THE OHIO STATE UNIVERSITY

Why is sustainable mobility so hard? Some observations on the paths forward

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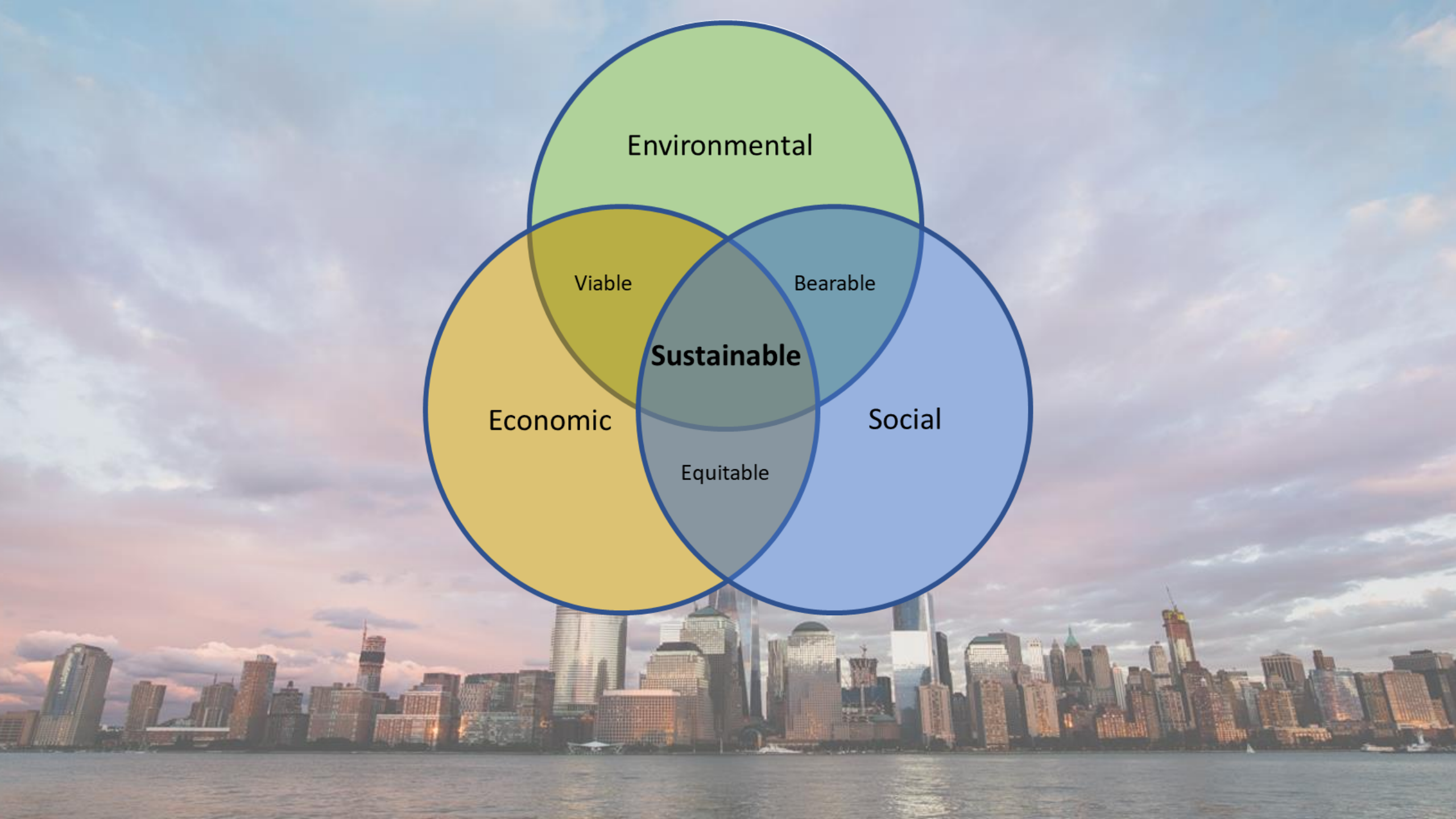
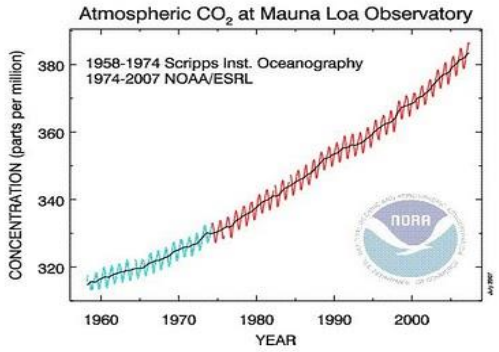

Environmental
Viable
Bearable
Sustainable
Economic
Social
Equitable

Good news: We live in an age of mobility miracles!

- We do **more things in more places, at all geographic scales,** than previous generations could have imagined in their wildest dreams



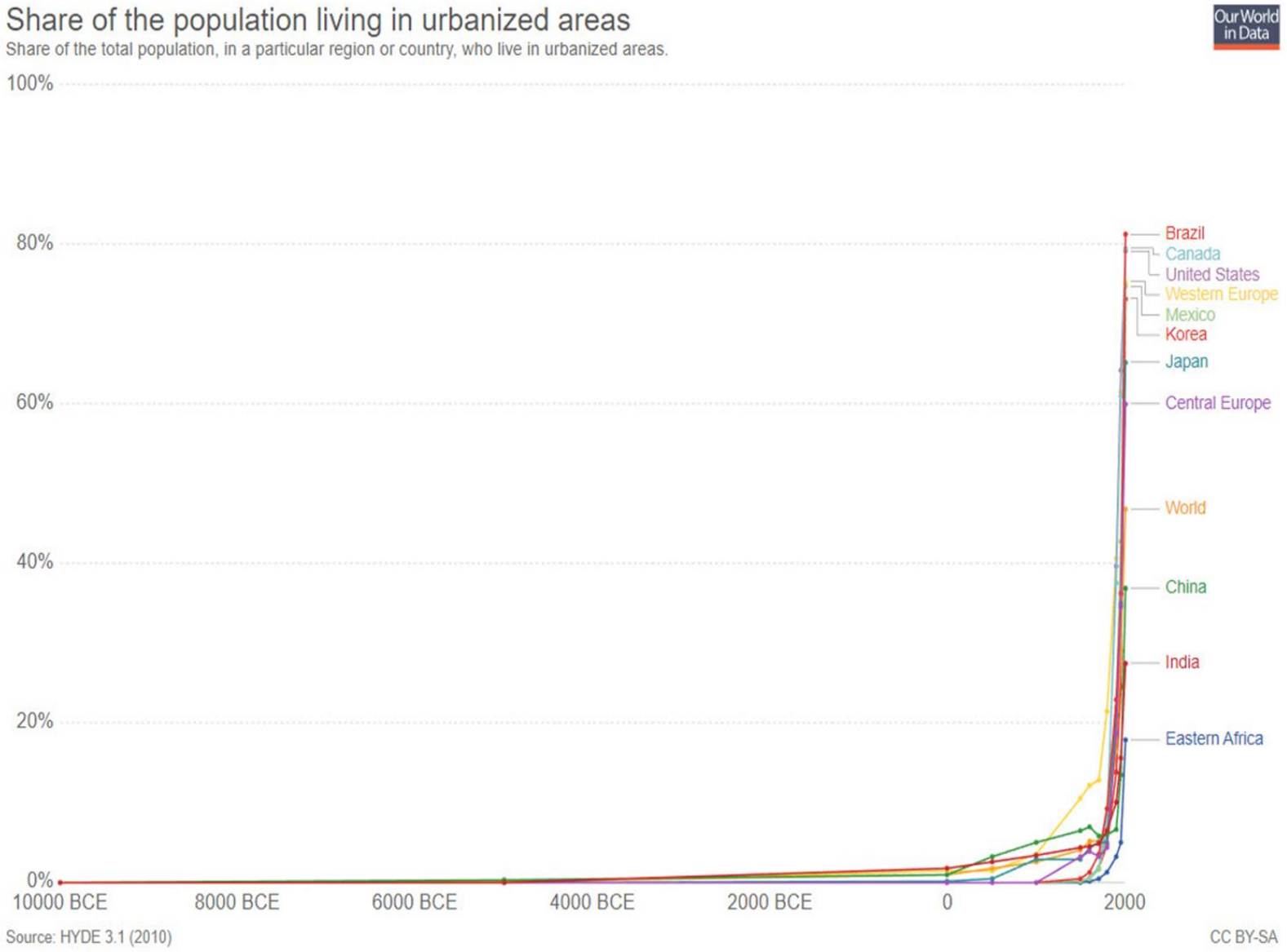



Bad news: Our mobility systems are **utterly unsustainable**

- Climate change
- Energy
- Air quality
- Congestion
- Social equity
- Health
- Safety

Mobility is central to urbanity, and urbanity is central to our common future as the **world's population crowds into urban areas.**

This is creating a **global urban mobility crisis** due to the unsustainability of our 20th century transportation systems for an urban world.



What about electric and autonomous vehicles?

EVs and AVs are a partial solution

- Highly inefficient: Energy and space
- Unclear safety improvements: Relative to public transit
- Inequities due to cost: Cars as smartphones – update requirements
- *AVs may never work!* Turns out that driving is hard

Towards sustainable mobility

Mobility monocultures

- Few mobility options
- Inflexible - *People must adapt to the system*
- Current infrastructure is saturated

Towards sustainable mobility

Mobility polycultures

- Wide spectrum of integrated mobility options
- Flexible - *System adapts to people*
- More effective, sustainable and resilient

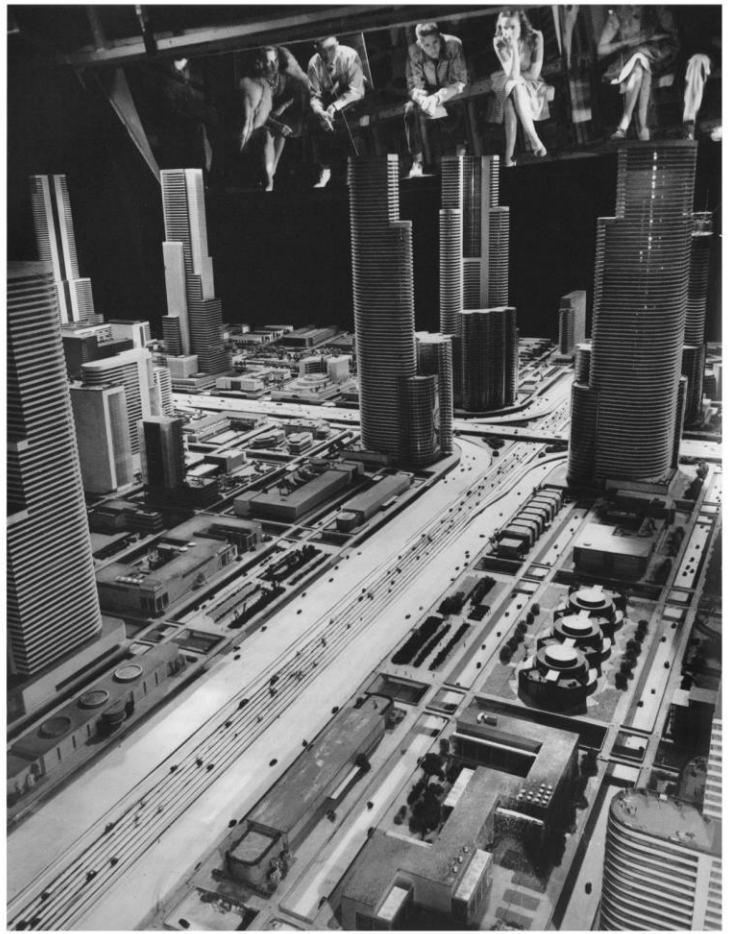
Why is sustainable mobility so hard?

Reasons I will not address:

- Sunk costs and lock-in
- Change is hard
- Political economy of automobility

Reasons I will address:

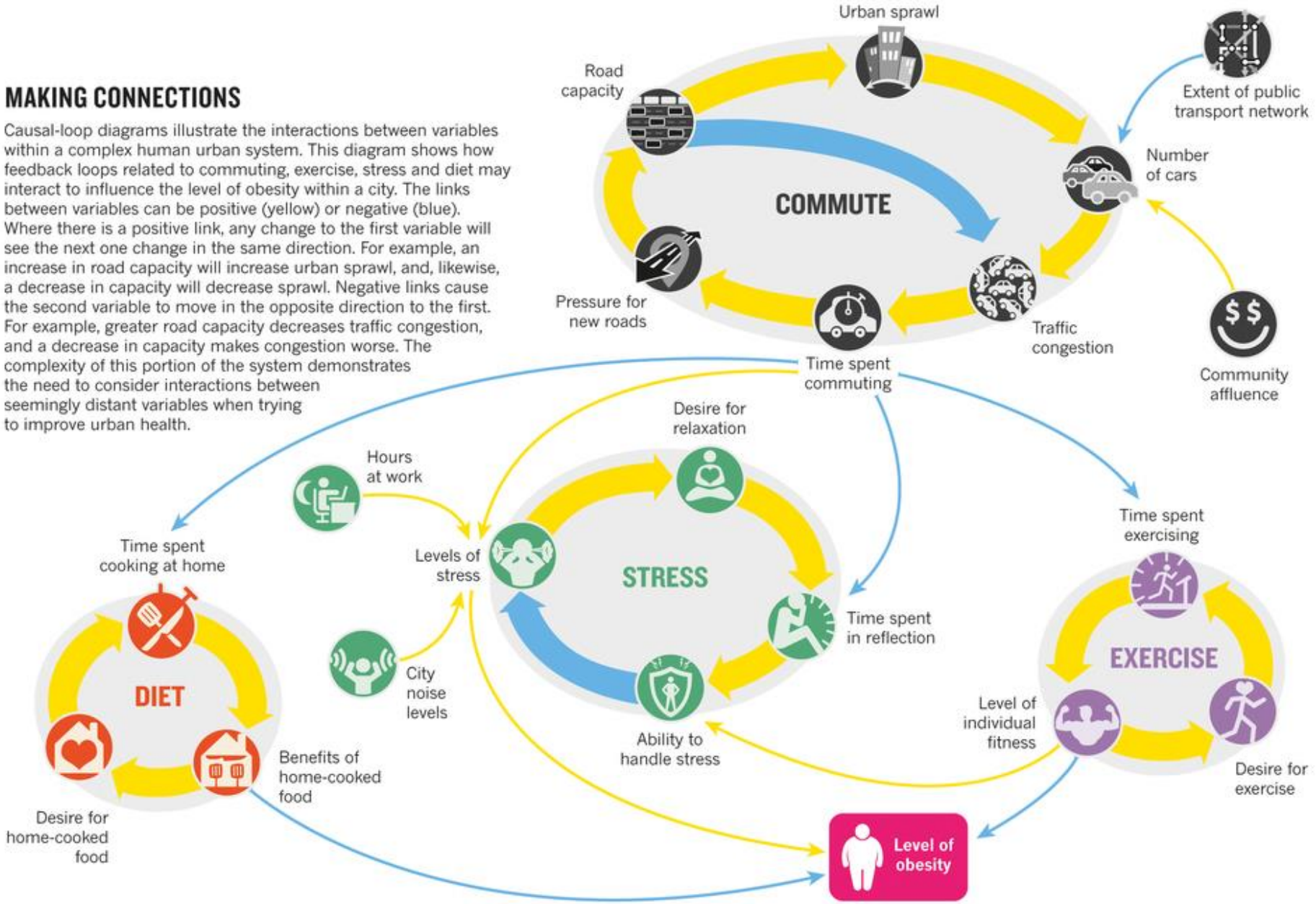
- Mobility is complex
- Mobility is wicked
- Mobility is a dilemma



Mobility is complex

"Cities are complicated. They comprise large numbers of people, and the many ecological, cultural, social and economic entities that make up their environment. **All these factors interact in time and space to form complex systems that constantly evolve in response to changes in climate, environment and people**."

Pollock, K. (2016) "Urban physics," Nature, 531, S64–S66 (17 March 2016)



Pollock, K. (2016) *Nature*, 531, S64–S66 (17 March 2016)


Tallin, Estonia
Damiano Cerrone SPIN Unit
http://www.damianocerrone.com/

Mobility is wicked

- Goals are ill-defined and malleable
- Conflicting elements
- Intricate interdependencies
- Values are integral

Graphic: Daniel Christian Wahl
medium.com/age-of-awareness/

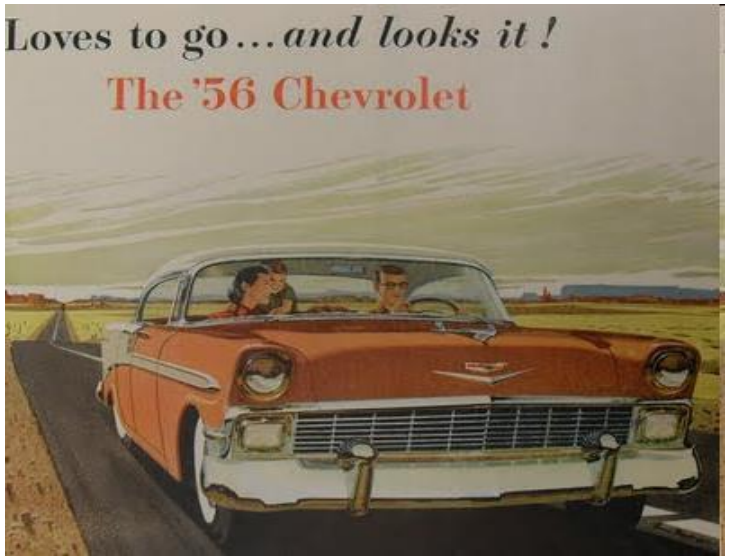
Rittel, H.W.J. and Webber, M.M. (1973) Dilemmas in a general theory of planning. *Policy Sciences,* 4, 155–169

Mobility is a dilemma

- Collective action dilemmas
  - Individually rational but collectively irrational
  - *Tragedy of the Commons* (Garret Hardin)

- It is **rationale for individuals** to go wherever they want whenever they want

- But **collective outcomes are terrible**



But back to good news:

We are in a scientific revolution!

- Mobility and urban data
- Urban experimentation
- Post-normal science
- Science of cooperation and collaboration


Graphic: www.geospatialworld.net

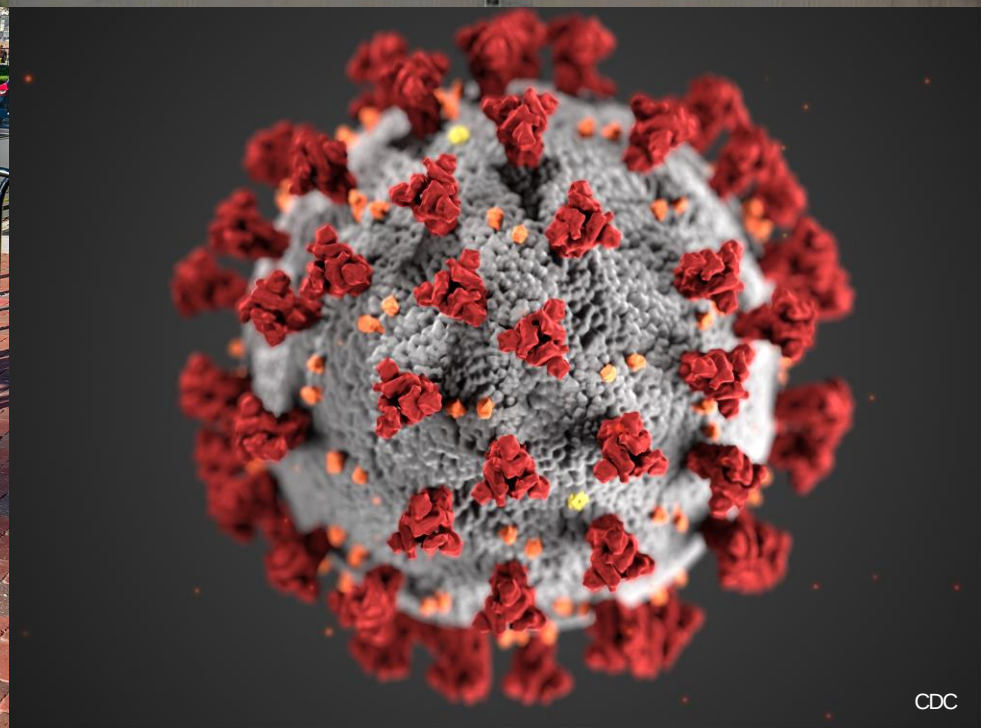
Cities are experiments

Disruptions are opportunities

Washington Post

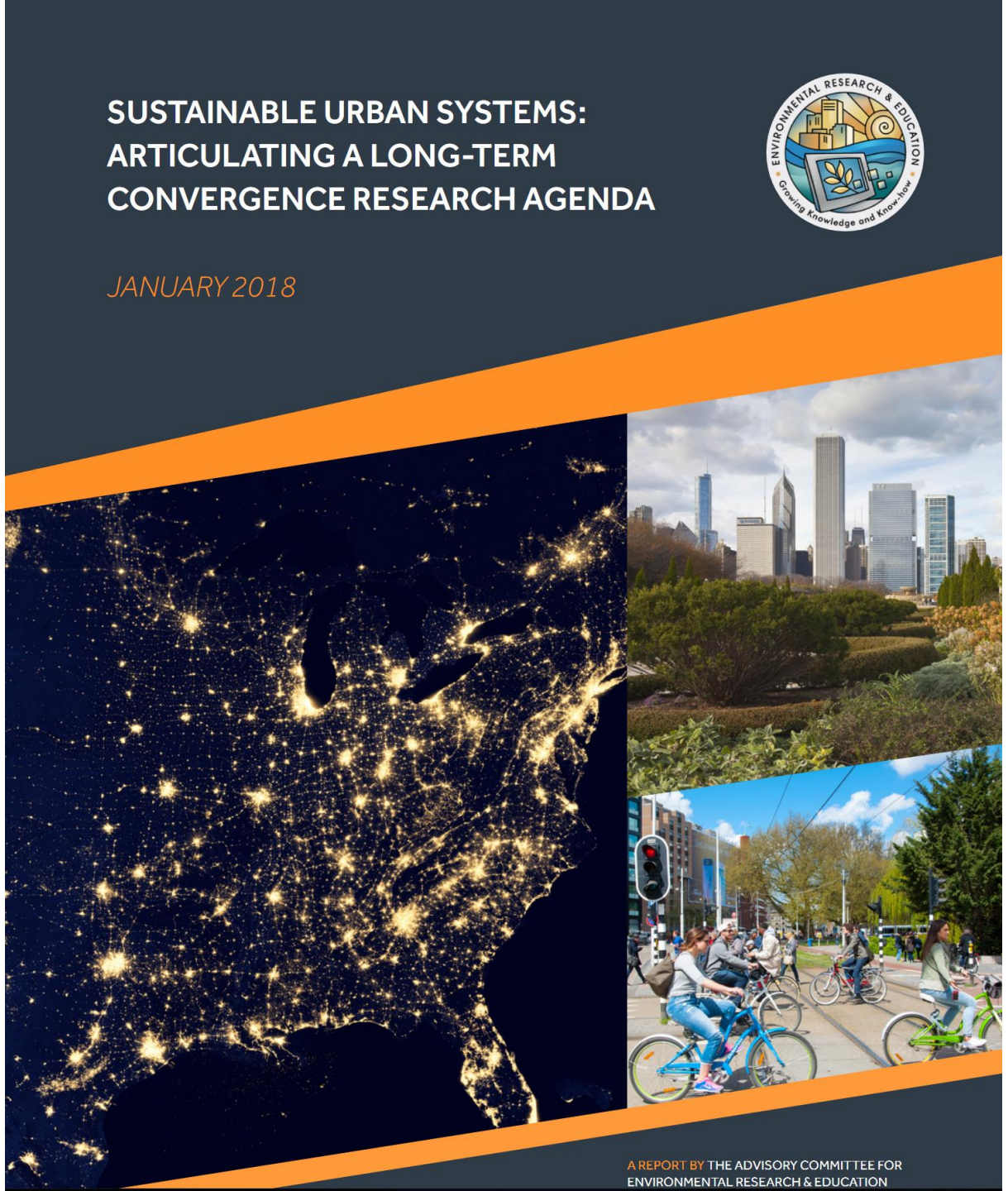
Ohio Department of Transportation

Wikipedia

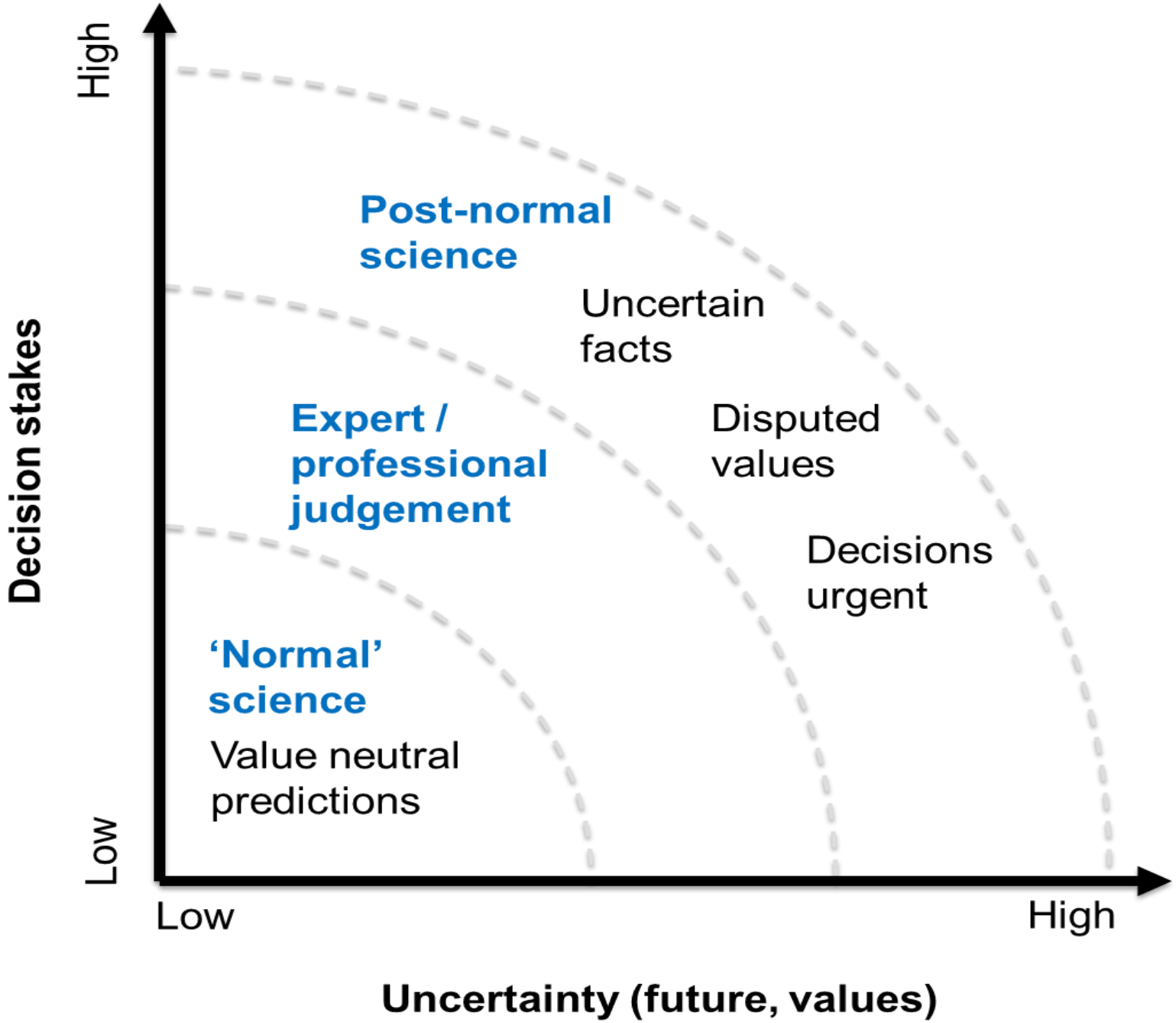

CDC

Next generation, convergence science of sustainable urban systems

- Multiscale
- Address tradeoffs among the environmental, economic and social dimensions
- Leverage new data technologies and ongoing experimentation



Beyond prediction: Post-normal science

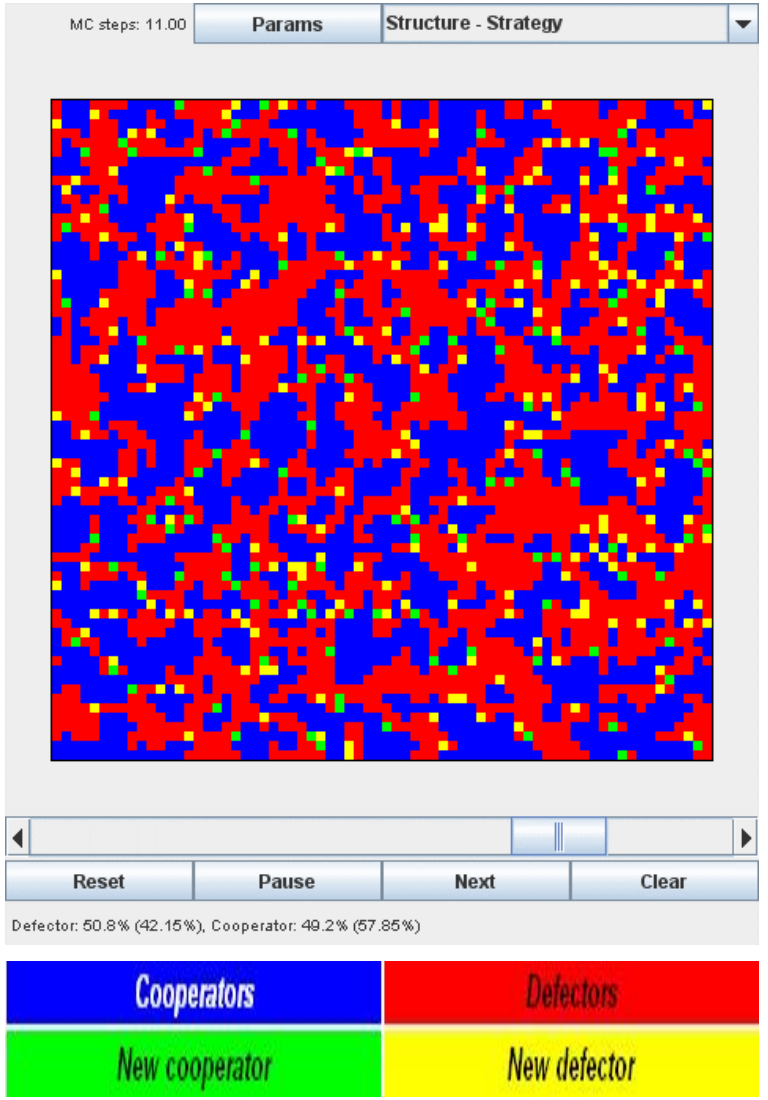


Funtowicz, S.O. and Ravetz, J.R. (1994) Uncertainty, complexity and post-normal science. Environmental Toxicology and Chemistry, 13, 1881-1885

Cooperation in biological and social systems

- More common than previously recognized

- **Conditions for cooperation**
  - **Time:** Iterated Prisoner's Dilemma (Robert Axelrod)
  - **Space:** Spatial Prisoner's Dilemma (evolutionary biology)
  - **Networks:** Dynamic networks and group formation



www.univie.ac.at/virtuallabs

Some paths forward

Respect the complexity: Treat cities as constantly emerging and contextual

Post-normal science: Embrace uncertainty and values

Opportunistic science: Leverage real-world events and experiments via ongoing observation and analysis

Beyond sharing: Build environments for collaboration and knowledge co-production


pixabay.com

Observatory science

What?

- **Ongoing** data collection and analysis based on a favored view, supported by technology and organizational processes

Why?

- **Discovery**: Generate new, surprising hypotheses
- **Dynamics**: Complex multi-scale dynamics
- **Monitoring and outreach**: e.g., volcano observatories
- **Ready when something happens!**

http://www.brown.edu/

Human observatories

Social observatories

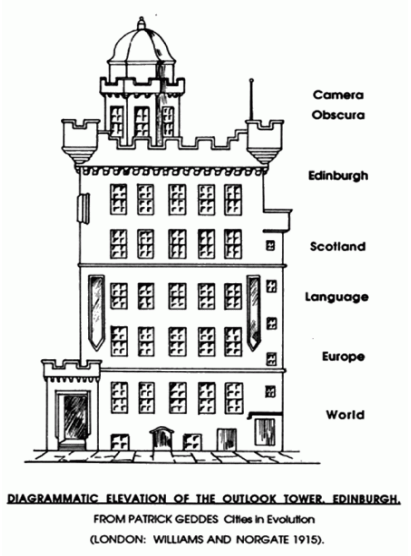
- Long-term study of social phenomena
- Traditional focus on health

Web observatories

- WWW as an info ecosystem
- Middleware for ***broad data*** – complex data from diverse Web sources

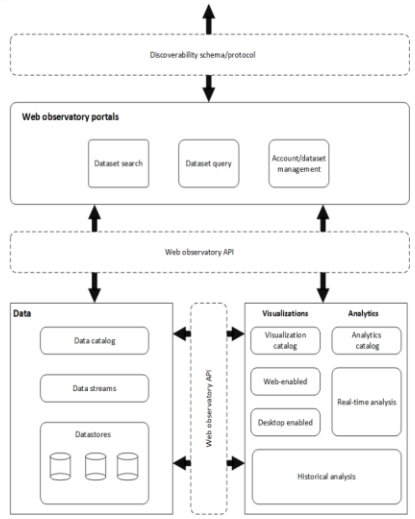
Geographic Information Observatories

- Observe geographic information itself
- Observe geographic information to observe the world



DIAGRAMMATIC ELEVATION OF THE OUTLOOK TOWER, EDINBURGH,
FROM PATRICK GEDDES Cities in Evolution
(LONDON: WILLIAMS AND NORGATE 1915).

Patrick Geddes Outlook Tower (Edinburgh, late 19th century)



Architecture for a real-time web observatory (Tinati et al. 2015)

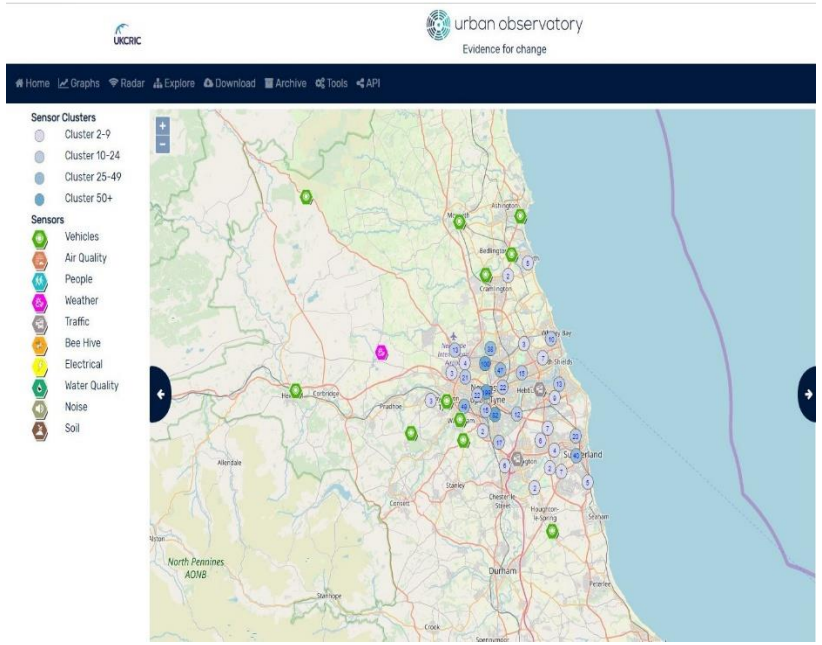
Urban sustainability observatories

What?

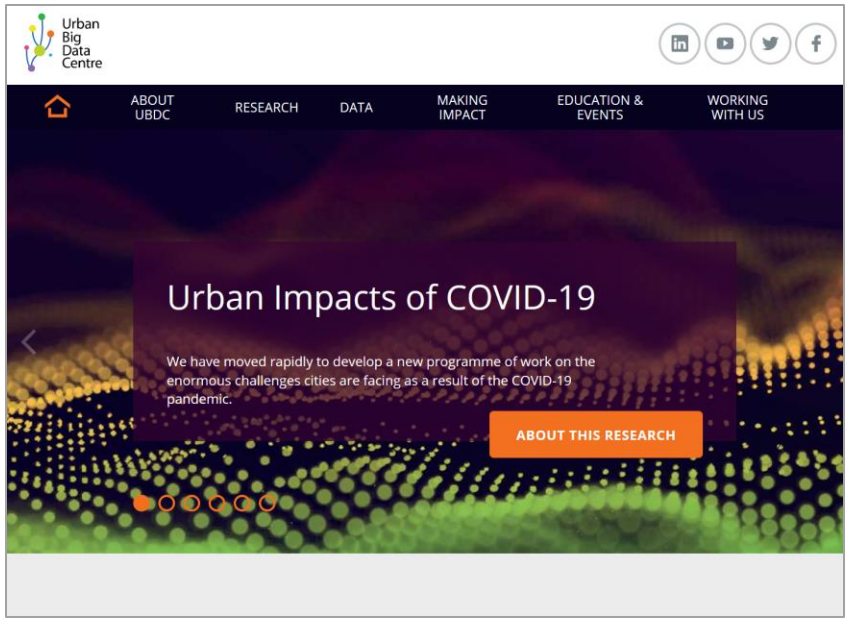
- Ongoing production and sharing of urban data and knowledge of cities as complex phenomena

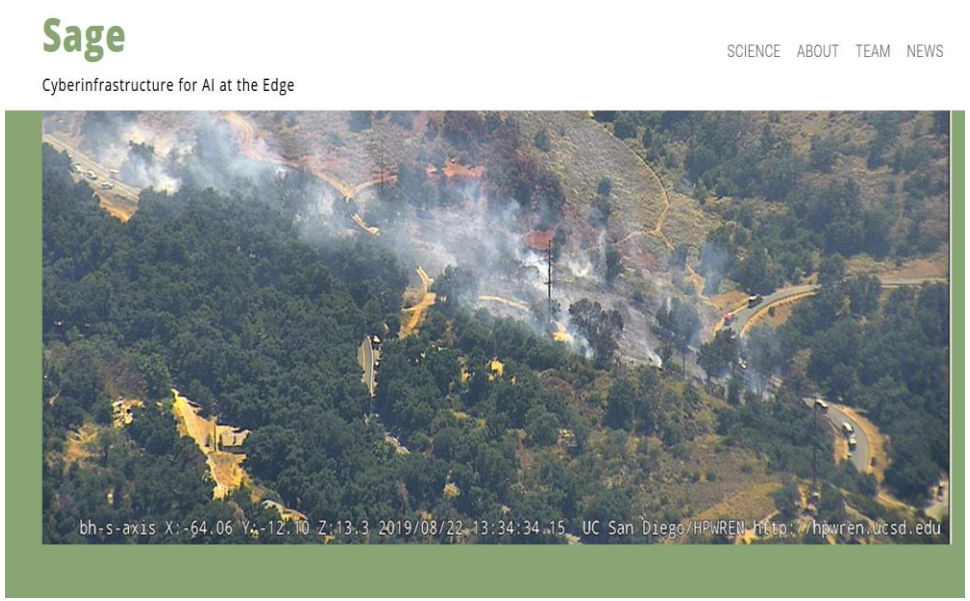
Why?

- Deeper understanding of complex urban environments
- Wise management and shaping of cities towards more sustainable outcomes




urban observatory


Urban Big Data Centre
ABOUT UBDC
RESEARCH
DATA
MAKING IMPACT
EDUCATION & EVENTS
WORKING WITH US
Urban Impacts of COVID-19
We have moved rapidly to develop a new programme of work on the enormous challenges cities are facing as a result of the COVID-19 pandemic.
ABOUT THIS RESEARCH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Cyberinfrastructure for AI at the Edge
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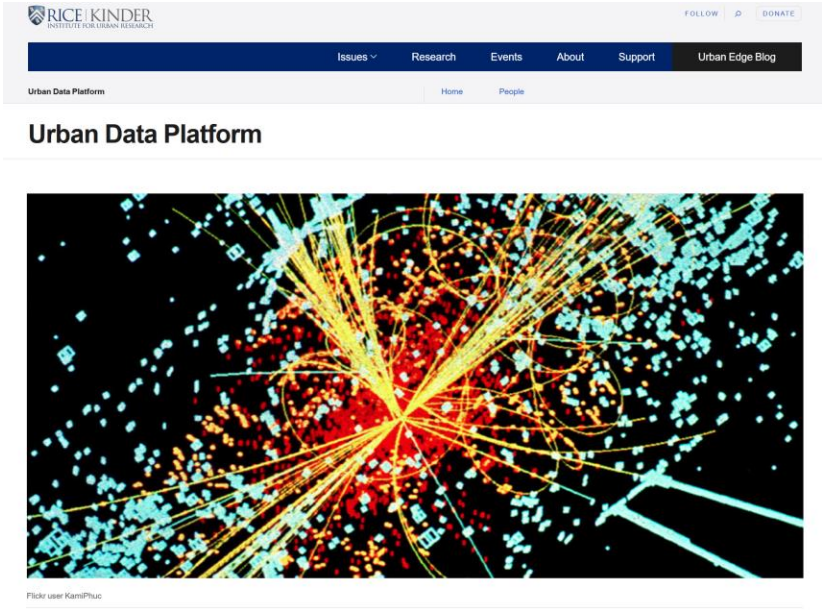
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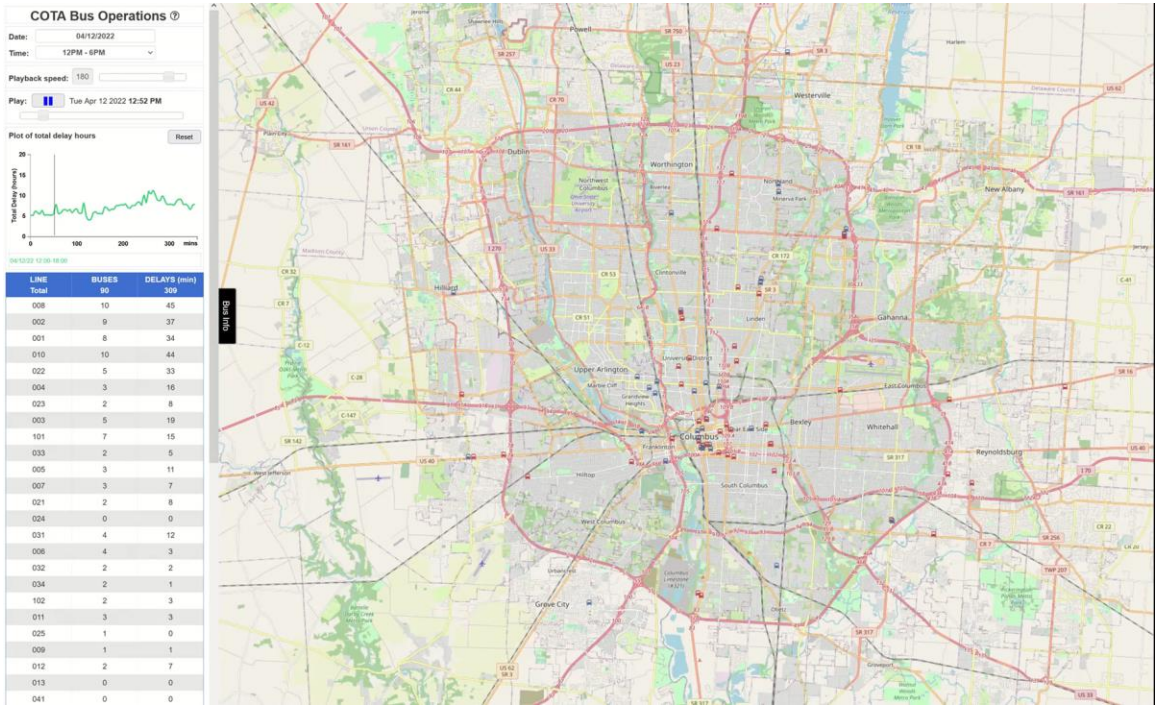
Flickr user KamiPhuc

Urban Sustainability Observatories

Integrated geospatial database and services

- Spatial, temporal, moving objects and streaming data
- Indicator selection based on:
  - **Science** – reflects the best settled science on urban sustainability
  - **Locality** – reflects local issues, interests and policy levers
  - **Comparability** – consistent with principles and existing frameworks

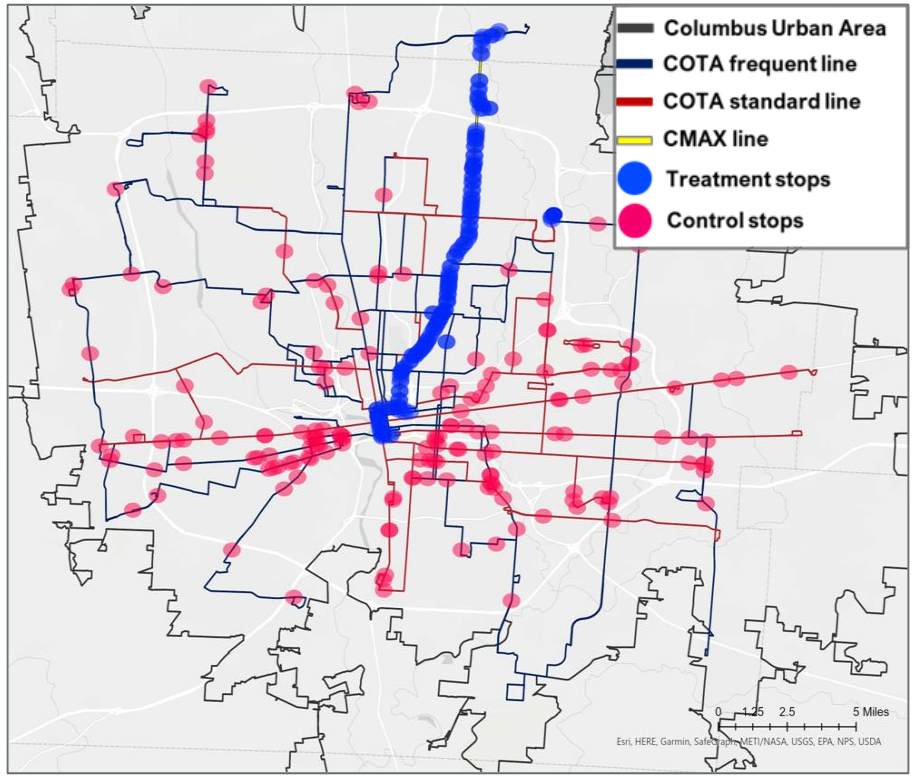


The Columbus Urban and Regional Information Observatory (CURIO): Transit delay and accessibility

Urban Sustainability Observatories

Tools for Opportunistic Science

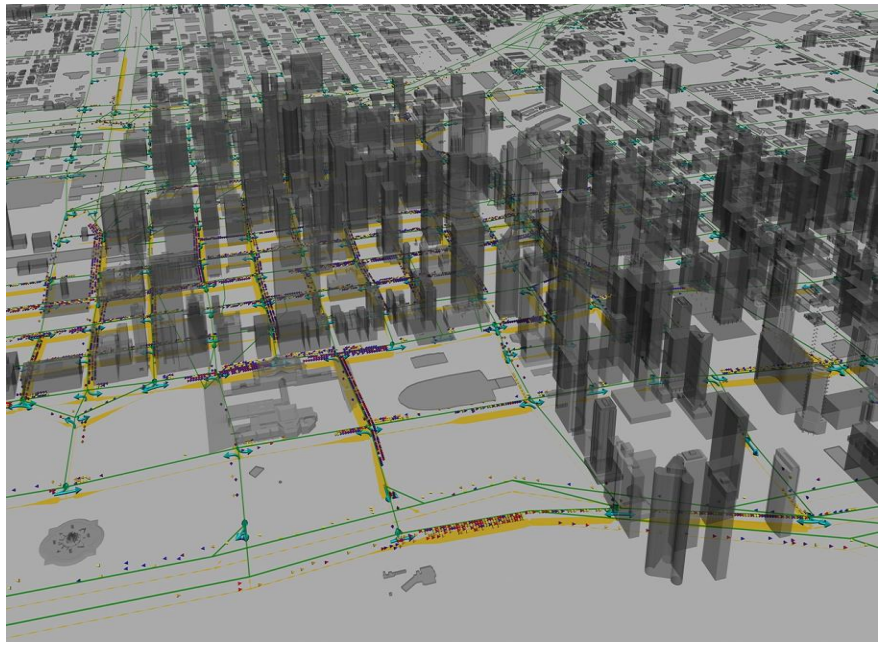
- Continuous, open-ended data collection
- **Always ready**: planned interventions and unplanned disruptions
- Quasi and natural experimental designs and case-control matching
- **Challenges**: scalability, data quality, missing data, nonparametric and spatial methods



Urban Sustainability Observatories

Building knowledge beyond local events

- Events and interventions are local and provisional
- Network effects are large
- Transfer knowledge across complex geographic systems
- Possible approaches
  - Geospatial, temporal and moving objects imputation
  - Simulation via digital twins / mirror worlds



http://avl-test.ncsa.illinois.edu/

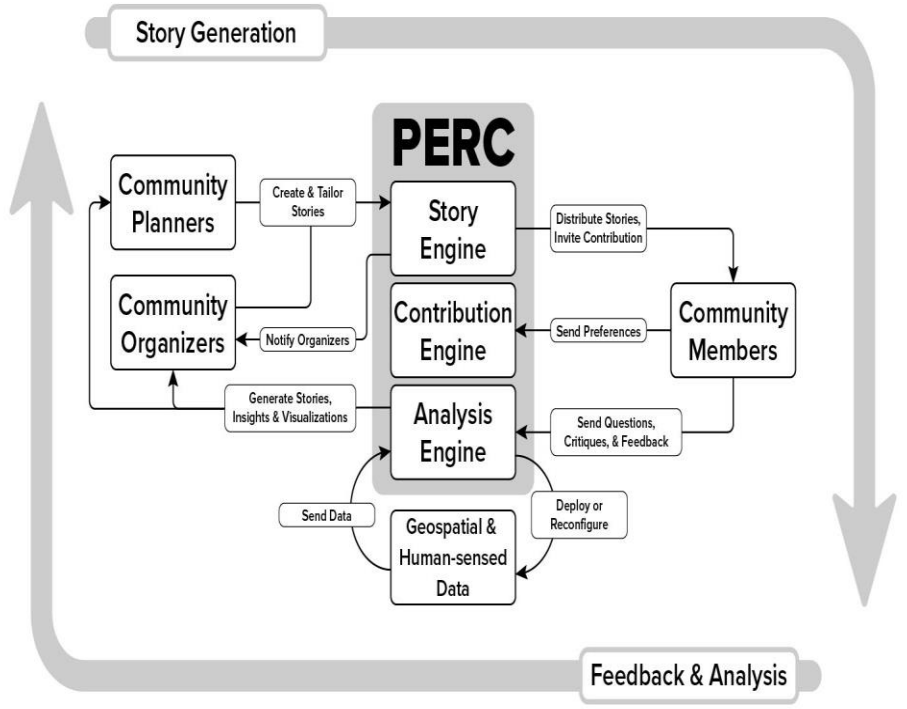
Urban Sustainability Observatories

Embracing uncertainty and heterogeneous values

Knowledge co-production by lowering friction *and* raising value of community interactions via:

1. Semi-automated story generation
2. Feedback and interrogation
3. Community-machine teaming

Next-generation story maps as a platform



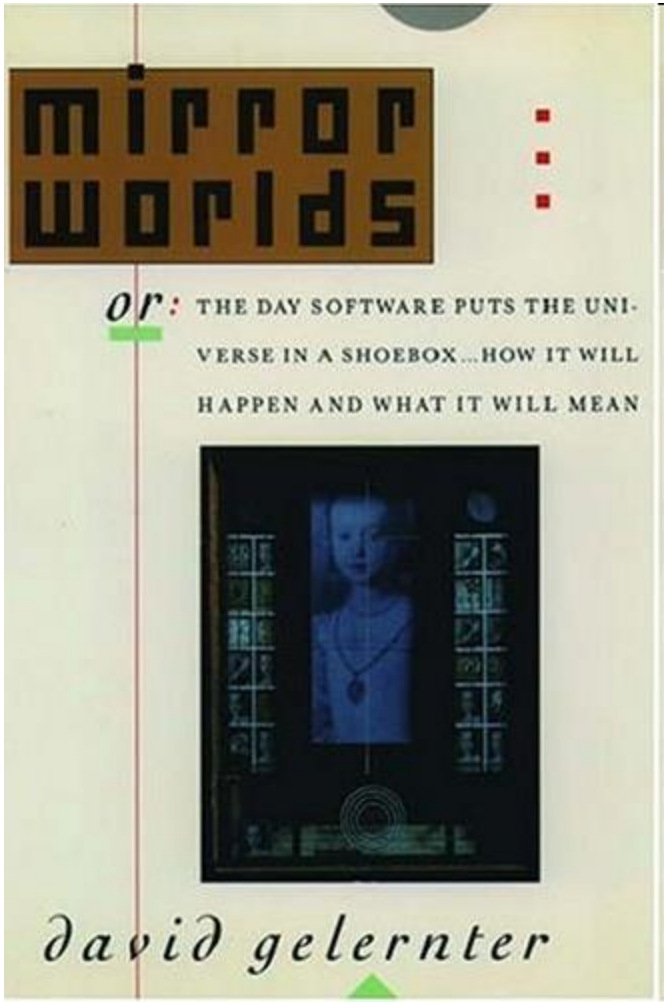
Public Engagement for Resilient Communities (PERC) architecture

USO as *Mirror Worlds*

- A **real-time**, **comprehensive**, **detailed**, **interactive** and **discoverable portrayal** of a complex **real-world system**.

- Not an alternative reality but a **reflection of reality** that is **tightly coupled to the real-world**.

- A tool for **investigating** and **managing** reality
  - Help managers, citizens, users understand and manage real world systems
  - Collaboration and shared decision making



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It's Time for Public Participation to Evolve With Transportation Planning

A manifesto by planning and transportation professionals committing to hearing all voices during public engagement processes.

November 15, 2021, 5:00 AM PST

By Marisa Denker, Mike Flynn, Samantha Donovan, Theresa Carr, Alexandra Zazula

Keep

- Offering virtual sessions
- Bridging the digital divide through creativity
- Sharing and shifting power

Start

- Leveraging hybrid engagement
- Measuring the impact of engagement
- Extending virtual engagement beyond a time-restricted event
- Understanding that engagement moves at the speed of trust

STOP

- Enabling check-the-box engagement
- Using buzzwords to communicate or sell complex ideas.
- Holding meetings at times and locations that only work for a small slice of the population.

Scientific challenges

1) How do we build tools and protocols for opportunistic sustainable mobility science?
2) How do we build knowledge in complex geographic systems?
3) How do we achieve shared understanding given uncertainty and heterogeneous values?
4) How do we resolve barriers to geographic knowledge co-production?
5) How do we make the system scalable, open, inclusive and collaborative?

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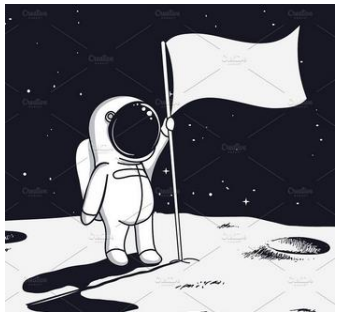
Scientific Merit



New insights into:

- Behavior of complex mobility, urban and other geographic systems
- Interactions among natural, human-built and social systems that drive sustainability across multiple scales
- Deeper understanding of how people interact with geographic data and information

Broader impacts: A sustainable urban planet

Conclusion

Sustainable mobility is challenging

It is complex - literally

Values and norms are integral

The stakes are high!

Leverage persistent data

Treat mobility and cities as complex systems

Embrace uncertainty and values

Enable adaptive science and knowledge co-production

The Columbus USO team

Ohio State University investigators

Darryl Hood (College of Public Health)

Huyen T. K. Le (Geography / Sustainability Institute)

Andy May (Civil, Environmental and Geodetic Engineering

Harvey J. Miller (Geography / Center for Urban and Regional Analysis)

Srinivasan Parthasarathy (Computer Science and Engineering)

Rajiv Ramnath (Computer Science and Engineering)

Michael Rayo (Integrated Systems Engineering / Translational Data Analytics Institute)

Community partners

City of Columbus – Department of Neighborhoods

City of Columbus – Department of Public Services

Central Ohio Transit Authority (COTA)

Mid Ohio Regional Planning Commission (MORPC)

Thank you for your kind attention!

Papers that are worth reading

- Miller, H.J., Clifton, K., Akar, G., Tufte, K. Gopalakrishnan, S., MacArthur, J., Irwin, E., Ramnath, R., Stiles, J. (2021) "Urban sustainability observatories: Leveraging urban experimentation for sustainability science and policy," ***Harvard Data Science Review***, 3.2.
- Miller, H.J. (2020) "Movement analytics for sustainable mobility." ***Journal of Spatial Information Science***, 20, 115-123.
- Miller, H.J. (2018) "Mesogeography: Social physics, GIScience and the quest for geographic knowledge," ***Progress in Human Geography***, 42, 600-609.
- Miller H.J. (2017) "Geographic information observatories and opportunistic GIScience," ***Progress in Human Geography***, 41, 489-500.
- Miller H.J. (2013) "Beyond sharing: Cultivating cooperative transportation systems through geographic information science," **Journal of Transport Geography**, 31, 296-308.

Research blog

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