ECOTECHNOLOGIES FOR RESTORATIONING THE WATERCOURSES, LAKES BANKS AND SLOPES

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Method I

This method is applied to the riverbanks of rivers with a high degree of erosion. The riverbanks have to be recovered by using filler material (two thirds of the initial riverbanks).

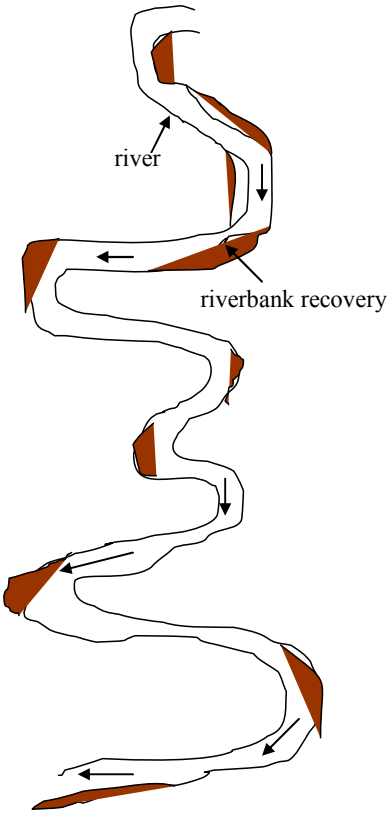

Figure I.1 Material additions for bed linearity – indicative scheme

Before pinning the material on the eroded riverbanks, those will be fixed with wooden structures (rectangular prisms) (fig.I.2).

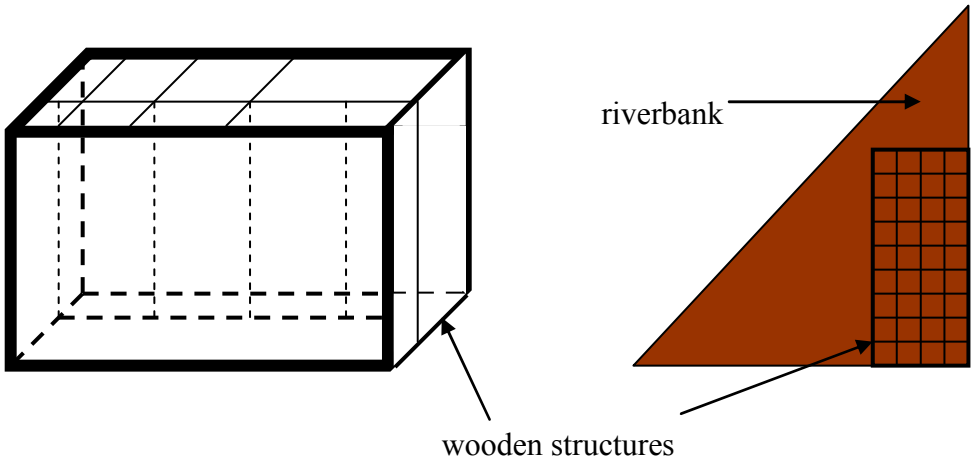

Figure I.2 Wooden structures fixing the riverbanks – scheme indicative

In addition to specialized wooden structures for riverbanks support, some wooden buttresses will be pin on the riverbank. These buttresses are maximum stressed and fixed after the prismatic wooden structures (fig.I.3).

The other third of the riverbank comes completed over these buttresses. The riverbanks will be finished in the form of an inclined plane and various species of local riparian vegetation will be planted in line to support the riverbanks. Between the buttresses and the radicular system of vegetation, an action-reaction system is to be formed in order to protect against the erosions.

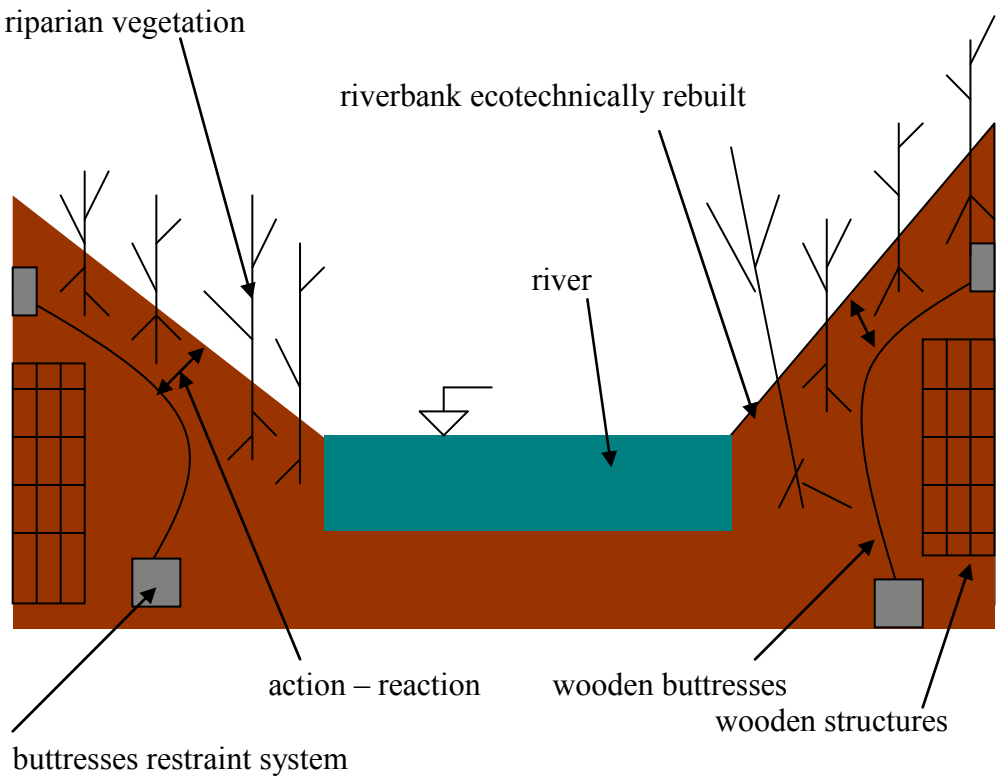

Figure I.3 The wooden buttresses system to stabilize the riverbanks – indicative schedule

If erosion of banks, wooden buttresses can replace the river banks and they cannot be eroded because they are glued to each other in order to form a wooden arched compact mass being very resistant to weathering. The buttresses' wood is treated as to resist the aquatic environment. The bioengineering solutions using only vegetation and rolls of coconut are useful but have not the strength of the solution presented. The buttresses can easily retrieve the shear due to floods better than fixed building systems for enforcing the riverbanks.

Method II

One way to protect and stabilize the riverbanks is represented by the adjustable wooden semicircles method (fig.II.1).

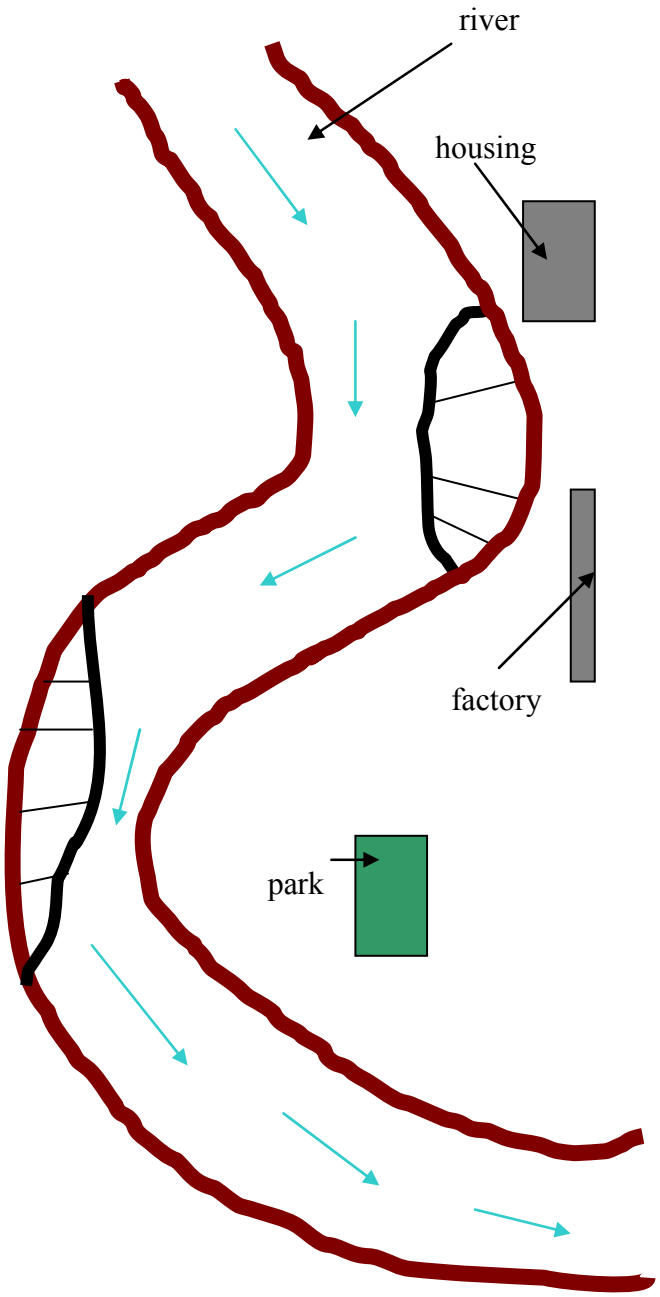

Figure II.1 Adjustable wooden semicircles to protect riverbanks

This adjustable protection system of riverbanks prone to heavy erosion is equipped with shock absorber positioned in line along the entire length of the system. fig. II.2.

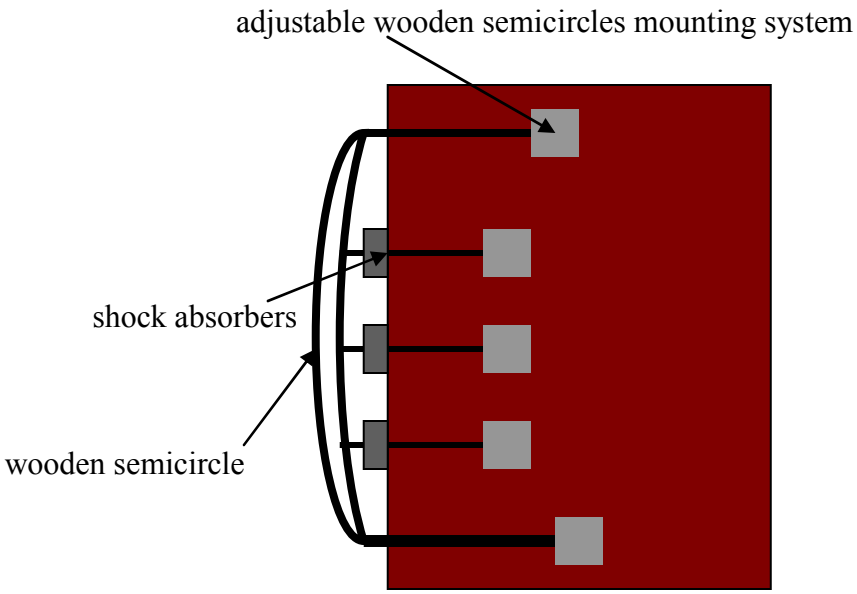

Figure II.2 Fixing adjustable wooden semicircles along the riverbanks, cross section – indicative schedule

Laminated and adjustable wooden semicircles are provided with shock absorbers lineally arranged that will absorb and dissipate energy created by the floods. The bottom shock absorbers and those up to average are more robust because constant pressure is applied to them (fig.II.3).

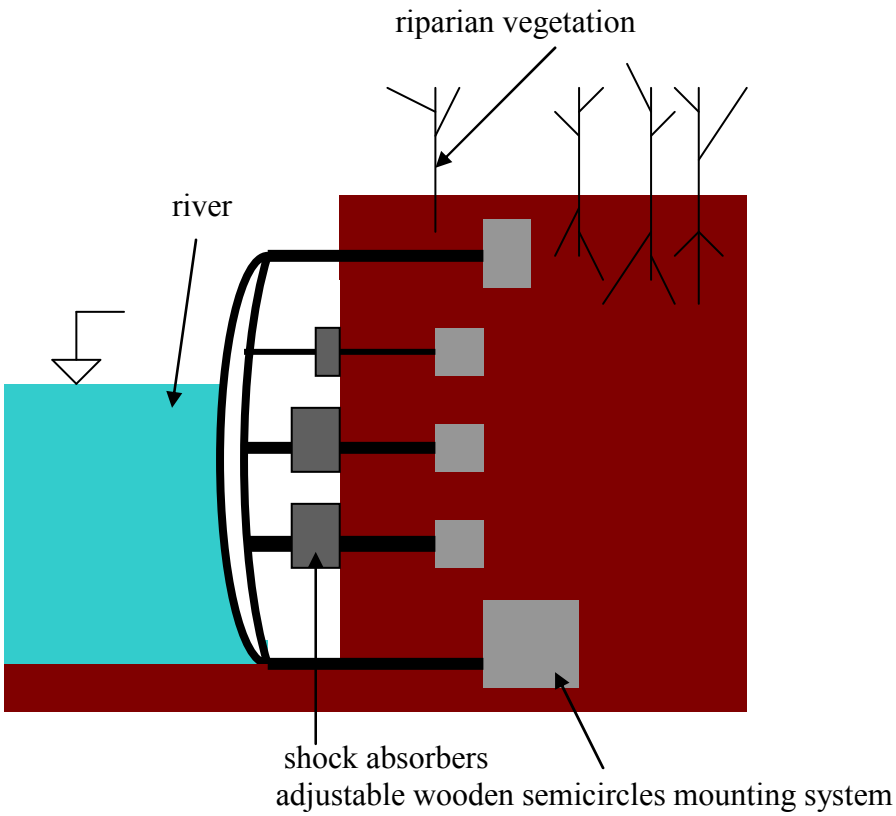

Figure II.3 The shock absorbers location and the arrangement of riparian vegetation – indicative scheme

This solution is especially useful where the meander cannot be extended because of agricultural land or construction. Even if the water level goes over wooden semicircles because of the strong floods, the system remains functional due to a deep fixing and a well-developed radicular system of the riparian vegetation. Riparian vegetation will fix the ground depending on the soil restraint systems (fig. II.4).

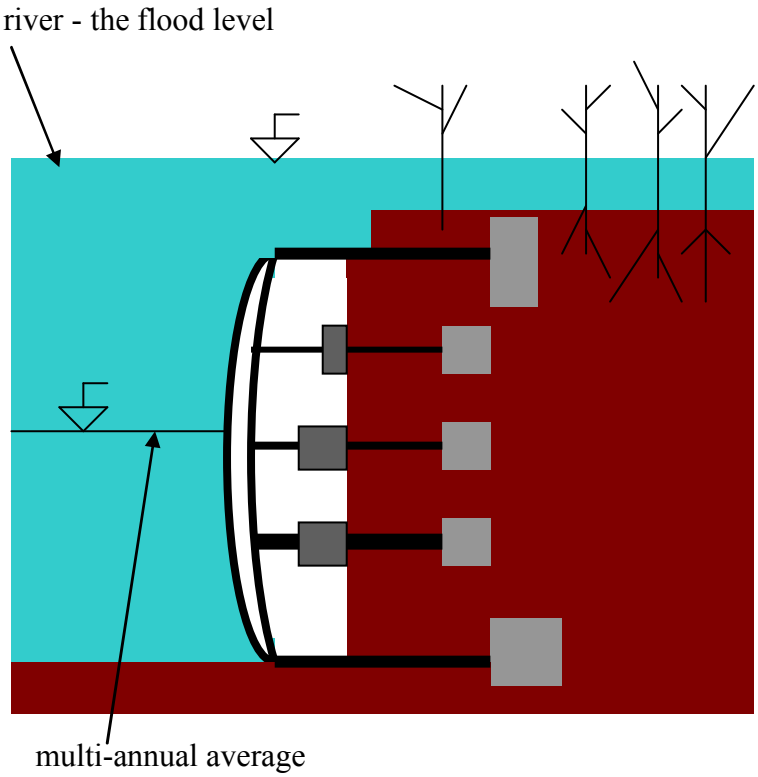

Figure II.4 Water tightness quality of adjustable wooden semicircles during floods – indicative scheme (river - the flood level, multi-annual average).

Method III

Riverbanks supporting system by the means of parallel sheet-piles

The banks of a watercourse cannot be arranged so as to stop the erosion only with ground cover (biological) but there should be an engineering support (bioengineering). Two parallel sheet-piles at a distance of 50cm up to 1.50m near should be arranged near the eroded riverbank in order to stabilize (fig.III.1).

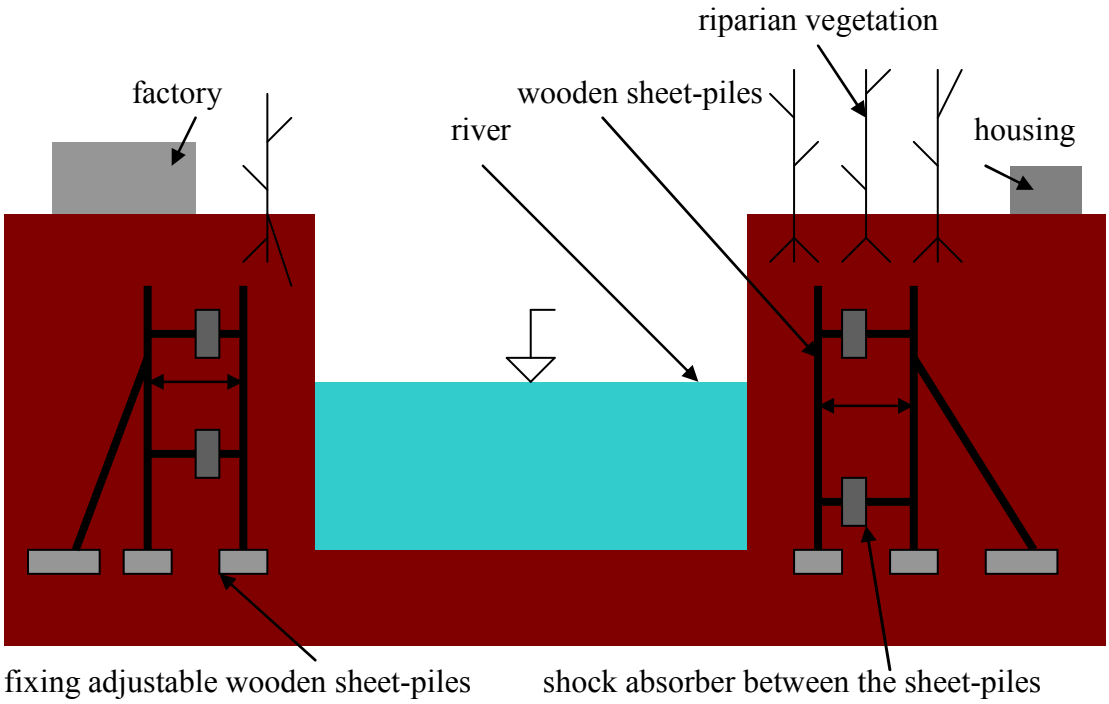

Figure III 1 Sheet-piles (wooden sheet-piles) arrangement within the riverbanks. – indicative scheme

The two sheet-piles are linked together by the means of some shock absorbers in order to overtake the loads generated by bodies of water during floods. (Fig. III.1). The external sheet-pile is supported by a steel structure fixed into a concrete support system. (Fig. III.1). The sheet-pile supporting systems are also made of concrete. Where possible, riparian vegetation should be planted between the two sheet-piles in order to support of the riverbanks. Over time, due to (anthropogenic or natural) riverbanks erosion and destruction of riparian vegetation, minor riverbed banks will consisted mainly in sheet-piles highly resistant to extreme phenomena (cold, rain, flooding).(fig.III.2).

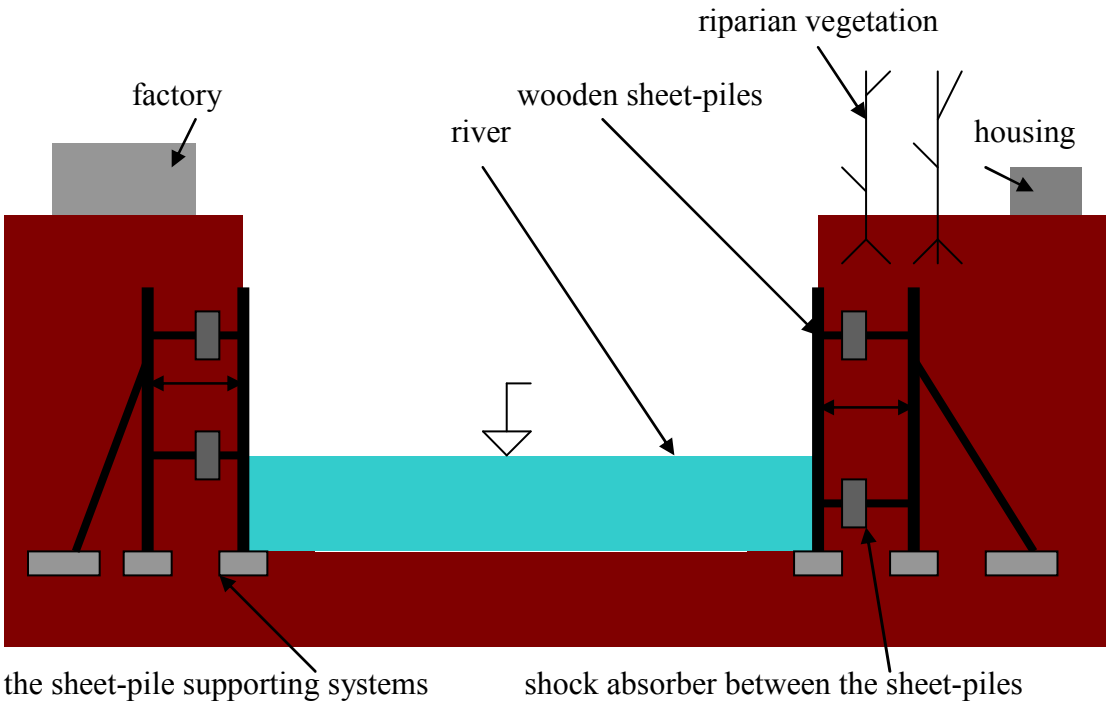

Figure III.2 Riverbank protection using wooden sheet-piles. – indicative scheme

If the first sheet-pile is destructed, the second sheet-pile will protect the riverbanks. These sheet-piles help the riverbanks keep the environmental characteristics of a river unaltered, which is an environmental development (bioengineering). It is completely different from the total or partial river beds concreting, which can destroy the lotic ecosystems.

Method IV

Ecological arrangement of an unconcreted and channeled watercourse

There are various channeled sectors (meandering or straight) of the watercourses. In the immediate vicinity of the banks there is agricultural land or civil and engineering building, which does not allow the river to enjoy more green space(fig.IV.1) .

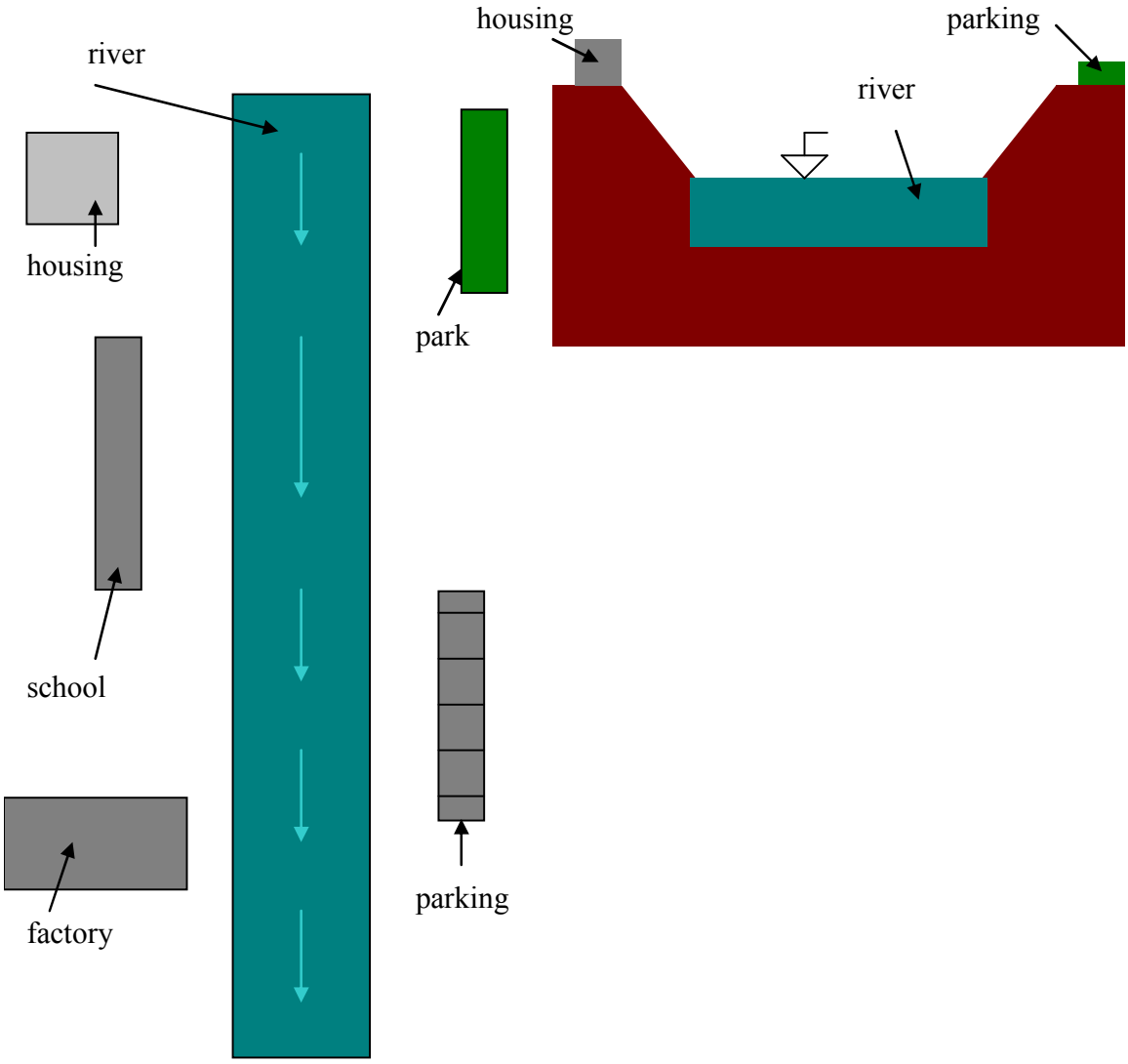

Figure IV.1 Channeled river sections: the longitudinal and transversal – indicative scheme

On these types of channels, because of lack of riparian vegetation and meandering, floods spreading are much stronger causing great damages. In the absence of vegetation and a riparian ecotechnical arrangement, the riverbanks erode and jeopardize the surrounding buildings continually. The river is not provided with an arrangement area laterally; therefore the environmental arrangement should be carried out within the riverbed. Rectangular parallelepiped-shaped platforms should be built in the middle of the river(fig. IV 4.). Riparian vegetation is planted in line on these platforms; sheet-piles made of waterproof timber are fixed into areas connected to water.

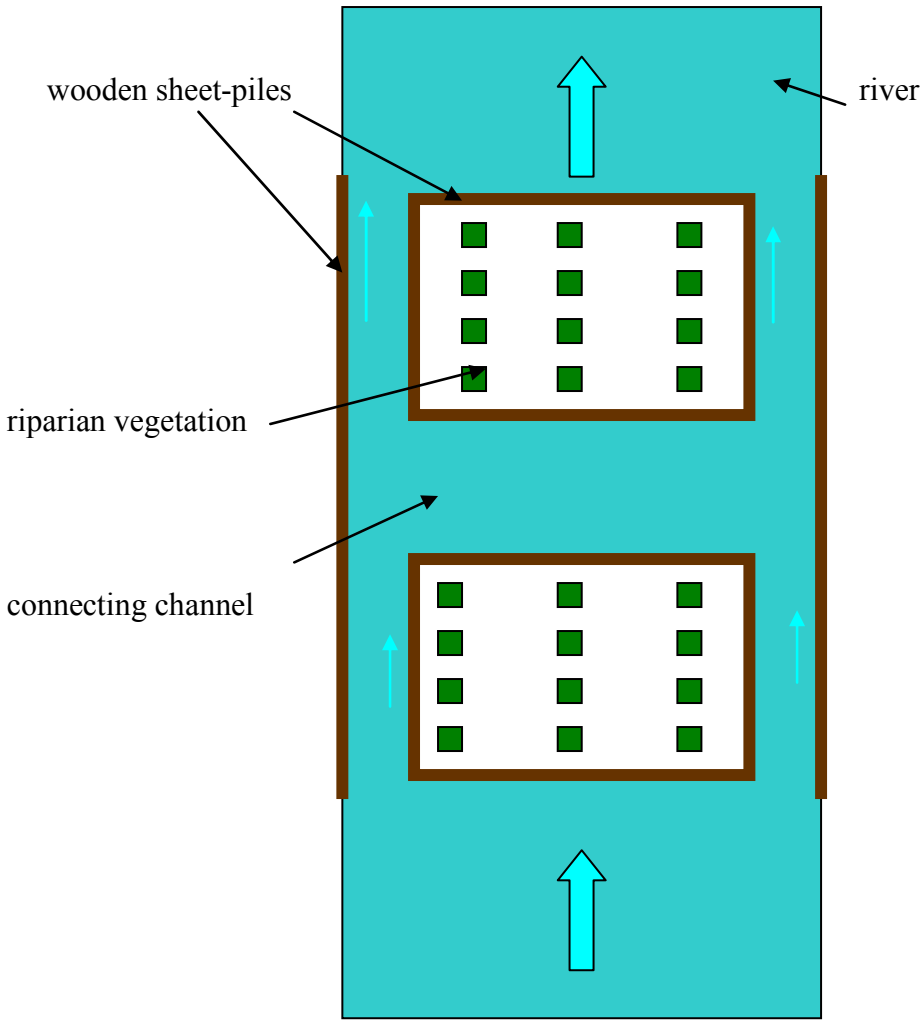

Figure IV.2 Channels connecting the sinks – indicative schedule.

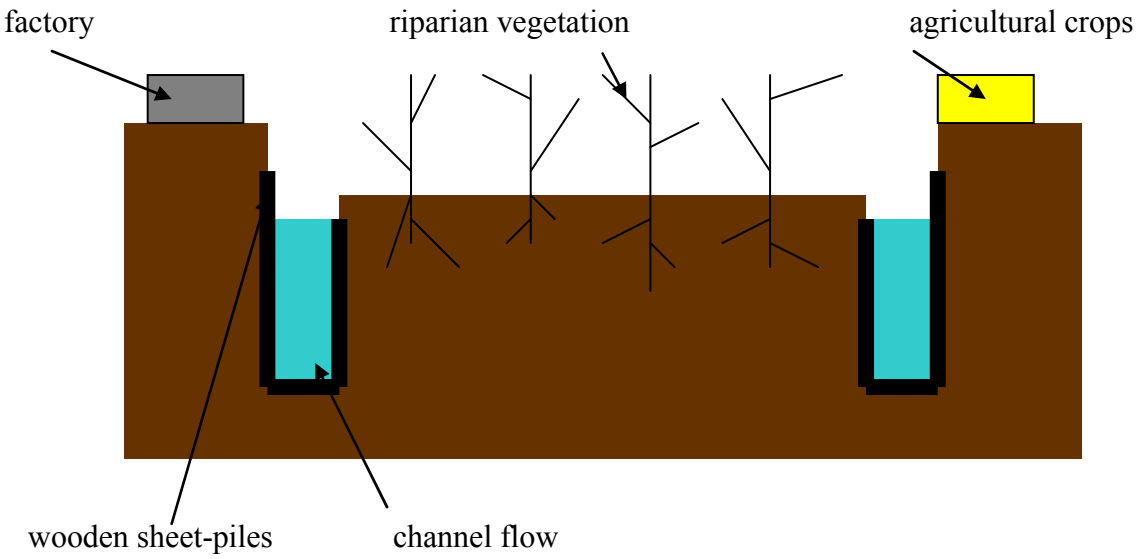

Figure IV.3 Rectangular parallelepiped-shaped ecological platform, cross section – indicative scheme

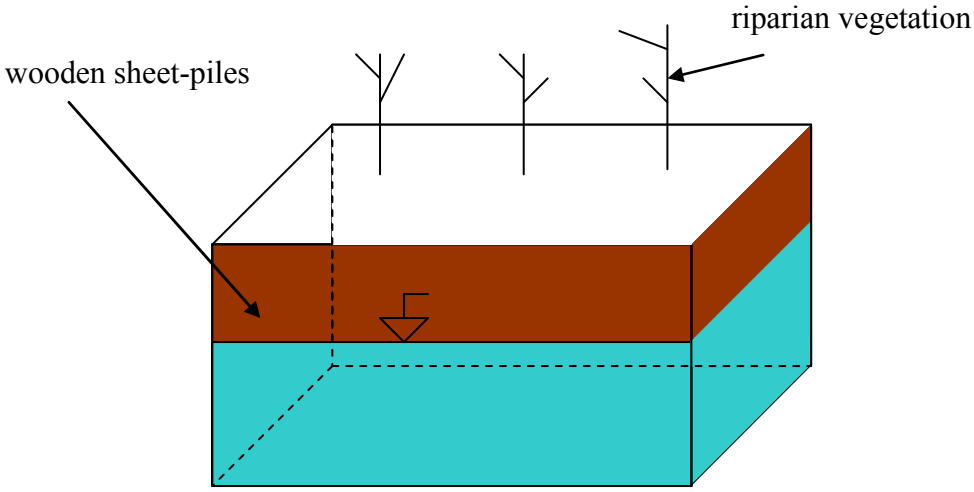

Figure IV 4 Sink in the form of a 3D rectangular parallelepiped indicative scheme

These structures create habitats for various species of local fish and poultry which gives the river an ecological evolution. These ecological sinks also aerate the river water by changing water course. There are old methods of watercourse modification achieved by the means of a semicircle of stones used especially for unchanneled (unconcreted) rivers. As regarding the artificial channels, the prismatic ecological sinks (Fig. IV.1) are very efficient both hydraulicallybut also ecologically; in case of

catastrophic floods, the first sinks in the sector are affected and also they can rebuild quickly. These sinks can be built without a major redirection, but only within the river.

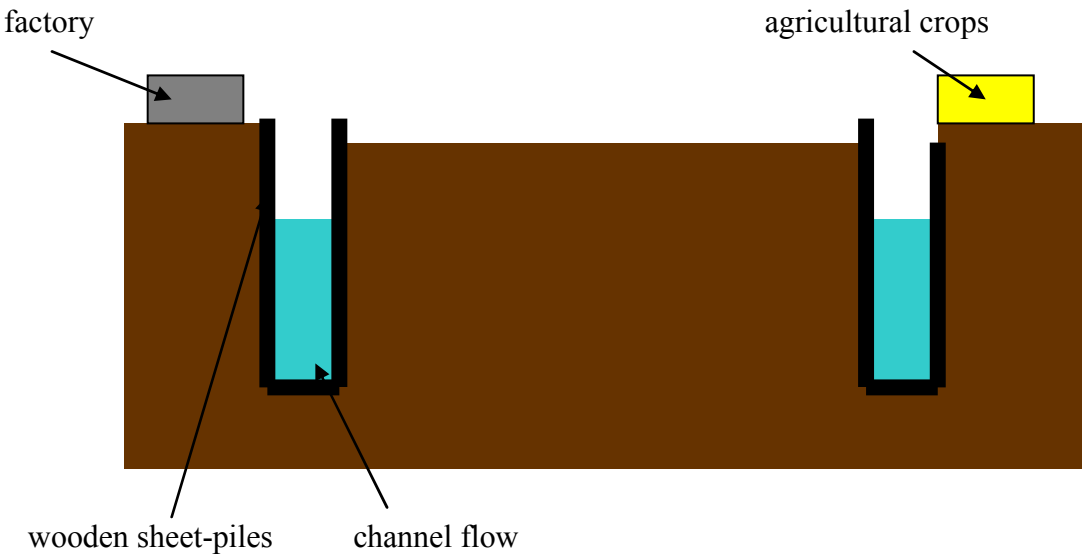

Figure IV.5 Technology of building a parallelepiped-shaped sink- indicative scheme

Technology of building a parallelepiped-shaped sink is as follows:

1. Redirecting the water river using some metal sheet-pile so that water flows only through the center of the bed. This redirection can help the construction of two parallel channels through which the entire river will flow.
2. After the river has been redirected towards the middle of the riverbed, two parallel channels can be built, taking into account that the riverbanks were reinforced by wooden sheet-piles.
3. Channel construction will be done with an excavator using many kinds of buckets depending on channel width and soil structure. Excavator will be positioned on the shore or river bed, depending on the room available.
4. After the construction of two parallel channels and their strengthening using sheet-piles (Fig. IV.3), parallelepiped-shaped sinks construction begins (Fig. IV.2).
5. After finalizing the parallelepiped-shaped sinks construction and riparian vegetation planting, connection channels will be built between these sinks (Fig. IV.2), real habitats for lentic fauna, which is to be developed along the arranged river sector.

Method V

Slope stabilization

Due to excessive deforestation, contamination with various chemicals used against pests, accidental pollution caused by deposits of harmful substances, illegal construction of houses, extraction of building materials etc. slopes bordering a river, a lake and so on, are going down because of the heavy rain, frost and thaw and also because of other natural and anthropogenic phenomena. Slopes reinforcement using flexible wooden semicircles and specially treated against weathering can bring a solution to these problems. This wooden semicircle is fixed upstream and downstream (fig.V.I).

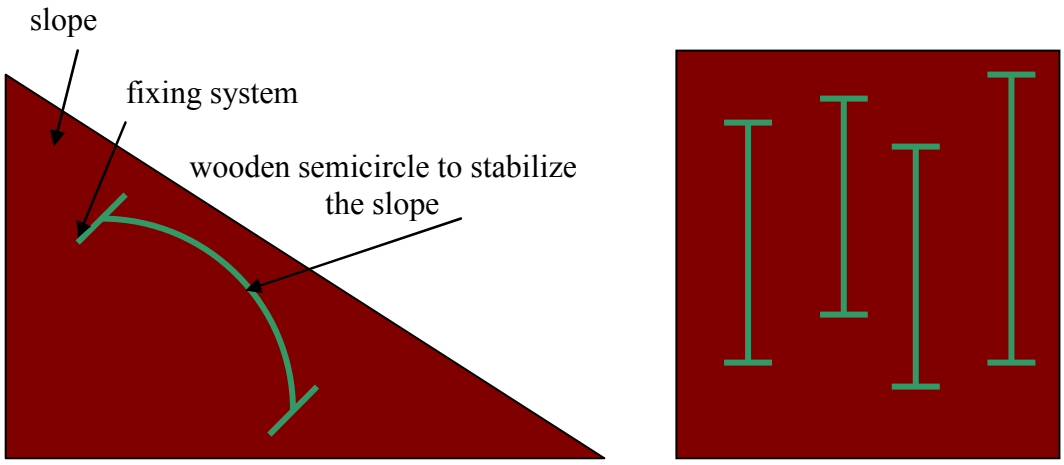

Figure V.1. Positioning of wooden semicircle on slope: transversal and longitudinal sections – indicative scheme

These wooden semicircle push the inside slope tangentially with a $\partial 1$ force smaller than $\partial 2$ – the force of pushing the soil; therefore, the forces of displacement within the slope cannot be form(fig.V.2).

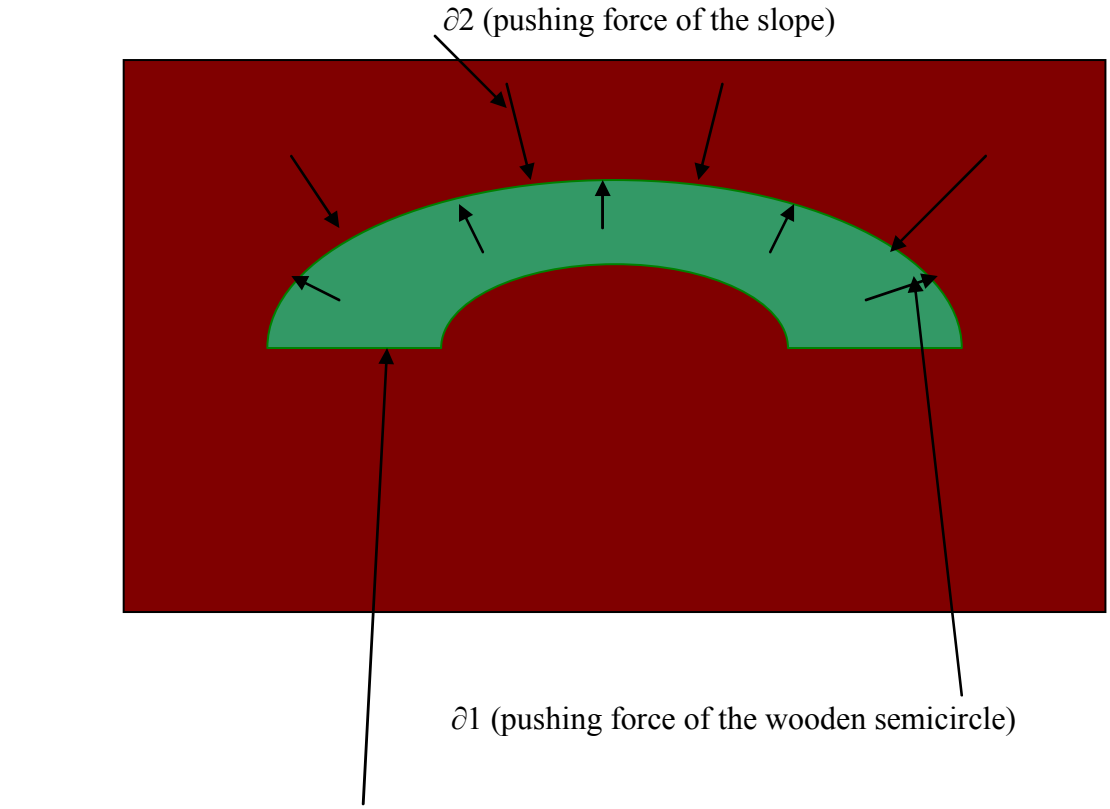

Figure V.2 The pushing and displacement forces of the slope– indicative scheme

Wooden semicircles that support the slope are connected by the means of at least two connection systems(fig.V.3).

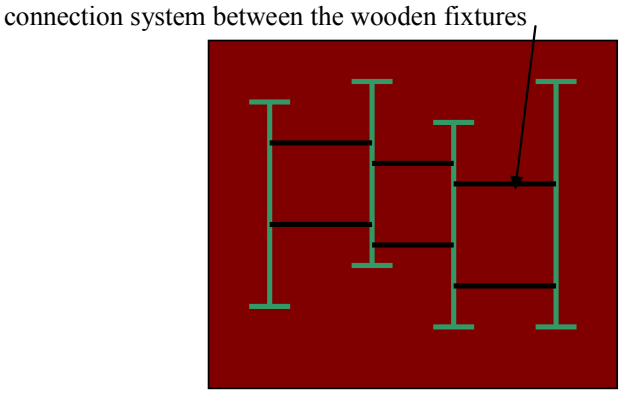

Figure V.3 The connection between the support semicircles - indicative scheme

These wooden fixtures are fixed to the top of the slope by massive wooden pillars, which in turn are supported by reliable elements, such as trees and rocks on the slopes, where these elements are(fig.V.4).

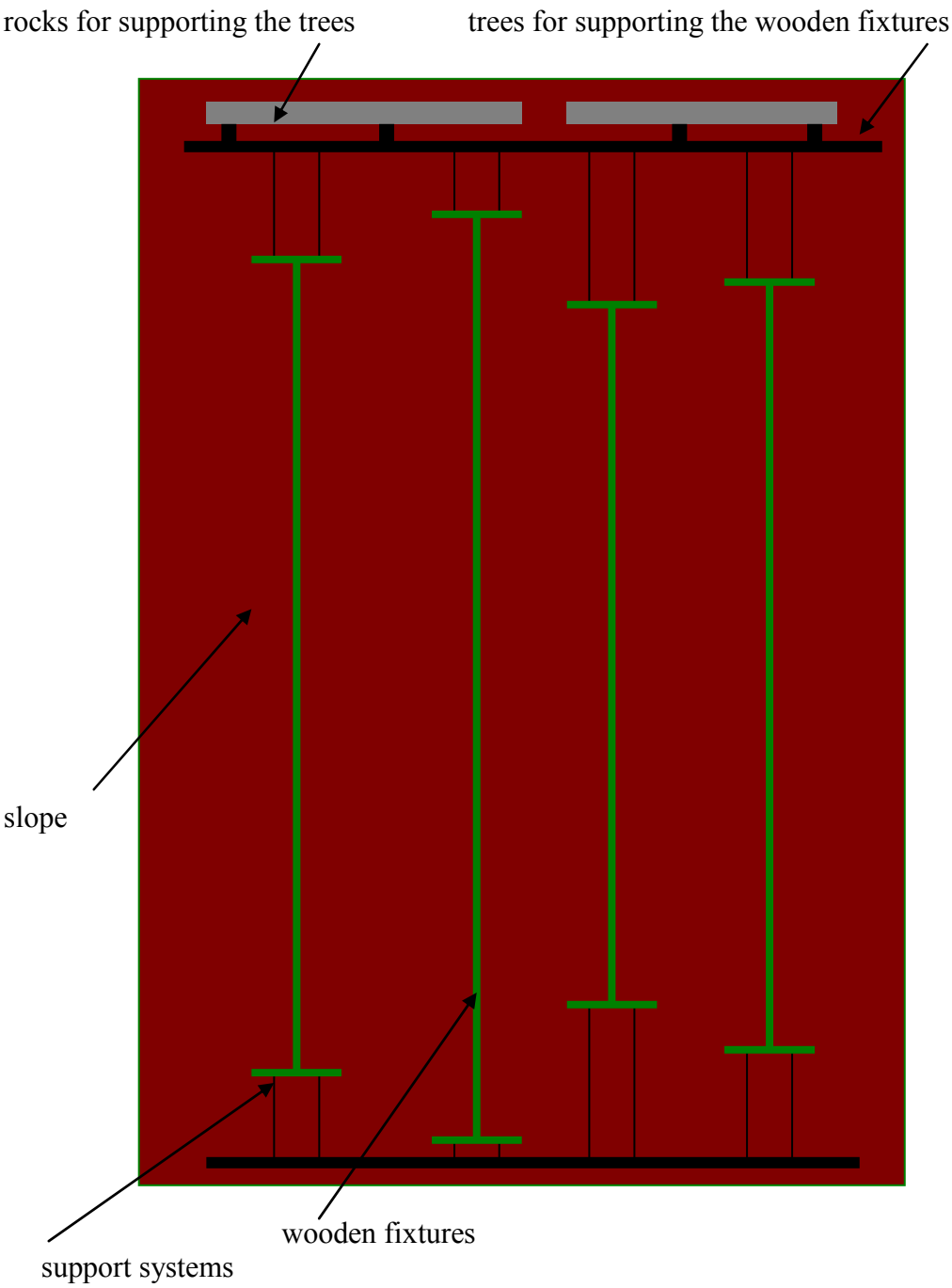

Figure V.4 The arrangement of wooden fixtures along the slope - indicative scheme

Method VI

Another bioengineering method of fixing the slopes is deep drilling in the space sector that is about to collapse and setting bars(fig.VI.1) jointed by wood (weathering) fitted with stopper systems having a variable geometry at the end of the slope(fig.VI.2). The stoppers may be of durable plastic or timber, everything depending on the slope and its structure.

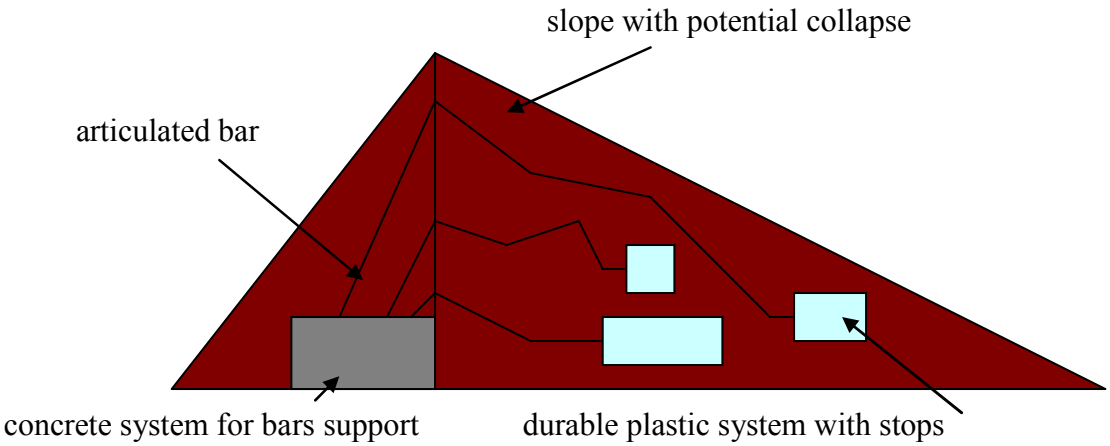

Figure VI.1 Wooden articulated bars to support the slopes, cross-section - indicative scheme

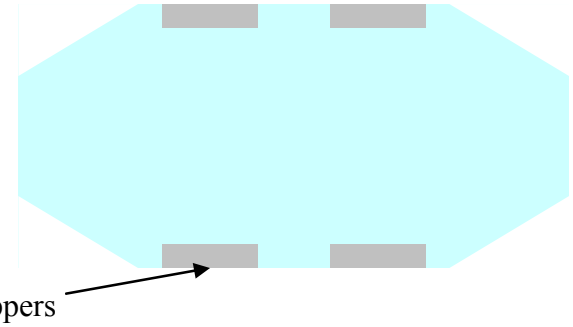

Figure V. 2 Resistant plastic system with durable plastic stoppers - indicative scheme

Once the system of durable plastic with stoppers has come at the end of the last drilling, it will pull back the whole system consisted of hinged bars with a F2 force greater than F1, the pushing force. Thus, the stoppers are fixed effectively into the slope structure (fig.VI.3). The stoppers system does not crumble the soil but fixes it more and more in time.

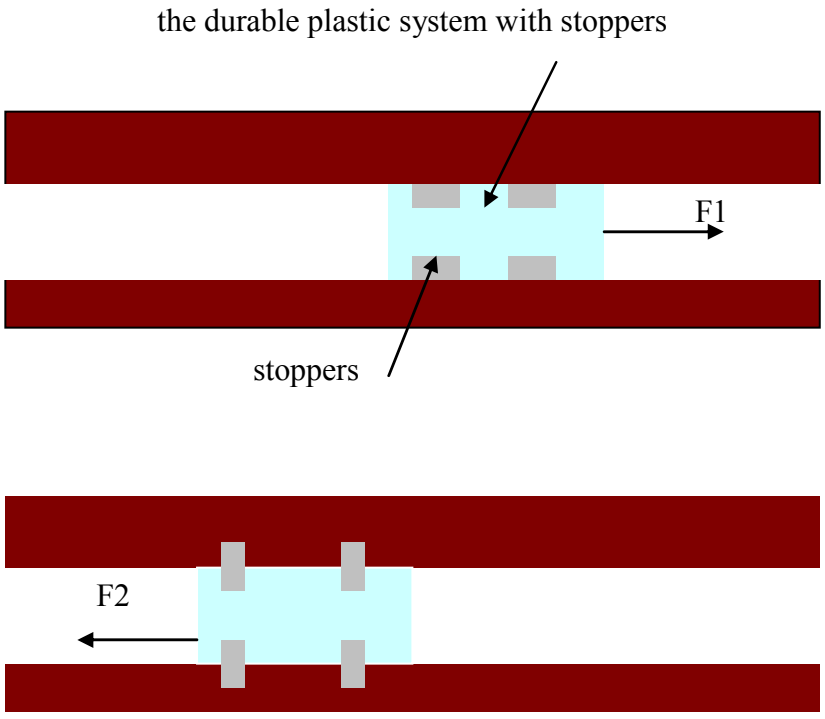

Figure VI.3 Fixing the stoppers into the slope - indicative scheme

The stoppers can fix the soil without damaging the roots and causing groundwater leakage which result in a displacement of part of the slope. These bars are equipped with stoppers made to support the slopes, and they shall be dimensioned according to the size slope, slope structure and the village's sewage and water supply system.(fig. VI.4).

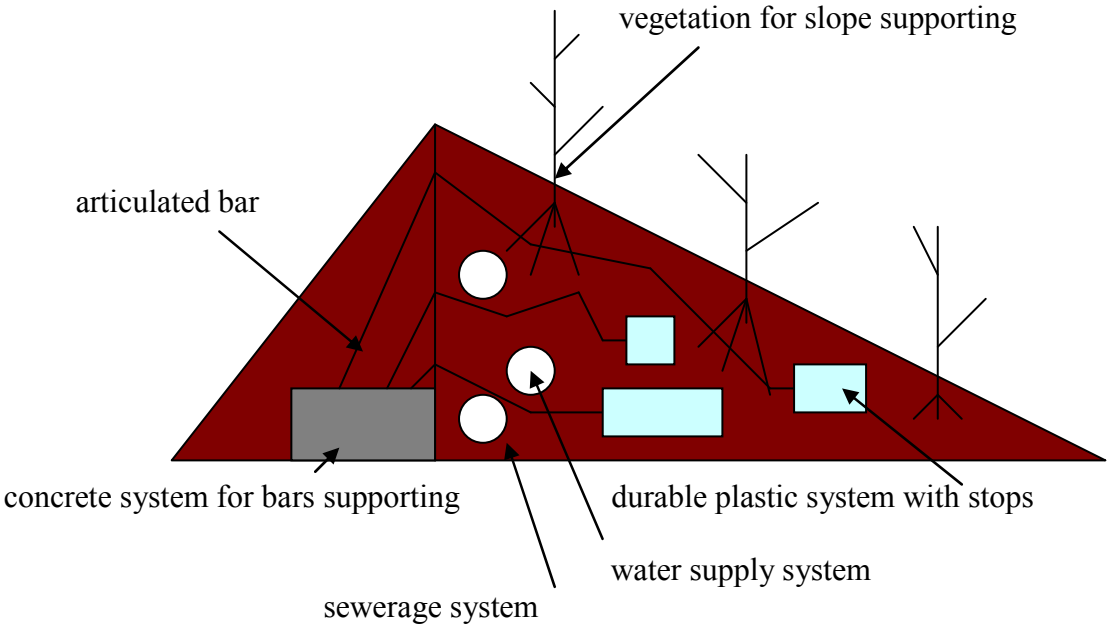

Figure VI. 4 Articulated bars within the sewerage and water supply system - indicative scheme

Bars articulations help their penetration inside the channels drilled into the slope. Wooden bars may be equipped with several stopper systems to fix the slopes better. There may be also wooden bars without articulations when there is about only straight drilling. After the bars were fixed entirely in the wells within the slope, they will be held back by the means of a mechanical vacuum system so that the stoppers can be well fixed in the soil.

The great advantage of this ecotechnic method consists in:

- It can be applied to any kind of ground slope;
- It does not require high costs of implementation and maintenance;
- It does not destroy the radicular system;
- It has a large functionality over time because it has been constructed mainly from ecological materials.

Slopes stabilization for lake slopes

Method VII

Sheet piling fixed by a helical system

Slopes bordering lakes often fall down and change the water quantity and quality. Stabilizing steep slopes with no vegetation is a complicated and timely question. One method would be represented by wooden sheet-piles secured to a metal spring, which, in turn is anchored to the concrete rectangular parallelepiped built inside the lake(fig. VII.1)

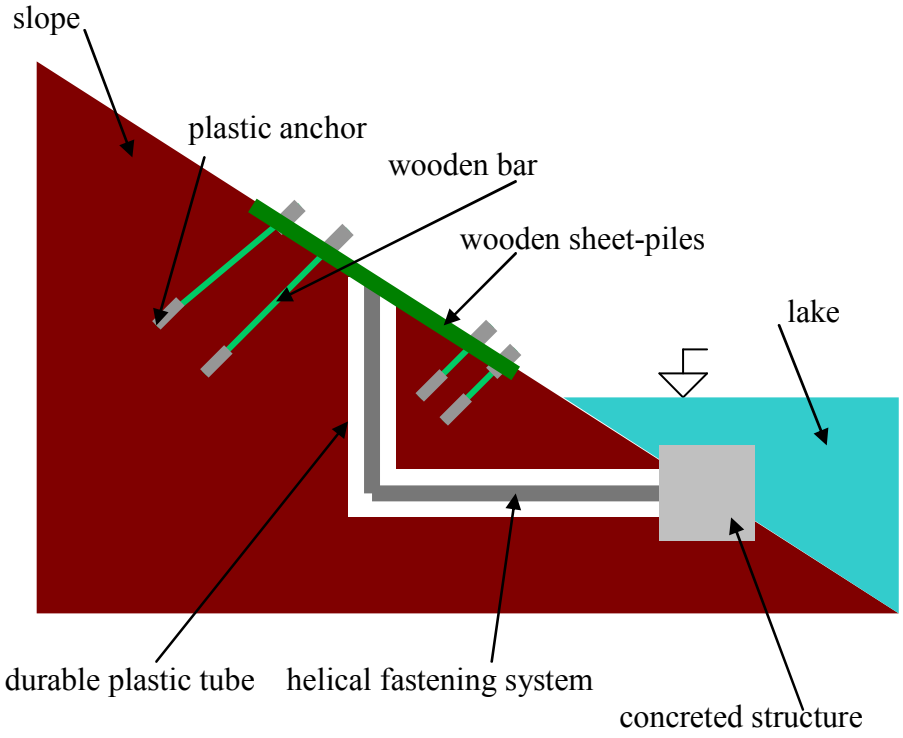

Figure VII.1 Slopes stabilization by the means of wooden sheet-piles -indicative scheme

The spring gives the sheet-pile a pressing force on the ground (slope). Besides this pressing force, the wooden bars fixed in the sheet-pile gives it a greater stability. Compression forces of spring doubled by soil reinforcement through the wooden bars, stop or diminish the frictional forces of the slopes, making them equally on all the slope's

surface. The bolts are provided with stoppers which can open if propelled by a force outside. This method is extremely useful in areas where no vegetation for stabilization can be planted.

Method VIII

Shores of lakes are often damaged, eroded or concreted. The ecological arrangement of these lakes may consist in building new sections of the banks by using ecotechnical methods(fig.VIII.I).

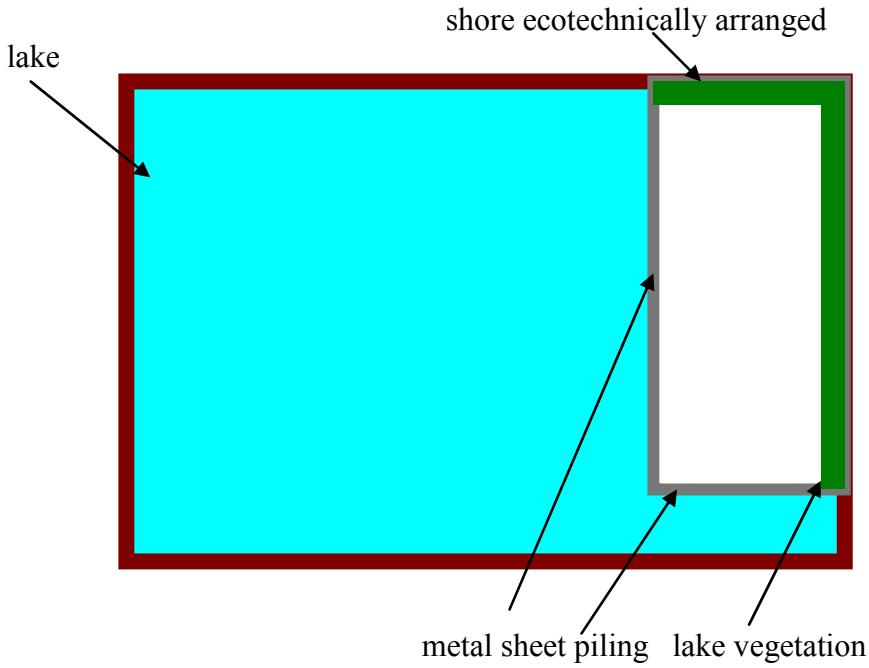

Figure. VIII.1 The ecotechnical arrangement of a lake-indicative scheme

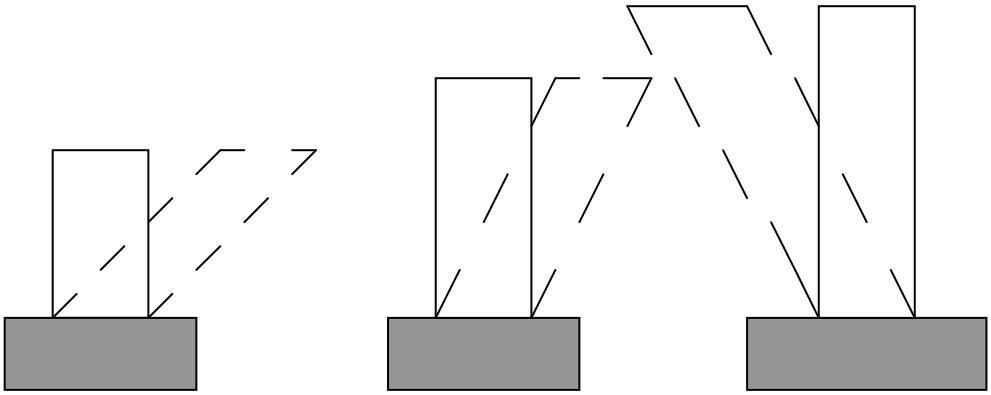

Figure. VIII.2 Gabions characteristics (elasticity, strength,)-indicative scheme

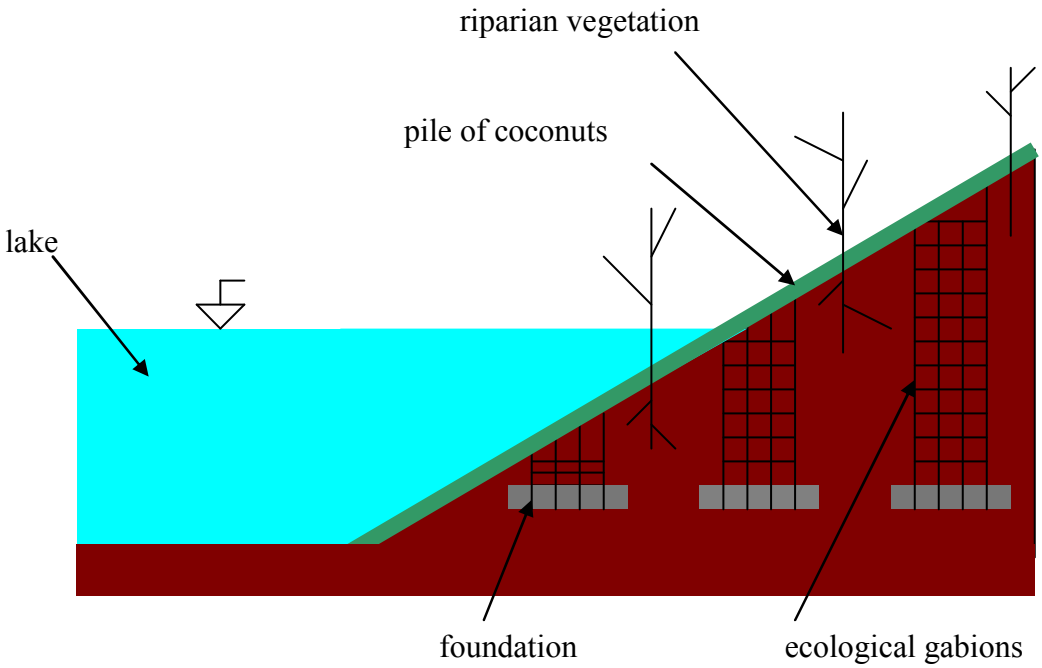

Fig. VIII.3 Gabions positioning into the lake shore-indicative scheme

The work area should be detached from the body of water using metal sheet-piles (fig.VIII.1). Wooden gabions will be build and fixed in concrete or wood foundations. Fig. VIII.3 Gabions positioning into the lake shore (pile of coconuts, riparian vegetation).

Timber used for gabions should be weather resistant and very elastic. Gabions are made of wooden bars forming 3/5cm rectangles between them. Shores will be composed of three or four gabions in line that can undertake static and dynamic loads of the body of water but also of other loads on the shores (fig.VIII.3). Gabions can work independently according to the forces acting on them (fig.VIII.2)

A pile of coconut, representing the latest development of the ecotehnnical method VIII, will be fixed in the gabions. This method can be applied to shores/banks which do not exceed 5 meters high. On the coconut carpet, where possible, regional semi-aquatic plants are fixed, which, by the means of the root system, can support the shore/bank.

As compared to the classical gabions made of metal piles and filled with rocks, the ecological gabions do not affect the texture of the bank, aquifer and aquifer water circulation and do not damage the banks design as the classic gabions do. The size of ecological gabions depends on where they have to be installed. By arranging with ecological gabions, the banks can be transformed into real recreation area integrating the lake into the local functional ecobiome.

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