over various land uses. Data from experimental catchments of different West and Center Africa cities have been analysed, and it has been already found that African urban runoff must be specifically modelized (Bouvier, 1986). Future researches will concern the technical and socio-economic survey of some urban storm drainage equipments.

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