Collective planning of hydraulic engineering projects

Manual for participation and decision support in hydraulic engineering projects

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1. Introduction

1.1 Motivation and objectives

In recent years sustainable flood protection has been embedded within all major laws and regulations governing hydraulic engineering. It is however much harder to translate this new philosophy into routine practice. There is a lack of clear recommendations for moulding public opinion and decision-making, including an understanding of how various stakeholders should be incorporated in the process. This manual aims to close this gap: for one thing, it analyses current hydraulic engineering practice and illustrate the fundamental problems in project implementation. It also proposes specific methods and identify an exemplary project cycle, both at project level and for the catchment area.

The recommended tools primarily address the following four subject areas:

- *Contextual analysis:* In hydraulic engineering projects, how can the social, spatial and historical contexts be analysed? How can significant stakeholders be identified?
- *Inclusion of stakeholders:* What motivates various stakeholders and how can they be included in the planning process?
- *Comparing options and finding consensus:* How do formal decision-making aids support this process? With inclusion of stakeholders, how are different options compared and solutions finalised?
- *Predictive models:* How can models be used to appraise the impacts of hydraulic engineering projects on ecology and local economies?

This manual focuses on revitalisation and flood protection projects (referred to as hydraulic engineering projects). Methodological tools can also be transferred to other subject areas (e.g. natural hazard and infrastructure projects). The applicability of tools depends on the different constraints faced by specific hydraulic engineering projects and is adaptable to the needs of the individual project.

The manual is aimed at those in charge of hydraulic engineering projects within local councils, cantons and the federal government, as well as contractors in engineering agencies, institutes and universities. The guidance is also useful for environmental and civil organisations, among others. The manual is closely associated with other reports by the Rhone-Thur Project (www.rivermanagement.ch): the report "Gerinneaufweitungen" (Rohde 2005), the report "Schwall-Sunk" (Meile *et al.* 2005), and the manual "Erfolgskontrolle" (Woolsey *et al.* 2005).

1.2. Stages of a hydraulic engineering project

Hydraulic engineering projects go through various stages, ranging from strategic planning to implementation and utilisation (Table 1.1). In the past, the focus of the planning process was on project planning (feasibility analysis and construction planning). Stakeholder inclusion and the decision-making process should however already take place at earlier stages of the project. This manual therefore focuses on two project stages, “strategic planning” and “preliminary studies”.

Improved strategic planning and preliminary studies leads to decreased costs in the subsequent stages of the project, both in terms of human resources and on a financial level. Possible conflicts can be identified at an early stage and solved together with the stakeholders. Delays in project realisation can be avoided. However, this requires more time and effort in the early stages of the project.

Stage	Sub-stage	Objective	Includes
Strategic Planning		Definition of higher-level objectives and parameters.	Deficit analysis Definition of overall concept Contextual analysis
Preliminary studies (concept, feasibility)		Development and comparison of different options.	Formulation of objectives Comparison of options; choice of hydraulic engineering options
Project Planning	Preliminary project	Detailed elaboration of the option selected.	Definition of the ideal constructional solution Cost estimates, deadlines Detailed impact assessment
	Construction project	Preparation of detailed studies as the basis for the construction permission application.	Technical report Project plans Environmental impact assessment if necessary (for hydraulic engineering projects with budgets of more than CHF 15 million)
Realisation		Implementation of the construction project.	Realisation of the construction Adaptation during construction
Utilisation		Maintenance of the construction project and performance review of the measures put in place.	Implementation of the performance review Maintenance of construction

Table 1.1: Important stages of a hydraulic engineering project. The project stages and objectives are based on SIA (1996) and FOWG (2001).

1.3. From analysis to practical recommendations

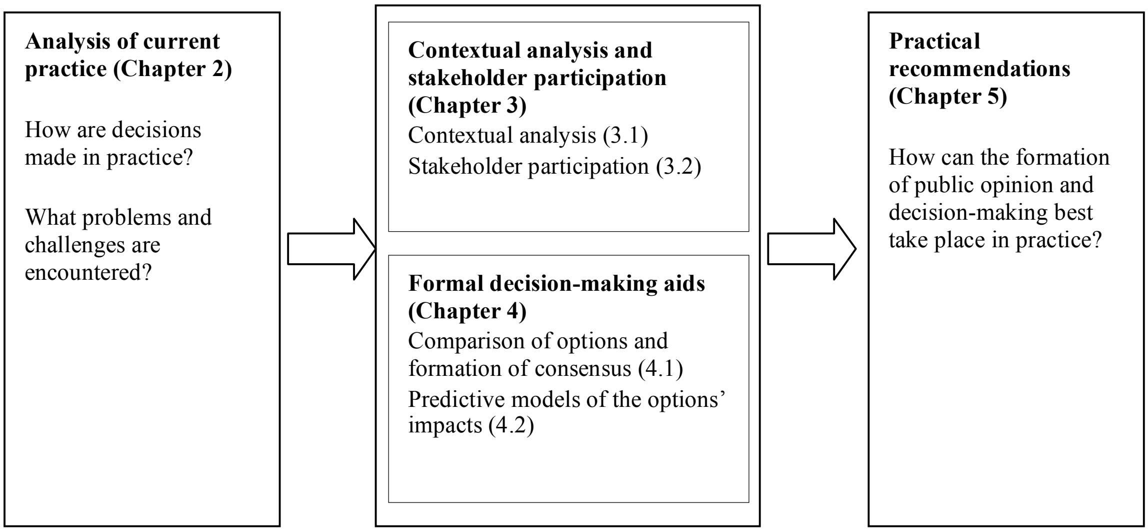


Figure 1.1: Structure of the manual

The starting point is an analysis of the decision-making process in hydraulic engineering (Chapter 2). Based on standards and the principles of sustainable flood protection, it describes common processes and methods. It also examines difficulties in implementation.

Chapter 3 presents possible approaches to solving current challenges in hydraulic engineering. First, a *contextual analysis* demonstrates how the complexity of a project can be ascertained (Section 3.1). This analysis permits the early identification of critical frameworks. Second, it explains the particular objectives of different stakeholders in the hydraulic engineering projects and possible *methods of including* stakeholders (Section 3.2).

Chapter 4 introduces formal *decision-making aids*. These assist the decision-making process in hydraulic engineering projects using a variety of approaches. The first considers how the affected stakeholders can be included and how different opinions can be consolidated and resolved (Section 4.1). It also introduces various predictive models that permit the impacts of hydraulic engineering on different target areas to be assessed, so that the chosen option can be optimised.

The final section of the manual illustrates specific *practical recommendations* (Chapter 5). It illustrates an exemplary project course for the decision-making process in hydraulic engineering projects. Methodological approaches exist at both the project (Section 5.1) and the catchment area level (Section 5.2).

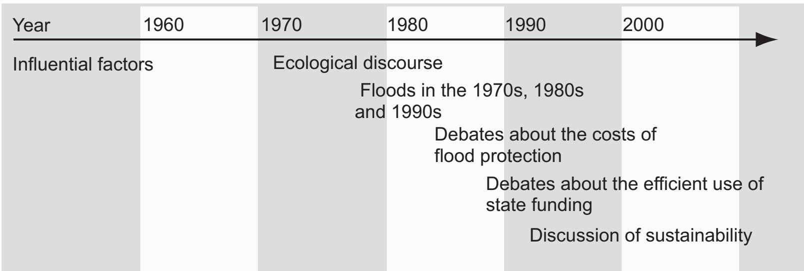
2. How decisions are made in practice

This chapter illustrates current decision-making processes in hydraulic engineering. Section 2.1 provides a brief overview of philosophical shifts in hydraulic engineering. The second part presents critical frameworks of current hydraulic engineering projects: standards, responsibilities and funding (2.2). It also describes the current decision-making process of hydraulic engineering (2.3). Based on this, important reasons for difficulties in implementing hydraulic engineering projects are illustrated.

2.1. “Philosophical shifts”: hydraulic engineering, past and present

The first significant rivers corrections in Switzerland in the early 19th century were projects implemented by the old confederation. Based on these corrective measures, a 1948 constitutional article aimed to facilitate future state participation in or funding of public projects on a similar scale. Faced with increasingly frequent floods from 1830 onwards, cantonal and communal resistance to centralisation of hydraulic engineering waned. Federal laws of 1876 and 1877 on forest and hydraulic engineering police enabled the federal government to coordinate and fund cantonal forest and hydraulic engineering projects.

Until the 1980s, integral flood protection measures in watercourses were restricted to river correction and land – reclamation – in response to the requirements and risks faced by the rapidly growing industrial society of the 19th century. The second half of the 20th century saw changes in the political, judicial and administrative environment of hydraulic engineering: protection of waters from construction took precedence over water use and flood protection measures. During the 1970s and 1980s, hydraulic engineering gradually adapted to the new demands. Experiments were initially conducted on streams and later on rivers, with attempts at an environmentally sensitive approach to hydraulic engineering. In terms of legislation, this new approach was first defined in the 1991Federal Law on Flood Protection (Figure 2.1).



	“integral” flood protection →	“Sustainable” flood protection
Objectives	Complete flood protection, extension of agricultural productions and combating diseases	Sustainable flood protection, conservation and promotion of natural state of watercourses
Characteristics	Cost intensive, same protection for all objects	Cost effective, adapted to differentiated protection targets
Landscape	Canalised watercourses	Watercourses with enough space
Type of construction	Rigid, uniform and generally unnatural constructions	Adapted constructions, near natural if possible
Decision making	“Technocratic”, primarily based on expert knowledge, non transparent inclusion of other interests	Based on expert knowledge, with transparent inclusion of heterogeneous social interests

Figure 2.1: Shift from integral to sustainable flood protection measures. Source: Zaugg (2005)

2.2. Hydraulic engineering today: Standards, responsibilities and funding

2.2.1. Standards and principles

In the 1990s, the objectives and principles of sustainable flood control protection were defined in the new Federal Law on Flood Protection (FLP) of 1991 and the Ordinance on Flood Protection (OFP) 1994. These standards have shaped the legal foundations for hydraulic engineering interventions in Switzerland. The primary objective remains the protection of people and property from water-related hazards. According to Article 4 FLP, any intervention in waters requires that “their natural course be maintained or restored as far as possible”. Article 3 provides that flood protection measures primarily be assured through minimal and sustainable maintenance, as well as through meet spatial planning measures. Only if these are insufficient should construction be carried out. To fulfil the purpose of hydraulic engineering, Article 3 FLP provides that it be coordinated according to spatial planning, agriculture, conservation or water protection measures. Flood protection measures are thus integrated into all governmental “planning and coordination of spatial activities” (FOWG 2001).

In 1998, the Ordinance on Flood Protection was supplemented by Article 21, “danger areas and the spatial requirements of watercourses”. Article 21 OFP provides that cantons designate danger areas and define the spatial requirements of water bodies for “the protection from flood waters and to safeguard the natural functions of these water bodies”.

In order to implement these far-reaching requirements, the Federal Office for Water and Geology (FOWG), in cooperation with the Swiss Agency for the Environment, Forests and Landscape (SAEFL, now the Federal Office for the Environment, FOEN), the Federal Office for Spatial Development (ARE) and the Federal Office for Agriculture (SFOA), produced the “Guiding principles for Swiss watercourses” in the late 1990s. Three objectives are foremost:

- Adequate riverine zones
- Adequate flow rate
- Adequate water quality

According to the principles of sustainable development, flood protection measures should be aligned in accordance with all existing water protection and utilisation requirements.

2.2.2. Obligations and responsibilities

Under the Federal Law on Flood Protection, individual cantons are responsible for flood protection . However, according to findings by Zaugg *et al.* (2004), in 2004 only half of the cantons had integrated the principles and objectives of the federal legislation into cantonal implementation laws. Those responsible for flood protection measures at cantonal level could fall back on standards from related sectors. According to Zaugg *et al.* (2004), the most important regulations emanate from the fields of spatial planning and construction, water and groundwater protection, environmental protection, hunting, fishing and forestry.

Responsibilities and obligations vary greatly from one canton to another. Several stakeholders from government or even the general public often share the obligations for hydraulic engineering. Thus, the cantons often remain responsible for flood protection measures in rivers, and communes for those in streams. In some cantons, private landowners are responsible for hydraulic engineering measures. Generally, a cantonal hydraulic engineering agency or department retains the principal supervisory function for hydraulic engineering or revitalisation projects. These specialised agencies sometimes also plan and implement hydraulic engineering projects themselves, but these tasks are often undertaken by local authorities in cooperation with external specialists. In some cases, hydraulic engineering projects are also implemented by other agencies, for example the roads office in the case of compensation measures for road construction projects, or the forestry services in the case of hydraulic engineering projects located in forests. In some cantons, project responsibility for smaller revitalisation projects is taken on by conservation agencies.

2.2.3. Funding

According to current cantonal financial compensation, the federal government subsidises 21 hydraulic engineering projects. Projects that fail to meet objectives and obligations of new hydraulic engineering policy are not subsidised by the federal government.

45% of project costs are covered by the federal government in the case of financially weak cantons (e.g. Bern, Valais). Financially strong cantons such as Zurich and Zug receive no federal subsidies. Under the new financial equalisation measures (NFA), which will come into force in 2008, rules governing federal contributions will change considerably. According to current objectives and targets, it will standardise regulations governing the natural hazard sector, such as for avalanche, flood and subsidence control measures, as far as possible. Cantons will have a global budget at their disposal for hydraulic engineering. There are further plans to allow the federal government to subsidise projects not covered by the global budgets. Based on regulations governing hydraulic engineering, ecology and participation, projects will be assessed according to priority and quality.

The cantonal hydraulic engineering offices favour projects that *combine flood protection with conservation measures*. Specific instruments to support the revitalisation currently exist in only a few cantons. One third of cantons differentiate between revitalisation and other hydraulic engineering projects. In Appenzell Innerrhoden and St Gallen, for example, ecologically sound hydraulic engineering projects receive additional financial support from the cantonal government. Cantons Bern and Geneva provide “re-naturalisation funds” for the ecological enhancement of waters.

In most cantons, maintenance costs must be borne by the individual proprietors of the waters. There are no federal subsidies for maintenance costs. In the study by Zaugg *et al.* (2004), various cantonal representatives consider this to be in contradiction to the proclaimed aims of the Federal Law on Flood Protection, which declares maintenance as a priority in flood protection measures.

2.3. Forming public opinion and decision making

Decisions surrounding hydraulic engineering projects involve a variety of stakeholders. The term "stakeholder" comprises all those who are affected by the project or who have influence on the project (Freeman 1984). Many hydraulic engineering projects involve multiple stakeholders. We can differentiate between the following categories:

1. *Project management and project team:* The project team is responsible for handling the project. It comprises the project management, made up of representatives of the various agencies, as well as representatives of private engineering offices.
2. *Stakeholders from within the administration:* Besides the agencies represented on the project team, other administrative internal stakeholders can also play an important role. These include, in particular, cantonal and federal agencies that are not represented on the project team.
3. *Non-governmental stakeholders:* These stakeholders can be divided into two groups – directly affected stakeholders and the general population:

    - *Affected stakeholders:* This group comprises all individuals and organisations materially and economically affected by the hydraulic engineering project, or those able to affect the project by a court appeal. They may be interest groups such as environmental and fishing associations. Those affected can also include individuals not linked to any particular association (e.g. property owners, foresters, tenants).
    - *General public:* This includes individuals within the project area who are neither directly affected by the project nor represented by organised interest groups. The general public can be affected by the project's impact on habitats.

2.3.1. Project management and project team

Project management comprises those responsible within the main agencies concerned. Conservation is given particular emphasis, in addition to hydraulic engineering. According to the individual projects, other representatives from sectors such as road planning or agriculture may also be involved. The project management acts as the client for the construction, and is therefore responsible for planning and implementation. In large-small and more complex projects, often with contradictory objectives, those responsible for the project are often required to take on the role of "moderators" between the various federal and civilian stakeholders (Kienast *et al.* 2004). They should also be able to make the necessary decisions.

Today, an interdisciplinary *project team* will handle the specific details of larger projects. This team consists of the project management plus representatives of private engineering offices with expertise in hydraulic engineering, ecology, hydraulics and project management.

Political responsibility for the project is often taken on by a *steering committee*. In consultation with officers from various agencies, this steering committee establishes the strategic and political guidelines of the project.

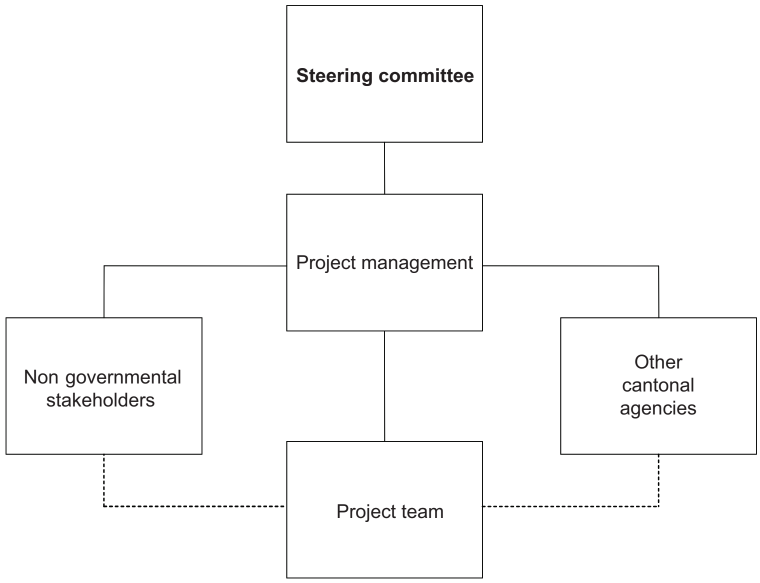


Figure 2.2: Potential organisation of a hydraulic engineering project. Illustration: Oliver Ejderyan

2.3.2. Stakeholders from within the administration

a) Federal agencies

The principles of sustainable flood protection require ongoing inclusion of the federal government, adjacent cantons and communes. Coordination with the *Federal Office for the Environment* (FOEN) (previously the Federal Office for Water and Geology) incorporates various meetings and encounters with the relevant hydraulic engineering inspectors. More complex and federally funded projects often involve a federal representative within the project organisation. The strategic coordination involves the FOEN working closely with cantons and other federal agencies on overall concepts and operational policies, as well as hosting technical conferences. Task groups within the catchment areas such as the Thur Working Group also serve as an intermediary between cantons and federal government.

b) Cantonal agencies

Contemporary hydraulic engineering projects affect various different interests. This requires a thorough coordination between the various cantonal agencies. According to Zaugg *et al.* (2004), most of the coordination by a cantonal agency for hydraulic engineering concerns the policy sectors of environment and conservation, construction and planning, forestry and fisheries (Figure 2.3).

To implement the new hydraulic engineering projects at cantonal level, *strategies, standards and practice* of the different policy areas need to be harmonised. This avoids conflict arising from heterogeneous objectives and principles. In response, about half of all cantons implement methods such as working groups or round tables (Zaugg *et al.* 2004). The strategic coordination often takes place through direct contact between those responsible from the various agencies, with effective communications being vital.

Project implementation requires *project-related coordination instruments*. The agencies involved are represented on the project management and project team, which permits ongoing and project-related harmonisation. Legally prescribed or voluntary consultation procedures lead to an internal administrative standardisation in terms of important or critical points (milestones) within the project. Direct contact between the hydraulic engineering agency and representatives from related policy sectors remains indispensable.

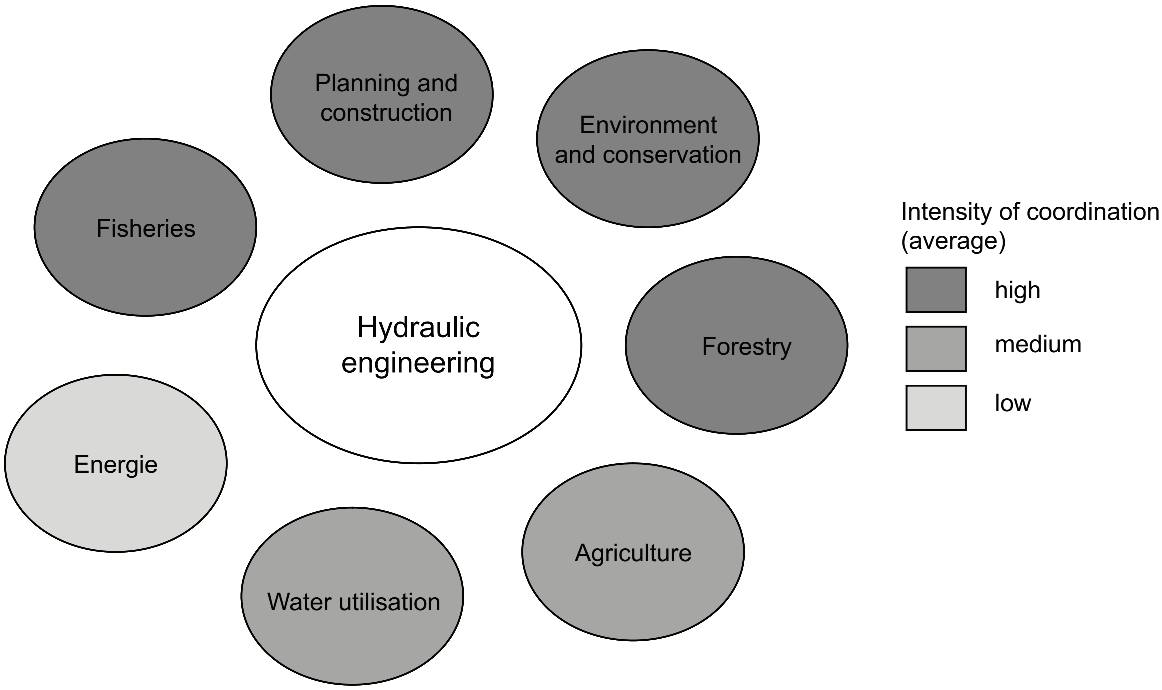


Figure 2.3. Coordination of hydraulic engineering with other agencies. Illustration: Oliver Ejderyan and Marc Zaugg Stern

Intercantonal commissions or working groups such as the Linth Commission (with cantons Glarus, St Gallen, Schwyz and Zurich) are important for *the coordination between cantons*. The commissions responsible for managing catchment areas, such as for regional drainage planning, will gain importance in the future.

c) Communes

The coordination with *communes* runs via contacts that are more or less formal, needs-oriented, written or verbal, direct or through clients, such as enquiries, accident reports, inspections or briefings. Some cantons collaborate their work with specific reference to the project. A third option is to fall back on existing bodies such as those in the construction, environmental protection and regional or residential planning sectors. In cantons such as Berne, in particular, where the canton is responsible for hydraulic engineering projects, positive working relationships between communes and cantonal agencies are vital.

2.3.3. Non-governmental stakeholders

Current standards of hydraulic engineering require *affected stakeholders and civil society* to be included in projects. The nature of their inclusion depends a great deal on the nature and size of the project. Until now, affected stakeholders and organised interest groups have primarily been included. This aims to address conflicts at an early stage and to foster acceptance of the planned procedures. The problem is, however, that the affected and organised interest groups represent only specific interests, acting on behalf of only a small fraction of the total population at local level (e.g. representatives from agriculture, local industry and environmental organisations). This will be covered in more detail in Section 3.2.

2.4. Challenges in practice

Every hydraulic engineering project is characterised by specific basic parameters. Difficulties in project implementation can nevertheless be traced back to four issues (Zaugg *et al.* 2004):

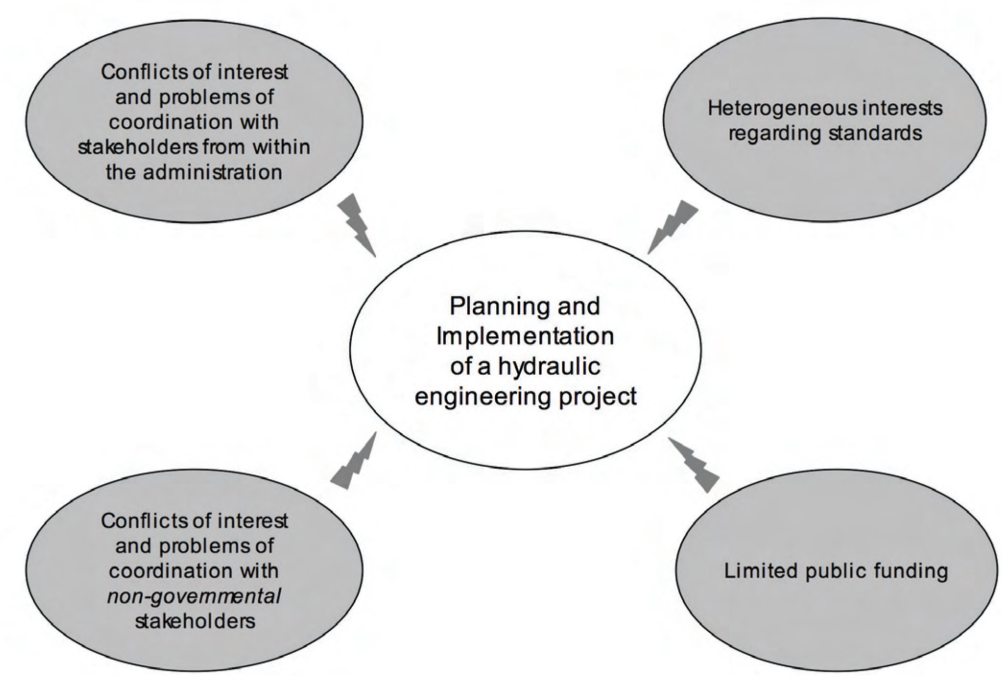


Figure 2.4: Four issues facing hydraulic engineering projects. Source: based on Zaugg et al. (2004)

- *Conflicts of interest and coordination problems with stakeholders from within the administration:* Coordination within the administration requires interests to be weighed up. Agencies need invest substantial time in this area. A positive communication culture within the administration is vital for effective coordination between agencies.
- *Conflicts of interest and problems of coordination with non-governmental stakeholders:* These stakeholders are most likely to resist hydraulic engineering projects that control or restrict agriculture or residential development. They may also be supported or even exploited by politicians.
- *Heterogeneous interests regarding standards:* Standards, philosophies or objectives reveal conflicting interests of the different related policy areas in several cantons – e.g. conservation, groundwater protection, drinking water provision. This requires complex consideration.
- *Limited public funding:* The situation of public funds limits hydraulic engineering today. Financial constraints facing communes in particular means that important ongoing maintenance needs cannot be met. From a medium- to long-term perspective, however, the apparent contradiction between economising on a communal level and flood protection can be resolved. The floods of 2005 showed that maintenance investments and a near-natural approach to watercourse management can be financially viable in the long term.

Difficulties in implementation are especially clear in intended spatial requirements of watercourses, leading to conflicts between spatial requirements and construction zoning. The communes feel their development potential is restricted. Outside residential areas, farmers (sometimes supported by farming organisations or cantonal farming agencies) resist the loss of land as well as hydraulic engineering or conservational interventions. Lack of land in and around residential areas hinders sustainable hydraulic engineering measures.

2.5. Conclusion: complex processes

In the second half of the 20th century, hydraulic engineering in Switzerland faced a substantial reorientation. Objectives of hydraulic engineering are now part of wider land use policy, including agriculture and water protection. The principles of sustainable development require a transparent process of balancing different represented interests. However, the hydraulic engineering sector needs to remain capable of making decisions and resolutions. Table 2.1 illustrates the most important factors of effective project planning and implementation.

Area	Supporting factors
Institutional and spatial context	Political support Support from the general public (e.g. increased awareness of ecological issues) Positive communication culture within the administration Consistent standards and laws Experience of past hydraulic engineering projects in the region Shortcomings of hydraulic engineering (urgency of project implementation) Current topics (incidence of flooding shortly before the planning phase)
Project organisation	Identification of possible points of conflict based on contextual analysis Timely information from affected stakeholders Good coordination between agencies
Negotiation process	Establishment of scope for negotiations between stakeholders Establishment of project objectives with stakeholders Definition of rules for the negotiation process Early and appropriate inclusion of stakeholders
Implementation	Monitoring of work undertaken, to ensure that execution complies with project plans Early information on changes to project plans
Evaluation	Evaluation of process and results provide the basis for learning processes and fosters trust between stakeholders

Table 2.1: Supporting factors for the implementation of hydraulic engineering projects. Illustration: Olivier Ejderyan, Marc Zaugg Stern, Urs Geiser

3. Contextual analysis and stakeholders

3.1. View beyond project boundaries – contextual analysis

Hydraulic engineers have to deal with complex processes. These include working within changing frameworks. The contextual analysis aims to identify stumbling blocks.

3.1.1. Background analysis

Hydraulic engineering takes place within a variety of contexts. We divide these into four categories:

- *Historical context:* Most projects have a case history that should not be disregarded. While the administration may consider a project to be completed, other stakeholders can remain affected by its long-term implications – especially where conflicts already existed. Even a decade later, these can remain significant for landowners, while long forgotten by the administration.
- *Legal context:* This refers to the legislative framework, e.g. the standards and guidelines that determine hydraulic engineering measures both directly (e.g. Federal Law on Flood Protection or cantonal structure plan) or indirectly (e.g. through property regime or user rights).
- *Political, economic and social context:* This requires consideration of stakeholders' communication behaviour, which can influence project planning and implementation.
- *Spatial context:* The physical conditions certainly play a significant role. It includes morphological characteristics (see Synthesebericht Aufweitung, (in German), Rohde 2005), and the relative location of the project to other watercourses in the catchment area (aspects of headwaters and underflow).

The contextual analysis should be performed as early as possible in the strategic planning process. Identification of relevant stakeholders will be based on this analysis. This means that those responsible for the project can adequately plan the cooperation with the various stakeholders (see 3.2). Contextual analysis completes the situational analysis; and in contrast, the contextual analysis is not constrained to only those stakeholders or factors directly responsible for the project. Rather, it also involves an analysis of how stakeholders can influence a project. For a description of a situational analysis in the context of flood protection measures, see Kommission für Hochwasserschutz (2004).

3.1.2. Contextual analysis: the checklist

Hydraulic engineering and revitalisation projects affect the social, historical and spatial contexts. This is why we recommend that a *contextual analysis* be a fixed part of a preliminary study. A checklist (Table 3.1) has been developed, based on detailed case studies (Ejderyan 2004; Zaugg 2005) and a survey of all cantonal agencies for hydraulic engineering (Zaugg *et al.* 2004). This does not mean, however, that all these aspect must be implemented in every project. Rather, it is a call to those in charge of projects to adapt this list to each specific case study – to shorten or lengthen it as required.

Contextual dimension	Possible elements for the checklist
Historical context (“case history”)	- Which “hydraulic engineering practice” with which stakeholders has established itself within the project area? - Which regionally effective projects have been implemented in the last decades? - Did conflicts arise (between which stakeholders? about what?) - Do these experiences raise issues that may further preoccupy stakeholders, and which could influence the intended project?
Legal context	- Which legislation exists at the federal, cantonal and communal level that affects the project? - Within the project perimeter, how are the property and exploitation rights defined? - Who bears responsibility for hydraulic engineering projects and maintenance? - How are the finances and keys for payment regulated in hydraulic engineering and revitalisation projects?
Political, economic and social contexts	- Which “political culture” is dominant (e.g. formation of public opinion and the decision-making process, handling of compulsory purchase)? - What is the political environment? For example, have the principles and objectives of conservation or sustainable hydraulic engineering been accepted and mainstreamed? - With which related policy sectors do conflicts arise, and how have these conflicts been taken into consideration?
Spatial context	- At what level has the planned project been settled (e.g. part of a river); i.e. does the spatial context of the river need to be incorporated (e.g. “catchment area”)? - What is the zoning plan of the project area (e.g. building or agricultural land)? - Which guidance and protection plans exist in the region?
Stakeholders of the project context (“stakeholder analysis”, see Section 3.1.2)	Which stakeholders are likely to play a role in the design of the project and what are their anticipated influential possibilities? e.g. - The various federal agencies - The various cantonal agencies (including specialist departments) - Communes - Communal and interest associations - Property owners - Private offices - Organised interest groups - The general public
Context of “participation” (interest groups within the administration, civil society (see Section 3.2)	- Which coordination process exists between the involved agencies at different stages? Which have proven successful? - How can the “communication culture” (formation of opinions and decisions) be characterised? - Which procedures have been legally prescribed to incorporate both organised civil society (e.g. conservation, local recreation, agriculture, forestry and hunting) and the general public? - Which of these have so far been implemented beyond legal requirements and with what success? - Are or have outcome-orientated procedures been implemented? - How much room for negotiation do existing legal regulations allow?

Table 3.1: A potential checklist for the contextual analysis. Illustration: Urs Geiser, Olivier Ejderyan, Marc Zaugg Stern

The contextual analysis requires us to ask the right questions. How information is gathered depends on the type of questions asked. A list of possible methods is given in Table 3.2.

Method for a contextual analysis	**Content**
Documentary analysis	View of the legal situation, development of property relations, land use patterns or earlier projects affecting spatial development.
Interview with key stakeholders	First, informal talks with key representatives can give insight into the local political culture, the case history and possible conflicts. Different opinions should be obtained.
Field inspection	Contacting property owners and end users of watercourses, banks and surrounding areas. Observation of usage methods and possible conflicts.
Survey	Survey of stakeholders to determine current situation and desire for modifications.
Stakeholder analysis	Identification and categorisation of stakeholders (see below)

Table 3.2. Potential methods of contextual analysis

The above illustration refers in particular to the initial stages of project planning. As a general rule, this planning process and the ensuing stages of feasibility analysis and project implementation last several years – a timeframe during which much can change. We therefore recommend that those in charge of the project continue to keep an eye on the project environment and to revise the contextual analysis every two years.

Example: Contextual analysis of the 3rd Rhone correction in Valais

To date, there have been only a few systematic contextual analyses of hydraulic engineering projects in Switzerland. It is therefore not possible to present a widely tested approach. Using the example of the 3rd Rhone correction in Canton Valais, we illustrate the different aspects of the contextual analysis – the project is currently at the planning stage.

- The synthesis report of June 2000 from the Department for Road and River Engineering (Canton Valais 2000) outlines the current geographic, economic and social conditions in the Rhone Valley, including its tributary valleys. It traces residential development and increases to the damage potential. The report covers an initial identification of affected interests of agriculture, tourism and hydropower.

- The information leaflet Rhone.VS, which has been distributed semi-annually to the population of Valais since 2001, circulates information regarding the 3rd Rhone Correction. Feedback from the "Letters to the editor" column allows for more targeted information, and to elicit forgotten stakeholders. For example, local officers in charge of civil defence were initially not informed directly. However, incorporating feedback from the column, the project management now takes the local civil defence into consideration in the planning process.

- The identification of key stakeholders at cantonal level resulted from a survey of specialist departments. Heads of departments were asked to list their most important contacts outside the administration. This procedure was subsequently also chosen at the local level. Lists were openly compiled and missing stakeholders were added retrospectively. Additionally, a research project by the EPFL developed and tested an advanced identification and categorisation method. Further information on this method can be found in Luyet (2005).

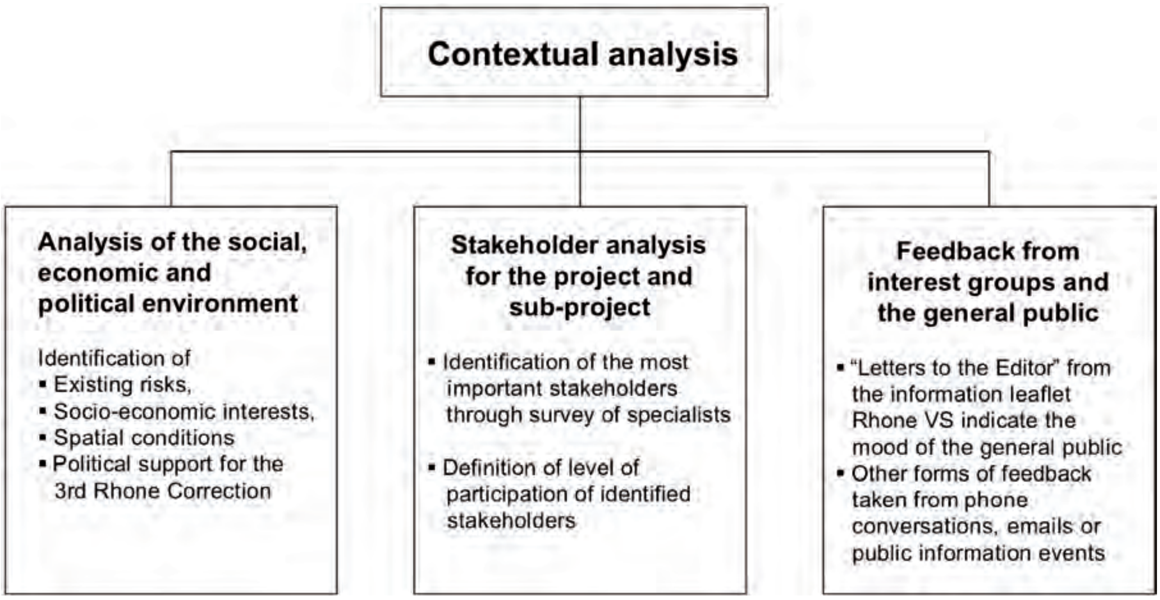


Figure 3.1: Elements of the contextual analysis of the 3rd Rhone Correction

3.1.3. Stakeholders

The stakeholders are another important factor in the contextual analysis. Here we recommend a methodology of how to identify and classify stakeholders.

a) Identification of stakeholders

Stakeholders are identifiable using the following indicators (IIED 2001):

- Expertise gained from previous projects: which stakeholders participated in previous projects?
- Expression of opinion, e.g. "letters to the editor" in newspapers, municipal assemblies.
- Identification based on media reports: which stakeholders have been mentioned in newspaper, radio or television reports?
- Snowball sampling: enquiries made to identified stakeholders.
- Call for self-identification at municipal assemblies, newspaper or official gazettes: interested stakeholders are invited to get in touch.

The aim should be the early identification of all potential stakeholders, as the exclusion of an important stakeholder can lead to potential conflicts at a later stage of the project.

b) Categorisation of stakeholders

The identification of stakeholders can often involve a great number of people. It is therefore important to categorise and group stakeholders according to defined criteria. The existing literature reveals different concepts (Mason & Mitroff 1983; Mitchell *et al.* 1997; IIED 2001). In practice, the concept devised by the International Institute for Environment and Development (IIED 2001), which recommends the principles of "influence" and "importance" (Table 3.3), has proven the most reliable.

Principle	Influence	Importance
Significant questions	What power does the stakeholder have in affecting the success of the project?	To what extent does the project satisfy the stakeholders' interest and needs?
Criteria	• Legal standards: attitude of the authorities, right of appeal (protection of property, right of appeal for associations, use or resources) • Social networks: mobilisation potential, support from the population • Knowledge base: expertise, local knowledge	• Concordance of project objectives with interests of stakeholders • Resolution of stakeholder problems by the project • Adverse effects of projects on stakeholders' interests • Adverse effects of existing rights and occupancy by stakeholder (land holdings, water use)

Table 3.3: Important criteria to assess how stakeholders' influence and interests are affected by the project. Illustration: Markus Hostmann

Using the above criteria, influence and importance of stakeholders can be assessed. Possible answers can range from "extensive", "great", "average", "small" to "very small".

c) Influence-interest matrix

To divide stakeholders into groups, the two criteria “Influence potential” and “Importance” can be mapped along two axes. The horizontal axis indicates importance, the vertical axis influence potential (Figure 3.2). The model allows stakeholders with similar influence potential and of similar importance to be grouped together.

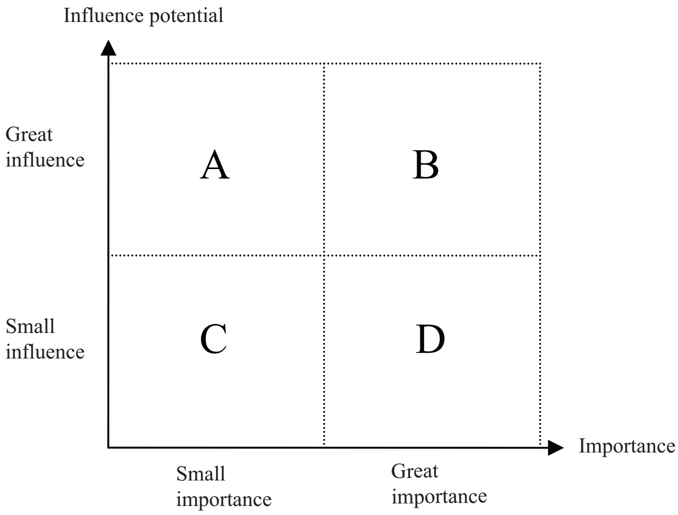


Figure 3.2: Influence-interest matrix

Stakeholders in A, B and D have great levels of influence and importance. These stakeholders need to be incorporated into the process at an early stage. To summarise their main features:

- A: Great influence potential, small importance: it is important to convince these stakeholders of the importance of the project.
- B: Great influence potential, great importance: these stakeholders need to be incorporated into the project at an early stage, as close collaboration is vital to secure the success of the project.
- C: Small influence potential, small importance: these stakeholders do not necessarily need to be incorporated into the decision-making process, but they do lend support to the project on a broader level.
- D: Small influence potential, great importance: it is vital for these stakeholders to be incorporated, as their opinions can otherwise be easily disregarded. This can lead to potential conflict.

3.2. Inclusion of stakeholders

3.2.1. Background

a) Motivation and objectives

It is particularly challenging to include non-governmental stakeholders into complex hydraulic engineering projects. Motivations and objectives can differ:

- Compliance with overall concepts and legal guidelines (e.g. Flood control at rivers and streams. Guidelines, FOWG 2001; Federal Law on Spatial Planning 1997; the planning law of Canton Bern 1985).
- Prevention of political opposition
- Prevention of (costly) conflicts for subsequent project stages
- Public legitimisation of decisions
- Promotion of wide public acceptance and approval of revitalisation
- Use of local knowledge base and local values
- Promotion of trust within the general population
- Promotion of public awareness of hydraulic engineering, environment and species conservation, and river landscapes
- Triggering the local learning, thinking and communication process
- Encouraging the local population to identify with the river catchment area and the individual project
- Promoting personal responsibility of the local and regional population in local landscape alterations and sustainable development.

Guidelines; avoidance of conflict
Approval; identification; personal responsibility; sustainability

The objectives can be attributed to two overarching categories: one is to comply with applicable regulations and to prevent conflict. The other aims to promote acceptance of landscape alternations, to increase personal responsibility and foster trust in the administration. These are the basic requirements for sustainable environmental development. (Buchecker *et al.* 2003)

b) Potential stakeholders

Table 3.4 gives an overview of possible stakeholders and applicable frameworks. Using a variety of criteria, stakeholder groups can be distinguished and assigned to one of three category groups – administration, civil society, economy. Further classification takes place following claims for inclusion, level of organisation, geographical lobbies (e.g. local, regional, supra-regional), level of importance, and influence on public opinion and decision-making. The table shows tendencies generally applicable to Switzerland. Every project is likely to require customisation to take local conditions into account. A methodology of how to identify and classify stakeholders for a specific hydraulic engineering project can be found in Chapter 3.1.3.

Stakeholder groups	Participation in objective	Potential influence*	Level of organisation	Geographical embedding	Political area of influence	Claims to inclusion	Importance
Farmers' union	Prevention of political opposition prevention of conflict	medium to high	high	regional	economy	high	high**
Local community	Prevention of conflict local knowledge; approval	high	high	local	civil society?	medium to high	high**
Recreational users (except sport)	Approval; personal responsibility; sustainability; local knowledge empathy	medium	low	local	civil society	low to medium	medium*
Fishing association	Prevention of conflict; local knowledge	medium	medium to high	local (to regional)	civil society	medium	high*
Trade associations	Prevention of conflict	low to medium	high	regional	economy	high	medium*
Interested local population (except recreational and sport users)	Promotion of awareness; endorsement of trust; local knowledge/values; sustainability; personal responsibility	low to medium	low	local	civil society	medium	medium*
Hunting association	Prevention of conflict local knowledge	low	high	local to regional	civil society	medium	medium*
Cantonal agency (hydraulic engineering)	(Initiation/ Planning)	high	high	cantonal	administration	automatic inclusion	high*
Cantonal agency (other)	Guidelines; prevention of conflict; legitimisation	medium	high	cantonal	administration	high	high*
Property owners	Prevention of conflict	Forte	medium	local	civil society	high	high*
Local Industry	Prevention of conflict	low to medium	high	local	economy	medium to high	medium to high**
Conservation groups (local)	Personal responsibility; local knowledge	medium	high	local	civil society	medium to high	high*
Tenants	Prevention of conflict	high	medium	local	civil society	high	high*
Local council	Prevention of conflict Local knowledge; approval	medium to high	high	local	administration	high	high*
Recreational users – sport (e g joggers)	Prevention of conflict Approval; empathy local values; sustainability	medium	low	local	civil society	low to medium	medium*
Conservation groups (e g WWF)	Prevention of conflict; legitimisation; local knowledge	medium to high	high	regional to supra-regional	civil society	high	high*

* Data taken from a Swiss national survey; ** Expert assessment

Objective: compliance with legislation and prevention of conflict

Objective: identification of the population with the measures, promotion of responsibility, trust in the authorities.

Table 3.4: Charts of potential stakeholders in hydraulic engineering projects. Illustration: Berit Junker and Matthias Buchecker

To foster acceptance of the planned procedures, affected individuals and organised interest groups are primarily included in the opinion and decision-making processes. These stakeholders are affected by the project on a material or other level and/or have the right of appeal, which may affect the project (Table 3.5). An additional factor: representatives from organised interest groups are known to have a larger support base.

Nature of importance	Affected stakeholders
Material/economic utilisation	Tenant, administrator, property owner, farmers' association, local industry
Legal/assets	Land owner, power industry
Idealistic/conservation	Environmental groups, local conservation groups
Quality of life/recreation/natural scenery	Recreational users, local population, neighbouring population, hunting associations, fishing associations
Home country/identity	Local population

Table 3.5: Level of affectedness and stakeholders. Illustration: Berit Junker.

Integrating only materially affected individuals and organised interest groups may have disadvantages. It can mean that groups with generally negative attitudes towards hydraulic engineering projects gain in importance. It is therefore vital that representatives of local recreational and sport users contribute to the project as well as the interested local population. In general, these stakeholder groups have a positive attitude towards revitalisation and hydraulic engineering projects. Possible conflicts between conservation and local recreational interests can also be identified at an early stage.

Only few people are materially affected by the project. The majority of the population does ask questions about quality of life, recreational use, and natural scenery, as well how this relates to local and national identity. In order to increase project acceptance for landscape alterations, the local population should contribute comprehensively to the project. Those with positive attitudes towards hydraulic engineering projects are also more likely to view these types of interventions to be a good use of tax resources.

Studies show that landscape alterations are generally viewed negatively by the local population, and rejected when perceived as an external intervention, that is, when it is perceived as being dictated from outside the local community (e.g. cantonal administration), and when it offends the local community's self-perception (Walther, 1988). Acceptance often follows initial opposition. This frequently leads to a creeping alienation from people's own environment (Responsibility-delegation) and often increases disaffection towards the responsible agency (Buchecker 1999). Considering these long-term risks again highlights the importance of including as many local stakeholders as possible.

All relevant stakeholders should therefore contribute to the opinion and decision-making processes. This principle is pitted against the policy requirements for projects to be as speedy, cost-effective and generally efficient as possible. Yet the early and comprehensive inclusion of stakeholders is invaluable. While being more cost- and time-intensive in the initial stages of the project, it can prevent often inefficient and time-consuming conflicts at a later stage.

c) Perspectives of different stakeholders

Different stakeholders will judge hydraulic engineering projects in different ways: what significance does the local river environment have for different groups? What interests and claims arise from this significance? What outcomes do they expect from the hydraulic engineering project? What conflicting objectives exist?

Table 3.6 is a general synopsis. The numbers are taken from a survey covering the whole of Switzerland as well as case study surveys from the rivers Thur and Flaz (Junker & Buchecker 2005). Note the specific conditions of each project.

Stakeholder groups	Relevant significance of river environment before revitalisation	Entitlements to river environment/ perceived need for action			Conflicts of interest expected with
		Less	Leave the same	More	
Farmers' associations	Economically usable area	FU	AU, PR, A, C, N	FP, WQ, GWQ	Environmental groups, conservation, cantonal authorities
Fishing associations	Experience of nature, ecologically valuable area	RI, AU, FU	A	WQ, N, GWQ, C	Property owners, agriculture
			FP		
Recreational users - sport (e.g. joggers)	Recreational area, experience of nature		AU, RI,	N, A, C, GWQ	Environmental groups, conservation
			A, PR, FP		
Recreational users (excluding sport)	Recreational area, part of the habitat, experience of nature, area of identity	AU	A, FU, RI, FP	N, WQ, PR, GWQ	Environmental groups, conservation, property owners
Local industry	Economically usable area		IU		Cantonal authorities, environmental groups
Trade associations	Economically usable area	RI	FP, FU, AU, A	WQ, N, GWQ	Cantonal authorities, environmental groups
Conservation groups (e.g. WWF)	Experience of nature, ecologically valuable area	RI, AU, FU	A	N, C, WQ, GWQ	Property owners, local industry, business associations, recreational and sport users
			FP, PR		
Local council	Area of unspoiled nature, source of danger, homeland, recreational area	FU	A, AU	WQ, N, RI, PR, GWQ, A	Property owners
				FP	
Property owners	Economically usable area		AU, PR, RI, A	GWQ	Environmental groups, conservation, cantonal authorities
			FU	FP, N, C	
Land users	Economically usable area, area of identity	RI	AU, PR, A, FP	WQ, GWQ	Environmental groups, cantonal authorities
			FU	N	
Hunting associations	Area of unspoiled nature, recreational area, homeland	RI, AU	FU, FP, PR, A	N, WQ, GWQ, C	Recreational users
Conservation groups (local)	Ecologically valuable area, experience of nature	RI, FU, AU	FP, PR	C, N, WQ, GWQ	Property owners, local industry, recreational and sport users
Interested local population	Experience of nature, recreational area, part of the habitat	AU, FU	FP, RI	N, PR, A, WQ, GWQ, C	Property owners, conservation and environmental groups

* Key: FU: Forest use; AU: Agricultural use; IU: Industrial use; FP: Flood protection; WQ: Water quality; GWQ: Groundwater quality; PR: Possibility of recreation; N: Naturalness; C: Conservation; RI: Recreational infrastructure; A: Access

Table 3.6: Stakeholders' perspectives of the significance of river area, entitlements to river area and expected areas of conflicting interests. Source: Junker & Buchecker (2005).

Different claims to future development of the river area become apparent from the general synopsis in Table 3.7. There are particular differences between the stakeholder groups typically integrated (e.g. environmental associations, farmers' associations, property owners) and those more likely to be excluded (e.g. recreational users and local population).

d) Types of inclusion

Types of inclusion can be assessed according to the following criteria:

- Stakeholders' information about the project and planning
- Transparency (for non-participants as well)
- Inclusion of objectives (how are stakeholders' objectives taken into consideration in the planning?)
- Supporting stakeholders' and project management's learning process
- Development of trust between stakeholders and project management
- Elaboration of consensual solutions
- Commitment to inclusion (to what extent are contributions by stakeholders integrated into planning)

Types of participation	Information	Transparency	Inclusion of objectives	Support of learning process	Development of trust	Elaboration of consensual solutions	Development of commitment
Information channels (webpage, newsletter etc.)	++	+	–	–	+	–	–
Survey of the population	+	+	++	+	+	–	+
Public information event	++	++	–	+	+	–	–
Interviews with stakeholders	+	+	+	+	++	+	+
Working group (planning cell, focus group, consensus conference)	+	+	++	++	++	++	+
Referendum	+	++	++	+	+	-/+	++
Popular initiative	+	+	++	+	+	–	++
Collaboration / hearing	–	–	+	–	–	–	+
Workshops/ideas forum	+	+	++	++	++	–	-/+

++ *very appropriate,* + *= partially appropriate,* – *= not appropriate*

Table 3.7: Classification of specific objectives/criteria of inclusion. Based on Beierle (1998), Mosler (2004) and Marttunen (2005).

The synopsis in Table 3.7 reveals that different processes of participation fulfil very different roles and cannot therefore easily be classified as "good" and "appropriate" or "bad" and "inappropriate". The greatest benefits can be gained by using a combination of different forms of inclusion (see Section 3.2.2).

3.2.2. Stakeholders in the planning stages

It is advisable to use different forms of inclusion for different stakeholders. Dialogue with *materially affected and organised interest groups* should take place at an early stage. This allows significant objectives and attitudes to be identified, and thus also possible conflicting objectives. Stakeholder groups are often brought together within a working group. The aim of such a working group should be the agreement on project objectives and comparison of solutions (see Section 4.1).

In order to include the *wider population*, they need to be informed of planned projects and the advantages of revitalisation. As many have become very much used to the existing state of "their" river environment, they may have difficulty visualising change. Visualisation of the revitalised river environment is therefore highly recommended. Excursions by interested parties to implemented projects can also be helpful. Future trends workshops or an ideas forum can help demonstrate more clearly to the various groups the positive potential of revitalisation. Surveys help assess objectives and values of the local population as well as consider existing underlying conflicts (see below). Representatives from the local population can be invited to participate in a working group to prepare different project options (Junker & Buchecker, 2006)

A combination of the different types of inclusion is most useful. Table 3.8 shows how stakeholder groups are addressed.

Stakeholders	Strategic planning	Preliminary studies	Project planning (reconnaissance)	Project planning (construction project)	Realisation	Utilisation
Materially affected individuals and organised interest groups	Personal conversatio ns	Personal conversations, working groups (discussion of options)	Information and consultation of working group	Information and consultation of working group		Working group (contribution to evaluation of success)
General population	Forums and workshops	Survey, public information events, excursion to case studies, sending representatives to working groups	Information (e.g. web page, events)	Possible participation in working group	(Possible call to voluntary work; e.g. Birs)	Environmental education through excursions; presentation board/nature trail; especially also in schools
Cantonal and federal agencies	Personal contact	Supporting group (option comparison from specialist perspective)	Information & consultation			
General (with all stakeholders)	Information (e.g. web page, events)	Information (e.g. web page, events)	Information (e.g. web page, events)	Information (e.g. web page, events)	Information (building site inspection	Information (evaluation of success)

Table 3.8: Inclusion of stakeholders at the different stages of the project. Illustration: Berit Junker

3.3.3 Survey of the population

The following are tips for the preparation of a written survey of the local population.

Possible *content* of a survey includes:

- The significance of the affected river area for the local population
- Its recreational use (frequency and type of utilisation)
- Preferences and interests regarding its future design
- Perceived/anticipated conflicts of interest
- Attitudes towards a hydraulic engineering/revitalisation project
- (preferences, concerns)
- Entitlements to participation in the decision-making process
- The most important socio-economic indicators (gender, age, occupation, affiliation with interest group)

When *compiling the questionnaire*, the following points should be taken into consideration:

- The questionnaire should not be evaluated by those conducting the survey
- Multiple-choice questions (yes/no) are preferable to open questions (this facilitates the evaluation of the questionnaire)
- Questions should be formulated in a way that allows clear and precise answers
- Clear and simple language with no technical jargon is as important as an appealing layout
- Multiple-choice answer layout should have equal space between answers. Example: 5 options with equal spacing:

□	□	□	□	□
Not important	Some importance	Average importance	Quite important	Very important

- Before distribution, the questionnaire should be tested on a small number of people

The following applies to the *distribution* of the questionnaire:

- Where budgets are tight, another option is to distribution the questionnaire through the local newspaper or a similar, regular publication.
- When feedback to the questionnaire is low (< 20%), redistribution with a follow-up letter is advisable

Example: Survey of Thur case study (Weinfelden/Bürglen project)

As part of a case study by the environmental science department of the Federal Institute of Technology Zurich (ETH), a survey of the population of Weinfelden and Bürglen (TG) was conducted in November 2002 (Junker *et al.* 2003). In Weinfelden data was collected by means of a street survey, while in Bürglen the questionnaire was distributed via the weekly local newspaper. The need for action was also questioned. In total, 240 people took part in the survey.

Questions: When considering a specific river-planning project between Weinfelden and Bürglen, within each of the following categories, what should be the extent of intervention?

	Much less than at present	Less than at present	Leave as is	More than at present	Much more than at present
Flood protection measures	❑	❑	❑	❑	❑
Water quality	❑	❑	❑	❑	❑
Naturalness of the environment	❑	❑	❑	❑	❑
Recreational infrastructure	❑	❑	❑	❑	❑
Forestry use	❑	❑	❑	❑	❑
Recreational use	❑	❑	❑	❑	❑
Agricultural use	❑	❑	❑	❑	❑
Quality of groundwater	❑	❑	❑	❑	❑

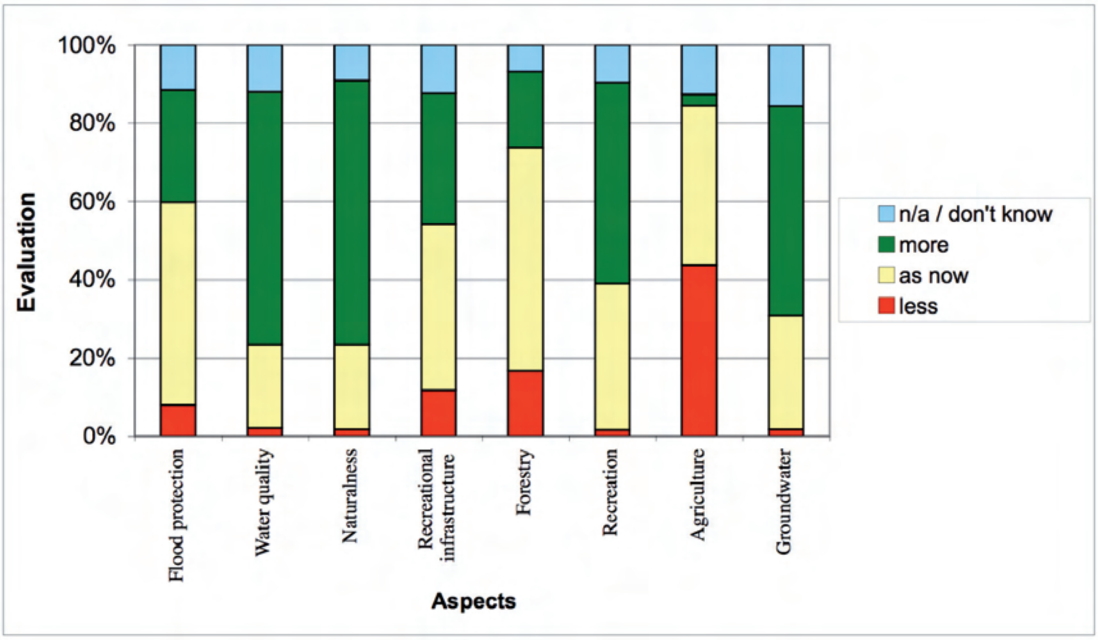


Figure 3.3: Overview of the population's preferences in the Weinfelden-Bürglen hydraulic engineering project. Source: Junker & Buchecker (2006).

A definite need for action is perceived important in naturalness of the environment, recreation and groundwater quality (Figure 3.3). The high percentage of the surveyed population that considers current flood protection measures as adequate and argues for reduction in agricultural activity is also notable. These are important findings, which can be integrated into the running of the hydraulic engineering project.

4. Formal decision-making tools

Hydraulic engineering projects are complex. Differing and sometimes conflicting objectives and interests need to be considered. Resulting conflicts can lead to the delay or even termination of the project. Implications of hydraulic engineering measures are often also hard to assess. The following six steps are therefore important to the decision-making process:

1. Contextual analysis and overall concept
2. Identification of objectives
3. Assessment of objectives (by project team or stakeholders)
4. Planning of solutions
5. Assessment of the impacts of solutions
6. Assessment of results: supporting the consensus-finding process

Which decision-making tools are most suitable depends on the specific project. If the primary objective is to incorporate stakeholders, their objectives need to be addressed, different options discussed and a consensual solution worked out (Section 4.1). The aim can also be to assess the impact of the options on the different objectives (Section 4.2). This manual therefore introduces a predictive model showing the impacts on ecology and the local economy (4.2.1). A further decision-making tool shows how specific procedures (e.g. construction of a hydroelectric plant) can be optimised (Section 4.2.4). The three decision-making tools mentioned can be adopted separately or in combination.

4.1. Comparison of options and the consensus-finding process

Divergence of interest is a central issue in current hydraulic engineering practice (see also Chapter 2). How to find a consensus is therefore also a major concern. *Multi-criteria methods*, which consider different objectives, lend themselves to this purpose. These can be realised interactively with stakeholders. It initially requires deliberation of project objectives, and only later the development of options. This process is also called *outcome assessment*.

More specifically, when comparing different options for a specific location, how is a consensus found (comparison of options)? Using this case study, the implementation of Multiple Criteria Decision Analysis (MCDA) will be illustrated below. Apart from this, there are a multitude of other applications for the MCDA, such as the comparison of types of procedures within a catchment area (Section 4.1.7). The implementation of the MCDA is based on the above six steps. A detailed description of the methodology of the case study can be found in Hostmann (2005).

4.1.1. Contextual analysis and overall concept

Following the contextual analysis (see Chapter 3), an overall concept is developed. This overall concept defines the visions and principal objectives of the project. Distinctions are generally made between the "expert concept" and the "citizens' concept". The expert concept is developed by the responsible project team (in collaboration with external experts), while the citizens' concept is developed in collaboration with the general population. For the citizens' concept, higher-level objectives can be defined at regional level and then be elaborated at local level. The overall concept should define the stakeholders' feasible objectives. These objectives form the basis for further planning. Examples of citizens' concepts include the "Leitbild Entwicklungskonzept Alpenrhein" (in German, IRKA 2004), and the "Regionale BürgerInnen-Leitbild Kamptal" (in German, NÖ Landesakademie 2005).

4.1.2. Identification of objectives

Based on the overall concept for a region, the objectives for a specific project are identified. The objectives need to be summarised clearly. Detailed guidelines are lacking, particularly for ecology and socio-economic factors. Guiding objectives are however indispensable for a transparent planning process and establish the prerequisites for a subsequent performance review (see Synthesebericht Erfolgskontrolle, in German, Woolsey *et al.* 2005).

The objectives are initially defined by the project team and are subsequently harmonised according to stakeholder objectives and objectives of the general population. Stakeholder objectives are obtained from personal conversation or through working groups, while the objectives of the general population are obtained by a survey (see 3.3.3). We differentiate between higher-level and subordinate objectives. The inferior objectives are always in reference to a higher-level objective (e.g. "Improvement of the morphological state" is an inferior objective of the higher-level objective "Ecology"). In the case of every objective, one or more parameters are defined. Figure 4.1 shows this in the Weinfelden-Bürglen (Thur) case study (without inferior objectives).

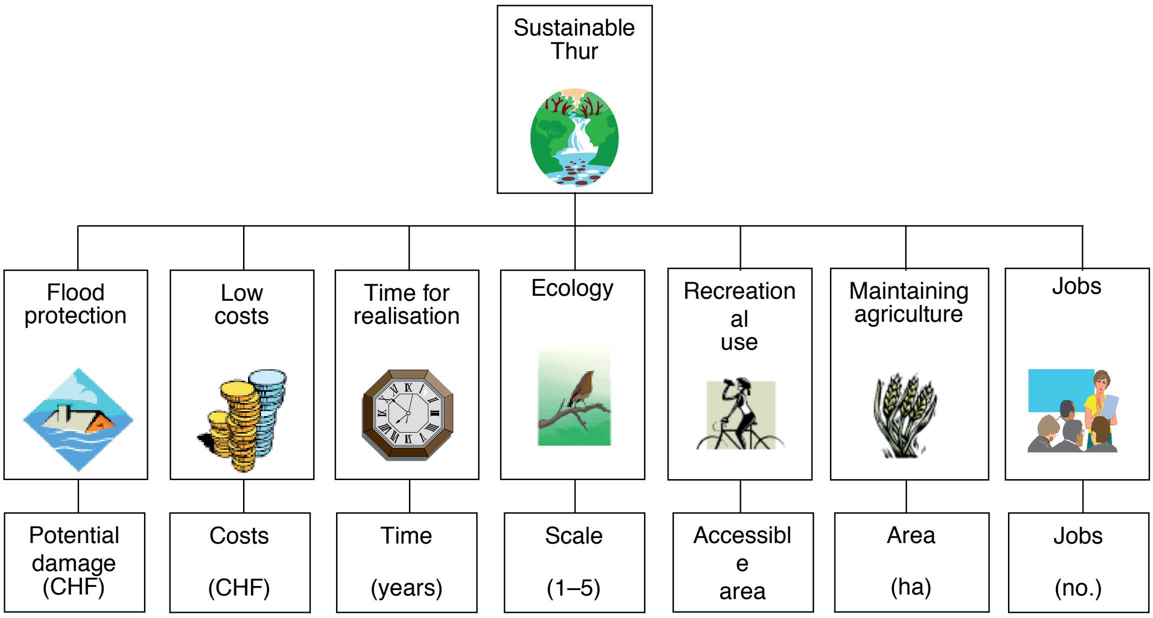


Figure 4.1: Example of hierarchy of objectives. Source: Hostmann (2005)

4.1.3. How stakeholders assess objectives

How important are objectives of a hydraulic engineering project for stakeholders? To find out, personal interviews are conducted with the stakeholders. Ideally, stakeholders are grouped according to similar interests. For stakeholders to assess objectives, the scope needs to be known: for example, to assess the objective “Low costs”, it is important to know whether project costs range from CHF 0 to 1 million or CHF 0 and 10 million

Figure 4.2 shows importance of different objectives using the Weinfelden-Bürglen case study. For each stakeholder group, the importance placed on objectives by 3–4 representatives was plotted using averaged data. Based on the emphasis given to different objectives, conflicts can be identified at an early stage. For the majority of stakeholder groups, the objectives “Flood protection” and “Ecology” are of great importance. Some stakeholders also stress the “Conservation of agricultural areas” and “Low costs”. An option, which fails to consider these aspects, can conceal potential of conflict.

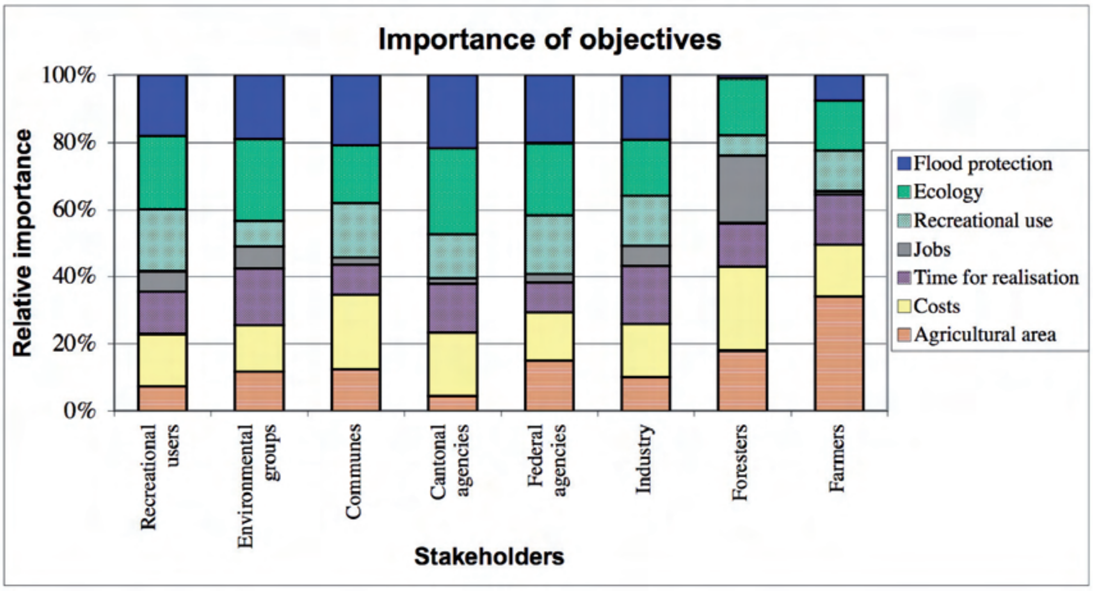


Figure 4.2: Importance of objectives for different stakeholders in the Weinfelden-Bürglen case study. Source: Hostmann (2005)

4.1.4. Elaboration of options

Ideally, several options are finalised and subsequently compared, taking into account the objectives of the different stakeholders. As a rule, the options are elaborated by the project team or by an external agency (e.g. engineering agency). In the case of the Weinfelden-Bürglen case study, the Rhone-Thur research team established the following options (Figure 4.3):

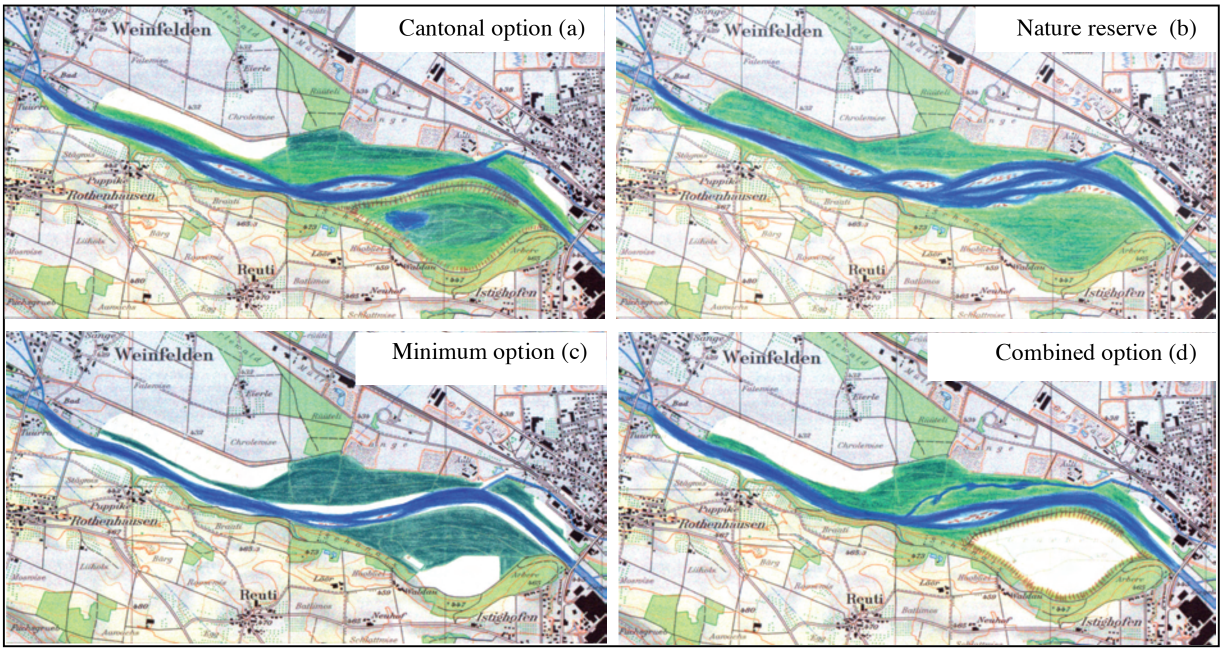


Figure 4.3: Example of rehabilitation options in the Weinfelden-Bürglen case study. The cantonal option (a) comprises a retention basin for flood protection and the widening of the riverbed. The nature reserve option (b) focuses on ecological improvement. The minimum option (c) includes doubling the width of the existing riverbed. The combined option (d) combines the objectives of "Flood protection", "Maintaining agriculture" and "Ecological improvement". Source: Hostmann (2005).

4.1.5. Implications of options

To evaluate the different options, it is important to be able to assess the implications of the different procedures. Current practice is to refer to assessments by experts (Table 4.1: Expert assessment in the Weinfelden-Bürglen case study). Standardised procedures exist (e.g. cost assessment, flood protection). For other objectives, implications are determined along with the definition of options (e.g. loss of agricultural land).

Attributes	Potential damage (CHF 10^6)	Costs (CHF 10^6)	Duration (years)	Ecology (scale 1–5)	Recreational use (ha)	Agriculture (ha)	Jobs (no.)
Current state	370	4.5	0	1.5	15	50	5
Cantonal option	12.3	18.1	20	3.4	55	15.5	23
Nature reserve	370	26.5	30	4.7	31.4	0	30
Minimum option	370	9.8	10	2.5	28.6	33.1	12
Combined option	113.5	12.2	15	2.9	26.8	45.4	15

Table 4.1. Implications of different options in the Weinfelden-Bürglen case study. Source: Hostmann et al. (2005)

The impacts on objectives such as "Ecology" and "Local economy" so far have been captured only rudimentarily. New predictive models were developed for the Rhone-Thur project, which permit a more accurate assessment of impacts on ecology and local economy. A detailed description of the predictive models can be found in Section 4.2.

4.1.6. Finding consensus

Based on the two factors: i) Emphasis placed on objectives by the stakeholders, and ii) Assessment of the impacts of different options on the objectives, the options can be ranked This ranking is also called “outcome assessment”. Figure 4.4. (left image) illustrates this in the Weinfelden-Bürglen case study.

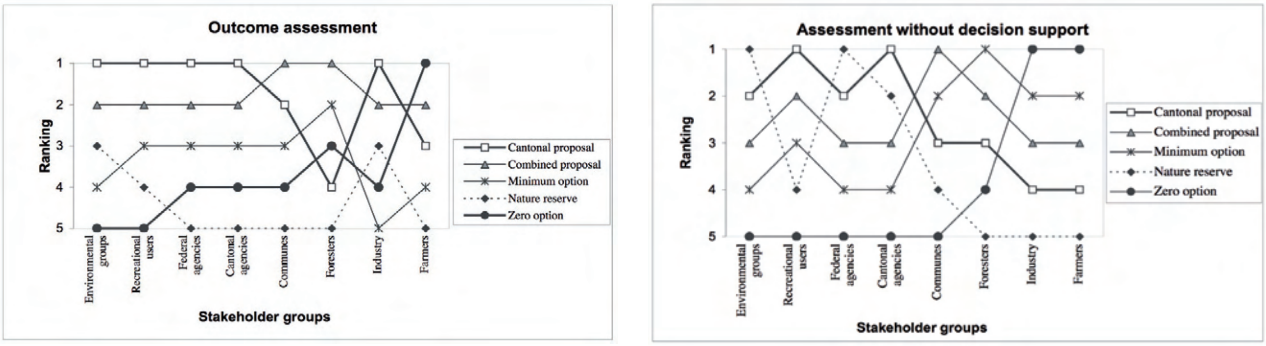


Figure 4.4: Ranking of different options for different stakeholder groups in the Weinfelden-Bürglen case study, based on outcome assessment (left), and assessment without decision support (right). Source: Hostmann (2005)

An outcome assessment, and assessment without formal decision support can contribute significantly towards resolving conflict when deciding between different options (Hostmann 2005):

- *Objective basis for discussion:* The two rankings bring commonalities and divergences between stakeholders to a practical level.
- *Elaboration of consensus:* Having the stakeholders weight their objectives (Figure 4.2) means that consensual solutions can be found at an early stage.
- *Support of learning process:* Outcome assessment and discussion of results can initiate a learning process by the stakeholders. Based on findings from recent experience, stakeholders were shown to consider a higher number of objectives within their decisions. The values and opinions of other stakeholders are clearer, and different positions more acceptable. Consequently, thanks to decision support, balanced solutions (consensual solutions) are valued more by stakeholders than previously.

Multiple Criteria Decision Analysis (MCDA) supports consensus finding between different interests. The example above is concerned primarily with organised (directly affected) interest groups. This decision support can also be used to incorporate the general population. It can equally be applied within a project team to work out a common position for different agencies.

4.1.7. *Catchment area and national level*

The Multiple Criteria Decision Analysis (MCDA) is useful at more than the local level; it can also be applied at catchment area leevel or at national level (Figure 4.5).

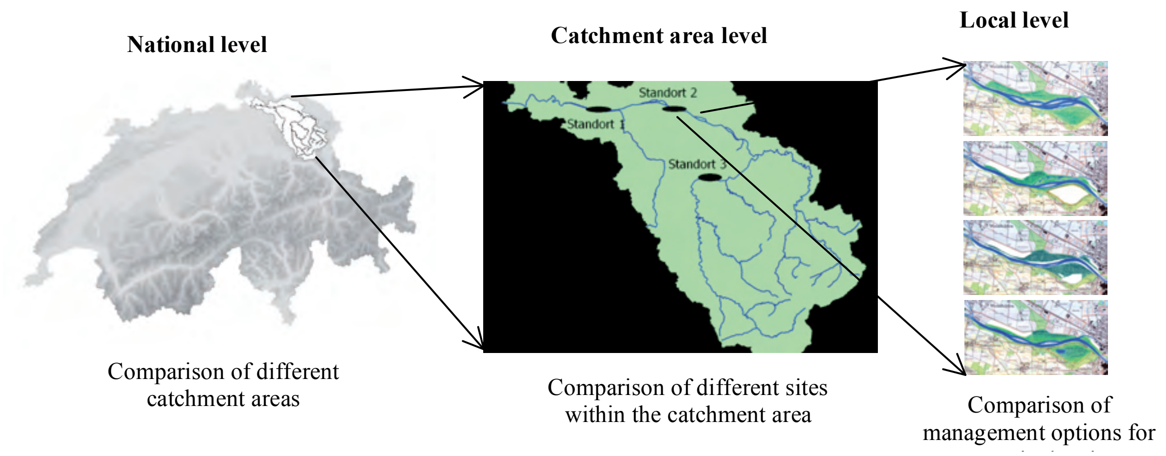


Figure 4.5: Multiple criteria decision analysis for different geographical levels. Source: Hostmann (2005)

National Level

At national level, MCDA is useful for comparing different river catchment areas. For example, it enables identification of catchment areas and river sections that, because of their favourable ecological and socio-economic conditions, are particularly suitable for channel extensions. Data must be available at national level, and it must be possible to implement them in the Geographic Information System (GIS). A detailed description of the methodology and results can be found in the synthesis report “Aufweitungen” (in German, Rhode 2005).

Catchment area level

At catchment area level, MCDA can be used to compare types of measures and locations.

Comparison of types of measures

There is a choice of different types of measures: for example, morphologic, hydraulic or chemical and physical measures can improve the ecological state of watercourses. The objective is to find the most efficient and/or effective measures.

Comparison of locations

The chosen types of measures are often implemented at different locations within a catchment area. For example, in the development concept “Alpenrhein”, there are plans for river widening measures at 18 locations (www.alpenrhein.net). Due to the long implementation phases (planning interval of 30 years) and limited financial means, priorities need to be set. MCDA can be helpful: this type of prioritisation of locations is described in detail in the “Alpenrhein” case study in Hostmann (2005).

4.2. Predictive models: assessing the implications

4.2.1. Background

In hydraulic engineering projects, decisions often have to be made between two options. It is difficult to assess the impacts on ecology and the local economy. Currently, ecological consequences are often assessed using individual parameters (e.g. the size of the typical floodplain for each individual option). A new predictive model now provides detailed data of the cause-effect relationship between hydraulic engineering procedures and important ecological and economic variables (Figure 4.6). Ecology comprises river hydraulics, river morphology, flora (aquatic plants, floodplain forest) and fauna (aquatic invertebrates, fish and terrestrial fauna). Impacts on the local economy are also include, e.g. jobs. This predictive model, made up of different sub-models, is called the Integrative River Rehabilitation Model (IRRM).

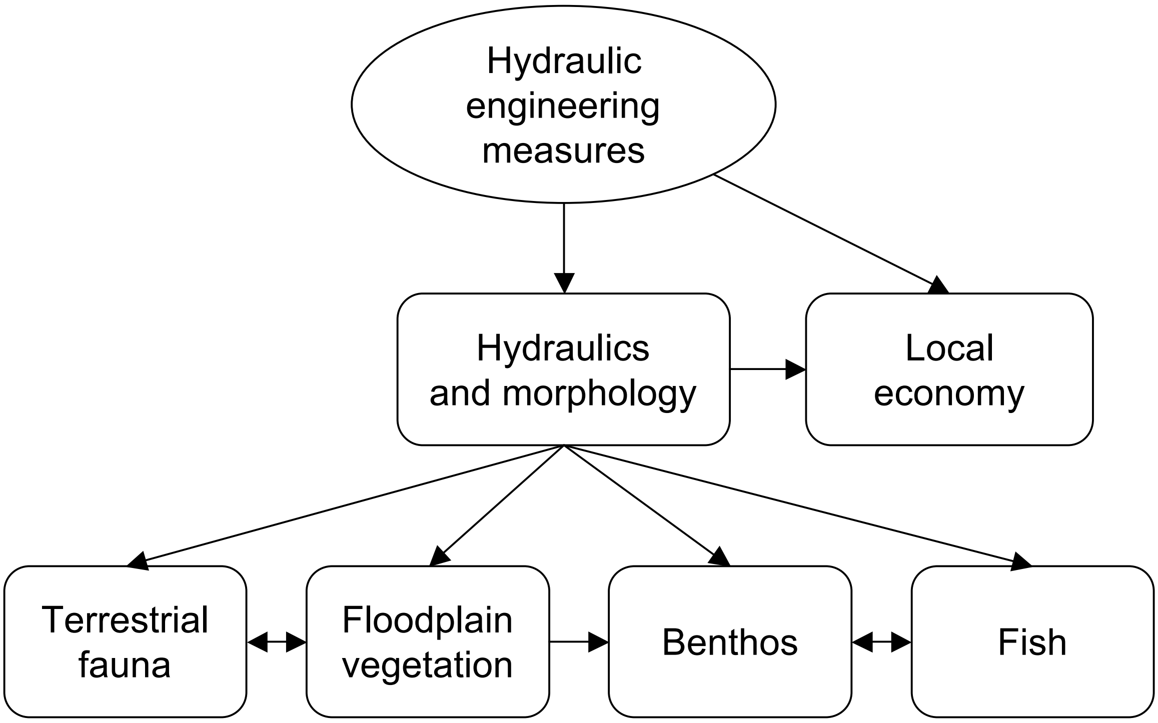


Figure 4.6: Structure and sub-models of the Integrative River Rehabilitation Model (IRRM).

The IRRM is implemented as a probability network and links scientific information from literature, existing models and experts' opinions. This allows the connections between the different aspects to be depicted more simply; and for uncertainties in initial variables, equations and results to be considered. The model can be applied to all regular and larger rivers in the alpine area. The only requirements are river-specific parameters for the different sub-models.

4.2.2. Sub-model hydraulics and morphology

The most important sub-model is that of hydraulics and morphology. In hydraulic engineering projects, all ecologically relevant evaluation parameters depend on this model. It allows statements to be made about river morphology, bed load balance, drainage depth, flow velocity and colmation of the bed. These aspects are briefly elaborated below. Detailed descriptions of the "Hydraulics and morphology" sub-model can be found in Schweizer *et al.* (2005a, b).

Prediction of river morphology

After a river expansion, the rivers morphology redevelops . This is an important criterion in determining the ecological success of river engineering projects. Furthermore, the channel morphology directly influences the distribution of the flow velocity and drainage depth, the bed load balance and the structural diversity in the affected section of the river.

The model distinguishes between the following river morphologies: 1) straight/channelled, 2) alternating gravel banks, and 3) complex channels. Whether individual channels or complex channels are formed after a river expansion depends among others on transport capacity and the bed load collection of the river section. One deciding factor is the resulting width (distance between the dams) of the river (Table 4.2).

Drainage depth and flow velocity

Drainage depth, flow velocity and grain size distribution are major determinants of habitat quality. Channelled, straight sections of river are characterised by similar distributions of drainage depths and flow velocities. Conversely, rivers with alternating gravel banks and complex channels demonstrate great variation in these parameters. The IRRM allows the distribution of the different types of habitat (e.g. ripple, flow, basin) to be estimated easily: the more complex the types of habitat, the better the conditions for fish and other marine life.

Colmation

Colmation (filling of cavities in the river bed with fine particles) and decolmation (loosening the fine particles) are ecologically meaningful processes, as fish, invertebrates and aquatic plants largely depend on the living conditions on the riverbed. The amount of fine particle matter on the riverbed influences the exchange between river and groundwater. The IRRM permits the progression and median degree of the colmation to be estimated, as well as the depth of colmation and permeability of the riverbed.

Example: Predictions about morphology in Weinfelden-Bürglen

What expansion of the riverbed is required for ecologically valuable habitats to appear? Figure 4.7 shows the probably distribution of different river formations associated with specific river widths in the case study Weinfelden-Bürglen (Thur). There, the IRRM forecast that widening the river to 150 m would produce the following results: 70% probability of "Alternating gravel banks" and 15% of both "Alternating gravel banks" and "Complex river course". In reality, by expanding the Thur at Niederneunforn from 50 to 150 m width, "Alternating gravel banks" appeared predominantly (although with slightly different entry sizes than in Weinfelden-Bürglen, Figure 4.8, right).

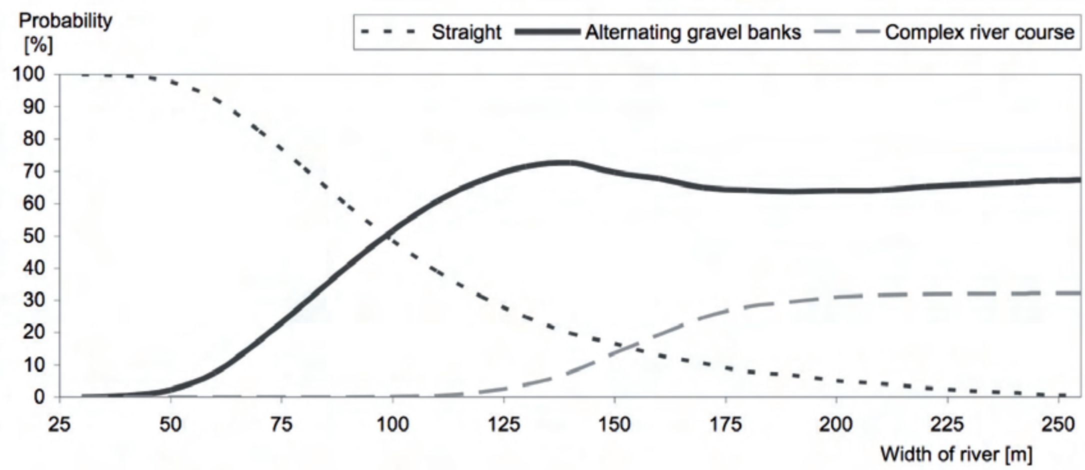


Figure 4.7: Probable distribution of different river formations (straight, alternating, gravel banks, complex) for a specific river width in the Weinfelden-Bürglen case study.

Figure 4.8: The Thur at Niederneunforn. Left: channelled Thur in June 2001. Right: revitalised Thur with alternating gravel banks (May 2004). (C. Herrmann, BHA team, Frauenfeld)

4.2.3. Further sub-models

In addition to the sub-model "Hydraulics and morphology", further sub-models were finalised. These will be introduced here. The modelled variables and required input variables are outlined in Table 4.2.

Benthos

The sub-model "Benthos" (available from mid 2006), forecasts the average seasonal density of algae, macrophytes and the functional feeding types of invertebrate (grazers, filter feeders, solution feeders, detritivores and predators) and their average processing rate. To do so, it assesses statistical correlations (regression equations) between the density of each individual functional group and their habitat conditions in different alpine affected rivers. Data from rivers in Switzerland, Austria, France, USA, New Zealand and Japan are used.

Floodplain vegetation

The sub-model "Floodplain vegetation" (available from late 2006) allows the prediction of long-term average values (biomass, height of vegetation), and different types of floodplain vegetation (hardwood flood plain, softwood flood plain, natural gravel cover, pioneer plant locations). The inflow of organic matter and the shading of the water body by the flood plain vegetation can also be assessed. The riverbank vegetation model will be a simplified version of the vegetation model Genz (2005).

Terrestrial riverbank fauna

This model calculates the density of spiders, ground beetles and other beetle species. Under natural conditions, densities of up to 200 spiders and 900 beetles per square metre have been observed (Paetzold *et al.* 2005). River straightening procedures and short-term changes in drainage, in particular, substantially reduce the density of the riverbank populations.

Fish

This models the lifecycle of fish, differentiating between 5 phases (Borsuk *et al.* 2005). The number of individuals at each specific phases of life depends on the previous stage and the death and reproduction rate, among others things. This sub-model considers the two fish species brown trout (Salmo trutta) and Nase (Chondrostoma nasus).

Local economy

Hydraulic engineering procedures also influence the local economy. In the Rhone-Thur projects, a predictive model was developed to assess how the different hydraulic engineering projects would impact on jobs (Spoerri *et al.* 2005). This model is based on an input-output analysis, linking different economic sectors (e.g. the building trade, service industry).

Example: Generation of jobs (Weinfelden-Bürglen)

The number of jobs created is correlated with construction expenditure. In the Weinfelden-Bürglen (Thur) case study it was calculated that for every million Swiss francs spent on construction, eight fulltime jobs were created. Assuming that the total cost of construction over five years adds up to CHF 20 million, 32 full time jobs would be created. Of course, the importance of these jobs depends on the regional job situation. In peripheral regions in particular, jobs can be an important criterion when comparing different options.

Sub-model	Modelled size	Important input variables
Hydraulics and morphology	- Likelihood of a morphology type - River habitats - Colmation - Flooding dynamic of the floodplain	- Annual flood discharge - Average grain size - Incline - Distance between lateral boundaries - Bed load - Horizontal distance between foreland/ floodplain and the average riverbed - Concentration of suspended matter
Benthos	- Mean density of benthos types (e.g. algae, macrophytes, invertebrates)	- Evenly distributed stream velocity and depth of drainage - Average grain size - Average period of flood recurrence - Radiation (irradiation of sun, shading, water depth, clouding) - Nutrients and water temperature - Concentration of suspended matter - Concentration of organic matter
Vegetation	- Height and type of vegetation in floodplains	- Time between flood recurrences, height, point in time and duration - Geometry of foreland - Climatic conditions (precipitation, atmospheric temperature, radiation) - Soil moisture - Nutrients
Terrestrial riverbank fauna	- Density of spiders and different types of beetles	- Retreat potential in the case of flooding - Area of gravel banks - Short-term changes in drainage - Colmation - Feeding situation
Fish	- Number of individuals at different life stages	- Conditions of river bed (grain size distribution, degree of colmation) - Water quality and temperature - Conditions of habitat (evenly distributed stream velocity and depth of drainage, water morphology) - Frequency of floods - Food supply - Anthropogenic influences (e.g. forest stocks, fishery) - Catchment area factors (extent of agriculture, population numbers)
Local Economy	- Number of jobs	- Costs (CHF) of the revitalisation measures, divided up according to different sectors (planning, construction etc.)

Table 4.2: Modelled variables and important input variables for selected sub-models of the IRRM

4.2.4. Optimisation of options

Decision support allows an option to be optimised according to various criteria. In this case, a study of the construction of a hydropower plant on the river Rhone was chosen (Heller *et al.* 2005). The hydropower plant should satisfy as many conditions as possible. Here, hydraulic, ecological and social aspects are important: the hydraulic aspects comprise energy production, flood protection, irrigation and shipping. Ecological aspects need to consider river morphology, fluctuations in water levels, and biotopes. Social considerations are fishery, recreation and landscape.

Example: Optimisation of a hydropower plant at the river Rhone

The hydropower plant evaluated consists of a river power plant including a reservoir (Figure 4.9, Heller *et al*. 2005). The power plant utilises the energy. The reservoir is a storage basin for flood protection, and reduces the effects of unnatural fluctuations of water levels. Benchmark figures of the power plant and reservoir were determined using a qualitative network analysis. The embankment dam is approx. 8.6 m high. The reservoir has an area of approx. 1 km^2. In The average volume of water in the Rhone is 65 million m^3 in winter and 180 million m^3 in summer.

A qualitative analysis shows the benefits of the optimised running of the reservoir. Possible rules for running the reservoir are: 1) minimisation of the required volume, 2) maximisation of water levels in the reservoir, and 3) minimisation of fluctuations in reservoir water levels . A constant high level of water in the reservoir maximises energy production. If the water levels in the reservoir do not fluctuate too much, harmful impacts on the ecology are lower and the utilisation of the reservoir higher (e.g. recreational use, biotope, energy production).

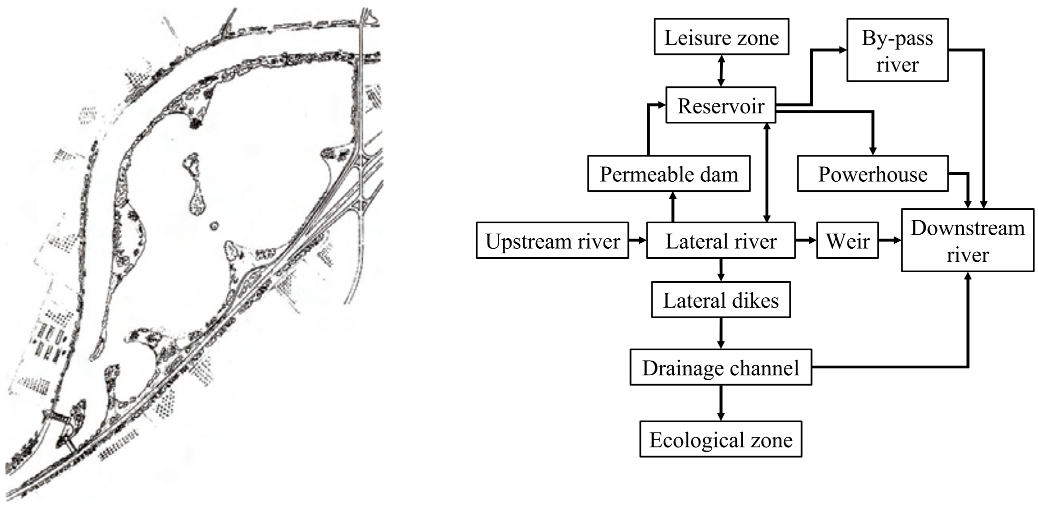


Figure 4.9: Recommendation for a multipurpose river power plant on the Rhone. Drawing (left) and diagram (right)

The results show that the amplitude of water-level fluctuation, particularly in the winter half-year, can be reduced significantly (Figure 4.10, left). In the summer half-year, drainage is generally higher, and therefore the reduction in the amplitude fluctuations by the reservoir is also lower (Figure 4.10, right). As a comparison with historical data confirms, natural drainage can be restored to about 85% (Heller *et al.* 2005).

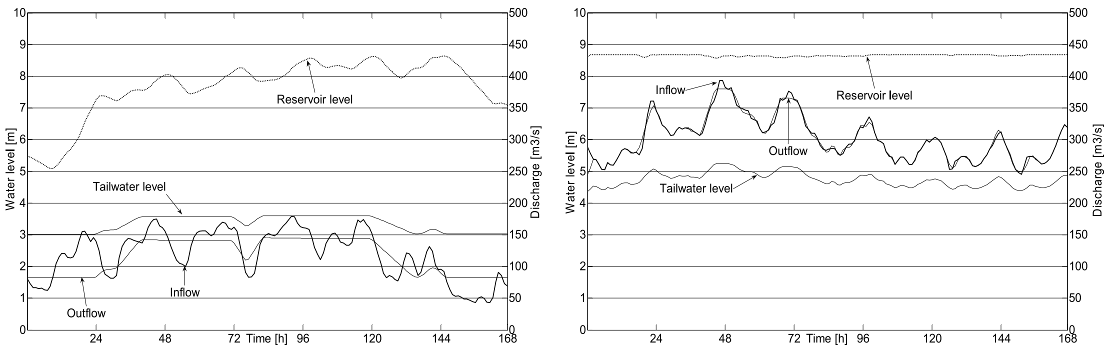


Figure 4.10: Water levels in the reservoir and size of inflow and drainage for a week in winter (left image) and a week in summer (right image).

5. Model project process

In conclusion, we would like to identify the ideal project process for forming public opinion and decision-making in hydraulic engineering projects. We differentiate here between hydraulic engineering projects at the project level (5.1) and at the catchment area level (5.2).

5.1. Project level

Figure 5.1 shows how decision-making tools can be implemented at the planning and construction stages of a project. The general project process and the most important synthesis tools for decision making are explained briefly. A detailed description of tools can be found in each respective chapter (see parentheses).

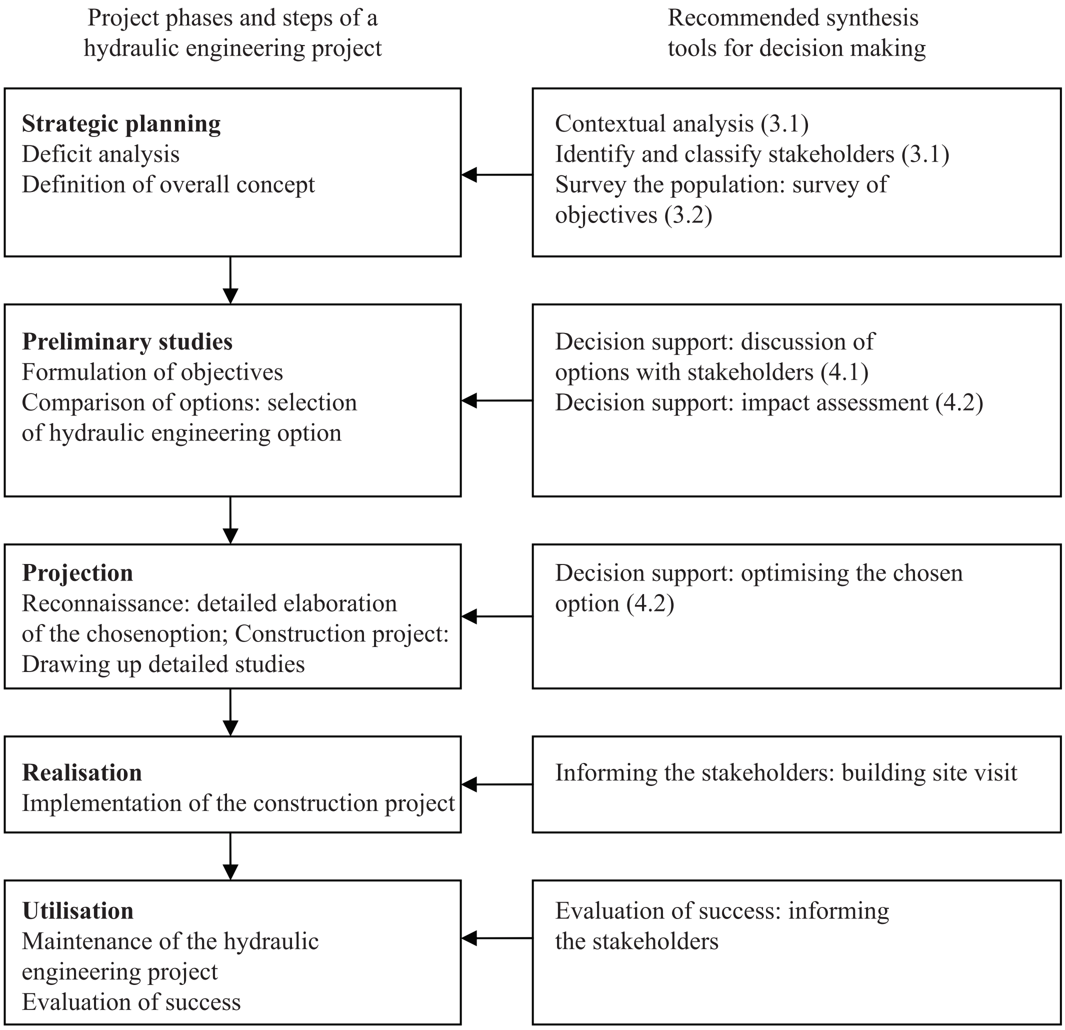


Figure 5.1: Tools for participation and decision making at the different stages of a hydraulic engineering project. The project stages are based on SIA (1996) and FOWG (2001).

At the initial stage of the planning process *(strategic planning)*, the context of the hydraulic engineering project is documented. Our guidelines present a checklist (3.1) and a list of beneficial factors (2.5). An important part of the contextual analysis is identifying and classifying the stakeholders (3.1). This stakeholder analysis forms the basis for including the general population. If an overall concept is developed, a survey can give invaluable insights to goals and values of the general population (3.2).

At the *preliminary study* planning stage (also called feasibility study) all possible options are discussed and the chosen option determined (FOWG 2001). Here, standardised decision support assists the elaboration and comparison of options. The manual demonstrates how stakeholders can be included in the discussion of options and planning of consensual solutions (4.1). Thanks to a new predictive model, impacts of the construction measures on ecology and local economy can be assessed more easily (4.2).

The project planning stage consists of feasibility analysis and the building project itself. The *feasibility analysis* comprises a detailed elaboration of the chosen option (including a rough estimate of costs, key measurements for construction works and an overview of impacts). Decision support also exists to optimise the chosen option (4.2). The building project comprises the technical report, the project plans and the cost estimate. It constitutes the basis for the building licence application, decision on subsidies, decision on construction and the tender (FOWG, 2001).

The new financial equalisation (NFA) will substantially alter the rules for federal subsidy. In future, certain minimum requirements of “profitability”, “ecological aspects” and a “participatory planning process” need to be met to justify the allocation of federal funds. Increased achievements in these areas will be particularly remunerated. The manual presents tools to meet requirements regarding the “participatory planning process”.

The construction project may need to be adapted to new requirements during *project realisation*. Stakeholders should be consulted if great modifications are under consideration. Regular communication is also important at this stage. Construction site inspections present a good opportunity to inform interested stakeholders about the project works on site.

At the *utilisation* stage, evaluation of success and maintenance are important. The performance review investigates whether ecological, hydraulic engineering and socio-economic goals of the project have been met. This allows for shortcomings to be recognised and corrections to be made. It also offers learning opportunities for future projects. The manual on the success evaluation of the Rhone-Thur project describes procedures and possible indicators in detail (Woolsey *et al.* 2005). It responds specifically also to socio-economic indicators such as “project acceptance”, “recreational use” and “participation process”. The results of the success evaluation should in turn be widely disseminated.

5.2. Catchment area level

The planning of hydraulic engineering requires the entire catchment area to be considered. In Switzerland, strategies and planning procedures are elaborated for the different catchment areas. Relevant examples are the Rhone (Canton Valais, 2000), the Alpine Rhine ("Alpenrhein", IRKA, 2003a, b, 2005), the Kander (Tiefbauamt des Kantons Bern, 2005), and the Linth (Linthverwaltung, 2005). The EU Water Framework Directive (WFD) require that strategies and planning procedures be developed at the catchment area level (European Parliament, 2005). Cross-border hydraulic engineering projects therefore require special resources; for example, the French instrument for the catchment area management, which was taken over by Canton Geneva (DIAE, 2005).

Important milestones at the catchment area level are the deficit analysis, the elaboration of an overall concept, and the planning procedures. Our overall concept lends itself to the following flowchart (Figure 5.2).

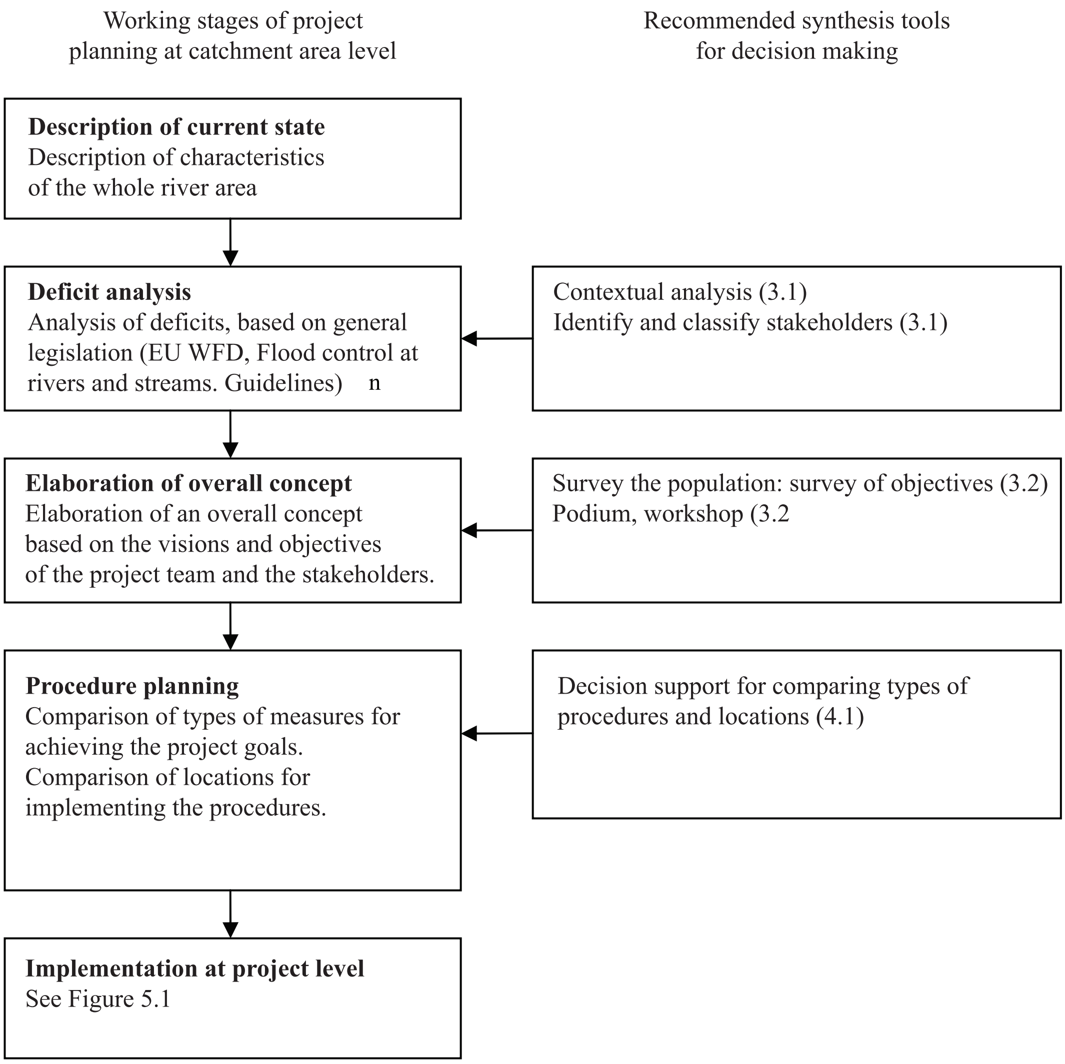


Figure 5.2: Recommended tools for the support of procedure planning at catchment area level. The stages are based on the EU Water Framework Directive (European Parliament 2000).

Procedure planning at catchment area level begins with the survey and *description of the current state* and the *deficit analysis*. The deficit analysis is not restricted to aspects of ecology and technical hydraulic engineering, but also considers social and historical aspects. A contextual analysis allows the timely recognition of critical aspects (e.g. earlier conflicts), and identification and classification of relevant stakeholders at an early stage (Section 3.1).

Visions and planning goals of the catchment area are defined in the *overall concept*. Ideally, the overall concept is worked out together with the stakeholders (citizens' concept). If the stakeholders can agree on a joint overall concept, it can subsequently be the basis for a joint planning process. The goals and values of the general populating are ascertained using surveys or workshops (e.g. future trends workshop, 3.2). Representatives of the regional interest groups are consolidated within a working group, to discuss project goals collectively. The methodology of decision support lends itself to the systematic structure of goals and sub-goals (4.1).

The *procedure planning* develops a strategy to achieve the objectives of the overall concept, comparing various types of procedures. Locations within the catchment area where the procedures are to be implemented often need to be decided. Formal decision support allows different types of procedures to be compared and locations to be prioritised (4.1). Decision support can be applied within the project team, or including the affected and general population.

The *project level* follows the completion of the planning procedure within the catchment area (see Chapter 5.1). Here, valuable synergies exist: for example, information from the catchment area can also be used for the local projects (e.g. the general population's objectives, contextual analysis). The tools presented in the overall concept can be applied at both levels, which simplifies matters.

6. Glossary

- Benthos: plants and invertebrates in watercourses.
- Colmation: deposition of suspended solids in and on the riverbed. It reduces the porosity and the pore space of the riverbed.
- Contextual Analysis: analysis of societal, historical and spatial framework of a hydraulic engineering project.
- Decision support: Formal method to support the decision-making process. Important decision-support tools include multi-criteria methods as well as predictive models (see below)
- Erosion: the wearing down and carrying away of rocks, sand, humus, plants etc. by water
- Fauna: the animal kingdom
- Flora: the plant kingdom
- General population: this refers to all persons living in the areas surrounding the project and which, due to the interventions of the project, are affected in their environment.
- Integrative River Rehabilitation Model (IRRM): specific predictive model, developed specifically for the Rhone-Thur Project.
- Multi-criteria methods: Formal decision-making method to support the decision-making process in the case of multiple, sometimes contradictory goals and different, conflicting interests.
- Outcome assessment: appraisal of options based on the Multi-criteria method. First, project goals are determined. Second, different options are considered and how the goals can be achieved.
- Participation: Inclusion of stakeholders in the formation of public opinion and decision-making processes.
- Predictive model: formal decision-making method, which assesses scale of ecologic and economic implications of hydraulic engineering interventions.
- Project management: the project management of a hydraulic engineering project comprises representatives of agencies responsible for implementation of project.
- Project team: the project team is responsible for the development of the hydraulic engineering project. The project team often comprises representatives from agencies responsible for project implementation (project management) as well as personnel of engineering offices.
- Revitalisation: restoration of a near-natural river environment. This is to allow improvement to the structure and function of the affected watercourse so that in time the ecosystem can recover.
- Stakeholder: the term “stakeholder” encompasses all those persons who are affected by the project or who can influence it (Freeman 1984).
- Survey: A survey allows goals and values of the population to be determined. A survey can be written or oral.

7. Bibliography

Beierle T.C. (1998) Public Participation in Environmental Decisions: An Evaluation Framework Using Social Goals. Resources for the Future, Washington DC

Borsuk M., Reichert P., Peter A., Schager E. & Burkhardt-Holm P. (2005) Assessing the decline of bown trout (Salmo trutta) in Swiss rivers using a Baysian probability network. submitted

Buchecker M. (1999) Die Landschaft als Lebensraum der Bewohner - nachhaltige Landschaftsentwicklung durch Bedürfniserfüllung, Partizipation und Identifikation. Dissertation am Geographischen Institut Universität Bern.

Canton du Valais (2000) Troisième correction du Rhône - Sécurité pour le futur. Service des routes et des cours d'eau, Sion

Commission pour la protection contre les crues (2004) Assurance de la qualité dans le cadre de la planification de mesures de protection contre les crues. Guide à l'intention des maîtres d'ouvrage et de leurs Mandataires. Association suisse pour l'aménagement des eaux, Baden p. 33.

DIAE (2005) Contrats de rivières. URL http://etat.geneve.ch/diae/site/eau/master-content.jsp?componentId=kmelia80&nodeId=648

Ejderyan O. (2004) Science "déjà faite" et science "en train de se faire" dans un processus participatif de prise de décision. Le cas de la renaturation de la Seymaz dans le canton de Genève. In: Contraintes environnementales et gouvernance des territoires (eds. Scarwell H-J & Franchomme M), pp. 309-316. Editions de l'Aube, La Tour d'Aigues

Environmental Agency (2004) Ribble Pilot River Basin: Public Participation and River Basin Planning - Early Experiences. Lancashire, England

Freeman R.E. (1984) Strategic management: A stakeholder approach. Boston

Glenz C. (2005) Process-based, spatially-explicit modelling of riparian forest dynamics in Central Europe - Tool for decision making in river restoration. p. 220. EPFL, Lausanne

Heller P., Schleiss A.J. & Bollaert E. (2005) Potential synergies of multipurpose run-of-river hydroelectric powerplants. p. 9. Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne

Hostmann M. (2005) Decision Support and River Rehabilitation. Doktorarbeit ETH Nr. 16136, p. 154. Eidgenössische Technische Hochschule Zürich

Hostmann M., Borsuk M., Reichert P. & Truffer B. (2005) Stakeholder values in decision support for river rehabilitation. Archiv für Hydrobiologie, Supplement, 155, 491-505

IIED (2005) Analyse du pouvoir des parties prenantes. International Institute for Environment and Development.

IRKA (2003a) Entwicklungskonzept Alpenrhein - Teilbericht Analyse. p. 159. Internationale Regierungskommission Alpenrhein IRKA, Internationale Rheinregulierung IRR

IRKA (2003b) Entwicklungskonzept Alpenrhein - Teilbericht Ist-Zustand. Internationale Regierungskommission Alpenrhein IRKA, Internationale Rheinregulierung IRR

IRKA (2004) Entwicklungskonzept Alpenrhein - Positionspapier. Lienz

Junker B. & Buchecker M. (2005) Gesamtschweizerische Befragung 2004/2005. WSL, Birmensdorf

Kienast F., Peter A. & Geiser U. (2004) Wasserbauer werden zu Moderatoren. Kommunalmagazin, 10, 12-15

Kissling-Näf I. & Wälti S. (1999) Der Vollzug öffentlicher Politiken. In: Handbuch der Schweizer Politik (eds. Klöti U, Knoepfel P, Kriesi H, Linder W & Papadopoulos Y), pp. 651-689. NZZ Verlag, Zürich

Linthverwaltung (2005) Das Linthwerk. URL http://www.linthwerk.ch/

Luyet V. (2005) Bases méthodologiques de la participation lors de projets ayant des impacts sur le paysage. Cas d'application: la plaine du Rhône valaisanne. GECOS. Thèse EPFL numéro 3342, Lausanne

Marttunen M. (2005) Framework for the sustainable management of regulated watercourses - A collaborative approach supported by multi-criteria decision aid methods. Manuscript of the Doctoral Thesis. Helsinki University of Technology, System Analysis Laboratory.

Mason R.O. & Mitroff I.I. (1983) Challenging Strategic Planning Assumptions: Theory, Cases and Techniques. Wiley, New York.

Meile T., Fette M. & Baumann P. (2005) Synthesebericht Schwall/Sunk. Publikation des Rhone-Thur Projektes. Eawag, WSL, LCH-EPFL, VAW-ETHZ.

Mitchell R.K., Agle B.R. & Wood D.J. (1997) Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. Academy of Management Review, 22, 853-886

Mosler H.-J. (2004) A framework for stakeholder analysis and stakeholder involvement. International Water Management Course IWMC, p. 18. Swiss Federal Institute of Aquatic Science and Technology, Rüschlikon-Zürich

NÖ Landesakademie (2005) Nachhaltige Entwicklung der Kamptal-Flusslandschaft. www.kamptal-flusslandschaft.at

OFEFP/OFEG (Eds.) (2003) Idées directrices cours d'eau Suisses: pour une politique de gestion durable de nos eaux. Berne, 12 pages.

OFEG (2001) Protection contre les crues des cours d'eau. Directives de l'OFEG, Berne 2001. Avec la participation de l'Office fédéral du développement territorial ODT, l'Office fédéral de l'environnement de la forêt et du paysage OFEFP et de l'Office fédéral de l'agriculture OFAG.

Paetzold A., Schubert C. & Tockner K. (2005) Aquatic-terretrial linkages along a braided river: Riparian arthropods feeding on aquatic insects. Ecosystems, in press

Parlement européen (2000) Directive-cadre sur l'eau. P.72

Rohde S. (2005) Synthesebericht Gerinneaufweitungen. Publikation des Rhone-Thur Projektes. Eawag, WSL, LCH-EPFL, VAW-ETHZ.

Schweizer S., Borsuk M., Jowett I. & Reichert P. (2005a) Predicting joint frequency distributions of depth and velocity for instream habitat assessment. Water Resources and Research, submitted

Schweizer S., Borsuk M. & Reichert P. (2005b) Predicting hydraulic and morphological consequences of river rehabilitation measures. In preparation

SIA Schweiz I.-u.A. (1996) TOP - Teamorientiertes Planen: mit dem neuen Leistungsmodell 95 des SIA (LM 95). SIA Schweiz, Ingenieuer- und Architektenverein, Zürich, Schweiz

Spörri C., Borsuk M., Peters I. & Reichert P. (2005) The Economic Impacts of River Rehabilitation: A Regional Input-Output Analysis. Ecological Economics, Submitted

Tiefbauamt des Kantons Bern (2005) Kander 2050. p. 12. Renaturierungsfonds des Kantons Bern, Bern

Walther P. (1988) Vergleichende Studien zur Konstruktion von Bildern über Umweltwandel in Wissenschaft und Alltag. Landschaft und Stadt, 20(1), 1-9.

Woolsey S., Gonser T., Hoehn E., Hostmann M., Junker B., Peter A., Roulier C., Schweizer S., Tiegs S., Tockner K. & Weber C. (2005) Handbuch für die Erfolgskontrolle bei Fliessgewässerrevitalisierungen. Publikation des Rhone-Thur Projektes. Eawag, WSL, LCH-EPFL, VAW-ETHZ.

Zaugg M. (2005) "Mehr Raum den Fliessgewässern!" Eine strukturationstheoretische Analyse des institutionellen Wandels im schweizerischen Hochwasserschutz seit den 1970er Jahren. Mathematisch-naturwissenschaftliche Fakultät, p. 287. Universität Zürich, Zürich

Zaugg M., Ejderyan O. & Geiser U. (2004) Normen, Kontext und konkrete Praxis des kantonalen Wasserbaus. Resultate einer Umfrage zu den Rahmenbedingungen der kantonalen Ämter oder Fachstellen für Wasserbau bei der Umsetzung der eidgenössischen Wasserbaugesetzgebung. GIUZ, Zürich.