Research Design in Urban Science

Un

Ecology Across Bo

UW URBDP 591A/598L:

Research Design in Urban Science

Fall Quarter 2021

Tue-Thu 9:00-9:20

Instructor: Marina Alberti
Department of Urban Design and Planning
E-mail: malberti@u.washington.edu

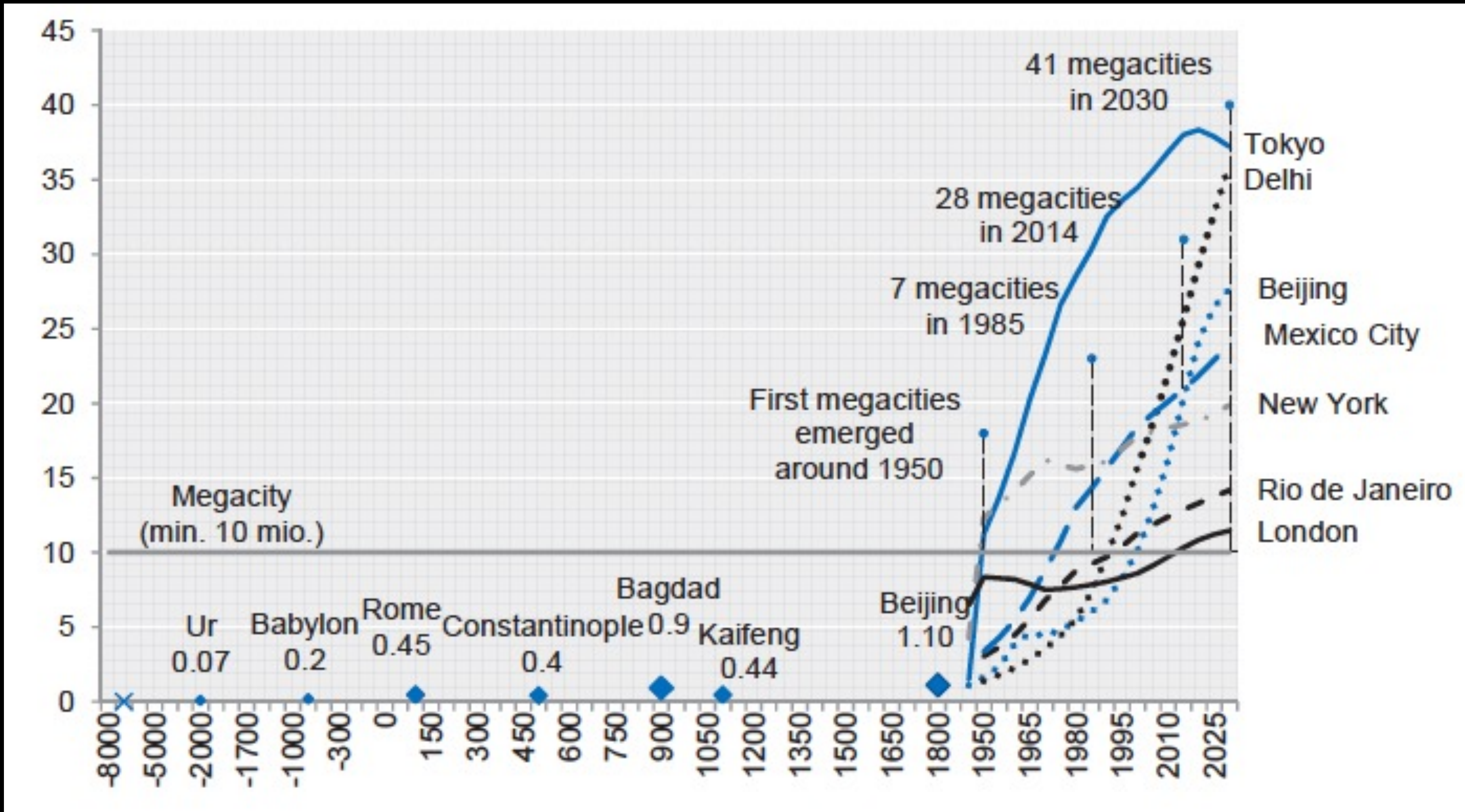
http://courses.be.washington.edu/udp/598/Urban_Science/

an URBAN planet

8,000 years ago

Uruk 4000–3200 BC

Earth Observation Center



41 megacities in 2030
28 megacities in 2014
7 megacities in 1985
First megacities emerged around 1950
Megacity (min. 10 mio.)
Tokyo
Delhi
Beijing
Mexico City
New York
Rio de Janeiro
London
Ur 0.07
Babylon 0.2
Rome 0.45
Constantinople 0.4
Bagdad 0.9
Kaifeng 0.44
Beijing 1.10
45
40
35
30
25
20
15
10
5
0
-8000
-5000
-2000
-1700
-1000
-300
0
150
300
450
600
750
900
1050
1200
1350
1500
1650
1800
1950
1965
1980
1995
2010
2025

OECD 2015

History of urbanization
3700 BC – 2000 AD

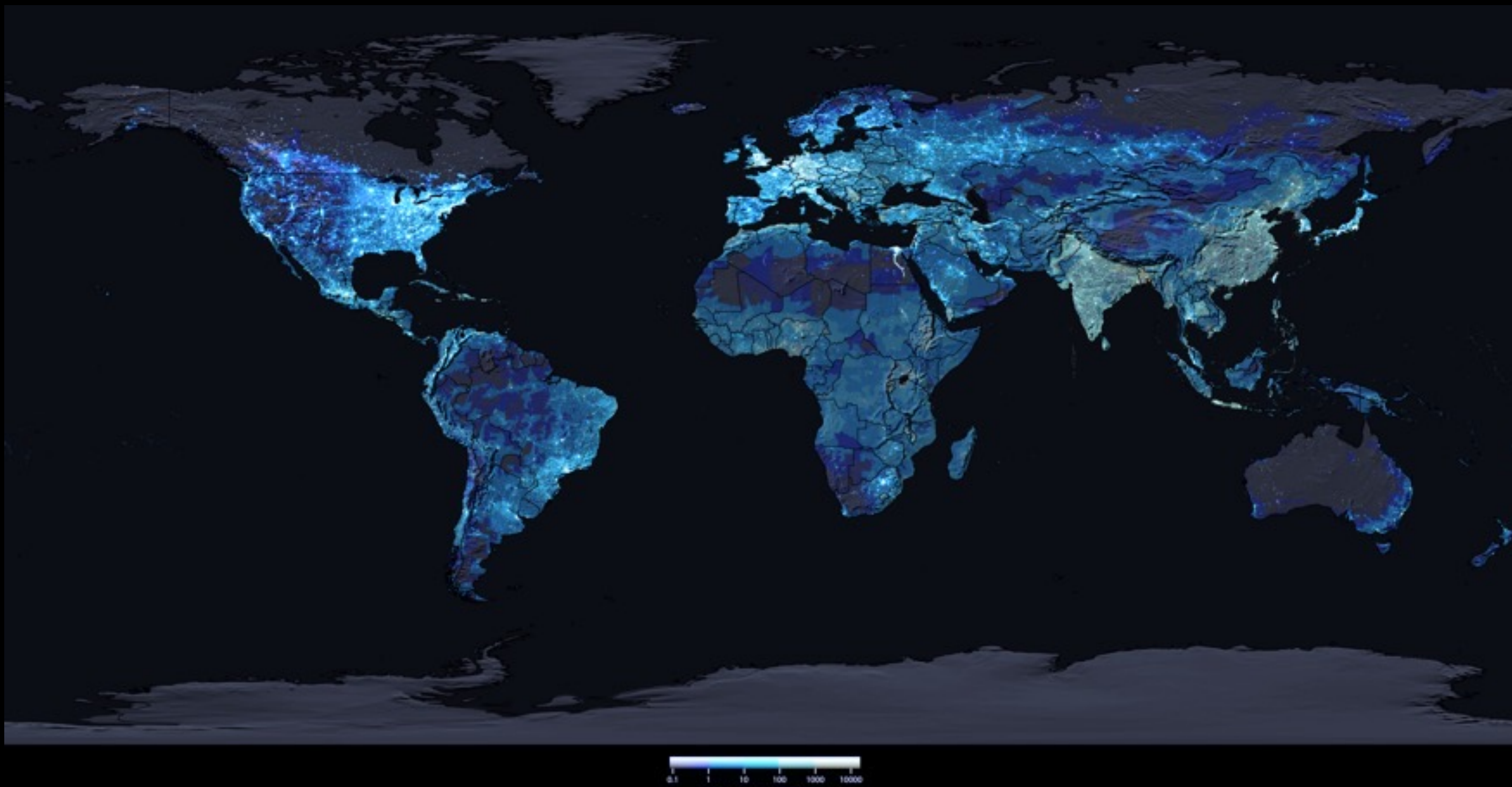

develop


adapt


collapse

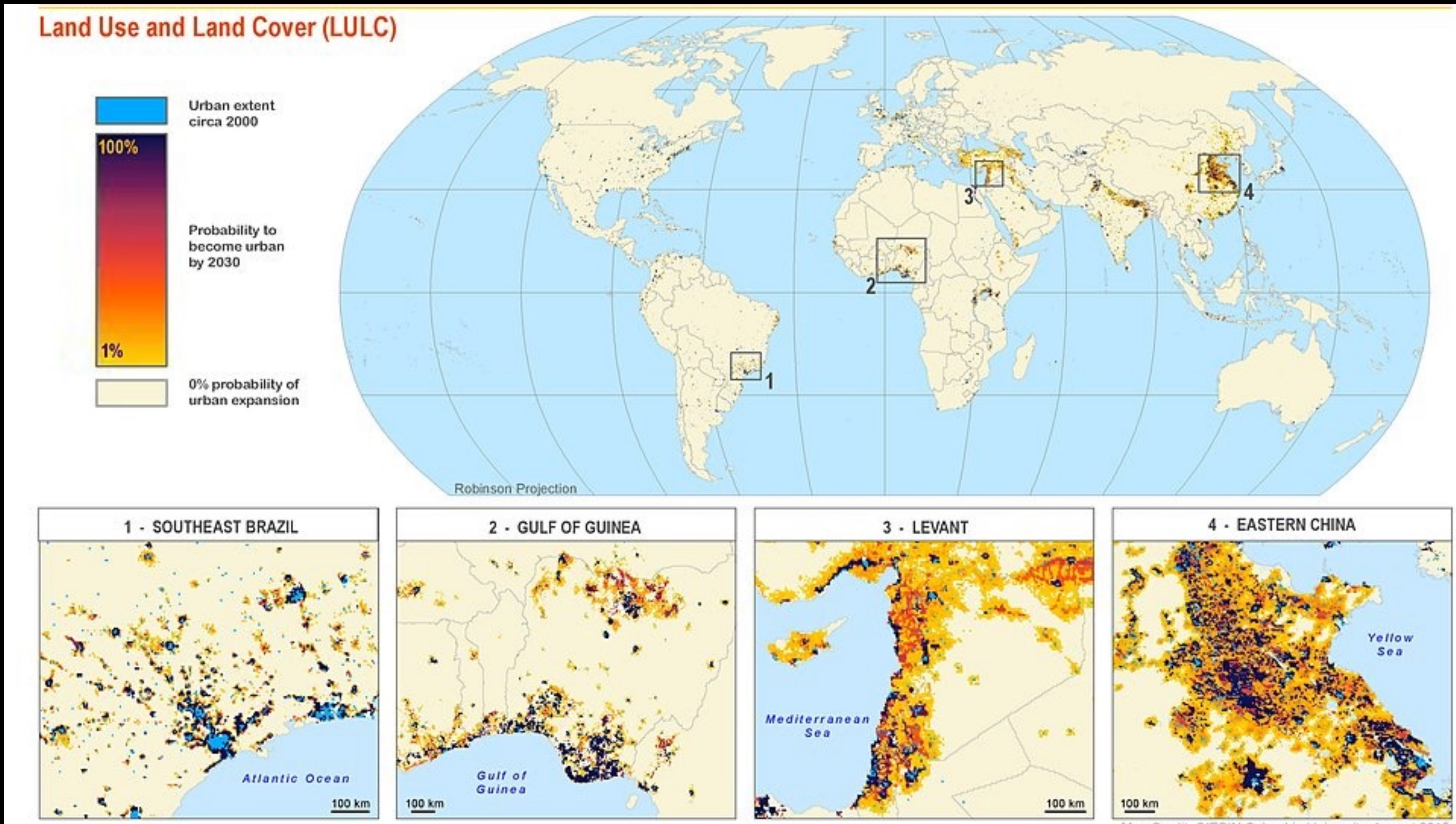

transfor
transform


WHAT FUTURES ARE
WE UNABLE TO IMAGINE?



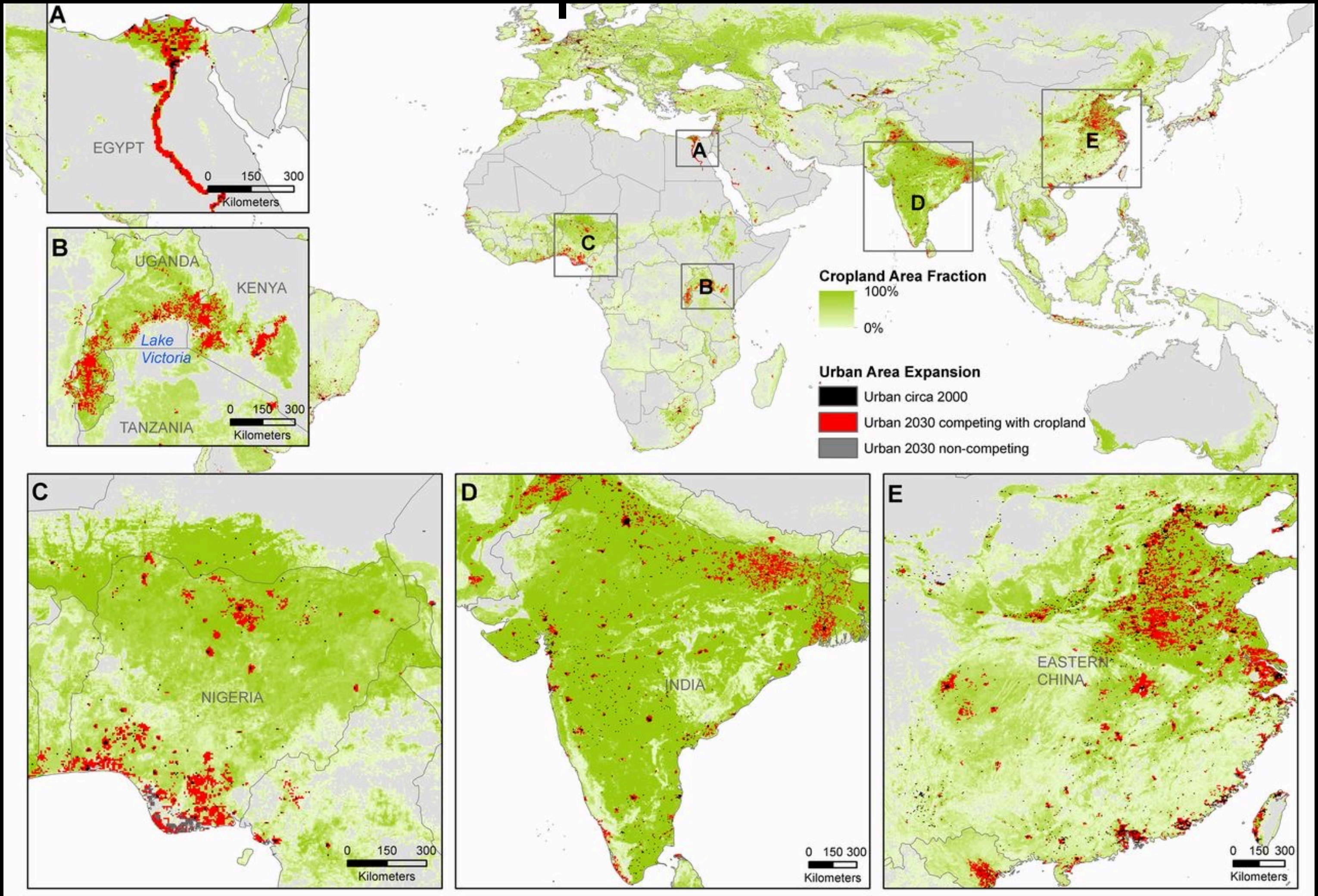
Population: 7.5 billion *Urban:* >55% - Gross World Product ~85 trillion *Urban:* ~80%
Energy Consumption 13,541 Mtoe *Urban* ~70% CO_2 emissions 35 Gton *Urban* ~70%

Predicted Urban Land Expansion



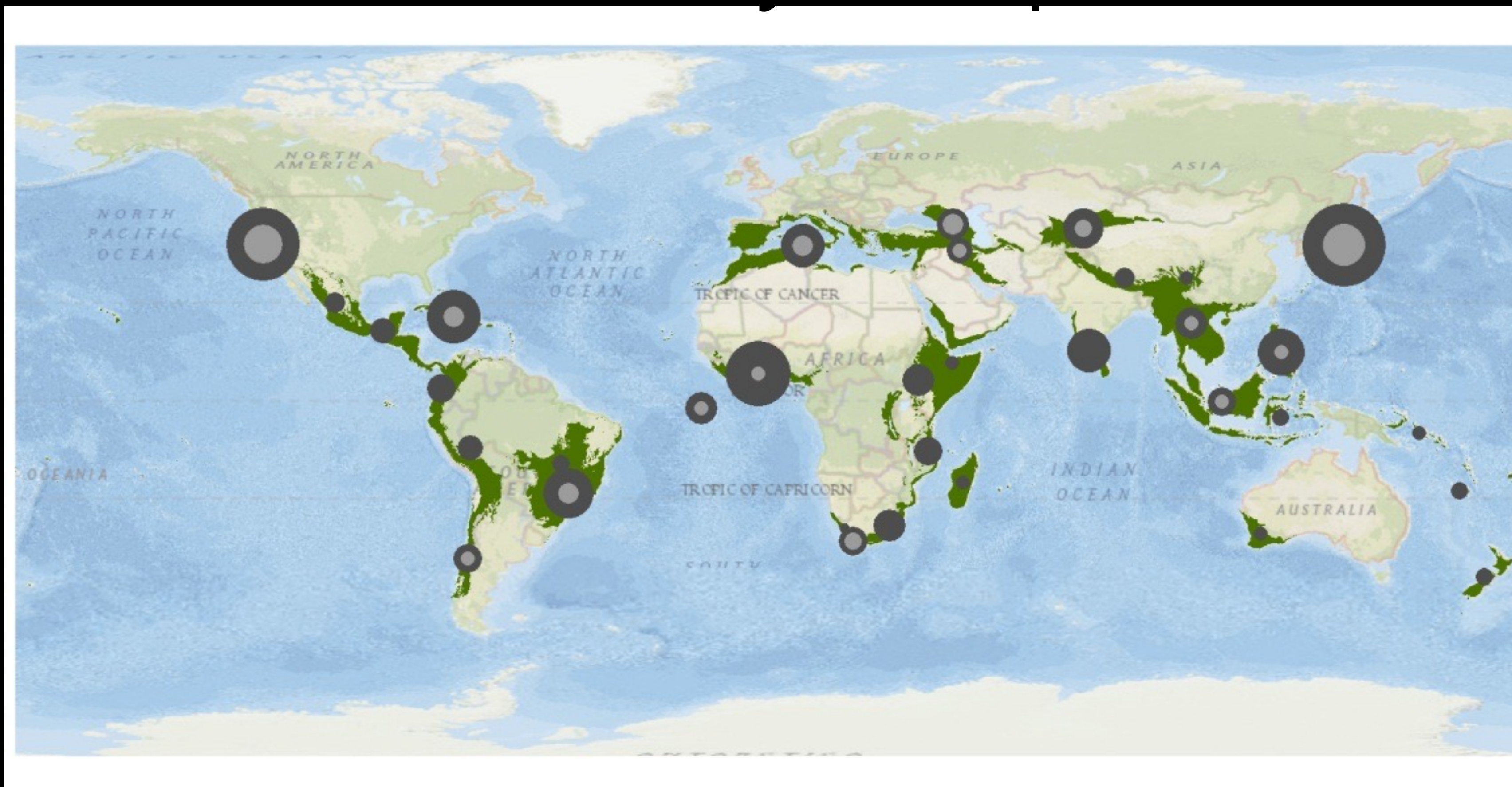
Seto et al 2012

Predicted Cropland Loss to Urban



CB d'Amour - 2017

Predicted Urban Expansion in



% urban in 2000 % urban expansion 2030 (75-100% probability quartile) Biodiversity hotspot

Adapted from Seto, Guneralp and Hutyra. 2012

Humans in cities are changing the rules of nature’s game

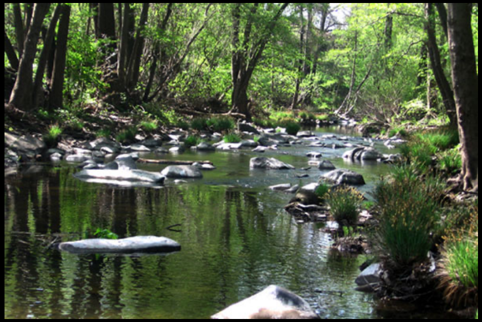
Cities drive rapid planetary evolutionary change

These species provide important ecosystem functions

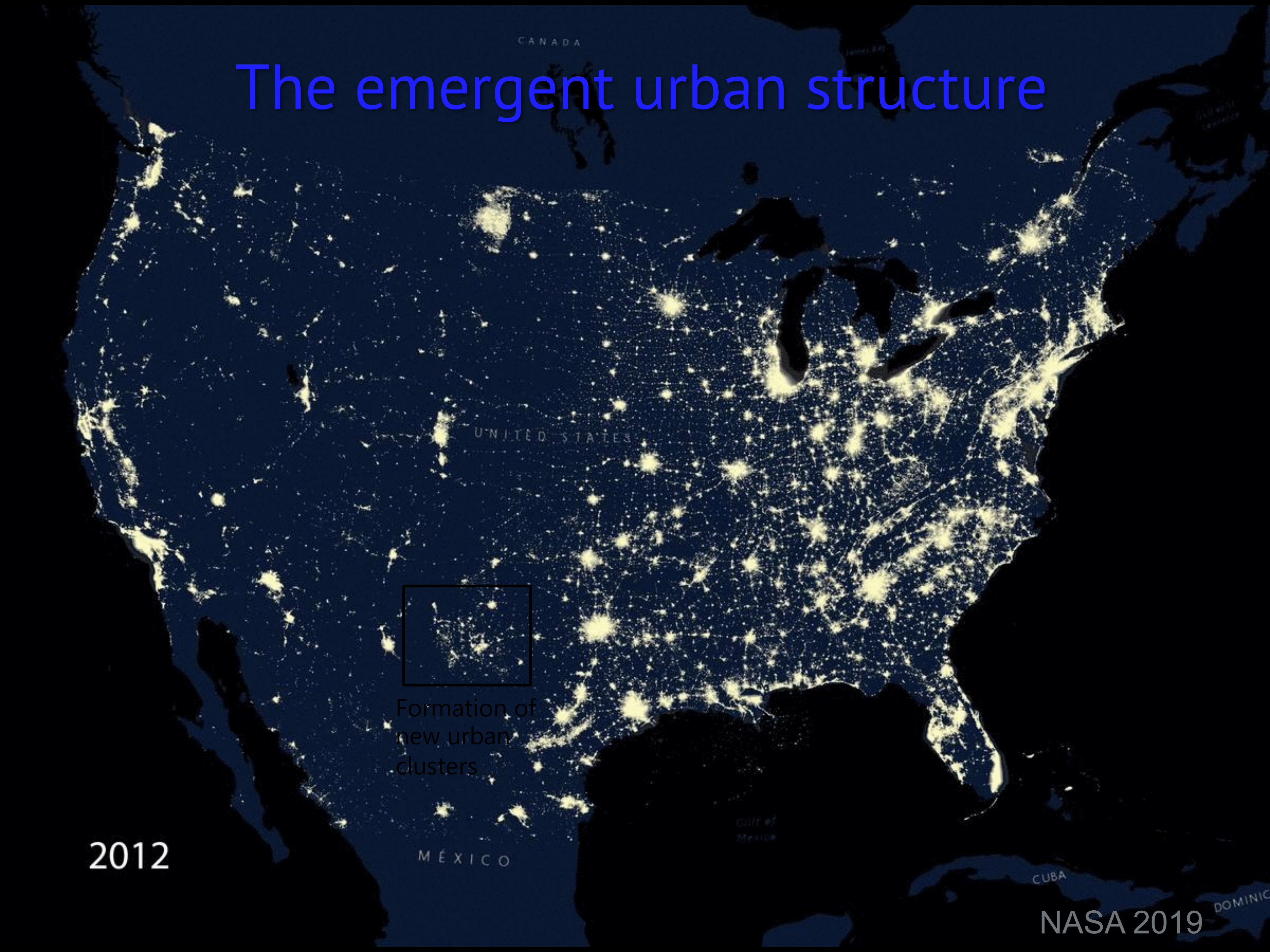


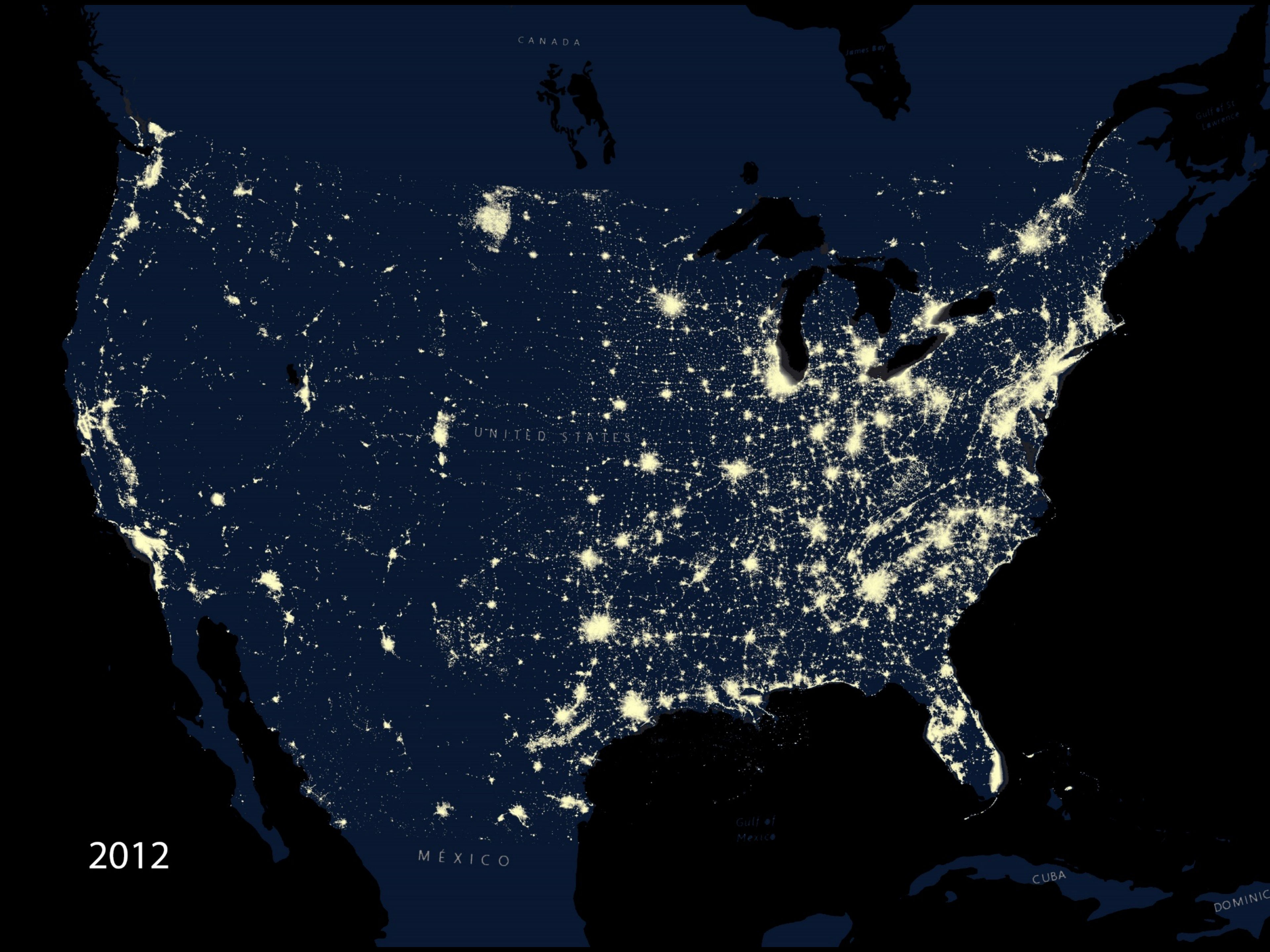


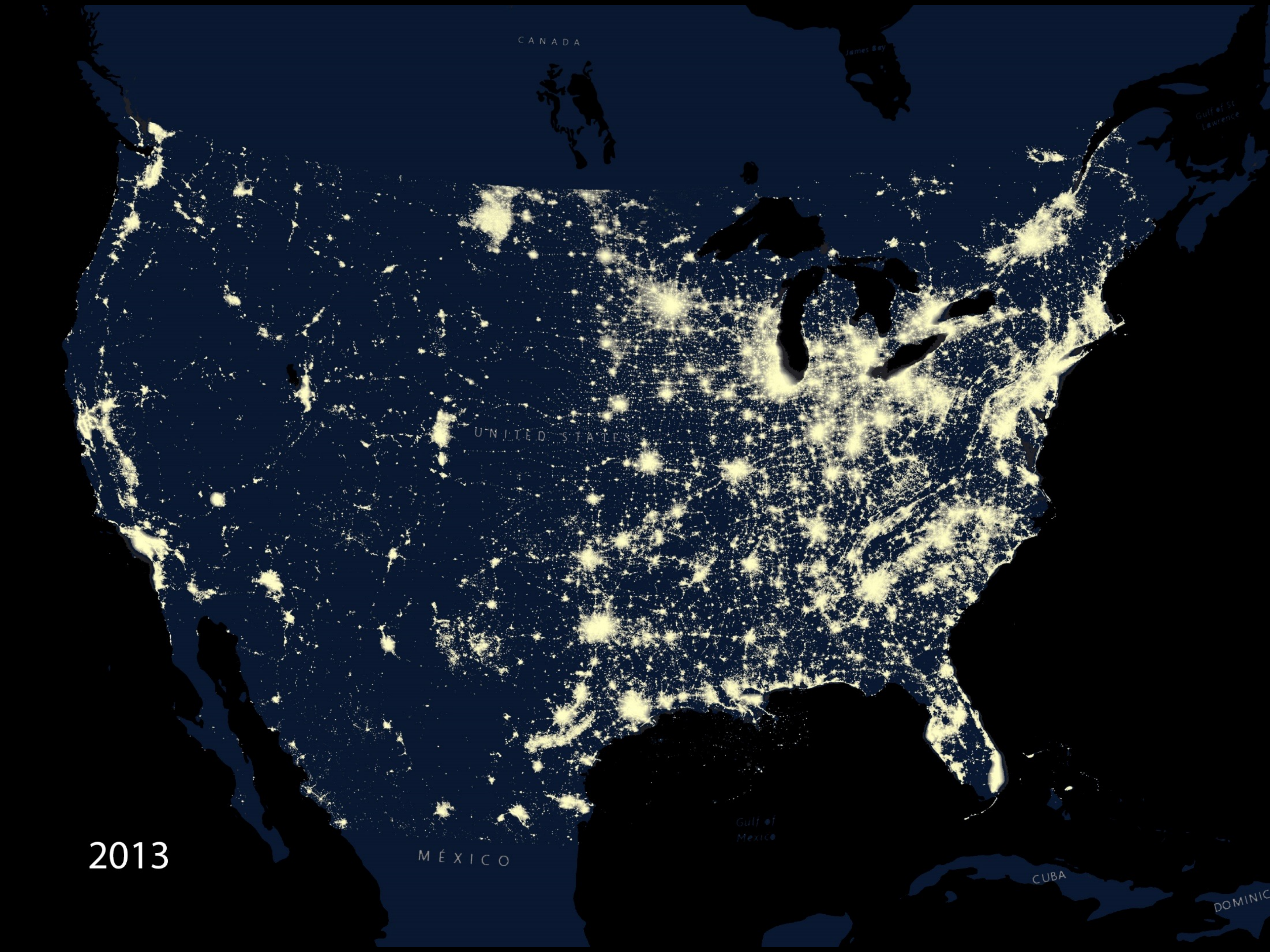


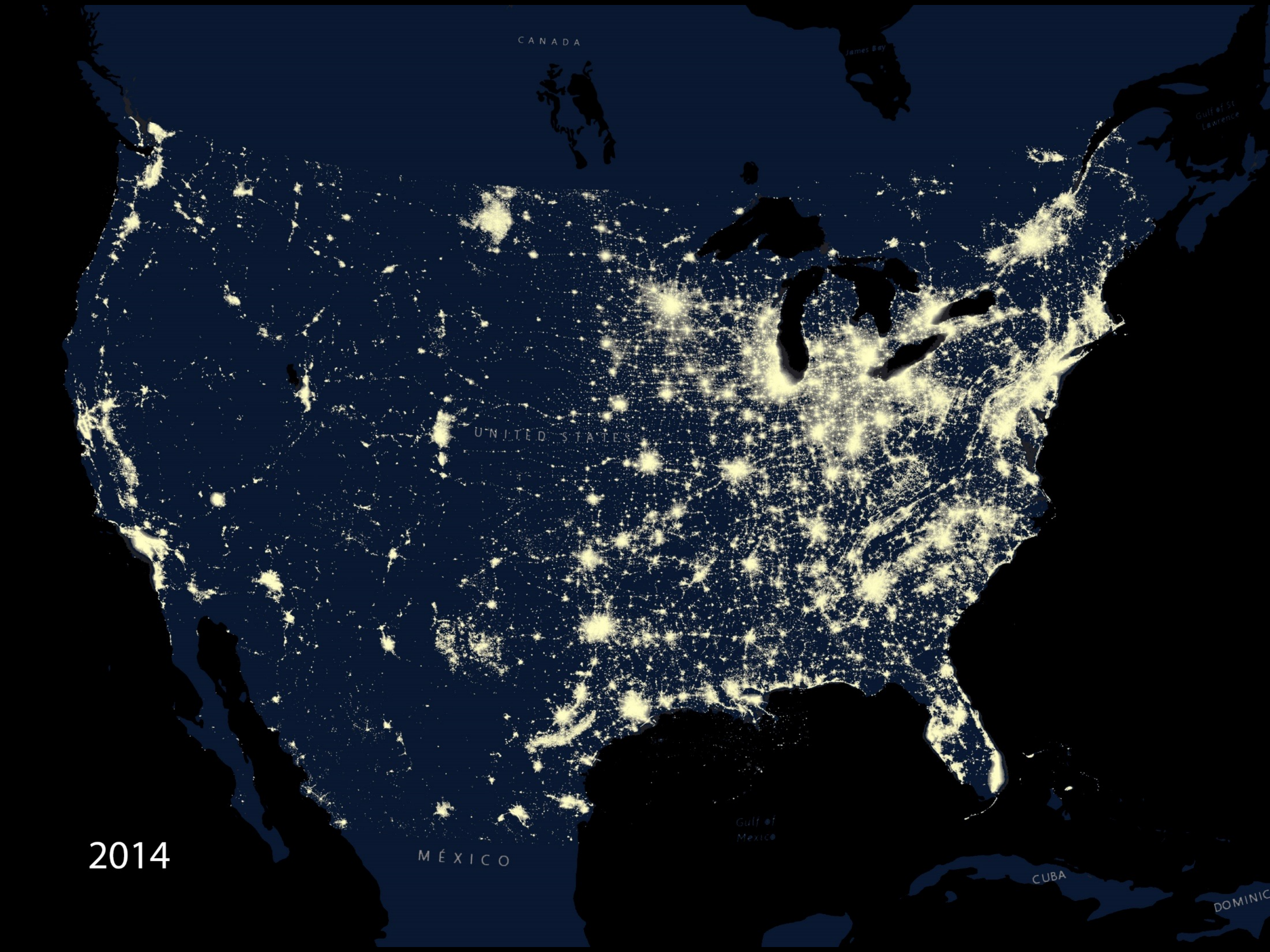


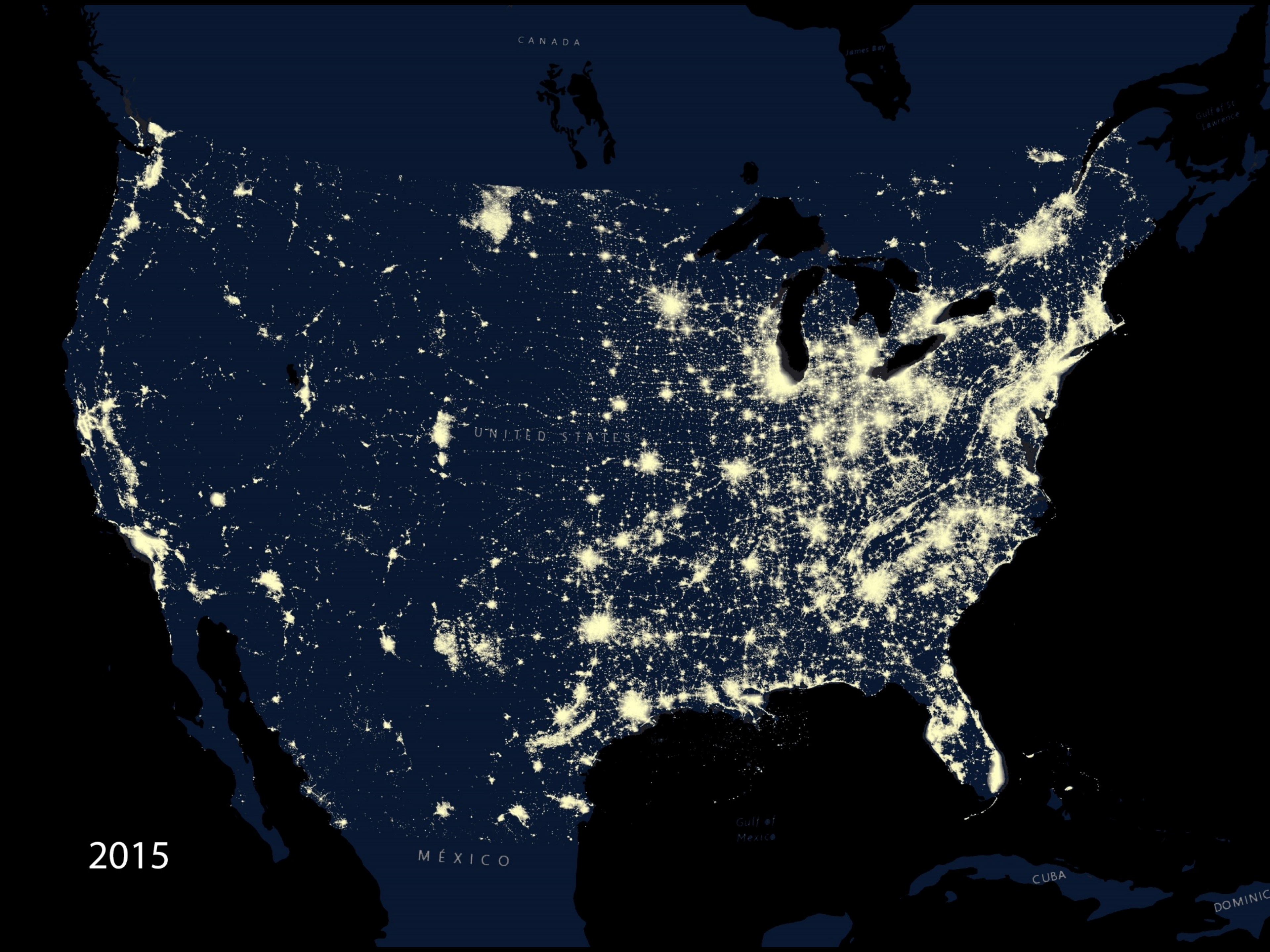
The emergent urban structure

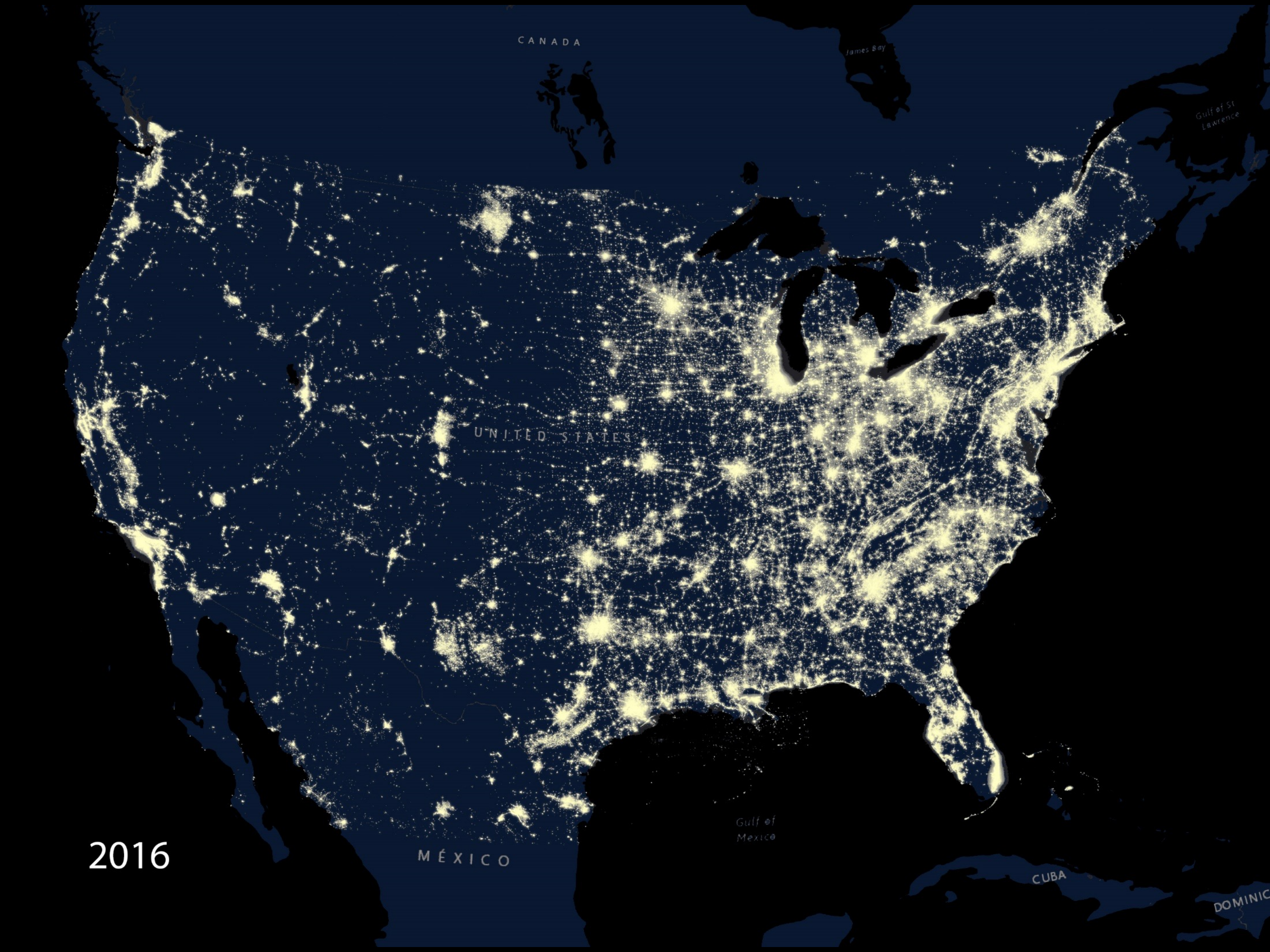



CANADA
James Bay
Gulf of St Lawrence
UNITED STATES
Gulf of Mexico
MÉXICO
CUBA
2012

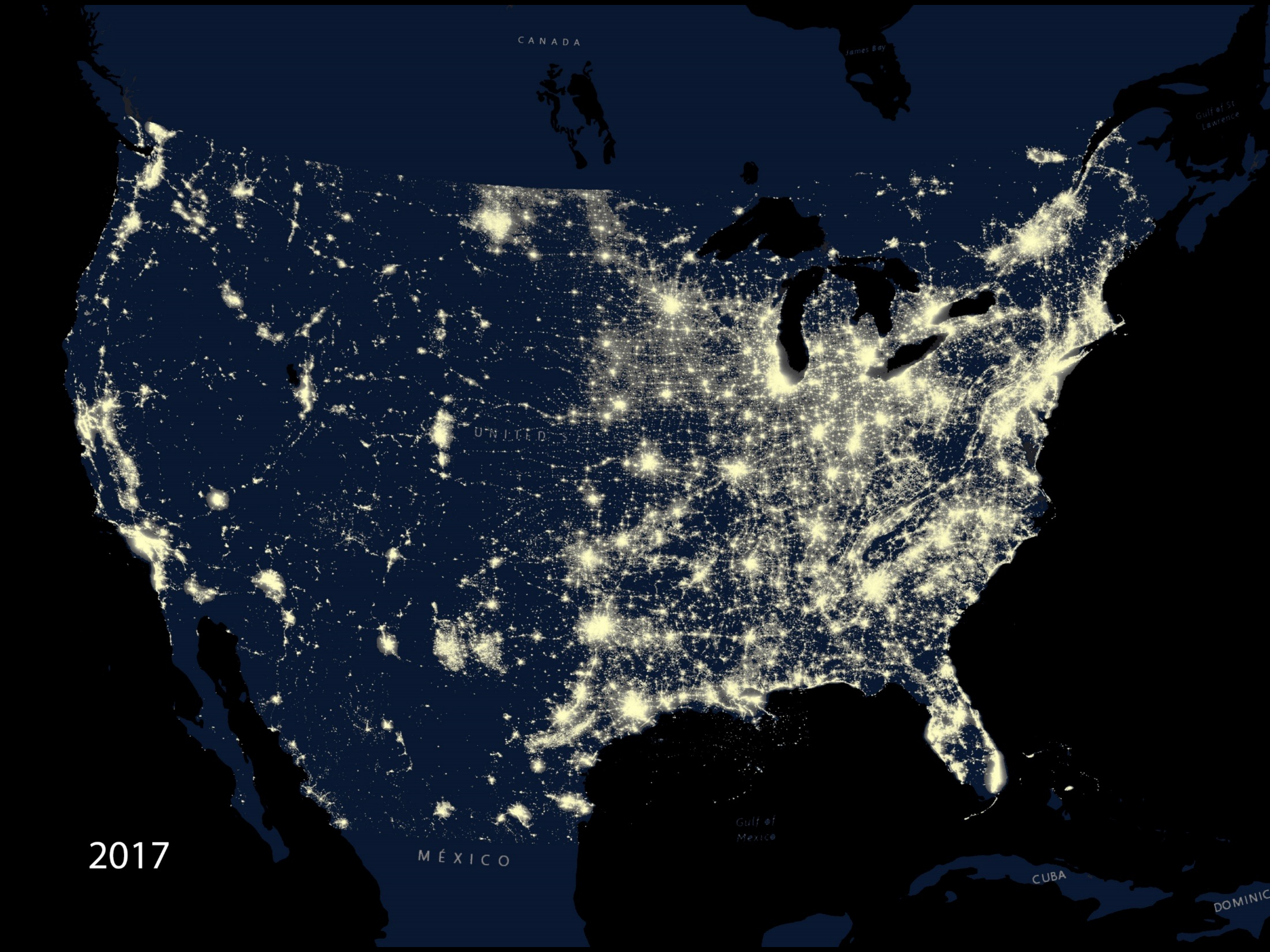

CANADA
James Bay
Gulf of St Lawrence
UNITED STATES
Gulf of Mexico
MÉXICO
CUBA
2013

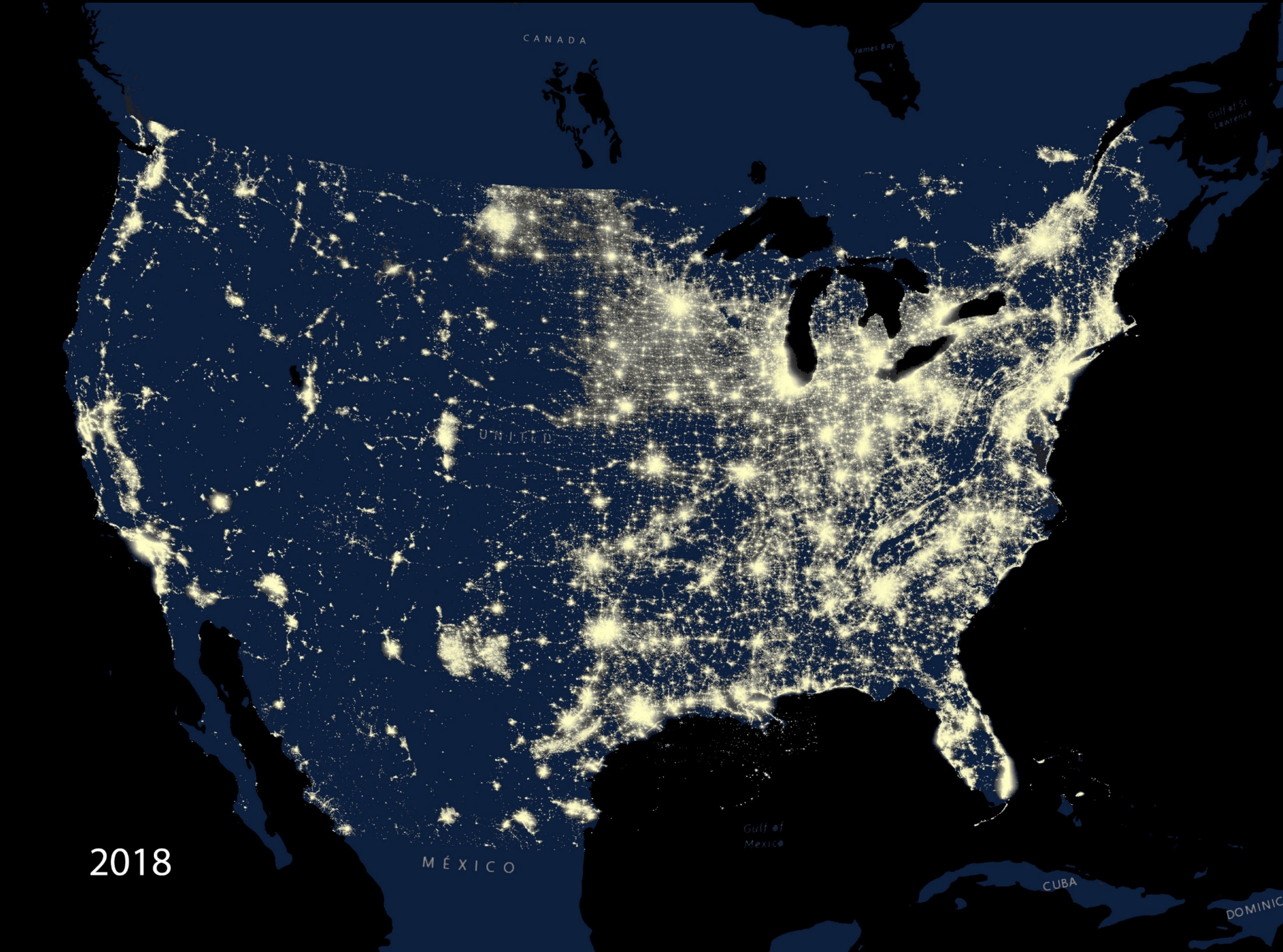

CANADA
James Bay
Gulf of St Lawrence
UNITED STATES
MÉXICO
Gulf of Mexico
CUBA
2014

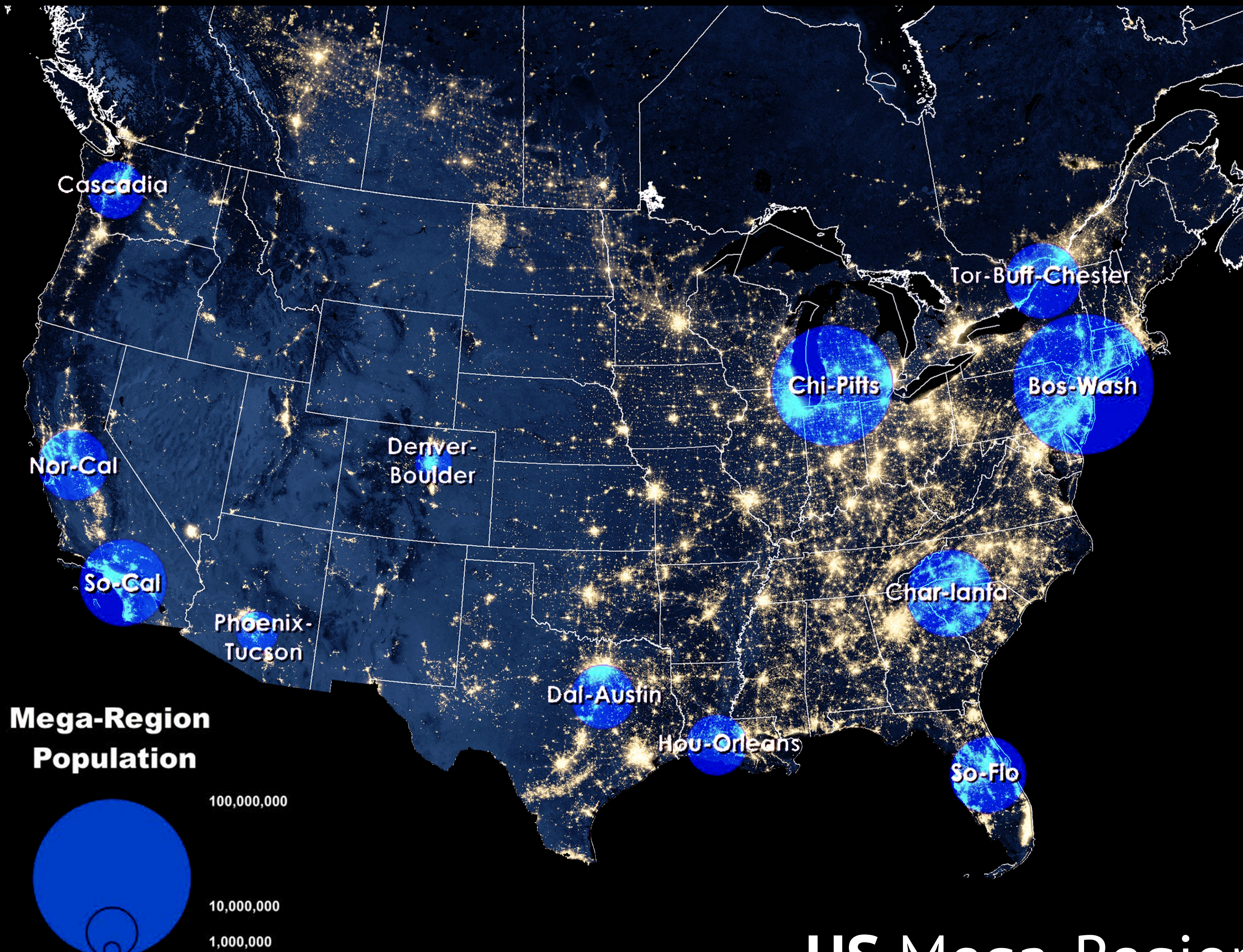

CANADA
James Bay
Gulf of St Lawrence
UNITED STATES
MÉXICO
Gulf of Mexico
CUBA
2015


CANADA
James Bay
Gulf of St Lawrence
UNITED STATES
MÉXICO
Gulf of Mexico
CUBA

2016

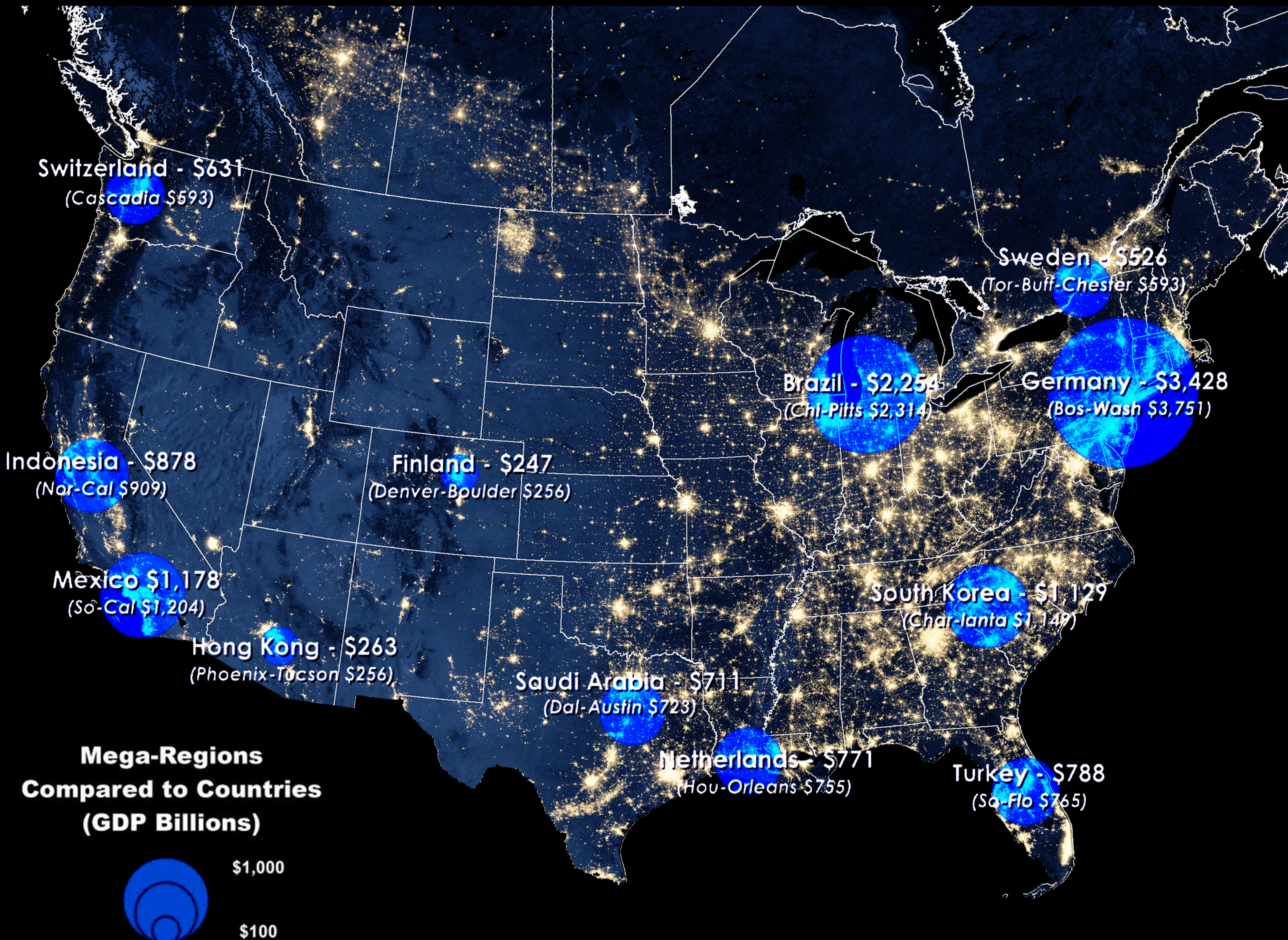

CANADA
James Bay
Gulf of St Lawrence
MÉXICO
Gulf of Mexico
CUBA
2017


CANADA
James Bay
Gulf of St Lawrence
MÉXICO
Gulf of Mexico
CUBA
2018



US Mega-Regions

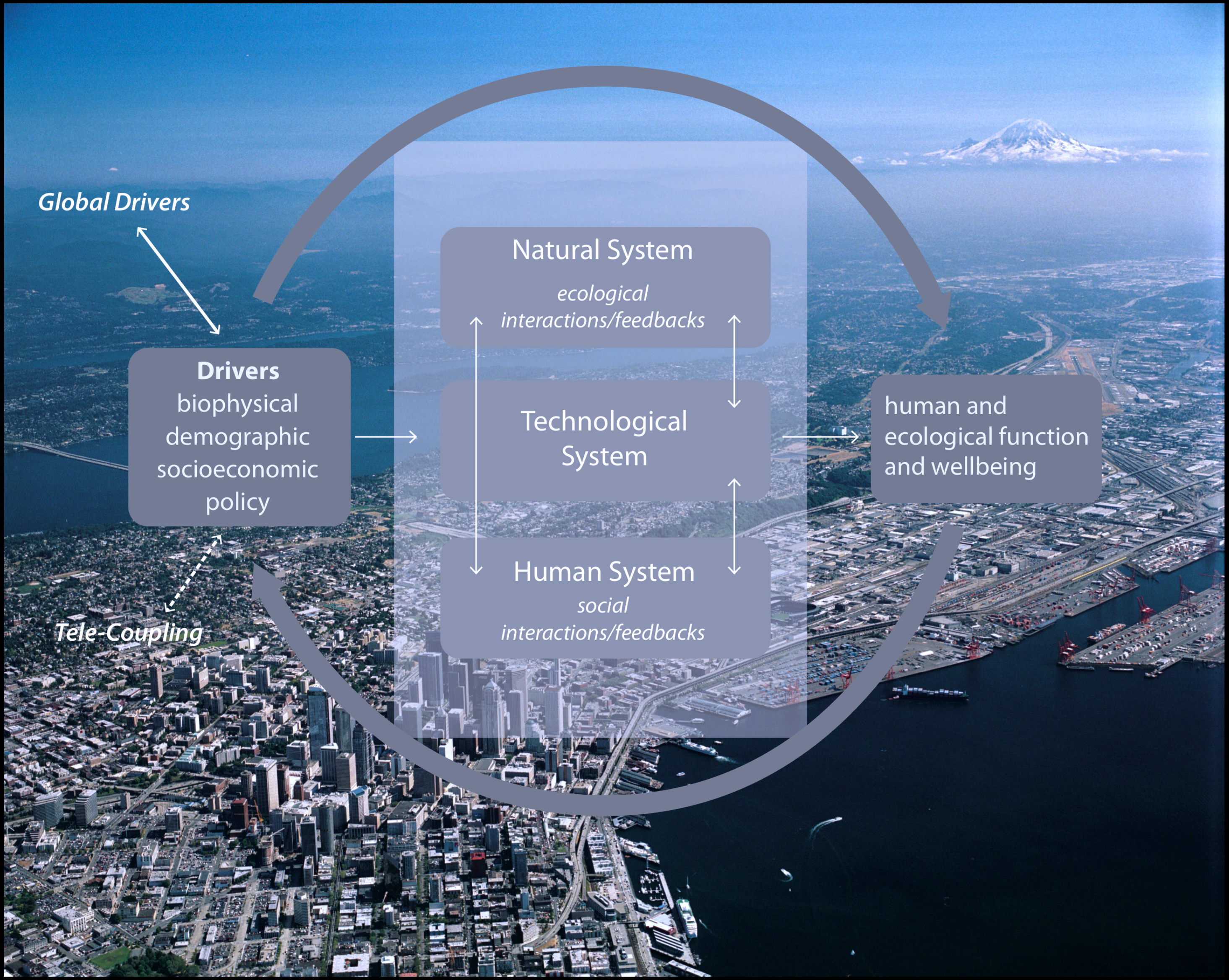
Data Source: City Lab



US Mega-Regions

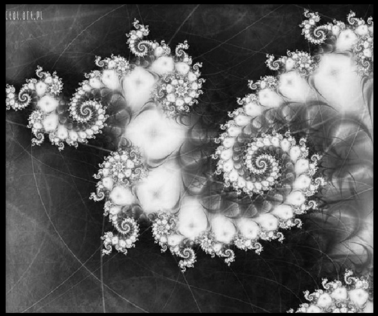
Data Source: City Lab

Cities as Complex Adaptive Systems

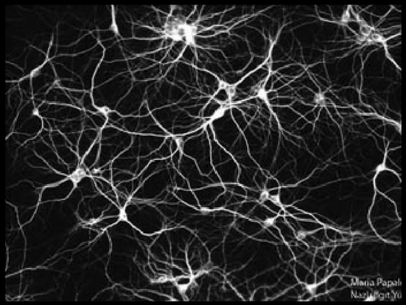


Hybrid ecosystems

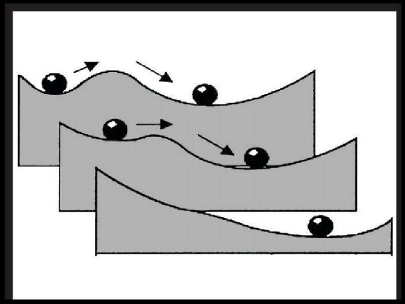
complexity



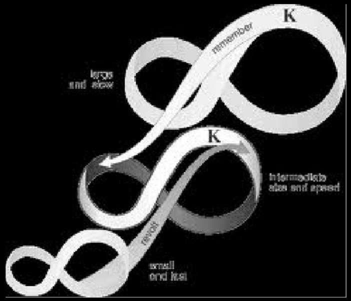
connectivity



regime-shifts



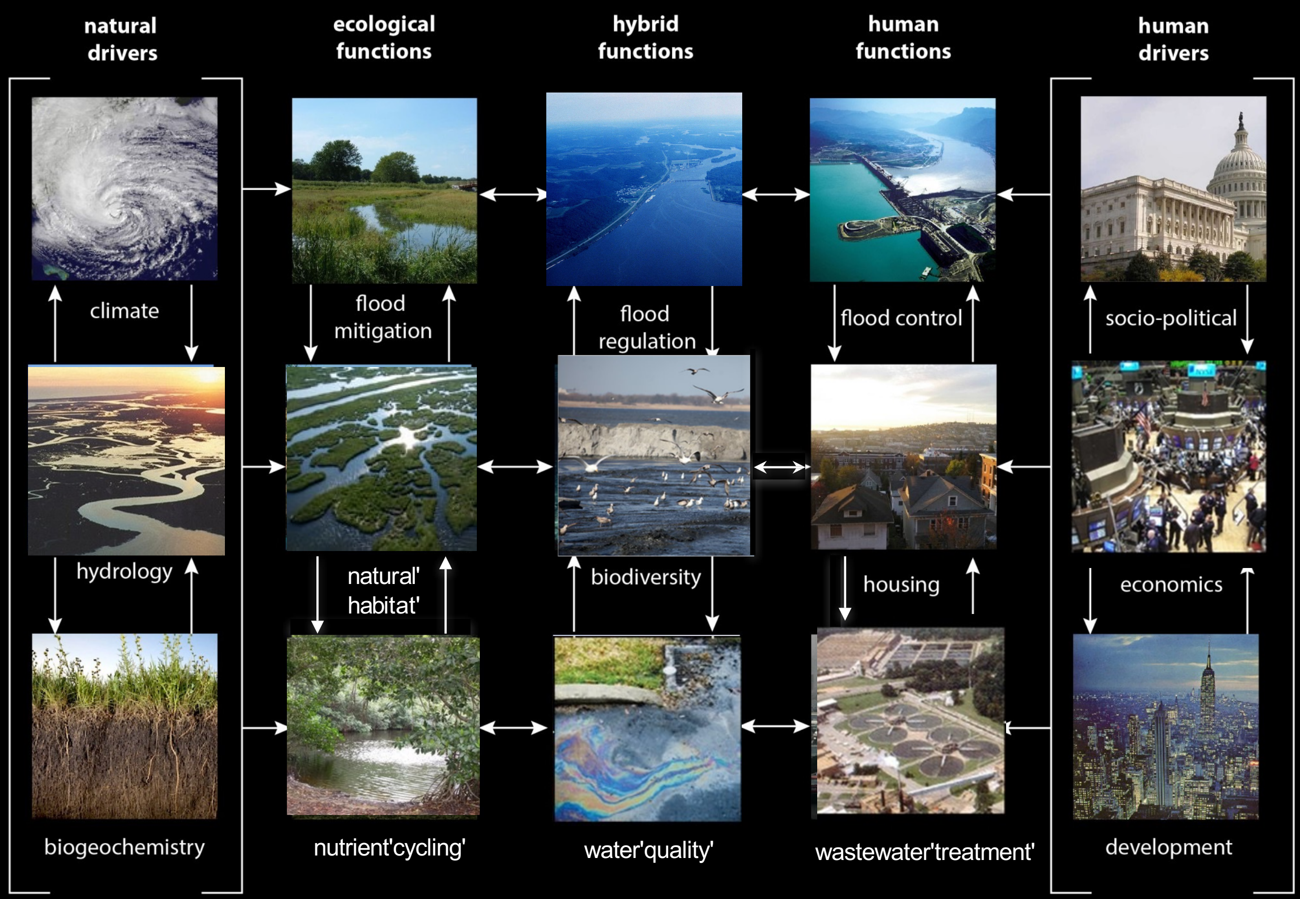
innovation



How do we plan for complex urban systems in which the components are highly heterogeneous and interdependent?

How can we build resilient urban infrastructures that are able to operate under uncertain future scenarios?

Complexity of socio-ecological systems



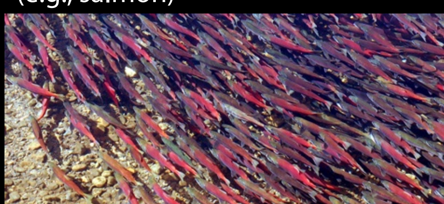
Emergence

Ecological Networks

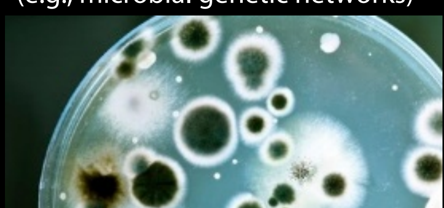
Physical networks
(e.g., rivers)

Mutualistic networks
(e.g., predator-pray networks)

Food webs
(e.g., salmon)

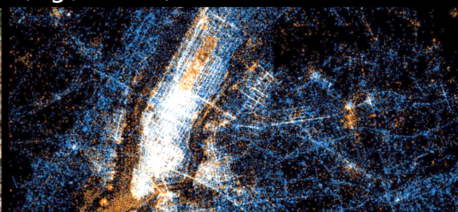


Genetic networks
(e.g., microbial genetic networks)



Human Networks

Social networks
(e.g., tweets)



Economic networks
(e.g. financial)

Information networks
(e.g., the Internet)

Institutional Networks
(e.g., healthcare, emergency service)

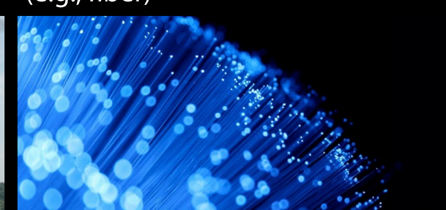
Built Networks

Transportation
(e.g., roads)

Power
(e.g., power grid)

Water
(e.g., water pipes)

Technology
(e.g., fiber)



Hybrid Networks

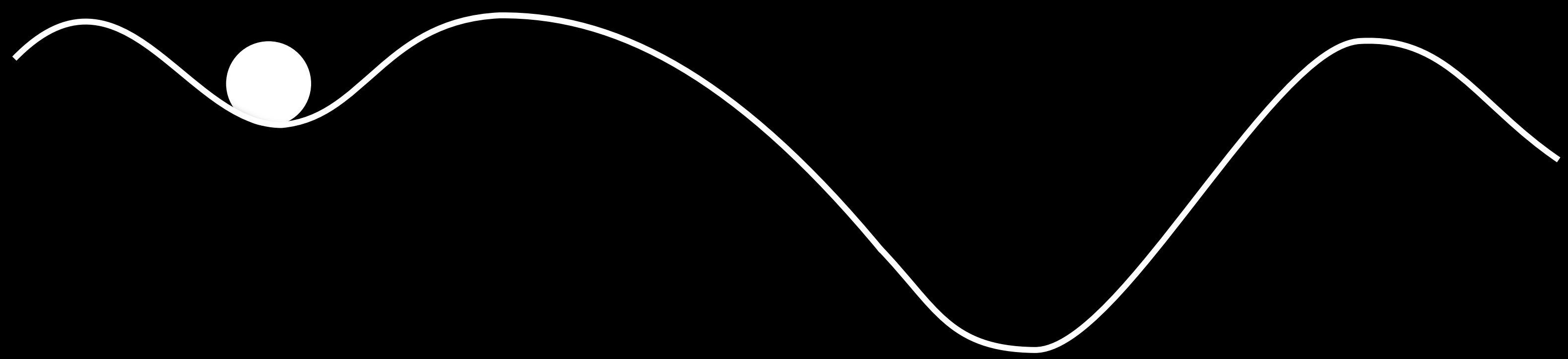
Socio-ecological networks
(e.g., conservation networks)

Built-natural networks
(e.g., green infrastructure)

Novel food webs
(e.g., synantropic species)

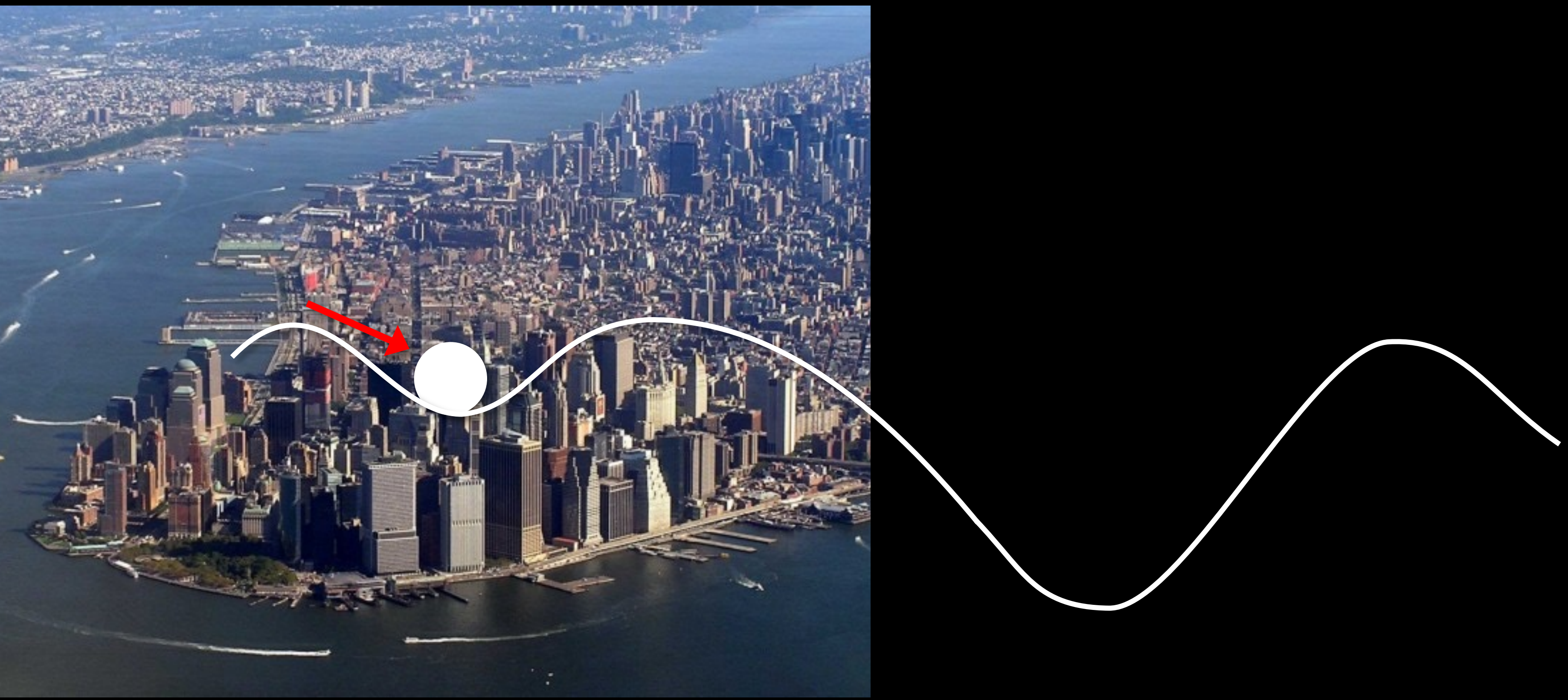
Emerging eco-evolutionary networks
(e.g., novel seed dispersal pathways)

regime shifts

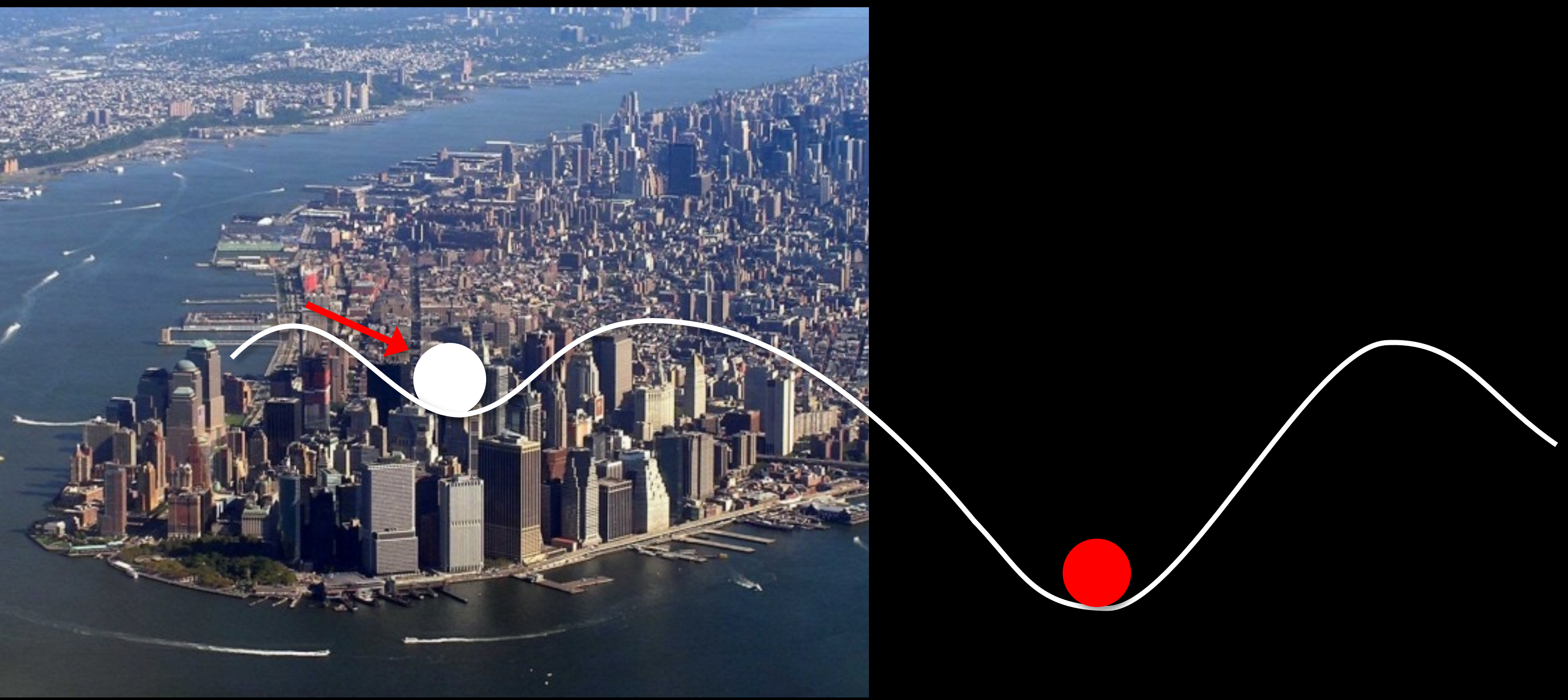


regime shifts

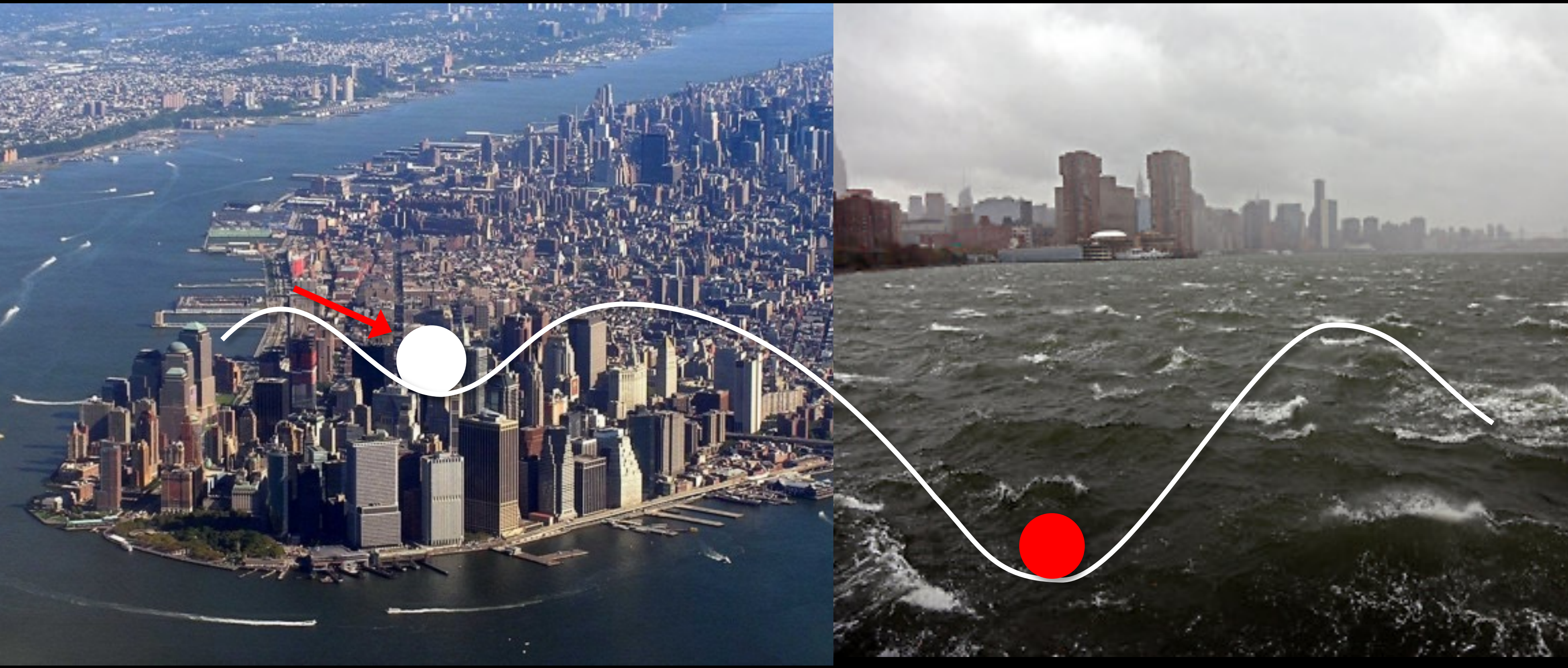
regime shifts



regime shifts

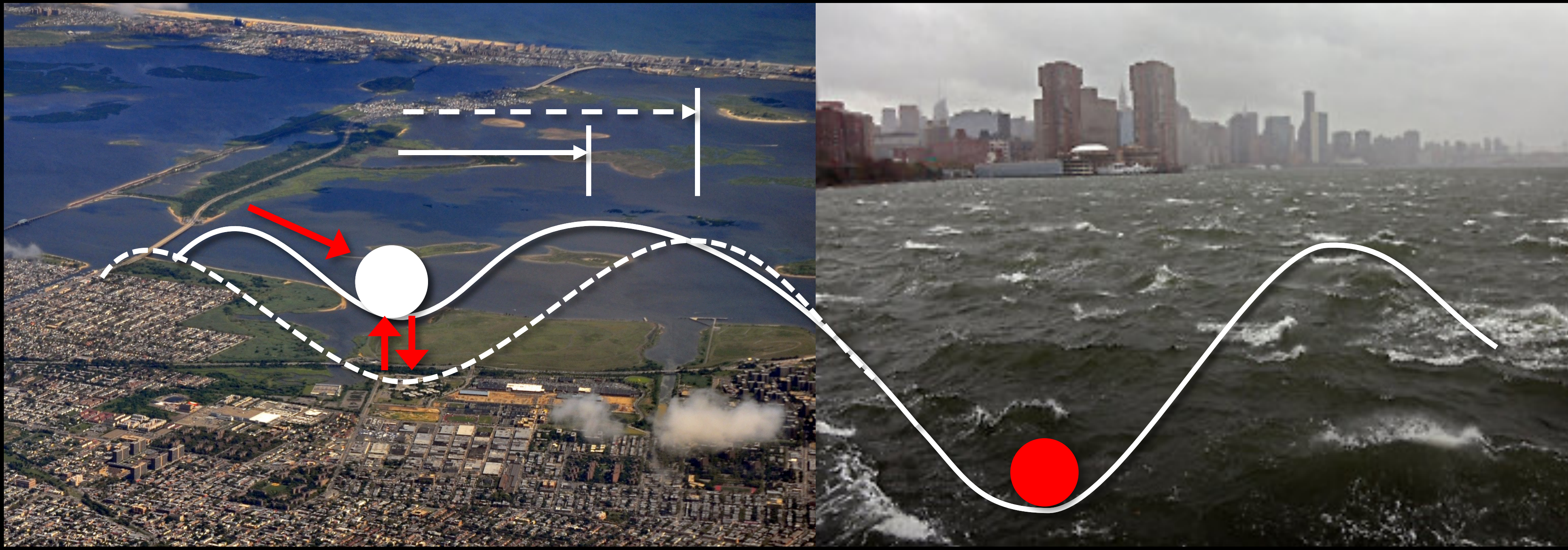


regime shifts



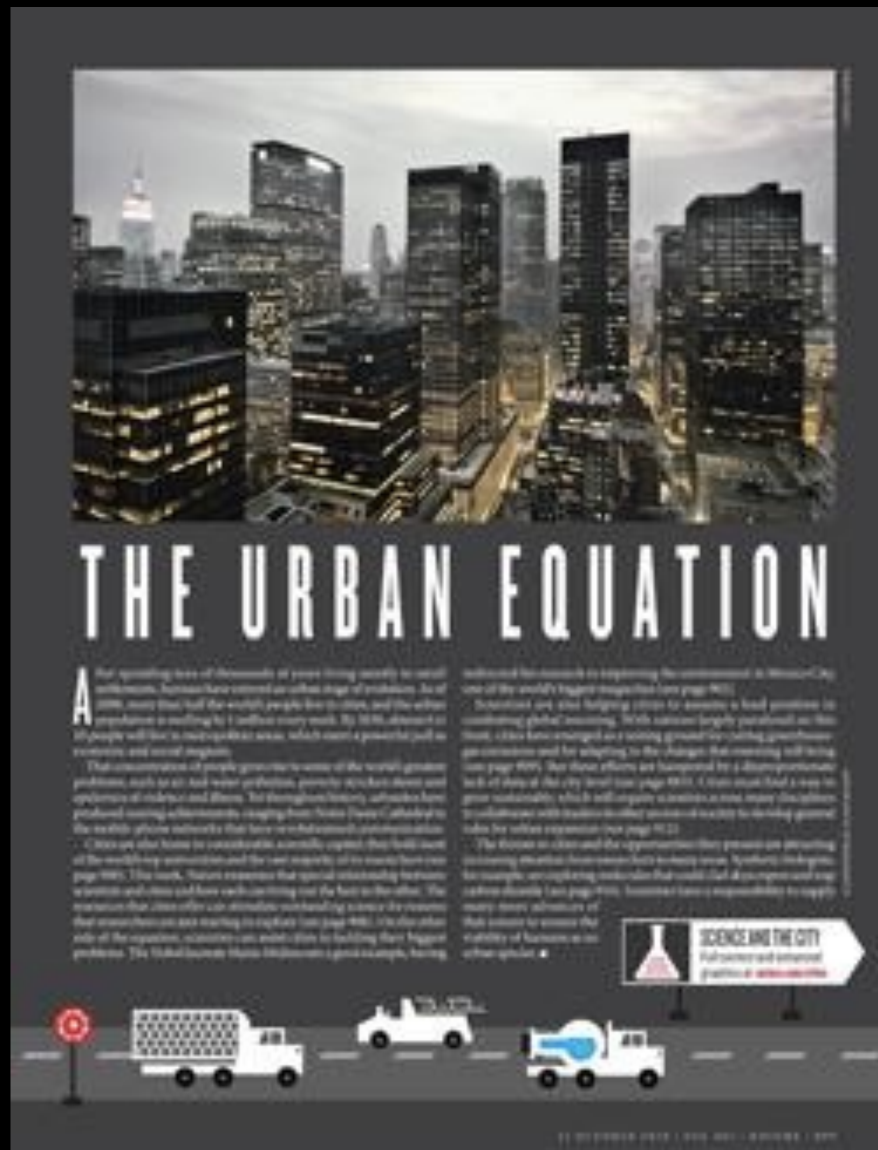
regime shifts

regime shifts



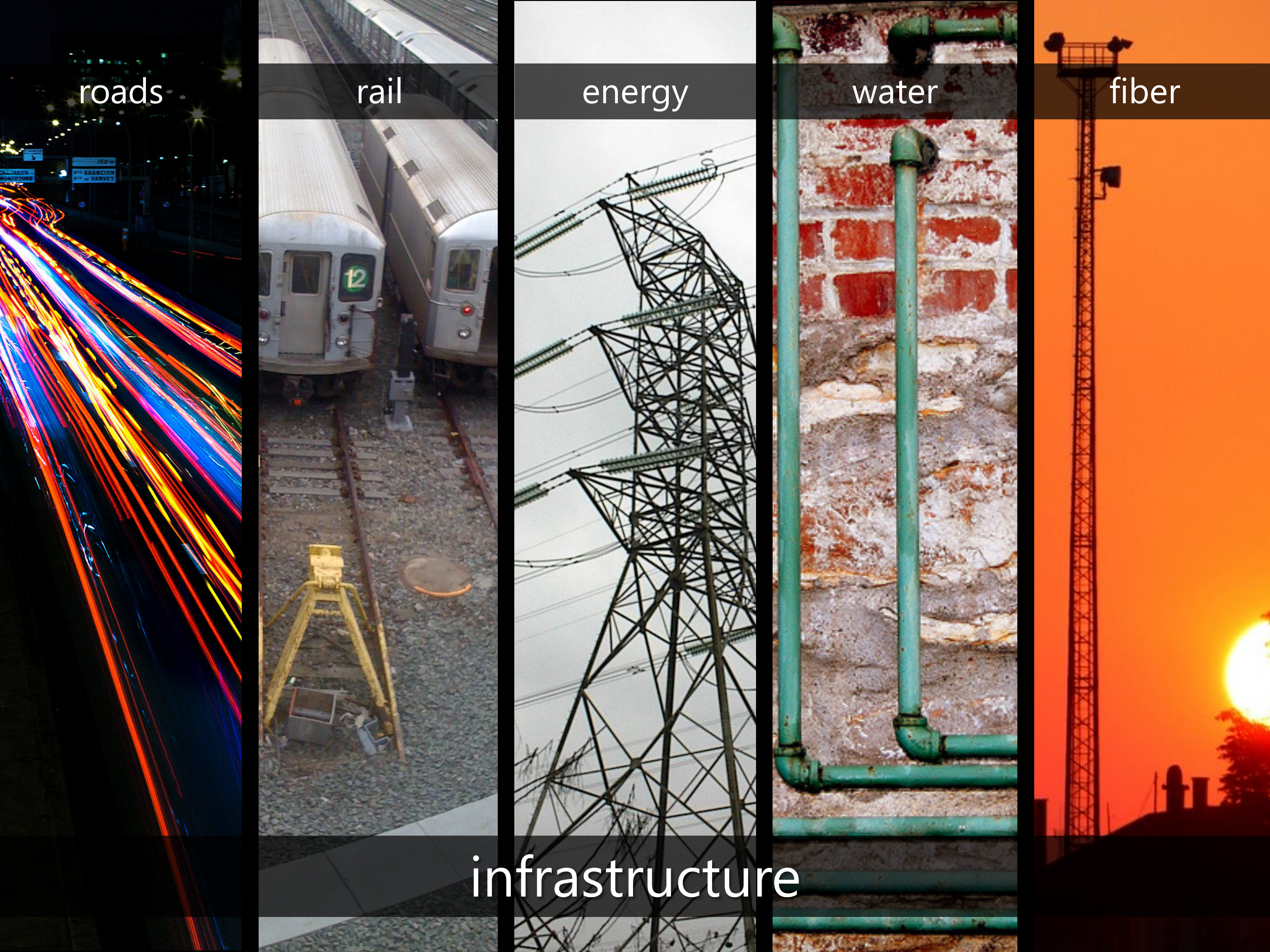
Innovation

Are cities governed by universal laws?

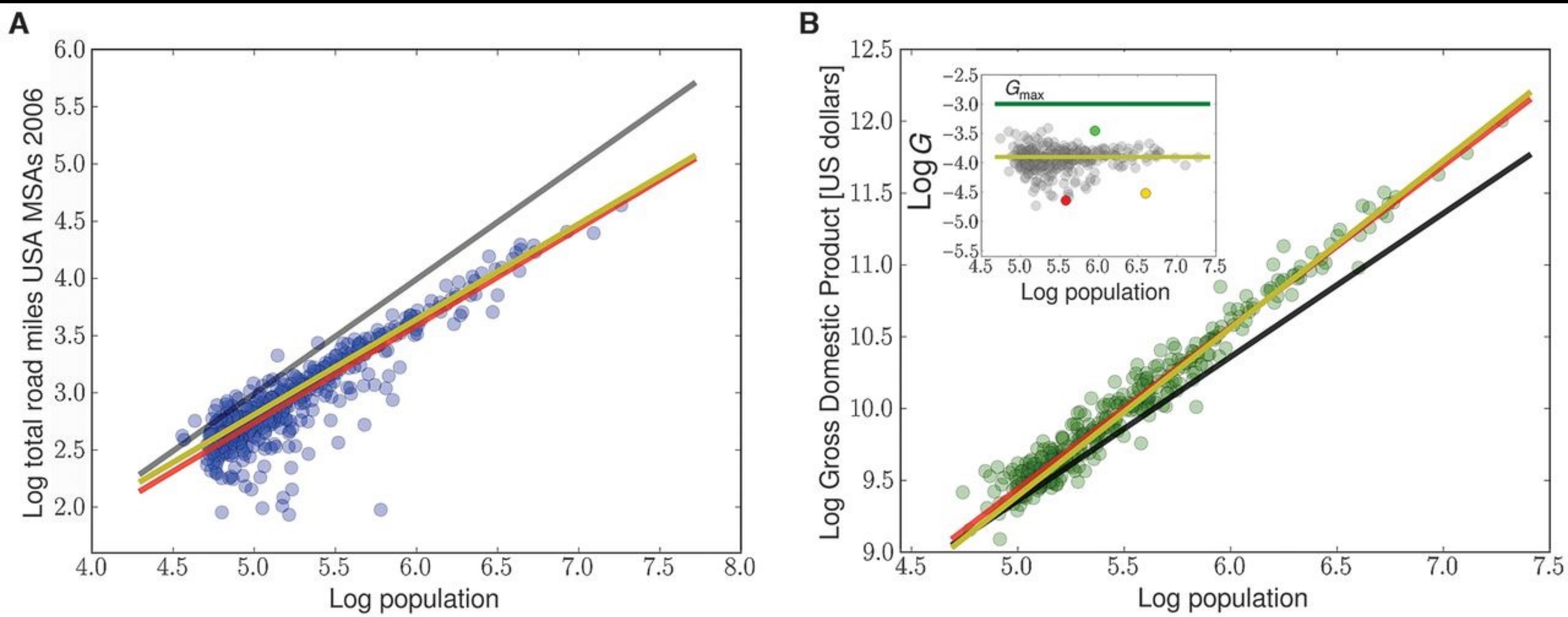


THE URBAN EQUATION

SCIENCE AND THE CITY

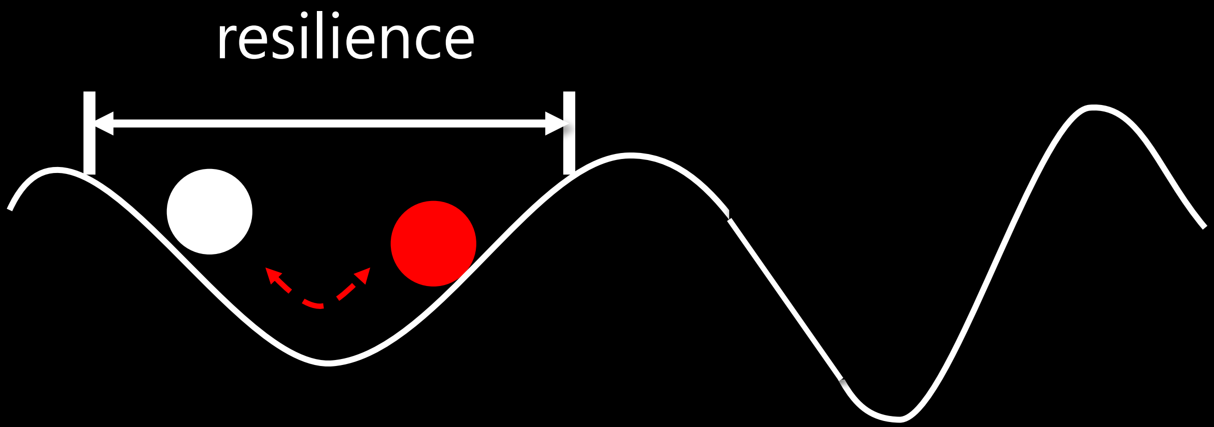

roads
rail
energy
water
fiber
infrastructure

Infrastructure and Economy

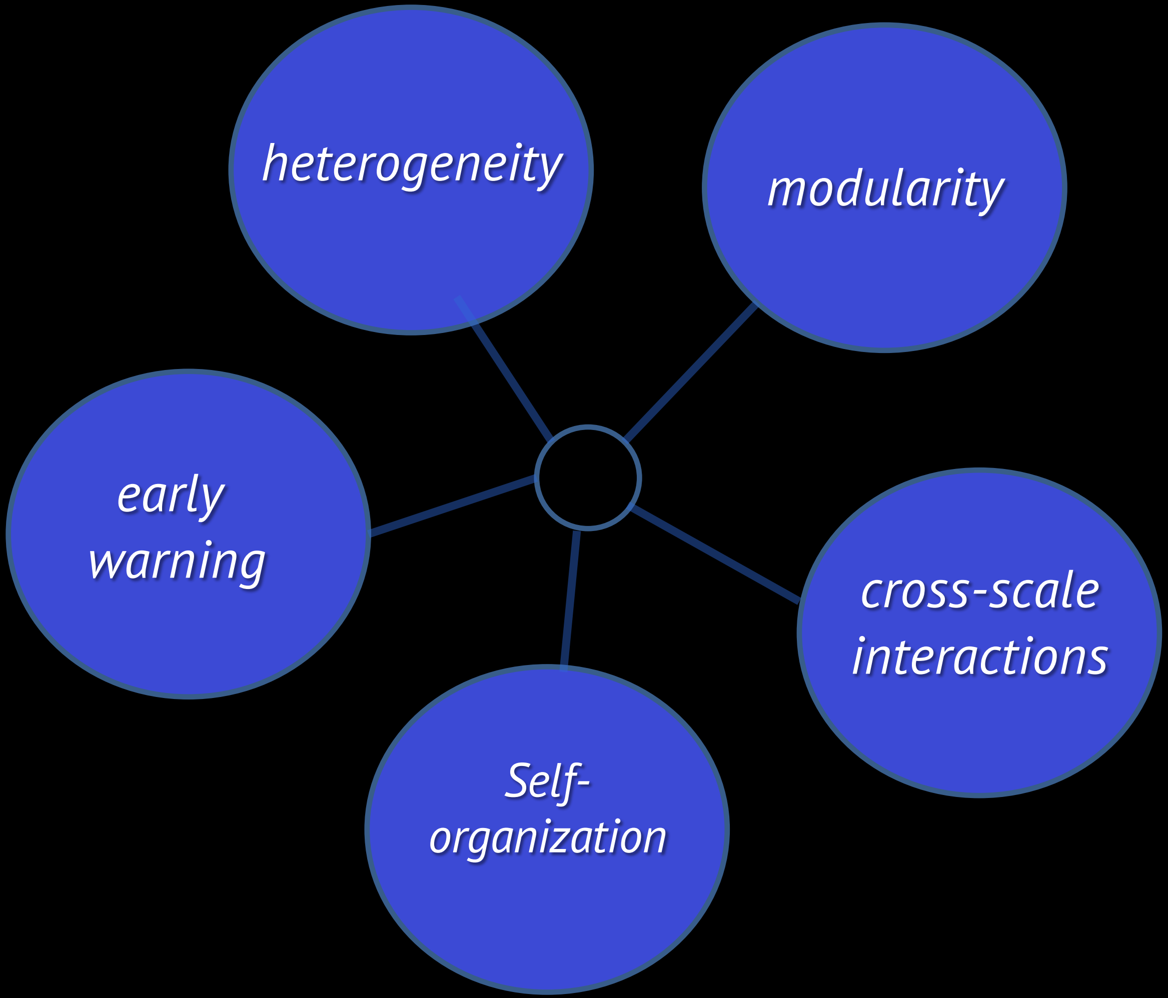


Source: Bettencourt - 2013

What makes an urban ecosystem simultaneously resilient and able to change?



Properties of resilient systems



Course objectives

- This course is designed to provide graduate students in the applied social and natural sciences the theoretical and practical skills for conducting *research in urban science.* The objective is to develop critical and analytical skills for designing and conducting empirical and applied research.
- The emphasis is on *integration and synthesis* of theories, concepts, and data across multiple disciplines.
- Research design is framed as an *emergent process.* The course examines the logic and limits of scientific inquiry, conceptualization and measurement of social and ecological phenomena relevant to urban design and planning.

Research Design as Problem Solving

Students will be exposed to the issues involved in research decisions and to diverse problem-solving strategies and technical tools for urban design and planning.

Students will learn how to

- frame a research question
- develop testable hypotheses
- provide operational definitions of research variables
- select appropriate analytical methods, and
- evaluate alternative research designs and strategies.

Learning objectives

- Gain exposure to and familiarity with a wide variety of research approaches and methodologies.
- Gain an understanding of the philosophical/theoretical perspectives that underlie alternative research approaches.
- Gain an understanding of major research problems and challenges and apply a variety of problem-solving strategies at various stages of the research process.
- Learn how to collect, query, and analyze both Small and Big Data.
- Use your imagination and your creative skills to develop a research design and conduct research.

Course structure

The course is structured in two components: a theoretical/methodological component and an applied research component.

The **theoretical component** consists of lectures on research design principles and approaches. Lectures cover statistical principles of research design, hypothesis testing and statistical inference, sampling strategies, and analytical approaches to randomized experimental, quasi-experimental, longitudinal and cross-comparative studies. Major theoretical issues include: threats to internal validity, sampling and external validity, reliability of measures, causality, interpretation of statistical analysis and ethics in research.

The **applied research component** focuses on the practice of scientific research through interactive sessions including collaborative pilot projects and open discussions on selected themes.

Course Assignments

Research Design Paper: Focusing on their individual research topic, students are expected to develop a *15-page research design* proposal which will articulate: a research question, testable hypotheses, appropriate research design and methods, and evaluation. To develop the research proposal, students will build on four exercises: 1) frame research question, 2) literature review, and 3) evaluation of alternative research design.

Collaborative Pilot Projects: In parallel to developing a research design paper, students will engage in a team pilot project to test their skills through an application using data on socio-ecological indicators available for US Metropolitan Areas. We will have 3 teams focusing on different questions on key themes of students' interest and for which data are readily available for the US Metropolitan Areas. Students teams will produce a pilot application and a brief blog report which will describe the main components of the research, data analysis, and findings.

Readings: Research Methods

Robert Alford (1998), *The Craft of Inquiry: Theories, Methods, Evidence*, Oxford University Press.

Thomas S. Kuhn (1962), *The Structure of Scientific Revolutions*, The University of Chicago Press.

Jeffrey A. Gliner, George A. Morgan and Nancy L. Leech (2017), Research Methods in Applied Settings, Lawrence Erlbaum Associates, Publishers.

David Ford (2000), Scientific Method for Ecological research, Cambridge University Press

The Oxford Handbook of Quantitative Methods I

The Oxford Handbook of Quantitative Methods II

Readings: Urban Science

Batty, M. (2013) The New Science of Cities. MIT Press, Cambridge

Alberti, M. Cities That Think Like Planets: Complexity, Resilience, and Innovation in Hybrid Ecosystems. UW Press. July 2016.

Bettencourt L. (2021) Introduction to urban science : evidence and theory of cities as complex systems. MIT PRESS.

Boyd D and Crawford K (2012) Critical questions for big data. Information, Communication and Society 15(5): 662–679.

Townsend A. Smart Cities: Big Data, Civic Hackers and the Quest for A New Utopia.. (W.W. Norton & Co., 2013)

Sessions	*Research Design*	*Urban Science*
I. Urban Science	09/30 Class Overview	
II. Research Design	10/05 Research Process	10/07 *Dig data and small data*
	10/12 Research Questions	10/14 *Urban Science:Defining research questions*
	10/19 Research Approaches	10/21 *Pilot Projects: Defining the research questions*
III. Observations	10/26 Sampling, Measurements and Observations	10/27 *Reading Discussion: Social Heterogeneity*
	11/02 Paul Waddell	11/04 *Pilot Projects: Modeling*
IV. Modeling	11/09 Integrated Modeling	11/10 *Reading Discussion: Social Equity*
V. Inference	11/16 Agent Based Models	11/18 *Pilot Projects: Modeling*
	11/23 Internal & External Validity	11/25 *Thanksgiving*
VI. Synthesis	11/30 Pilot Projects Reviews	12/02 *Pilot Projects Teams preparation*
	12/07 Synthesis	12/09 Teams workon Projects Reports & Presentations

What is Science?

Science is a set of logical, systematic, documented methods with which to investigate human and natural processes; also, the knowledge produced by these investigations.

Objectives of Science

- Theory building
- Explanation
- Modeling
- Prediction
- Problem-solving

Science is a process

The game of science is, in principle, without end. He who decides one day that scientific statements do not call for any further test, and that they can be regarded as finally verified, retires from the game.

Sir Karl Popper
The Logic of Scientific Discovery

Comparing paradigms

- Ontology: the nature of the "reality”? What is real?
- Epistemology: validation of knowledge claims: the relationship of the "knower" to what is "knowable." How do we know what we know about the world around us?
- Methodology: how we know what we know; what ways we think are legitimate for generating knowledge
- Causality: the possibility of causal linkages, distinction between cause and effects
- Neutrality: the role of value, degree of subjectivity

Definitions

THEORY

A formulation of apparent relationships or underlying principles of certain observed phenomena which has been verified to a certain degree.

POSTULATE

A conjecture, a new or unexplored idea written in the form of a proposition.

HYPOTHESIS

A statement based on empirical or theoretical assumptions constructed to give a test to a postulate.

Research Design Approaches

- Experimental
- Quasi-Experimental
- Cross-Sectional
- Longitudinal
- Observational
- Reverse Modeling

Urban Science

The study of cities as complex social, ecological, and technological networks embedded in space and time.

Cities as Emergent Phenomena