Synergism Between Flood Protection and Stream Ecology

Space as the Key Parameter

The Federal Law on Hydraulic Engineering dictates that human life and material assets be protected from damage by water. This needs to be achieved while having a minimal impact on streams and reserving sufficient space for them to fulfill their multitude of ecological functions. These general principles are to be translated into a flood protection philosophy that is in balance with the environment.

Even as recently as in the 1970s, hydraulic engineering projects were dominated by concerns for flood protection and drainage. Increasing environmental awareness and severe storms in 1987 and 1993, however, led to a fundamental change in attitude; sustainability[1] has been adopted as the guiding principle. A new general framework for flood protection was developed, and laws were changed accordingly.

The core characteristic of this new approach to stream management is integrated planning which considers ecological, political, economic and social factors. The key parameter in the planning process is the amount of space the stream will be allowed to occupy. Giving a stream sufficient space has positive effects in a number of ways: the natural habitat is preserved, the water quality is improved, recreational space is enhanced, and the risk of floods and damage to protective structures is reduced. Based on a broad-based problem analysis, the following strategic goals for flood protection have been formulated:

- areas occupied by dwellings and industrial or agricultural zones are to receive adequate protection;
- preventive measures should minimize damage in the case of flood events;
- streams are to be respected as important elements of the landscape, linking different parts of nature.

These goals will only be reached if federal policies in all of the relevant areas are coordinated, including flood protection, water protection, fisheries, environmental and landscape protection, hydroelectric power generation, forestry and agriculture. Readiness for cooperation and the ability to reach consensus will, therefore, be crucial if we want integrated planning and management to become a reality.

Sustainable Flood Protection

Based on the requirements for sustainable and integrated flood protection, the following principles have been formulated:

Principle 1: Determine stream condition and risks

Before we can evaluate the ecological condition of a stream or decide on the need for protection, detailed information is needed about its hydrological conditions, the status of current flood protection structures, its ecological condition and the primary risks or types of risks associated with it.

Principle 2: Preserve natural retention capacity

Preservation or recreation of the natural retention zones is just as desirable as the preservation of the natural course of a stream. Larger retention zones delay the flow and dampen peak flows.

Principle 3: Differentiate the aims of protection

Flood protection should differentiate between different values of the objects to be protected (e.g., communities, structures, agricultural areas). The higher the value of the object, the higher the need for protection.

Principle 4: Minimize intervention

Flood protection should be achieved with a minimum of intervention within the natural space of a stream. The stream needs to be given adequate space for fulfilling its many ecological functions. In addition to the stream itself, we need to consider the areas adjacent to the stream and their uses.

Principle 5: Maintain streams and continue to monitor problem areas

Appropriate maintenance of a stream is an ongoing task. We need to insure that protective structures remain intact, that the runoff capacity is maintained, and that no ecological functions are impaired. Protective structures need to be periodically tested for structural integrity and stability under extreme runoff conditions. Potential weak spots need to be identified and eliminated.

Principle 6: Guarantee the space required by a stream

A stream should be more than a gully; a river should not be degraded to a canal. It is the obligation of the Cantons to determine the space requirement for streams and to incorporate this information in all directives and land use plans or other activities dealing with the assignment of “space”. Based on these principles, we have developed a flow chart for developing stream protection plans (Fig. 1). A sustainable flood protection project will give ecological function and flood protection equal weight. The starting point of any catalog of potential measures is always a survey of the current status; the process should identify concrete, realistic goals within each of the two areas. It can then be decided where remedial action is needed and how it should be prioritized. An overall optimization should be performed in a final review, weighing all the different demands on the stream against each another [1].

How Much Space does a Stream Need?

An interdisciplinary group has studied this question and developed two different meth-

[1] Sustainable measures in flood protection are measures that can be implemented with little effort, are socially acceptable, have the desired long-term effects, limit damage, and can easily be modified.

ods for determining the minimum space a stream has to be given [2]. Both methods will be used in the planning and design of new hydraulic engineering projects in Switzerland. If the two approaches yield different answers, the larger of the two calculated space requirements will be used.

Any structures to be built have to be located outside the area assigned to the stream.

Hydraulic Approach (Flood Protection)

Based on the hydrological conditions and the specific protection goals [3], we have to determine the minimum space that has to be secured for the stream in the long-term. In settled areas, the key parameter normally is the HQ_{100}, the flood stage that is statistically reached once every hundred years. The design value corresponding to such a flood event allows us to calculate the hydraulically required minimum width of the stream bed. This is a theoretical value, and special local conditions need to be taken into account where appropriate. Allowing a slope of 1:2 for the stream bank and a buffer zone of 3 meters along both sides of the stream (guaranteeing access to the stream), we can determine the minimum space required by a stream from a flood protection perspective (Fig. 2).

Ecological Approach

The ecological approach is based on literature research and a number of case studies. Streams were treated as functional entities, including the stream as well as the stream bank, buffer zones and recreational space. We were able to define the so-called "key line", delineating the natural outline of the stream bed, which serves as the reference line for defining the minimum space to be added on either side of the stream (Fig. 3, black curve). For small streams, the minimum width should be 5 meters on each side. For larger streams (stream beds up to 15 meters wide), the requirement increases to 15 meters. This simple procedure allows us to produce a rough estimate of the

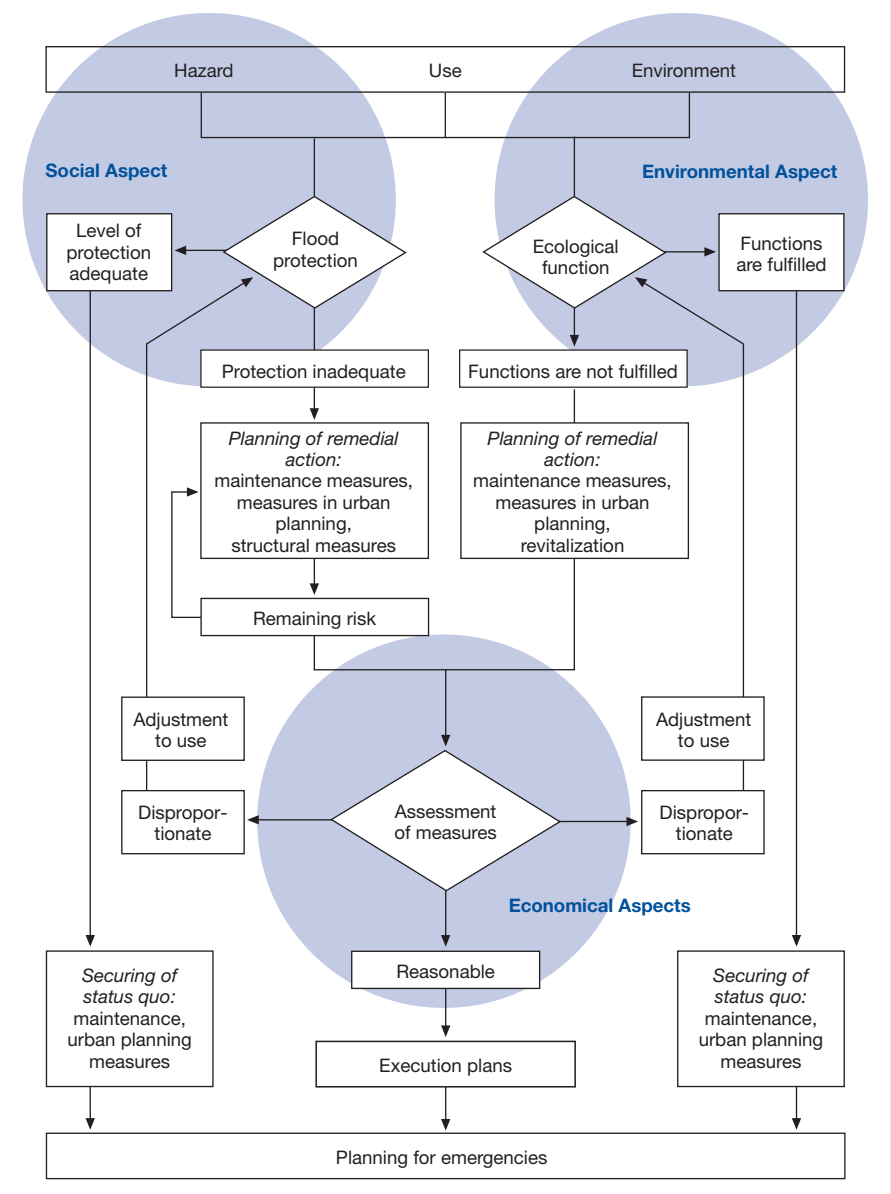

Fig. 1: Flow chart for remedial action planning.

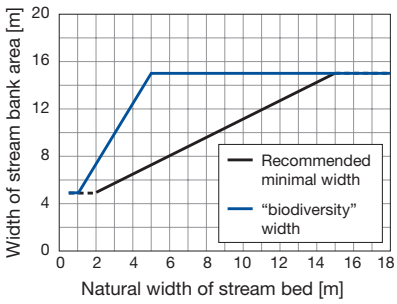

Fig. 3: Required width of stream bank area as a function of natural stream bed width.

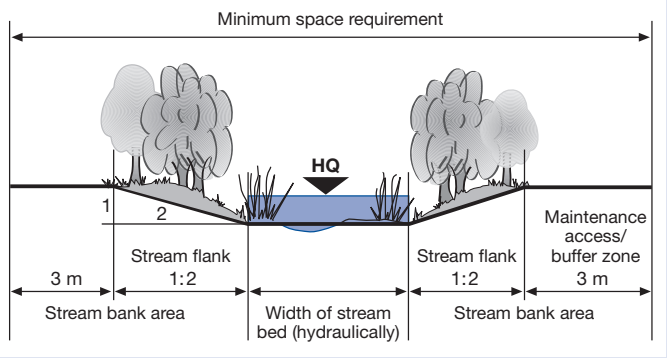

Fig. 2: Minimal spatial requirement from the flood protection perspective.

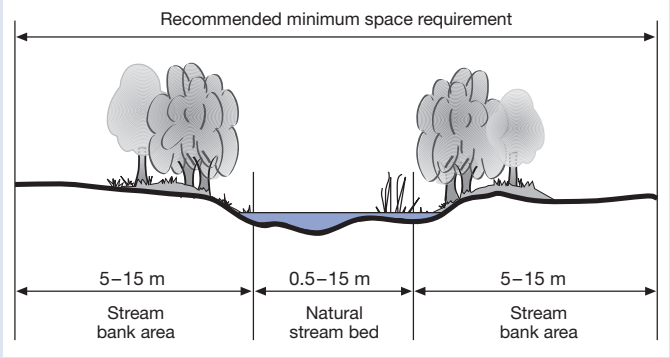

Fig. 4: Minimal spatial requirement according to ecological criteria.

Baudirektion des Kantons Uri

The flooding of the Reuss in Canton Uri in 1987. The motorway acted as a dam, effectively closing off the valley. The flood waters backed up and caused significant flooding.

minimum space requirement for a stream (Fig. 4); however, results should always be checked against the situation in the field, and additional space be reserved for recreational use.

In priority areas (e.g., nature preserves, water protection zones, fish protection zones), we must also safeguard the natural diversity of the native fauna and flora. As shown in Fig. 3, this produces a minimum space as defined by a "biodiversity line". Within areas of national priority (e.g., alluvial zones), nationally designated protected areas and in areas of extensive use, the reserved zone should be extended to 5–6 times the natural width of the stream bed in order to guarantee incorporation of the stream into the adjacent landscape (meandering of the stream, formation of side-channels).

Realization

With the obligation to determine the spatial requirements of streams and incorporate them in planning directives and stream utilization plans laid out by law, the question of how to realistically meet these requirements is raised. The basic set of tools are those of conventional urban planning (e.g., general directives, utilization plans, frontage lines, setbacks from streams, zoning, exchange/purchase of properties). For over a hundred years, streams have become more and more restricted and their space reduced to an absolute minimum. Now it has become clear that in the long term, streams must regain some of this space. A landmark decision of the Federal Court demonstrated as early as 1998 that even in urban areas, land must be set aside in order to allow environmentally responsible flood control [4]. Conflicts over land use are the most serious and the most difficult to resolve in urban areas, but even in areas dominated by agricultural uses, there is a significant potential for conflict.

Bringing in Agriculture

Naturally, farmers do not have any interest in giving up land since this reduces both their base of operations and their income. Solutions have to be found that are beneficial to agriculture, the environment, recreational and flood protection. Since agricultural policy holds a key role in this task, it is important to include farmers in the solution of the problems. One way of achieving this would be to have farmers participate in the maintenance of streams and to compensate them for their efforts.

The Contribution of Science

Remediation projects will only be accepted by the general public if they are based on solid facts and answers from the scientific community. The most pressing task is to gain an overview of the condition of streams and identify hazardous situations. Working procedures to accomplish this step have been published [5, 6]; EAWAG has been involved in the development of these procedures. They allow us to set priorities and to use available funding in the most useful ways possible. In areas where we still have open questions, we need to continue to conduct basic research while building in mechanisms for monitoring the success of any remedial action taken. Specifically, scientists need to:

- reveal interdependencies within systems,
- identify areas with potential for new developments,
- formulate goals in the area of ecology,
- devise mechanisms for monitoring success and define corresponding indicators,
- develop strategies for problem solving and conflict resolution.

The third river works of the Rhone between Brig and Martigny is a tremendous opportunity for developing these tools and strategies in a real-life situation. The enormous and highly ambitious project, which will extend over more than 20 years, offers a wide spectrum of opportunities for scientific study.

Visions of the FOWG

According to the Swiss Federal Office for Water and Geology (FOWG), the Cantons and the communities have to respect the ecologically recommended minimum stream bank widths in all future hydraulic engineering projects. Such minimum widths are to be determined beforehand using established tools of urban planning. The newly designed stream sections and the vegetation along the streams will slow down runoff (flood protection) and will at the same time be esthetically pleasing (habitat for plants and wildlife). The near-stream areas will be maintained by farmers who will be reimbursed by the federal government for their efforts.

Conclusions

Streams are important components of our environment, but are subjected to a variety of demands. We can meet all of these different needs only if the "affected parties" become "participants" and take part in the search for solutions. Streams do not stop at property or community boundaries, but must be viewed as continuous systems. Integrated and interconnected approaches are absolutely essential. We need to examine the effect that local actions have on the system as a whole. The new general directive for flood protection encourages hydraulic structures where ecological considerations and flood protection aspects are complementary to one another.

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[1] FOWG (2000): Hochwasserschutz an Fliessgewässern, Wegleitung (Vernehmlassungsentwurf).

[2] FOWG, SFOAG (Swiss Federal Office for Agriculture), SAEFL (Swiss Agency for the Environment, Forests and Landscape), SFOSP (Swiss Federal Office for Spatial Planning) (2000): Raum den Fliessgewässern (Flyer), FOWG.3.00/35372.

[3] BGE Uster, April 1998.

[4] FOWG, SAEFL, SFOSP (1997): Berücksichtigung der Hochwassergefahren bei raumwirksamen Tätigkeiten, EDMZ 804.201 d.

[5] SAEFL (1998): Ökomorphologie Stufe F (flächendeckend), Mitteilung zum Gewässerschutz Nr. *27,* 49 p.

[6] FOWG (1995): Anforderungen an den Hochwasserschutz '95, Flyer, Biel.