



Ensuring the last mile: from production to patients



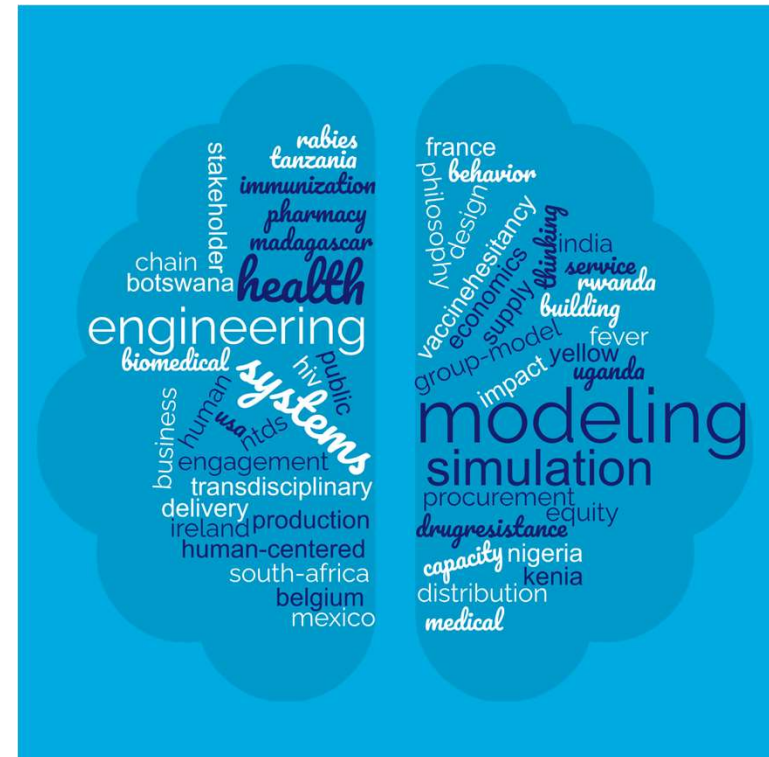
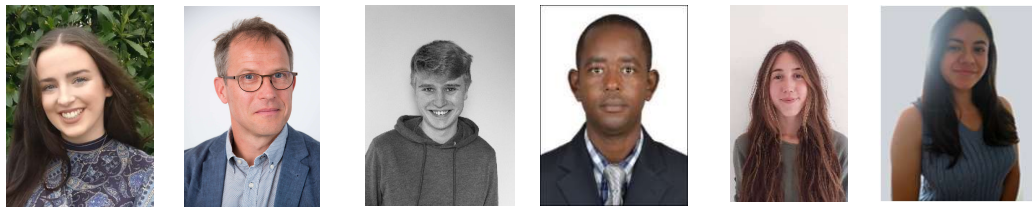
Broad spectrum antivirals workshop

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ATM – Access-to-Medicines Research Centre @ KU Leuven



<https://feb.kuleuven.be/research/decision-sciences-and-information-management/om/access-to-medicines-research-centre>

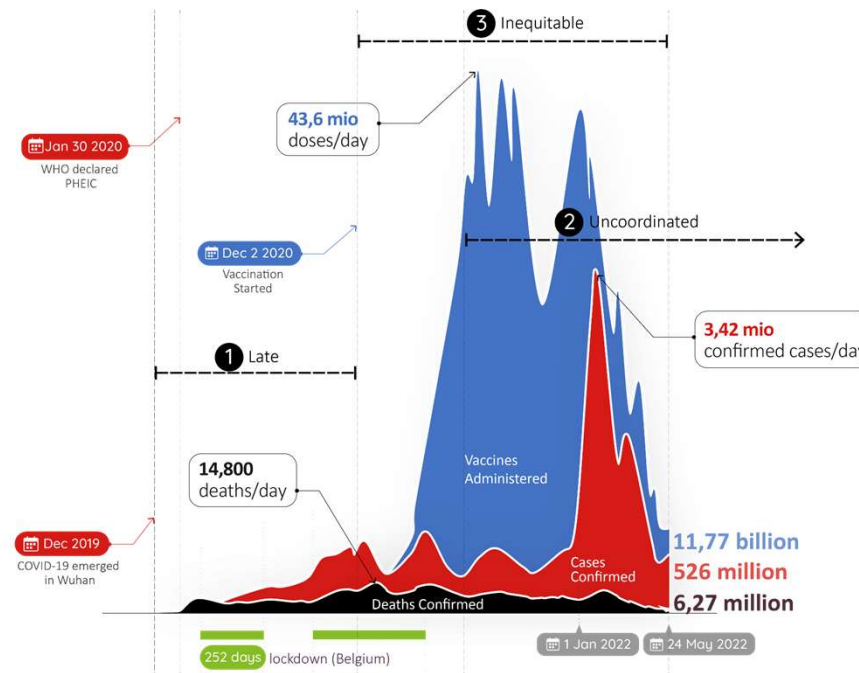
Overview

- Antivirals' role in epidemic response
- Pandemic preparedness: main decisions to be made
- Need for model-based decision support for subsystems and the broad system
- ATMs design framework, modeling methods and experiences
- Conclusions

Role of Antivirals for pandemic preparedness learnings from the COVID-19 vaccine roll-out

1 Buy response time

353 days between detection and first vaccination, missing the opportunity to keep the outbreak small.



3 Improve availability and access

vaccine allocation leaving room for variants to emerge and excess deaths in under-immunized areas.

2 Improve manufacturing sustainability

Vaccine manufacturing ramp-up causing inefficient supply-demand mismatch and lower vaccination effectiveness.

Next to vaccines, there was a need for therapeutic medical countermeasures

How can we prepare for disease X and respond accordingly?



* Response Time is the time between the first identification of the outbreak and the service delivery of countermeasures

Prepare against outbreaks of suspected Disease X

Develop and obtain regulatory approval for new countermeasures (platforms)

Design and model **response scenarios** using diagnostics, vaccines, therapeutics, and commodities against suspected disease X

Manufacture modeled quantities of **stockpiles** of relevant countermeasures

Reserve manufacturing capacity and **raw material sourcing** according to response scenarios

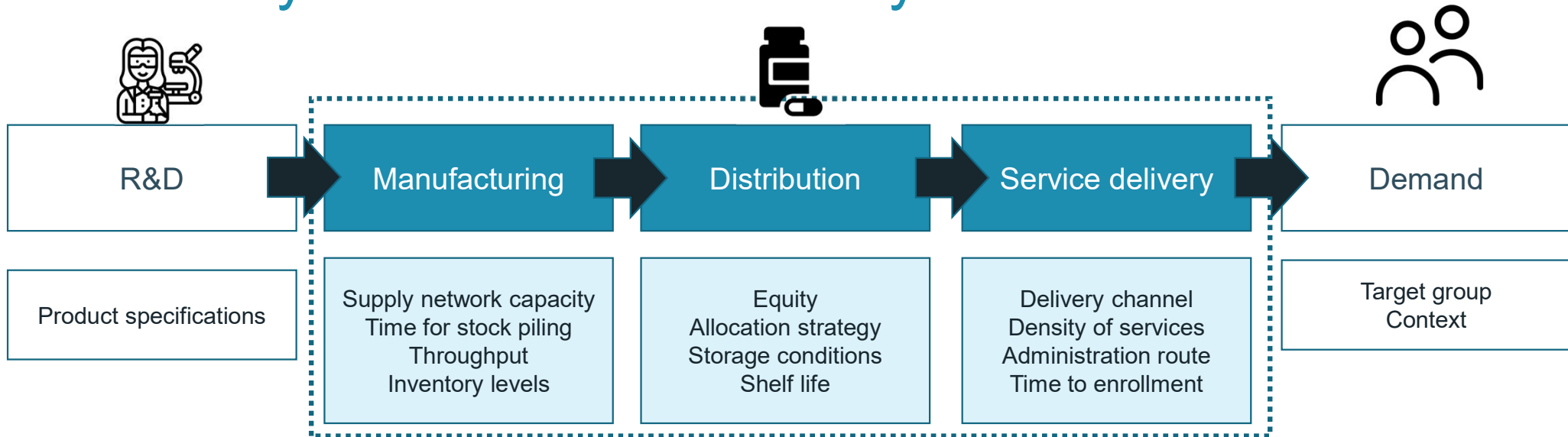
Respond timely, effectively, efficiently (Z -> X)

Immediate response based on **stockpiled** countermeasures and rapidly activate instant capacity to manufacture new products (vaccines, therapeutics, commodities)

Allocated to where most needed for **most effective** response to combat and contain the outbreak

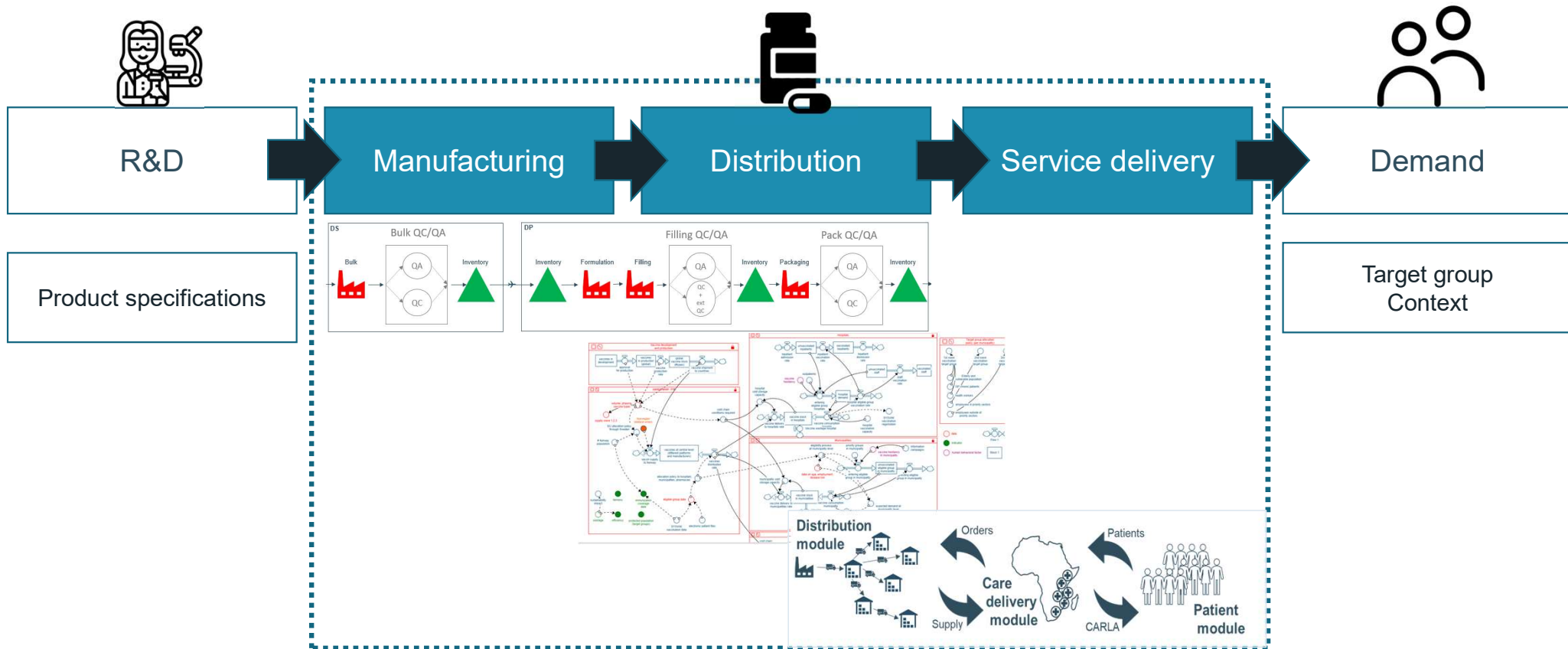
Efficiently coordinated based on a modeled scenario and in collaboration with stakeholders.

From production to patient: supply-chain decisions are driven by R&D decisions and dynamic demand

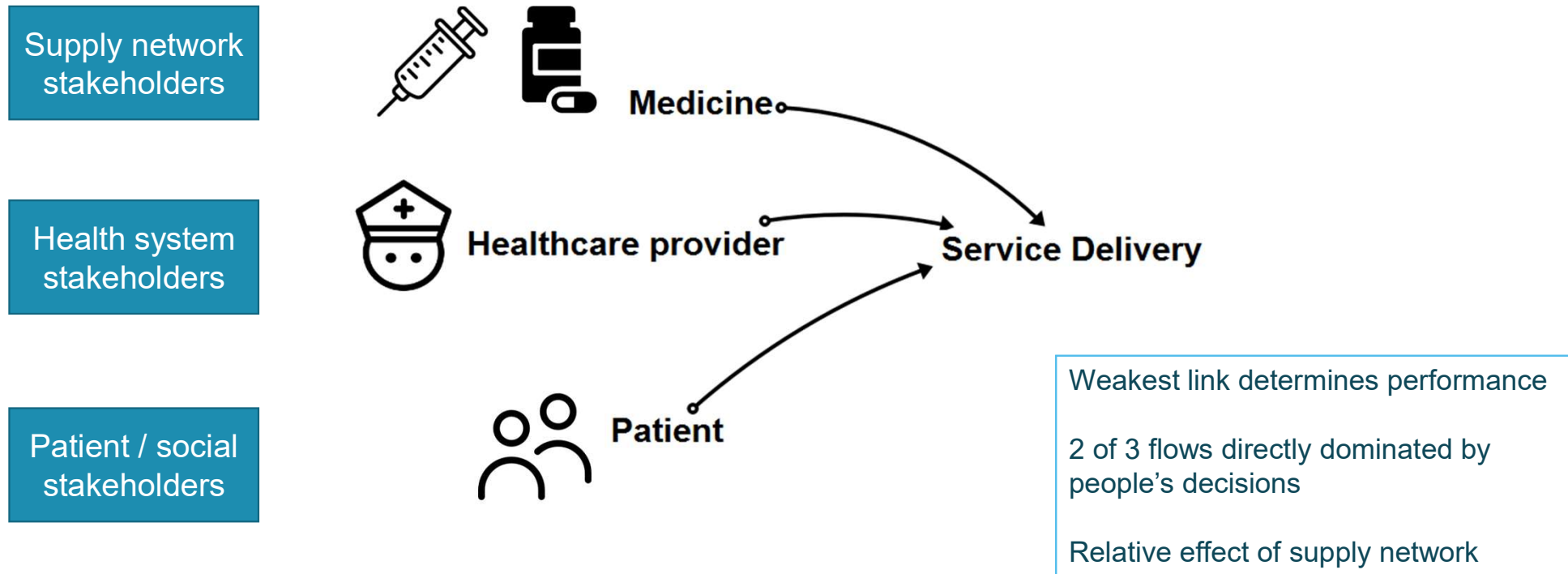


← Patient & health providers' needs & preferences. Health system and supply chain capabilities
Targeted drug, process and service design for increased health impact (implementation science)

Production to patient: manufacturer's perspective



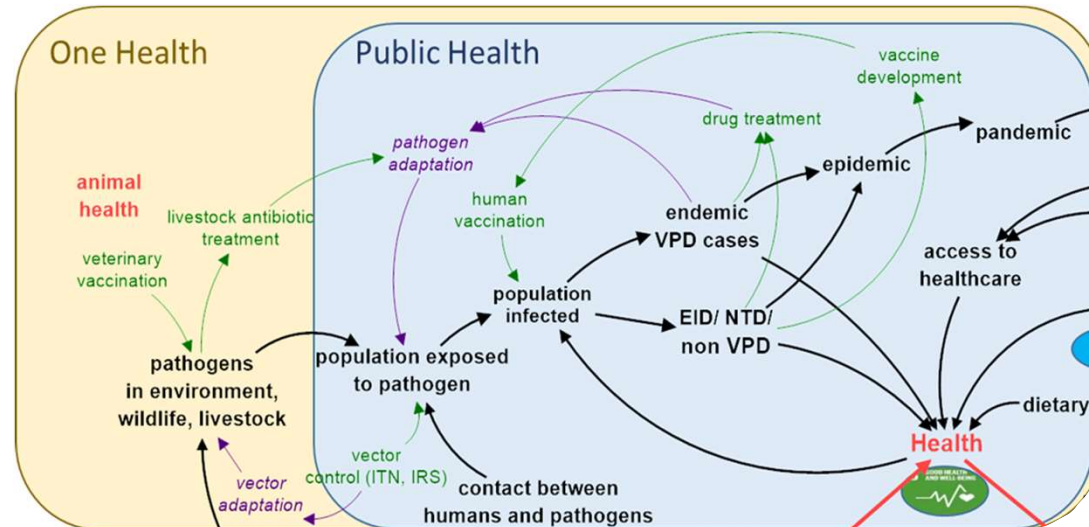
Importance of human behavior: Health impact when 3 flows are synchronized



Health systems are complex adaptive systems

Pandemics challenge health systems' resilience

- Self-organizing
- Constantly changing
- Tightly linked
- Governed by feedback



- Non-linear
- History-dependent
- Counter-intuitive
- Adaptation
- Resistant to change

Natural system



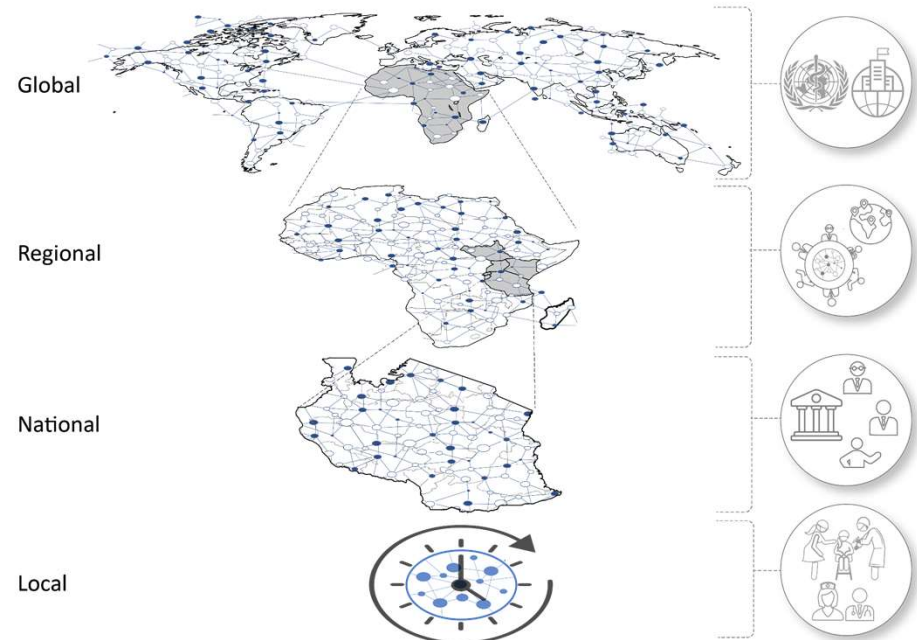
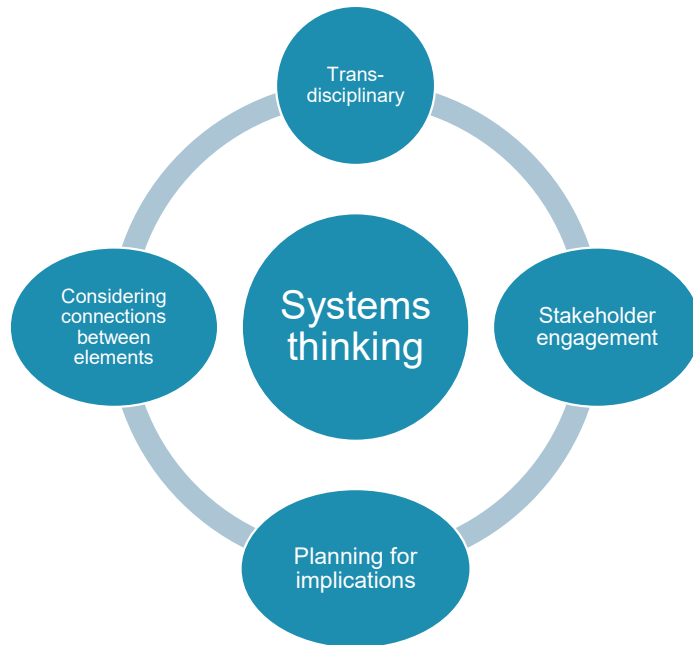
Human-made system

We cannot rely on **single-countermeasure strategies** (e.g. vaccination) for pandemic response and should consider **unintended consequences** (e.g. drug resistance)

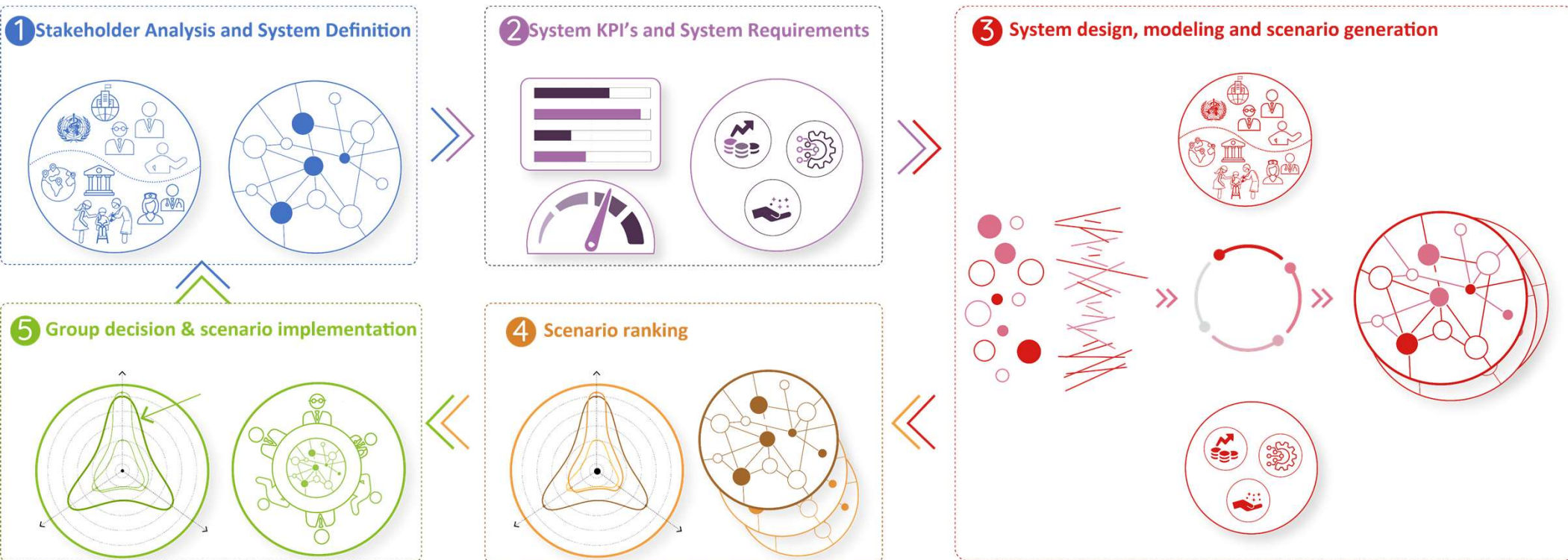
What is a systems approach?

A paradigm or perspective that considers **connections** among different components, **plans** for the **implications** of their **interaction**, and requires **transdisciplinary thinking** as well as **active engagement** of those who have a stake in the outcome to govern the course of change.

Leischow – Systems thinking and modeling for public health (2006)

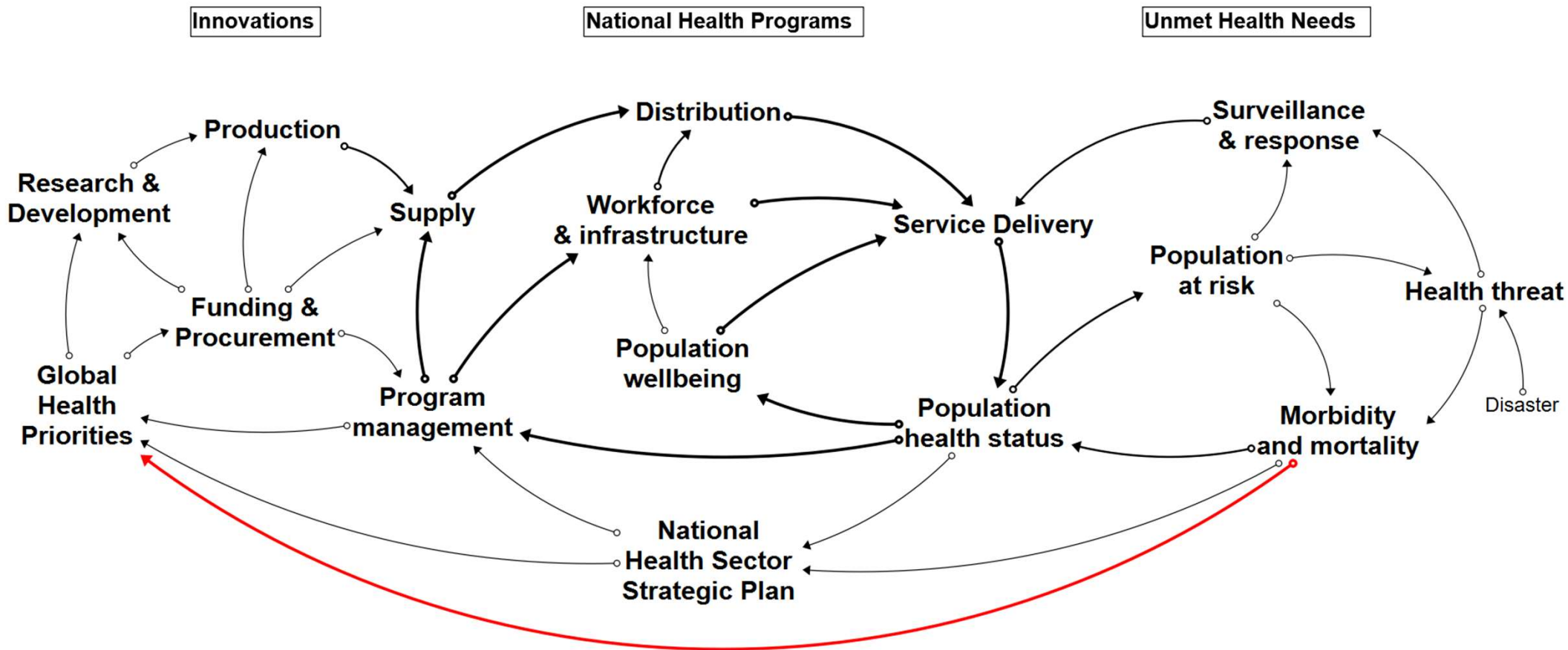


ATM Modeling & design framework



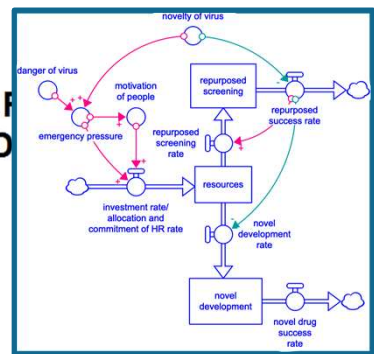
Adapted from Decouttere C, Vandaele N, Lemmens S, Bernuzzi M. The Vaccine Supply Chain Multathlon: the Reconciliation of Technology, Economy and Access to Medicines. In: *Advances in Managing Humanitarian Operations*. International Series in Operations Research & Management Science. Cham: Springer International Publishing; 2016:205-227. doi:10.1007/978-3-319-24418-1_10

Subsystem modeling methods for decision support



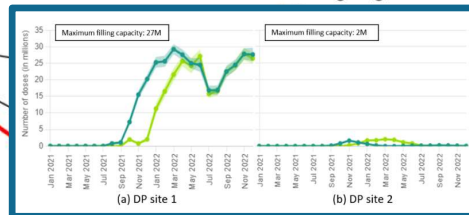
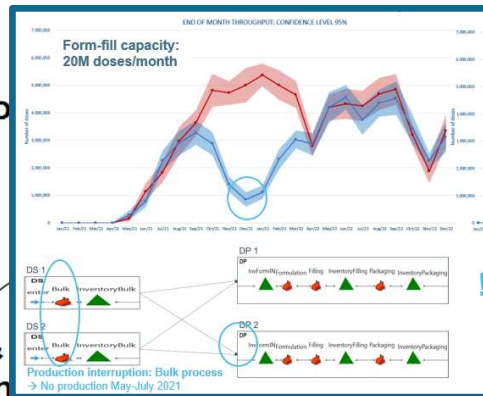
Subsystem modeling methods for decision support

Innovations

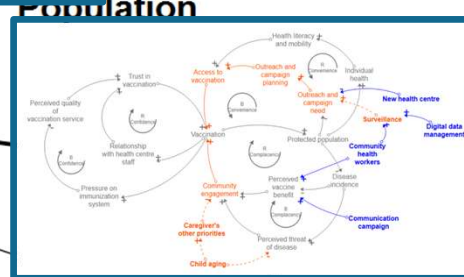
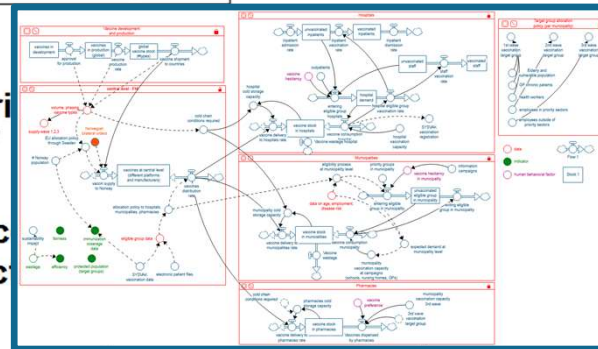


Global Health Priorities

National Health Programs

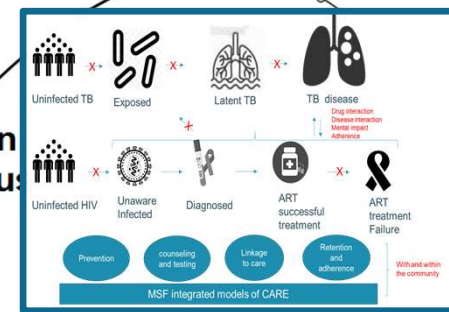


Population Health Status



Health Sector Strategic Plan

Unmet Health Needs



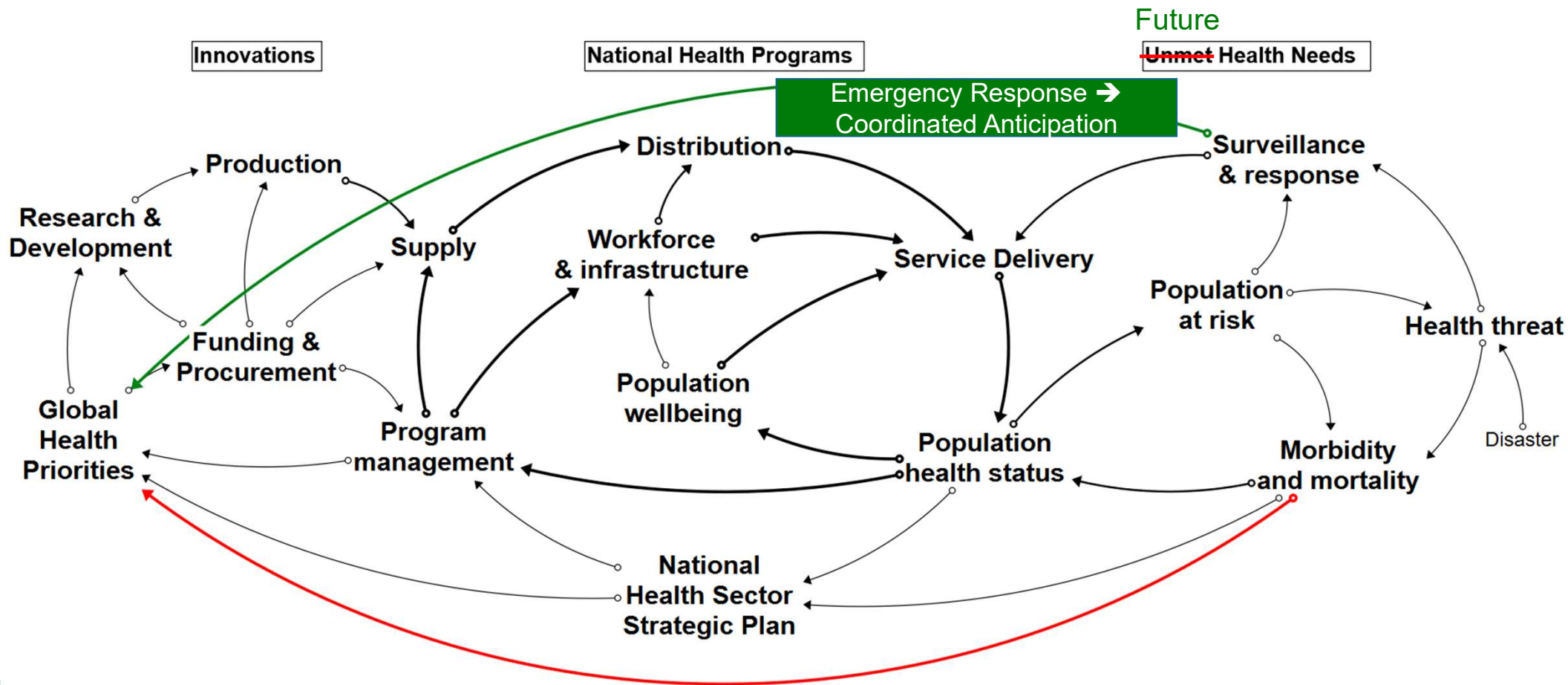
Surveillance & response

Population at risk

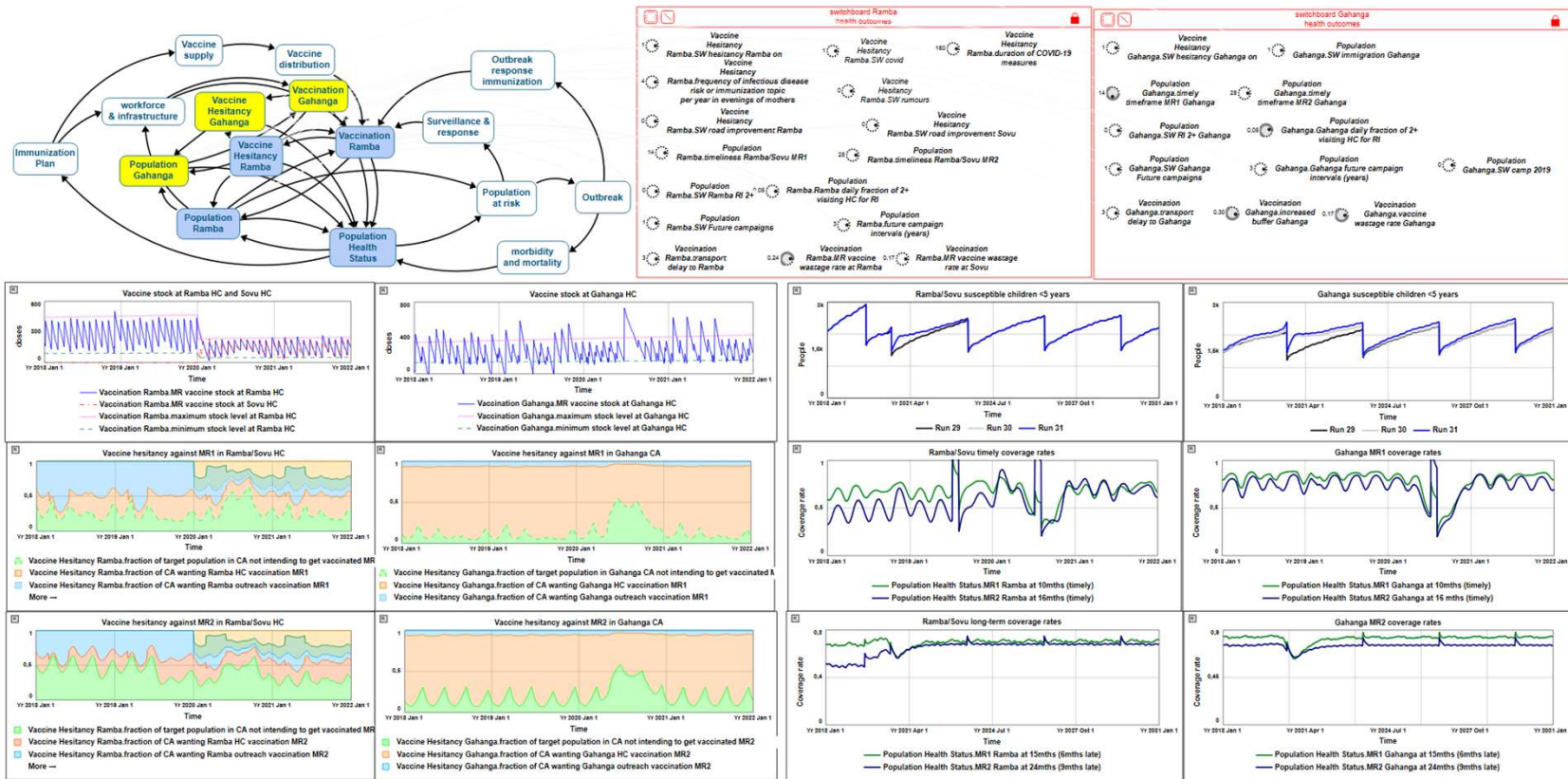
Health threat

Disaster

Broader system modeling for policy making



Broader system modeling for policy making with System Dynamics Modeling and policy analysis



Decouttere C. Sustainable Immunization System Design in sub-Saharan Africa. 2020.

Conclusions

- **Implementation design**, concurrently designing antivirals, their supply network, and service delivery to the patient, serves increased health impact
- **Systems modeling approach** is essential to capture the dynamic behavior, uncertainties and complexity of pandemics and the impact of antivirals and other medical countermeasures
- Subsystems and the broader pandemic preparedness and response system can be **quantitatively modeled** to provide decision support and policy analysis

Thank you!

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