Better understanding and preparedness for drought risk: use of the "chrono-systemic timeline" tool for a transversal analysis (case study in Belgium) LIÈGE université SPHERES

Technical topic : Drought Preparedness

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INTRODUCTION AND OBJECTIVES

With its slow dynamics, broad scope and numerous cumulative and multidisciplinary impacts (Wilhite & Glantz, 1985; Sthal et al., 2016), drought is a complex and extreme climatic event that can cause both a simple environmental disturbance and a major socio-economic crisis. Moreover, global warming will increase the frequency and intensity of droughts (IPCC, 2021). The consecutive droughts of 2018 and 2019 in Europe are already considered to be unprecedented in the last 250 years (Hari et al., 2020).

In Wallonia (southern part of Belgium), water deficits have multiplied in an almost structural way over the last twenty years. Autorities must therefore prepare for this new climatic challenge in order to limit costly and destructive impacts. A way to prepare for this risk and to improve crisis management is to analyse feedbacks from field actors who have experienced droughts. This process of increasing the knowledge is optimal if a multidisciplinary logic is used.

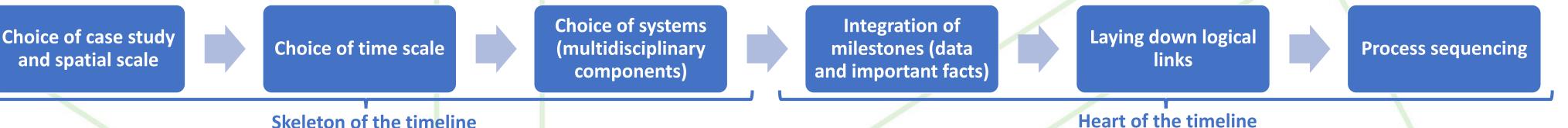
In this context, this study build and develop an original and innovative tool the chrono-systemic timeline - in order to better understand the interdisciplinary process of droughts and to promote a sustainable and transversal management of this risk.

METHODOLOGY

A chrono-systemic timeline is an interdisciplinary instrument for analysing change processes in a territory (Bergeret et al., 2015). This tool contributes, through a socio-ecosystemic analysis of an experience, to improve the management of similar future situations.

The timeline is constructed in six stages :

In the context of a drought during which the consequences are extremely varied, whether sectorally, spatially or temporally, the timeline allows us to combine the key events of the crisis and the logical links between them in a single and synthetic diagram.



Skeleton of the timeline

The case study selected is the successive droughts of 2018, 2019 and 2020 in Wallonia. These events have exceptional weather conditions marked by much higher than normal sunshine and temperatures, as well as exceptionally low precipitation in frequency and quantity. These droughts are also recent and in phase with the current climatic reality. In terms of temporality, the chrono-systemic timeline is constructed on a linear time scale of three years.

MAIN RESULTS

12 meteorological seasons with higher than normal average temperatures + 6 heat waves

3 years with precipitation < normal (-328 mm over 3 years \approx -13%/year)

Critical situation of water resources from August to November in 2018 and 2020

The contexts considered are climatic and hydrological conditions, economic and social context (water production, agriculture, natural environments, energy, navigation, tourism, public health) and political decisions. The data used for each of these contexts comes from the Regional Crisis Centre of Wallonia (CRC-W), the Royal Meteorological Institute of Belgium (RMI) and the National Institute of Public Health in Belgium (Sciensano).

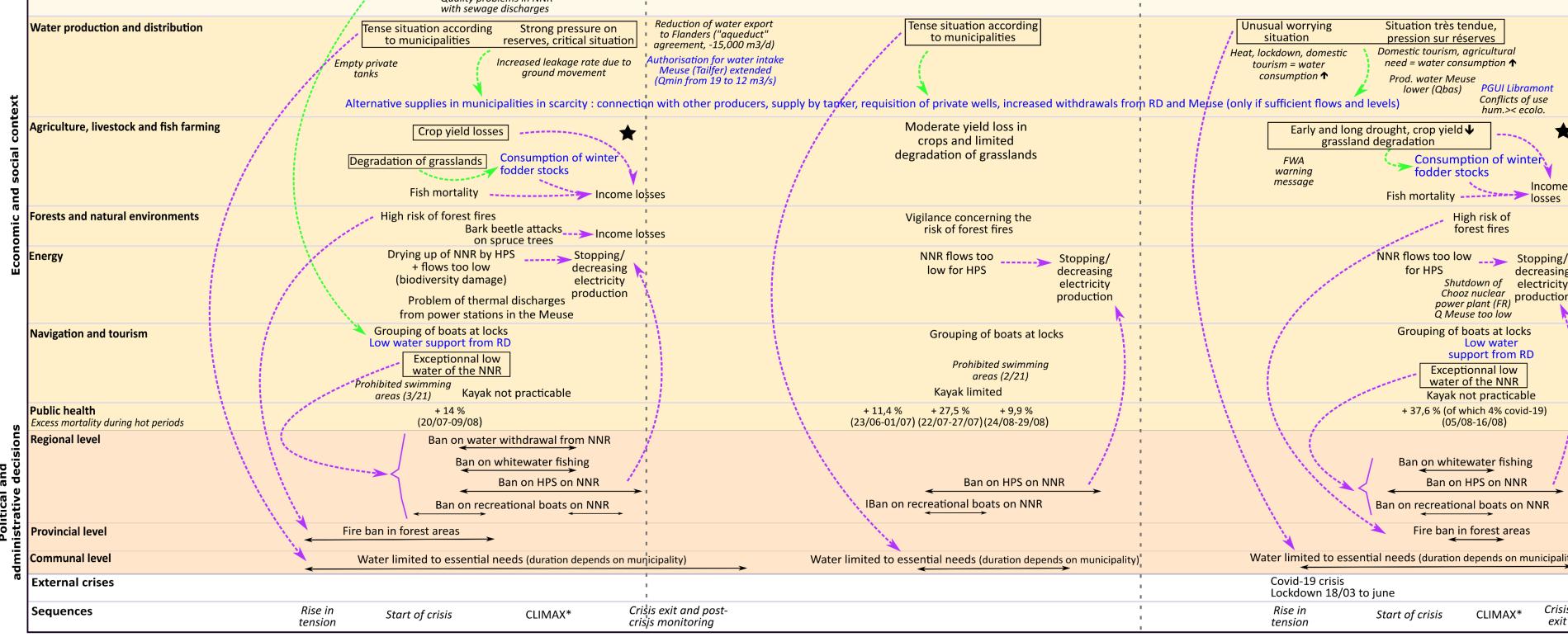
		2018	-					-	2019					2020				
		WINTER	SPRING	ડા	JMMER		AUTUMN		WINTER	SPRING	SUMMER		AUTUMN	WINTER	SPRING	SUMME	R	AUTUMN
Climatic co					eat waves						3 heat <mark>waves</mark>					1 heat wave		
Avrage ten (deviation from	mp. in Uccle om normal)	² 3,8° (+0,2°)	11,5° (+1,4°)	19,	.8° (+2,3°)		11,8° (+0,9°)		5,2° (+1,6°)	10,5° (+0,4°)	19,1° (+1,5°)		11,3° (+0,4°)	6,3° (+2,7°)	11,3° (+1,2°)	18,8° (+1,	2°)	12,3° (+1,4
Cumulative ro (deviation fro	rainfall in Uccle om normal)	232,6mm (+12,1)	150,7mm (-37,1)	134,7	′mm (-89,9) 1	168,5mm (-51,4)	2	235,8 _{mm} (+15,3)	176,5mm (-11,3)	198,8mm (-25,8)	2	209,3mm (-10,6)	230,3mm (+9,8)	105,7mm (-82,1)	168,2 mm (-	56,4) 2	219,2mm (-0,7
	cal conditions er ressources	Good winter recharge	\bigcirc			Ab	normal low levels			\bigcirc			•	Good winter recharge	Faster than norm decrease	al		0
Surface wat	ter ressources													1				
	- NR	\bigcirc	\bigcirc	\bigtriangledown		Early low flows	$\overline{}$	\triangle	\bigcirc	\bigcirc	\bigtriangledown		\bigtriangledown	\bigcirc	\bigtriangledown	\bigtriangledown	$\overline{\mathbf{\nabla}}$	$\boldsymbol{\wedge}$
	- NNR	\bigcirc	Early low flows	\			Late severe low flows	\triangle	\triangle	\bigcirc	\bigtriangledown	\bigtriangledown	▼	¦ 🔘	Early low flows	\bigtriangledown	Historica flow	
	- RD	\bigcirc	\bigtriangledown		\bigtriangledown		\bigtriangledown	Δ !	\bigcirc	\bigtriangledown	\bigtriangledown		$\boldsymbol{\wedge}$		\bigtriangledown	\bigtriangledown	\bigtriangledown	
Quality				Cyano	obacteria Quality with se	v problems in wage disch	n NNR arges	-			Cyanoba	octeria			Cyanobacteria	Cyanoba	icteria	

- Strong pressure on the distribution of drinking water Alternative supplies
- \searrow crop yields and severe degradation of grasslands with major financial and health impacts
- > mortality and bark beetle attacks (Ips typographus) High risk of forest fires
- Stopping or \searrow production by hydroelectric power plants
- Grouping of boats at locks, impacts on water recreation
- High excess mortality during hot periods
- regional \rightarrow bans on water extraction, fishing, hydroelectric micro power plants and tourist navigation; drought recognised as an agricultural disaster allowing compensation
- provincial \rightarrow ban on fires in forest areas
- communal \rightarrow water use for essential needs only
- Repetition of the cycle : rise in tension \rightarrow initiating phenomenon \rightarrow crisis management \rightarrow climax \rightarrow crisis exit

CONCLUSIONS

The chrono-systemic timeline constructed from feedbacks of recent droughts in Wallonia highlights several long periods of major impacts, a slow return to

With its synthetic, transversal and temporal approach and logical links between socio-ecosystems studied, the chrono-systemic timeline is really an



	Climatic conditions		Hydrological condi	tions	Economic and social contexte - Politi	ical and administrative decisions	Recognition of the drought as an agricultural			
σ	temperature (Uccle)	150 Observed cumulative seasona mm rainfall (Uccle)	Groundwater levels (groun Reservoir dam levels (surfa River flows (surface water)	ce water)	abc Object and period of the political and/or administrative decision	Causality Logical links Adaptation	2018 : 2 June to 6 August - aid of €31.5 millior 2020 : 15 March to 15 September - aid of €34.			
en	Deviation from normal temperature (°C, meteorological season, Uccle)	Deviation of cumulative rainfall from normal (mm, meteorological	very high			Adaptation				
50	> +3 degrees	season, Uccle)	highmoderatly high	 increasing level no data 	abc Milestones, decisive elements	HPS Hydroelectric power stations	Chrono-systemic time			
<u>ا</u> ت	> +2 degrees	Cumul. > +75 mm			for the evolution of the crisis	FWA Walloon Federation of Agriculture	Childho-Systemic time			
	> +1 degree	Cumul. > +25 mm	around the mean	stable level			2018, 2019 and 2020			
	Temp. near normal	Cumul. near normal	📃 moderatly low	NR navigable river	Societal responses to problematic		2010, 2019 and 2020			
	< -1 degree	Cumul. < -25 mm	📒 low	NNR non-navigable river	events or situations	* Refers to the most acute phase of the crisis	in Mollonia (Poldium)			
	< -2 degrees	Cumul. < -75 mm	very low	RD reservoir dam		Refers to the most dedic phase of the chais	in Wallonia (Belgium)			

eline of the 20 droughts

a so-called normal situation and a reactive crisis management (decisions of the authorities taken mainly when the crisis is established). The tool shows the presence of a water stress situation in all the socio-ecosystems of the territory and confirms that the consequences and extent of a drought depend strongly on the environmental and societal context (Thibaut & Ozer, 2021).

efficient instrument to better understand the dynamic process of drought risk and to improve a holistic management of water scarcity. In conclusion, this tool should be integrated in the crisis management system and the risks related to water deficits should be better considered in public policies in order to implement an anticipative and adaptive management of these risks.

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