Natural pandemics
& where to find them

A field guide

Mannat Vikramaditya Jain

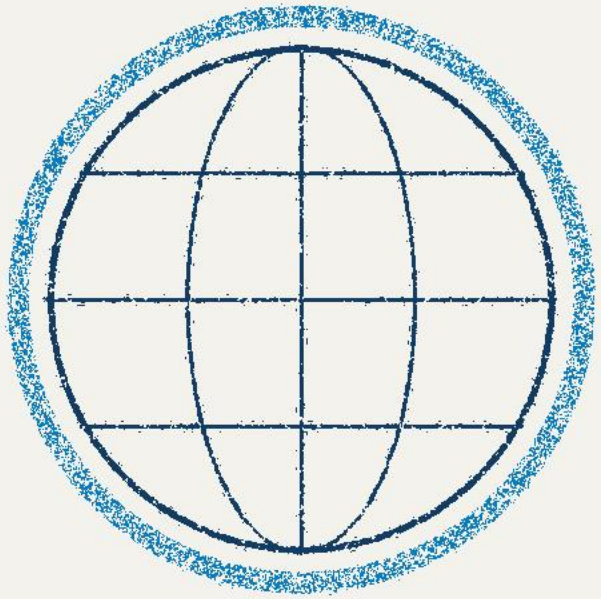


Natural pandemics can cause extraordinary harm.

Tens of millions

of deaths worldwide

in the 1918–1919 influenza pandemic

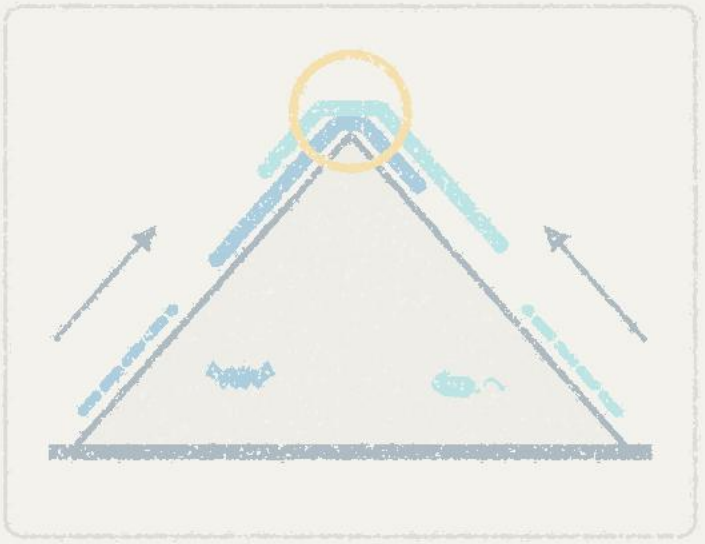


Taubenberger & Morens 2006, Emerg Infect Dis 12(1); Spreeuwenberg et al. 2018, Am J Epidemiol 187(12)



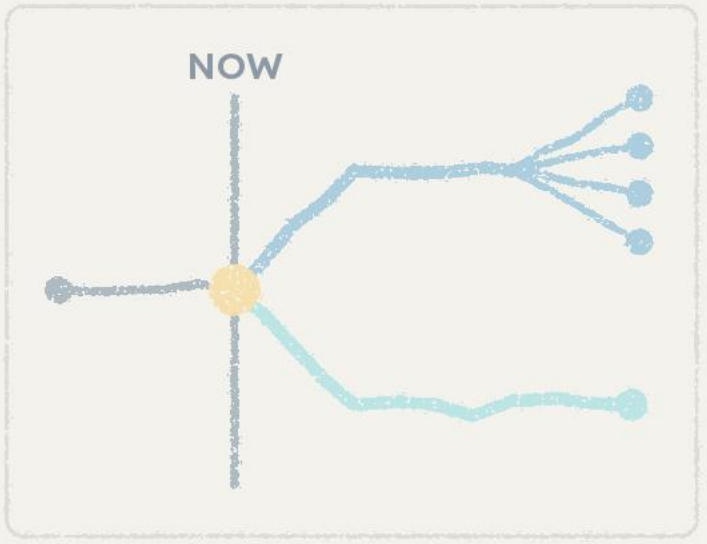
I

Land-use change



II

Climate change



III

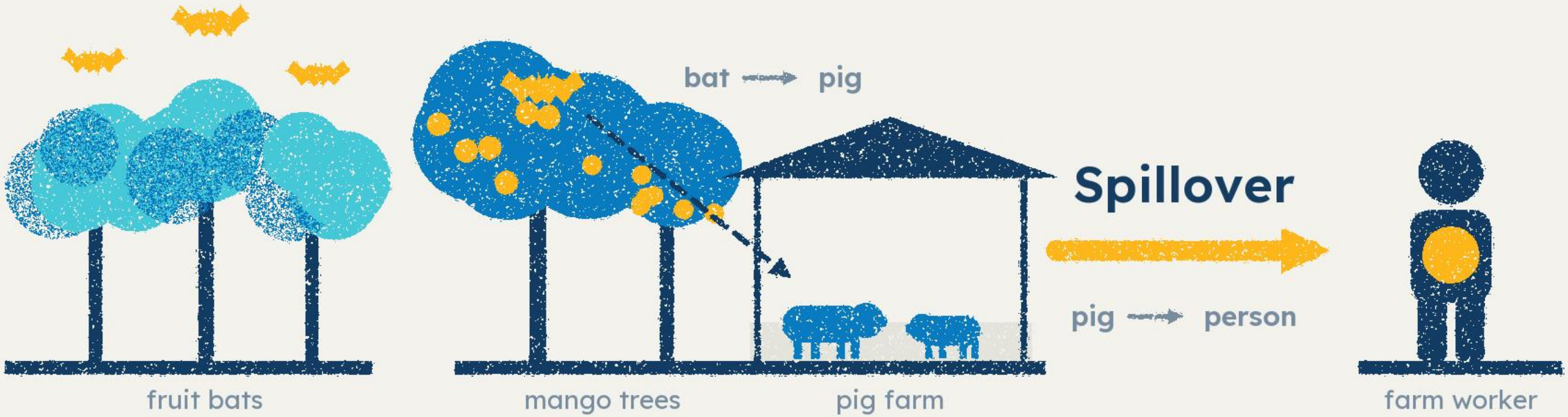
Why biosecurity researchers should care

Coming up...

- How can land-use change open a route for spillover?
- Do human-dominated habitats favour known pathogen hosts?

Land-use change can open a new route for spillover.

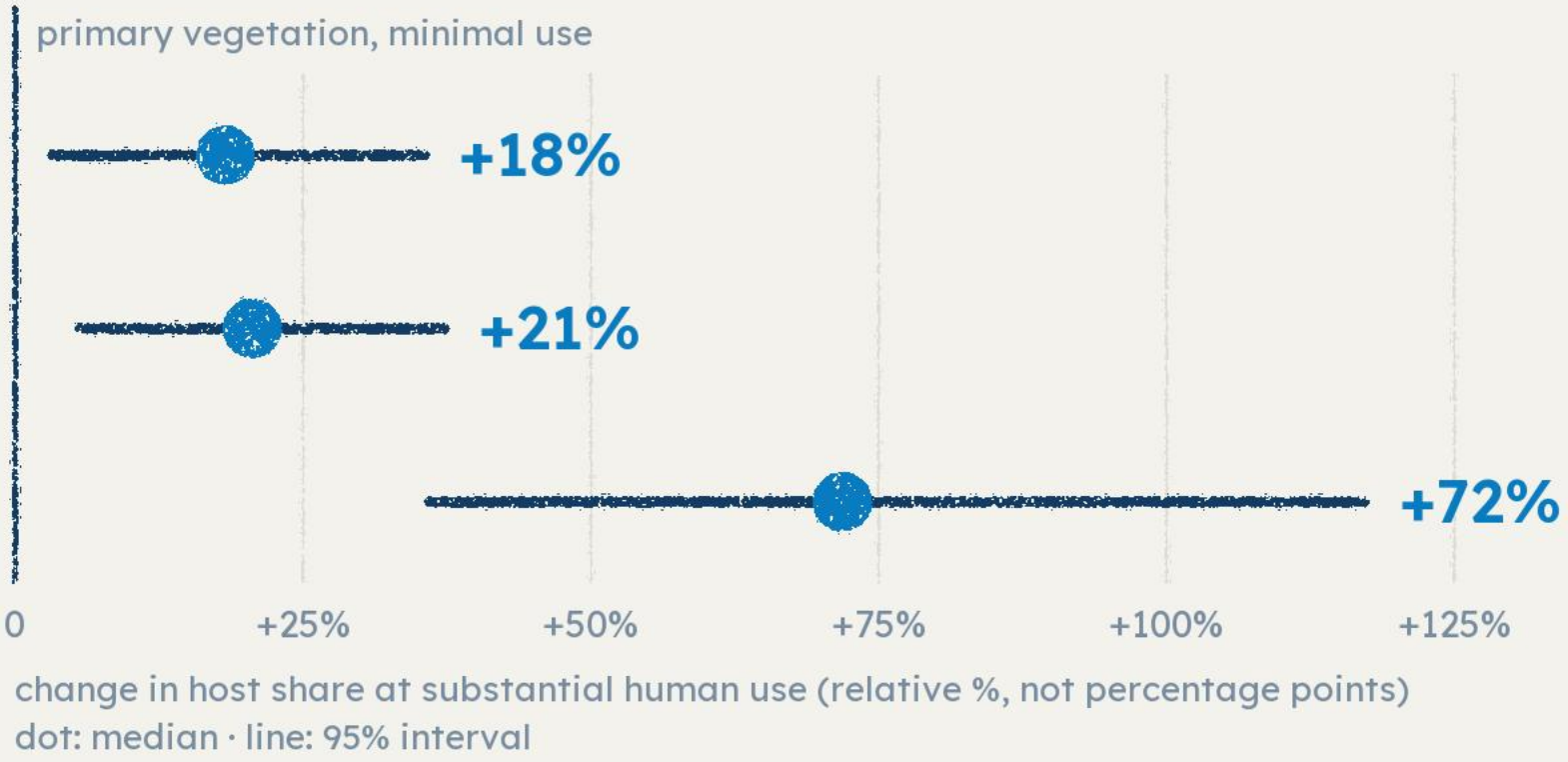
Nipah virus outbreak, Malaysia, 1997–1999



Mango trees planted beside pigsties brought bats over pigs. An outbreak, not a pandemic.

Historical outbreak illustration after Pulliam et al. 2012, J R Soc Interface 9:89–101, doi:10.1098/rsif.2011.0223

Human-dominated habitats favour known pathogen hosts.



Host share: of the species recorded at a site, the fraction known to carry pathogens that also infect people.

Gibb et al. 2020, Nature 584:398–402, Fig. 2c; redrawn from publisher Source Data Fig. 2



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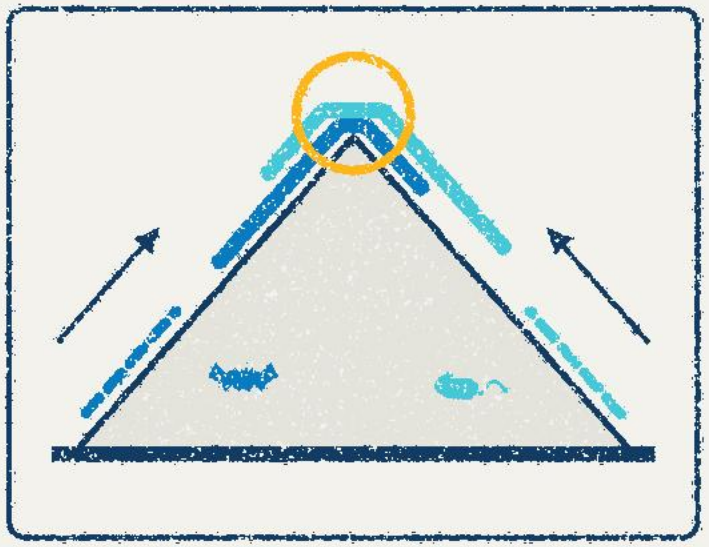
Land-use change



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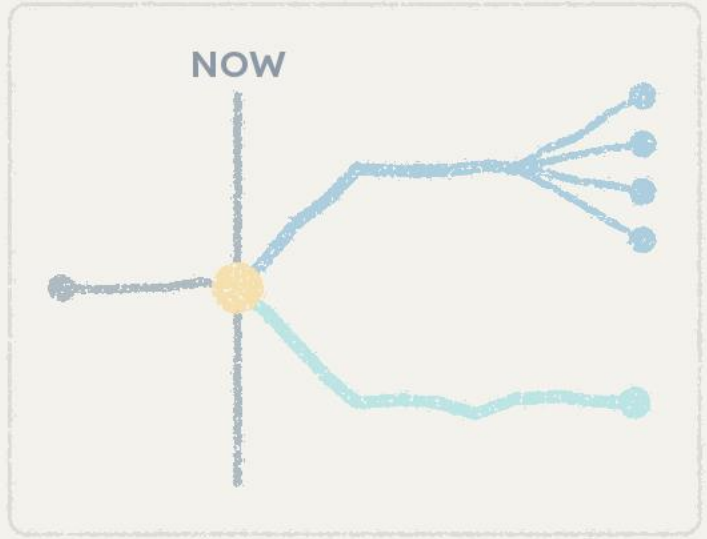
Climate change



III

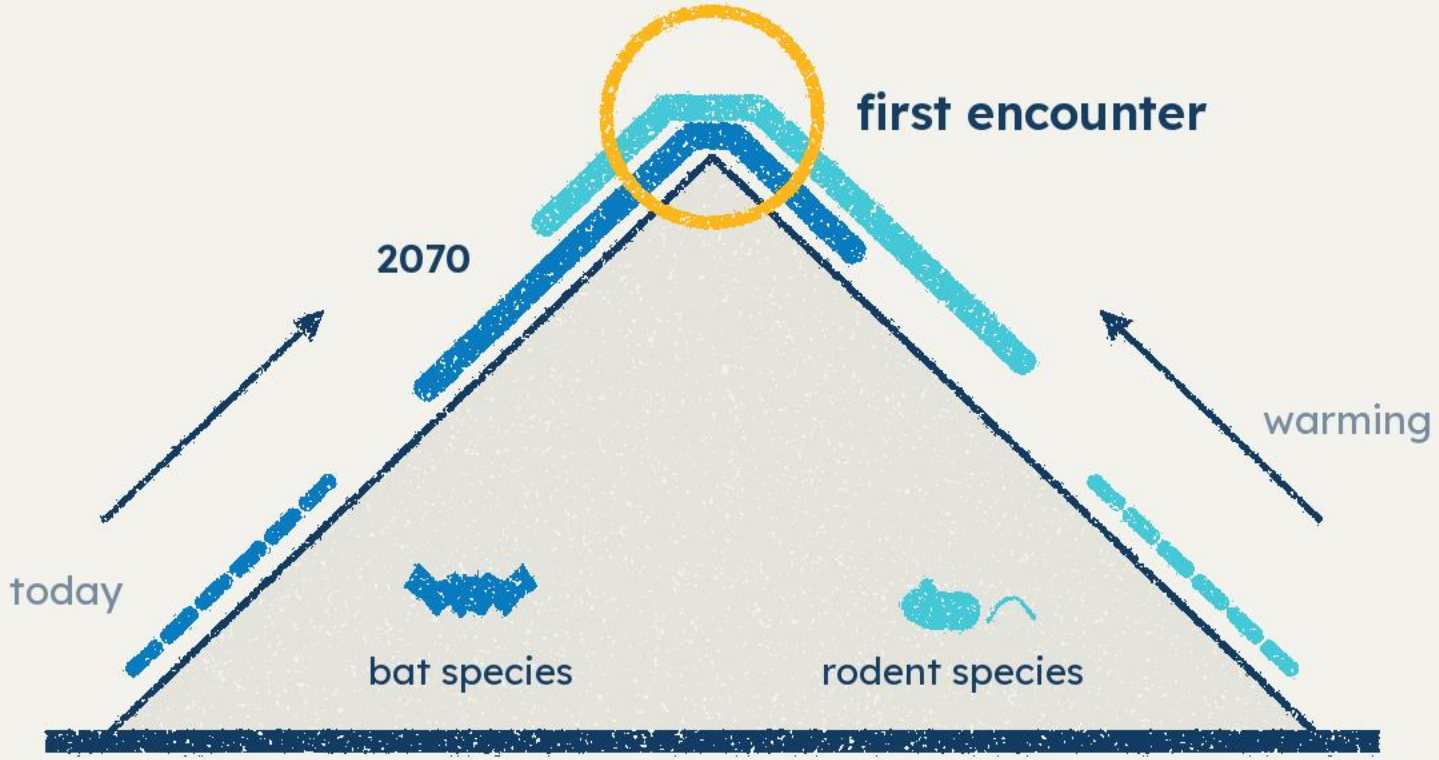
Why biosecurity researchers should care

Coming up...

- Where do shifting mammal ranges meet for the first time?
- How many new virus-sharing events among mammals are projected?
- How do more emergence opportunities bear on pandemic risk?

Warming pushes mammals upslope, so species from opposite sides of a mountain meet for the first time.

Carlson et al. 2022 · 3,139 mammal species · ranges projected to 2070



Schematic of the mechanism after Carlson et al. 2022, Nature 607:555–562

Those first encounters are projected to cause about 4,500 new virus-sharing events among mammals.

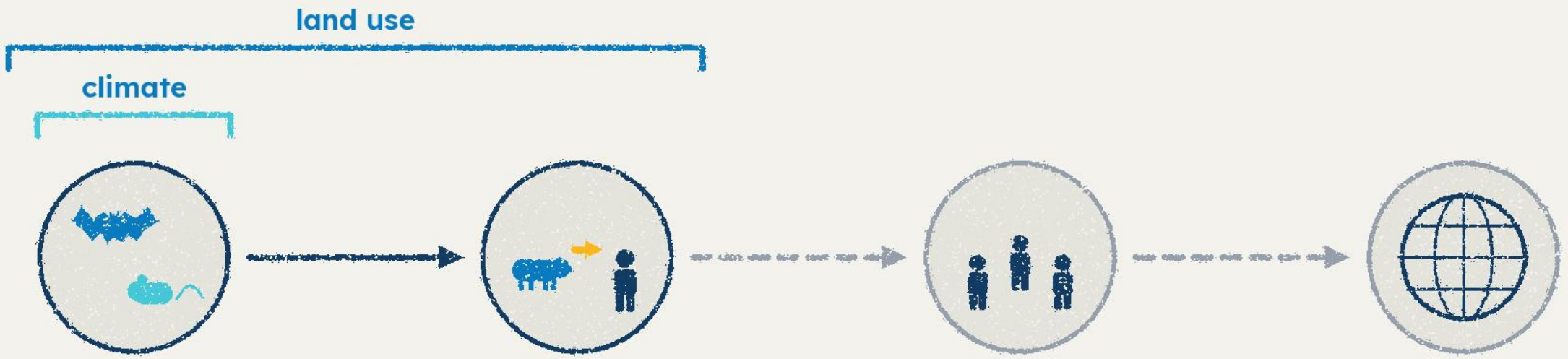


One event: a newly meeting pair of wild mammal species shares at least one virus.

Expected events by 2070 · 3,139 mammal species · dispersal-limited · mean ± SD of nine climate models

Carlson et al. 2026, Nature 607, Extended Data Fig. 3c

More emergence opportunities put upward pressure on pandemic risk.



Spread also depends on the pathogen, detection and response.

Carlson et al. 2022; Gibb et al. 2020; Pulliam et al. 2012 · mechanistic inference, not a forecast



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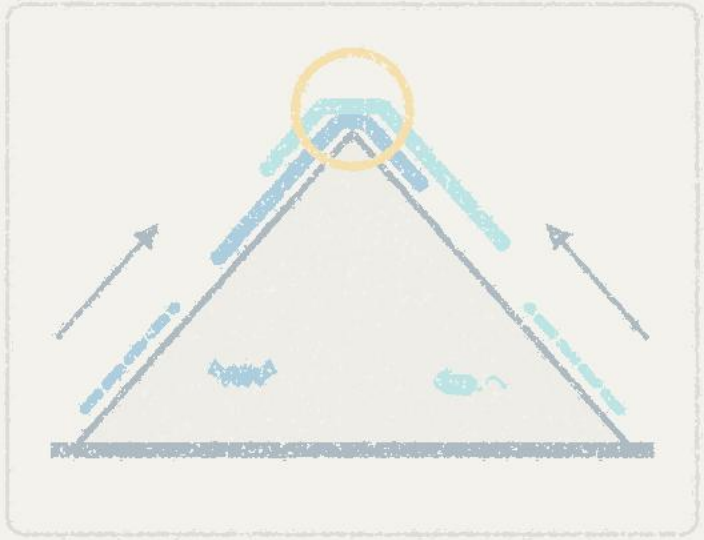

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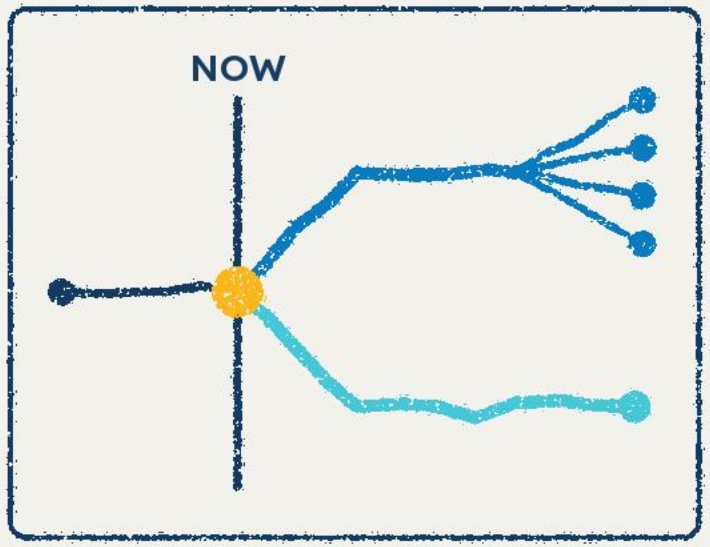


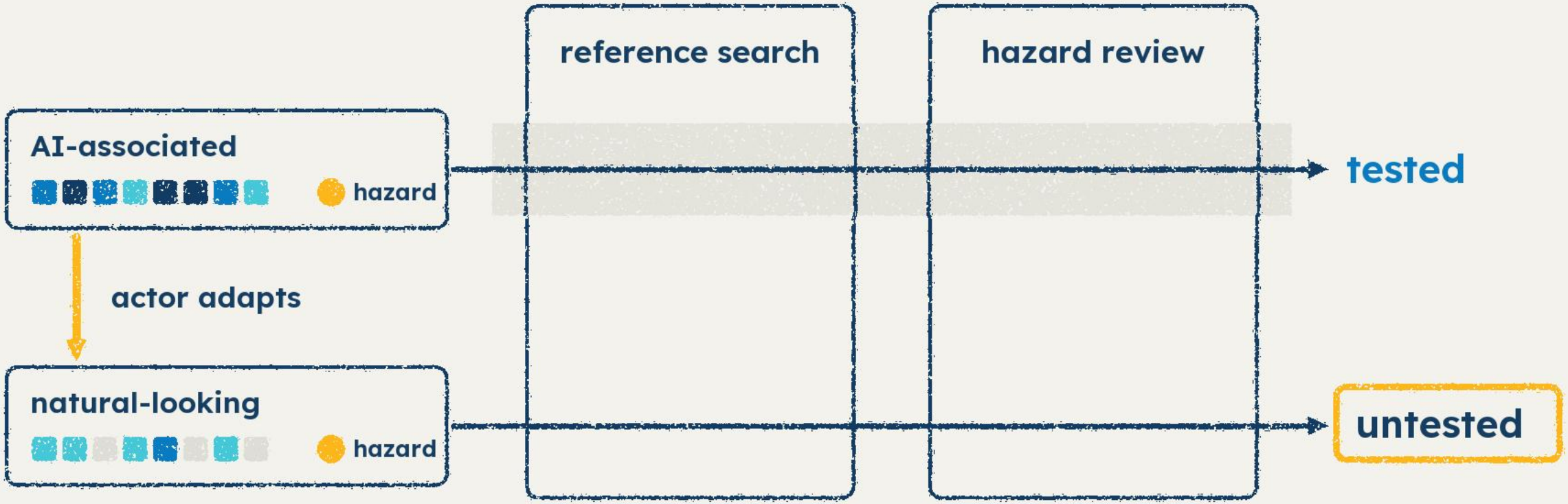
III

Why biosecurity researchers should care

Coming up...

- What does an AI-only pipeline leave untested?
- How can routine natural-hazard work justify deploying a tool now?
- Why choose the scope now rather than later?

An AI-only pipeline leaves a natural-looking gap.

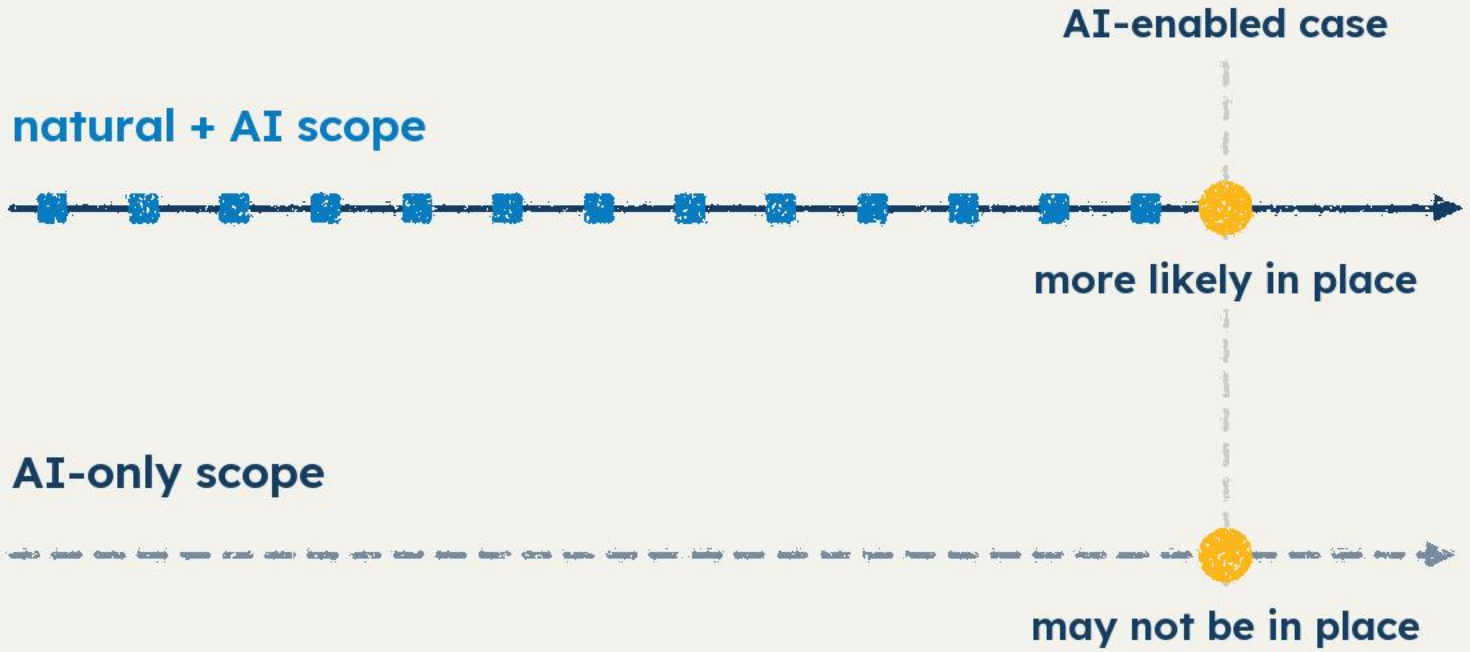


Routine natural-hazard work can justify deploying a tool now.

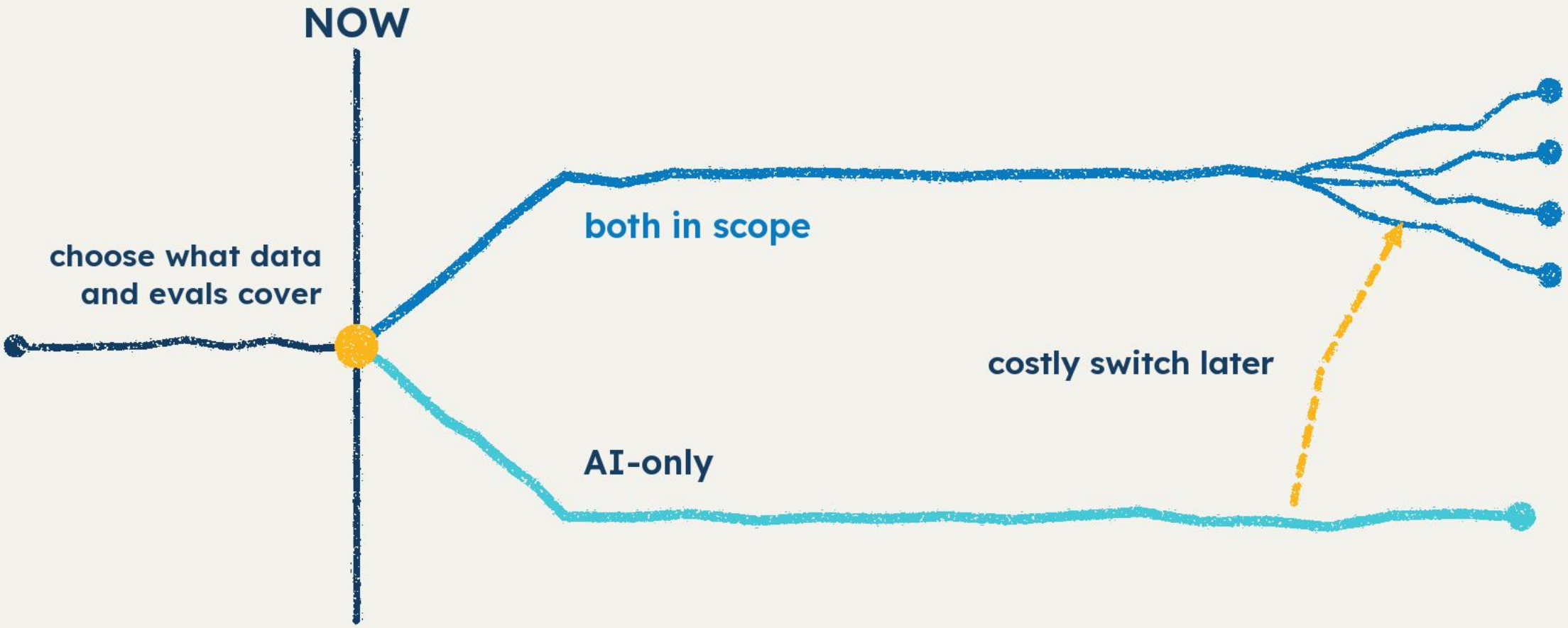


public-health sequencing lab

triages outbreak sequences weekly



Small choices now can preserve options later.



After the “life paths” drawing, robdthomas.com

Design for natural and AI-enabled threats from the start.

Include both in your threat model, datasets and evaluations.

