DOMINO – Faits structurants, points de bascule et leurs influences sur un grand fleuve, le Rhin : approches historiques et prospectives

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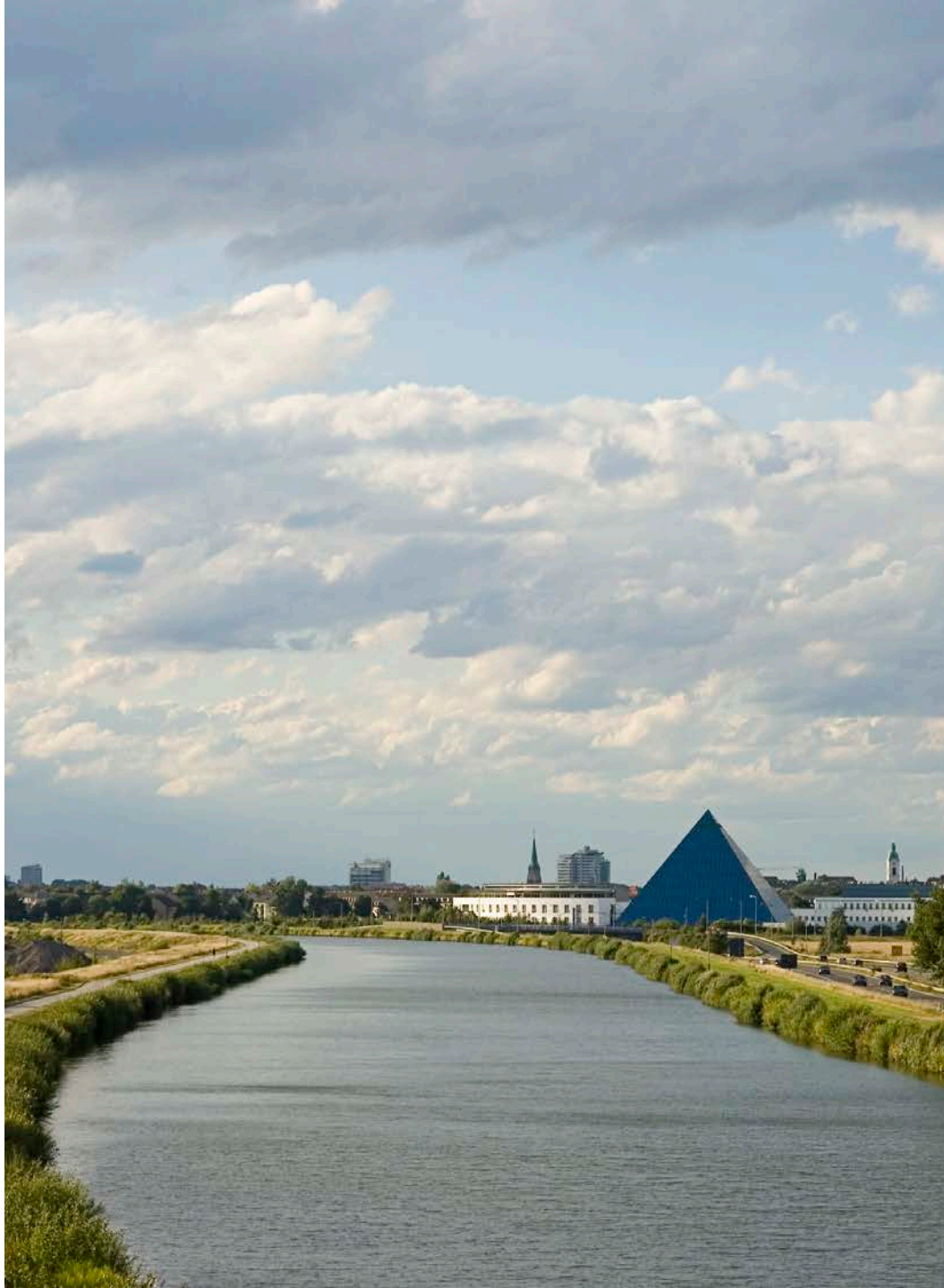

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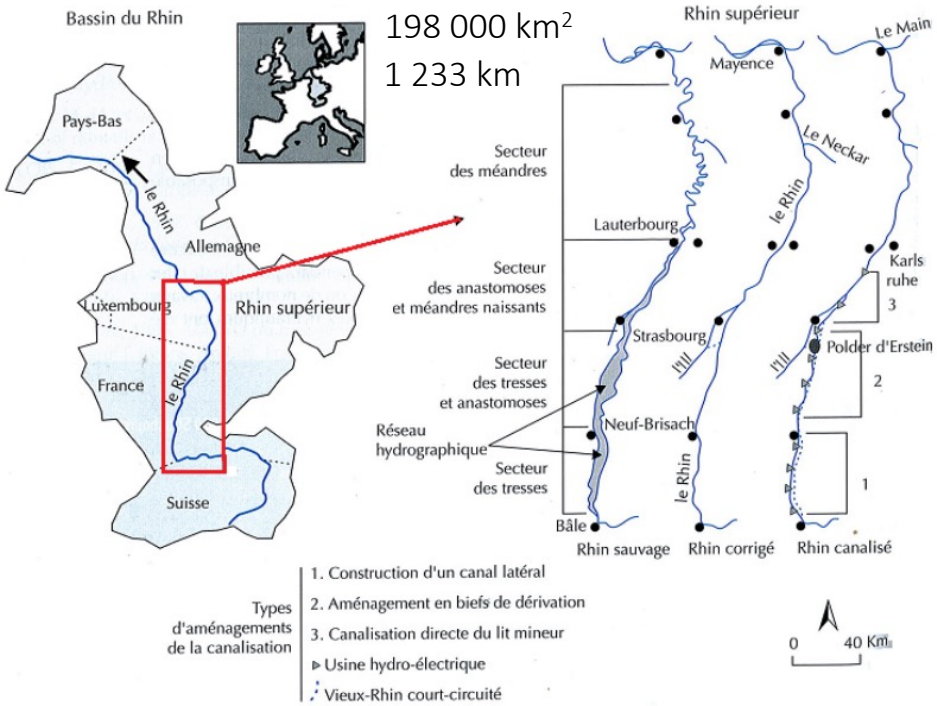
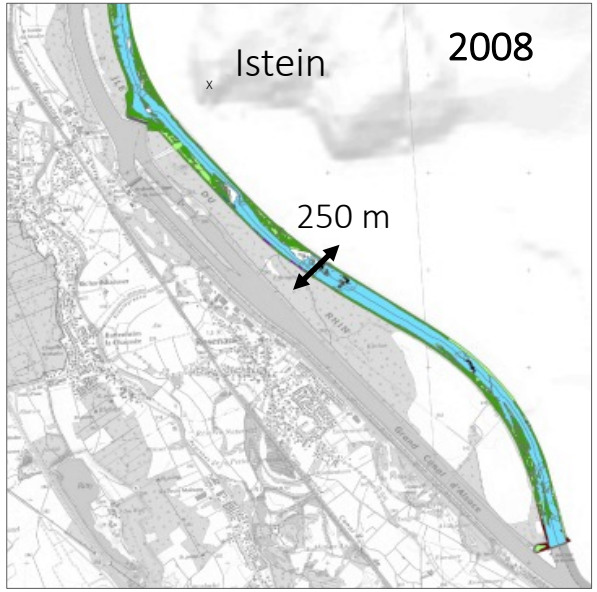
Faits structurants, points de bascule et leurs influences sur **un grand fleuve, le Rhin**

- Rhin Supérieur - Fleuve aux trois **frontières** (Allemagne, France, Suisse)
- Aménagements historiques importants
- Importance socio-économique
- Faits structurants

Grande perte de mobilité latérale
Biodiversité altérée & déficits écologiques



Piégay *et al.*, 2010



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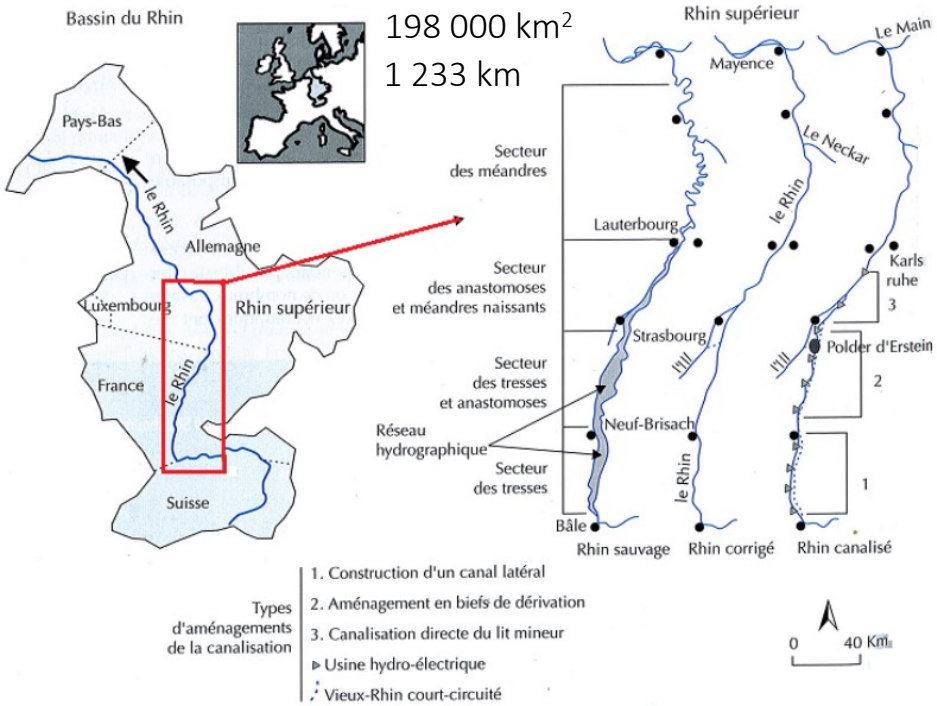

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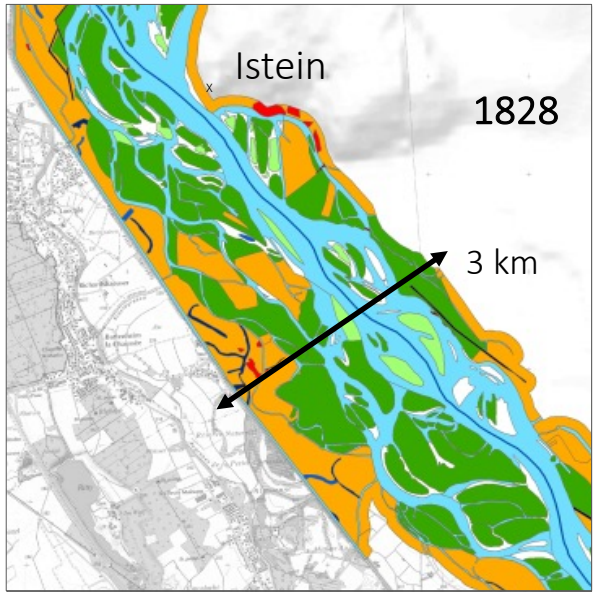

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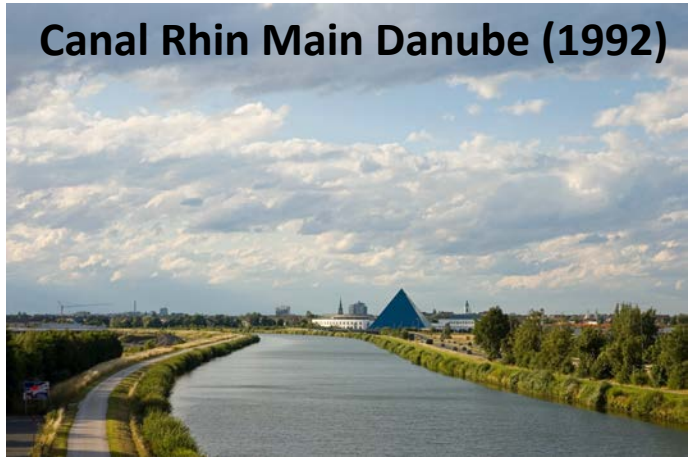
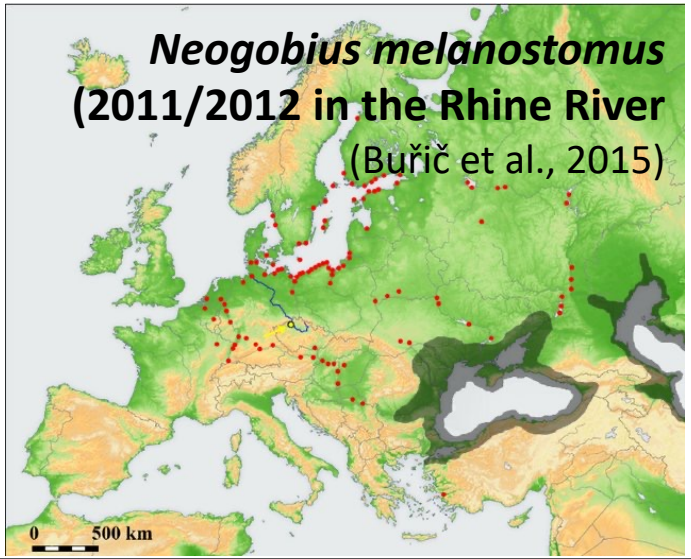


Dikerogammarus villosus
(1999 in the Rhine River)



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- **Très utilisée en restauration écologique** (Suding, 2004; Rohr et al. 2018

Table 1. Terminology and definitions used within the context of tipping point in marine, freshwater and terrestrial studies.

Term	Definition
Alternative stable state	Refers to the theory that predicts that ecosystems can exist under multiple nontransitory states, or stability domains. An unstable equilibria, generated by a change in external condition, marks the border between two stable states (Holling 1973; Scheffer and Carpenter 2003)
Breakpoint	Value along environmental gradient whereupon a system will move into an alternative stable state. Often used as a synonym of *threshold* (May 1977)
Driver	An environmental change (naturally or anthropogenically driven) that results in a quantifiable biological response, ranging from stress to enhancement (Boyd and Hutchins 2012)
Equilibrium	Circumstances in which the processes that affect the state and properties of a system all balance out so that the system does not change (Scheffer 2009)
Hysteresis	After a parameter returns to its original value following a perturbation, hysteresis is revealed if the system can change back to the original state at a different threshold (Beisner et al. 2003; Faassen et al. 2015)
Phase transition	Theory that states that a system can undergo strong change in its macroscopic properties if a suitable control parameter is adequately tuned. Near these critical points, the critical components (i.e., key characteristic constants) are the same for very different systems. Often used as a synonym of *critical transition* (Solé et al. 1996)
Regime shift	Sharp change from one dynamic state to a contrasting one. In the region where a regime shift occurs, a small change in pressure can cause a disproportionately large and abrupt change in system properties (i.e., single species, populations, ecosystem functioning and services) (Scheffer et al. 2001; Beisner et al. 2003; Lauerburg et al. 2020)
Stressor	An environmental change (naturally or anthropogenically driven) that decreases organismal fitness (Boyd and Hutchins 2012)
Tipping point	Thresholds of localized effects, including multiple system properties (i.e., ecological, sociocultural, and economic). Zones of rapid change in a nonlinear relationship between a response/condition and the intensity of a given driver (Selkoe et al. 2015; van Nes et al. 2016)

Carrier-Belleau et al. (2022)

- **Tipping point** = zones de changement rapide dans une relation non linéaire entre l'état d'un écosystème et l'intensité d'un driver donné (Selkoe et al. 2015 - écosystèmes marins).
- **Tipping point** = le phénomène selon lequel, au-delà d'un certain seuil, un changement rapide propulse un système vers un nouvel état (van Nes et al. 2016).

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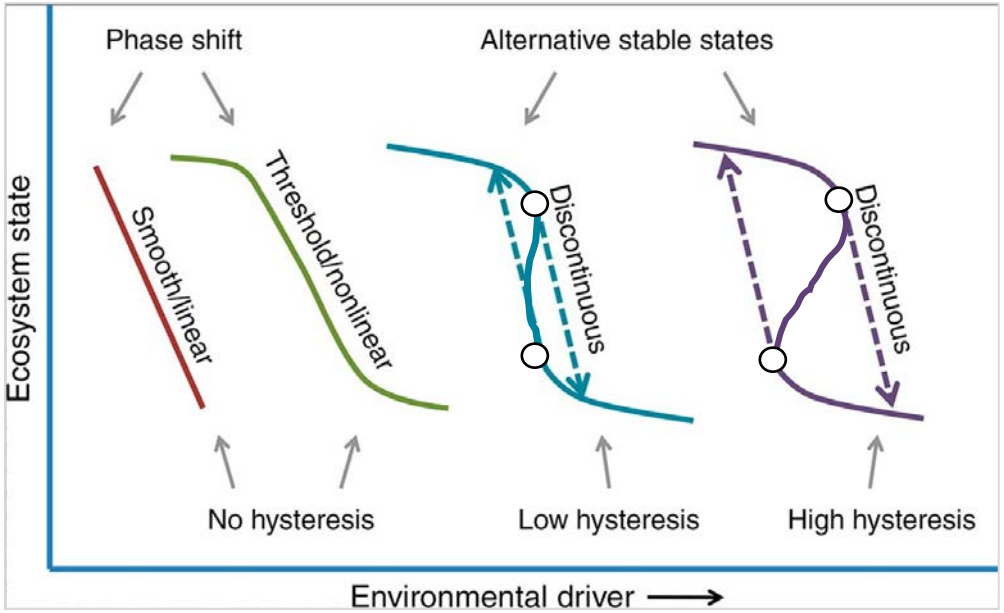

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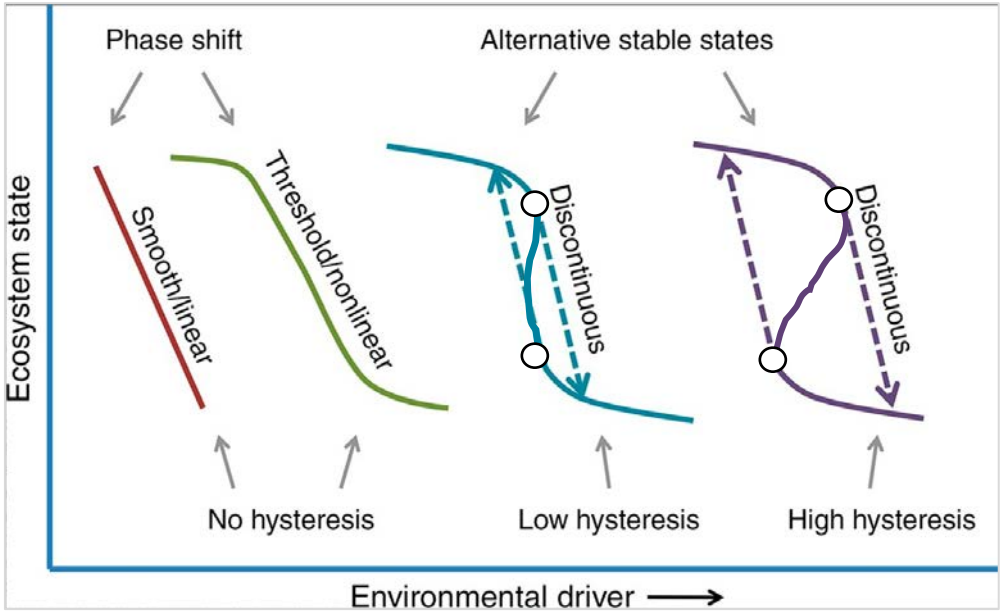
Faible considération des drivers/dimensions multiples (Halpern et al. 2019)



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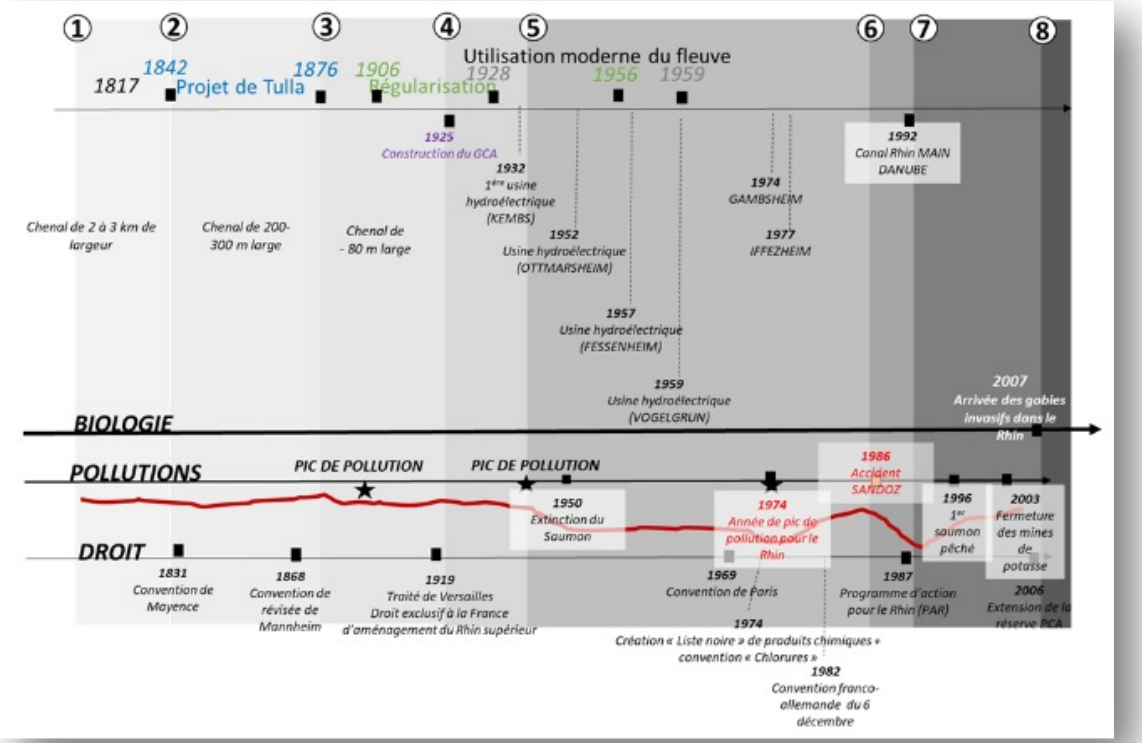
Objectifs & Méthodologies

- Expliquer les changements graduels ou les « tipping points »
- **Caractériser** leur potentiel de réversibilité = résilience de l'écosystème (hysteresis)
- **Dissocier** les tipping points dans un contexte multi-drivers
- **Prédire les** tipping points



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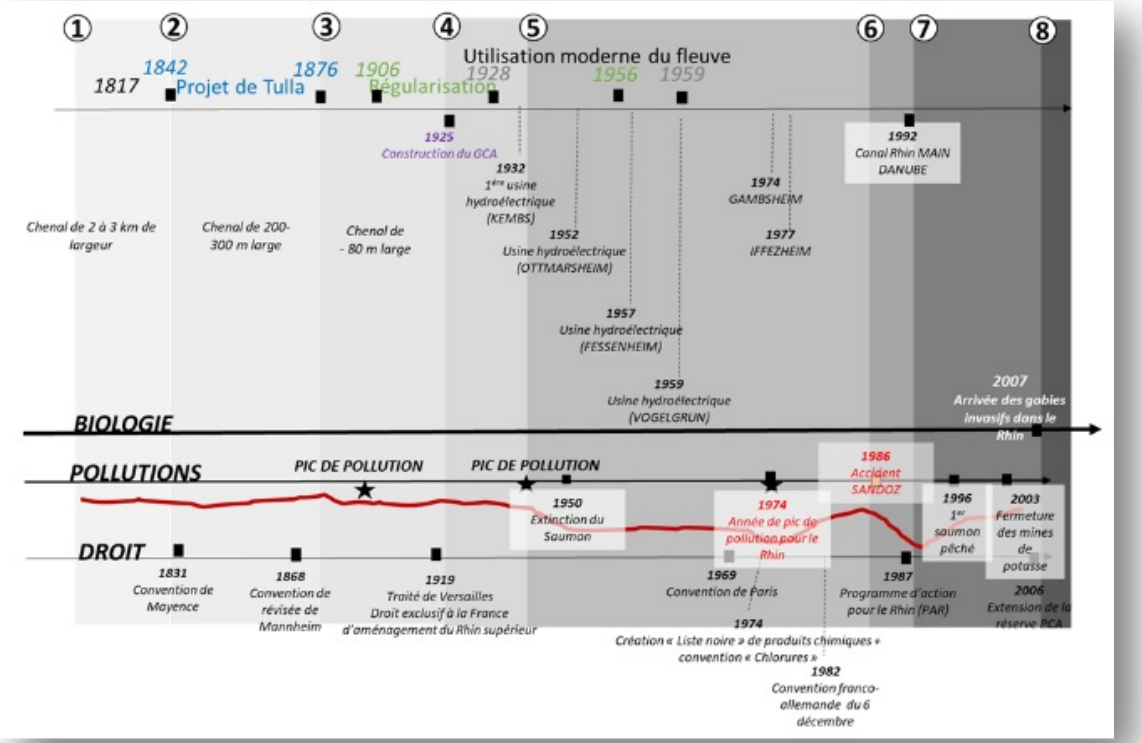

- **Données biologiques** depuis les années 90's
- **Données historiques & observées** *(qui <u>est</u> là et qui <u>était</u> là)*
- **Données théoriques** (qui <u>devrait</u> être là)

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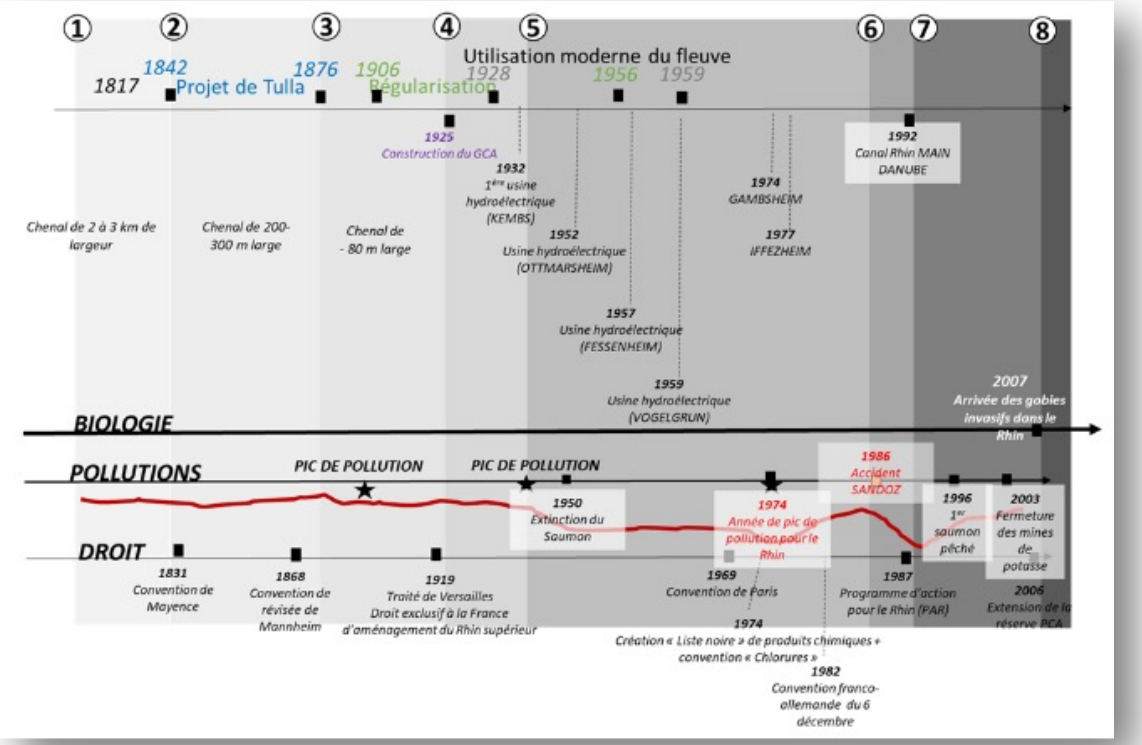
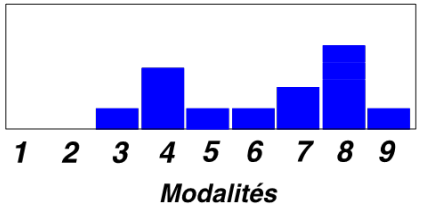


Exemple :

Variable	Modalités de la variable								
	1	2	3	4	5	6	7	8	9
Nourriture	sédiments fins + microorganismes	débris < 1 mm	débris végétaux (≥ 1 mm)	microphytes	macrophytes	débris animaux (≥ 1 mm)	microinvertébrés	macroinvertébrés	vertébrés
Agrypnia (Notes d'affinité)	**0**	**0**	**1**	**3**	**1**	**1**	**2**	**4**	**1**

Profile of the Trichoptera Agrypnia for the« food »



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Résultats à venir

- **Tipping points & effets sur les réponses biologiques et les processus fonctionnels du Rhin Supérieur ?**
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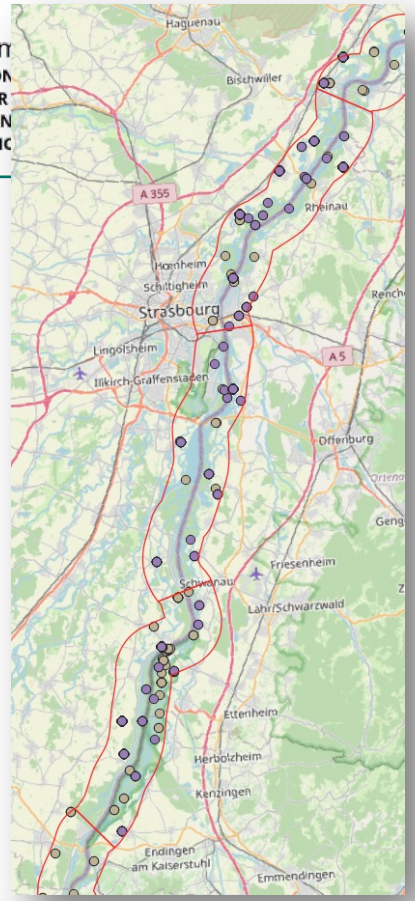

TRONCONS	SOURCE	METRIQUE	GENRE	PERIODE	ESPECE	FAMILLE	ANNEES	COMPTAGE	PRESENCE	TYPE
60	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	salmo_salar	NA	1885	4917	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	gobio_gobio	NA	1886	2	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	alosa_fallax	NA	1886	9	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	alosa_alosa	NA	1886	426	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	alburnus_alburnus	NA	1886	10	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	lampetra_fluviatilis	NA	1886	4	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	gasterosteus	NA	1886	1	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	blicca_bjoerkna	NA	1886	8	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	platichthys_flesus	NA	1886	8	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	leuciscus_idus	NA	1886	2	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	coregonus	NA	1886	4	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	petromyzon_marinus	NA	1886	1	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	osmerus_eperlanus	NA	1886	1	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	leuciscus_leuciscus	NA	1886	4	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	cyprinus_carpio	NA	1886	1	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	pomatoschistus_minutus	NA	1886	1	1	POISSONS
43	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	scardinius_erythrophthalmus	NA	1886	1	1	POISSONS
44	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	clupea_harengus	NA	1886	89	1	POISSONS
44	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	gasterosteus	NA	1886	4	1	POISSONS
44	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	lampetra_fluviatilis	NA	1886	21	1	POISSONS
44	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	osmerus_eperlanus	NA	1886	39	1	POISSONS
44	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	alosa_fallax	NA	1886	39	1	POISSONS
44	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	platichthys_flesus	NA	1886	50	1	POISSONS
44	GBIF	OCCURRENCE	BIOTIQUE	1876 - 1925	pomatoschistus_minutus	NA	1886	8	1	POISSONS

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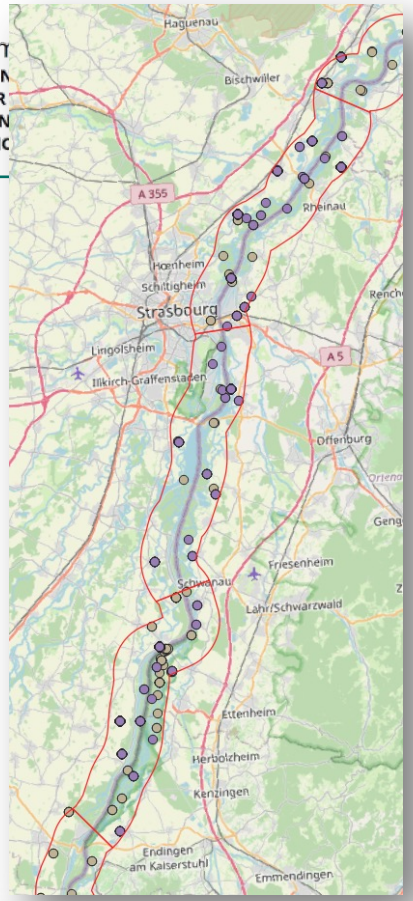

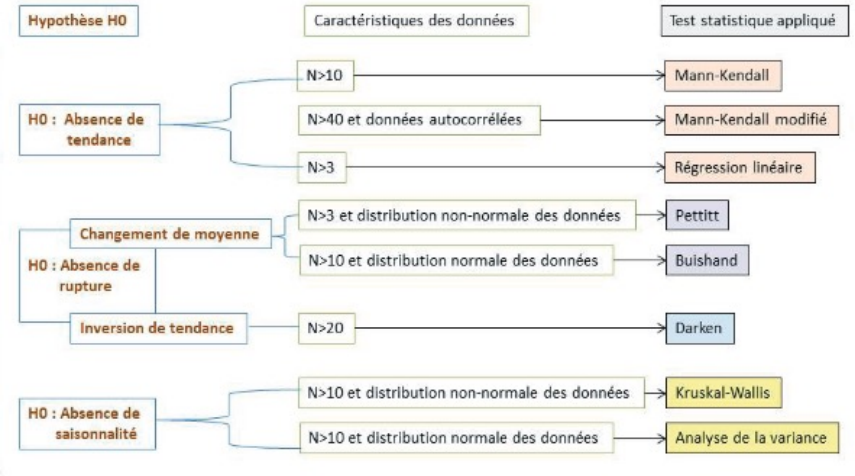

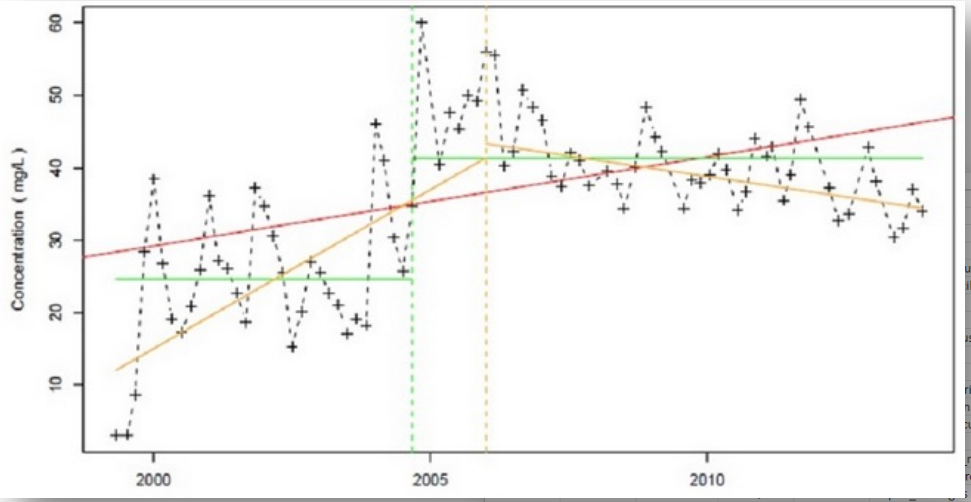

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					us	NA	1886	10	1	POISSONS
					ilis	NA	1886	4	1	POISSONS
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						NA	1886	8	1	POISSONS
					us	NA	1886	8	1	POISSONS
						NA	1886	2	1	POISSONS
						NA	1886	4	1	POISSONS
					rinus	NA	1886	1	1	POISSONS
					nus	NA	1886	1	1	POISSONS
					tus	NA	1886	4	1	POISSONS
						NA	1886	1	1	POISSONS
					minutus	NA	1886	1	1	POISSONS
					rophthalmus	NA	1886	1	1	POISSONS
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Merci !

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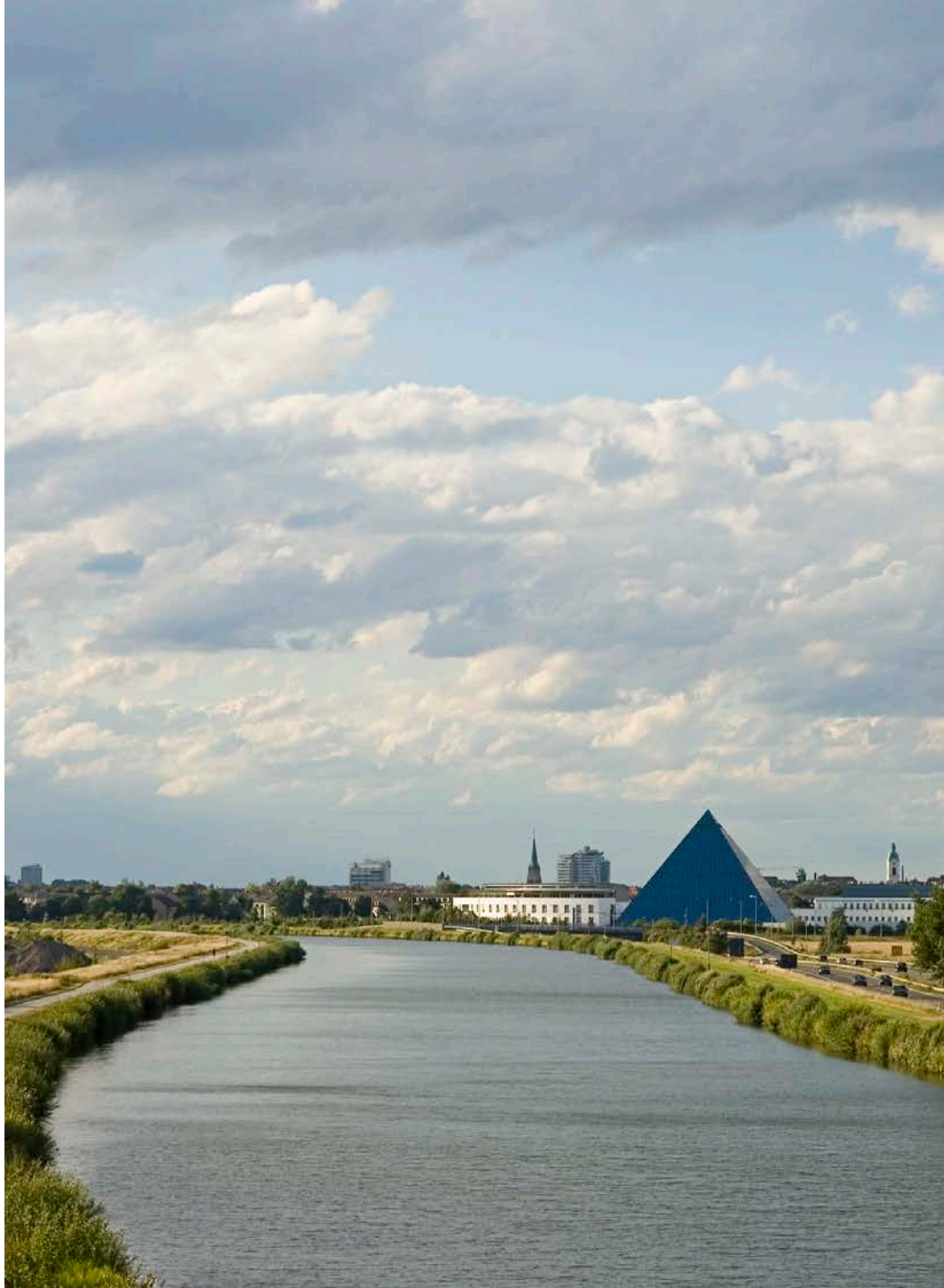
ENGEES/LIVE, UMR CNRS 7362
Université de Strasbourg

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