Committing to the environment and climate at MIT

ENVIRONMENTAL SOLUTIONS INITIATIVE

John E. Fernández, fernande@mit.edu
Dir., ESI and Urban Metabolism Group
Massachusetts Institute of Technology

MIT ESI

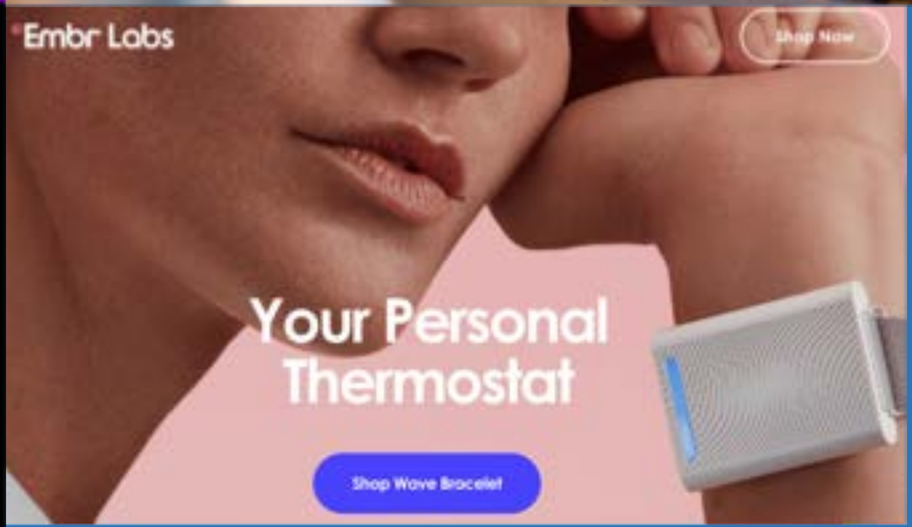
ENVIRONMENTAL SOLUTIONS INITIATIVE


Climate Science and Earth Systems
Cities and Infrastructure
Sustainable Production & Consumption
+74.36
132.1
82.5


PLANET
PEOPLE
PROFIT

SOLUTIONS

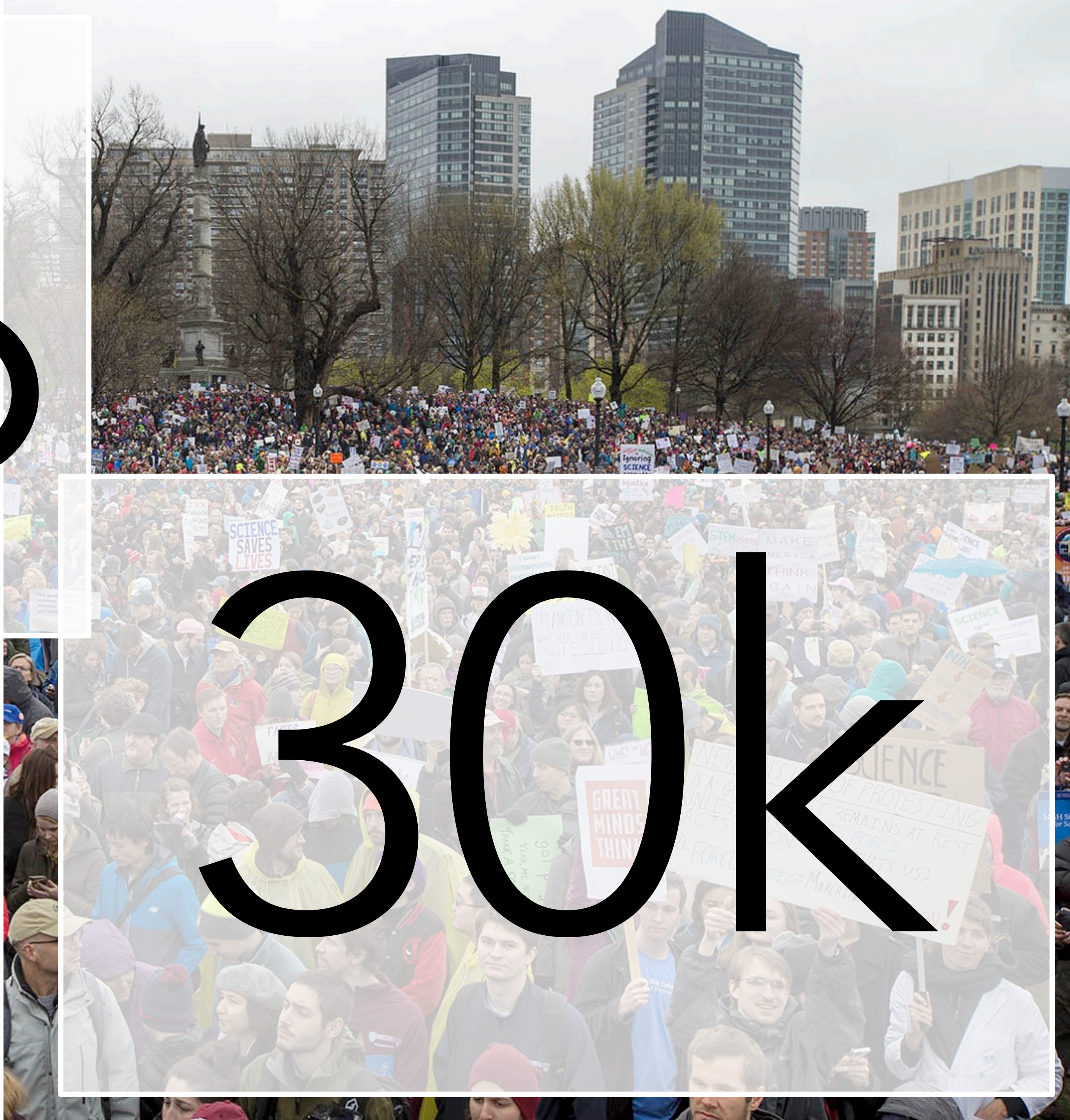

MIT
Technology
Review
The
Artificial
Intelligence
Issue


Embr Labs
Shop Now
Your Personal
Thermostat
Shop Wave Bracelet

20%
100%
Charles Harvey
Alan Hatton
Colette Heald
Harold Hemond
Lodovica Illari
Sertac Karaman
Valerie Karplus
Janelle Knox-Hayes
Elfatih Eltahir
Bevin Engelward
John Essigmann
Glenn Flierl
Jessika Trancik
Jennifer Light
David McGee
Dennis McLaughlin
Heidi Nepf
Julie Newman
Leslie Norford
Paul O'Gorman
Thomas Peacock
J. Taylor Perron
Martin Polz
Christoph Reinhart
Harriet Ritvo
Francis O'Sullivan
John Ochsendorf
Elsa Olivetti
Shuhei Ono
Parag Pathak
Robin Scheffler
Noelle Selin
Susan Solomon
Justin Steil
John Sterman


Mara Freilich
Daniel Gallagher
Elise Harrington
Tunde Alawode
Irene Dedoussi
Josh Hester
Fatima Hussain
Soyoung Kim
Samantha McBride
Jesse Jenkins
Ella Kim
Paul Kishimoto
Marco Miotti
Adam Rieth
Sarah Sofia
Megan May
Sergey A. Naumov
Jeremy Poindexter

75%


SCIENCE SAVES LIVES
GREAT MINDS THINK

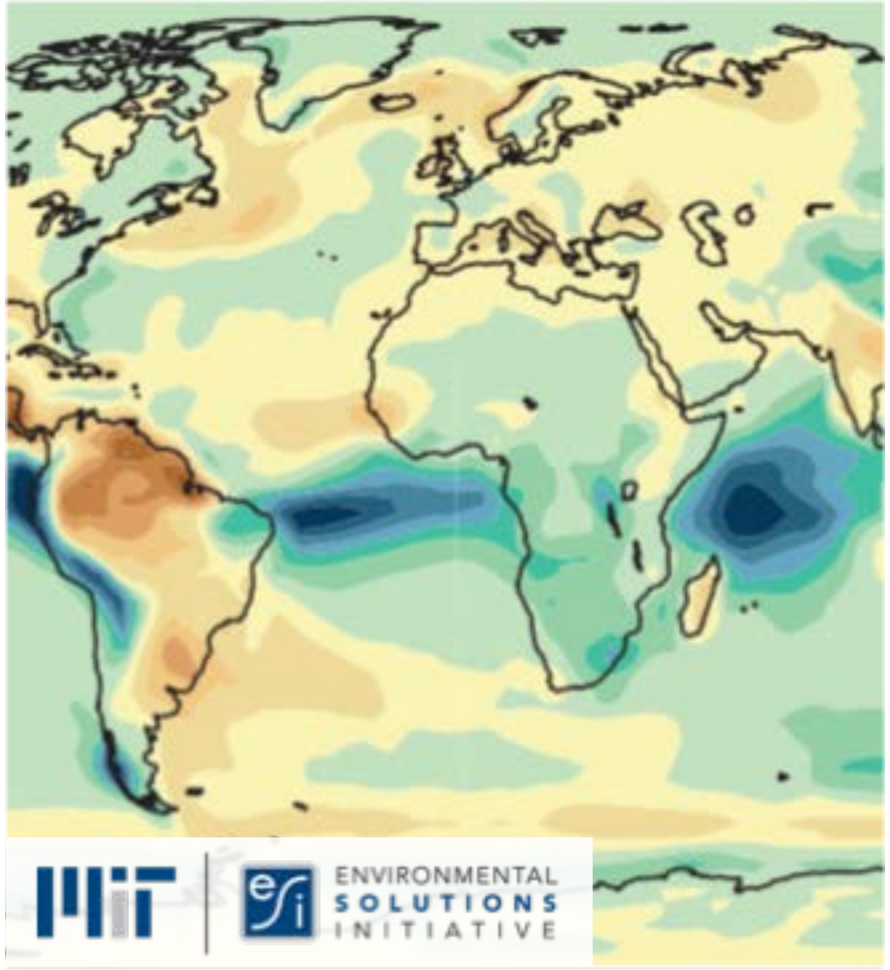
30k


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

AI & Next Gen Climate Models

Using machine learning to take advantage of vast new observational datasets in global climate models

Paul O'Gorman
Pgm. in Atmosphere, Ocean and Climate



Persistent Problems

Climate models have done a good job of capturing global trends, but regional biases make it hard to predict local impacts of climate change

New Opportunities

Machine learning can improve climate models by incorporating huge observational datasets and new high-resolution simulations too complex to run in live modeling

Non-CO_2 Greenhouse Gases

Providing tools to better compare greenhouse gases like CH_4 and HFCs directly to CO_2

Jessika Trancik
Prof. of Energy Studies

Regulatory Blind Spot

Non-CO_2 greenhouse gases account for one third of global warming effects, and may rise under regulations that target CO_2 alone

Energy Implications

More natural gas means more CH_4 emissions; more refrigeration means more HFCs

Policy Evaluation

New metrics are needed to compare energy mixes

Air Pollution in China

Quantifying the environmental impacts of China's coal reductions under the 2013 Air Pollution Action Plan

Valerie Karplus
Prof. of Global Economics & Mgmt

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Environmental Impact

Measured carbon, ozone and mercury emissions against baseline and captured regional variation

Econometrics

Concluded that health benefits from coal reductions outweighed the cost of the APAP

Policy

Presented results to senior policy officials in China and at the 2015 Paris Climate Conference

Autonomy-Enabled Transport

Modeling new transport systems with self-driving vehicles to minimize environmental impacts

Steven Barrett

Director, MIT Laboratory for Aviation & the Environment

Multiple Scales

Analyze the most efficient systems for autonomous trucks, aircraft, and door-to-door transport

Deep Learning

Take advantage of large satellite datasets to model truck convoys on highways and contrails in air travel

Environmental Efficiency

Study whether designing the most efficient transport systems conflicts with minimizing carbon emissions

Repurposing Industrial Waste

Turning coal ash and other industrial byproducts into cement-like building materials

Elsa Olivetti

Prof. of Energy Studies

Sustainable Production

Design chemical processes to form building materials with safe chemical activators at low temperatures

Multiple Benefits

Repurpose environmentally harmful waste products into a substitute for energy-intensive cement

Past Success

Build on a regional project in India creating safe, high-quality bricks from boiler ash

Deep Sea Mining

Mineral mining of the sea floor is a new phenomenon with unknown impacts on the environment

Thomas Peacock
Prof. of Mechanical Engineering

Modeling

Developed a new model of sediment plumes and tailings created in deep sea mining

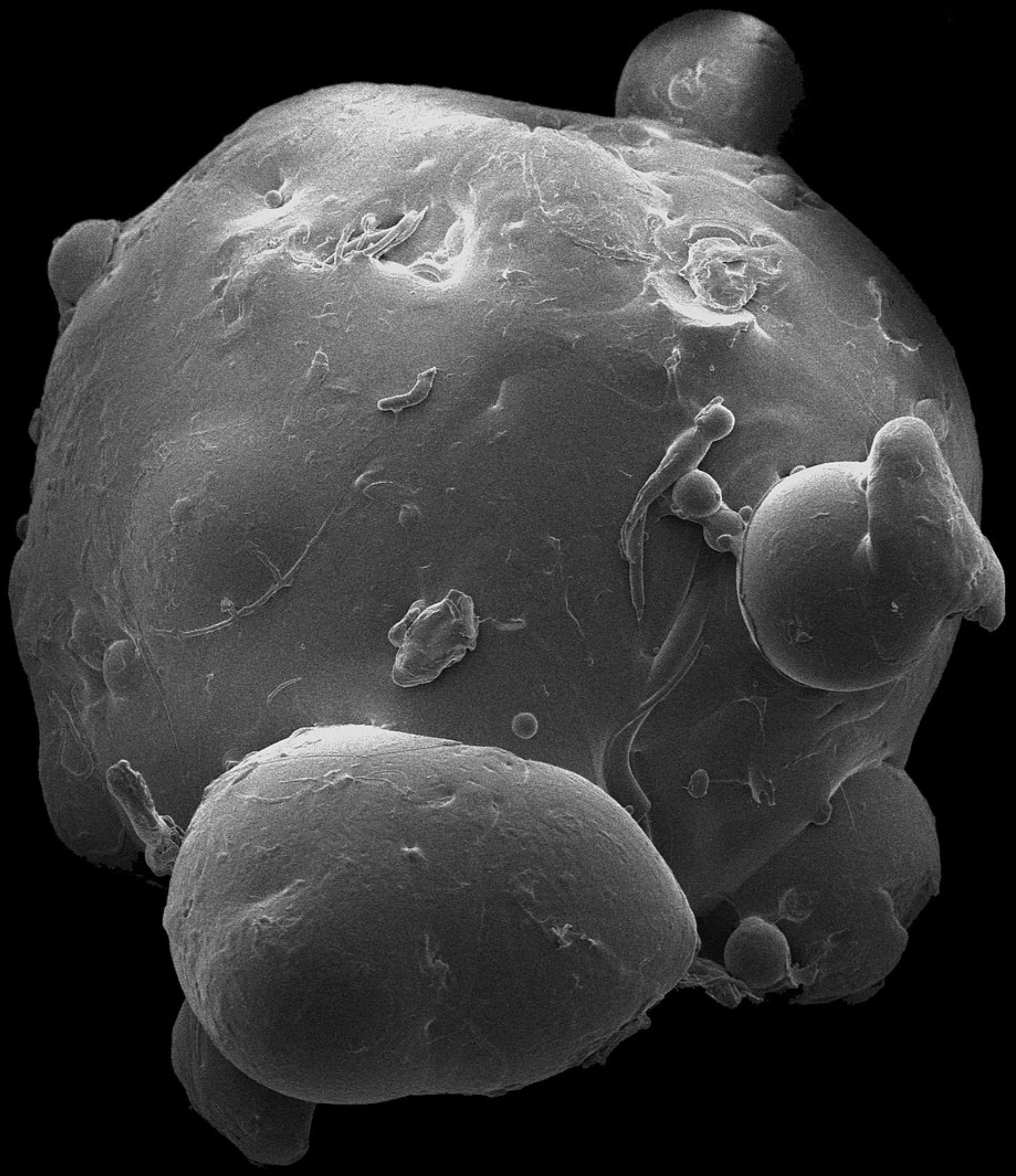
Field Work

Released tracer dye in a planned mining location to collect real-world data on dispersion of byproducts

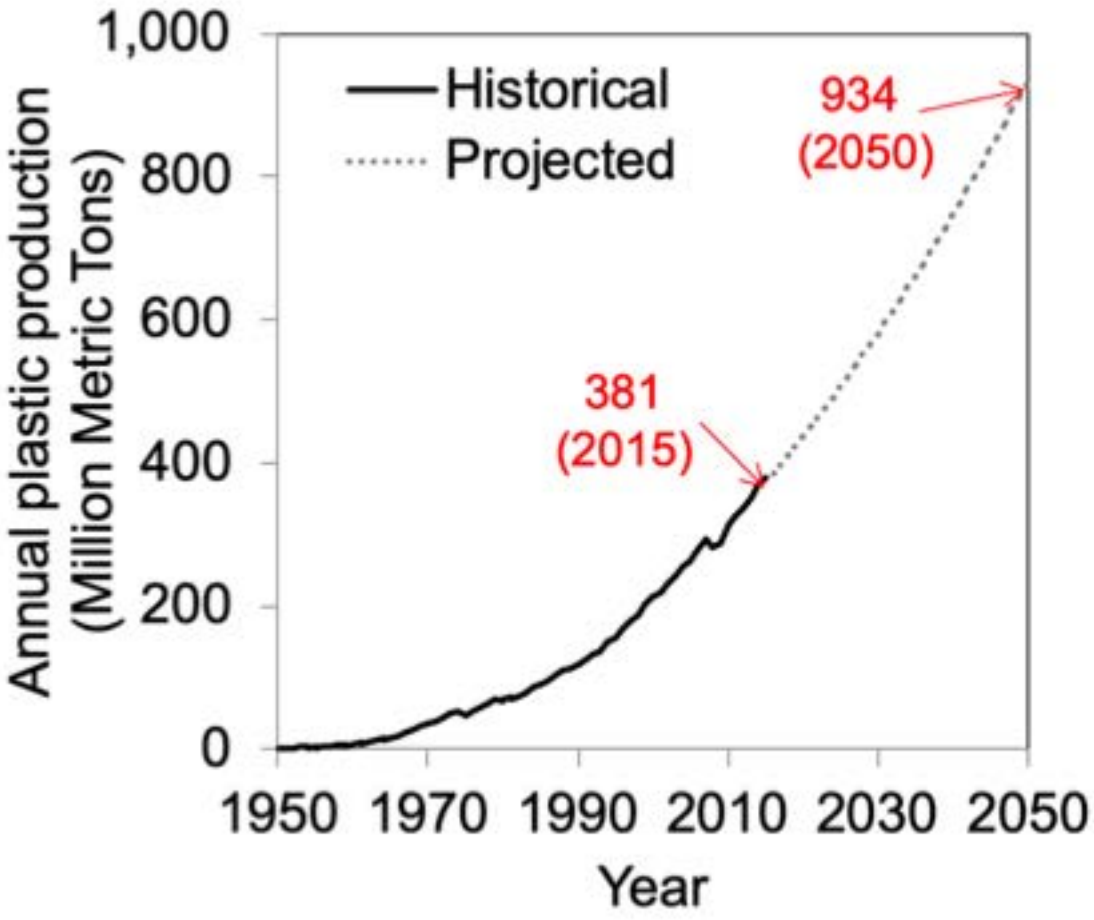
Policy

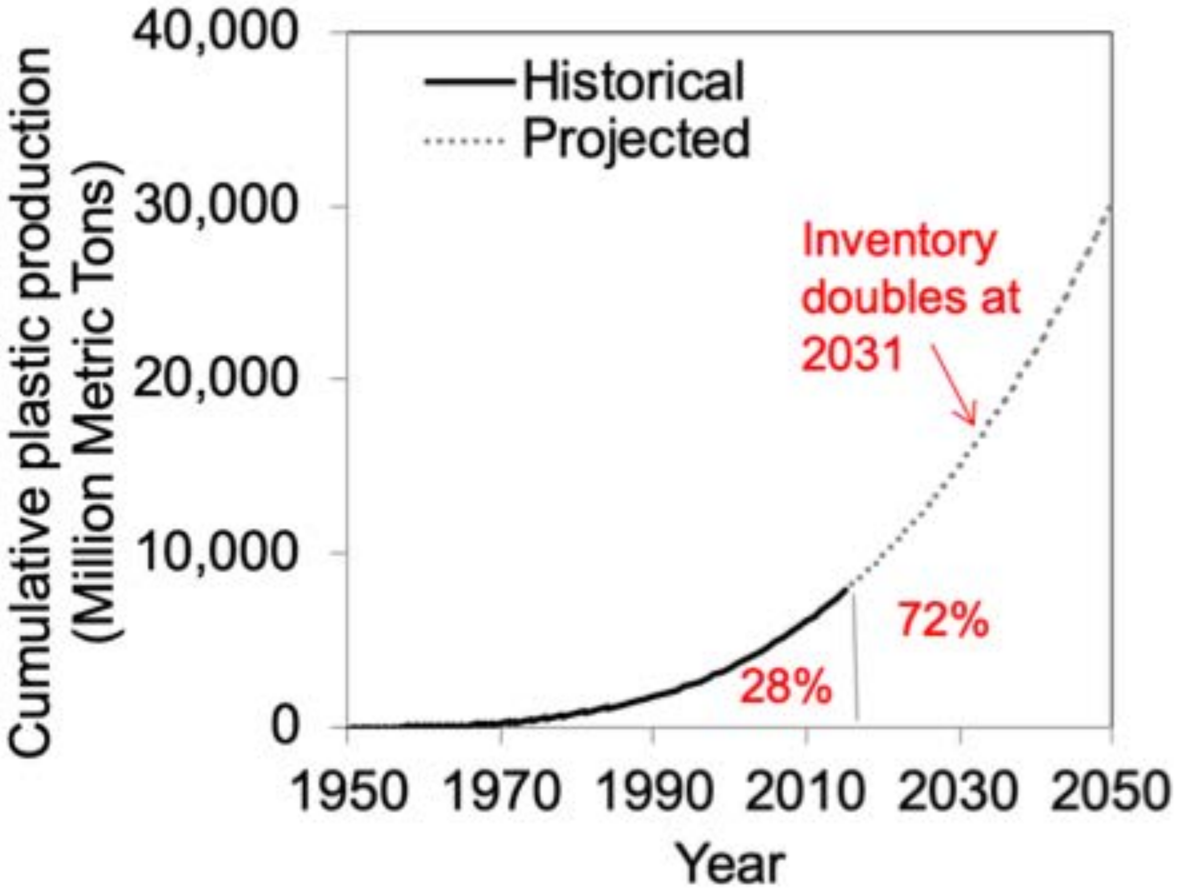
Produced a new protocol to evaluate future deep sea mining projects for risks to the environment

Plastics and the Environment Prog



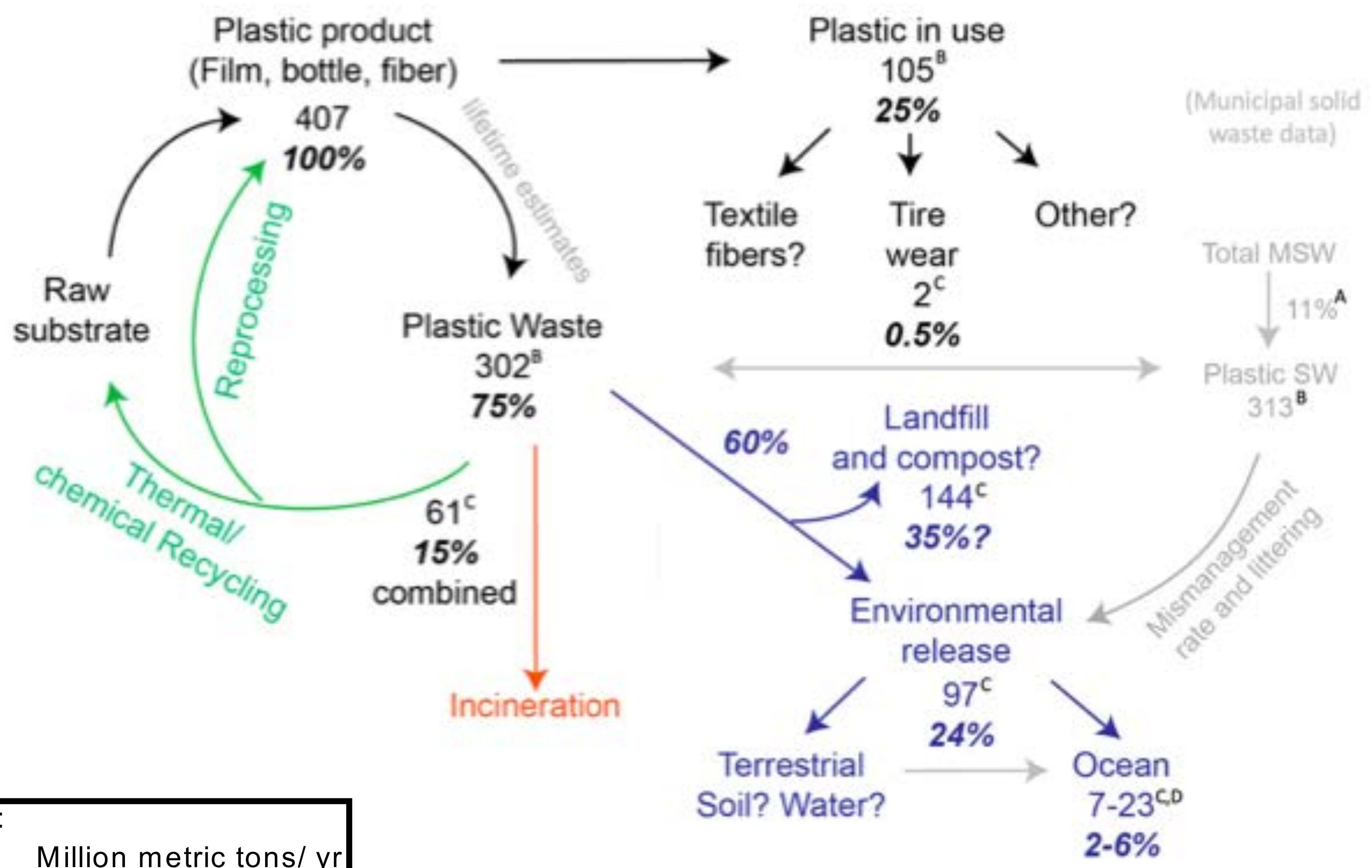
Plastics: annual and cumulative production





Data sources:
PlasticsEurope's Market Research and Statistics Group (PEMRG); Conversio Market & Strategy GmbH;
*Geyer, R. and Law, K. L., Production, use, and fate of all plastics ever made. Science advances **2017***
Compiled by Boya Xiong, PhD (Plata Lab)

What we currently know about the plastic lifecycle



Units:
Million metric tons/ yr
% of total plastic products

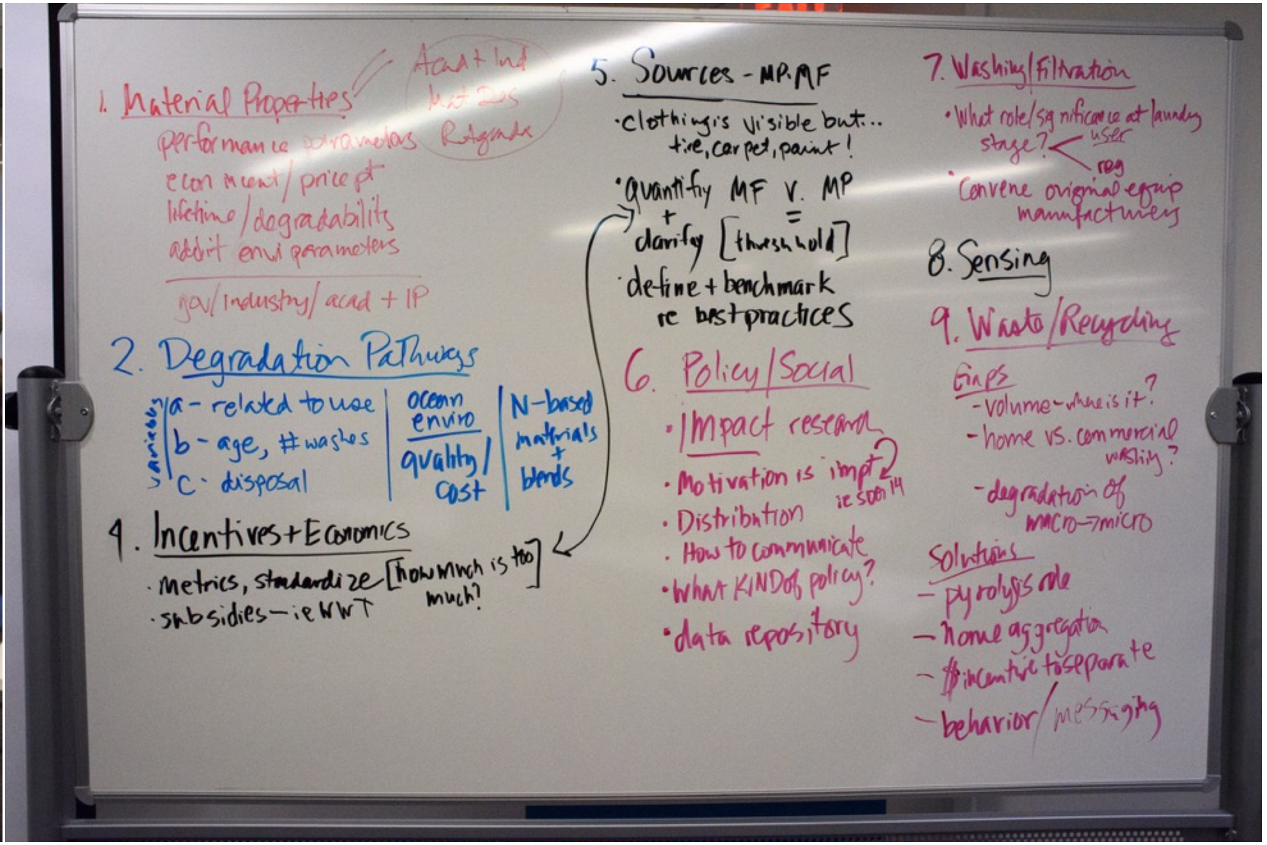
A= Direct measurement B= Calculated from mass balance
C= Assumed release rates D= Poor estimate

Xiong, Johnson, Olsen, Plata; unpublished

Plastics and the Environment (PEP)

Chris Noble
Director of Corporate Engagement

MIT faculty and students are working with the public sector, foundations, industry, and other researchers to reduce the impact of plastic waste in the environment



Plastics and the Environment: current research

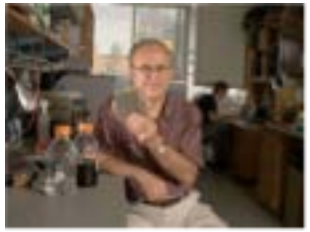
Prof. Desirée Plata[1] *Engineered environmental degradation pathways for broad families of polymer types and multiple environmental variables*

Prof. Admir Masic[1] *Sensors for characterization of microplastics in the oceans*

Profs. Pierre Lermusiaux[2] & Tom Peacock[2] 3D *modelling of dispersion and degradation transport and biological interactions in aquatic environments*

Prof. Jeremiah Johnson[3] *Chemical modification of existing polyolefins to enhance recyclability through depolymerization & compatibilization strategies*

Prof. Julia Ortony[4] *Recyclable, self-assembled nano-scale fibers*



Profs. Anthony Sinskey[5] & Gregory Stephanopoulos[6] *Bioprocess for closed-loop PET (polyethylene) recycling**

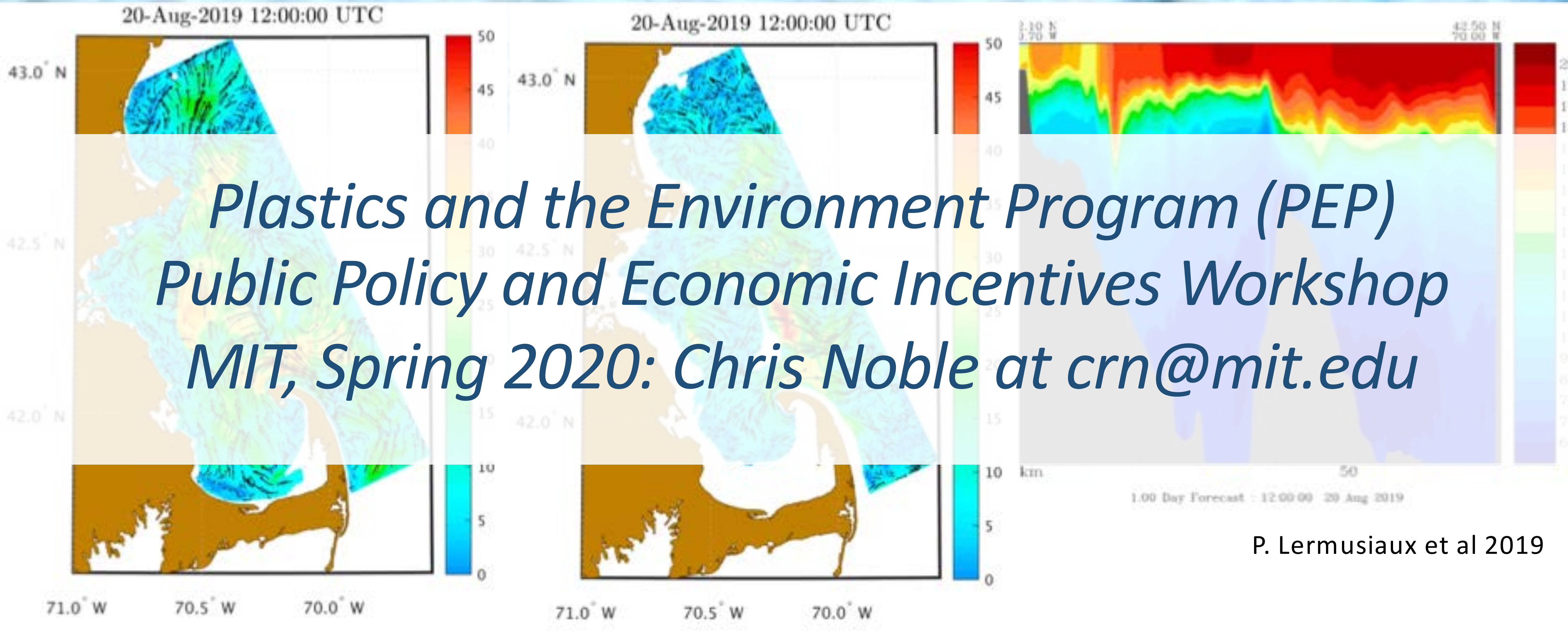
Prof. Brad Olsen[6] *Packaging simplification for hybrid degradation-recycling*

Prof. Jeff Grossman [4] *Microfiber filtering technology*

[1]Civil and Environmental Engineering
[2]Mechanical Engineering
[3]Chemistry
[4]Material Science and Engineering
[5]Biology
[6]Chemical Engineering

**MIT Energy Initiative Seed Grant*

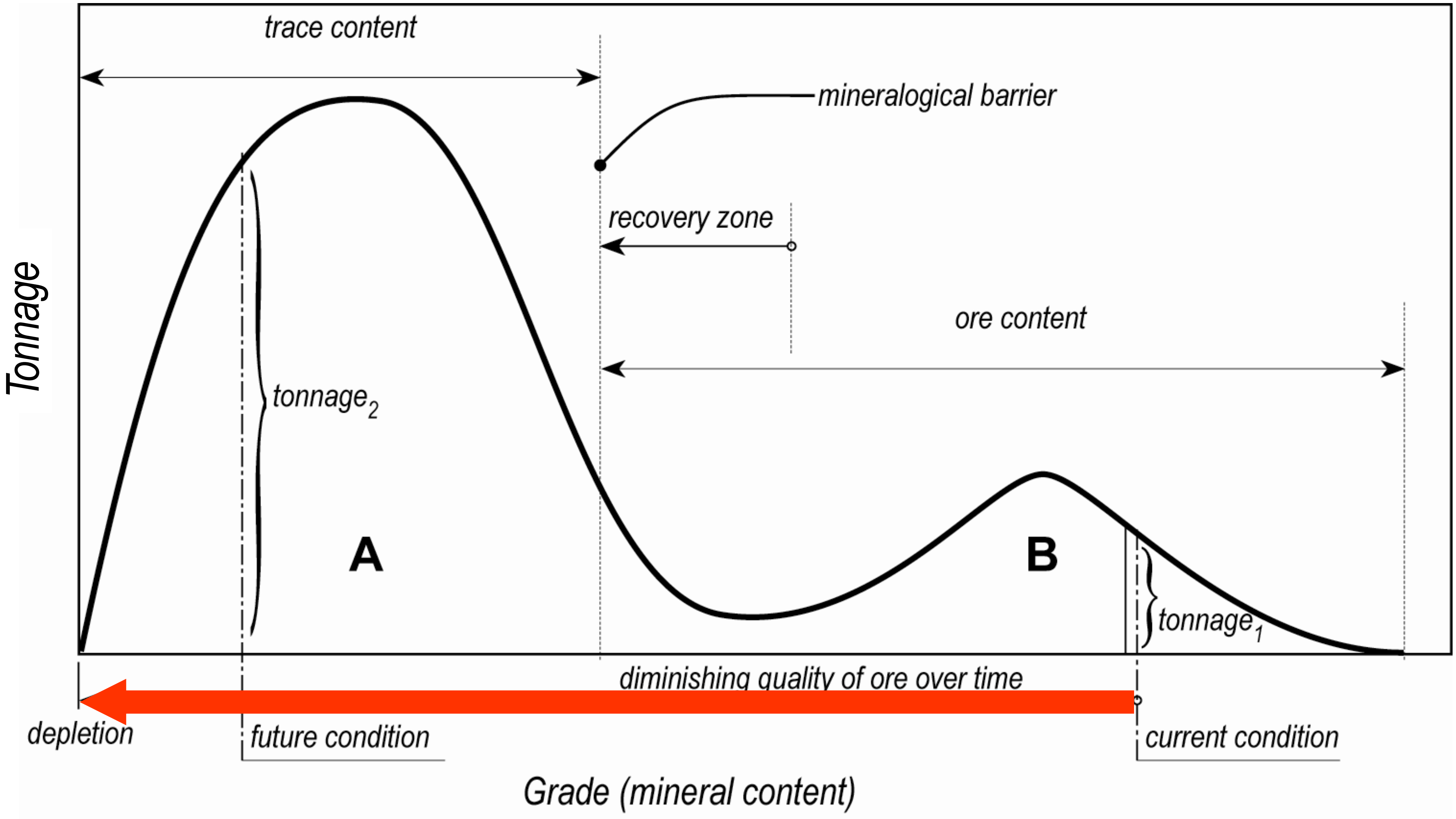
MIT-MSEAS Realistic Data-Driven Ocean Modeling



Plastics and the Environment Program (PEP)
Public Policy and Economic Incentives Workshop
MIT, Spring 2020: Chris Noble at crn@mit.edu

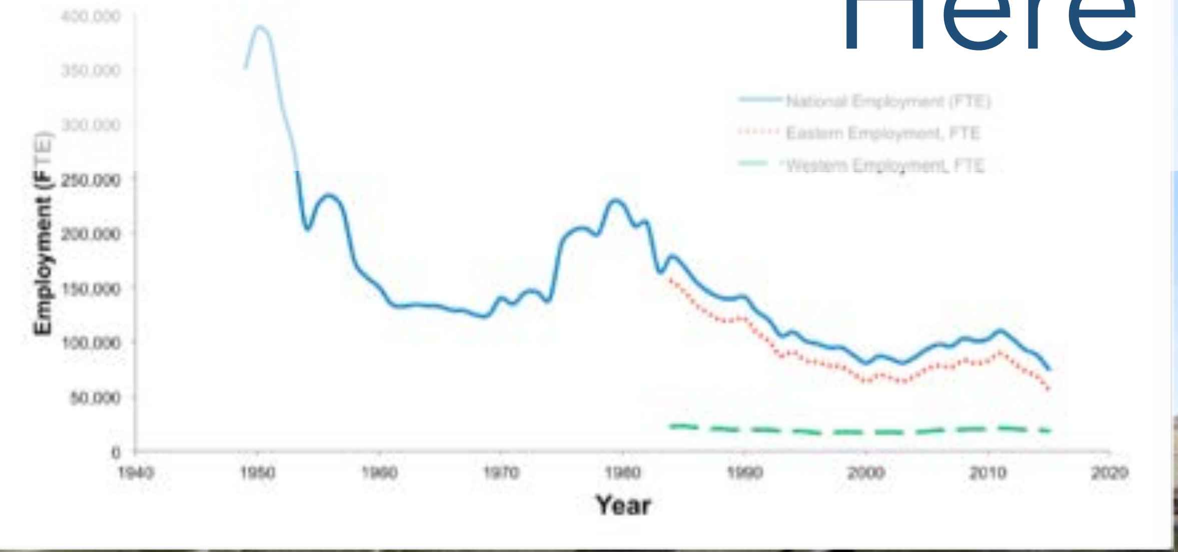
P. Lermusiaux et al 2019

Mining and the Environment



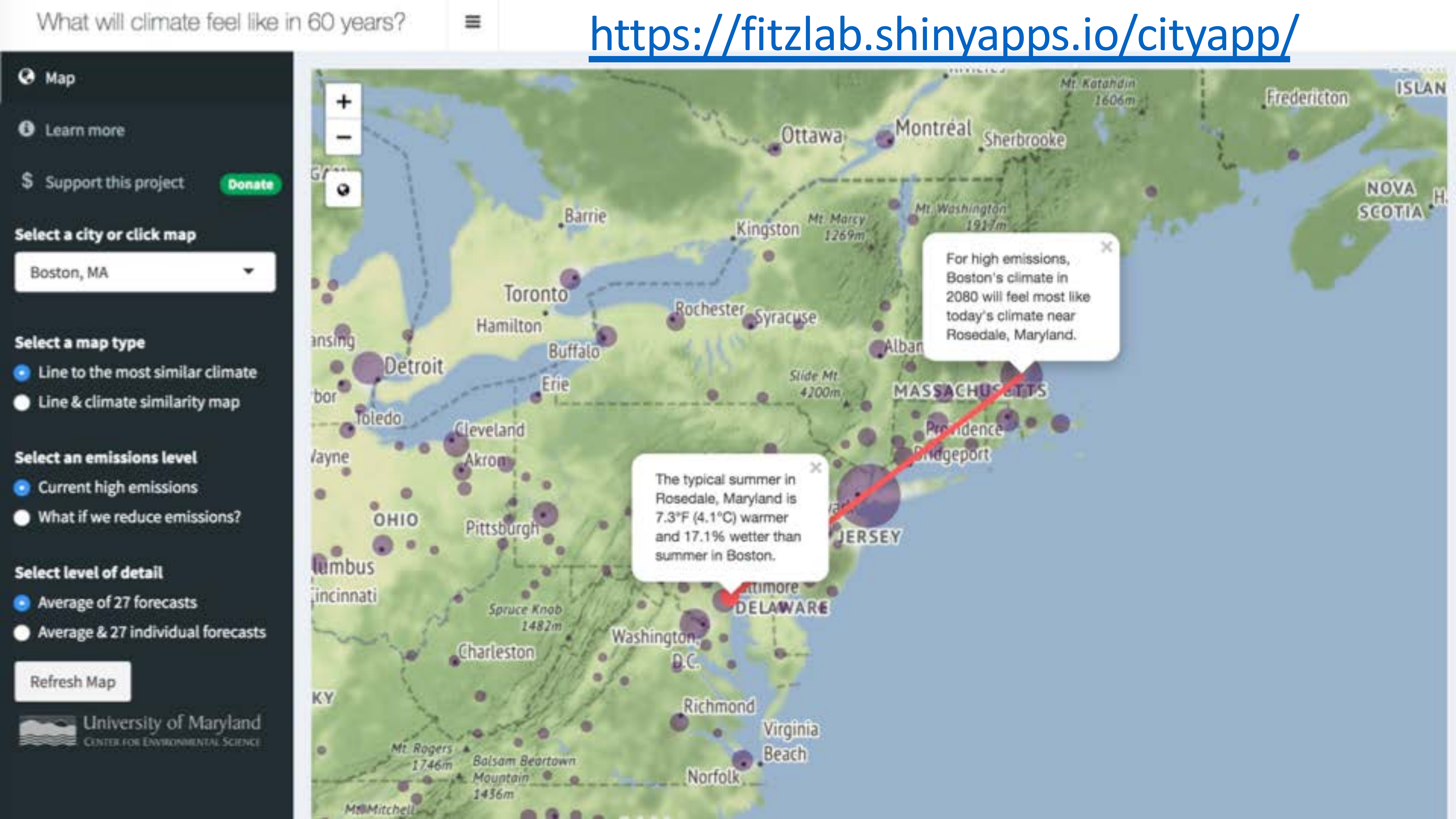
Adapted from: Graedel and Allenby; Gordon, Koopmans, Nordhaus and Skinner

Here and Real



Cities adapting to climate change

https://fitzlab.shinyapps.io/cityapp/



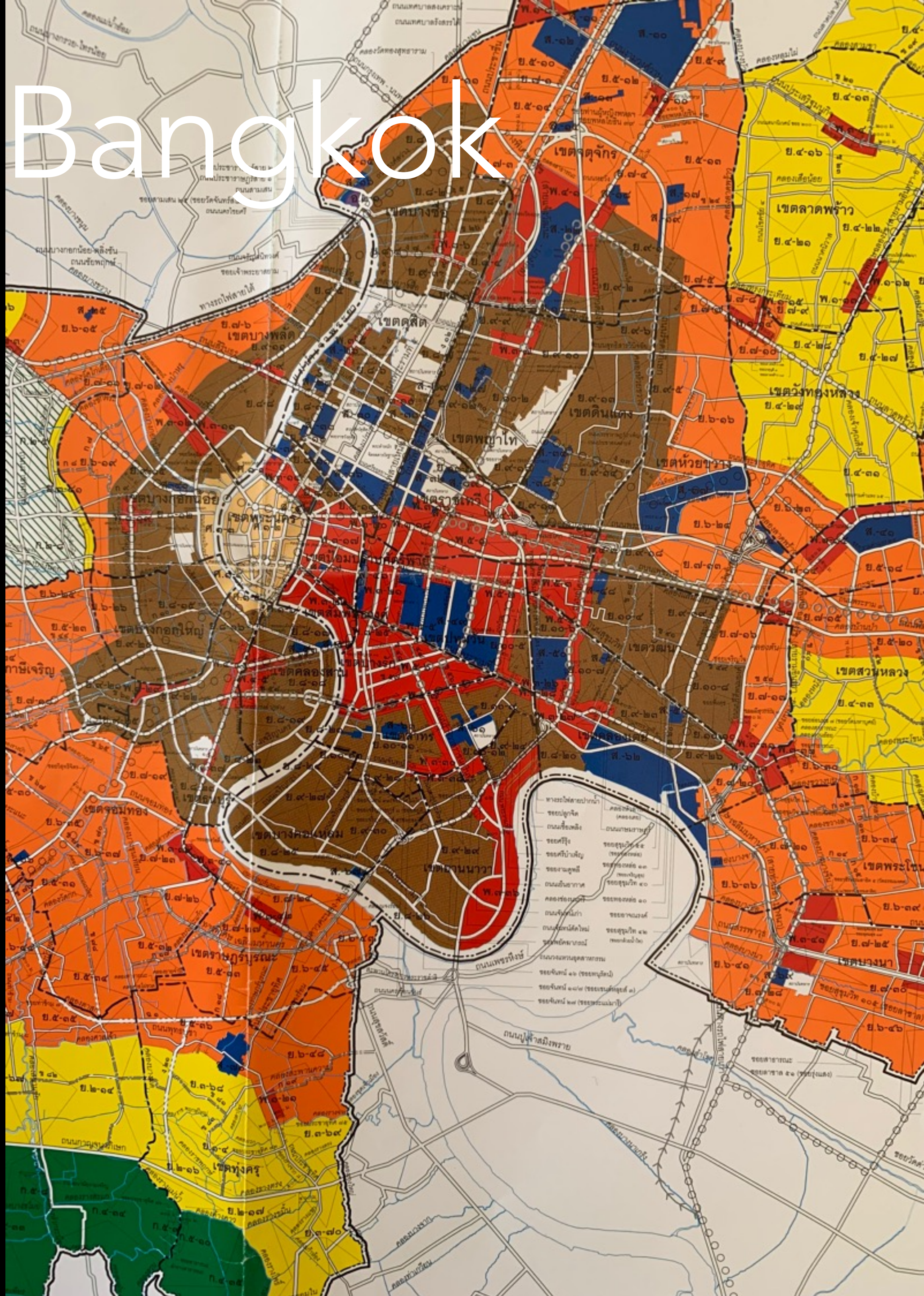
Los Angeles 1948 (early pm)

Los Angeles
06JAN1948

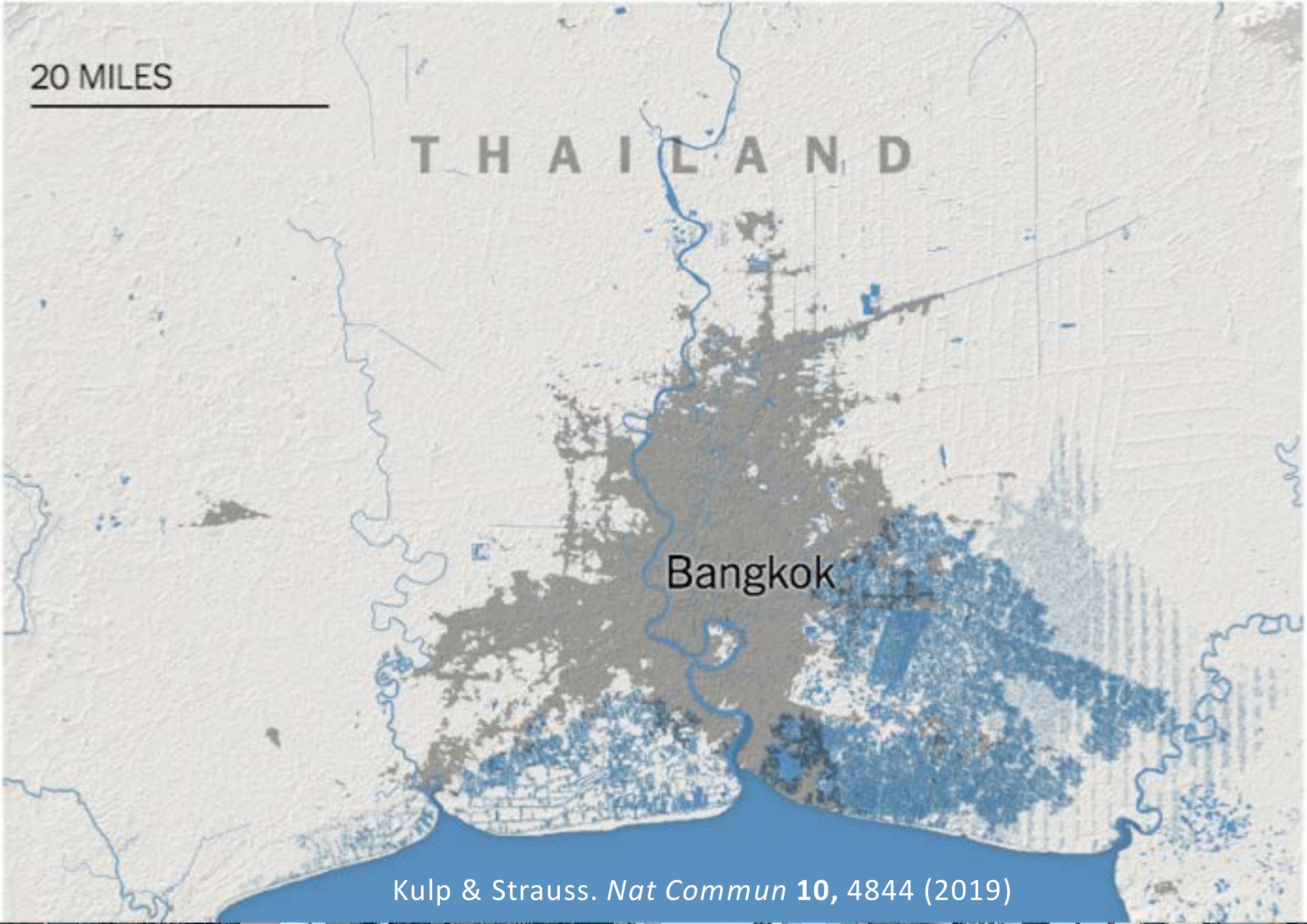
Beijing 2018 (11am)

Beijing, 11AM
13NOV2018

Urban Metabolism of Bangkok

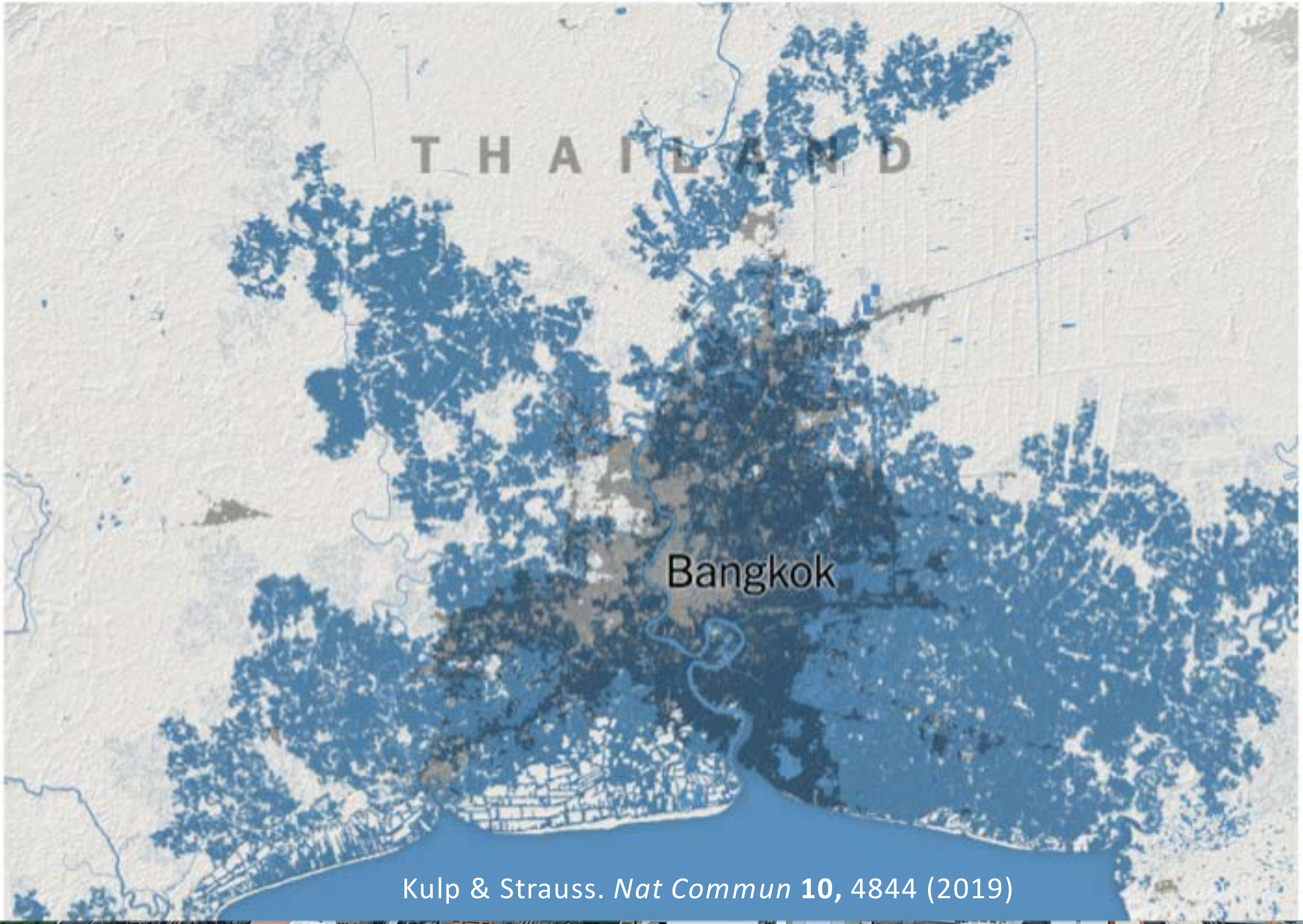


Old projection for 2050



Kulp & Strauss. *Nat Commun* **10,** 4844 (2019)

New projection for 2050



Kulp & Strauss. *Nat Commun* **10,** 4844 (2019)

In 2100, 80-85% of global population will be living in cities, the largest in Africa and Asia.

A 21st c. World of Cities
HOW TO ADAPT & THRIVE IN A CHANGING CLIMATE?

DRIVE

Climate Action through TECHNOLOGY DEVELOPMENT & DEPLOYMENT

Climate Science

+

BIG & PERVASIVE DATA

COMMERCIALIZATION

Industry + MIT Partnerships

WHAT ARE THE CATALYSTS FOR FUTURE GROWTH?

the ESI announces…

Cities and Climate Change – C3

BD/AI UAVs ES + Inf Resilience UrbMet/Risk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John E. Fernández
fernande@mit.edu
Director, ESI

Chris Noble
crn@mit.edu
Dir. Corporate Engagement, ESI

environmentalsolutions.mit.edu
MIT Environmental Solutions Initiative