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THE MAIN MEASURES AND METHODS TO LIMIT THE ATTENUATION OF SOIL WATERPROOFING IN LARGE URBAN AGGLOMERATIONS

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Abstract: In recent decades, due to the increase in the number of inhabitants worldwide, the extent of territory occupancy with buildings has increased greatly. Compared to population growth rate, the increase of waterproofed surface, that is, of the urbanization and of the infrastructure, has more than doubled. The most important cause that leads to soil damage and implicitly soil degradation is its waterproofing, when it is covered with a waterproof material such as concrete or asphalt. Given that in recent decades the built-up areas have increased uncontrollably, meaning that big surfaces in large urban areas have been waterproofed, the waterproofing of an increasing portion of soil occurs, which triggers the increase in the risk of floods especially during torrential rain. At present, Europe and all the more so Romania are affected by the uncontrolled growth of impermeable surfaces as a result of urbanization. Thus, some surfaces that were intended to draining rain water were transformed into impermeable areas. Also due to the expansion of cities, large areas of agricultural land have also been replaced with partially or totally waterproofed residential buildings. The water draining surface has diminished considerably, and the remaining surfaces cannot fulfill the same role, especially during short and high flow rain. The present paper will analyze and propose methods for reducing and mitigating runoff in urban areas.

Keywords: waterproofing, rainwater, construction of buildings, limit the attenuation, soil degradation, waterproof material.

1. INTRODUCTION

Since the early 1950s, the total area of cities in Europe has increased by about 80%, while the population has increased by only 33%. Marginal areas, sometimes called peri-urban areas, have the same percentage of built-up land as urban areas, but with a population density that is only half that of the population in urban areas.

The main threats to sustainable territorial development are the uncontrolled urban sprawl of recent times and the spread of urban settlements with a low population density but a high degree of surface waterproofing. In large urban agglomerations, due to the fact that the number of inhabitants and the population density has increased, public services are more expensive, more difficult to provide, natural resources are overexploited. Public transport networks are insufficient here, so cars are used and traffic jams in and near cities are common. Haotic urban sprawl involves waterproofing soils and threatening biodiversity, thus increasing the risk of flooding.

The need for new homes, locations for the business environment and transport infrastructure is the reason for waterproofing soils. Due to the growing population and the desire for a higher quality of living standards, ie larger homes, more social and sports facilities, the waterproofed surface is always increasing and it is necessary to take measures in this regard. There are several factors that explain the chaotic urban sprawl. Many people settle in peri-urban areas because here they find better quality housing with larger living spaces per capita. In Romanian cities, the average area per person is 15 m², compared to 36 m² per person in Italian cities and 40 m² in Germany [1].

As life expectancy increases, so will the average age of the population, which means a larger population in need of housing, of course with high expectations regarding their size. It was observed that despite a noticeable decrease in the average number of inhabitants of a house, the living area tends to increase a lot.

2. THE EFFECTS OF SOIL WATERPROOFING

The effects of soil waterproofing are multiple and will be briefly presented below. Due to the waterproofing of the soils, high pressures appear on the water resources, the state of the environment in the area of those hydrological basins changes. This will affect water-related ecosystems and services. A good soil can store up to 3750 tons of water per hectare or 350-400 mm of rainwater. Waterproofing these lands reduces the amount of rainfall that can infiltrate and be absorbed into the soil. In some cases,

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due to the complete waterproofing of some surfaces, it is possible that the absorption and infiltration process is completely prevented. Thus, the sewage network will not cope with torrential rains and will have the effect of floods, which can sometimes be catastrophic, even with loss of life.

If rainwater were to seep into the soil then it increases quite a bit, sometimes even significantly the time it takes for the infiltrated water to reach the rivers. This reduces the maximum flow and, as a result, the risk of floods, we can say in these situations that the natural landscape has a role in mitigating floods. If water infiltrates easily into the soil, we say that the soil has a higher degree of water infiltration. In this case, in order to collect very large amounts of precipitation, it is no longer necessary to store artificial storage with the help of storage tanks. It is thus possible to work on exploiting the capacity of the soil to support water and the vegetation on the surface of the land. They can temporarily store water instead of collecting, channeling and treating it. But, on the other hand, in cities where there is a high degree of soil waterproofing, the sewerage system can no longer cope with heavy runoff, especially during rains that have a high flow that accumulates in a very short time (torrential rains). Thus, floods can inevitably occur, with those well-known negative effects [1].

With the waterproofing of soils, both the biodiversity of the subsoil and that of the soil surface is affected. Scientists have calculated and estimated that at least a quarter of the species on the planet live in soils. These soil microorganisms have an important role in the decomposition of organic matter in the soil and in the recycling of nutrients, but, last but not least, in the storage of carbon. Soil waterproofing through roads and highways can act as a barrier for certain wildlife because their migration is interrupted and their habitat is affected. As a result of the construction of highways and roads and urban sprawl, a large number of harmful effects can occur, such as a drastic reduction of wildlife species, climate change in that region, an increasing degree of pollution and noise generated. of traffic on these newly built roads. All this contributes even more to reducing biodiversity.

Historically, all urban settlements have been established near the most fertile areas. Because it is being built continuously, the occupation of this fertile land and implicitly the waterproofing of the soils takes place. Thus, the most fertile soils can be and are frequently affected, which has a negative impact on food quality.

Due to the continuous construction of buildings, evapotranspiration in urban areas is reduced. This is because through these constructions there is a waterproofing of the soils, vegetation is lost and there is an increasing absorption of solar energy absorption which is due to dark surfaces, asphalt or concrete, and, no lastly because of the roofs. Everything listed above is a significant factor. These factors together with the heat resulting from the air conditioning systems as well as the heat resulting from the traffic contribute to the so-called "island heat island" effect. This effect can be particularly serious for human health, especially in summer, when temperatures are very high (heat waves). Therefore, in order to support the ventilation of urban areas, it is especially important in the near and distant future to optimize the design of urban areas, ie the incorporation of parks and green spaces between these buildings and the conservation of strips of permeable green strips.

The first waterproofing of soils with new constructions destroys the connection between the chemical and biological cycle of terrestrial organisms. This is because the cycle is completed in the soil, so the soil can no longer recycle dead organic matter and thus the substances that make up this dead matter.

If in an urban agglomeration there is the possibility of arranging qualitative and large green spaces in the form of green corridors then all these contribute to the regulation of water and temperature and have a positive effect on humidity. Thus, if all these were not taken into account when modernizing the cities and resulted in a much too high level of soil waterproofing without these open spaces of sufficient quality, it is very true that the quality of life will be affected in the long run. inhabitants and may even reduce the quality of life. Waterproofing and urban sprawl can lead to landscape degradation, which is of immense economic importance (for example, it is no longer attractive for tourism) [2].

3. EXAMPLES OF LAND USE PLANNING IN THE WORLD

In some European countries (Austria, Germany and Luxembourg) certain quantitative limits are set on the annual occupancy of land with new construction. However, the growth of waterproofed land could not be avoided here either. In Germany, for example, new construction is limited and achievements are regularly assessed, and yet it has been found that, in the absence of mandatory measures and programs, these measures are not enough.

In the south of Spain, there is an interesting case, we can even say special. There, in Andalusia, the regional plan introduces a quantitative limit of urbanization (40% of the previously existing urban land or 30% of the previously existing population over a period of eight years) [3].

An example of extending the space of a locality in compliance with the rules so as not to produce too great negative effects is presented in the figure below (Figure 1).

Figure 1. An example of extending the space of a locality

In Latvia, due to the exaggerated expansion of waterproofed areas in recent years, large restrictions have been imposed on land use on the Baltic Sea coast, the Gulf of Riga, surface water bodies (rivers and lakes) and forests around cities. All these measures have been taken to reduce or eliminate negative anthropogenic impacts. In rural areas, in the first 300 m from the seafront, construction works are prohibited or even limited. Around lakes and along watercourses, depending on the length and size of water bodies, the legislation imposes restrictions from 10 m to 500 m. This legislation allows avoiding or sometimes evening strict control of soil waterproofing in certain places.

In Denmark, there are very clear restrictions on the construction of shops or large shopping malls on green spaces outside the largest cities. Small retailers in small and medium-sized cities are promoted here.

In both large and small cities, land use and soil waterproofing can be limited with the help of so-called "green belts". There are several reasons to include these lands surrounding large cities in green belts. One of the reasons is that the introduction of these green belts limits the expansion of cities and prevents the merging of two nearby cities, if any.

In some countries such as Bulgaria, the Czech Republic, Slovakia, Poland, in order to reduce the demand for the transformation of agricultural land into building land that waterproofs these initially fertile agricultural soils and destroys the most beautiful landscapes, the transformation of agricultural soils is done with a fee determined according to the quality of the soil, the category of the residential area and the possibilities to irrigate these lands. Polish law allows the authorities in the case of conversion of agricultural land, to remove valuable topsoil from land to be transformed into built-up areas and use it to increase the fertility of other soils. Failure to do so will result in a penalty fee. In areas where there are many very fertile soils, the removal of the vegetal soil layer is done quite frequently, this fertile soil being as mentioned above used for fertilizing other soils [1].

4. IMPROVING THE QUALITY OF LIFE IN SOME URBAN AREAS

Even if urban areas continue to develop in terms of built-up area, urban development programs are needed in order to attract new inhabitants and create new jobs in those central urban areas that are in decline. In the following we will give some examples of urban development and renewal programs in different countries.

In Malmö, a village was built on the site of an abandoned port. Thus, 1000 new homes were created, their construction being done with the least possible impact on the environment.

In Vienna, there were homes for 6,000 new inhabitants on the surface of five disused industrial sites inside the city. Thus, 40,000 jobs were offered and their construction was done with the least possible impact on the environment. The apartments in the figure below were built on a disused industrial site (Figure 2) [1].

Figure 2. The apartments built on a disused industrial site

In Helsinki a development project was developed and a residential neighborhood was built that is in accordance with the highest ecological standards and the highest level. It was built to meet the housing needs of the people in that area. This project has shown that new living standards can be successfully developed even with minimal impact on the environment. The average built-up area per capita that has become waterproof is much lower compared to standard homes. Homes have been equipped with alternative energy sources, so the average energy consumption per home is low.

5. METHODS FOR LIMITING SOIL WATERPROOFING

The fundamental principle that must be followed to protect the soils is those of "less and better", ie a low degree of waterproofing and a better arrangement must be obtained. In the happiest cases, landscaping is based on limiting soil waterproofing. If this is not possible, and generally not possible, then the aim is to preserve the "best" soils. Priority should always be given to limiting the waterproofing of soils, and then mitigation measures should be taken into account, as this phenomenon is almost irreversible.

Limiting soil waterproofing can be done primarily by reducing land use. Thus, the aim is to transform green spaces, agricultural lands and natural areas into residential areas as low as possible. Another way to stop land occupation and turn it into impermeable land would be to waterproof the soils, but using land already occupied, for example derelict industrial sites.

In order to see what tools are available to the authorities for the efficient planning of any territory in order to reduce soil waterproofing, priority objectives must be taken into account. One of these priority objectives is to make the most of existing urban space in general, without having to sacrifice green spaces. This is sometimes possible through greater use of existing disused industrial sites. These places are a legacy of Europe's industrial past and can be affected by pollution with various pollutants. Sometimes the costs required to revitalize them are higher than those involved in occupying green spaces. That is why a cost analysis is needed beforehand. On the other hand, some disused industrial sites have the advantage of being included in an existing local infrastructure and no other road projects are needed [4].

Another factor that could lead to a reduction in soil waterproofing would be to stimulate and provide incentives for the population to rent uninhabited houses. This can eliminate the pressure exerted on some areas of European territory that would otherwise have unnecessarily occupied that land. It is imperative to increase the number of rented homes. This is a sustainable prospect due to the problems of territorial blockade that arise due to the fact that a large number of houses are uninhabited.

Where the quality of life in large urban centers has improved, there have been urban renewal programs and they are effective because they have attracted new inhabitants and led to the reversal of the current from urban centers to the periphery. This has created new jobs in declining urban areas. The attractiveness of small and medium-sized urban centers should also be increased. This could reduce the pressure on areas of large urban agglomerations. Well-developed small and medium-sized cities can significantly improve the quality of life, not only of their own inhabitants, but also of the surrounding populations. All scales play an important role and are essential to avoid migration to cities, and eliminate depopulation of rural areas.

An important role is played by the correct management of the stock of office buildings in cities in order to avoid the construction of new locations despite the existence of office spaces [5].

Due to the fact that there are many families who own many homes in which they live very little during a year, we are talking about those so-called seasonal or holiday homes, it is necessary to introduce restrictions and taxes on these second homes. Examples of mitigation measures are numerous and include the use of materials and surfaces with a high degree of permeability, green infrastructure and water collection. Among these we list:

- Use of permeable materials and surfaces
- Green infrastructure
- The natural water collection system

6. MODELING THE RUNOFF THROUGH A PERMEABLE SOIL

Following the modeling with the MODRET program, it was concluded that the infiltration modeling results indicate that the domestic water from the sewerage system together with the flow from the abundant precipitations will increase the water level in these peak periods of precipitation. Thus, the sewerage system, in case the soil is permeable, is helped by it to take over a part of the drain, preventing in this situation the floods. The difference between the proposed and the calculated value is relatively small, and the modeling will not be repeated (Fig. 3). This run will also be performed on a less permeable soil, which cannot take water from heavy rainfall and solutions will have to be found to avoid flooding on these lands.

If this value were much different, the modeling would have to be repeated. Because the calculated value is very close to the value used of the inlet flow, the results are satisfactory and the level of domestic water together with that from precipitation can be used to design the system of water retention from precipitation (Figure 4). Almost the entire retained volume can be infiltrated within 72 hours after torrential rain. The essential problem is in the case of waterproofed or partially waterproofed soils, which can only take over a small amount of water flow from torrential rains.

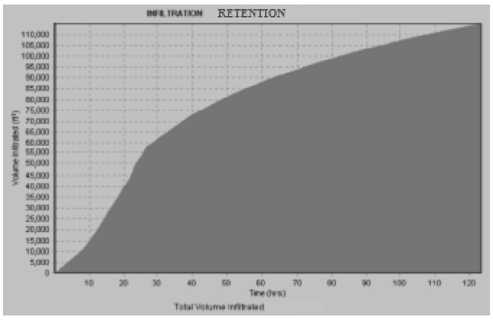

Figure 3 Correlation of the retention infiltration ratio

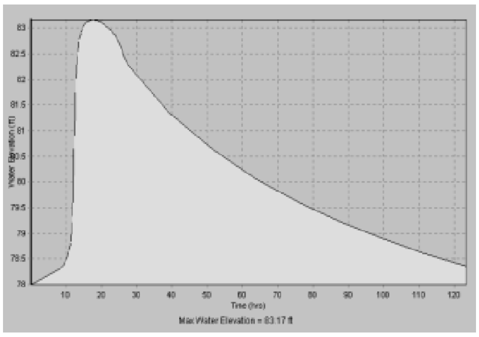

Figure 4 Water infiltration through a permeable soil

7. CONCLUSIONS

It is not possible to make a general assessment of the costs for natural water collection systems in relation to normal sewerage systems because these costs depend on local conditions, the availability of open spaces, and the price of land. However, it can be considered that an efficient arrangement can keep under control the costs for surface infiltration and can allow the efficient use of resources. All this must take place taking into account the resulting benefits, such as the reduced risk of floods, the use of rainwater instead of tap water to water gardens. In new settlements, the costs should not exceed the costs of normal sewerage systems.

It is necessary and important that in areas that are affected by land use and soil waterproofing, permanent monitoring and assessment of soil losses be carried out. Thus, appropriate measures must be established according to future land demand.

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