EGU General Assembly 2020
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Effects of Interactions between Society and Environment on Policy in Water Resources Management: exploring Scenarios of Natural and Human-Induced Shocks

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EFFECTS OF INTERACTIONS BETWEEN SOCIETY AND ENVIRONMENT ON POLICY IN WATER RESOURCES MANAGEMENT

EXPLORING SCENARIOS OF NATURAL AND HUMAN-INDUCED SHOCKS

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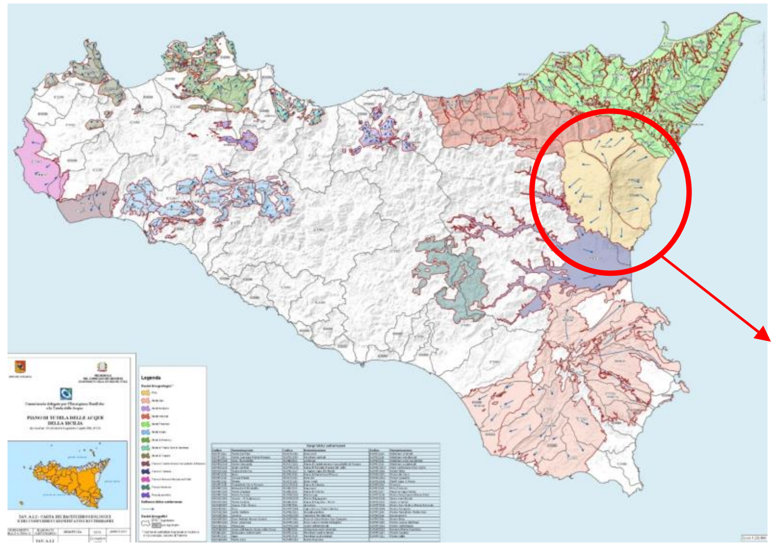
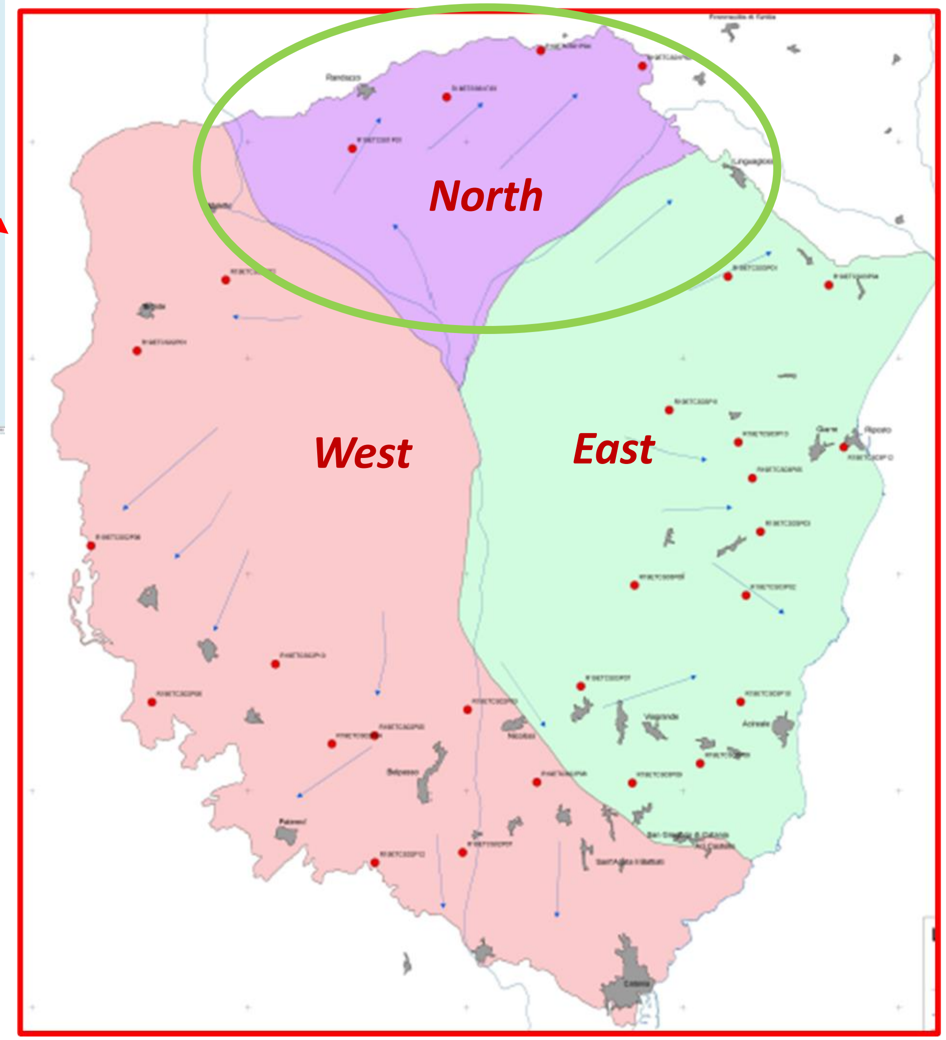
Introduction to Case Study



Sicilian Hydrogeological Map (Sicily, Italy)



Etna Groundwater Basin

ETNA MOUNTAIN

Active Volcano partially covered with snow during all the year

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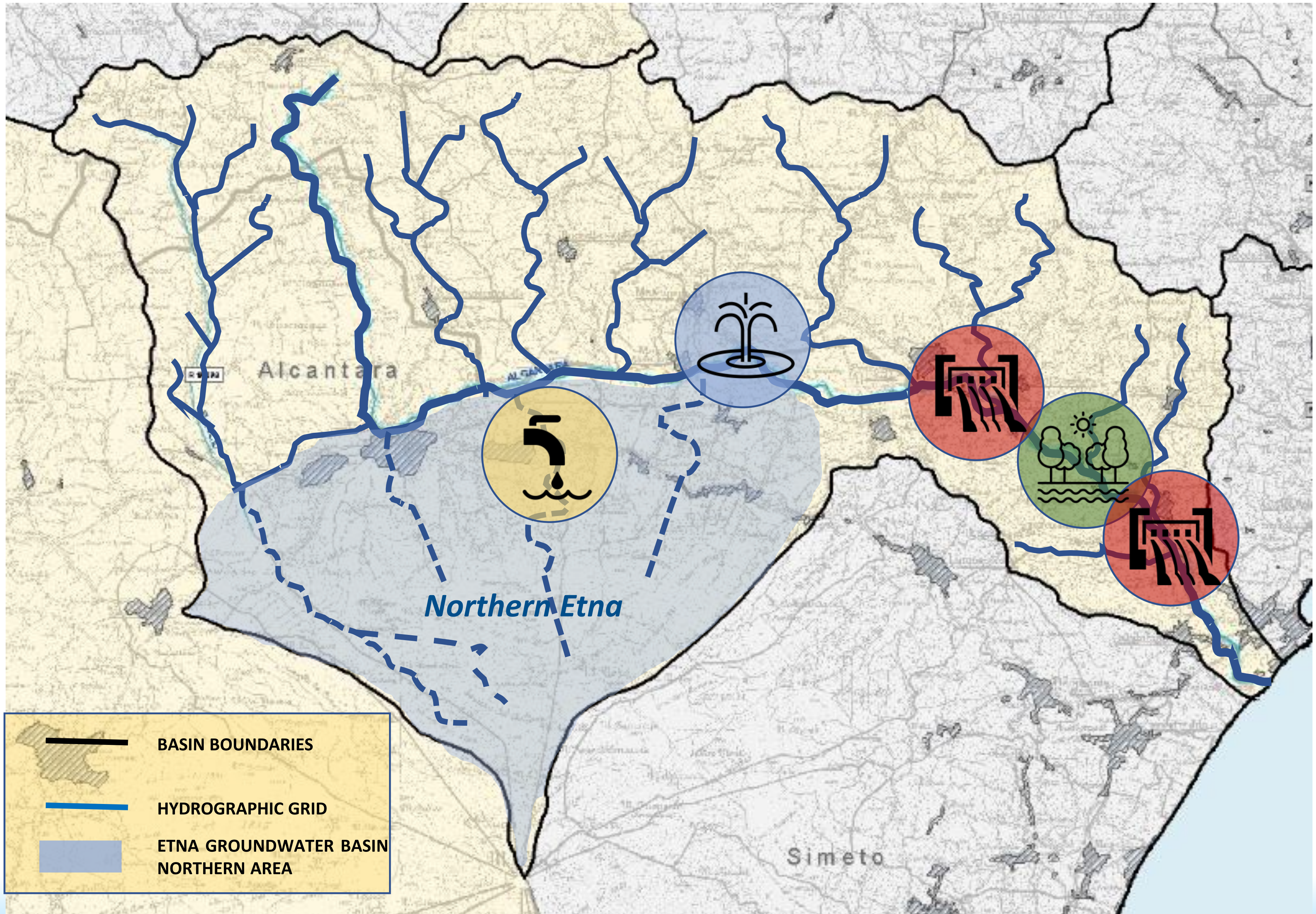
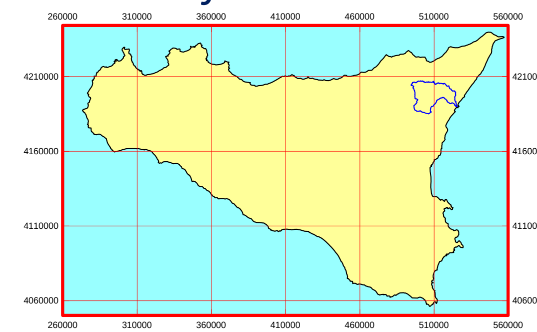
The Alcantara River Basin System



Alcantara River Basin

Area (km^2)	606
Mean elevation (m)	531
Max elevation (m)	3274
Min elevation (m)	0

Main Informations Table



Groundwater Springs

Drinking Water Extraction

Power Plants

Alcantara Fluvial Park

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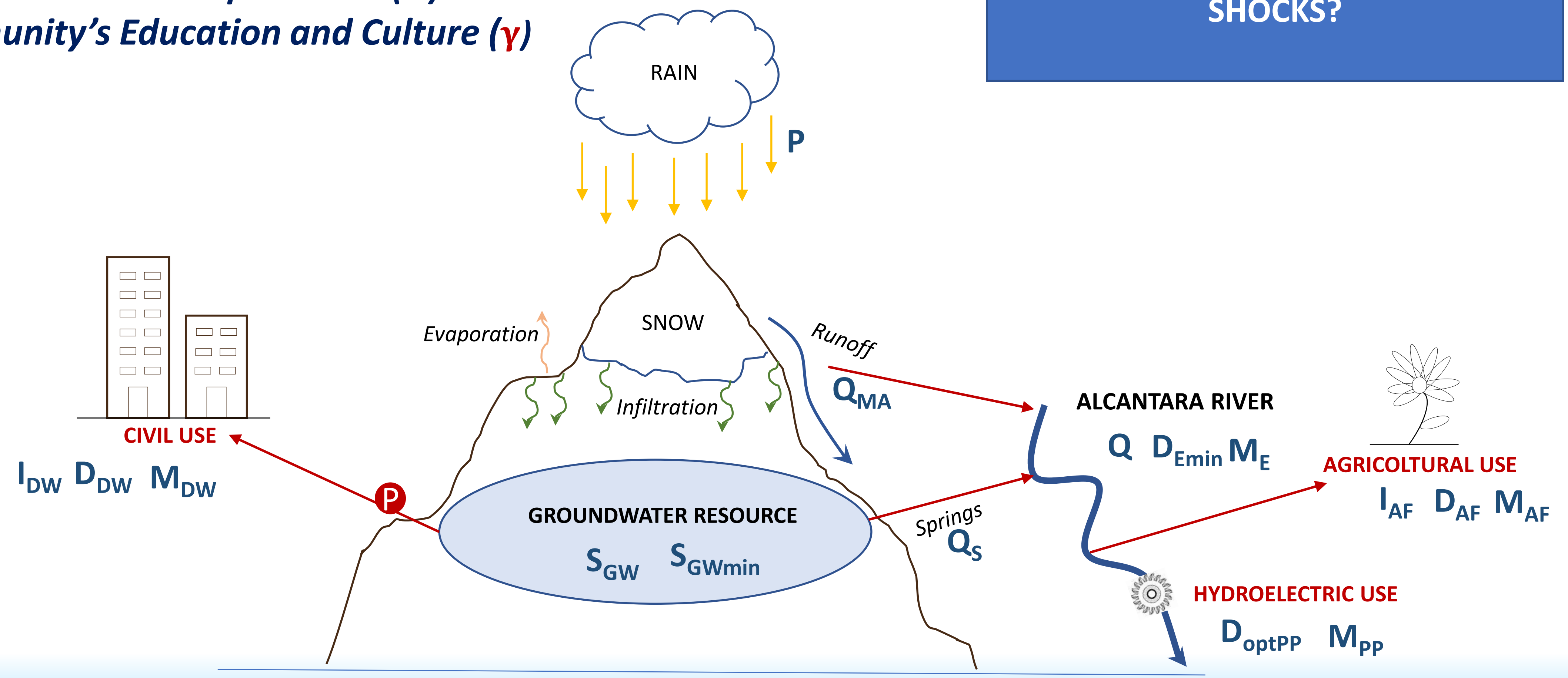
Socio-Hydrological Model Set-Up

***Social Aspects** (Parameters of the model):*

- ***Governement (μ)***
- ***People's Personal Experiences (α)***
- ***Community's Education and Culture (γ)***

HOW DO SOCIAL ASPECTS IMPACT ON POLICY DURING (AND AFTER) NATURAL AND HUMAN-INDUCED SHOCKS?



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Different Scenario Simulations

	Natural Shock to the System (Progressive Shock)	Human-Induced Shock (Immediate Shock)
SHORT TERM	1 Drought Event of 10 years in 25 years long time serie	Water Demand from Groundwater extraction increases for a definite period
LONG TERM	Multiple Drought Events of Various lenght in longer time serie	Multiple Events of Water Demand from groundwater Increasing in longer time serie

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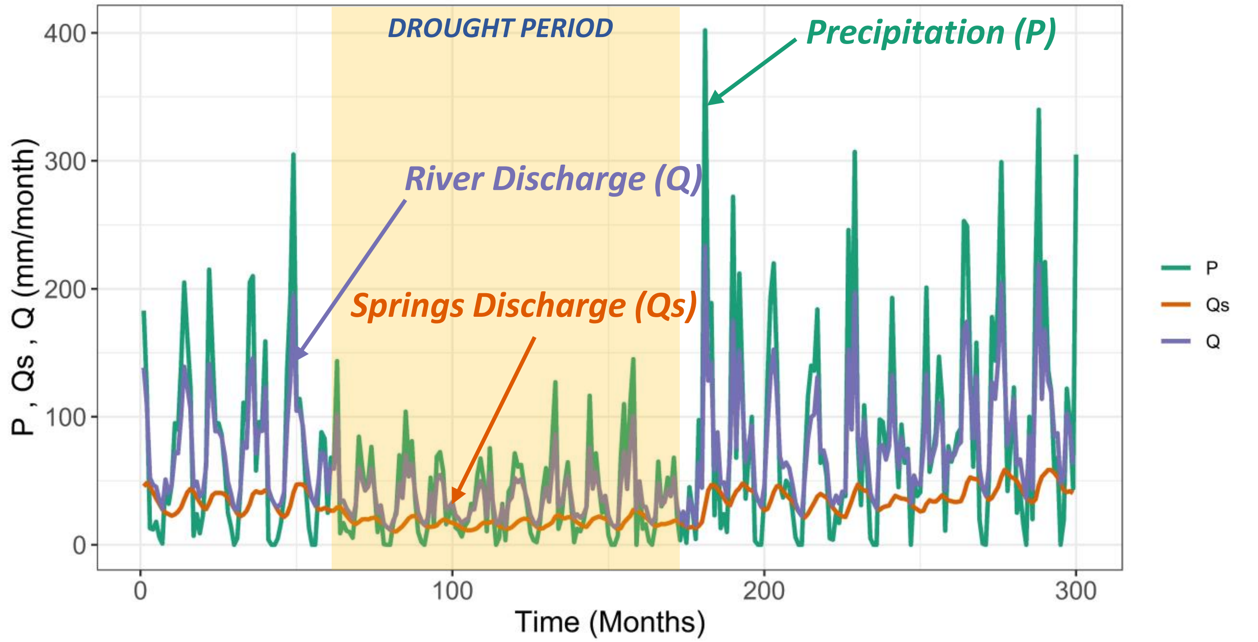
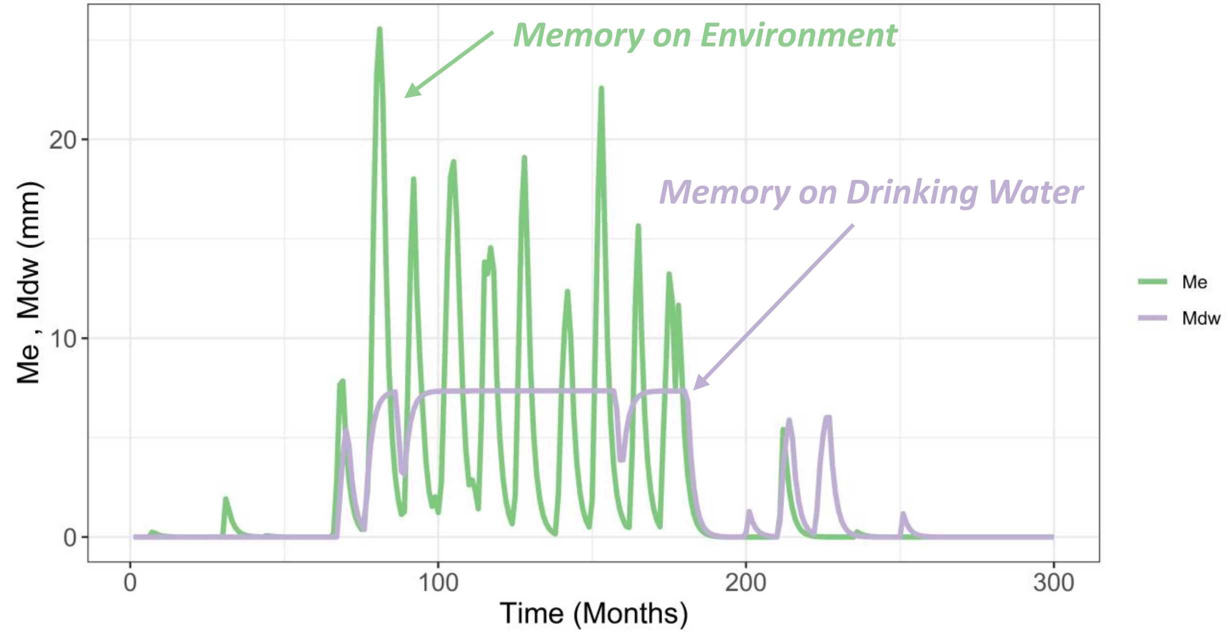
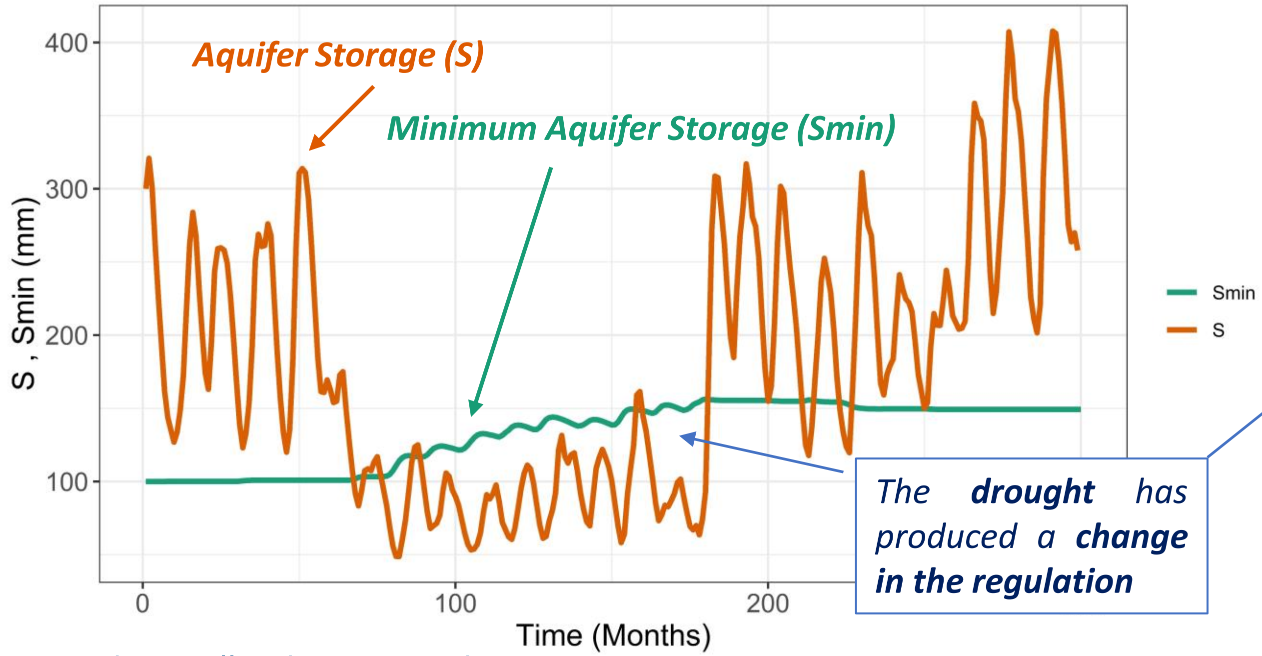
Scenario A: «Natural Shock to the System» - Simulation Results







Feedback Mechanism

- *The shocks produce a change in the regulation.*
- *The Minimum Groundwater Storage level increases (or decreases in Human-Induced Shock Scenario) to preserve the environment from future shocks (or to let people extract more groundwater fo drinking water supply in future)*

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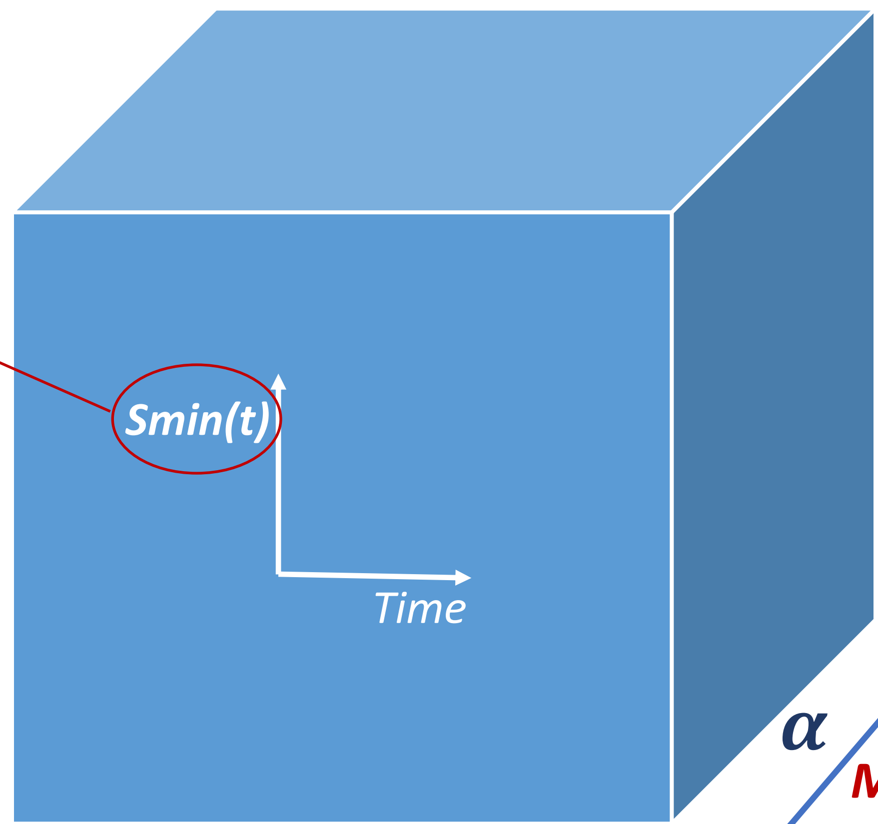
HOW DO SOCIAL ASPECTS IMPACT ON POLICY DURING (AND AFTER) NATURAL AND HUMAN-INDUCED SHOCKS?

Exploring Space of Socio-Hydrological Parameters



Feedback Mechanism On Policy

γ

Green Mind $\frac{\gamma_E}{\gamma_{DW}}$

Environmental Awareness
More important than
Drinking Water Awareness

The way of thinking of community
(Community's Education and Culture)

Grey Mind $\frac{\gamma_E}{\gamma_{DW}}$

Environmental Awareness
Less important than
Drinking Water Awareness

α

LONG MEMORY

Memory: the capacity of community to remember water crisis
(People's Personal Experiences)

SHORT MEMORY

μ

FAST ACTION — *SLOW ACTION*

Speed in Implementing Management Decisions
(Governement)

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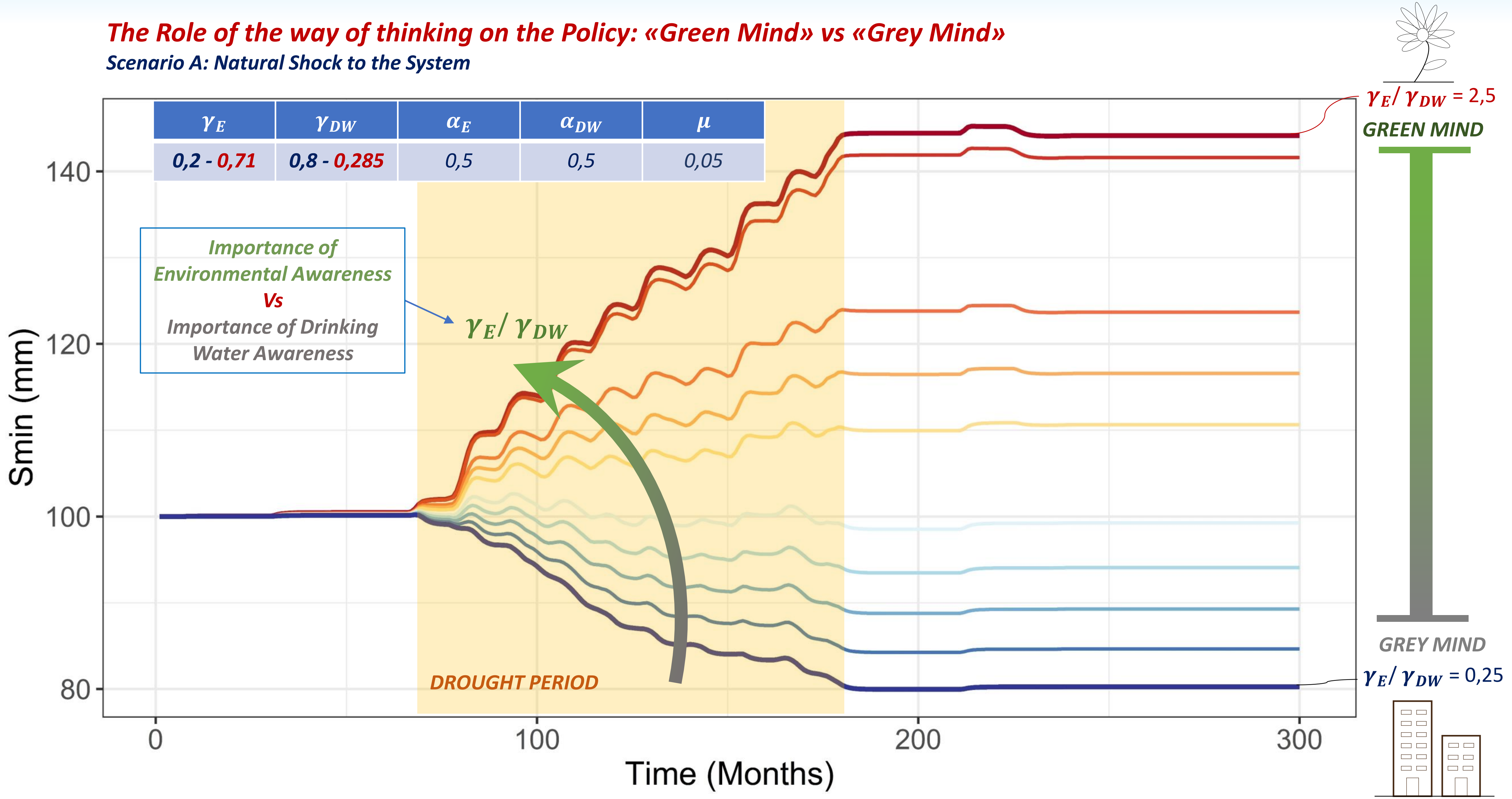
The Role of the way of thinking on the Policy: «Green Mind» vs «Grey Mind»

Scenario A: Natural Shock to the System

γ_E	γ_{DW}	α_E	α_{DW}	μ
0,2 - 0,71	0,8 - 0,285	0,5	0,5	0,05



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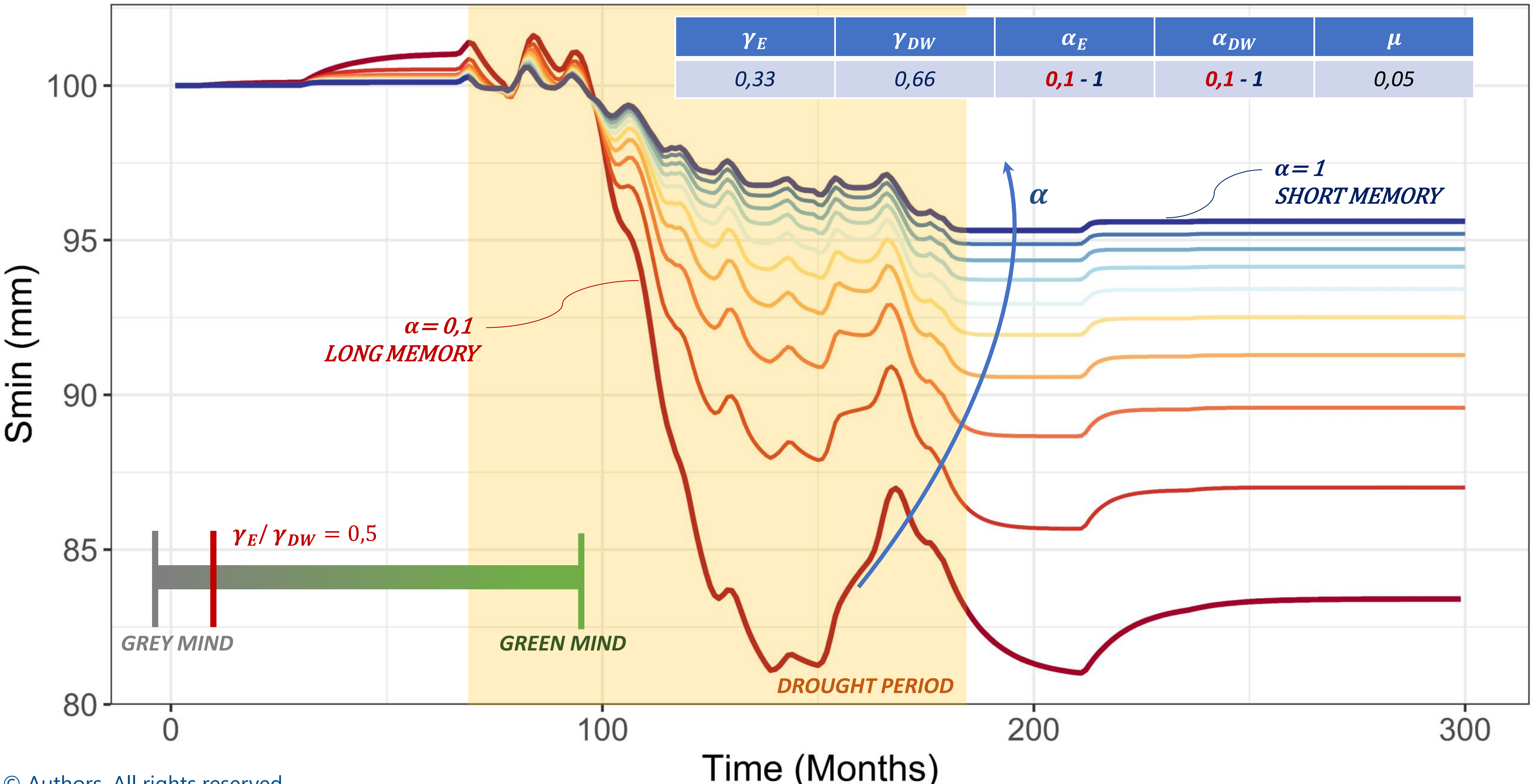
The Role of the the Memory on the Policy

Scenario A: Natural Shock to the System



γ_E	γ_{DW}	α_E	α_{DW}	μ
0,33	0,66	0,1 - 1	0,1 - 1	0,05

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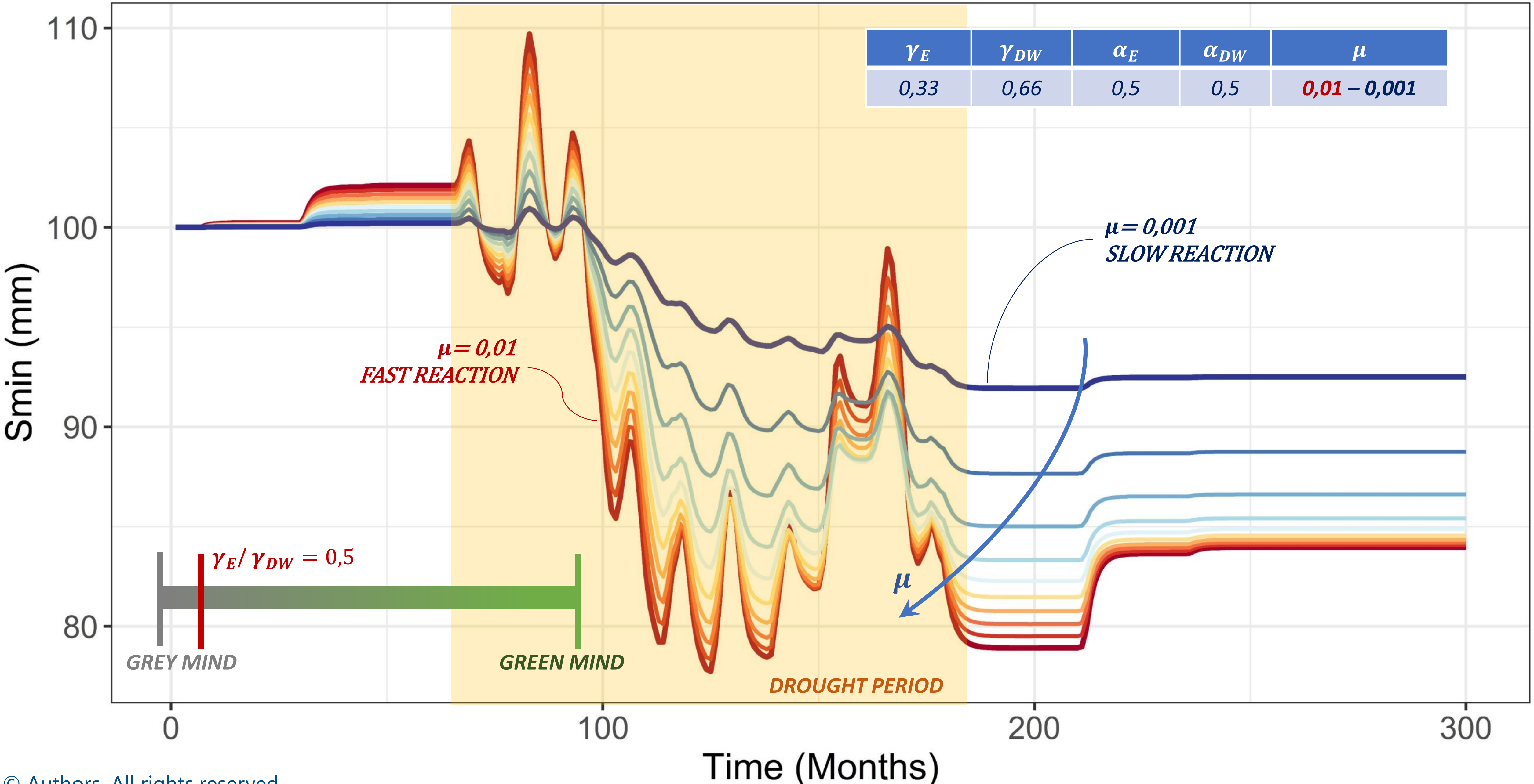
The Role of «Speed in Implementing Management Decisions (SIMD)» on the Policy

Scenario A: Natural Shock to the System

γ_E	γ_{DW}	α_E	α_{DW}	μ
0,33	0,66	0,5	0,5	0,01 – 0,001



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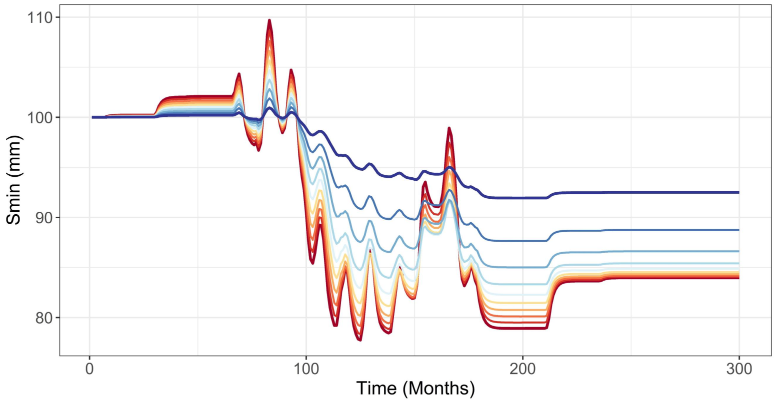
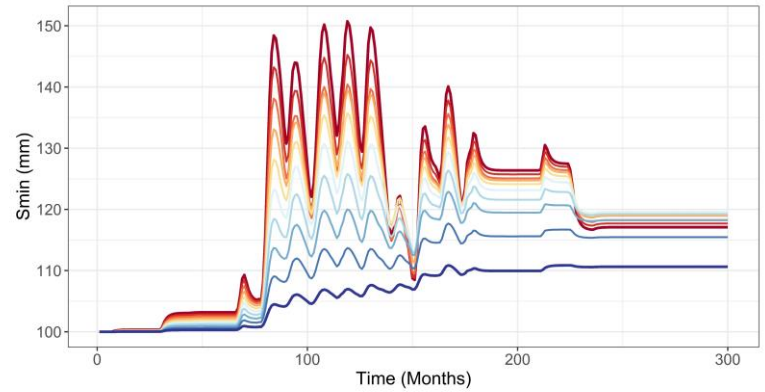
Investigating the Role of SIMD on the Policy

SCENARIO A NATURAL SHOCK

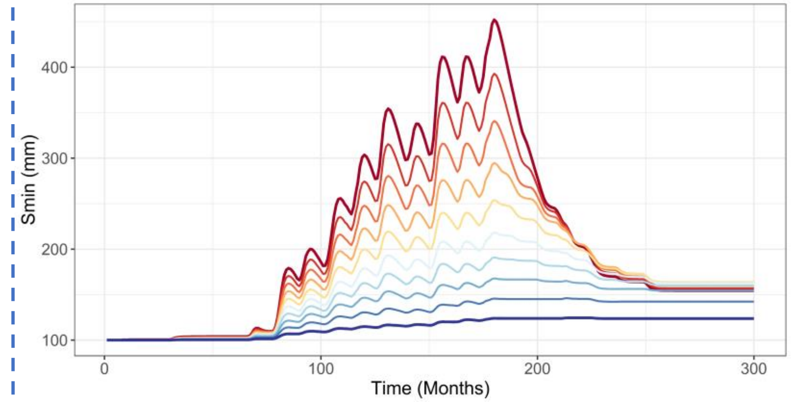
γ_E	γ_{DW}	α_E	α_{DW}	μ
0,33	0,66	0,5	0,5	**0,01 – 0,001**



γ_E	γ_{DW}	α_E	α_{DW}	μ
0,5	0,5	0,5	0,5	**0,01 – 0,001**

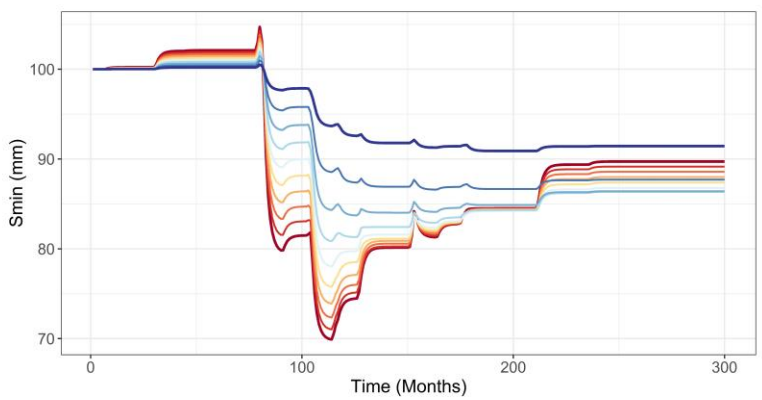


γ_E	γ_{DW}	α_E	α_{DW}	μ
0,6	0,4	0,5	0,5	**0,01 – 0,001**

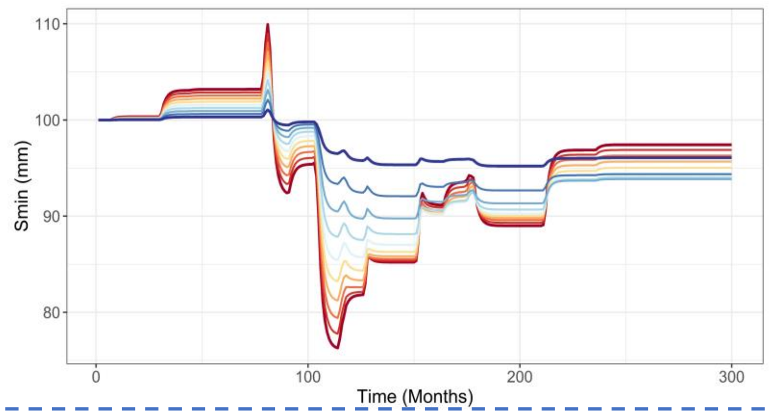


SCENARIO B HUMAN-INDUCED SHOCK

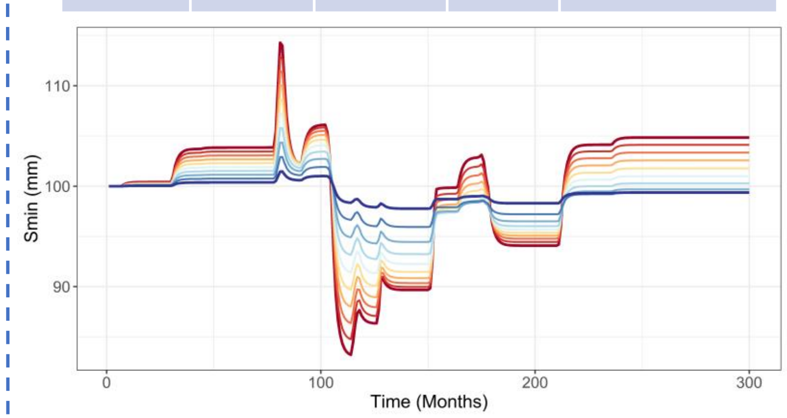
γ_E	γ_{DW}	α_E	α_{DW}	μ
0,33	0,66	0,5	0,5	**0,01 – 0,001**



γ_E	γ_{DW}	α_E	α_{DW}	μ
0,5	0,5	0,5	0,5	**0,01 – 0,001**



γ_E	γ_{DW}	α_E	α_{DW}	μ
0,6	0,4	0,5	0,5	**0,01 – 0,001**



GREY MIND

$\gamma_E / \gamma_{DW} = 0,5$

$\gamma_E / \gamma_{DW} = 1$

$\gamma_E / \gamma_{DW} = 1,5$

GREEN MIND

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The Need to Quantify: Sustainability Index Approach

Sustainability Index is calculated with Loucks (1997) definition:

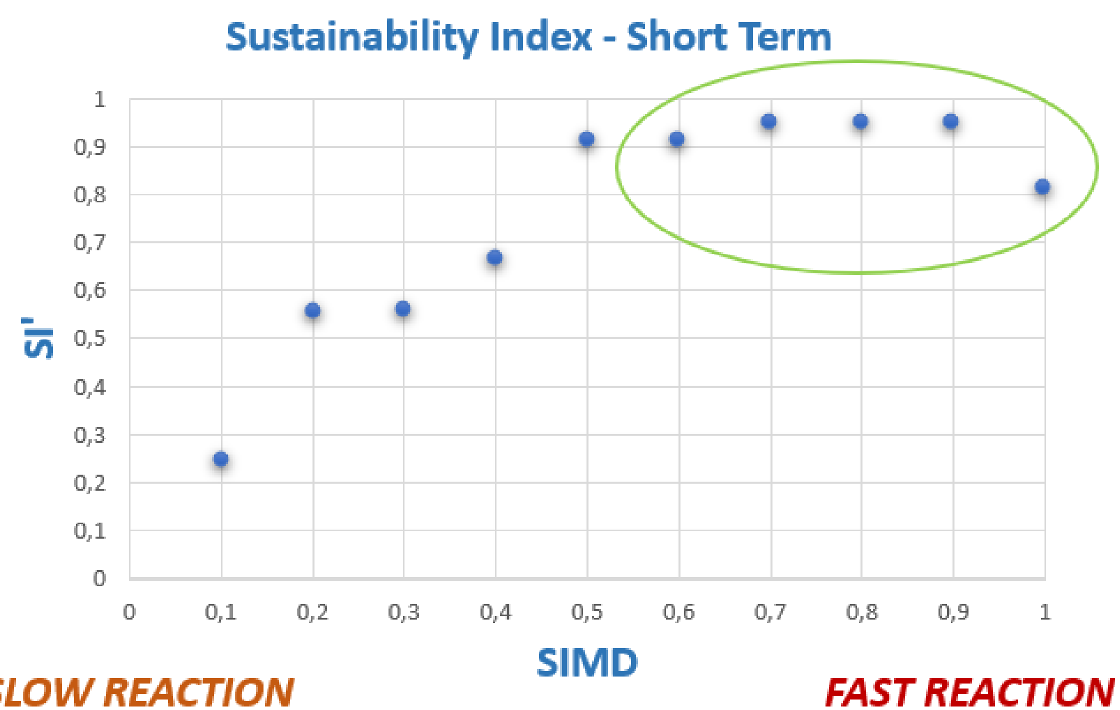
$$SI = [REL * RES * (1 - VUL)]^{1/3}$$

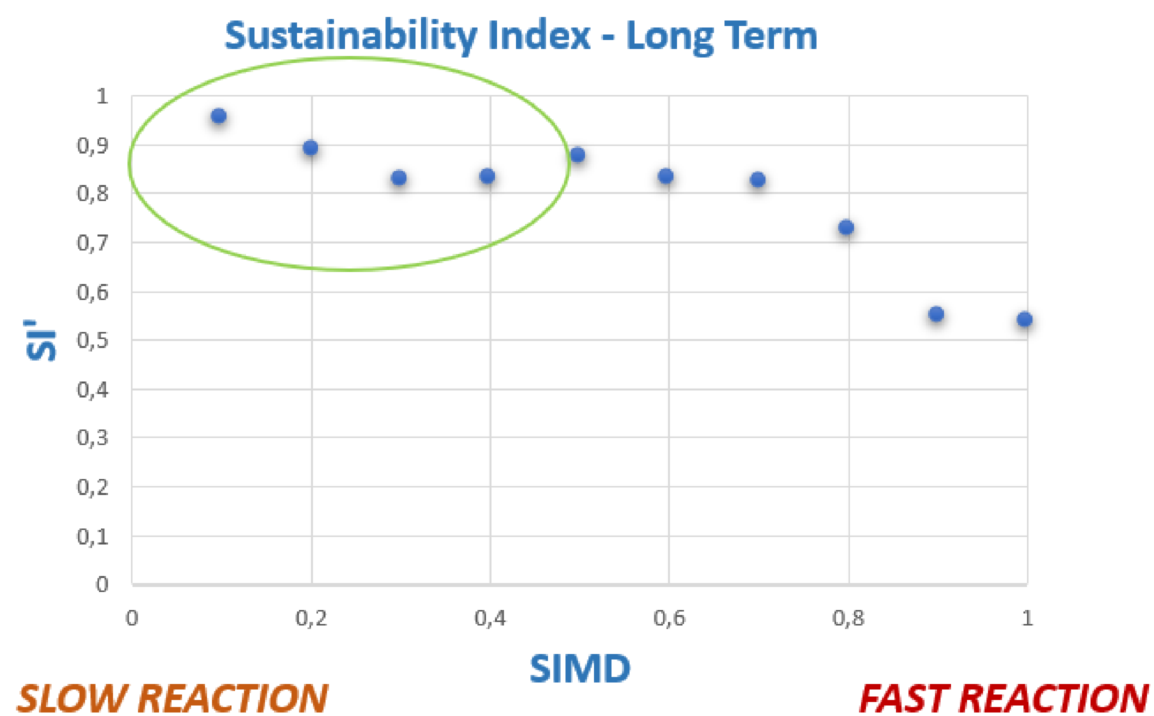
$SI = \ Sustainability\ Index$

$REL = Reliability$

$RES = \ Resilience$

$VUL = Vulnerability$





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Deductions and Conclusions

- For different **way of thinking** «grey» or «green», the *policy on system regulation* changes
- For different **memory** values, so for different ***capacities of the community to remember water crisis***, the *policy on system regulation* changes
- For different ***Speed in Reaction (SIMD)*** the policy on system regulation changes and consequently the sustainability of the system:
- **For faster reactions in the implementation of possible regulations we get to underestimate** (or overestimate) **the protection of groundwater resource to the detriment of environment** (or to the detriment of the drinking water supply). **This is a paradoxical effect.**
- It follows that **extremely rapid decision-making strategies (for example, programmed in conditions of water crisis) can be counter-productive in the long term** if not updated over time and if elaborated by **analyzing the problem on a short-term scale (immediately) without considering the long-term effects** that a socio-hydrological model like this may suggest.
- **Not taking decisions** in water crisis also damages the environment

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Thank you for the Attention