WATERCOURSES CONNECTIVITY. ECOTECHNIC METHODS

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Method I

Stabilization of banks by using sheet piling system with spring.There are many new possibilities to be completed and, then to put theory into practice in order to stabilize the river banks.

Circular erosion on a watercourse is most common. In this case, the stabilization of the bank would be possible by inserting a waterproof timber frame. This timber frame is fixed in two directions (figure 1). The timber frame will overcome few meters the erosion ends on both sides.

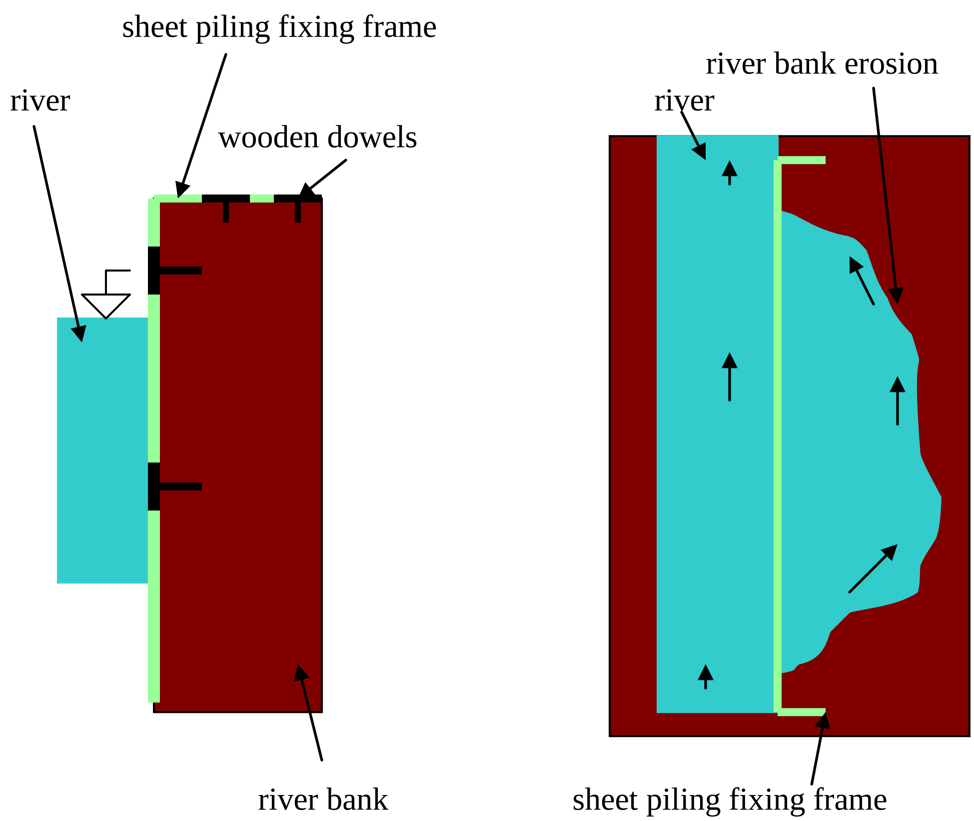


Figure 1 The sheet piling frame for fixing

After piling wood frame was set in the bank collapsed, eroded area is filled with earth and then it linearizes (figure 2).

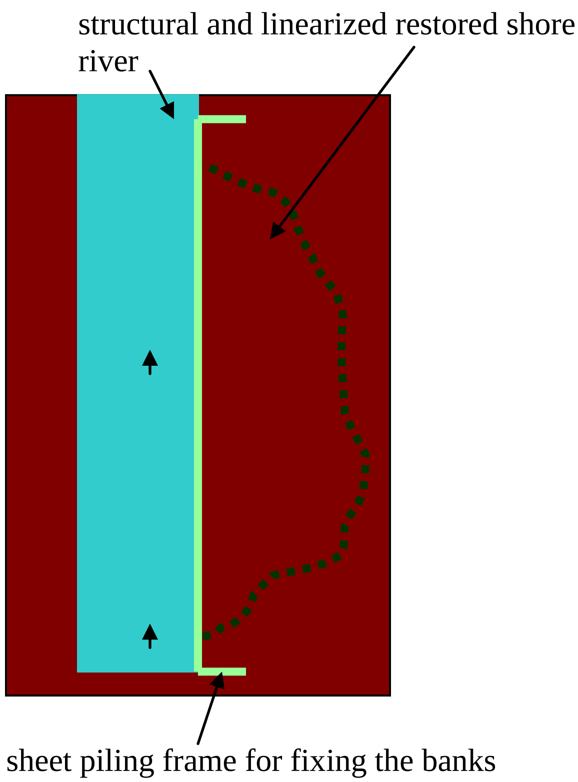


Figure 2 Bank linearization

Wooden or hard plastic sheet pilling will also be fixed on this timber frame. The fitting system is made of a metal plate on which a water resistant fixed metal spring is fixed (figure 3).

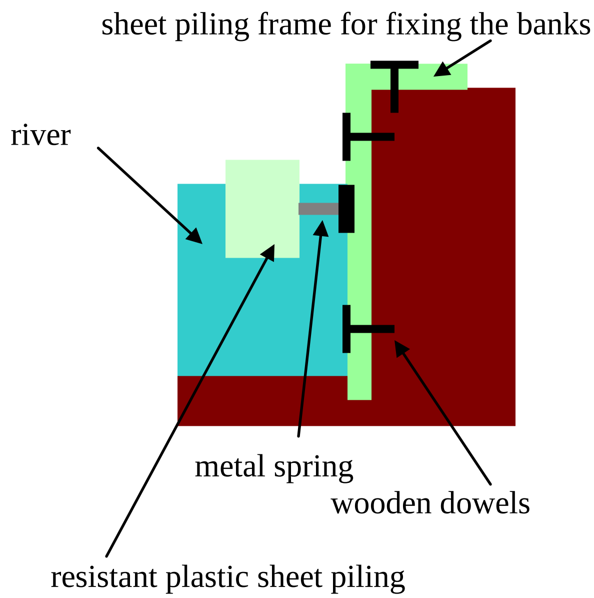


Figure 3 Plastic sheet pilings for dissipating the energy of the river

Such sheet piling is symmetrically distributed along the length of the timber frame, in this way diverting and dissipating any whirl near the bank. Such plastic sheet piling can divert both stones and logs brought by the floods, and keep the bank intact. Such piling works with the same effectiveness if backwaters phenomenon occurs, in case of watercourse blocking. The number of resistant plastic sheet piling will be calculated depending on the water speed, water level, flow, geographical area, etc. Such sheet pilings supported by extremely durable springs is also functional for mountain rivers (figure 4).

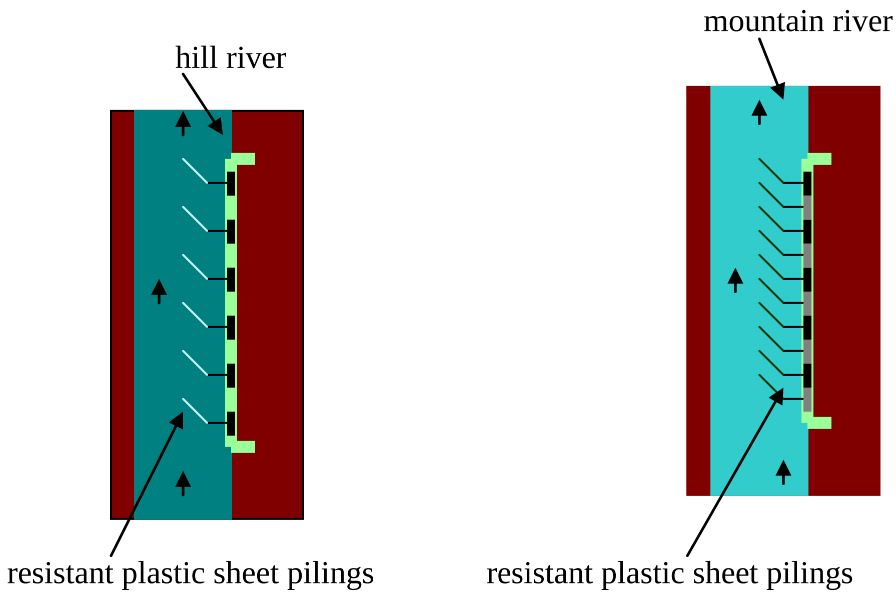


Figure 4 Number of sheet pilings depending on river – indicative scheme

Method II.1

Method of stabilizing slopes with cable supports or bent pillars (figure.1).

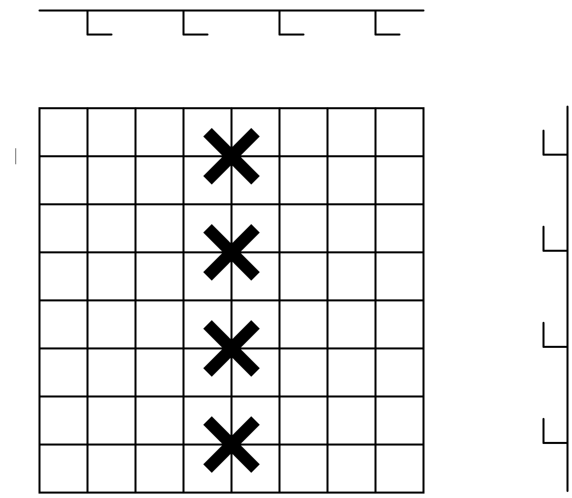


Figure 1 Network of cable supporters – indicative scheme

A network of cables supporters will set the ground below it, but a layer of soil should be placed above. Trees or grass with fasciculated roots should be planted on this layer of soil.(figure 2).

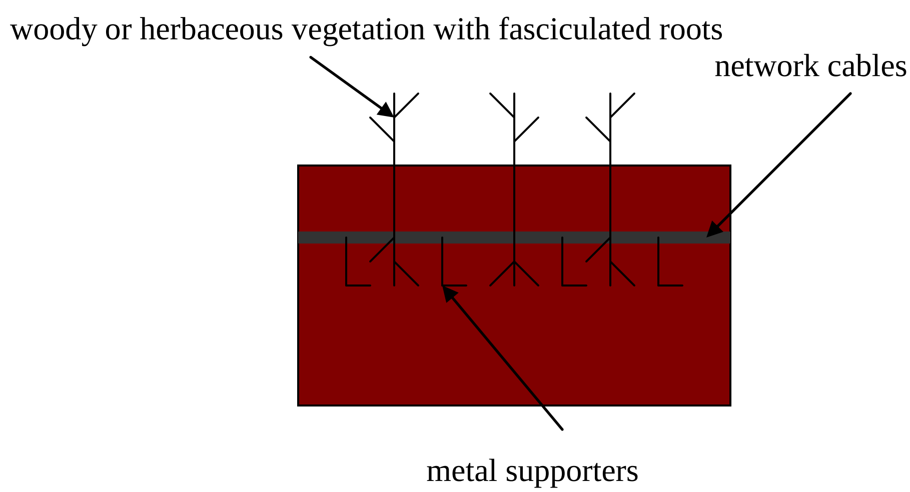


Figure 2 Metal supporters - indicative scheme

The network cable is fixed on the slope by using some metal piping systems. Such piping is fixed in the soil by the means of a system of threaded dowels. (figure 3).

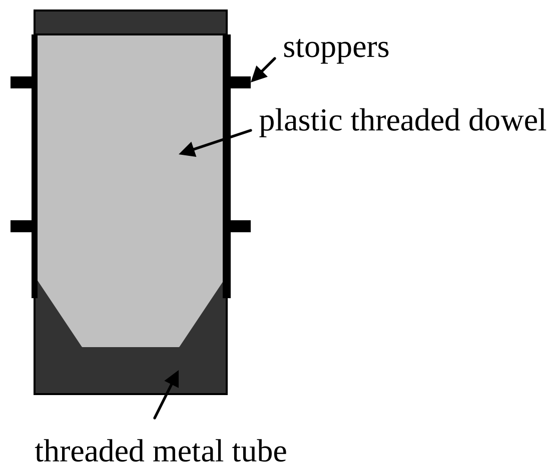


Figure 3 Supporting system for the network cable – indicative scheme

This network consisting of cable stoppers can support a layer of soil above it, but also vegetation and its radicular system (figure. 4).

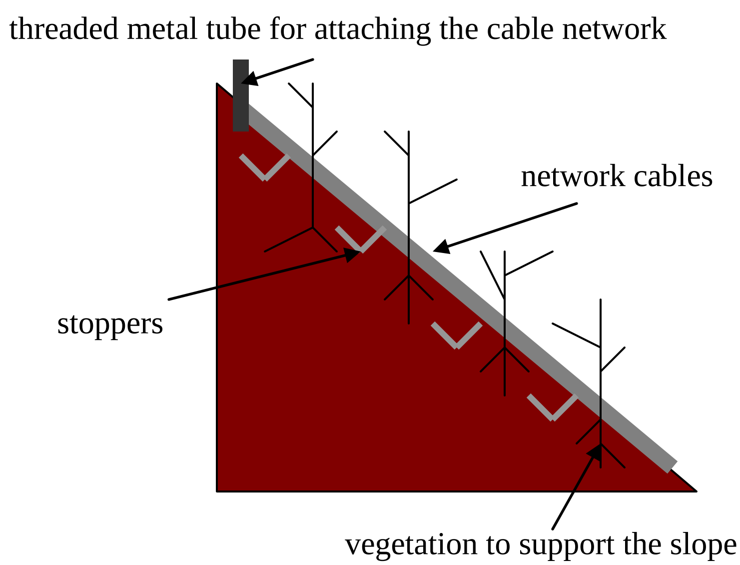


Figura 4 Slope supported by cable network – indicative scheme

Method II.2

Another method to support the banks of a river is to build a wooden frame with triangular prism bases.

The two triangular prisms are filled with fascines and behave like buttresses against landslides in the riverbed. The wooden pillars give the timber frame an additional support (figure1).

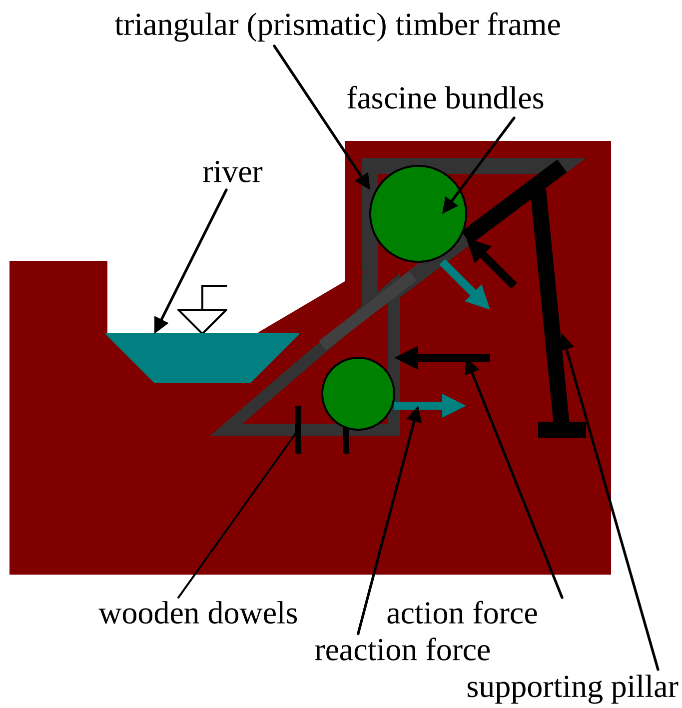


Figure 1 Riverbanks supporting system – indicative scheme

The soil inside cannot move towards the water body because is blocked by the timber frame system. Water from precipitation and water during floods will flow outside the timber structure avoiding erosion of the banks. Even if, due to major floods, the soil covering the timber structure will disappear, this structure will work by sheet piling system for bank protection.

Method III

Counterweight basin

For migration of ichthyofauna, near the dam spillway a metal bar should be fixed. Other two metal bars should be fixed on the first, and then two pulleys should be fixed on each of the two metal bars. A perfectly extended cable is mounted on the pulleys. A metal basin for fish transportation, but also a counterweight to lift and lower the metal basin will be set by this cable. In the top of the dam a crenel will be executed along the metal basin (figure 1).

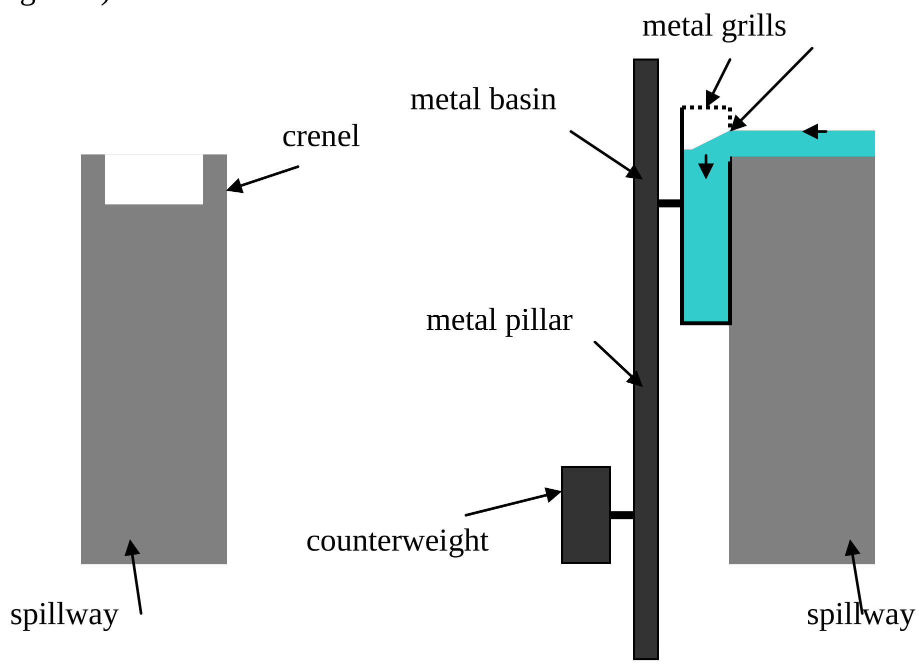


Figure 1 Metal basin – indicative scheme

The metal basin must have a counterweight so that when filled with water, including fish, it descends into a specially designed basin in the river bed, downstream from the dam spillway. Both metal basin and the counterweight can be drawn from the two metal bars and be repaired. The basin for fish transportation can be of glass resistant with metal corner. When the metal basin is lowered, there is a metal hatch going down immediately. This hatch is set on two steel rails (figure 2).

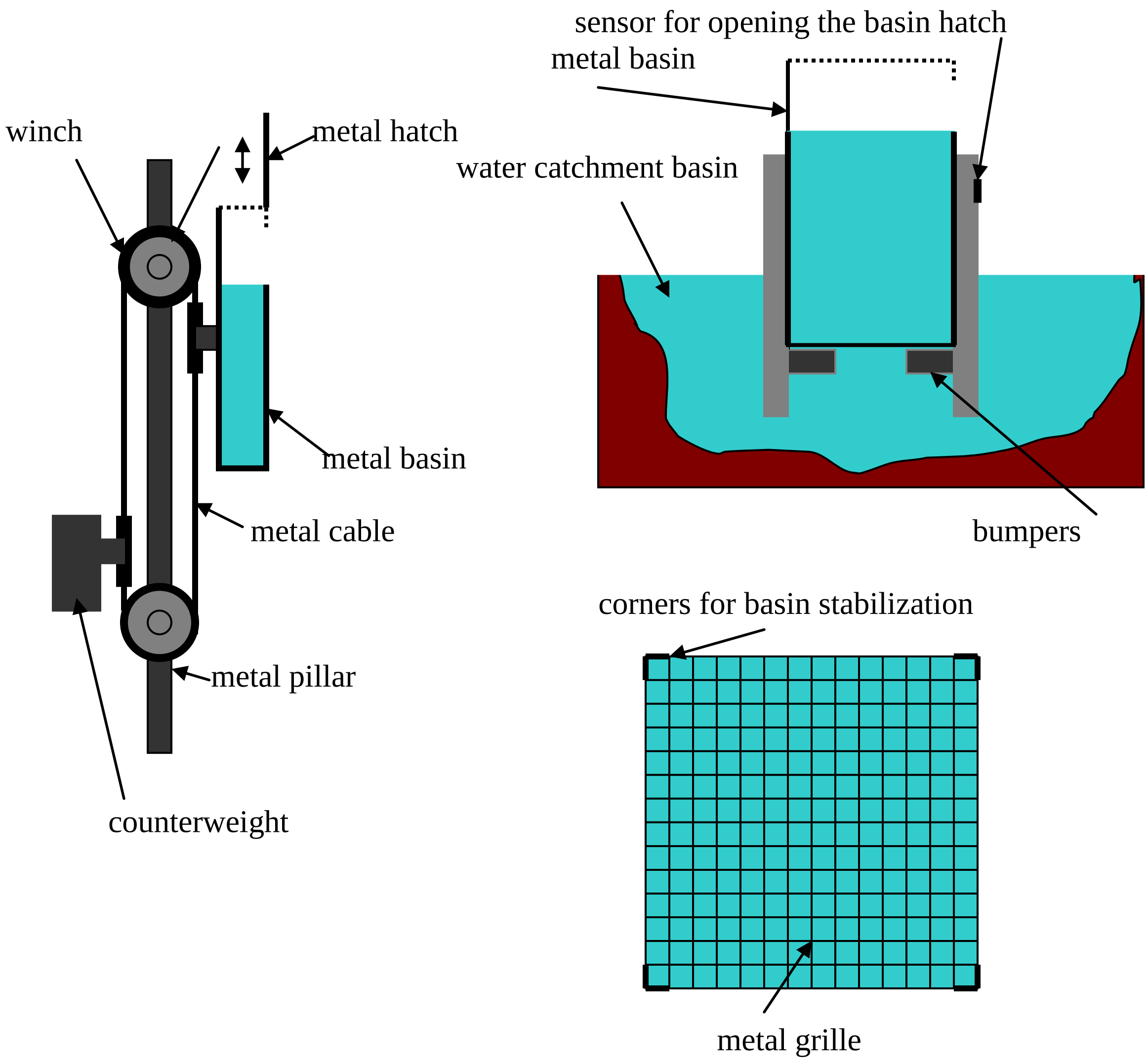


Figure. 2 Transport system – indicative scheme

One side of the metal basin slides and when the basin reaches the corners for stabilization, the sensor located on one of the corners triggers the hatch opening. Also, the hatch of the basin can be opened mechanically if a bar is welded on one of the corners blocking the hatch and raising it by the means of a sliding system. When the basin was filled with water, it is heavier than the counterweight and goes down towards the water catchment basin built near the dam spillway or the flood defense threshold.

After the hatch has been lifted on the sliding system, the water and fish inside the metal basin fish reach the catchment basin (figure.3). There will still be about one third of the water amount remaining in the metal basin (figure 4). At this level, the counterweight will lift the metal basin.

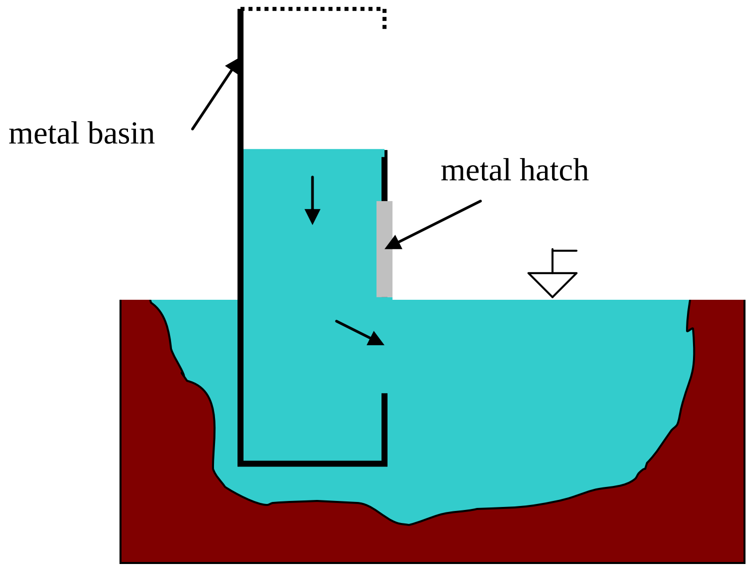


Figure 3 Discharging water from the basin, cross section – indicative scheme

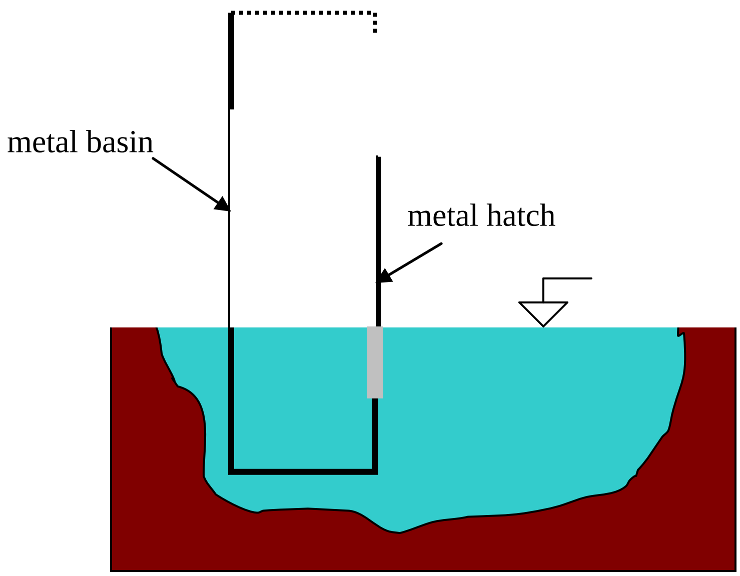


Figura 4 The time when the counterweight lifts the basin up to the top of the dam, cross section – indicative scheme

It is important that through this method very little electricity (sensor) is consumed or not consumed at all (running strictly mechanical). Fish lifts from large dams consume electricity. Even if this mechanism fails, it does not affect the functionality of the dam spillway. Metal cable can be locked for repairs or for loading fish into the metal basin. This system is generally used for lowering fish and less for their lifting, but it can be successfully used when man intervenes directly in the process.

Method IV

Metal bar for transport

Another possible method that helps fish migrate upstream or downstream of the dam or threshold is to create a mobile basin fixed on a metal bar that bypasses the dam spillway. The mobile basin is fixed to a rectangular metal bar by the means of a metal sleeve. An electric motor having a castellated metal wheel is fixed throughout a metal sleeve that covers up to two thirds of the bar. The top bar is rack-shaped which helps castellated wheels (mobile basin and electric motor or with oil) to establish and lift or lower the mobile basin upstream or downstream of the dam (figure.1 and figure 2).

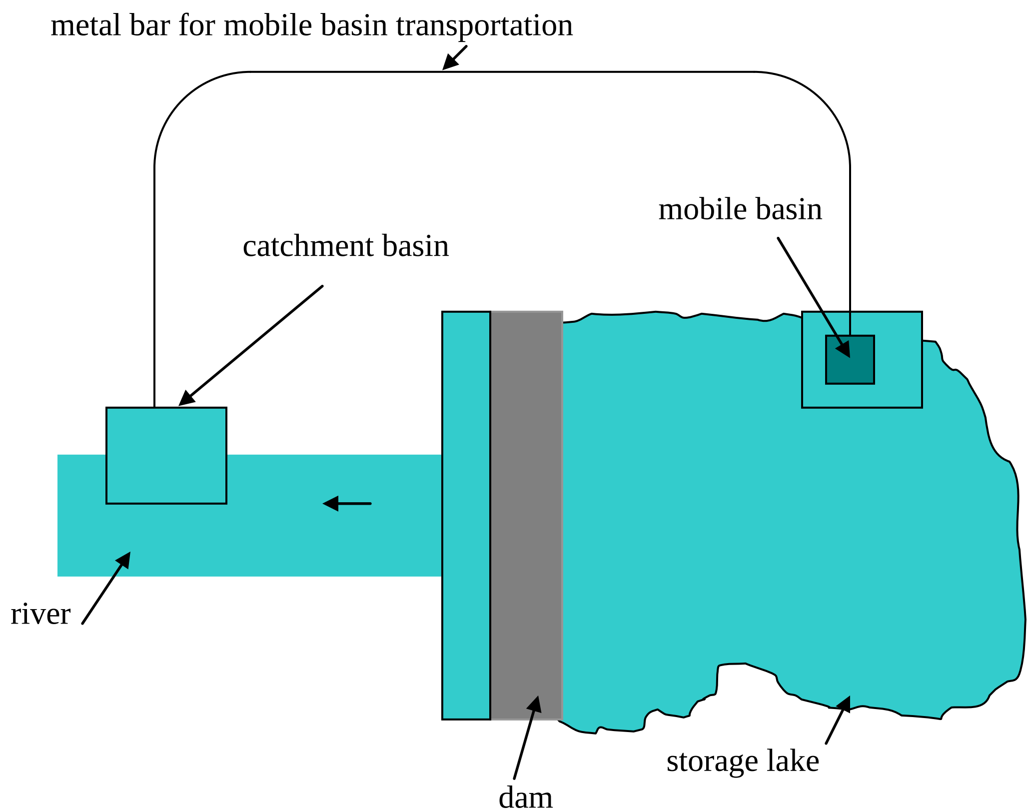


Figure 1 Positioning of mobile basin transportation system – indicative scheme

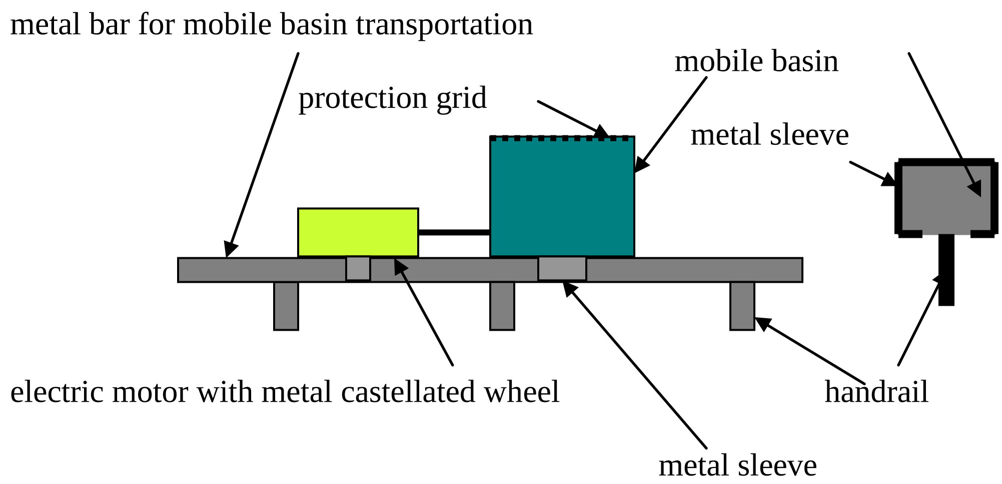


Figure 2 System components – indicative scheme

The mobile basin is provided with a protection grid that goes up one meter before reaching the catchment basin (figure 3). The motor is sealed so that water cannot penetrate it.

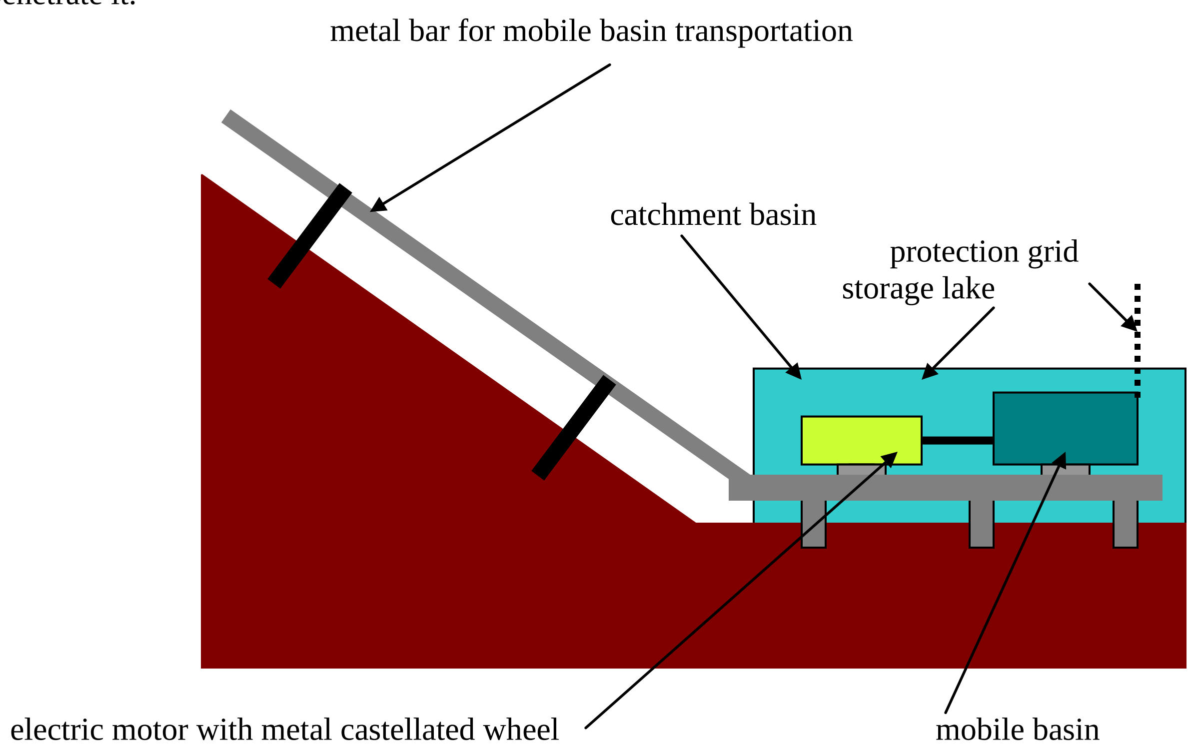


Figure 3 positioning of mobile basin into the storage lake – indicative scheme

The metal bar used for mobile basin transportation is compact and rectangular in cross section in order to support both the electric motor and the mobile basin. Inside the mobile basin there is a system attached to the metal sleeve which makes the mobile tank be always horizontal so that water cannot flow (figure 4). In both parts of the mobile basin, two springs are linearly fixed on either side, so that they proportionally shrink to the slope the basin is lifted or lowered. The basin is fixed on the metal sleeve by the means of a bearing device. The metal sleeves have small bearings inside so that they can slide on the metal bar.

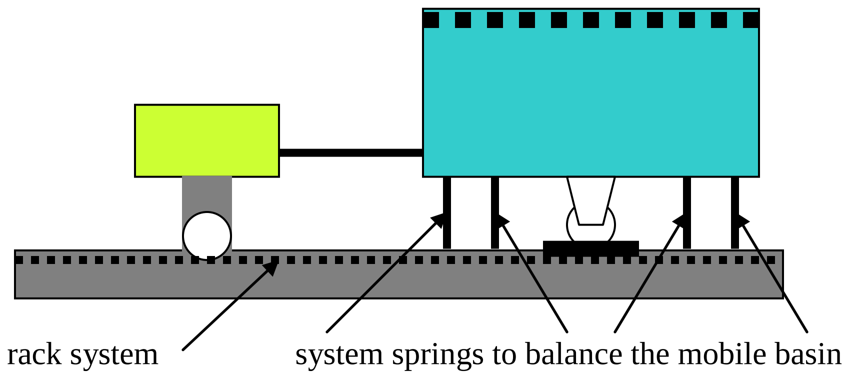


Figura 4 The stabilization system to the mobile basin

This ecotechnical solution is also available for large dams. In such cases the metal bar is attached to rocks, whatever their inclination would be (figure 5).

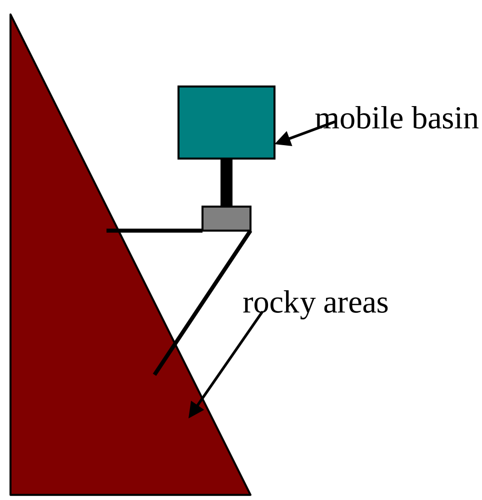


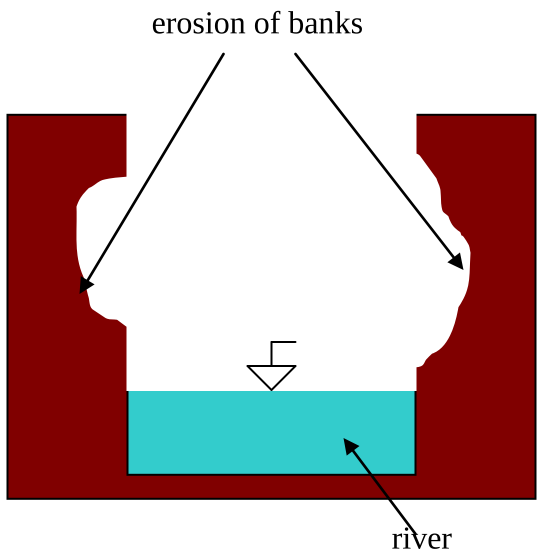
Figura 5 Ecotechnical solution for rocky areas – indicative scheme

The catchment basin downstream of the dam is located few meters below the maximum level where the fish can go up. This engineering solution has some costs of production but also implies costs for repairing the elevators for ichthyofauna; some dams are already provided with this type of elevators.

Method V

Stopping erosion

Another way to stop the erosion of banks, but also to recover them, is to create a timber frame positioned in the middle of the watercourse. In the middle of the river some wooden pillars are fixed at 4-5m depth. Outside the water, the pillar should be about one meter high, depending on the banks height. (figure 1).



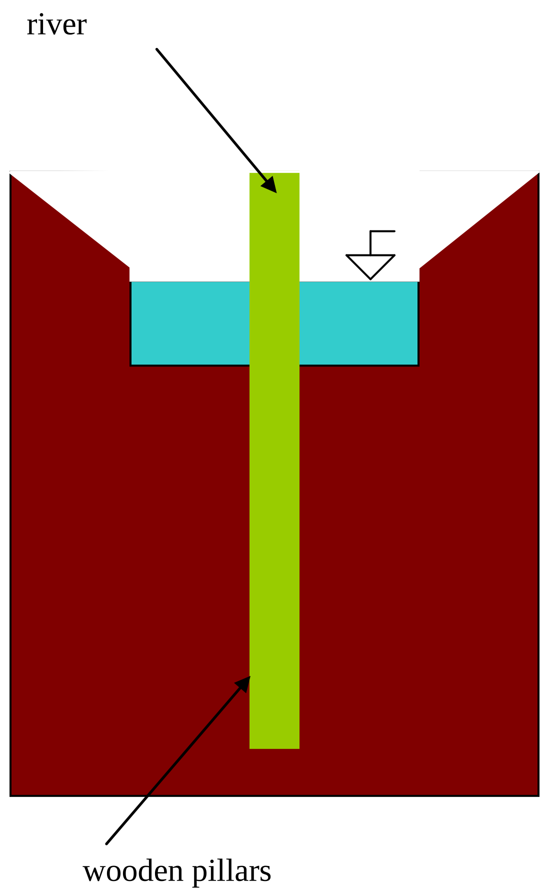


Figure 1 Erosion and riverbed channel arrangement – indicative scheme

After the riverbed is linearized and compacted, a canal or two are dug on the side of the bed where the bank was eroded. Coconut rolls to hold water that seeps into riverbed are fixed in this canal. After the blocking the canals in that area, some timber sheet pilling are fixed with wooden dowels. The timber sheet pilling will not be supported by wooden pillars attached to those pillars in the middle of the river. Wooden cross bars are below the average annual discharge of water and, in some cases, even in the riverbed. These bars are placed across the water course and will not stop the migration of fish in any way. Central supporting pillars can be used by aquatic birds as resting areas (figure 2).

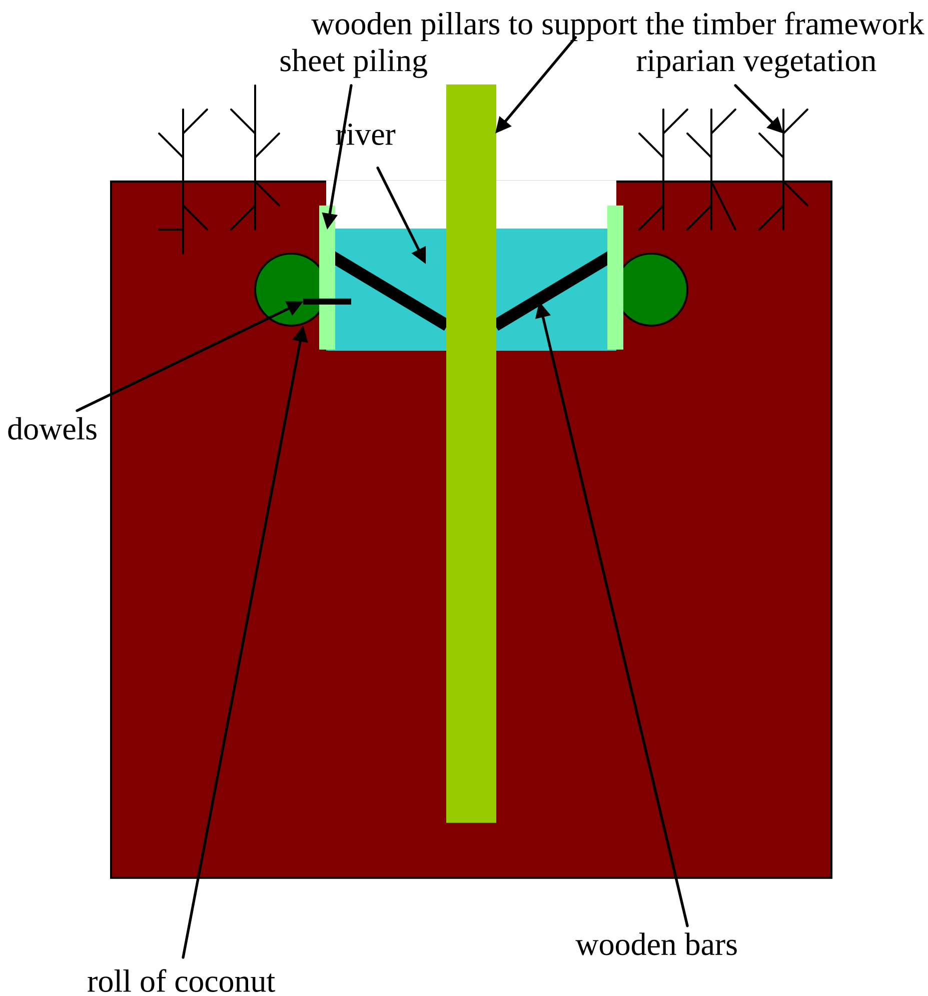


Figure 2 Supporting timber frame – indicative scheme

Restoration of the watercourse is also safe in case of large floods; it has low cost and can be applied to almost any watercourse. Local riparian vegetation must be planted on the riverbanks.

Method VI

Floating canal

We can build a plastic resistant floating canal so that fish can migrate over the dam. This canal is also a collector and can have circular or rectangular shape. (figure 1). The floating canals can have triangular or rectangular prismatic shape.

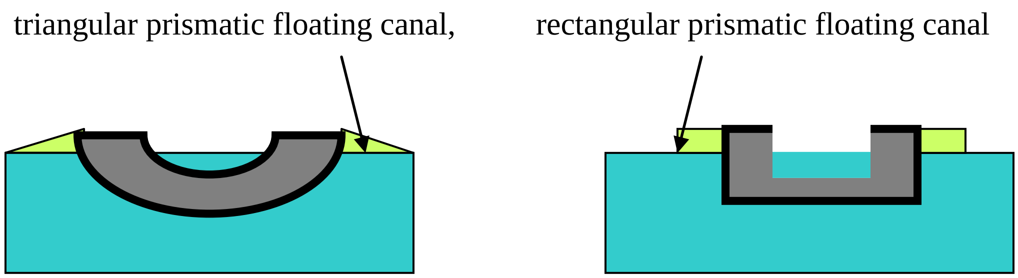


Figure 1 Floating canals – indicative scheme

These floating rectangular prismatic floating canals provide free crossing space for logs on the watercourse or on the lake. Floating channels are set diagonally. They are filled with water having the average speed of the river. At the upstream end, the water is captured in this floating canal through a crenel. The water speed inside the floating canal is calculated depending on the angle of water intake. At the upstream end, the floating canal is fixed in two bars having a rectangular cross section. Two metal cables with bearings at each end are to be fixed on the floating canal (figure 2).

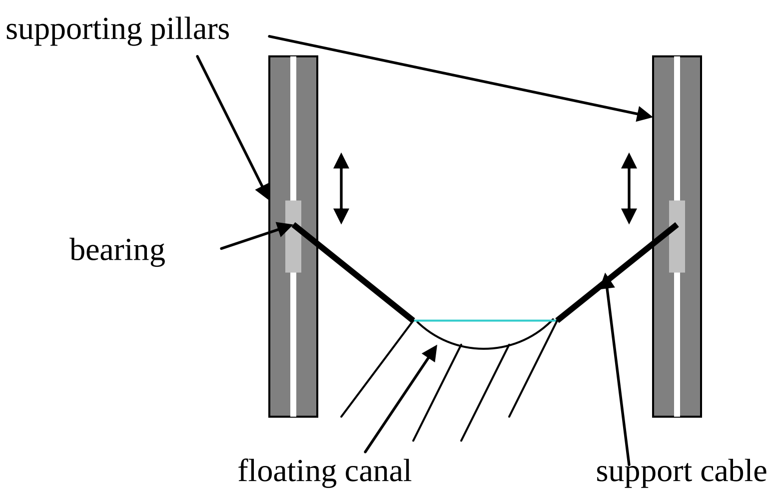


Figure 2 Floating canal mounting system – indicative scheme

The metal bar has a hole, a crenel so that metal cable can penetrate. The bearing is thicker than metal cable and so it can slide inside the metal bar moving according to the water level of the river or lake. The upstream end of the canal should be provided with sheet piling or floating timbers pile that redirect fish towards the floating canal (figure 3).

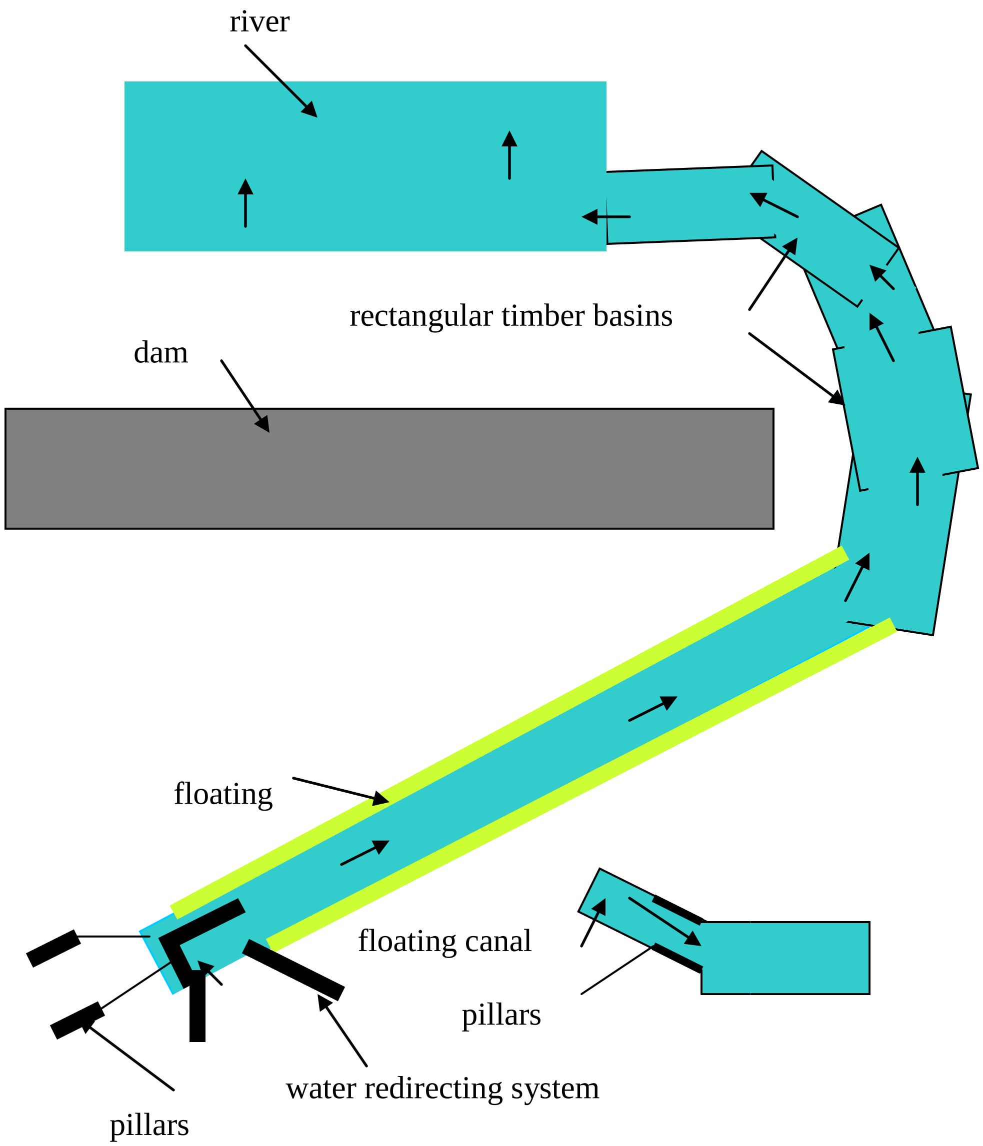


Figure 3 Timber basins positioning – indicative scheme

The floating channel can be placed anywhere related basins can be built to slopes, until they reach the confluence with the river downstream of the dam (Figure 3). Basins will be made of wood or durable plastic. At the end of the downstream, the floating canal is also fixed into the metal pillars, but without having a sliding system as the upstream end. Defined by its flexibility, the downstream end has less capability of movement as the upstream end. This method and others are applicable to dams up to ten meters.

Method VII

The metal system attached to the dam spillway

Another possibility of restoring longitudinal connectivity of rivers is fixing a metal canal (chute) and box with upper force of catchment on the dam. The upper force of catchment of the metal box is made through a crenel in the dam crest(figure 1). The grid box is all around the metal box meant to stop fish (especially salmon) jumping directly into the river. The water flow entering the crenel is more substantial than the one taken by the metal channel.

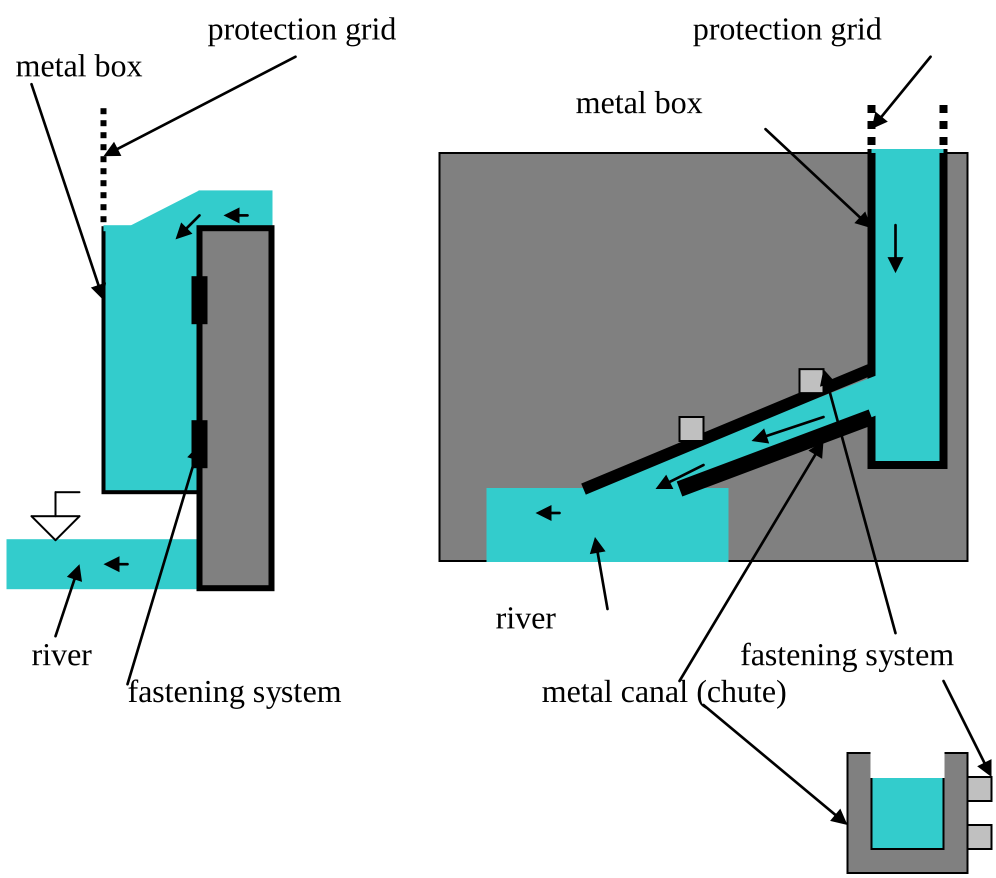


Figure 1 Metal canal positioning on the dam – indicative scheme

Attachable metal channel is designed for fish migrating upstream and downstream of the dam. The metal chute or canal is fixed on the dam and is inclined according to the species of fish that migrate. Both metal box and canal are anti-corrosive. If an important quantity of water flows over the dam spillway, the metal canal will be covered by a glass surface (figure 2).

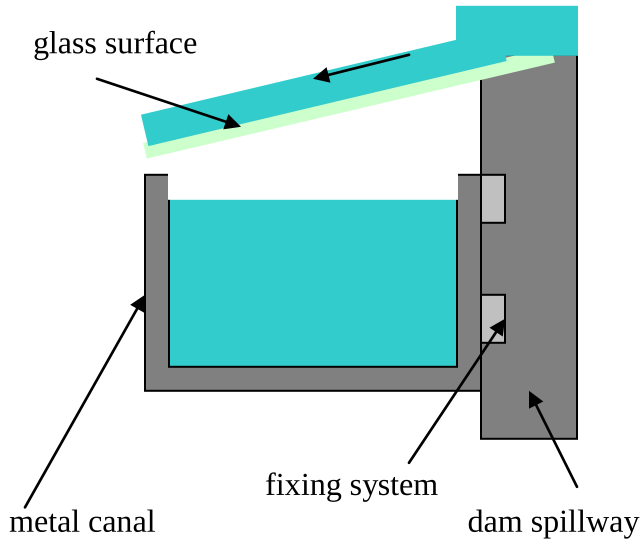


Figure 2 Metal canal protection system – indicative scheme

If there is no fish in the river, this system for fish migration can be detached and fixed to another dam, which is important.

Method VIII

Mobile bridge

There is another possibility for fish to migrate upstream and downstream of the dam spillway. Two metal plates are fixed to the dam.(figure 1).

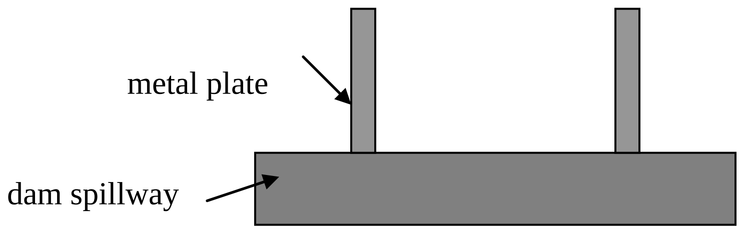


Figure 1 Metal plates fixing on the dam – indicative scheme

Within these metal plates a rectangular parallelepiped sliding element (mobile bridge) without the upper side is fixed (figure 2).

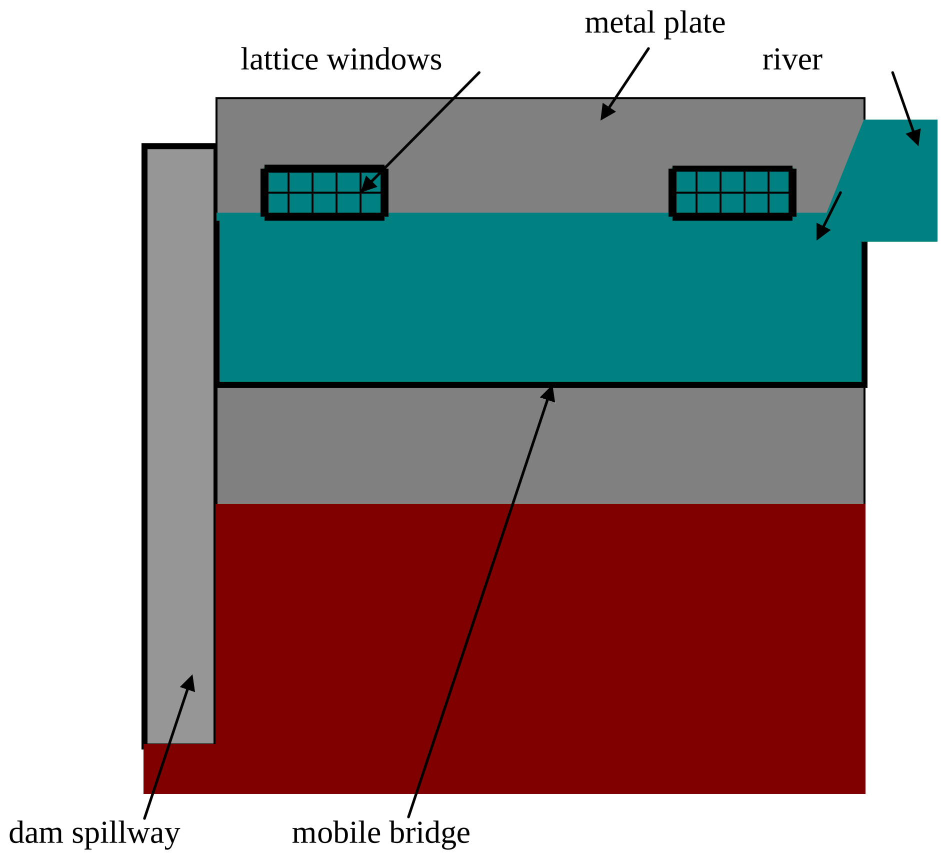


Figure 2 Mobile bridge positioning within the metal plates – indicative scheme

There is also a water guidance system for to reach the mobile metal bridge. Windows made in metal plates, which support mobile bridge, act as an overflow and do not allow the water to pass over these windows. The mobile bridge has a variable geometry near the dam. Under the mobile bridge there is a metal plate on which two telescopic hydraulic cylinders are fixed (figure 3).

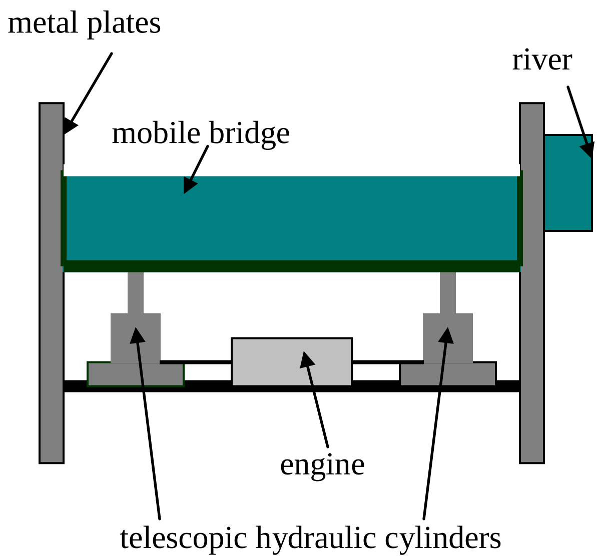


Figure 3 Mobile bridge lifting system – indicative scheme

Telescopic hydraulic cylinders work due to the engine positioned between these cylinders. The engine is programmed to start every hour but it can be rescheduled according to the flow of ichthyofauna migration. When the mobile bridge reaches the upper side of the dam crest, the metal surface of the mobile bridge rotates to the left over the dam crest. (figure 4).

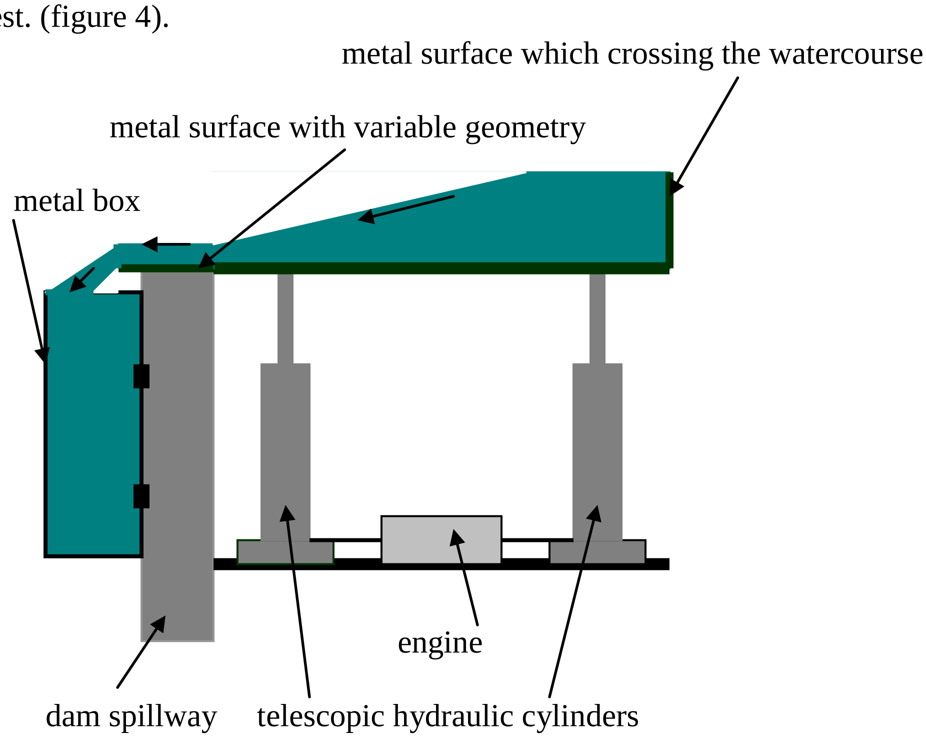


Figure 4 Engineering system operation – indicative scheme

The watercourse diverted between metal plates is blocked for a short period of time until the water containing fish inside the mobile bridge get into the reception metal basin (metal box, method VII) fixed the dam spillway. The folding symmetric surface belongs to the mobile bridge during lifting operation and completely blocks the water flow passing through the metal plates. The water is blocked without passing over the metal surface, as long as water inside the mobile bridge runs down to the metal box. After downloading the water and fish, the telescopic hydraulic cylinders fall back letting the water fill the mobile bridge. The system of fish collecting and directing is the same as presented in Method VII. For any repairs to the system, but also for supplying the engine with fuel, all the water is redirected using steel sheet piling. The motor can be electric and the power generator can work with hydropower. It is a method that may work well in dams up to ten meters high and is convenient and also efficient.

ISBN 978-973-0-12246-6

Bucharest

2012