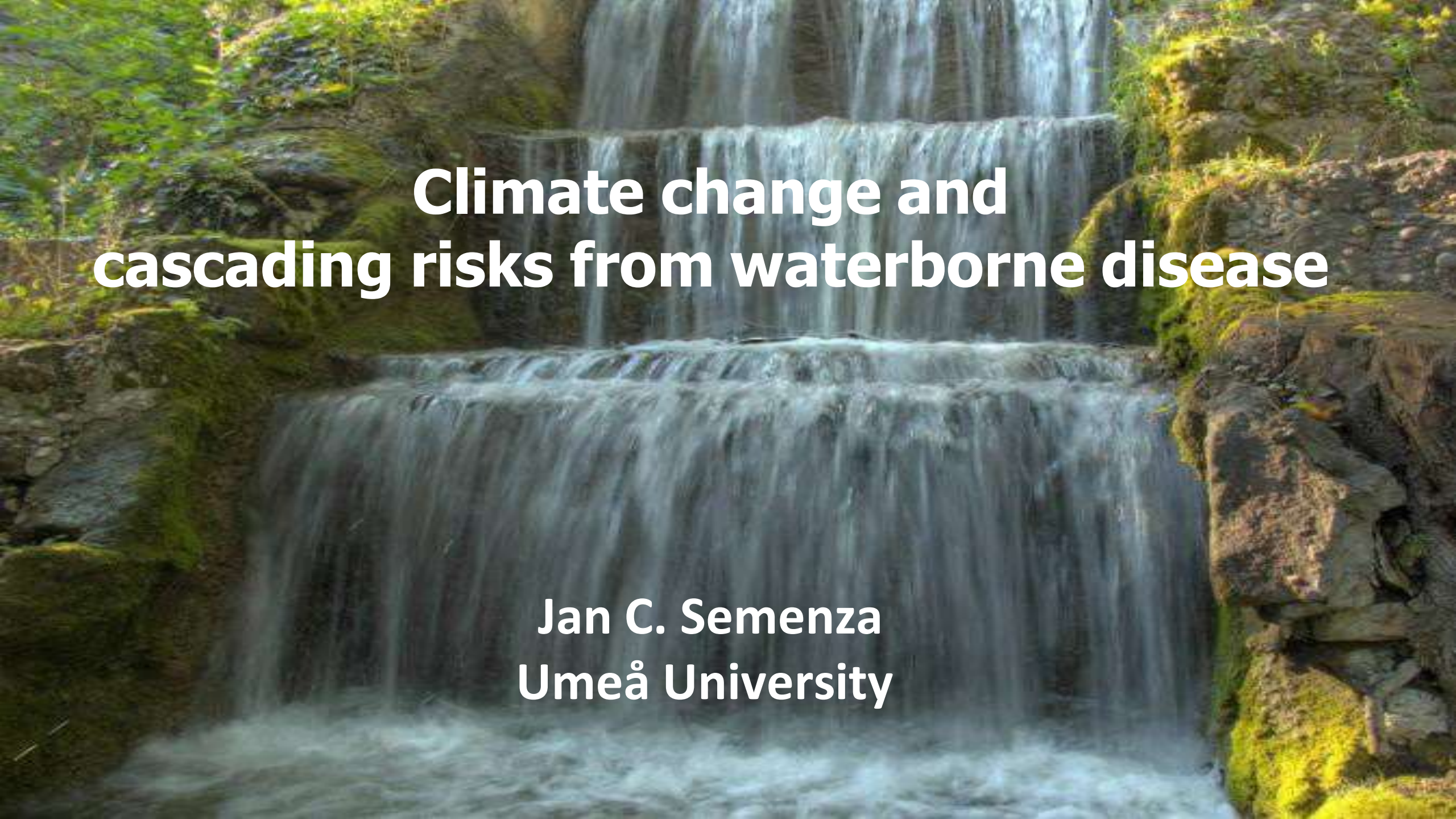
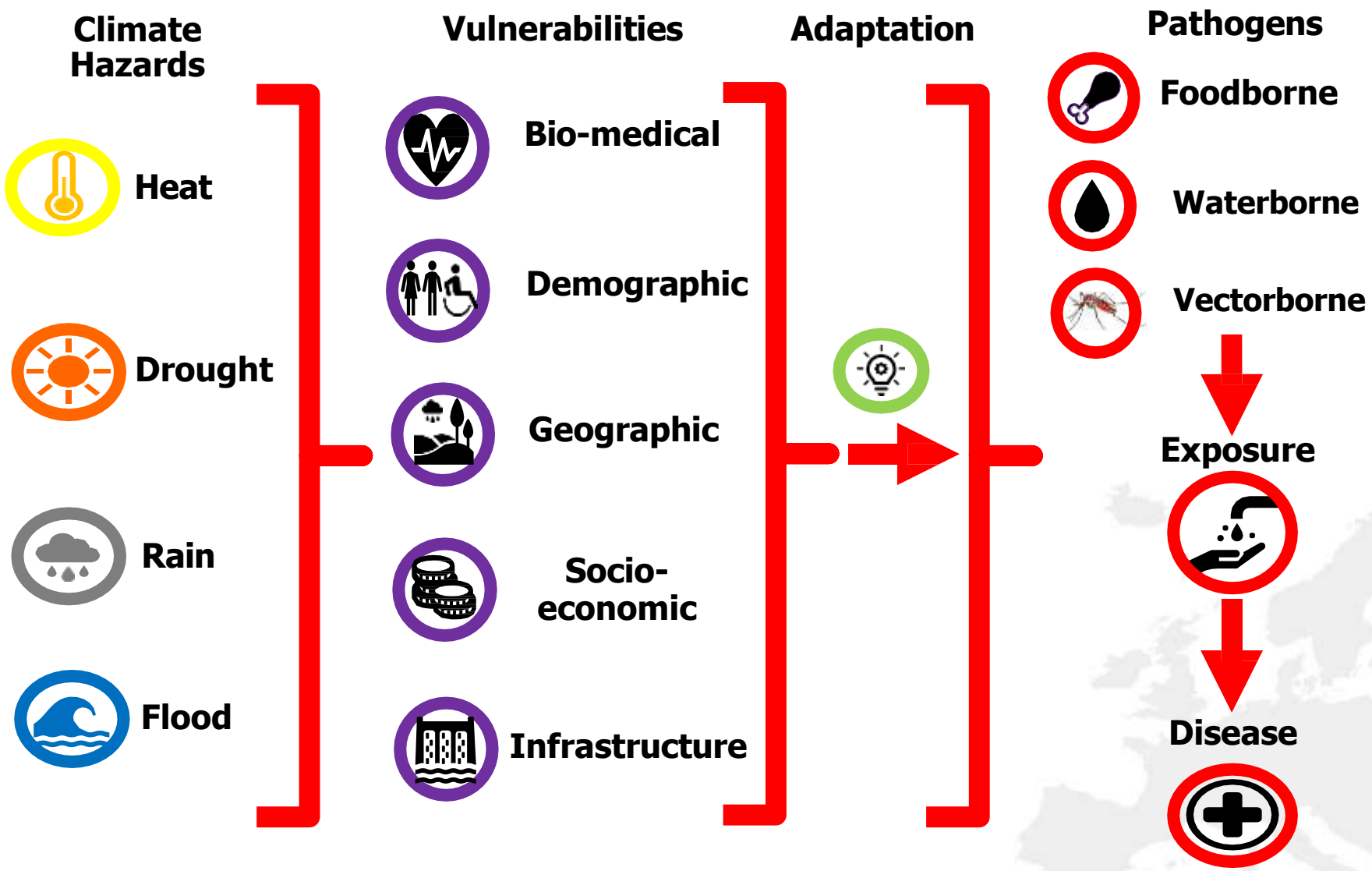
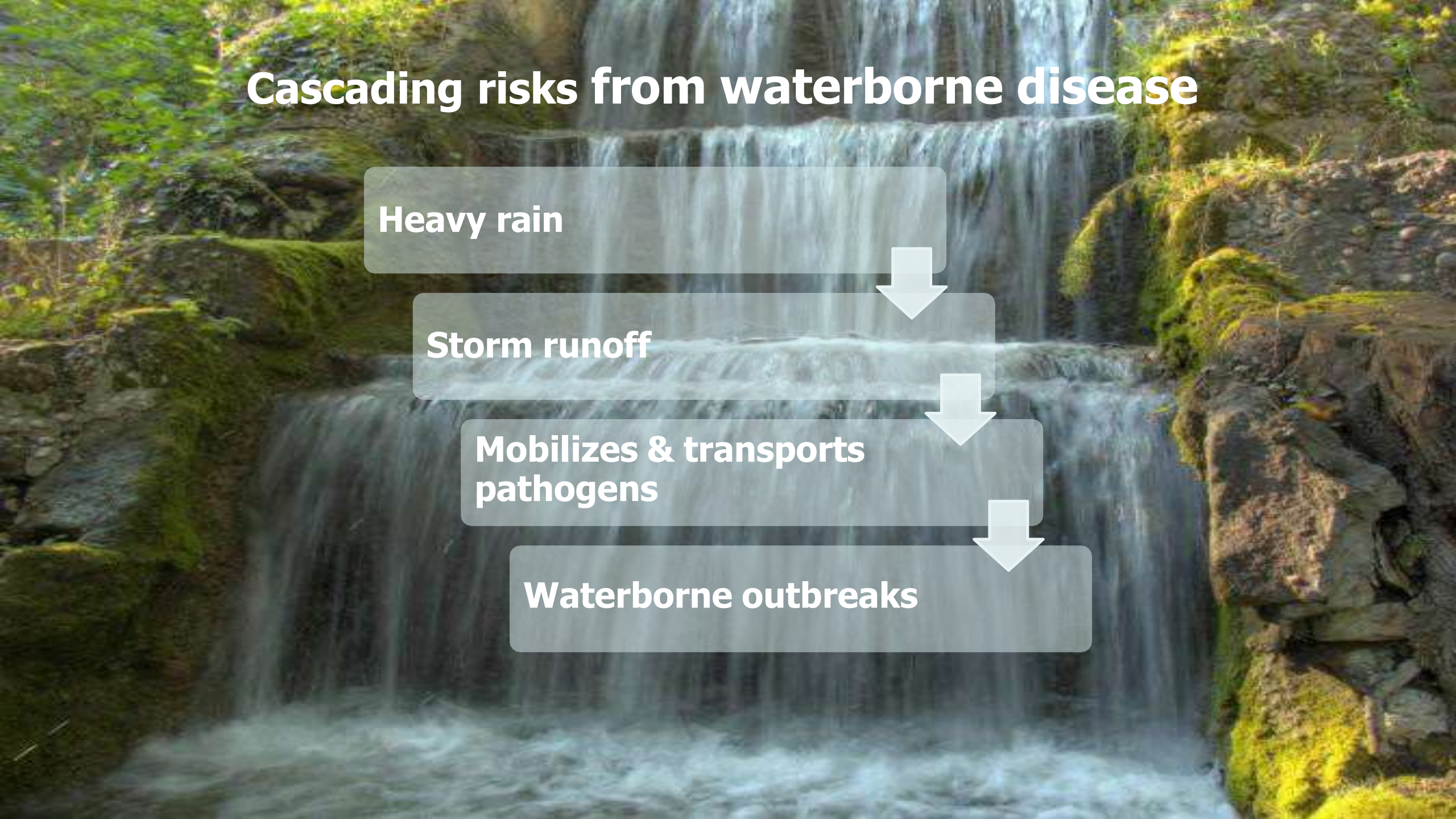


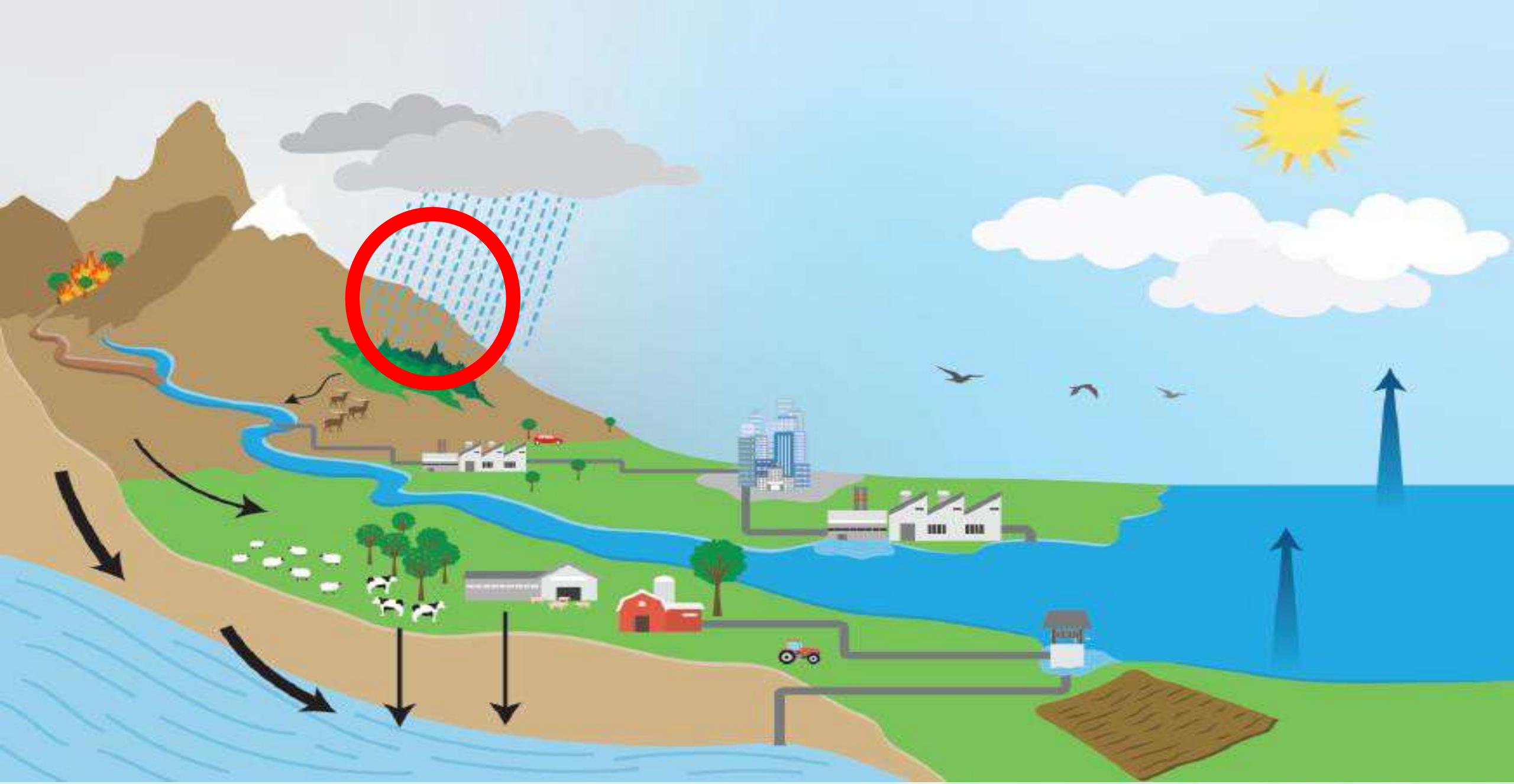
Climate change and cascading risks from waterborne disease

Jan C. Semenza
Umeå University

Hazard – Vulnerability – Exposure – Disease




Cascading risks from waterborne disease
Heavy rain
Storm runoff
Mobilizes & transports pathogens
Waterborne outbreaks

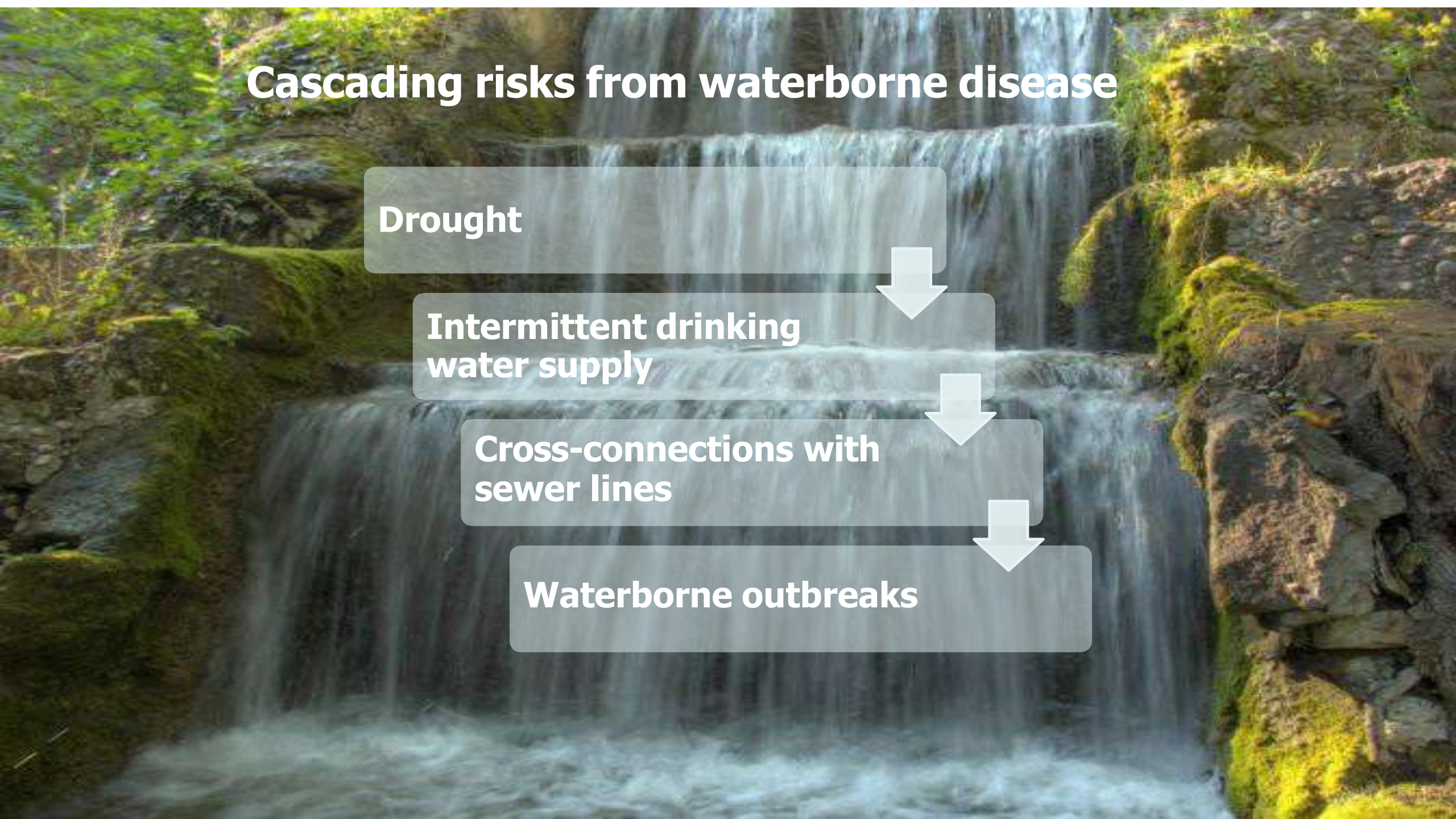


Semenza JC, *Nat Immunol. 2020 May;21(5):484-487*

Precipitation exceedance-days prior to waterborne outbreak

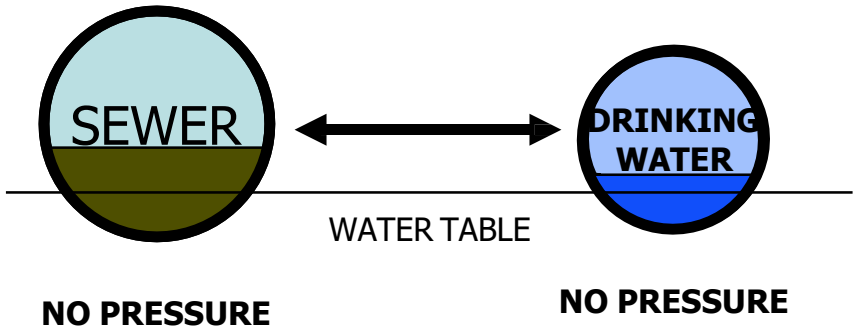
	Cases						Week 1 prior to outbreak (1–7 days)			
	N (exceedance days)			Controls			1 day		≥ 2 days	
Sample	0	1	2+	0	1	2+	OR (95% CI)	p	OR (95% CI)	p
All	26	51	12	88	249	19	1.39 (0.82–2.37)	0.219	**3.06 (1.38–6.78)**	**0.006**
Spring–summer	20	34	9	57	184	11	1.81 (0.96–3.42)	0.069	**4.27 (1.61–11.33)**	**0.004**
Autumn–winter	6	17	3	31	65	8	0.75 (0.27–2.04)	0.570	1.45 (0.34–6.13)	0.613
Groundwater	22	36	8	62	189	13	1.80 (0.99–3.29)	0.055	**3.13 (1.20–8.17)**	**0.020**
Surface water	2	12	3	17	47	4	0.43 (0.09–2.06)	0.29	3.23 (0.63–16.61)	0.160
Single household	5	10	5	19	57	4	1.43 (0.44–4.65)	0.549	**8.64 (1.58–47.11)**	**0.013**
Municipal/private	20	37	7	66	176	14	1.41 (0.76–2.60)	0.277	2.31 (0.87–6.14)	0.092

Guzman-Herrador B, *J of Water and Health* 2016;14(6):1019-1027

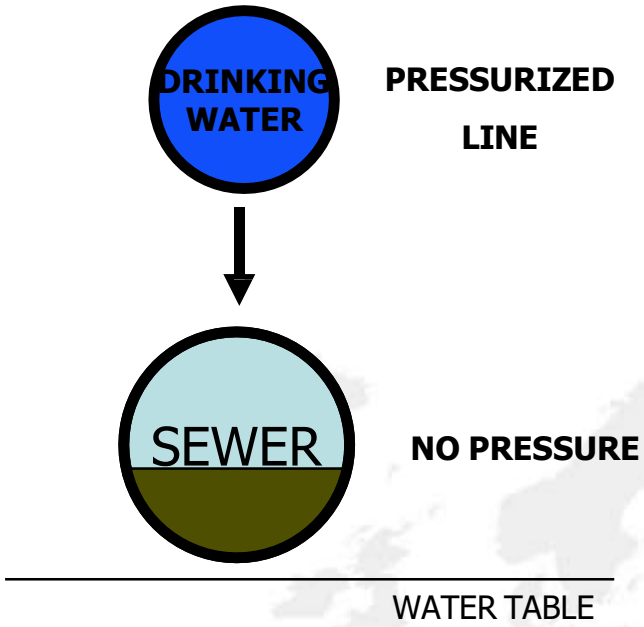

Cascading risks from waterborne disease
Drought
Intermittent drinking water supply
Cross-connections with sewer lines
Waterborne outbreaks

Drought: Intermittent drinking water supply
Cross-connections with sewer lines

Cross-connections



Climate change adaptation



Semenza JC, et al., *Am J Trop Med Hyg*. 1998;59(6):941-6

Table 1 | Examples of cascading [illegible] from climate variability
Cascading risk pathways from heavy rain and flooding
Storm runoff yields water turbidity, which compromises water treatment efficiency
Storm runoff mobilizes and transports pathogens
Overwhelmed or damaged infrastructure compromises water treatment efficiency
Floods overwhelm containment systems and discharge untreated waste water
Floods damage critical water [illegible] sanitation infrastructure
Floods displace populations towards inadequate sanitation infrastructure
Cascading risk pathways from drought
Low water availability augments travel distance to alternative (contaminated) sources
Intensified demand and sharing (e.g., with livestock) of limited water resources decreases water availability and quality
Intermittent drinking water supply results in cross-connections with sewer lines and water contamination
Uncovered household water containers are a source of vector breeding
A decrease in the volume of source water and an increase in the concentration of pathogens results in poor hygiene
Accumulated human excrement and animal manure results in human exposure to pathogens
Cascading risk pathways from increasing temperature
Extended transmission season for opportunistic pathogens
Permissive temperature for the replication of marine bacteria
Enhanced pathogen load in animal reservoirs (e.g., chicken)
Pathogen survival and proliferation outside of host
Degradation of water quality from wildfires during heat waves
Exposure to contaminated water [illegible] for consumption
Behavior change (e.g., barbecue) and food spoilage
Cascading risk pathways from sea-level rise
Population displacement due to powerful storm surges
Disruption of drinking water supply and sanitation infrastructure due to inundation
Decline in soil and water quality due to saline intrusion into coastal aquifers
Seawater infiltration into drinking water distribution and sewage lines

Note: Examples are purposely not exhaustive and should be considered illustrative.

Semenza JC, *Nature Immunol.* 2020 May;21(5):484-487

Conclusion: Climate change and cascading risks from waterborne disease

- Weather can potentially trigger a **sequence of secondary events,** when risks are causally connected, with one triggering the next.

- These **cascading risk pathways** of causally connected events can result in large-scale **waterborne disease** outbreaks.

- **Climate-proofing water treatment and distribution systems**, is critical for preventing, preparing for, and managing climate-sensitive waterborne diseases

Thank you!

Jan.Semenza@lateralPHC.com

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