

Chapter 12

Urban Development and Anthropogenic Geomorphology

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Abstract The spreading of settlements and urbanization processes, along with the construction of the necessary infrastructure are of decisive local influence on geomorphic evolution. The chapter investigates the following general problems: What are the most important impacts of settlement development on geomorphic evolution? What environmental principles have to be observed during urban planning and the implementation of development plans? What are the most typical human-induced processes and surface features in settlements? What consequences anthropogenic intervention has on the land use, environmental conditions and scenery of settlements? Among the aesthetic consequences and positive impacts, artificial mounds in green areas and artificial water surface are mentioned, while among the negative influences the visual appearance of flood-control dykes and the large-scale road-cuts and supporting walls are listed.

Keywords Urban development · Landscaping · Urban anthropogenic landforms · Terrain transformation

12.1 Introduction

Interactions between relief and urban development have been well known for centuries. Landscape, as one of the ‘allocating factors’ (Mendöl 1963), was a major consideration for the site selection of settlements. Detailed research into its multifaceted impacts has always belonged to the traditional topics of urban geography. The impact in the opposite direction, i.e. of expanding settlements on the topography of their environs, however, received relatively less attention. In the course of urban development, modified relief takes a modified path of evolution. It means that

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in addition to natural topography, anthropogenic landforms should also be taken into account, and this subject is regarded to be essential in anthropogenic geomorphology from both a conceptual and a practical point of view. The issue is of particular significance for developing countries (Gupta and Ahmad 1999).

This chapter discusses

- the impacts of urban development on topography,
- the principles of settlements' terrain correction planning and implementation,
- characteristic anthropogenic landforms in settlements,
- the impacts of geomorphic processes in settlements on land use, ecological and urban conditions.

12.2 Geomorphic Impacts of Urbanization

The most characteristic geomorphological consequences of urban development are the following:

Modified drainage and surface sealing change or stop previously operating natural geomorphic processes.

New surface is developed next to buildings and other structures (terraces, slopes, drainage facilities, artificial ponds, etc.).

Debris and waste accumulation results, over a longer period of time, in landfills (as in the area of the Castle Hill of Buda).

The majority of minor features are destroyed by construction works, which can also be a direct threat to geomorphic values (e.g. Budai Hills).

Particularly in town centres and in industrial-commercial areas, most of the ground surface becomes built-up or sealed and, consequently, runoff conditions are modified.

Unfavourable geomorphologic processes, such as erosion on slopes or mass movements emerge (Szabó 1993).

Artificial hollows developed during urban engineering can cave in (Gálos and Kertész 1997). Examples from Hungary are the cellars in the centre of Eger and Pécs.

Landfill in natural and artificial depressions by construction rubble and materials excavated during the construction of fundamentals.

During settlement development, the same surfaces can undergo multiple alterations. The construction of trenches and ramparts for strategic defence purposes is mostly also linked to towns. Some of them were part of fortifications, whereas others were built along the city borders. Most of them, however, had been abandoned by urban development by the 21st century, and become sites for anthropogenic surface formation for a second time (e.g. Szolnok, Komárom, Sárvár).

The construction of dams for flood prevention created a new situation in the 19th century when built-up areas extended over former floodplains (e.g. in the case of Szeged on the Tisza River).

A special case of geomorphic impact is related to the extraction of building materials, and, subsequently, to placing and extending buildings into the slopes at the rear of yards in loess hills. In certain villages, these cuts have become decisive elements of settlement structure or of the landscape (e.g. at Gomba and Bénye in Pest County and at Gyöng in Tolna County, Hungary – Fig. 12.1). Surface alterations of a similar scale also took place along the margins of the North Hungarian Mountains, where the patterns and views of villages are also defined by walls, cellars and cave dwelling cut into volcanic tuffs (e.g. in Noszvaj and Cserépfalu in the southern foothills of the Bükk Mountains; Egerszalók, Sirok and others between the Bükk and the Mátra Mountains).

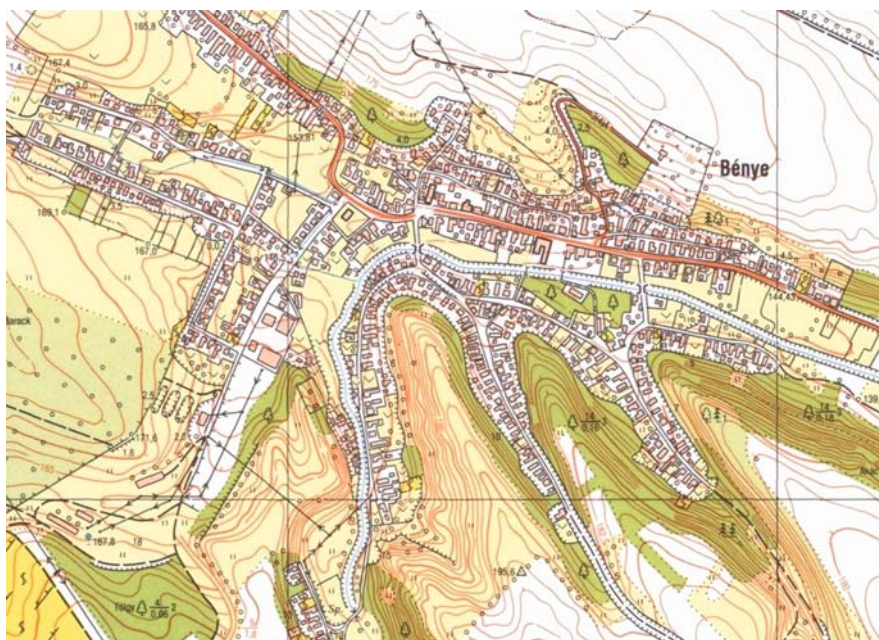


Fig. 12.1 Small settlement cut into high loess bluffs, Bénye, Pest County, Hungary

12.3 Settlement Infrastructure and Topographic Transformation

The surface character has an influence on the arrangement and inner structure of infrastructural networks and structures such as the road network, railway lines and public utilities in settlements. The role of infrastructure elements in man-induced geomorphic transformation is also significant (as in the case of railway

embankments, airports, ground drainage networks). As the character of surface transformation is similar to the impacts of the construction of infrastructure outside the settlements, they are not discussed in detail here.

12.3.1 Development and Terrain Transformation as a Function of Slope Angle

In addition to other geomorphologic factors, the angle of slope also affects the identification of potential sites for urban development. Based on literature data, planning guidelines and principles, the table below summarizes the relationship between the mean angle of slope, housing development and landscaping (Table 12.1).

Table 12.1 Mean angle of slope, housing development and landscaping

| Angle of slope | Development potential and the required landscaping |
|----------------|--|
| Up to 5% | Area with easy and economic development potential. In general, terracing is not necessary; landscaping exclusively restricts to drainage. Relief does not mean a limit either to build-up density or building sizes. |
| 5–12% | Increased development costs. Landscaping is inevitable; development is only possible with terracing and slope levelling. Somewhat limited development. |
| 12–25% | Area with a development potential at significant cost and labour expenditure, only with terraces and supporting walls provided. Major topographic transformation; the relief fundamentally controls the type of development to be applied. |
| 25–35% | Surface with limited potential for urban development. Low building density with small-sized buildings allowed. |
| Above 35% | Surface unsuitable for urban development. |

The percentages indicated in the table are only guidelines, as the housing development potential of a given area greatly depends – among other factors – on bedrock stability, the joint pattern on the surface, the building size planned and the parameters of the access road network. It is also important to note that such limitations mainly apply to contiguous urban-type architecture. This does not necessarily exclude the siting of individual buildings in slope categories unfavourable for urban development. Today technological progress is not limited by slopes; development, however, often results in large-scale aesthetic destruction and degradation of ecological conditions.

Specific costs of construction works can significantly increase due to the necessity for landscaping. This, however, would not scare off those intending to build on steep slopes, as the value of estates is highly increased by favourable relief. A fine panoramic view is a significant factor of value added.

The above remarks apply only to natural relief conditions. Even more attention should be paid to them when further development takes place on artificially shaped

slopes. There may be a high variation in stability when compared to natural slopes with similar parameters.

12.4 The Principles of Urban Landscaping, Its Planning and Implementation

12.4.1 *The Need for Landscaping*

As part of architectural/landscape architectural activities, physical landscaping includes the intentional and expedient modification of surfaces (Ormos 1953). Landscaping is based on technical planning. The transformation of the terrain for construction is also meant to impede surface erosion and mass movements. The steeper a slope is, the more jointed the surface is, the larger the scale of landscaping required.

During macro-scale landscaping, level or gently sloping surfaces have to be established either by planating rough surfaces or by terracing or slope levelling. From a geomorphic aspect, levelling means ‘obliteration of landforms’ whereas terracing means ‘creation of landforms’ (Chapter 10).

12.4.2 *Macro- and Micro-scale Landscaping*

Landscaping associated with urban development is practically classified by the degree of its geomorphic impact into categories of micro-scale and macro-scale landscaping. *Macro-scale landscaping* affects large surfaces like plots for housing blocks, industrial areas and sports facilities before development.

Micro-scale landscaping, on the other hand, refers to smaller surfaces like (parts of) plots within individual properties.

Since they differ in their different functions, it is important to define the goals of landscaping for architectural and landscape architectural (landscape management and gardening) purposes. For *architecture*, macro-scale landscaping facilitates the placement of buildings and prevents mass movements. In *landscape management*, macro-scale landscaping promotes the restoration of disturbed water budget (Chin & Gregory 2009); allows landscape rehabilitation (the elimination of scars or destructed surfaces that emerged from either previous activities or from construction works); fits architectural ensembles into the landscape from an ecological and landscape-aesthetic aspect – facilitating construction while preserving the original character of the surface.

For *architecture*, the reason for micro-scale landscaping lies in preserving the condition of buildings (for instance, through draining away excess water) and in fitting buildings and structures into the urban landscape (street view).

For *garden architecture*, macro-scale landscaping aims at improved drainage (usually forming an artificial recipient, a canal or a ditch); at preventing surface

erosion; at facilitating the establishment of green areas, parks and gardens as well as habitats favourable for plants and at providing an optimal ecological and aesthetic environment for buildings and structures, through promoting favourable interactions between the original and artificial surfaces.

12.4.3 Planning and Implementation Objectives

In the landscape design phase of urban development plans, surfaces of natural value and artificial surfaces with cultural–historical values in the planning area have to be identified (Csima et al. 2004). The measures required for their conservation or possible restoration have to be specified.

In the environmental and green area management phase of urban development plans, the principles of landscaping are defined and numeric values can be prescribed as far as the permitted height, slope gradient and other parameters of earthworks in the construction area are concerned.

Landscaping techniques have to be designed as part of the environmental arrangement (garden architectural) work phase, in accordance with the directives of building measures (in Hungary, primarily *National urban development requirements*). Planning can be carried out by providing the altitude data and gradients proposed or by contour representation. The activities related to earth excavation, removal and accumulation at other locations are called ‘earthworks’ by the technical nomenclature and can be ‘linear, areal or hollow in character’ (Markó 1975).

12.4.4 Typical Anthropogenic Landforms in Urban Areas

Urban anthropogenic landforms resulting from landscaping can be studied on two levels:

- the level of urban architecture and
- the level of construction of individual buildings and structures.

The main groups of anthropogenic landforms influencing both settlement pattern and the urban landscape are

- earthworks like ramparts, mottes for strategic defence purposes, (for instance, the fortifications in the town of Komárom, being decisive for settlement pattern) protected as local historical values;
- macro-terraces, backfillings or plateaux for housing development (residential blocks, terraced houses, streets; as in Salgótarján or Miskolc in Hungary);
- water management facilities including flood-control dykes, with particular prominence in lowland Hungary (in Komárom, Szolnok, Szeged), regulated river channels (the Élővíz Canal at Gyula), banks of rivers or streams (in Budapest,

but Szentendre and Veszprém with a more varied topography are also good examples), lake shores (in Siófok, Gárdony), surfaces upfilled for the purpose of flood prevention (in Szeged);

- surfaces of transportation facilities, among them, linear embankments of national main roads and railways, airports, noise prevention mounts.

The anthropogenic surface features which are part of architectural facilities can be functionally classified as follows:

- terraces, slopes, supporting walls and surface drainage systems developed for building safety;
- green surfaces above underground facilities (such as underground garages);
- earthworks of local public utility works (e.g. water reservoirs) and of local transport facilities;
- landforms related to garden architecture: sledging mounds (in the housing estates of Budapest) (Plate 12.1), outlook platforms (on the Gellért Hill, Budapest), large mounts for bordering or dividing space (in Kecskemét and Szekszárd), surfaces of sport facilities, garden supporting walls and slopes, garden ponds.



Plate 12.1 Sledging mound in a public park in Budapest (Csima 2008)

12.4.5 Secondary Impacts of Surface Transformation at Settlements

Urban landscaping, i.e. the establishment of anthropogenic landforms can also influence land use and the ecological and aesthetic properties of the settlement in question. Within each group, positive and negative impacts are distinguished.

The impact on land use is positive if landscaping makes a given area suitable for development and negative if it results in subsidence, collapse, eventually making the area unsuitable for construction. The ecological consequences are positive if new habitats emerge (in gardens and urban parks) and negative if former habitats disappear in the wake of alterations in water budget and solar radiation conditions (e.g. on partly built-up hillsides). A favourable change in aesthetic conditions results from landscaping if artificial mounts established in green areas successfully divide space and if the water surface of artificial channels becomes more spectacular. A feeling of oppression is created by masking river embankments and by establishing major cuts (slopes, supporting structures) (Plate 12.2).



Plate 12.2 The building of high-rise residential homes involves a major transformation of the terrain (Csima 2008)

References

Chin A, Gregory K (2009) From Research to Application: Management Implications from Studies of Urban River Adjustment. *Geogr Compass* 3(1):297–328

- Csima P, Gergely A, Kiss G, Módosné BI (2004) Természetvédelem – védett területek tervezése (Nature conservation – Planning protected areas). University Notes, Budapest University of Economics and Administration, Budapest
- Gálos M, Kertész P (1997) Mérnökgeológia (Engineering geology). University Notes, Műegyetemi Kiadó, Budapest
- Gupta A, Ahmad R (1999) Geomorphology and urban topics: building an interface between research and usage. *Geomorphology* 31(1–4):133–149
- Markó I (1975) Földművek – védelem (Earthworks – prevention). Műszaki Könyvkiadó, Budapest
- Mendöl T (1963) Általános településföldrajz (The geography of settlements). Akadémiai Kiadó, Budapest
- Ormos I (1953) Kertészeti földmérés és kerttechnika (Horticultural geodesy and techniques). Mezőgazdasági Kiadó, Budapest
- Szabó J (1993) A társadalom hatása a földfelszínre (The impact of society on the surface). In: Borsy Z (ed.), Általános természeti földrajz. Egyetemi tankönyv, Budapest