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Rhône River Challenges: Local Dam Drainage, Global Impact

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Abstract This article undertakes a critical examination of the Verbois Dam's flush-drains on the Rhone River, assessing the feasibility, desirability, and rationale behind their potential removal as a key strategy for sustainable development. The study delves deeply into the long-term environmental, social, and economic repercussions associated with modifying sediment management practices. Originating from the discussions held at the 2006 Rhone Congress in Geneva, the research provides a comprehensive analysis of the historical, technical, and human dimensions of this complex local issue. It emphasizes the necessity of strengthening Franco-Swiss cross-border cooperation and argues for the expansion of the 'Rhone Plan, a sustainable development initiative' beyond its French inception. The proposed extension aims to cover the entire span of the Rhone River, from Gletsch in Switzerland to its Mediterranean terminus, thereby fostering a more holistic and sustainable approach to river management.

Index Terms dam, sediment management, flush-drain, sustainable development, trans-border cooperation.

I. Introduction

The genesis of this inquiry lies in the persistent concerns voiced by fishing companies in the canton of Geneva, perturbed for years by the ecological impacts accompanying each flushing and emptying of the Verbois dam. The Rhône Congress, convened through the initiative of the Industrial Services of Geneva (SIG), responsible for dam operations in collaboration with the canton of Geneva's administrative services, seeks to assess the viability of the current sedimentary mode of operation and explore alternative solutions.

The fundamental questions arise: Is it feasible, desirable, or prudent to discontinue—or space out—the drain flushes of the Verbois dam? What challenges emerge in the realm of sustainable development? Specifically, what are the environmental and socio-economic implications tied to the decision to halt or continue Verbois flushing? Additionally, how should one approach the analysis of this issue from a sustainable development perspective? Which domains and spatio-temporal scales must be considered to ensure a comprehensive understanding?

These pivotal queries formed the core of discussions during the Rhône Congress held in Geneva on June 15 and 16, 2006. The event aimed to provide insights that could guide decision-makers in their future choices, establishing a shared knowledge platform and fostering exchanges related to the Rhône River. It sought to evaluate the river's current state, raise awareness among stakeholders about contemporary issues, and communicate reflections on sediment management and the potential operational shift in the Verbois dam's sediment management (including the cessation of flushing). Over two

days, the congress brought together approximately 250 Swiss and French water stakeholders, including politicians, managers, scientists, and representatives from the fishing community and nature and environmental protection groups.

II. Historical Background

The Verbois dam, constructed and operational since 1942, is a significant component of the extensive infrastructure developed along the Rhône River. The initial structures, dating back to the mid-19th century, aimed at safeguarding riverside residents from flooding and fostering agricultural growth by reclaiming arable land. Subsequent developments focused on generating electrical energy, facilitating navigation, and promoting tourism, transforming the Rhône into one of Europe's most harnessed rivers.

In the Swiss basin, the first major Rhône redirection occurred from 1860 to 1890, alleviating living conditions in the Valais valley through ambitious projects. Over thirty reservoirs and numerous dikes have since been established, shaping the Valais Rhône into a highly altered river with a disrupted hydrological regime.

Downstream from Lake Geneva to the Mediterranean mouth, extensive infrastructure, including 12 dams, 14 locks, and 19 hydroelectric power stations, has been erected. These developments, illustrated in Figure 1 [1], have significantly impacted natural river processes, deviating from the conditions described by naturalist Robert Hainard in 1979.

These transformations have led to profound consequences on the watercourse's eco-morphology, hydrology, and biology.



Figure 1: Meeting of the Rhône (left) and the Arve in Geneva.

Canalization, bank elevation, riprap installation, and various engineering structures have disrupted natural river processes, altered flood flow and sediment transport, and constrained the river's evolution. The once characteristic braiding has transformed into a singular, linear, deep, and slightly sinuous channel.

Complex interactions occur as human-induced alterations combine with changes in land use and landscapes in the watershed, affecting water and sediment circulation. River engineering works often prompt swift modifications to the immediate environment, narrowing the channel and expanding riparian forests. This, in turn, accelerates dynamic flows, leading to the removal of mobile benches. Impacts vary depending on local morphology, with bank fixation negatively affecting ecotonal zones and the disappearance of wandering river areas.

These alterations contribute to the rise of river margins, comprising îlons, Girardon traps, wooded islands, and flood-prone zones, impacting biological diversity. The intricate interplay between engineering interventions and natural processes underscores the need for a comprehensive understanding when addressing the challenges posed by the Verbois dam and similar developments along the Rhône River.

III. A Complex Local Challenge with Diverse Dimensions

Deciding whether to abandon the drain flushes of the Verbois dam is a nuanced task, given the multitude and diversity of factors at play. While the concerns of fishermen about water quality and fish fauna are vital, they represent just one facet of the broader considerations.

In the realm of scientific understanding, various fundamental concepts must be grasped to comprehend the structural and functional dynamics of the river, as well as the repercussions of human interventions:

- The hydrosystem concept [2] underscores the importance of carrying capacity between different compartments, emphasizing the four-dimensional structure of the system (longitudinal, transverse, vertical, and temporal dimensions).
- The River Continuum Concept [3] introduces the notion of an upstream-downstream gradient in lotic ecosystems.
- The Flood Pulse Concept [4] integrates lateral connections with the floodplain.

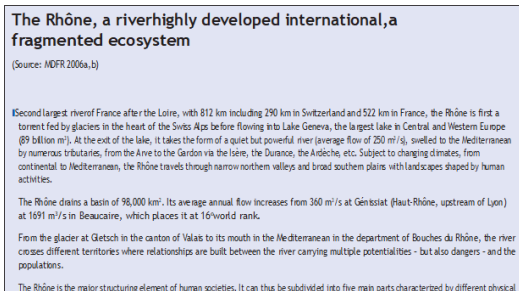


Figure 2: Rhone Rive: A fragmented Eco system

- The Hyporheic Corridor Concept [5] underscores the significance of vertical exchanges.

The transport of solids in rivers and sediment management involves a complex interplay of factors, encompassing geomorphological dynamics, water quality, and ecosystem considerations.

Resolving this issue necessitates a multi-criteria, multi-scale approach, factoring in the specific speeds of hydrological, sedimentary, and biological processes operating across diverse spatio-temporal scales.

Moreover, the problem extends to various socio-economic considerations across different spatial scales, including sediment flows, flood prevention, hydro-energy production, electrical development, navigation enhancements, and the fostering of cultural (heritage, Rhône festivals) and social (leisure, tourism) practices [6].(Figure 2)

It becomes evident that adopting a sustainable development approach, acknowledging the interdependence of environmental, social, and economic aspects, is imperative for addressing this intricate challenge.

IV. Collaborative Solutions: Cross-Border Consultation for Shared Interests

The sediment management challenge at the Verbois dam necessitates a holistic approach, extending beyond the local context to encompass the entire hydrosystem formed by the Rhône and its tributaries from its source in Valais to the Mediterranean. Recognizing that sediment issues are intricately connected upstream, involving contributions from the Arve, and downstream, with alterations in sediment flow, the focus expands beyond the Verbois dam and the Rhône on Swiss territory.

Decisions made regarding sediment management in Geneva can exert direct and indirect impacts on downstream reservoirs [7] and even extend to regions as far-reaching as the Camargue and the mouth of the river in the Mediterranean. Therefore, fostering cross-border collaboration becomes imperative, adopting a shared vision of the Rhône as a common good and safeguarding the interests of all stakeholders on both sides of the border, both upstream and downstream.

V. Conclusion: Toward Integrated and Sustainable Rhône River Management

Over the decades, the approach to the Rhône has evolved from a reactive stance, primarily focused on risk control and protection against the river's force, to a proactive strategy supporting hydroelectric production, navigation, and, more recently, tourism. Recent shifts highlight a growing emphasis on rectifying past errors and preserving the river for sustainable development.

The perspective of sustainable development encompasses various dimensions, including the water and ecological qualities of the ecosystem, landscapes, economic activities, and leisure practices. This holistic view ensures that environmental considerations are not limited to risk management but extend to promoting water quality, enhancing ecosystems and landscapes, and creating opportunities for socio-economic development that enhance the quality of life for local populations and foster high-quality tourism [8].

In light of evolving insights into river structure and functionality, our historical intent to domesticate the Rhône for flood control has proven excessive. Unintended consequences have surfaced, resulting from the resolution of specific problems with spatial and temporal ramifications.

An evaluation of past and present actions, aimed at harnessing the Rhône's potential and managing constraints like floods, reveals that a highly sectoral approach—viewing the river merely as a watercourse rather than an ecosystem—can generate difficulties affecting other sectors both laterally and upstream and downstream.

Fortuitously, since the 1960s, several dedicated programs have emerged to preserve the ecological functions of the Rhône and its tributaries. Initiatives such as the creation of the International Commission for the Protection of the Waters of Lake Geneva (CIPEL), the Rhône Action Plan, and various restoration programs underscore a growing commitment to ecological sustainability.

This proliferation of initiatives calls for evaluation, consolidation, reinforcement, and expansion into a cohesive strategy for the sustainable development of the river and its tributaries.

In response to the intricate system, diverse community needs, and territorial issues tied to the Rhône, French stakeholders are actively pursuing coherence through the development and implementation of a comprehensive project. This project aims to optimize the territory's potential, manage inherent constraints effectively, and preserve its environmental integrity [9].

The "Rhône Plan, a sustainable development project," was conceived to safeguard the environmental richness and the living environment of the Rhône's inhabitants. This initiative, organized in reflection by water stakeholders, focuses on the French stretch of the river. Its primary goals include flood prevention, responding to events in 2003 and 2005, and advocating for the restoration, protection, and social reappropriation of natural environments along the river, fostering activities such as leisure and tourism.

The program embraces the philosophy of "Living with" rather than "living alongside," encapsulating the broader movement initiated by associations in the 1970s and currently advanced by local authorities. In the Swiss part of the watershed, consultations occur among public actors through the CIPEL and the Franco-Geneva Regional Committee (CRFG). Extending the "Rhône Plan" to encompass the entire basin, from its source to its mouth, would be a desirable extension of the French Rhône Plan for integrated and global management.

The current politically-administrative approach with fixed geometry in Rhône management needs to evolve toward a functional type management with variable geometry. This shift, highlighted in the Rhône Congress, underscores the importance of considering the consequences of choices made in the medium and long term, integrating the impacts of global warming through a sustainable development approach.

The proposal for a "Franco-Swiss Rhône Plan" seeks to provide a comprehensive vision of the river, fostering coordination among initiatives related to flooding, water quality, energy, transport, and tourism. This collaborative approach aims to ensure coherence, synergy, and accelerate the achievement of objectives in this crucial territory for both countries and their residents. The Industrial Services of Geneva, in collaboration with the administration services of the canton of Geneva, is actively contributing to the implementation of a similar approach.

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