Retention basins – experience of flood control in Styria

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Abstract

Flood control is attributed great importance in the well-wooded, but also in some parts, densely populated Austrian state Styria. The primary objective is to infiltrate the precipitation in the area before draining it off into the receiving water. If this should not be an option the construction of technical protective structures are necessary. To reduce the maximum flood discharge, which increased in the last years due to climate change, flood control reservoirs offer often the only possibility, when linear protective structures are no alternative.

From the Government of Styria, the Department of Water Protective Economy and Groundwater Resources supervises the interests of flood control. The department supports and sponsors the construction of flood control basins already for decades. The constantly increasing ecological as well as landscape architecture requirements have been integrated into the design of the retention basins and have become standard with these constructions today. The electronic capture of the basins is conducted by Graz University of Technology, Institute of Hydraulic Engineering and Water Resources Management. The aim of this work is to create a tool for optimizing the management of the basins. Operational experience of the constructions is attributed special attention to in order to find optimized solutions for future projects.

Introduction

Since decades flood retention basins are an essential part in the strategies of technical flood protection in the state of Styria. Until now approximately 100 flood retention basins have been built at the rivers of the Federal Water Engineering Administration. Further 25 basins are planned and the realization of 6 basins is already in progress. In the area of responsibility of the Torrent and Avalanche Control there are 19 constructions in operation, 4 in the realization phase and 14 are planned. The inspection of these basins is conducted by 17 civil engineers.

Retention basins in Styria

The construction of retention basins in Styria begun quite early, the first basins have been built in the end of the 1960s. In the year 1985 the Styrian government resolved "the catalogue of measures for the near-natural hydraulic engineering". With the commitment to give water retention top priority and linear measures comes second, the main focus is on the construction of flood retention basins. About 70% of the flood retention basins in operation have been built in the period of 1985 to 1995. Figure 1 shows all retention basins of the Federal Water Engineering Administration until 2010.

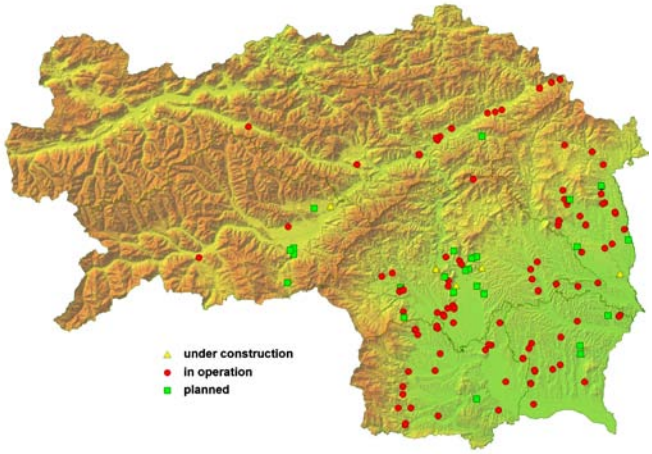

Figure 1: Retention basins in Styria

Construction and construction types

1992 a book entitled "Flood retention basins – planning, construction and operation" was published by the Styrian Government, which serves as guidance for the construction and maintenance of the retention basins [4].

From 99 retention basins, 3 retention basins are constructed as parallel connection, and 13 are featured with a ground swell. All in all 83 retention basins are built as earth-fill dam, whereof 10 are zoned dams with a sealing layer. 13 retention basins consist of a concrete wall as well as an earth-fill dam and only 3 retention basins are completely constructed as concrete walls. About one-fifth of 74

investigated basins have a control system of the bottom outlet, with the advantage of an increased efficiency. [3] Figure 2 illustrates some examples of common construction types and Table 1 shows the total storage volume of all basins.

Figure 2: Different types of constructions,
a: Concrete wall - Ligistbach,
b: Earth-fill dam - Lobmingbach,
c: Earth-fill dam with light well - Stullneggbach,
d: Earth-fill dam with concrete wall - Gamlitzbach

TABLE 1: STORAGE VOLUME OF ALL BASINS

Storage volume	Number of basins
≤ 100.000 m³	72
100.000 – 500.000 m³	25
> 500.000 m³	2

Due to ecological reasons nowadays the common building type of a retention basis asks for a combination of an earth-fill dam and a concrete wall. The concrete wall should be situated in the area of the water body to ensure the shortest and lightest way through the barrage for the aquatic wildlife (see Figure 2-d). The ecology was also taken into account in the older construction as e.g. structured bottom outlet or a light well (see Figure 2-c).

Flood events summer 2009

The summer 2009 in Styria was characterized by a multitude of extreme flood events. Remarkable was the fact these were mainly small scaled events. During this period the retention basins have proved themselves as an effective flood protection measures. 28 retention basins were ponded, wheras 15 of them were fully filled. Figure 3 shows a map with all retention basins in operation. E.g. the basin Auersbach retained 400.000m³ water and protected the municipality Raabau and the city of Feldbach from enormous damages [5].

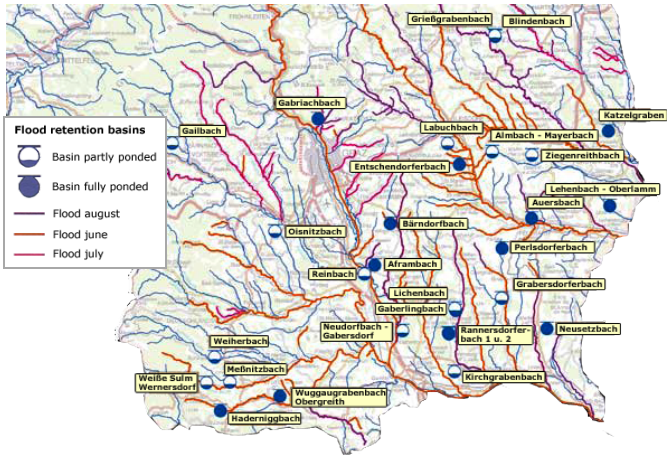

Figure 3: Retention basins in operation, summer 2009

Inspection System

During the operation of the retention basins it became evident, that the operator of the construction – municipalities and water boards – neglected the maintenance of the construction and the inspection of important system parts. Often there has been a lack of expertise.

The appointment of someone how's responsible for the retention basin (caretaker, supervisor) has not been foreseen in the early notifications.

In 1993 all retention basins have been inspected in regard to design or constructional shortcomings as well as in terms of weak points during the operation of the constructions. The results of this analysis and the shown shortcomings disposed the responsible persons in the regional government authority to install a system for a regular, periodical inspection of the constructions through professional skilled experts. Together with representatives of the Chamber of Engineers of Styria and Carinthia the scopes of work of the "retention basin supervisor" has been worked out 1994.

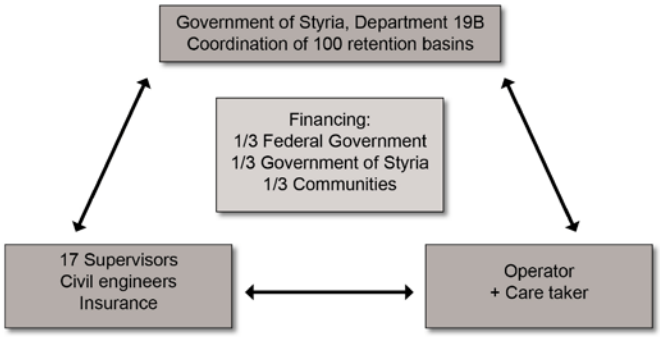

Figure 4: Organization of the inspection system

During the annual site inspection and control of the construction in regard to existing shortcomings in construction, design and static also the functional capability of all plant components have to be checked. Additional to the annual control the retention basins have to be inspected after every event respectively after every ponding of the basin. The inspection report is forwarded to the client, to the operator of the basin as well as to the Water Right Authority. Further a caretaker, e.g. a municipal employee, is responsible for the maintenance of the construction which is documented in an operation diary. This system is financed by the federal government, the Government of Styria and by the operator.

Tasks of the supervisor

- Preparation of a retention basin book (technical and legal documents)
- Preparation of a handbook and work rules
- Annual inspection of the construction visual and functional
- Report to the water right authority, Styrian Government Department 19B, operator, district construction management and torrent und avalanche control
- Training and education of the caretaker
- Inspection of possible reconstruction works
- Payment according to a special contract

Tasks of the caretaker

- Keep a operation diary
- Maintenance of the construction
- Status control of all plant components (4 times a year)
- Removal of log jams
- Inform the operator in case of emergency

Special case

An important detail is, that the construction of a basin which is higher than 15m or has a storage volume of more than 500.000m³, has to be permitted by the Federal Ministry of Agriculture, Forestry, Environment and Water Management (commission on dams). Due to the higher risk in case of a failure, the inspection and monitoring system of the dam has to be conducted in the same way as for dams which are used for hydropower purposes. [9] Only 6 out of 74 investigated retention basins in Styria belong to this category [3].
But the increasing number of "small dams" and safety needs of the population also ask for an enhanced inspection of these small constructions. Therefore the Federal Ministry published in 2009 a guidance for "small dams", depending on the level of risk potential (considerable or low) [10].

Warning and Alerting System

During a flood event a clear communication and responsibility chain is needed to ensure a successful operation of the retention basin. This is exactly defined in the operating instructions of each retention basin.
You can distinguish between a reporting plan and an emergency plan.

Reporting plan

In case of weather conditions which could lead to a flood event the caretaker has to check the retention basin in regard to a possible ponding. The beginning of a ponding has to be documented. Depending on the reached water level in the basin different persons in charge have to be informed and also the supervisor has to go there (see Figure 4).

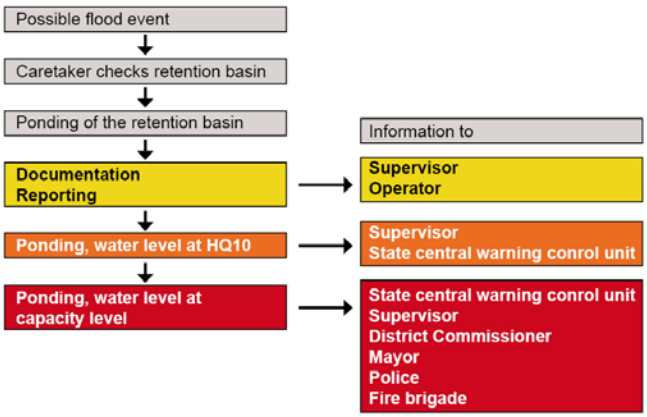

Figure 5: Warning and alerting system

Emergency plan
In case of an alarm situation, this means an exceptionally incident; the civil protection law will be applied.

Such a particular episode would be for example:

- Extremely reduced bottom outlet
- Land slide or dam slide
- Water outlet at the dam toe
- Considerable increasing of the overtopping of the spillway
- Other emergency situations

The civil protection law indicates that the public authority has to preposition disaster control plans and take adequate measures in case of emergency, e.g. warning of the population or evacuation.

Experiences

The inspection of the retention basins in Styria via civil engineers has proved itself optimally. All constructions are in a proper condition. Since 2008 these system is organized together with the Torrent and Avalanche Control. The sense of responsibility is increased due to the activities of the civil engineers and because of the common annual field inspection. Permanent improvements in the field of the equipment and during the operation of the constructions are also a result of the ongoing inspection activities. In the scope of a research project a radio-controlled alarm system for exposed basins was developed in regard to warning and alerting in case of a flood. The experiences of the civil engineers out from their activities as supervisors expanded into the planning of new retention basins and arise clearly at the new developments and at the technical standard of all plant components.

In June 2007 a study about the experiences of the supervisors was conducted at the Institute of Hydraulic Engineering and Water Resources Management of Graz University of Technology. Thereby 74 basins have been investigated [3].

These are the main results:

- 58 basin have been ponded (details see Figure 6)
- Out of 50 basins in average every 18 months a basin has been ponded
- Only two spillways were in use until the study
- 46% of all basins have a rack, with have proved themselves
- 58% of all basins have a interrupted bed-load discharge

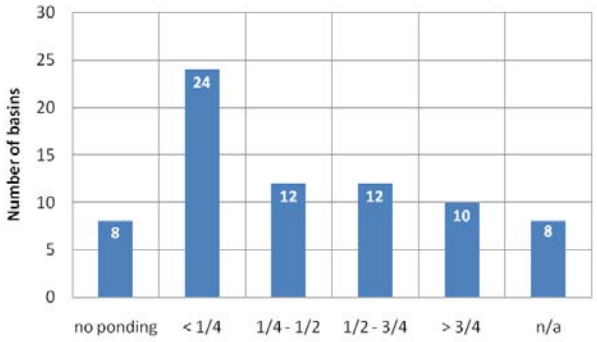

Figure 6: Height of ponding of the basins

Example Retention Basin Labuch

Due to flood events in the 1990s and in the year 2002, which inundated the borough Urscha in the municipality Labuch, a flood retention basin was constructed in the year 2008. All experiences in planning and operation of the past 40 years have been integrated into the construction of this basin. Table 2 shows the key information about the retention basin.

TABLE 2: RETENTION BASIN LABUCH

Name	Labuch
Construction method	Earth-fill damm and concrete wall
Barrage height	12.3 m
Crest length	130 m
Crest width	2.5 m
Cubic capacity HQn	130,000 m³
Design flood	100 years

The Labuchbach has got a catchment area of 4.3 km², which leads to a discharge of 20m³/s for a 100-year flood. This will be reduced due to basin to a maximum of 3.7m³/s. The bottom outlet is furnished with a hydraulic regulated, float lever controlled steel gate. The retention basin was built as reinforced concrete angular retaining wall with sideways dam filling. This construction type is currently the least possible intervention for the aquatic wildlife.

Figure 7: Retention Basin Labuch

The main focuses in addition to the flood protection are the consideration of the ecology, to preserve the appearance of the landscape plus the implementation of cultural aspects of the region. [11]

- At the line of the 10-years flood two "L" are situated which are symbols for a gate to the region Hügelland östlich von Graz"
- These two "L" show also the holy Nepomuk, who is the patron saint against floods and flood marks
- At the line of the 100-year flood scattered fruit trees are planted.
- In the area between the lines of the 30-year and the 100-year flood a 2,100m² huge strip with wild herbs grows.
- With the word "Gedächtnis – memory" people should remember the past flood events
- For using the retention basin as recreation area several rafts are situated in the middle of the basin which should serve as picnic areas, benches or tables
- Stones next to the stream allow people to jump over the stream and to discover the basin from different views.

Database

Already at an early stage the need for a documentation of all built flood retention basins was identified. This led to the publication of two books entitled "Flood retention basins in Styria, Vol. I and Vol. II" in the years 1992 and 1994. All basins are described in detail including pictures and all relevant plans. This work was carried out by the Institute of Hydraulic Engineering and Water Recourses Management of Graz University of Technology.

Figure 8: Publications about retention basins in Styria

This collection of knowledge will now be updated from the same institution. All data about the basins which are built since 1994 will be surveyed and the current status of all basins will be documented with photographs. Instead of publishing another print media, a multimedia-based approach will be used to provide the so far as well as the new gathered information to the public. This data will be integrated in the Geographical Information System of the Styrian Government. Currently the location of the retention basins, the actual status and the construction type could be queried (see Figure 9).

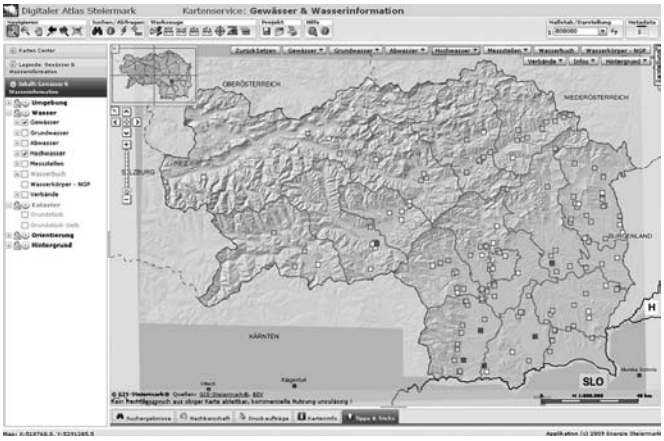

Figure 9: GI-System

The following information will be available after the end of the project:

- General data (e.g. location, responsibilities)
- Hydrological data (e.g. catchment area, design flood)
- Bottom outlet data (e.g. length, slope)
- Barrage data (e.g. type, height)
- Spillway data (e.g. type, flood discharge)
- Groundswell (e.g. area)
- Rake (e.g. position)
- Actual pictures of all relevant plant components
- All relevant plans

This way of presentation, in comparison to the print media, has got the advantage that a bigger group of people could get easily access to the information. You can distinguish between three different types of users.

1. **Population**
   They can inform themselves about the measures of flood protection in Styria and maybe discover protection constructions in their vicinity.

2. **Public authorities and action force**
   The public authorities and action forces should, of course, know all the details about the retention basin in question. But it could be a very useful tool for getting quick information about their supervised basin, if necessary.

3. **Students, interested experts from abroad**
   During their education students of certain branches of studies need information about flood retention basins. This is a perfect way to give them an insight into this topic. Further interested experts from abroad could also use this tool and benefit from the experiences in Styria.

Summary

In this paper the experiences of 40 years flood retention basins in Styria are presented. This includes the identification of the need of water retention in the 1980s as well as the current number of about 100 retention basins and the changing construction designs in the course of time. Further the inspection and warning system with a caretaker and a supervisor, as an essential part of the functional capability of the flood protection, is explained in detail. The integration of the ecological, landscape and cultural requirements nowadays are shown in the example of the retention basin Labuchbach. In the future a GIS-based web-service, which is now conducted, will provide all key facts about the retention basins in Styria and will guarantee a fast and easy accessibility.

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