Environmental design of regulated rivers- Case Ljungan River Sweden.

Concilier hydroélectricité et préservation de l'habitat du saumon : l'exemple de la rivière Ljungan, Suède.

Morten Stickler[1], Angela Odelberg [2], and Sylvie Guillouët

[1)] Statkraft AS, CR&HSE corporate staff, P.O. 600 Lilleaker, Norway
morten.stickler@statkraft.com

[2)] Statkraft Sverige AB, HSE quality division, Sweden.
Angela.odelberg@statkraft.com

[2)] Statkraft France SAS, Sustainability & HSE, technical division, Lyon, France.
sylvie.guillouet@statkraft.com

RÉSUMÉ

La rivière Ljungan est une rivière longue de 399 kilomètres située dans le nord de la Suède, sur laquelle STATKRAFT exploite 5 centrales hydroélectriques. La rivière Ljungan est un important réservoir de biodiversité, accueillant notamment une population unique de saumons. Le projet présenté se concentre sur les 17 derniers kilomètres de la rivière, à l'aval de la centrale de Viforsen. L'objectif de ce projet est de mettre en œuvre la méthodologie développée par le CEDREN, appelée "handbook for environmental design in regulated salmon rivers", ou comment concilier hydroélectricité et préservation de l'habitat du saumon. Le principe de cette méthode est, dans une première étape, de collecter les données relatives aux conditions dans lesquelles évoluent les populations de saumon et d'en faire une cartographie, puis de caractériser le fonctionnement des installations hydroélectriques et les effets liés à leur exploitation, et enfin d'identifier les « conflits » entre les deux. La seconde étape consiste à concevoir des solutions en s'appuyant sur différents outils.

Ce guide permet de trouver des mesures adaptées pour améliorer les conditions à la fois pour le saumon et la production d'énergie.

ABSTRACT

The Ljungan River is a 399 kilometers long stream in the Northern Sweden where STATKRAFT owns and operates 5 power plants. The Ljungan River is home to important biodiversity, including a unique salmon population. The project is focused on the last 17 kilometers of the river, downstream Viforsen plant. The aim is to apply a methodology developed by CEDREN, called "handbook for environmental design in regulated salmon rivers". The principle of this tool is, in a first phase, to collect data and map the environmental conditions in the river for the salmon population, analyze the hydropower system and the regulation effects, and then identify bottlenecks. The second phase is the design of solutions and measures, with some assisting tools.

This handbook gives the potential to find adapted measures to improve conditions for both salmon and power production.

KEYWORDS

Environmental design, regulated rivers, salmon, power production

1. INTRODUCTION

The European Water Framework Directive is a key driver towards the development of hydropower as a renewable and sustainable energy resource through establishing targets for improved environmental conditions in regulated rivers. Thus the Directive also exerts pressure on the industry to develop new cost-effective solutions that optimizes the trade-offs between renewable energy production and local environmental conditions. Recently, the handbook *Environmental Design in Regulated Salmon Rivers* was published (CEDREN, September 2013). Statkraft has been the main industrial contributor for this handbook, and recently applied the methodology on a Swedish regulated stream. The main objective of the application was to test the methodology and on the same time seek for cost-effective solutions to ensure sustainable management of a local and unique population of Atlantic salmon (*Salmo salar* L.).

2. STUDY SITE AND METHODS

The Ljungan River is a regulated river with 14 run-of-river plants. The lowermost hydropower station is Viforsen with an installed capacity of 10 GW producing 79 GWh annually. Ljungan River is a moderate large river with an annual median flow of 138 m^3/s and a median stream with of 40 meters. The stream is pool dominated with riffles and rapids signifying a variable aquatic environment (Figure 1).

Statkraft and Viforsen hydropower plant has today an increased pressure from the authorities and local NGO's concerning management of a local and genetic unique population of Atlantic salmon requiring target Good Ecological Status considering the EU Water Frame Directive. Unfortunately, in 2013 a rapid decrease in water flow occurred, leading to discussions and uncertainties whether the single event had an impact on the Atlantic salmon or not, and whether such events had been multiple. As a step forward the principle and method of the adaptive management approach was integrated as a basis for further work in Ljungan River downstream of Viforsen power plant. The work was designed as an R&D project in a multidisciplinary manner and collaboration between national authorities, county officer, local and national NGO's and research institutes. As a tool and basis for the research work the recent handbook *Environmental Design in Regulated Salmon Rivers* (CEDREN, 2013) was implemented. The handbook contains of two major steps; i) Diagnosis, and ii) Design solutions. With the objective of mapping potential bottlenecks for salmon the first part of the handbook was applied focusing on D1: Mapping of river type, substrate and cover; D2: Hydrological alteration analysis (see Figure 2 for an example of result); and D3: Mapping of spawning habitats; and D4: Water temperature analysis.

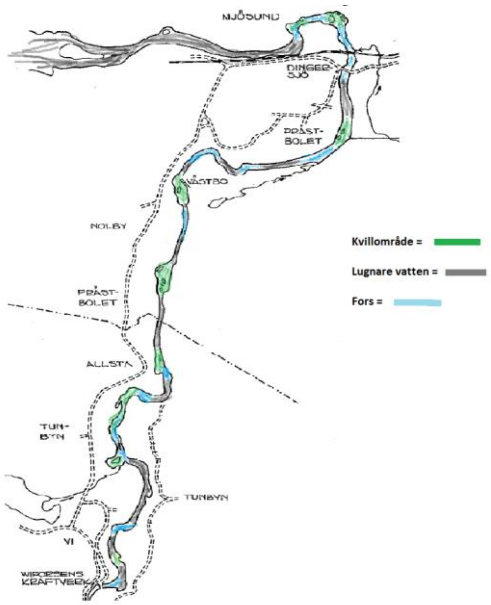

Figure 1: Map of Ljungan River downstream of Viforsen hydropower plant demonstrating distribution of pools (green colour); glides (grey colour) and rapids (blue colour).

3. RESULTS AND CONCLUSION

The approach combining adaptive management and recent methodologies in structured mapping of potential bottlenecks, the handbook, gave valuable insights both with respect to research results, and communication and collaboration with different interest parties. Such an approach is essential and a key to reach optimized trade-offs between renewable energy production and local environmental conditions that are accepted by various stakeholders. Results and experiences from the given work will be discussed and presented.

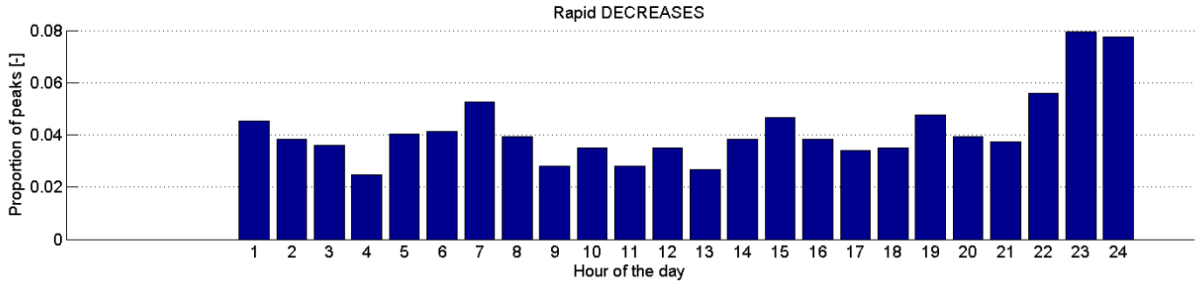

Figure 2: Proportions of rapid decreases in River Ljungan distributed throughout a 24 hour cycle (daily decreases) for the period 1994-2014 using the COSH tool for hydrological alteration analysis.