Small Rivers in Germany – Potentialities and Limits of Ecological Improvements by the EU-Water Frame Directive under the Influence of Extreme Floods

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Abstract

The ecological situation of rivers in Europe shall be controlled and improved by the European Water Framework Directive. This is shown on the example of small mountain rivers in Saxonia in Germany. After an extreme flood, which occurred in the rivers of Saxonia in august 2002, the flood protection works in the region were renewed and enlarged. This is in conflict with the ecological improvements which are achieved by increasing the residual flow in the mother bed of the river near the water power stations, where the target is to restore native fish population. The rivers are protected as Flora Fauna Habitats. So the best solution for both nature and infrastructure is to be installed. Looking for best solutions the hydraulic and biological parameters were collected and habitat modelling was used with this data. In this way potentialities of ecological improvement and limits of mitigation in conflict situations for small mountain rivers in Germany may be shown.

Keywords
European Water Framework Directive, fish habitat restoration, flood protection, residual flow, water power

1. INTRODUCTION

The human use of big streams or small rivers is always a nature relevant problem – not only in Germany. All over the world most of the rivers are heavily antropogenic modified. The steady growing public environmental awareness works against this. In this way in Europe the European Water Framework Directive (WFD) /6/ was lanced already in December 2000. With this new European water policy the „good ecological status“ in all surface waters and groundwater should be achieved until 2015 in all countries of the European Union. There are a number of objectives to protect the water quality. Here the key ones are general protection of aquatic ecology and specific protection of unique habitats.

All users of European water resources are now wanted to protect or achieve the “good ecological status”. For the use of water in water power stations for example there will be further exemptions. They will have to obey the aims of the WFD. Therefore, in case of diversion power plants, it is to be expected that the water abstraction for power generation will be reduced. Especially in case of small plants the economic benefit has to be balanced thoroughly to ecological impact.

A further aspect of use, affecting all inhabitants near a river, is the land use and the flood protection. Flood protection may be ensured in many ways. By sustainable flood protection impacts may be avoided in order to achieve the “good ecological status” of the water body. By technical means, like dams or embankments, flood protection does not always work in the sense of ecology. This may be the source of a new conflict if we don’t manage to obey all state of the art demands. Uniting flood protection and water abstraction may be a difficult task if you have to obey ecological claims and if the new WFD gives no specific goals in this special topic.

That is why an example will be shown, where the two problems, water abstraction for water power and flood protection had to be solved. The licence for water abstraction from river Blackwater in Saxonia, Germany, for the use for electric energy production had to be renewed and authorized in the year 2000 because of many reasons like growing environmental awareness, alternations in the water laws because of the joining of the former German Democratic Republic and the already described alternations coming with the new European water directive. Shortly after this an extreme flood occurred in the year 2002. This caused significant changes in the geometry of the river bed. And the following technical reconstruction again altered the face of the river. After all these changes in river morphology the licence for water abstraction had to be renewed again.

This gives us the chance to compare the ecological and technical demands by the aspects of ecology, which means here mainly fish biology, water power and flood protection. The over all question is how to combine generally the technical use of a water body with the requirements of environmental and nature protection.

2. INFLUENCES OF WATER ABSTRACTION ON THE ECOLOGICAL QUALITY OF A RIVER

There are a lot of possibilities to influence the ecological quality of a river. We have to select and take because of the above described task the use by water power and the aspects of flood protection.

2.1 Ecological minimum flow in the mother river channel after diversion for water power use

Many water power stations are diversion plants. This means the main ecological impact is the abstraction of water from the mother channel of the river. As the ecological context of in-stream flow is very complex we would have to consider too many influences and that is why we confine on fish habitats. Under this restriction we notice the following changes through the water abstraction in the mother channel:

- decrease of water depth, wetted area and aquatic volume
- loss of shelters and pools for fish
- change of flow, velocity, turbulence, drag
- accretion of silt, this means infilling of gravel pores with fine material
- rise of water temperature in summer, freezing to ground in winter
- decrease of dissolved oxygen concentration
- changes in the natural variety of species
- lower ground water level
- loss of in-stream and riparian vegetation

All these changes have negative impact on the amount and diversity of species, whereby the rare and protected ones will diminish. Dry or low flow river beds are bad for migration of fish and macroinvertebrates. Sufficient residual flow has to be fixed. The over all aim is to find the minimum flow which will just compensate the above shown negative impacts.

Besides these ecological regards the economic interests of water power stakeholders have to be taken into account. Additionally Small Hydro in Germany is public sponsored as green energy production.

And we have to ensure flood protection in intensively populated river valleys.

2.2 Flood protection under the aspect of ecological minimum flow

The ecological minimum flow is related to the general low water situation. The lowest flow, which is considered to be ecologically sufficient to produce the "good ecological status" according to the European WFD shall be installed. In these low flow considerations the natural morphology of the river with multiple bed structures and high relative roughness is desired.

But in case of flood these bed structures reduce flow capacity. On the contrary now smooth and uniquely rectified channels are wanted. In our example, the river Blackwater, the run off of the extreme flood caused severe erosions of the river bed. This was followed by additionally enlarging the flow capacity by dredging measures after the flood.

3. INVESTIGATIONS TO DETERMINE THE ECOLOGICAL MINIMUM FLOW

As we have the data from the former investigations /5/ before the flood, it is possible to compare the habitat quality before and after the changes of the river bed.

3.1 Structural classification of the river bed morphology

Fig. 1: River bed morphology in the year 2000 (left) and the same reach in 2003 (right)

In the beginning of the work a structural classification /2/ of the river bed morphology is helpful. Parameters of the bed structure, pools or riffles, composition of the bed, boulders, gravel or silt, are collected.

3.2 Determination of the minimum flow by the method of the federal water association

For the determination of the ecological minimum flow worldwide many methods may be found. In Saxonia the method of the Federal Water Association LAWA /3/ has to be applied by law. This procedure may be characterized by field sampling of water depth and velocity. If the likewise determined minimum depth and velocity does not produce sufficient habitat quality the maximum residual flow will be confined by the mean minimum low water flow.

3.2.2 Determination of the ecological minimum flow by habitat modelling

With the additional application of habitat modelling we want to control the results of the above described LAWA method for the ecological minimum flow. For habitat modelling we took the model CASIMIR /1/. For this purpose all the characteristics of the river that shall be used for the modelling have to be collected. These are mainly:

- river geometry, cross sections, length profile
- water depth, near bed flow velocity
- pool riffle sequences, pool types
- substrate, pores and permeability of gravel
- shelters
- shading
- bank features e.g. rip rap.

4. RESULTS – COMPARISON OF THE EXAMINATIONS OF 2000 AND 2003

The comparison of the examinations of the year 2000, this was before the flood and the reconstruction works for flood protection, and the examinations of 2003, after this event, show the following differences:

4.1 Wetted area and aquatic volume

A change of flow did effect the wetted area and aquatic volume more than now after the reconstruction of the river bed. When the flow was raised from 0.1 to 0.36 m^3/s the wetted area went up for 55% and the aquatic volume for 118%. With the new geometry there remains only an increase of 14% for the same increase of flow (Fig. 2). This means that the structures in the examined reach were in 2003 as monotone that an increase in flow makes only minimal improvement in habitat quality.

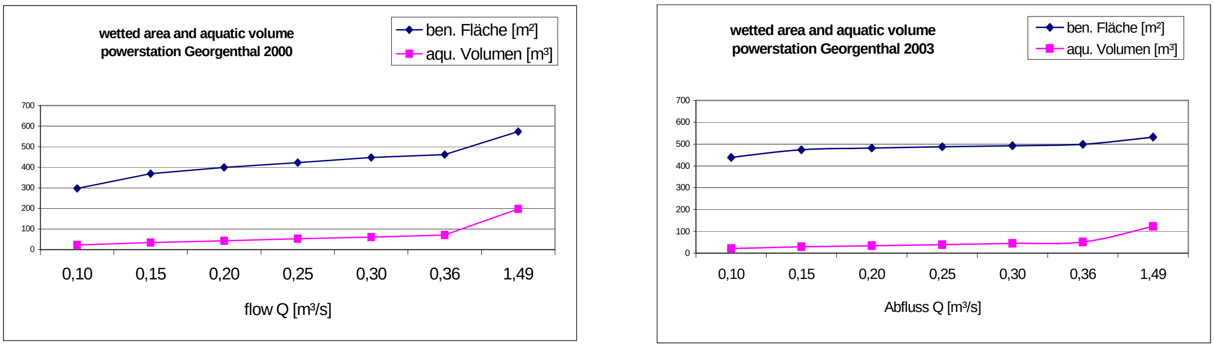

Fig 2 Comparison of wetted area and aquatic volume

4.2 Water depth

The investigations in the year 2003 proved for the same flows an inferior distribution of water depth. They show only depths of 0.2m compared with the former stage showing 0.4m. And there is almost no more variance of depth (Fig 3).

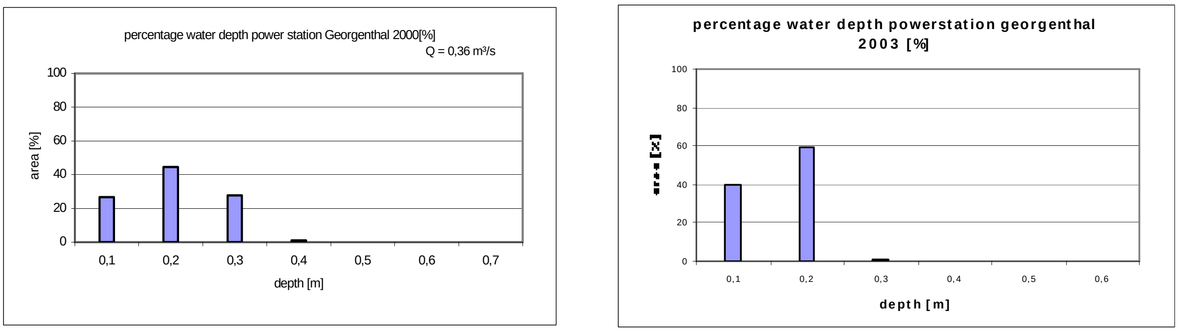

Fig. 3. Comparison of water depth

4.3 Flow velocity

The same impression followed for the comparison of flow velocities (Fig 4).

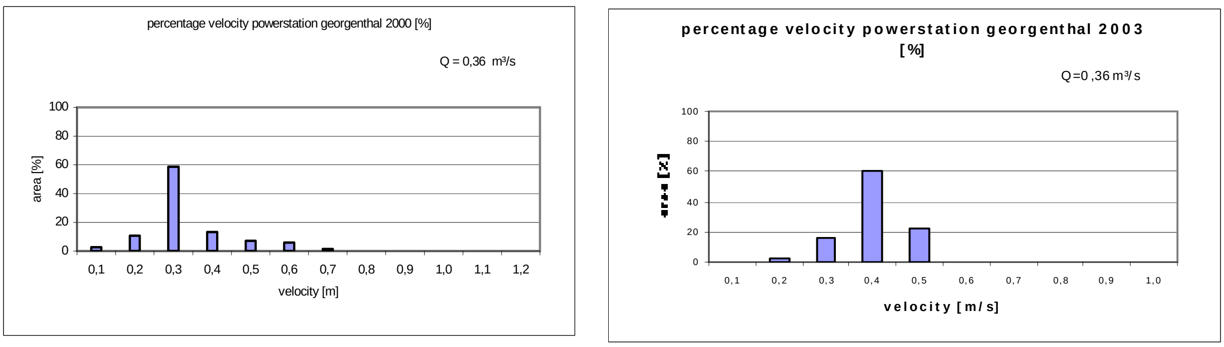

Fig. 4 Comparison of flow velocity

4.4 Habitat suitability

For the comparison of habitat suitability the preferences of the upper trout region were used, as the reach of the river Blackwater is in this region. As result of habitat modelling with CASIMIR, module SORAS (structure oriented river analysing system) /4/ the hydraulic habitat suitability is shown in Fig 5.

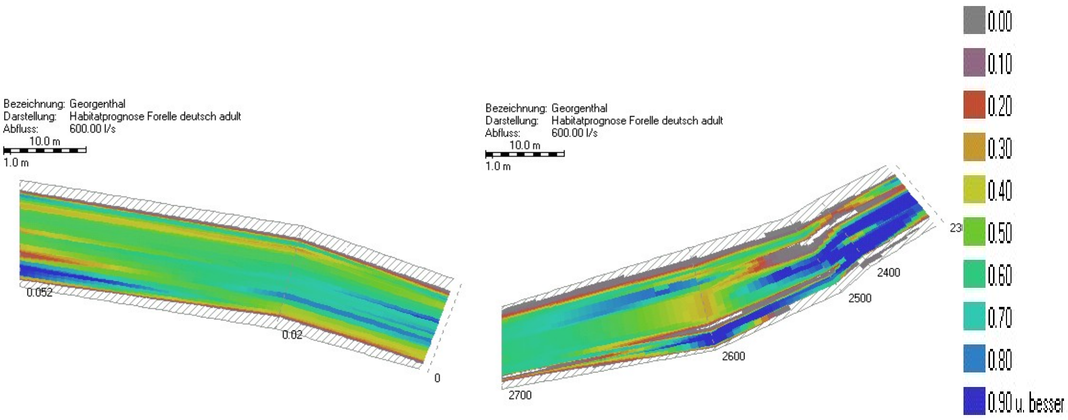

Fig 5 Habitat modelling 2000 compared to 2003 (the figure shows two different reaches)

5. CONCLUSIONS

With this comparison before and after the restoration works it may be shown that now a bigger residual flow is required to get the same habitat quality for the trout. This is of course not in the interest of the Water power stakeholders and it is standing against the sponsoring of green energy production.

Measurements for ecological improvement have to be installed in the uppermost stage of organisation. It is not enough to work with one instrument only, which was the flow in this example.

A technical restauration for flood protection of a reach of a river which is used for water power is a potential conflict situation. Solutions have to include the structural habitat suitability for fish. The European WRL will help in this sense if its recommendations are regarded.

List of References

/1/ GIESECKE J.; JORDE K. (1999): Simulationsmodell zur Beurteilung ökologischer Auswirkungen von Mindestwasserregelungen Teil IV. Abschlussbericht über ein Entwicklungsprojekt, gefördert unter dem Az: 03995 von der Deutschen Bundesstiftung Umwelt. Institut für Wasserbau, Lehrstuhl für Wasserbau und Wasserwirtschaft, Universität Stuttgart.

/2/ LÄNDERARBEITSGEMEINSCHAFT WASSER (LAWA), 2000: Gewässerstrukturgütekartierung in der Bundesrepublik Deutschland. Verfahren für kleine und mittelgroße Fließgewässer – Empfehlung. 1. Aufl., Schwerin. Kulturbuch-Verlag GmbH, Berlin

/3/ LÄNDERARBEITSGEMEINSCHAFT WASSER (LAWA), 2001: Empfehlungen zur Ermittlung von Mindestabflüssen in Ausleitungsstrecken von Wasserkraftanlagen und zur Festsetzung im wasserrechtlichen Vollzug. 1. Aufl., Schwerin. Kulturbuch-Verlag GmbH, Berlin.

/4/ SCHNEIDER, M. (1997): Hydraulisch-morphologische Modellierung mit dem Simulationsmodell CASIMIR: Aquatisches Volumen. Wasserwirtschaft 87, Heft 7-8, S. 372-373

/5/ HACK, H.-P.; KANZOW. U. (2000): Untersuchung zur Mindestwasserfrage am Schwarzwasser Wasserkraftanlagen Georgenthal. Bauhaus-Universität Weimar, Fakultät Bauingenieurwesen, Lehrstuhl für Wasserbau

/6/ Richtlinie 2000/60/EG des Europäischen Parlaments und des Rates vom 23. Oktober 2000 zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft im Bereich der Wasserpolitik (European Water Framework Directive – WFD)

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