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July 17 - 22, 2021

# Dealing with COVID-19 Pandemic in Complex Societal System for Resilience Study: A Systems Approach

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# Outline of presentation

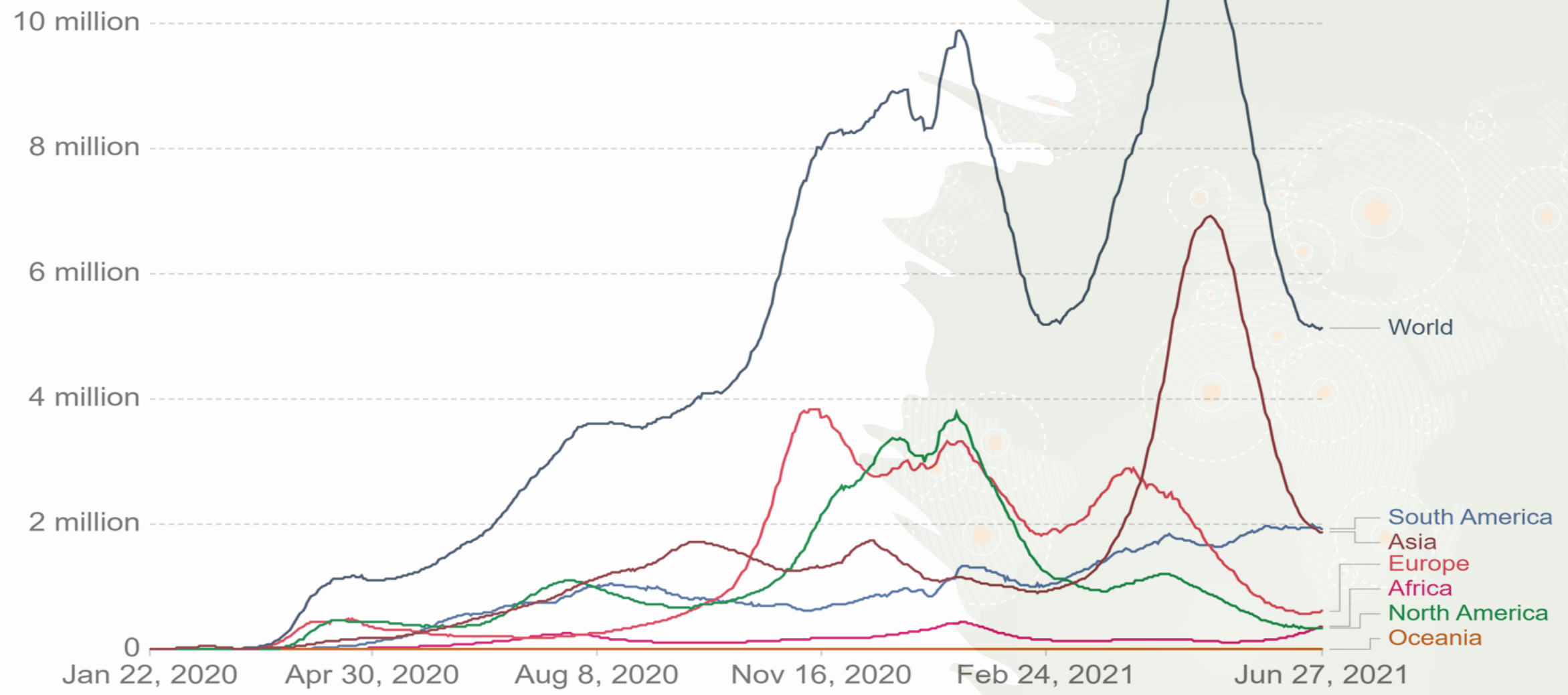
- Background: current situation
- How to understand COVID-19 in the complex societal system
- Discover the interactions among human behavior, governance and resilience
- Stage of Resilience
- Deepening the assessment: finding the dynamic, causal and complex feedback mechanisms
- Conclusion and future work



# Biweekly confirmed COVID-19 cases

Biweekly confirmed cases refer to the cumulative number of confirmed cases over the previous two weeks.

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# How to understand COVID-19 in the complex societal system via system approach

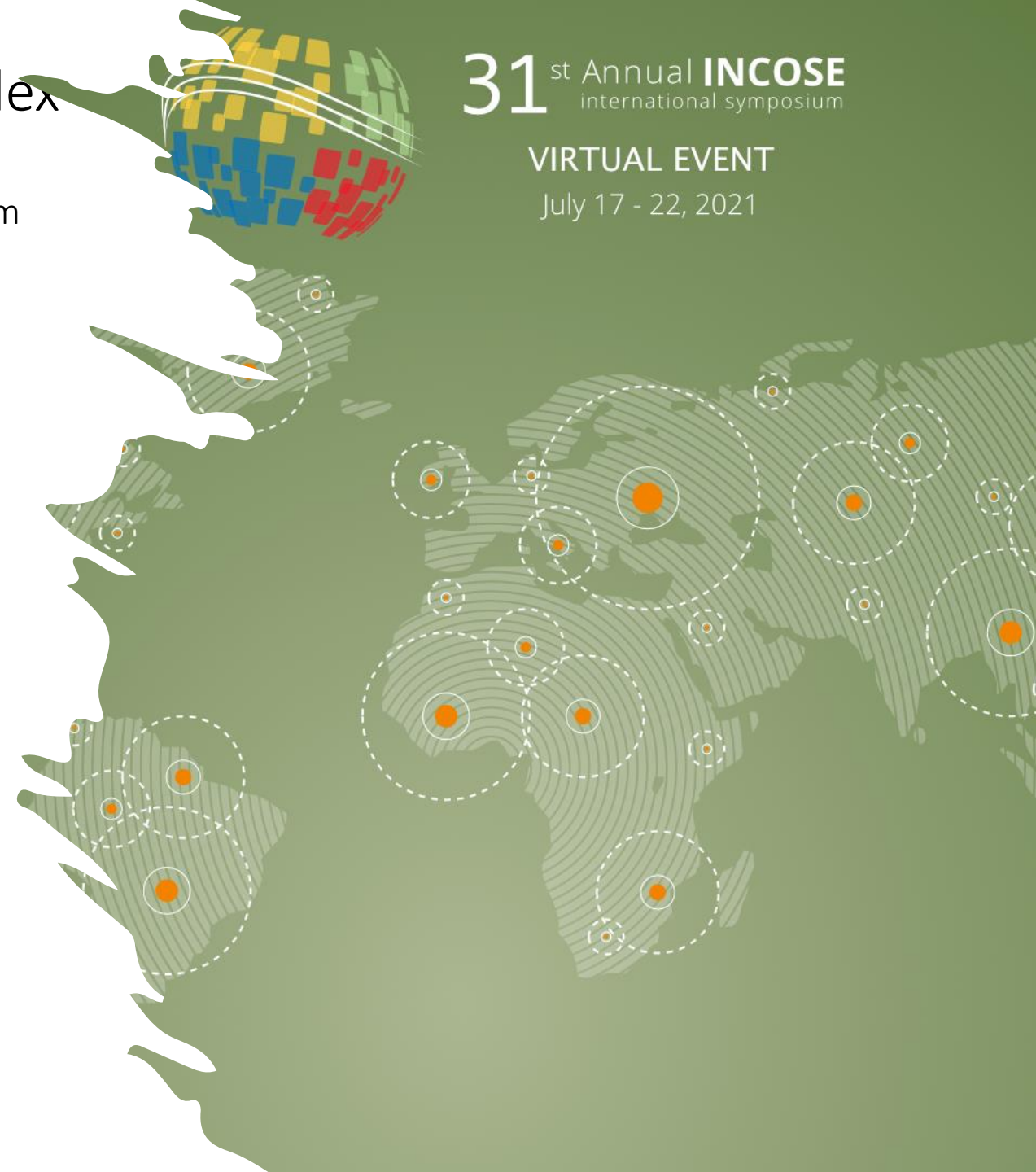
----Capture the Relationships and Complexity in the Societal System

- Not just a pandemic ,but also a societal system crisis
- Societal system can be seen as a dynamic and complex system involving many interrelated sub-systems and factors
- Cascades in changes or feedbacks, potentially affecting the condition of the entire complex system on the scale-free network
- High complexity, self-organization, non-linear and interdependency of societal system
- Systems approach provides a better understanding of behavior change for the complex system and visualizes interactions of policy interventions linked to system resilience

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# Human Behavior, Governance and Resilience within the Complexity and Interaction

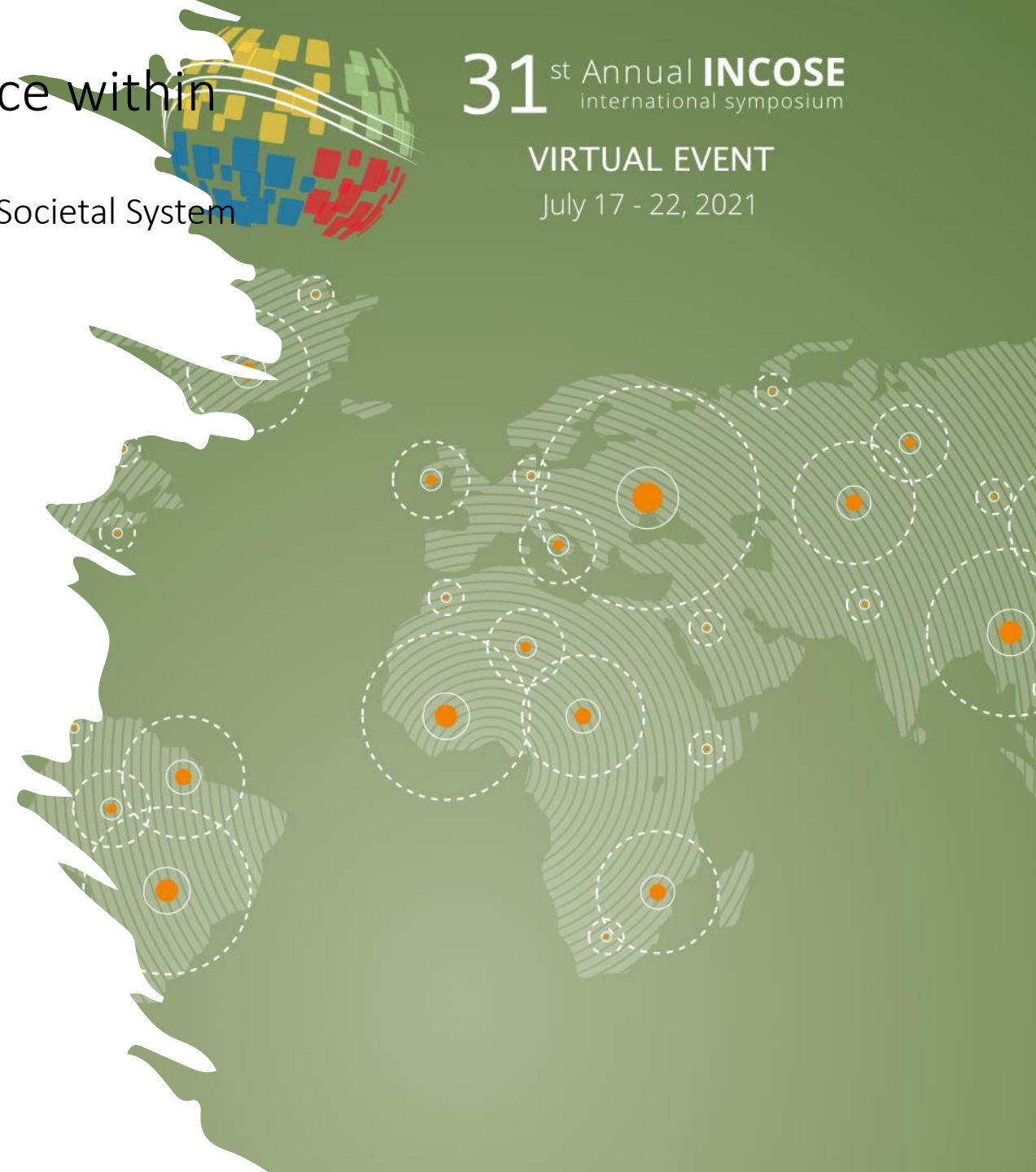
----Resilience: an Inherent Attribute under Complex and Adaptive Societal System

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- Resilience is a concept that first emerged from the ecosystem
- Now resilience is a crucial concept with continuing rising popularity during the COVID-19 pandemic
- Resilience:
  - Inherent characteristic
  - Not just a moment that societal system collapse and lose part of or whole functionality
  - A process from disrupting to restoring
  - an ability to suffer from the pressure and maintain the basic function in and after disturbance of trauma
  - continuously be formatted and shaped by multiple subsystems



# Human Behavior, Governance and Resilience within the Complexity and Interaction

----Governance: Managing and Responding to Uncertainty and Complexity in the Crisis

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- In the governance area, resilience discourses are system-oriented as a hallmark different policy portfolios
- Different policies continuously interlace and overlap, emerging interconnectedness in inter- and intra-systems
- Linked with human behavior, economy , developed infrastructure system and technology, etc.
- Considered from temporal-spatial dimensions with different intensities





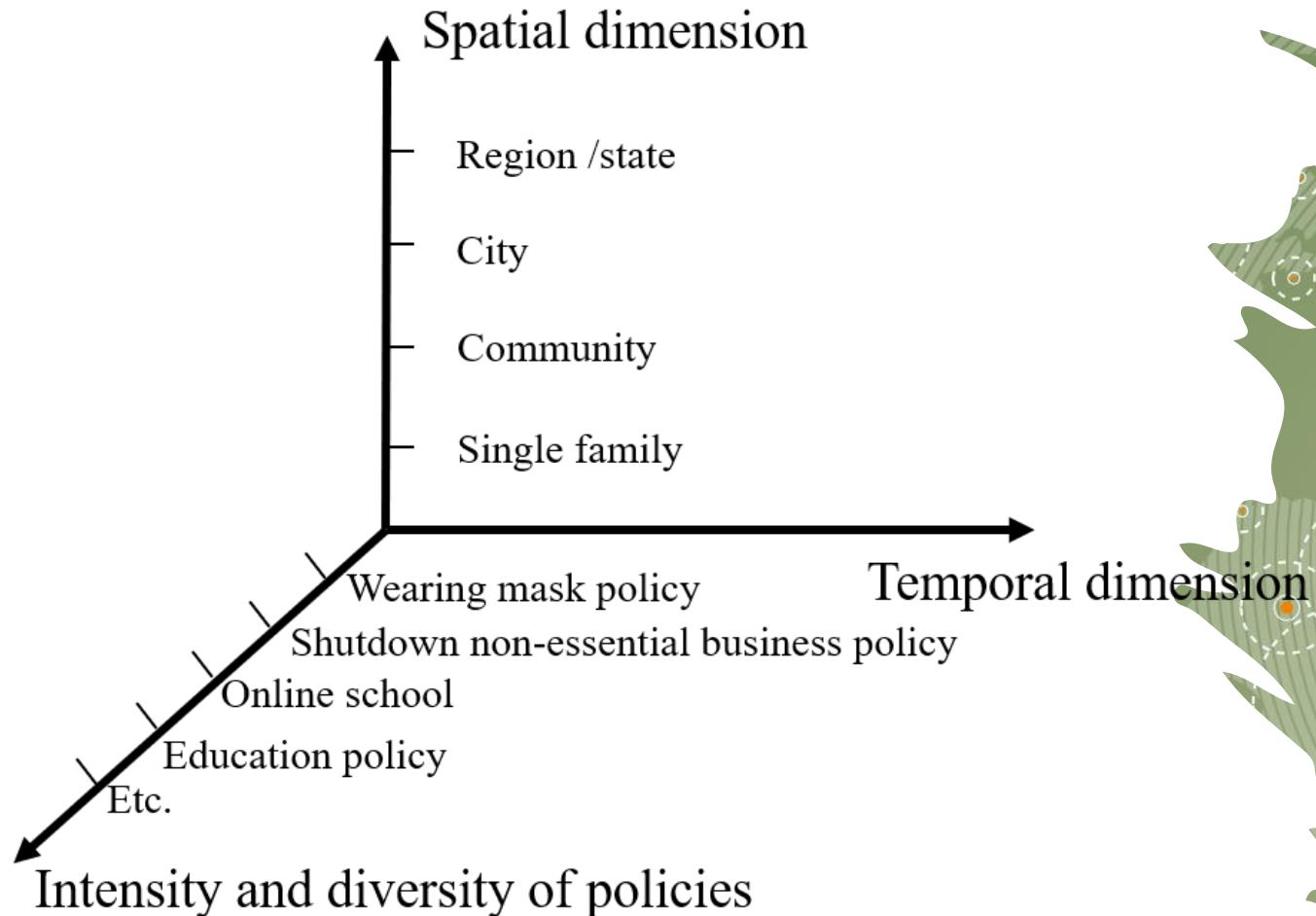
# Human Behavior, Governance and Resilience within the Complexity and Interaction

----The dimensions of policy implementation in governance system

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# Human Behavior, Governance and Resilience within the Complexity and Interaction

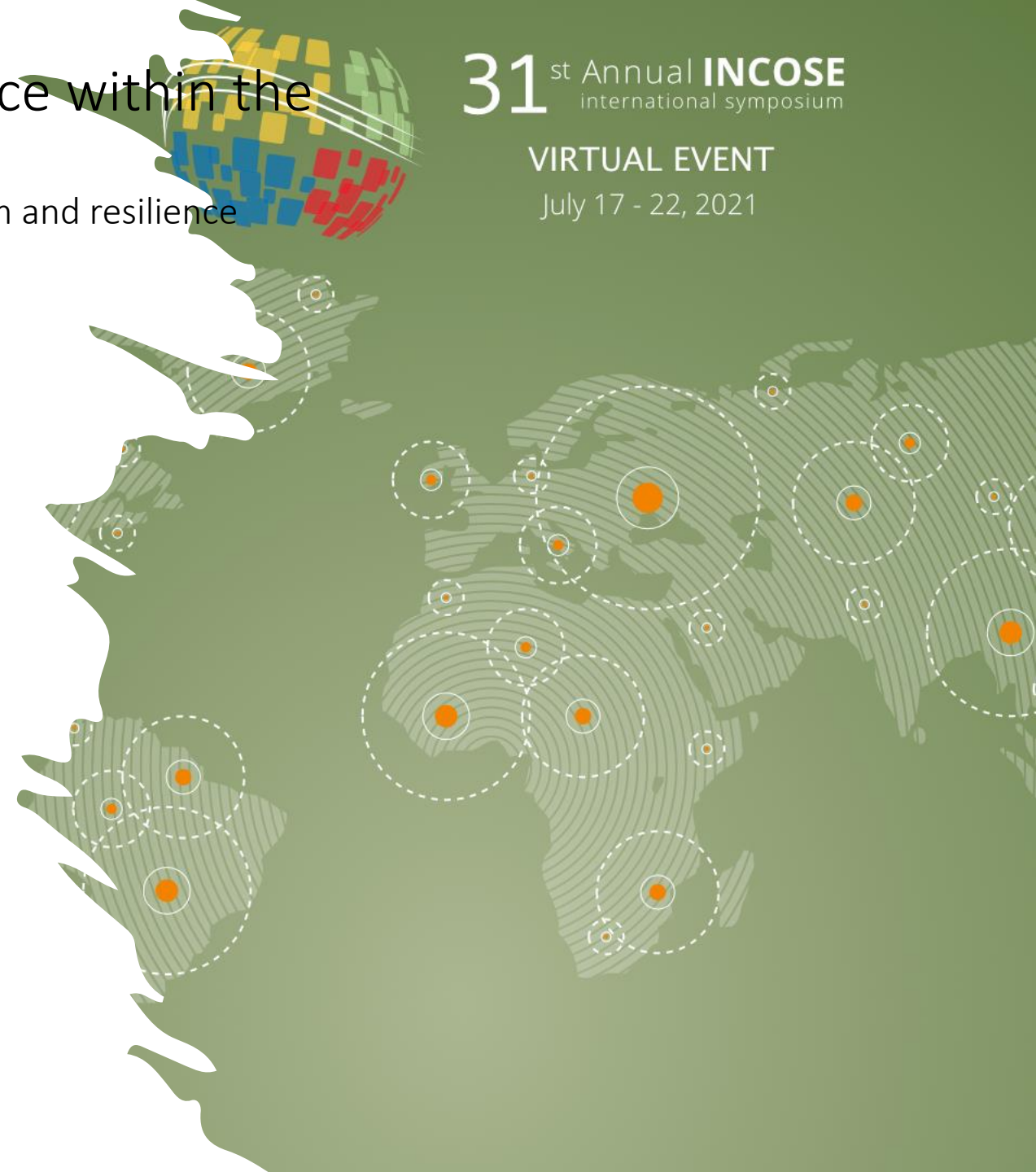
----Human behavior: constantly configuring the governance system and resilience

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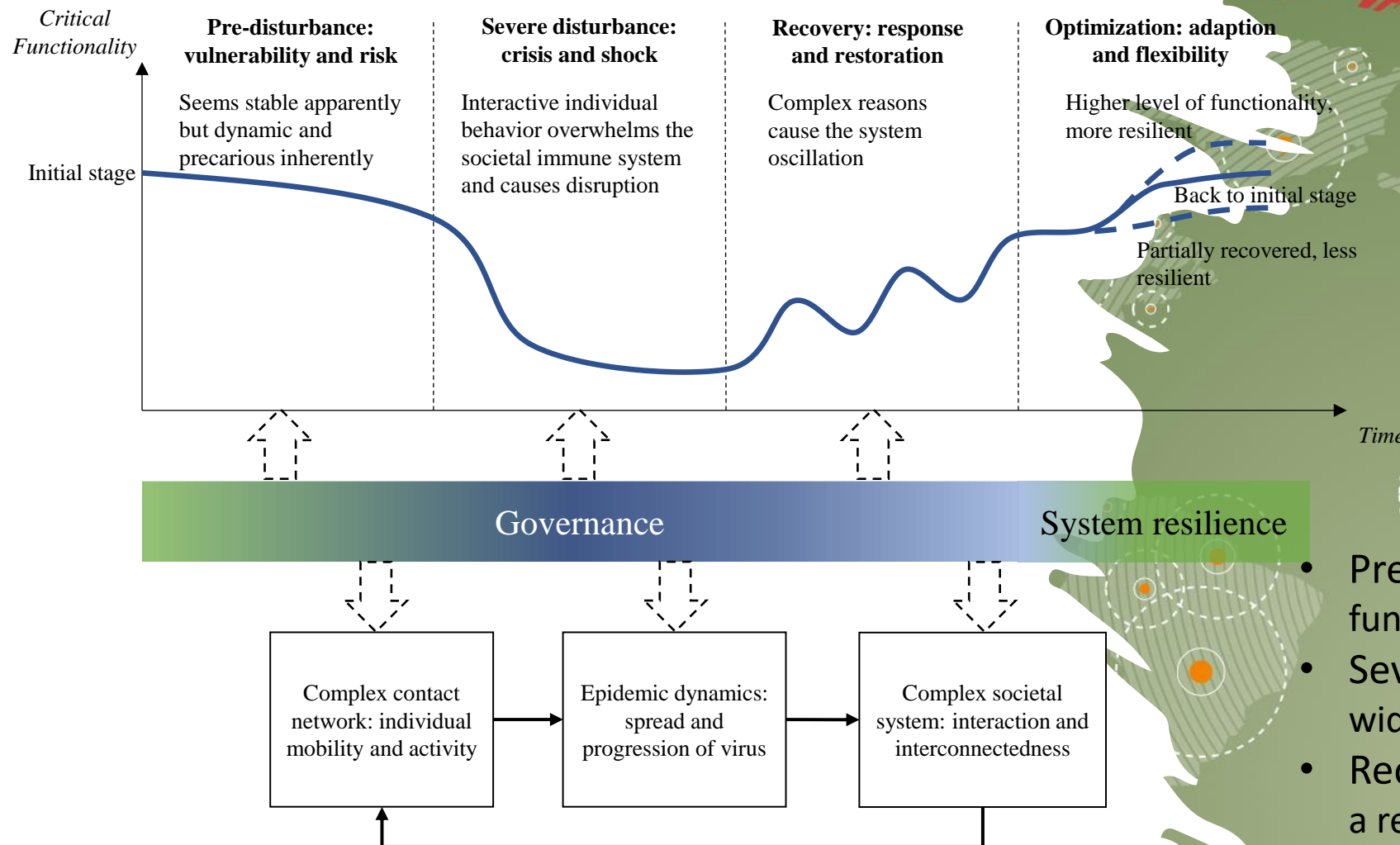
- Individuals are the most essential component of the societal system
- High complexity, self-organization and interdependency of human behavior, people with multiple socio-psychological, socio-economic, socio-natural interrelations continue affecting the spreading of the virus in the complex network
- Adaptation and variation of people's behavior and activity can change the spread of virus on the complex network
- In turn, be reconfigured and shaped by the governance system





# Stage of Resilience

---Resilience Framework under COVID-19 Crisis at different stage



# Green Bar Represents No/Less Policy Intervention, while Blue Bar Represents the Intense Policy Intervention

- Pre-disturbance stage ---still fully functional but inherently unstable
- Severe disruption stage --- virus will widely spread on the scale-free network
- Recovery stage --- prepare to get into a restoration stage
- Last stage --- fully recover or partial recovery with a long-term plan

# Deepening the assessment:

---Finding the dynamic, causal and complex feedback mechanisms in the complex societal system

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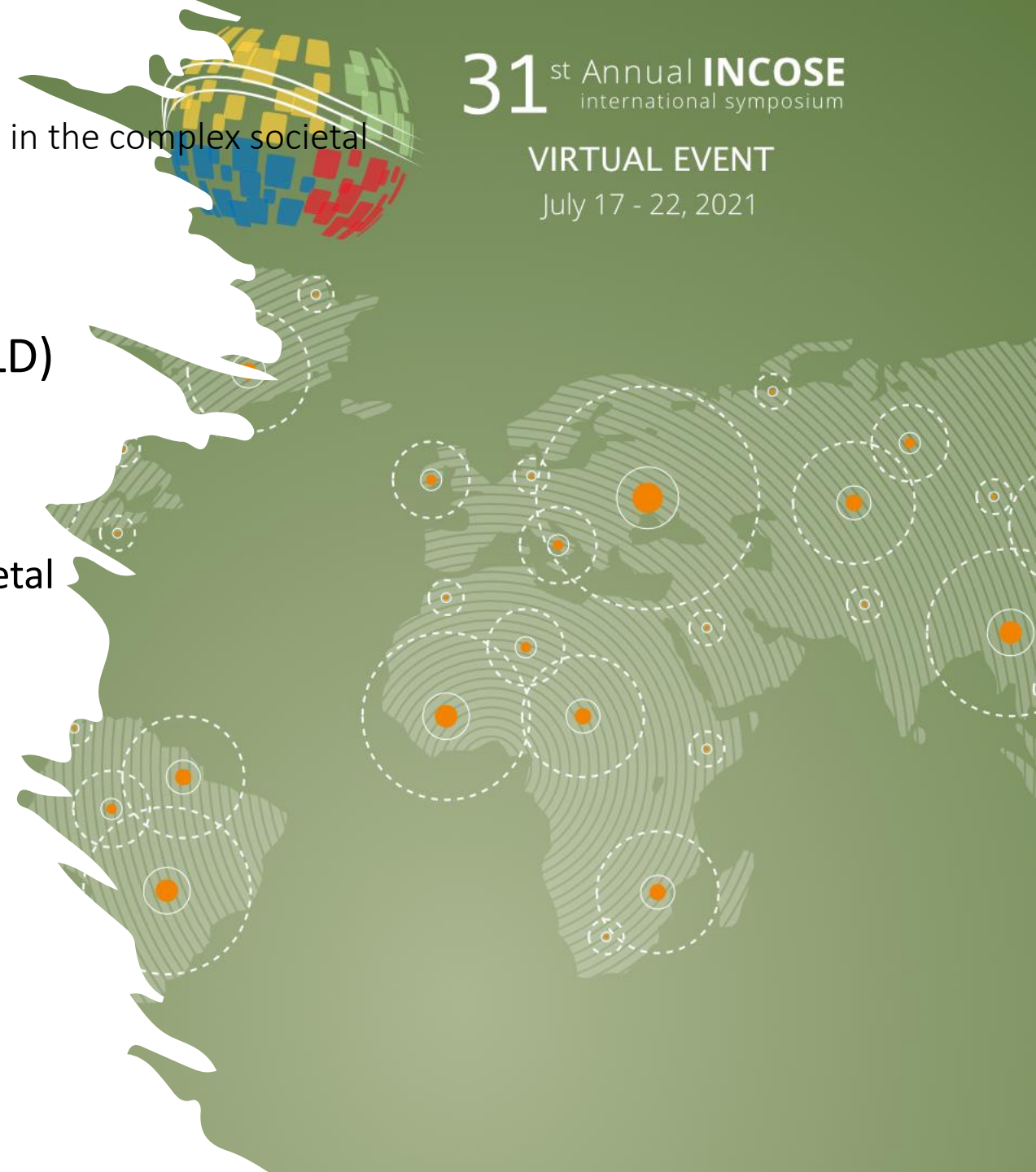
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## Model development --- Causal loop diagram (CLD)

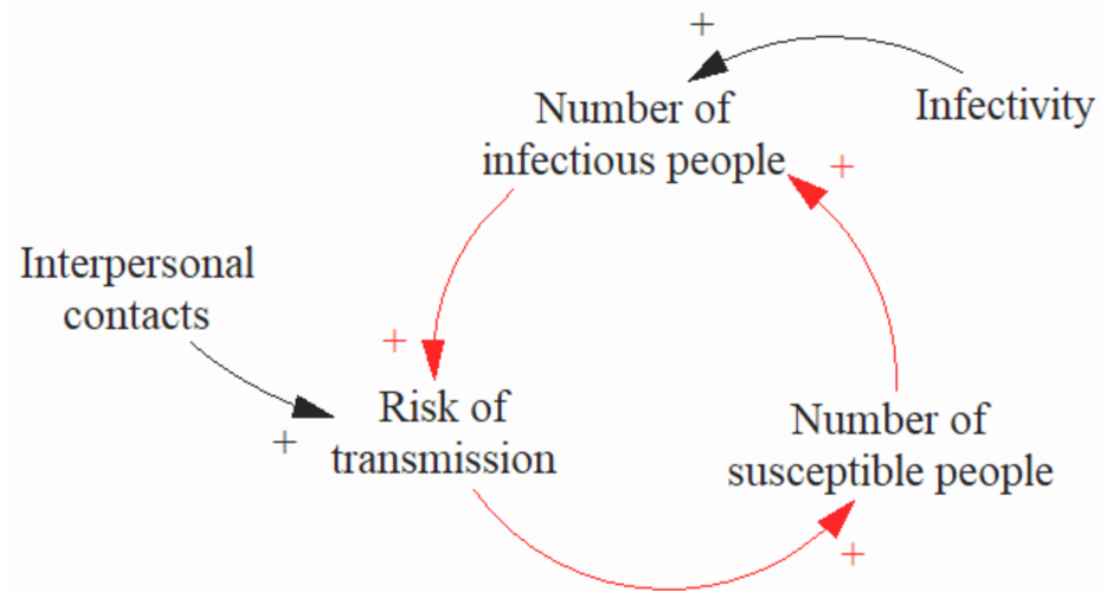
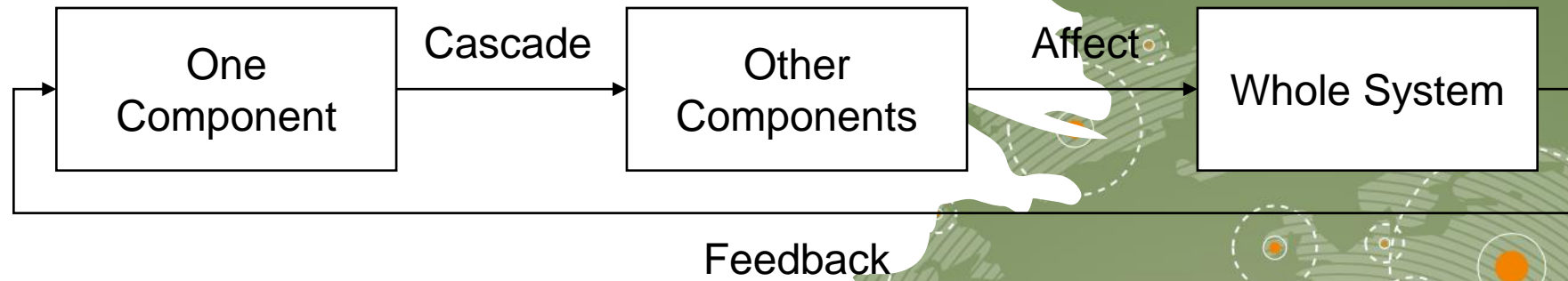
- Why CLD:

- An efficient approach to explore the complex societal system
- Providing a comprehensive and dynamic causal understanding
- Highlighting the interactions, causalities and interrelationships with multiple feedback loops
- Support the complex and interactive policymaking process with time effects



# Deepening the assessment:

---Causal loop diagram for the spread of COVID-19 at the early stage





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*No response and  
action: exponential  
increase*



*Early stage of spread:  
vulnernbility and risk*

# Deepening the assessment:

---Attentions on time delays

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Time delays in:

For governance:

- Policymaking
- Policy implementation
- Behavior recognition
- Behavior change
- Information asymmetry
- Lack of information

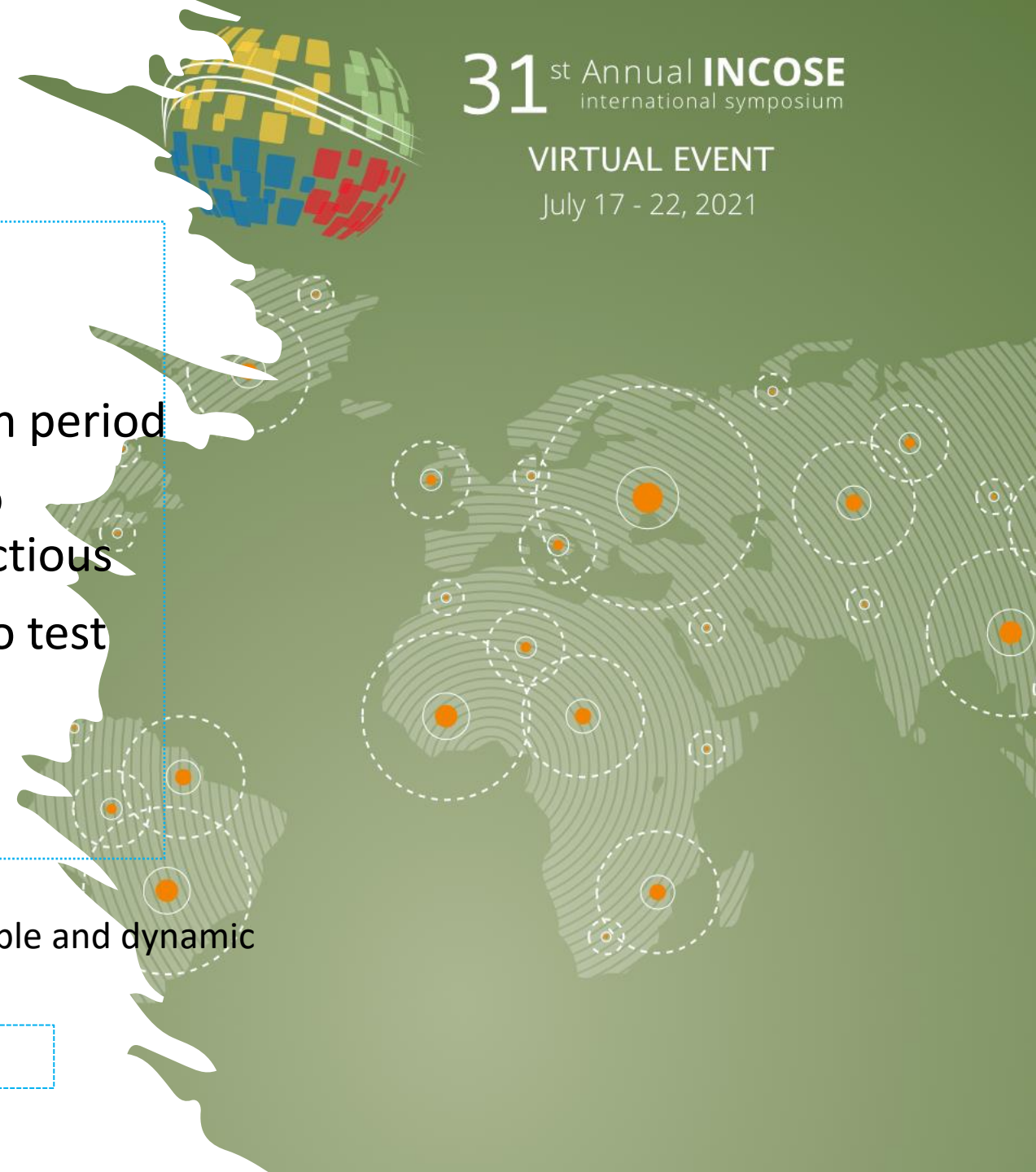
For virus:

- Existing incubation period
- From infections to symptoms or infectious
- From symptoms to test

Add a step

More unpredictable and dynamic

Complexity and non-linear of the societal system





# Conclusion and future work

---Summary

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- The rapid spread of COVID-19 can be regarded as the emergent result of the interaction, self-organization and interconnection in the characteristics and systems of the systems
- The rebound and development of our societal system will continue shaped by this crisis
- System resilience can be thought as the inherent system properties that plays a critical role in the whole society
- Further resilience system should integrate human activity, governance system together to accomplish sustainability
- Multi-stage system resilience framework is proposed to demonstrate human behavior change with the effort of different governance actions under COVID-19 propagation showing function loss at different stage
- A system dynamics model related to the spread and inhibition of COVID-19 adds a level of big-picture thinking about current crisis and challenges with dynamic interaction and interconnectedness in the societal system under time effect



# Conclusion and future work

---Challenge and future work

## Challenge:

### ➤ Challenge

- Better understanding how different policies influence the human behavior change in terms of spread in of COVID-19 in societal system.

### ➤ Implementation

- Multi-stage resilience framework
- System dynamics model

### ➤ Results

- Virus spread out approach illuminated in complex system
- Policy execution process demonstrated at different stage
- Interaction and interdependency clarified

## Future work:

### ➤ System dynamic modeling with real-world data

- Validating the system dynamics model by simulation approaches such as agent-based model
- Testing the interaction and impact between governance system and human behavior in the societal system from multiple dimensions
- Evaluating the efficiency of different policies from temporal-spatial dimensions with varying intensity
- Providing an insight about how to evaluate the policy combinations and test the complex interactions in several scenarios and phases by the real-world data.

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Thank you!

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