

Mass fish mortality events: a
(novel?) threat to hydropower in
tropical systems.

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The 2nd International Conference on

Sustainability in Hydropower 2023

-Ecological mitigation, best practises and governance

Steady growth of fish mortality events reported globally

Judge's order revives movement to remove Snake River dams

By NICHOLAS K. GERANIOS Associated Press Nov 6, 2016

According to the Army Corps of Engineers, more than 90 percent of the river's young fish survive passage through each dam's fish ladders. But the total effect from dams and slackwater reservoirs adds up to mortality rates of 50 percent or more for Idaho-spawned fish as they migrate to the ocean. The fish then have to survive several years in the ocean before running the gauntlet of dams again when they return to the Northwest to spawn.

Clarify the knot of 4 tons of dead fish at the end of the Chao Phraya Dam caused by lack of oxygen Lean non-toxic in water



Usina é multada em R\$ 36 milhões por mortandade de 7 toneladas de peixe em MT

A infração foi calculada aplicando sanção de R\$ 6 milhões por operar em desacordo com a licença e mais R\$ 6 milhões por não adotar medidas de precaução.

COLOMBIA | BOGOTÁ | MEDELLÍN | CALI | BARRANQUILLA | SANTANDER | BOYACÁ | LLANO | MÁS CIUDADES



Investigan muerte de peces en el embalse Porce II en Antioquia

Usina hidrelétrica é multada em R\$ 50 milhões por causar morte de 13 toneladas de peixes em MT

Relatório da perícia apontou lançamento de sedimentos na água do rio durante abertura de comporta, segundo o governo. A empresa responsável alegou que tomou todas as medidas para amenizar a situação.

Medio Ambiente

Tragedia ecológica en el embalse de Betania por la inesperada muerte de 1.000 toneladas de peces

Por: Textos y fotos Diario del Huila

Tras 70 días continuos de verano, hubo una caída, a mínimos históricos, de los niveles del agua del embalse. Además, se presentó un ingreso inesperado de tierra y lodo generado por la erupción del volcán Nevado del Huila. Esto provocó una inmensa pérdida de oxígeno. El impacto económico para el departamento es considerable.

26/12/2007



PLANETA CARACOL

Alerta por mortandad de peces en el Embalse de Betania, Huila

A 20 toneladas asciende el número de peces muertos en el embalse de Betania, ubicado entre los municipios de Hobo y Yaguará.

6,9 TONELADAS

Relatório aponta dano ambiental de R\$ 22 milhões por morte de peixes em barragem de Sinop

SÉRIE PEIXE VIVO

RISK ASSESSMENT OF FISH DEATH AT HYDROPOWER PLANTS IN SOUTHEASTERN BRAZIL

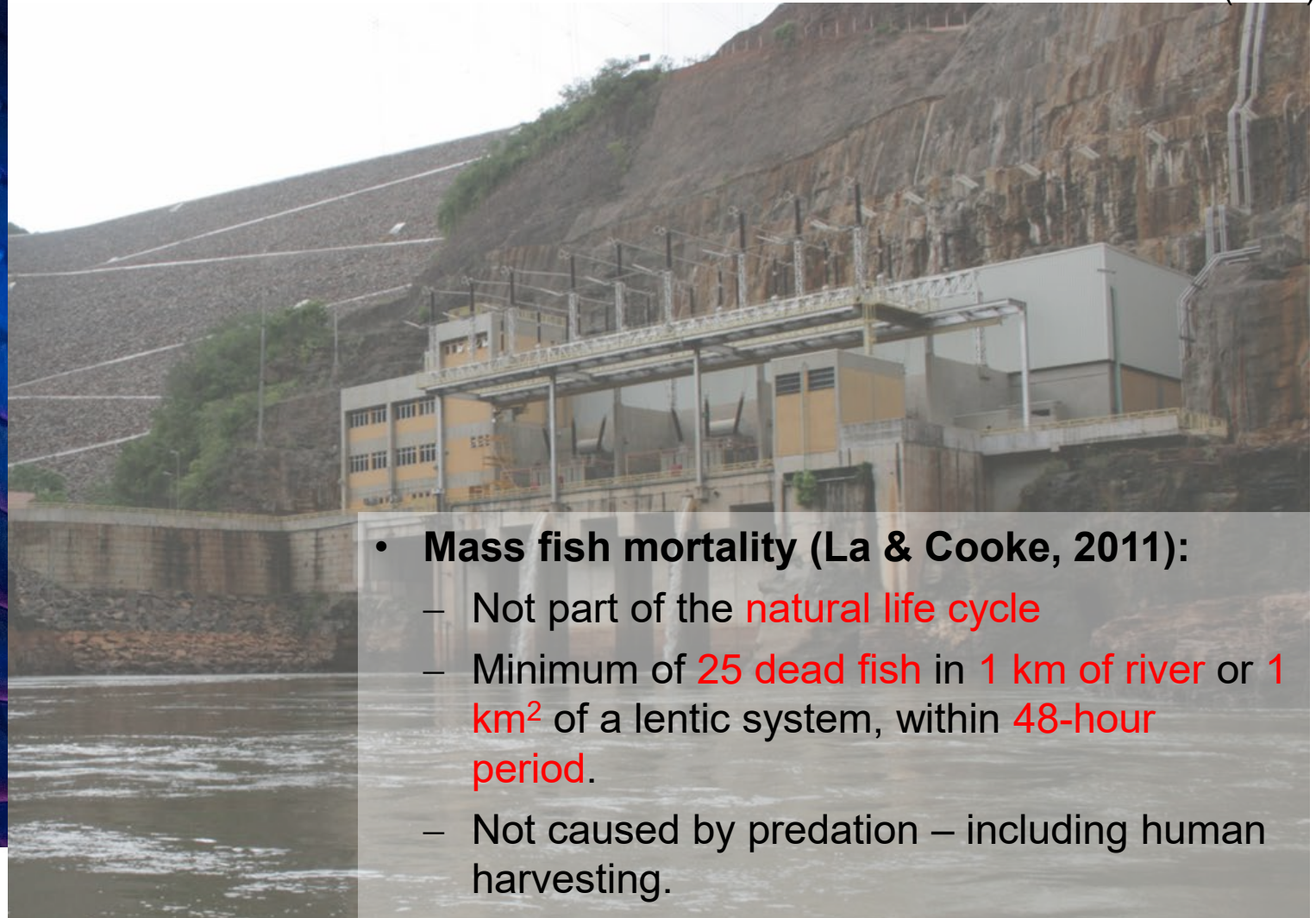


PROGRAMA PeixeVivo CEMIG A natureza em sua companhia

R E P O R T

Fish mortality at hydropower plants

IDENTIFYING PROBLEMS AND
CO-CREATING SOLUTIONS



- **Mass fish mortality (La & Cooke, 2011):**
 - Not part of the **natural life cycle**
 - Minimum of **25 dead fish** in **1 km of river** or **1 km²** of a lentic system, within **48-hour period**.
 - Not caused by predation – including human harvesting.

Financial Support



Host



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Organization



**Newton
Fund**



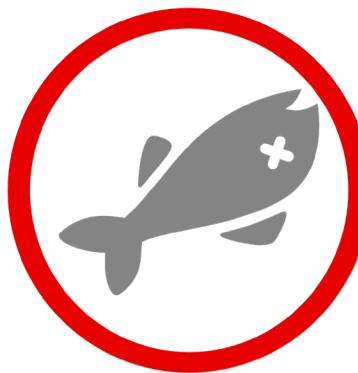
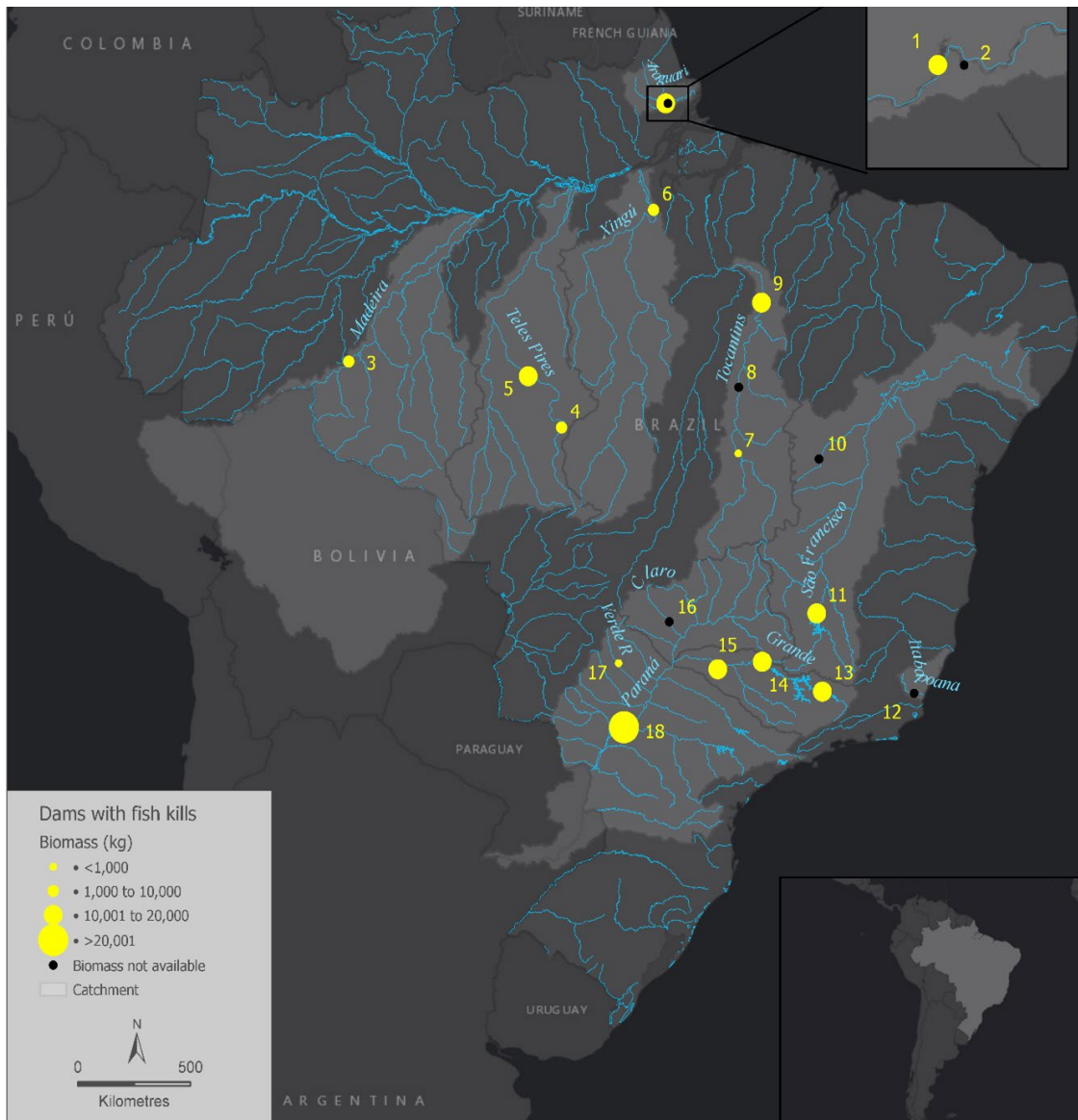
Institute for Environmental Engineering - IfU



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UNIVERSITY OF
Southampton

Steady growth of fish mortality events globally



Over 250 tonnes of fish killed in the last decade.



More than 150 million Euros in fines.

Sinop Dam – Teles Pires River, Brazil

- **Hydrology:**

- Watershed: ~ 38 000 km²
- Mean annual flow: ~ 927 m³/s

- **Turbines:**

- 2 Kaplan
- Discharge range: 272 m³/s – 1600 m³/s

- **Installed capacity:**

- 402 MW
- Head: 27.6 m

- **Spillway:**

- 3 gates – Creager weir (radial gates)
- Discharge range: 450 m³/s - 6650 m³/s



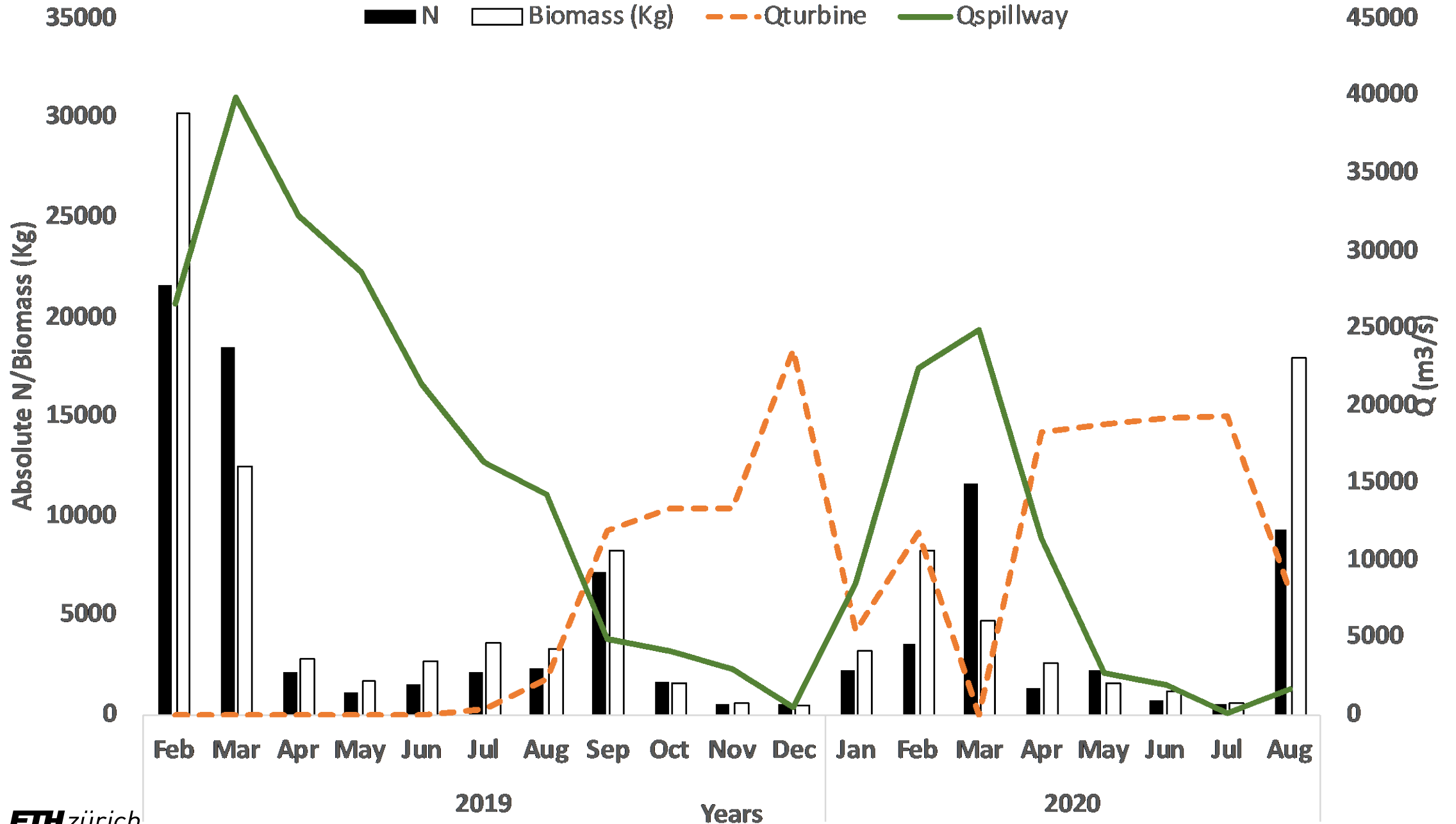
Sinop Dam – Teles Pires River, Brazil

- **Operation:**

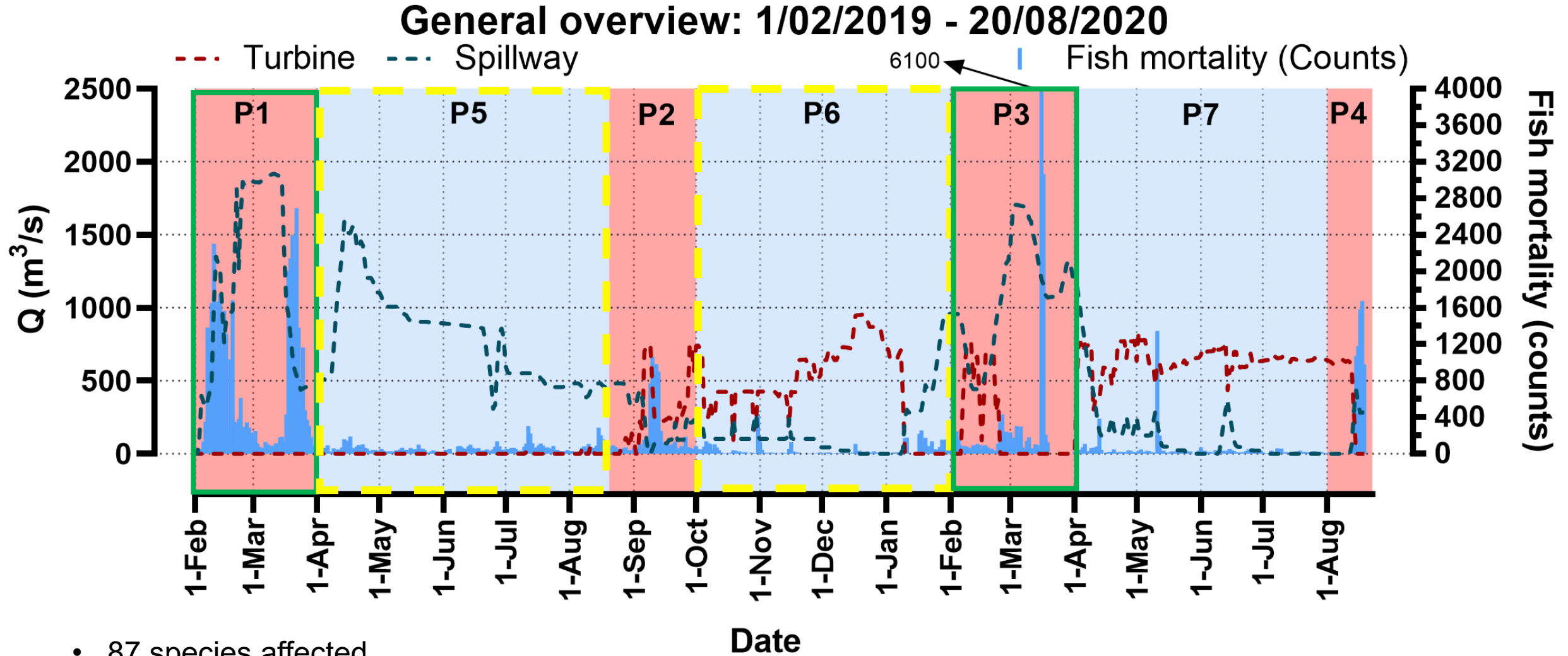
- Started in February 2019
- Spillway operation initiated to regulate reservoir filling
- Fish kills started to occur
- Local **environmental authority** required assessment of the mortality events using a **scientific basis**.
 - **Expert panels**



Sinop Dam – Expert Panel Assessment



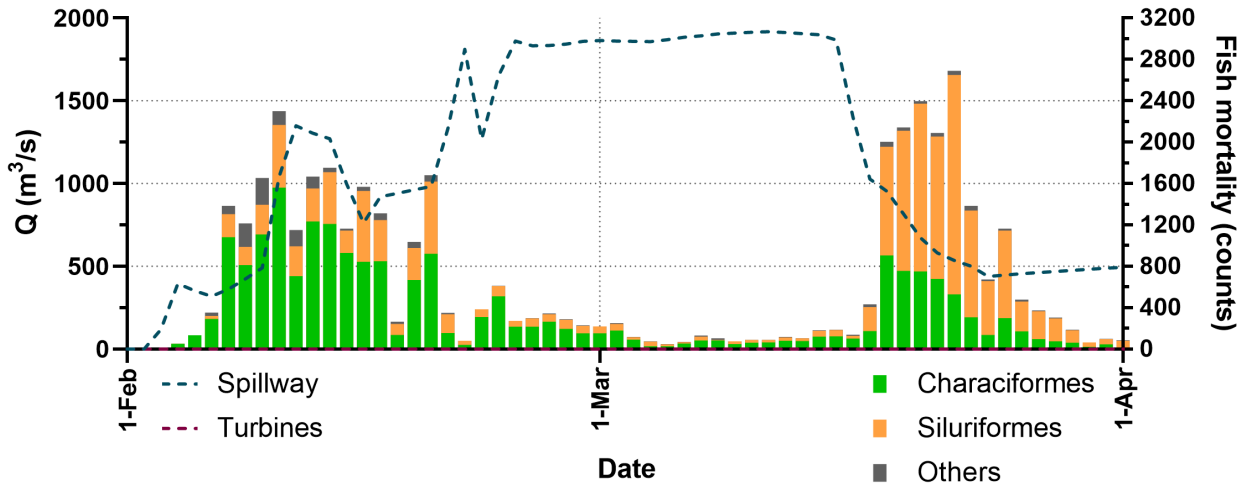
Sinop Dam – Expert Panel Assessment



- 87 species affected
- 10 species represented more than 75% of the total abundance

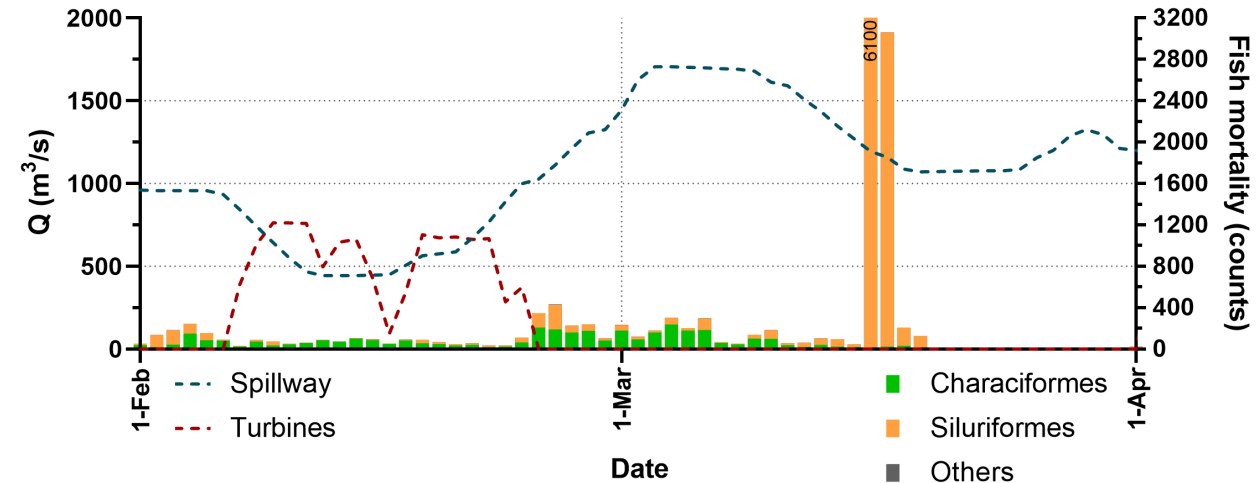
Number of species and taxonomic groups affected

Period 1: 01/02/2019 - 31/03/2019



- 67 species
- 4 taxonomic orders – Characiformes and Siluriformes
- 42% of the total biomass affected

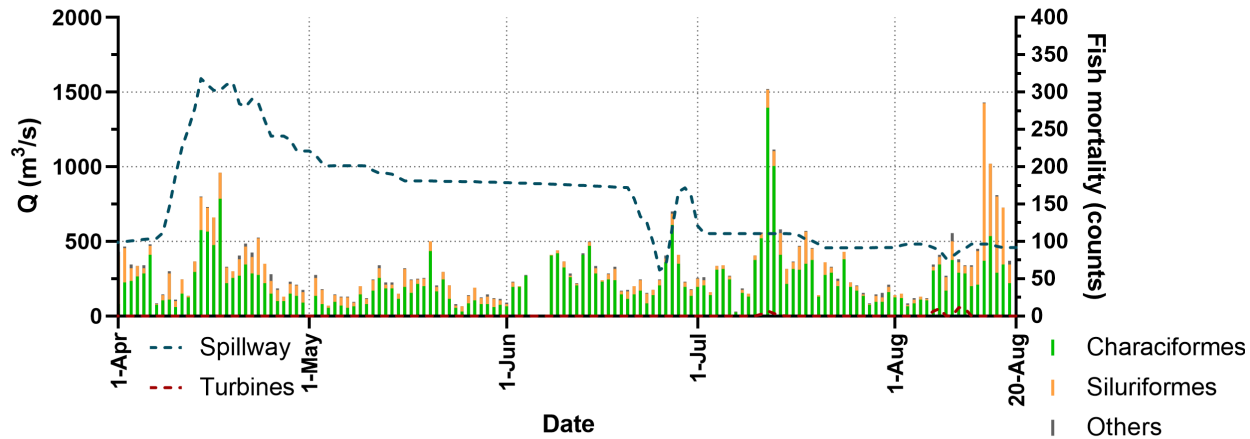
Period 3: 01/02/2020 - 31/03/2020



- 33 species
- 2 taxonomic groups – Characiformes and Siluriformes
- 12% of the total biomass

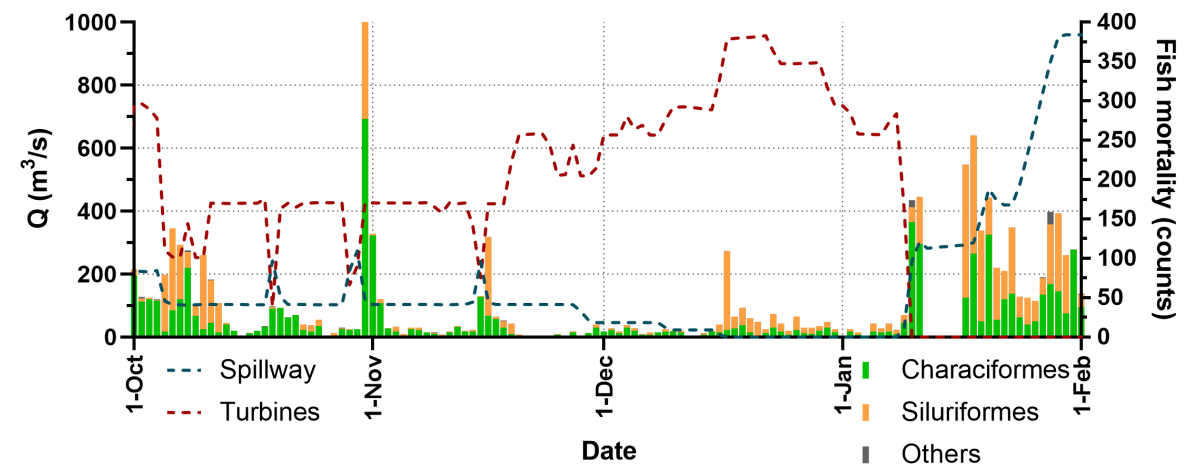
Number of species and taxonomic groups affected

Period 5: 01/04/2019 - 19/08/2019



- 50 species
- 3 taxonomic orders – Characiformes and Siluriformes
- 12% of the total biomass affected

Period 6: 01/10/2019 - 31/01/2020



- 35 species
- 3 taxonomic groups – Characiformes and Siluriformes
- 5% of the total biomass

Factors related to mortality

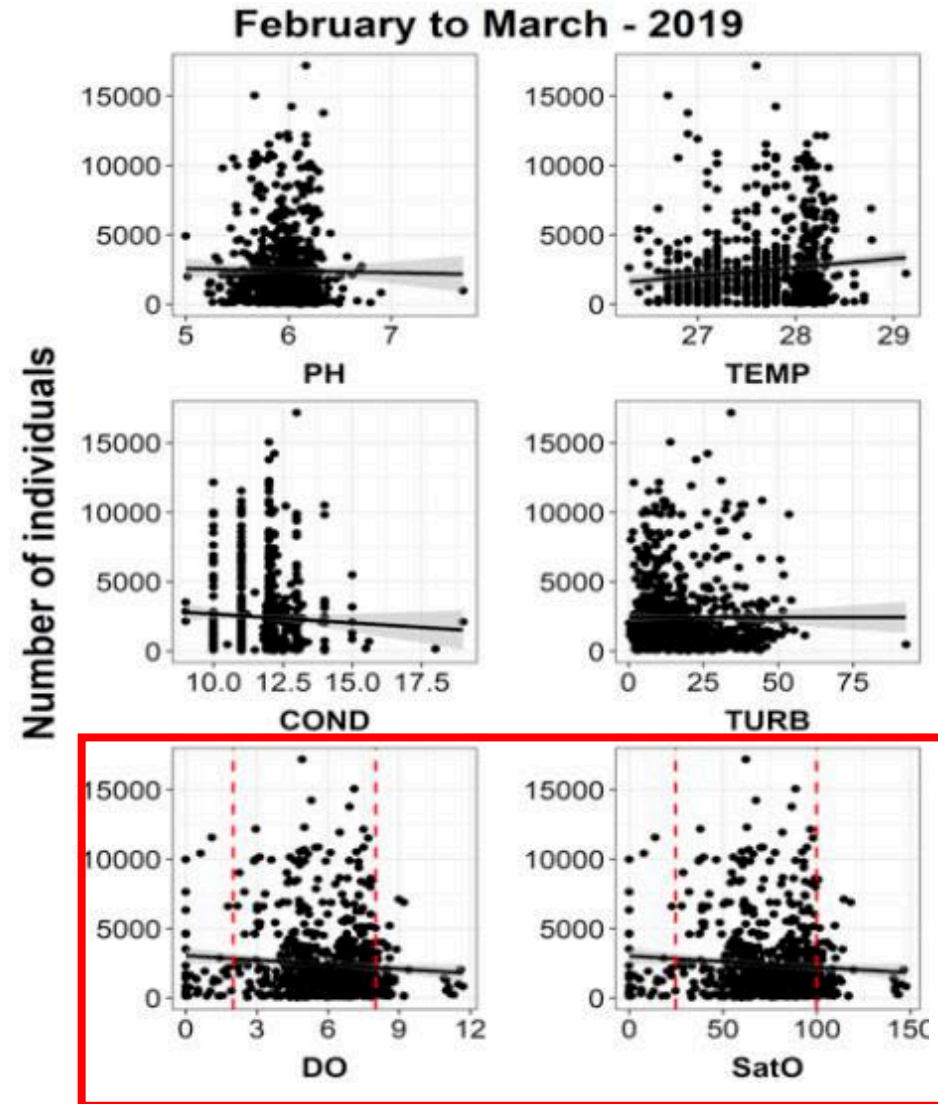
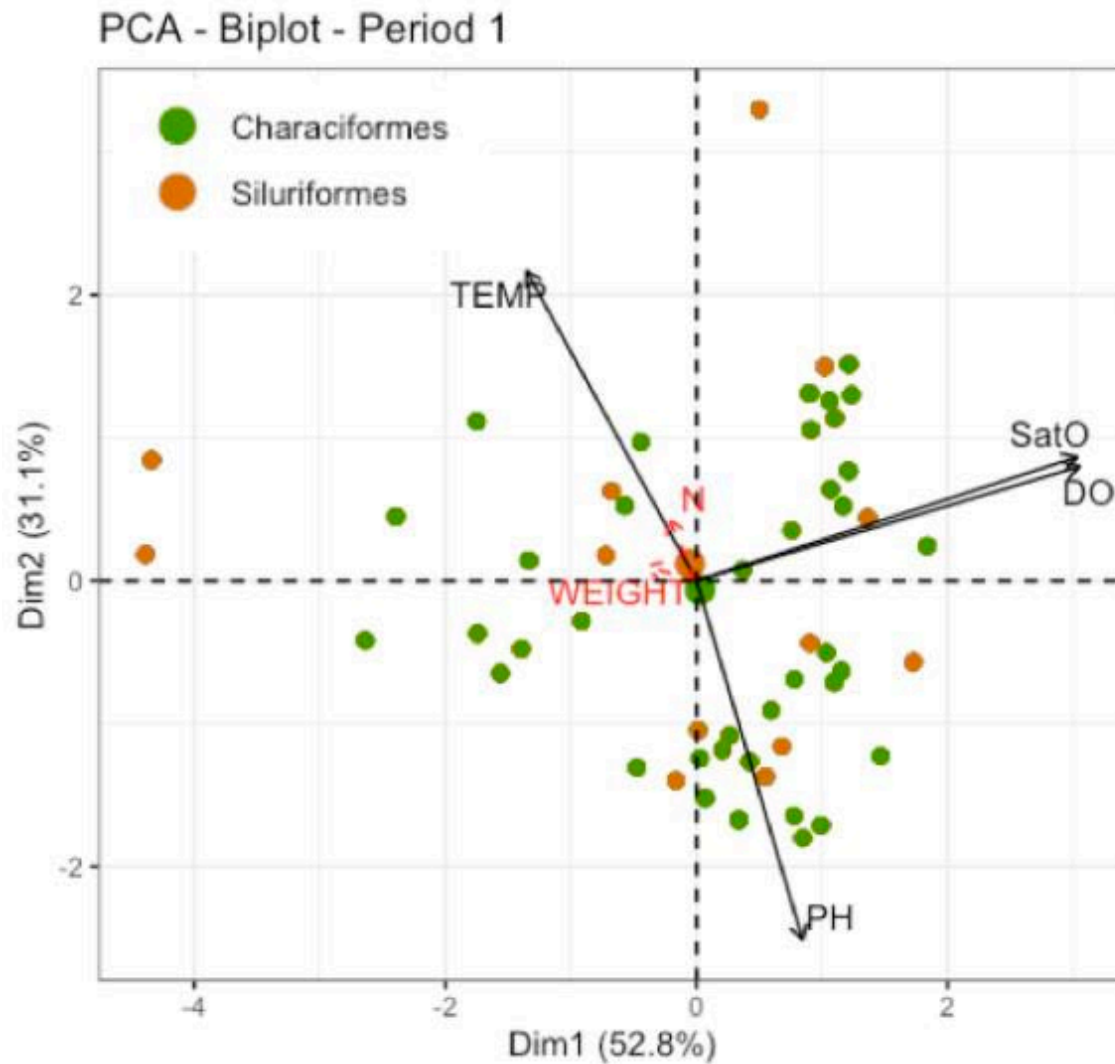
- General Linear Mixed Models – fixed effects (autocorrelation and best model fit based on Akaike Information Criterion (AIC))
- Combination of spillway and turbine discharge depending on the period.

Parameter	Estimate	Standard error	z-value	p-value
AVG_QS	-1.426	0.358	-3.988	< 0.001
AVG_QT	-1.330	0.517	-2.574	< 0.05
STD_QS	1.130	0.575	1.964	< 0.05
STD_QT	-	-	-	-
AVG_SatO	-0.821	0.381	-2.155	< 0.05
AVG_pH	-	-	-	-
AVG_Temp	0.746	0.316	2.365	< 0.05

- QS – spillway discharge; QT – turbine discharge; SatO – oxygen saturation; Temp – temperature. AVG – average; STD – standard deviation.

Factors related to mortality

- PCA and correlation showed significant effects of oxygen saturation



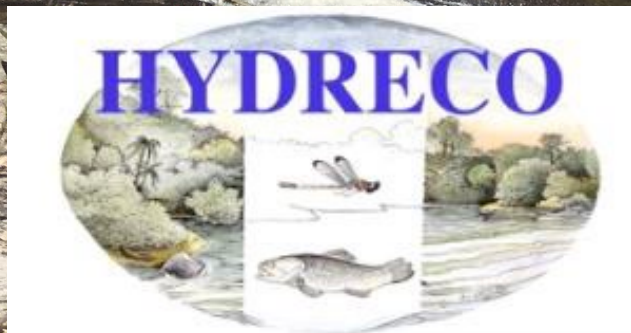


Closing remarks

The results led to the implementation of **management solutions** at Sinop Dam in the **short-, medium- and long-term** and an ambitious **ecological and technical** programme.

- Short-term: **control of spillway operation** → somewhat constraining but no events registered since put this action in place.
- Medium-term: identification of **supersaturation thresholds supported by target species** and implementation of **gas saturation sensors** for monitoring.
- Long-term: spillway **design modifications**.
- Potential for synergistic effects between water quality and hydraulic variation.
 - Temperature
 - pH

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Thank you!

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