Setting up a sediment monitoring system from a socio-ecological perspective for the adaptive governance of the Usumacinta watershed in Mexico.

Mise en place d'un système de suivi des sédiments avec une perspective socio-écologique pour la gouvernance adaptative du bassin versant de l'Usumacinta, Mexique.

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RÉSUMÉ

Le fleuve Usumacinta coule librement sur plus de 1 000 km, prenant sa source dans les montagnes guatémaltèques et se jetant dans le Golfe du Mexique. A travers l'Observatoire des sédiments de l'Usumacinta, issu du projet interdisciplinaire franco-mexicain Val-Uses (CONACYT-ANR), nous avons défini un système de suivi des sédiments dans le bassin du fleuve Usumacinta, au Mexique. Nous avons utilisé une approximation socio-écologique du concept de co-production des services et dis-services écosystémiques liés aux sédiments. A partir de ce cadre conceptuel, nous avons sollicité un groupe d'experts scientifiques et développé un système d'indicateurs sur l'état du système écologique et social, les services et dis-services écosystémiques liés aux sédiments, et les actions humaines qui les coproduisent. Nous partageons les premiers résultats concernant les défis et les opportunités de mise en œuvre de ce système dans une région spécifique du bassin : le système de la lagune de Catazajá qui est actuellement confronté à une forte accumulation de sédiments. Nous soulignons que les dynamiques sédimentaires altérées qui affectent la pêche, le tourisme, les habitats et le bien-être humain devraient être des indicateurs fondamentaux de l'intégrité socio-écologique, mais aussi que des systèmes adaptatifs, intégrés et participatifs devraient diriger leurs trajectoires.

ABSTRACT

The Usumacinta River flows freely for more than 1,000 km, originating in the Guatemalan mountains and draining into the Gulf of Mexico. Through the Usumacinta Sediment Observatory, initiated by the French-Mexican interdisciplinary project Val-Uses (CONACYT-ANR), we defined a sediment monitoring system in the Usumacinta basin, Mexico. We adopted a socio-ecological approximation by applying the concept of co-production of ecosystem services and dis-services related to sediments. Within this framework and through expert advice, we set up a system of indicators on the state of the ecological and social system, the ecosystem services and disservices associated with sediments and the human actions that co-produce them. We share the first insights regarding the challenges and opportunities to implement this system within a specific region of the basin, Catazajá lagoon system that is currently facing problematic sediment accumulation. We highlight that altered sediment dynamics which affect fisheries, tourism, habitats and human wellbeing should be elemental indicators of socio-ecological integrity and that adaptive, integrated and participatory systems should govern their trajectories.

KEYWORDS

co-production, ecosystem services, human-nature relationship, interdisciplinary research, sustainability sciences

1 THE NEED FOR MONITORING SEDIMENTS IN USUMCINTA

The Usumacinta basin encompasses a significant portion of the Guatemalan highlands and the Mexican Lacandon jungle, which correspond to the upper basin. The middle basin includes a substantial portion of the Petén and Chiapas jungle. Finally, a portion of the Tabasco floodplains and the Laguna de Términos in Campeche constitute the lower basin. Through these lands flows one of the last free rivers in the world, yet in addition to water, tons of sediments flow, creating habitat for flora and fauna, providing nutrients for ecosystems and agriculture, and raw material for the construction of infrastructure. Civilizations have flourished thanks to sediments, but human action, in turn, has transformed ecosystems' state and functions that sustain life itself.

In the face of growing uncertainty linked to global environmental changes, as well as increasingly interconnected and interdependent systems, it is urgent to question how we govern social-ecological systems. Although there is an increasing production of data and information, it is generally not integrated into initiatives that favor the adaptive governance of socio-ecosystems. We face a growing dispersion of data, with sometimes unknown origins and qualities, which prevents effective decision making for planning, management and evaluation regarding conservation and sustainable management. In response, socio-environmental observatories emerge as collaborative spaces for the integration of information, disciplines and capacities to enlighten the governance of resilient and adaptable socio-environmental systems. One of the purposes of socio-environmental observatories is to understand system dynamics through socio-ecosystem monitoring.

The Sediment Observatory of the Usumacinta Basin in Mexico is one of the results of the Val-Uses project (ANR-CONACYT 2018-2022) and was grounded on the French experience from the sediment and human-environment observatories in the Rhone Valley. An interest in designing a monitoring system from a socio-environmental approach prevailed in Val-Uses. To define such a system, we sought to understand the role of sediments within society and nature interactions (more details in section 2). One way to address the latter was by recognizing that there are ecosystem processes and functions that can either harm or benefit society (more details in section 3).

2 ITERATIVE INTERDISCIPLINARY PROCESS

Based on the experience of the Rhone observatories, we integrated to the observatory a scientific committee composed of 25 specialists from complementary disciplines (from materials engineers, ecologists and hydrologists to archaeologists, political scientists and geographers). Through workshops, working teams, interviews, field work and an extensive review of academic and grey literature, we revolved around 3 fundamental questions: 1) What information is available for understanding and monitoring sediment dynamics? 2) What is the role of sediments in the socio-ecological system? And 3) who should we seek for advice and collaborate with to design and implement the monitoring system? Attention to these questions allowed us to gain cumulative understanding in an iterative process. For instance, understanding the existence or the gaps of information led us to identify key experts to seek advice from, reveal new information and knowledge, and participate in investigating the role of sediments within socio-ecological systems.

3 FRAMEWORK FOR SOCIAL-ECOLOGICAL SEDIMENT MONITORING

Our conceptual framework is rooted in the idea that ecosystem services and disservices serve as bridging concepts for the study of nature-society interactions (Pahl Wostl 2015; Vaz et al. 2017). Ecosystem services are the benefits we receive from nature, but more specifically the functions and processes perceived as beneficial to society; while those that are perceived as harmful or problematic to society are known as "dis-services" (Blanco et al. 2019). Based on knowledge, values, and preferences, people make decisions about natural resources. Whether decisions target at extracting, conserving, or restoring, these human responses impact the ability of ecosystems to sustain their functions. To operationalize this idea, we applied the DPSIR model (driver, pressure, state, impact and response) adapted by Nassl and Löffler (2017) who "closed the cycle of service provision and societal feedback" by integrating the ecosystem services cascade to their model. We further incorporated the concept of ecosystem dis-service, as well as an explicit mention of the concept of the co-production of ES (Palmo et al., 2017), which establishes the need to recognize that ES (and DSE) are often catalyzed or altered by human action.

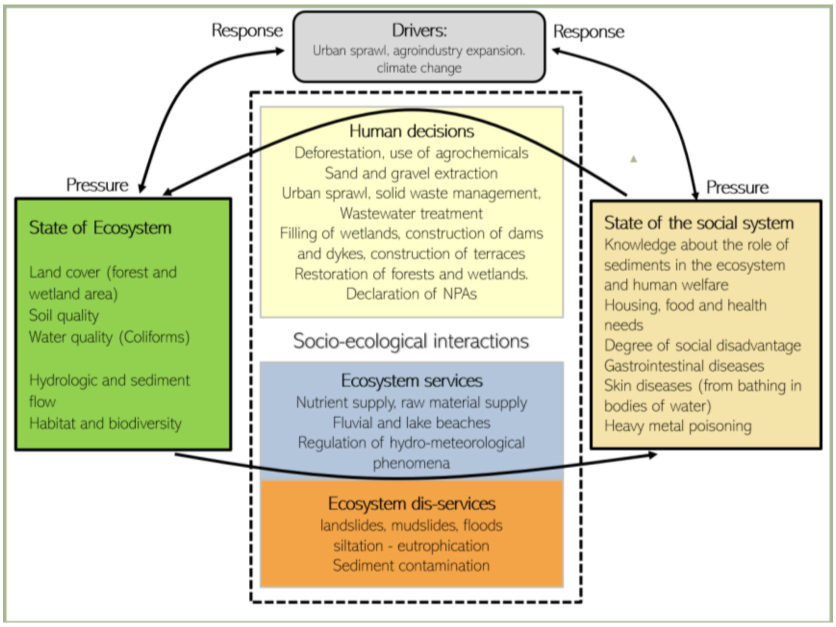

Figure 1. Framework for socioecological sediment monitoring system. Adapted from Nassl and Löffler (2015); Vaz et al (2017)

Although river sediments do not directly provide ecosystem services, they are associated with ecological processes and functions that are critical for the integrity, viability and sustainability of ecosystems and human well-being (green and light orange boxes in figure 1). For example, sediment accumulation contributes to habitat foundation, as well as to the formation of beaches for recreation (light blue box in figure 1). However, sediments can also transport contaminants like persistent organic pollutants, heavy metals or polycyclic aromatic hydrocarbons. This constitutes ecosystem dis-services (orange box in figure 1). Human decisions and public policies (yellow box in figure 1), whether oriented to the extraction and use, or conservation and restoration, affect the flow of ecosystem services and disservices associated with sediments. In other words, they contribute to the co-production of ecosystem services and dis-services.

4 FINAL REMARKS

During the last 4 years the research team has made a major effort to integrate concepts and knowledge from various disciplines to better understand the role of sediments in watershed processes. The design of the monitoring system is the process and the unfinished result of these interdisciplinary exchanges. Moreover, despite the operational challenges imposed by the pandemic, we sought ways to integrate the participation of governmental and local stakeholders, with the additional adversity that sediments are not on the political and environmental agenda of the country. However, we saw the potential for collaboration in a lagoon system within the watershed. The Catazajá lagoon system is facing a latent crisis due to sediment accumulation resulting from the damming of the lagoon, which affects fishing productivity, scenic beauty and socio-environmental health. These problems and the local sense of urgency to do something, represent a possible window of opportunity to move towards adaptive forms of governance where collaborations between academia, government and society are integrated for the implementation of the socio-environmental sediment monitoring system.

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