

## The concept of the model mountain valley: a case study of the Biała Łądecka river

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**Abstract:** River valleys are specific ecological corridors, the disturbance of which might result in serious consequences for the biotopes. Thus development strategies of river valleys should be thoroughly discussed and realized by interdisciplinary teams. Complex development strategies for a river take into account the influences of several factors. Firstly, changes in riverside landscape and new investments may cause disturbance to water management. This is one reason why works concerning the function of ecological corridors situated along river valleys are considered. Secondly, river corridors join protected areas – both green areas and places that are valuable due to their cultural context (of historical setting or historical building development). This work is intended to select the main features and guidelines for creating „a model mountain valley” that would form the basis for a creating development plan that is compliant with balanced development in mountainous terrain. This paper focuses on issues associated with the restoration of the Biała Łądecka river (southern Poland) in terms of its cultural, environmental and landscape protection.

**Key words:** *model development of the river valley, landscape protection, green corridor*

### **Introduction**

River valleys form a basic axis of settlement development; countless generations of people, as well as many animal species, have wandered along their banks. They are specific ecological corridors, the disturbance of which might result in serious consequences for biotopes connected with river valleys. Ecosystem management is the most effective when ecological, not political boundaries define the management area (Grumbine 1994).

### **Materials and methods**

The paper is concentrated on selection the main features and guidelines for creating „a model mountain valley”. Separating and detailing a kind of system for model development and management of a river valley seems to be indispensable from a time perspective. The situation of towns located along the river

forces them to develop in a particular way. That kind of urbanization is seen as a widespread form of human activity which may also threaten biological biodiversity in fragile, valleys systems. Therefore, introducing guidelines into the model method of development and management of cities, villages, and tourism development within communes situated in mountainous river valleys is vital. Such models are not yet widespread. A general concept of a model mountainous valley should be based primarily on an assumption of balanced development and must take into account recreational development without any loss in biotopes. Improving the recreational potential of rivers can be an important objective which helps the public acceptance of river restoration projects. Poland is a country with a relatively high biological diversity, which leads to concern amongst ecologists regarding the high rate of tourism development and uncontrolled development of urbanized areas. The damage occurring to numerous habitats is a consequence mainly of advancing urbanization, traffic development, industry influence, etc. Nowadays, pursuant to the "Convention of Biological Diversity" approved in Rio de Janeiro in 1992 (Dz. U. of 2002 No. 184, item 1532), protection of biological diversity is directed at the whole natural space, most of all at terrains used by man, and even at terrains transformed by him significantly, such as towns. This must be taken into account in model considerations. Protection of biological diversity and use of its elements in a balanced way are strictly interrelated (Agenda 21, 1993). Within urbanized areas of river valleys that are used for tourism it is important to maintain enclaves of different types of unused habitats (swamps, mid-field afforestation, peat bogs, basins of surface waters, water courses, river valleys, mid-field balks, waste lands, etc.)

The concept of a "model valley" illustrated by the Biała Łądecka valley example is based on the rules of balanced development which respect the natural environment, landscape, and historical values whilst taking into account human needs. Preferences for strip development of valuable tourism areas along the stream have been taken into consideration. In the "model of a mountain valley" the aspects of mutual interactions between changes in riverside landscape and possibilities of disturbances to water management were highlighted. In the model, the approach to tourism development in the river valley industry development is also an important issue. As has been mentioned before, many cities are "squeezed into" narrow river valleys which form a barrier limiting the development of suburbs. Developing compact industrial areas might result in the creation and development of adverse local atmospheric conditions, such as the so called valley smog. These problems are visible in numerous Polish cities.

### ***Effect of human activity on the habitat of river valleys***

Consumption of underground water affects proper water management. Furthermore, change and regulation of riverbeds also results in a change of water management throughout the whole river valley. A large majority of rivers have been modified by dams and other engineering works. In Europe, floodplain losses approach 95% (Tockner and Stanford, 2002). Groundwater levels are gradually falling across all the EU countries. Overflow of water from meliorated areas should be gathered in stationary reservoirs. The need to protect remaining floodplain systems and to restore degenerated river valleys has grown in recent decades (Ward et al, 1999). Decision VII/30 included in the Strategic Plan for the Convention on Biological Diversity introduced at the Conference of the Parties in 2002 focused attention on promoting sustainable use of biodiversity, maintaining ecosystem integrity and reducing the rate of loss of the components of biodiversity. One of the main objectives of the Strategic Plan is to determine that biodiversity is the living foundation for sustainable development. The key 2010 Biodiversity Target is to achieve a significant reduction in the current rate of loss of biodiversity and its components. Conservation and sustainable

management of natural and man-made resources and biodiversity is one of the fundamental issues of successful regional planning.

Near the bottom of valleys a temperature inversion often exists that is associated with the down-slope flow of the cold layer of air close to the ground. A water reservoir located at the bottom of the valley reduces the influence of cold air. Forest stands restrict or completely cancel the unfavorable effects of an inversion, very often occurring as a consequence of improper human forestry. Wind is another phenomenon affecting the microclimate of river valleys. The wind may be stopped or weakened by the natural shape of the terrain or vegetation. Winds blowing at the time of maximal or minimal air temperature are particularly dangerous for mountain agriculture. Damage to forests and agriculture is made by windfalls, and changes are particularly visible in the top part of a mountain on the windward side or on the slopes parallel with the wind direction. Wooded land covers about 30% of the European land area (UN-ECE 2000). In recent years we have observed loss of old forests, increasing isolation of wooded land, disruption of natural fire regimes and increased road building. Many parts of the ecological network have been eroded and their continuity has been broken. The frequency of fluvial flooding along river corridors and other watercourses will increase. The flooding in Poland in 1997 has shown how important the establishment of a system of passive and active protection is for flood protection. Green areas have a special significance in minimizing the risk of flash floods, and research shows that afforesting the upper reaches of a river delays water flows downstream. Hence, it is important to conduct research on the renaturalisation objectives of ecosystems and increase of forest cover in river catchments. It is worth keeping in mind that a river flowing in a stiff river-bed with strengthened banks less able to self-clean than the primal flow which meanders with natural greenery. Besides, natural rivers are attractive recreation areas, providing opportunities for outdoor activities (Constanza et al, 1997, Newsome, Stephen, 1999).

The most important factor contributing to changes affecting a the function of a sensitive system of river valleys is human industrial activity. Heated water from a power station and industrial plants is carried directly to the river. Rivers do not freeze, as a consequence of pollution and rise in temperature. Environmental pollution contributes inter alia to a change in the chemical composition of the air which consequently reduces the intensity of the Sun's energy reaching the Earth's surface, decreases the relative humidity, increases the temperature of the growing season, and alters the surface vegetation cover. Therefore mountain industry, which ruins the environment, should be located at the estuary. Alteration to the landscape of river valleys caused by human activity is connected mostly with a change of forest plant species on the flood terrace and valley slopes, deforestation and afforestation of slopes, artificial terracing of slopes, erection of roads, embankments, and dams, filling up old river beds, locating building development at the bottom of the valley, building technical facilities (bridges, pipelines, pillars, regulating and canalizing rivers, building storage reservoirs), resource mining, extracting sands and gravels, drawing water for industry, polluting water with waste and refuse, and charging underground water. The riparian zones are exposed to a risk of fertilization, forest fires and the existence of dead and decomposing wood.

### ***The characteristics of the Biała Łądecka valley***

The valley of the Biała Łądecka (southern Poland) is divided into three parts: up to Radochów it is called the valley of the Biała Łądecka, the part from Radochów to Stronie Śląskie is called Obniżenie Łądku i Stronia, and beyond Goszow it is the valley of the Upper Biała Łądecka. In the upper part of the valley

a river flows in a winding corridor through a forested area. The part of the Biała Łądecka to Stronie Śląskie is one of the most beautiful areas in the Sudety Mountains. The Biała Łądecka flows through a narrow valley (figure 1).



Fig. 1. Biała Łądecka River Valley in New Gieraltów

Along this part of the river are depopulated villages that used to form a compact settlement circle of high tourism importance. The bottom of the valley is covered by narrow meadows, while the mountain slopes are covered by mixed woods of spruce and beech. In the section between Bielice and Nowe Gierłtów, cataracts and cascades are present along the river. The Biała Łądecka forms a picturesque



Fig. 2. Concrete and stone embankments alongside Biała Łądecka River in Łądek Zdrój make the river easily accessible for residents

gorge between Stronie Śląskie and Radochów. Then, from Radochów to the estuary the river flows in a vast valley. A chain of old settlements of 14th century origin are located along the river. Łądek Zdrój and Stronie Śląskie are situated by the Biała Łądecka, and constitute the biggest population centre of the settlements situated along the river. The bed of the Biała Łądecka is regulated (figure 2).

Almost all the regulations date back to 1910, but some were installed after the war period. Two examples may be the building of a stone weir at point 22.98 km on the river (1966), and the concrete cover of the river bed and erection of the concrete weir in Łądek Zdrój from the 1960s. As a rule, the river bed was strengthened by a wall of stone pavement, sometimes with a retaining wall of stone and concrete. The flood of July 1997 proved that river waters of Klodzko region create a significant flood hazard which may be prevented by erecting retaining basins. Management of the area in question with a system of retention basins incorporated into the mountainous surroundings in the future might make the valley landscape more attractive and improve tourism development in the region. However, physiographical analyses of river valleys carried out by the authors of this work, prove that such steps might not be sufficient. In the case of afforestation of the upper part of the reception basin, a beneficial delay in rain water discharge occurs. Reasons of violent freshets may be found on in naturally narrowed parts of the river, climatic conditionings, and significant decline of flowing rivers. Properly shaped forested areas are capable of restricting or even preventing arising flood hazards.

### ***Alterations to the landscape of the valley of Biała Łądecka – a historical overview***

Intensive alterations of the natural environment in the Sudety mountains took place in the second part of the 13th century when Henry I „Bearded”, the Silesian prince, initiated settlement development on their northern foot-hills and Przedgórze Sudeckie. Settlements connected with forging, glass-works, and mining developed. Settlements of the street or oval system were built in the lower valley, and chain villages of the filed system arose in the higher valleys, gradually extending to increasingly high parts of the mountains. The 14th century brought intensification of forest cutting for industrial purposes, mainly for smiths, iron-works and glass-works. Metallurgists and lumbermen moved on to new locations as they ran out of wood, exploiting the wood resources and felling further into the Sudety forest. Already by this point, more and more floods were occurring as a negative consequence of deforestation. In 1598 the Nysa River overflowed, which washed out the steep slopes of the valley opposite Bard and threatened the town. At first, flood courses were covered by trees, whose roots protected the river banks against side erosion. Trees growing on the slopes protected valley slopes against soil erosion. When the protection disappeared, the natural erosion process was intensified. Slopes flattened down, and rich soil covered the bottom of valleys. Man attempted to counteract similar phenomena by excavating the soil material from the lower parts of the slopes and moving to the cultivable slopes. Cultivation of the soil contributed to soil devastation. Due to ploughing and the slope of the terrain, deeper and deeper furrows were created, which drained rain water. Forest-free valley sides accelerated the flow of surface rain water. Also, medieval mining affected the landscape of the Sudety Mountains. Traces of mining are visible in a form of funnel-like sinks near Złoty Stok, Stronie, and Srebrna Góra. At the end of the 16th century, as a result of the shrinking forests and their intensive exploitation, an action of afforestation was undertaken on the southern slopes of Śnieżnik. On the Wredem's plan from the 18th

century one can find a complex of woodlands that is significantly more sparse in the village surroundings. 19th century agriculture based on an iron plough with a share altered the landscape of the Sudety significantly. New tools made ploughing possible across the mountains and gave the valley slopes their terrace-like look. Fields on terraces were divided by high grass baulks, additionally strengthened with stones and bushes. Similar ploughing is visible today *inter alia* in villages of the valley of the Biała Łądecka, on the slope of Śnieżnik. Industry development in the 19th century was of fundamental importance in the alteration of the Sudety landscape. Increasing demand for wood for industrial plants and mines caused systematic deforestation of the Sudety Mountains. Then, during the last 100 years, regulation of rivers, localization of retention basins, construction of railway tracks and railway stations, and the building of new roads, have caused the final alterations in the region. As research shows, the panoramas from numerous places have been unfavorably changed. Land development incompatible with the local styles of villages or towns has dominated or ruined the aesthetical values of many places. Not only have Łądek Zdrój and Stronie Śląskie been affected in this way: so have some of the bigger villages in the valley of the Biała Łądecka, such as Trzebieszowice or Oldrychowice Kłodzkie. Many smaller mountain settlements have also been affected (figure 3).

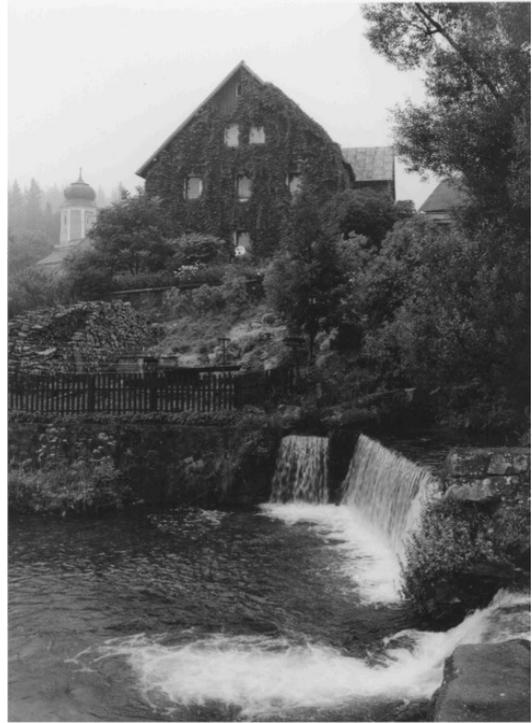


Fig. 3. Palace in Oldrychowice Kłodzkie. Present bad technical condition is caused by establishment in eighties in the main palace building State-owned Farmstead agency

Fortunately, due to lack of funds, most villages situated in the valley of the Biała Łądecka have maintained their special development and regional building development styles. There are only few cases where the architecture or size of buildings differ significantly from the traditions of regional building engineering (figure 4).

Similar examples may be observed in Oldrychowice Kłodzkie and Nowy Gieraltów, where block-like building developments were created in the 1970s.

Fig. 4. A sill in the Biała Łądecka River in New Gieraltów, mill and church in the background



### ***The model of the strip development***

The basic question connected with development in areas which possess scenic value and naturally formed systems (ex Biała Łądecka valley) is the conceptual choice between strip management and concentration of development at a dense network of points. The answer to this question is defined in the paper as “the model of the strip development”. The basic idea of the model is that areas of urban expansion will join in belts, established from settlement, recreation, national and scenic parks, forests and agriculture terrain. In the concept the framework of each belt is composed of communication, river and road networks. The constant belt system includes: tourist, pedestrian and bicycle route systems, formed parallel to the main village roads, united by vegetation, which penetrate freely into the settlement areas. The system is based on elastic belts, including various length stretches of development joined by communication network. Vegetation related to the riverside terrain including open green areas, boulevard, promenades, plazas and recreation spaces has a positive influence on environmental protection. The green zones formed parallel to the river create enclaves united by the pedestrian and bicycle communication.

### ***A concept of strip development of the Biała Łądecka valley***

In the valley of the Biała Łądecka, villages are mainly formed by settlements of the chain system or of the chain system of multi-road villages. Thus, a pattern of spatial combinations is quite obvious. The river and traffic strip running along the river mark major development directions. Vegetation has a hierarchic

structure: from high vegetation covering mountain slopes to low vegetation situated by the river. The valley bottom is covered by meadows located along a river. A strip system of forests, pastures, cultivable fields, orchards, and meadows provides the best climatic conditions, and improves retention qualities. To enhance the environmental balance, proper afforestation of valley slopes is particularly important. Research shows that in the case of afforestation of the top part of a river, a delayed water flow towards the bottom of the river occurs. Whereas afforestation comprises to a greater extent the middle part of a drainage basin, flow inhibition and a flood wave occur. Research proves that – when other conditions remain unchanged – in the forest-free areas, the surface flow is twice as fast as in the forested areas. Furthermore, a proper proportion of forests and meadows improves air quality in the valley and eliminates valley smog, which becomes very unpleasant, particularly in highly industrialized cities, and during the winter when heating is needed. By contrast, strips of vegetation that have been improperly designed and selected may adversely affect the flood wave, thus resulting in uncontrolled overflow of river water and a consequential increase flood damage. In the present work we have attempted to determine the general concept of “a model mountainous valley.” The model of an ideal valley based on a traffic strip and a river bed requires that valley afforestation should amount to at least 35% of general area, and pastures in valleys of agricultural character – about 10% of the area, garden and fruit culture about 12%, housing – 12%.

### ***Model valley- design principles***

According to a ‘model’ concept, strips of vegetation in the river valleys would be connected with the style of vegetation formed in settlements by pedestrian and bike traffic. Green zones are multifunctional. First of all, they enhance valley retention, increasing the mosaic character of settlements; they create an internal system of greenways connected by ecological corridors of protected areas adjacent to the valley; and they introduce enclaves where recreational areas may be situated. Deciding upon the extent of low, medium, and high plants from the river bed and determining their proper proportions is also needed in order to balance the visual appearance and the performance of the flood protection system for a particular place.

The distribution of vegetation – of parks and woods and recreational areas connected by a strip of land for pedestrians and bikers forms, in the concept of a ‘model valley’, the basic spatial scheme. Strips of recreational green areas stretching parallel to the river in the ‘model valley’ concept form small tourist enclaves with squares, open areas, promenades, and bike routes. In the valley of the Biała Łądecka there are not enough investments connected with the riverside landscape. Moreover, land development of the 1970s and 1980s negatively affected the space both functionally and aesthetically. A very conspicuous example may be the multi-family housing estate in Stronie Śląskie. Locating housing and garages directly neighbouring the river has made it impossible to carry out any further land development which would put the spatial chaos in order. It is impossible to draw pedestrian or bike traffic, or to create of strip of recreational area next to the Biała Łądecka. There are many more negative examples similar to this, especially from the 1970s and 1980s, such as the location of multi-family housing in Oldrychowice Kłodzki and Łądek Zdrój (figure 5).

In the ‘model valley’ concept settlements are located on sunny slopes. Traffic routes (tourism routes, bike routes) should be designed and located on the shadowed northern slopes. Furthermore, it is important that they are located parallel to a country road along the river. A strip of meadows should stretch between both roads. If the above mentioned guidelines are followed, then vantage points with small car parks should be located along a similar traffic axis, and a view over the whole village should be found that



Fig. 5. New Gieraltów – Bolko pension. Its present technical shape resulted from postwar negligence

is accessible from the main traffic route. In a model valley of tourism value, along the inter-settlement road there will be suitable conditions to create a strip of small agro-tourism farms, resorts and private guest houses. This would result in the development of tourism and tourism-related services: shops, inns, restaurants, and cafes. Parallel to the main road, along a river, there should be a strip system of traffic for pedestrians and bikers, and a system of recreational green areas. In such a system, a river forms a basic functional and topographical role in shaping the tourist scheme. Thus, recreational areas, boulevards, and squares are organized along its banks.

Tourists' lives may be focused mainly in the central part of the village, at picturesque bridges, or in places of special landscape values. A river should not be a barrier here, but on the contrary – it should attract and join two parts of the valley.

Most recreational villages are characterized by concentration of summer building development around places attractive for tourists, and, as a rule, summer building development is formed in a distance from farms. In the new type of recreational villages both these functions will be combined, creating small centers of recreational and agricultural character, where agriculture is of secondary importance, accompanying the tourist services. In order to maintain a specific character of the region it is important to adhere to traditions connected with local settlements and to maintain the proper proportions between green and built-up areas. Open recreational areas, pitches will be situated in a distance from the river. An ideal place for similar areas is the space between the village railway station and the main traffic route close to housing. Thus, open recreational areas might be created *inter alia* in villages such as Trzebieszowice, Oldrychowice Kłodzkie and Żelazno. Connected by a system of vegetation and pedestrian and bike traffic routes running parallel to the river, they would form an ideal place to relax both for village residents and tourists.

## **Monitoring**

The Biała Łądecka is one of the mountain rivers that is especially threatened by floods, due to their high magnitude, thus land development in this valley should focus on problems connected with future flood hazard. Monitoring is the most important strategy since it will allow the identification of areas that are

prone to flooding, calculation of a hundred year return-period water level, and an estimate of the optimal proportions of low, medium, and high vegetation. Flood terraces should remain undeveloped, and model recommendations will help to determine places where controlled flooding may take place. Water management is of basic importance in the functioning of inhabited valley areas. For farming purposes, surface water is drawn from rivers, and then stored in reservoirs or by constant water intakes. Drawing underground water, most often of higher quality, causes disturbance to local water management and may affect soil erosion. Increasing water retention will positively influence water resources in every river valley. It is important to recognise that an increase of water circulation will help maintain the natural retention qualities of a slope, which is of particular significance for the areas threatened with high water levels or floods.

Most mountain water courses are found to have a high level of water pollution. In order to improve water purity and quality, the waste discharged into a river must be adequately controlled, and should be cleaned in a natural way (for example in rattan ponds), and also adequately aired by cascades and small waterfalls (Reed, Middlebrooks, Crites, 1988). Due to a local changeable climate, management of waste must be based mainly on artificial water treatment plants, and biological plants should be favored. On the other hand, non-treated water and sewage should be drained to local treatment plants through a sewage system making use of natural terrain drops for fast drainage of sewage. From the point of view of the possibility of river self-purification, the river course and river-bed morphology are of primary importance.

Rivers flowing in natural meanders have greater possibilities for self-purification, whereas in the case of mountain rivers steep terrain decreases the possibility of meandering, and the river bed is forced to be of a v-shape. In the case of river beds covered with concrete, the bed friction is smaller than in natural flows (irrespective of the increased width of its bed). If the river has been anthropologically changed, there is a possibility of a friction increase and then, instead of concrete, gabions may be used which increase oxygenation of the river water. (Begemann and Schiechl 1999). A terrace system and a high quality surface material – preferably stones – increase the friction of water flowing against the bank. The model presented is in a state of balance, whereas a system involving man, his changes, and the environment, is very sensitive to change. Thus, systematic control of the natural environment via a well designed monitoring programme is essential. In the above model, recreational functions which stimulate regional development are assumed, and will become the main branch of industry in the region if introduced gradually. Also the character and a form of using soil of multifunctional centers are changing, and tourist facilities are created without excessive environmental losses. It must be kept in mind that all changes involving the shaping of vegetation and location of recreational areas in river valleys must be backed by proper physiographical studies. In a model strategy of a river valley, especially in the mountainous areas, flash flooding must be taken into account. Unfortunately, most rivers have been regulated and often “squeezed” into too narrow a river bed, which – in cases of flash flooding – generates a high flood hazard. Besides, if floods occur riverside areas are doomed to devastation and huge damage due to a lack of crisis plans, retention basins, polders, etc.

Another relevant issue is the protection of the visual appearance of villages against poorly designed land development. Land development of villages of the Biała Łądecka valley was shaped from a simple chain scheme. In the central part of such a settlement there was a church usually situated on a small hill. Some more impressive farmsteads were grouped near the church, and the building development became less and less dense with an increasing distance from the church. In bigger villages there was a palace, and very often establishments were set up connected with weaving or glass works. During this period, factory chimneys dominated the village landscape. This is today's view of Ołdrzychowice Kłodzkie. In the model valley, the historic appearance of the countryside and revalorization of the countryside topography ruined by the system of land development after 1945 are of particular concern. A system of pylons and

overhead cables is especially important in the visual countryside landscape. The area of the valley of the Biała Łądecka is "sliced" by overhead cables. Their importance for sharing the countryside image was mentioned by the authors of "The Strategy of Development of the Mole Valley" mentioned above, while devising a plan for overhead cables. Overhead cables should be gradually phased out and replaced by underground cables. Control of advertisement location is also taken into account in the model valley. Advertisements placed next to roads, signboards etc. in the zone of protected landscape should be of a form and material consistent with regional traditions. Also, a similar concern is associated with the appearance of bus stops, squares and car parks. The appearance of squares and car parks should be as neutral as possible. A similar effect may be attained by using suitable surfaces: stone, brick, or gravel. The concept of "a model valley" concerns mostly tourist villages, though some issues connected with water and waste management may refer also to villages of agricultural character.

## **Conclusions**

The following conclusions have been drawn based on the analyses above.

1. The system based on strips of development connected with communication and rivers creates conditions promoting easy access to tourist services. The strip system comprises strips for pedestrians, bikers and communication, and also strips of greenery and recreational areas creating "ecological corridors on the micro scale of a river valley, which are of significance for biotopes present in the valley. The strip system can be completed by providing services for tourists and car parks based on a network of wheel transport. The model allows the dispersion of 'honey pot' tourist centres that accumulate in larger towns. In the model concept, tourist services are not located uniformly along traffic axes. Intensity of their concentration is dependant on the calculated tourist capacity of a given area. Saturation of tourist services in a particular strip of development depends on the absorption and development strategy applied. This way short parts of a strip rather than a whole strip area are formed from towns and villages of similar investment capacity. The constant strip system forms a system of routes for walkers and bikers shaped along the river and combined with green areas that freely penetrate into settlements.

2. In touristy areas where a river forms the main development axis there are conditions for creating development strips, based on river valleys conforming to a repeatable model scheme consisting of recreational green areas, tourist services, car parks and strips of traffics for vehicles, pedestrians and bikers, as well as a sewage system and water treatment plants. In the model valley there is no regulation of the river bed. The flood protection system is based mostly on the development of green land, an increase of retention and creation of polders.

3. Tourist development of historical settlements and of urban character should be based on analyses of the landscape. Studies of topography allow to evaluate the extent of proper proportions maintained in the material, regional features of building engineering, which is of significant value for further planning activities. Studies of topography allow evaluation of the most suitable building materials and features for the region, which is of significant value for further planning activities. Landscape analyses allow to penetration of the "third dimension" of spatial development. Topographical studies are of special importance for urban development. Their main aim is to specify acceptable sizes of land development, balance of bodies, forms of greenery, building heights, shapes of roofs, etc. Furthermore, analyses of panoramas carried out simultaneously with physiological and functional studies allows the identification of places that are optimal for the location of future building development.

4. Shaping a system of vegetation based on the strip system connected with riverside areas comprising green areas, boulevards, promenades and recreational areas, positively affects the protection of sensitive ecosystems and visual appearance of river valleys. Physiographical and hydrological studies are of basic importance for the development of green areas connected with rivers. Research connected with the development of areas situated on the edge of river-valleys will allow determination of the proportion and extent of vegetation, which is particularly important to maintain an ecological balance of riverside areas and to prevent possible floods.

## **Discussion**

The research investigates the connections between areas of human investment and natural forms of the environment such as: nature reserves, national parks and landscape parks. The idea was to create a flexible system, which would join distant terrain located along the river. The basic task of the model was that areas of urban expansion will be connected by belts, established from settlement, recreation, parks, forests and agricultural terrain. The main idea suggested in the research was to shape a space in ways which allow for the coexistence of areas with different functions and maintain a balance between urban expansion and the natural environment. The concept allows treats a country's settlement network as one flexible system that can be supplemented by gradual modernization of green belts and junction enlargement alongside the belts' axes.

The main result of the research was the derivation of a spatial scheme – the model of the belt development based on a certain configuration of river and road networks, which could be introduced into future regional planning.

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