Schedule for Case Study Presentations

Class 24, April 15, 2019:
• Amanda Devleeschower: Degradation of Mangroves
• Charles Schoonover: Loss of Ecosystem Services of Wetlands
• Tyler French: Extinction of Species

Class 25, April 17, 2019:
• Amy Perez: Sargassum.
• Anthony DeSocio: Population growth and sustainability
• Jessie Lyman: Pollution

Class 26, April 22, 2019:
• Lexi Watson: Plastic Pollution in the Ocean.
• Tasneem Abdur-Rahman: Landfills and Sea Level Rise
• James McCann: Impacts of sea level rise and climate change on the Back Bay National Wildlife Refuge.

Class 27, April 24, 2019:
• Elton Van Buskirk: Invasive Species.
• Zihrije Bohanan: Lionfish
• Dennis Long: Sustainable Cities
Mitigation and Adaptation Studies

Class 23: Developing Options: Mitigating the Degradation of Earth’s Life-Support System

Contents
- Sustainability and Policy Making
- Making Choices between Options
- Adaptation to Sea Level Rise
- Accounting for Extremes
- Accounting for Slow Changes
- Copying with Risk and Uncertainty
- Systemic changes versus system improvements
- Change by design
Accounting for Extremes
Assumption: We know the extreme end of the hazard spectrum

Planning is impacted by social construct of risk and vulnerability:
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Planning is impacted by social construct of risk and vulnerability:

**North Sea countries:**
- general perception (based on 2,000 years of cultural heritage): vulnerability to, and risk associated with storm surges is very high and a national/regional problem;
- approach to extreme events: there is a 1% chance that the 1 in 10,000 years flood happens in this century.
- Approach to SLR: What is the maximum SLR in the 21st century that cannot be excluded?
Assumption: We know the extreme end of the hazard spectrum

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- Approach to SLR: What is the maximum SLR in the 21st century that cannot be excluded?

**United States:**
- general perception: vulnerability to, and risk associated with storm surges is more a local problem and can be addressed ad hoc by (horizontal) evacuation;
- approach to extreme events: there is a 1% chance that the 1 in 100 years flood happens in this year.
- Approach to SLR: What curve should we choose? Definitely not the maximum SLR in the 21st century that cannot be excluded!
Accounting for Extremes
Accounting for Extremes

Knowing the “worst case:” worst case scenarios almost always fall short of reality
Accounting for Extremes

Knowing the “worst case:” worst case scenarios almost always fall short of reality

Paradigm shifts:
• identifying the vulnerabilities and comprehensively assessing the risks
• understanding the worst cases (food, water, heat waves, droughts, storms, sicknesses, social unrest, wars, ...)
• increasing preparedness and general resilience
• having early warning (for extreme events and rapid impacts)
Preparing for surprises

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Preparing for surprises
Accounting for Extremes

Accounting for Extremes

St Vincent and the Grenadines: Preparing for surprises
Accounting for Extremes

St Vincent and the Grenadines: Preparing for surprises

- Carry out high-resolution LIDAR survey
- Identify possible flood zones and landslide areas under extreme events
- Advice/regulate new constructions to be in safe areas
Cyclone Idai: cholera cases rise to more than 1,000 in Mozambique

Some 900,000 doses of oral cholera vaccines were due to arrive in the cyclone-battered Beira city on Tuesday.

Cholera has infected at least 1,032 people in Mozambique's central province, the health ministry said on Monday in a new report, marking a five-fold increase from 193 cases reported four days ago.

The new data represents an average of more than 200 cases a day.

Cyclone Idai: 3 million in urgent need

In Mozambique, Malawi, and Zimbabwe, at least 3 million people have been affected by Cyclone Idai. When emergencies happen, the world turns to WFP. The agency oversees the delivery of all food, supplies and staff for the entire aid community during times of crisis.
Accounting for Extremes
Accounting for Extremes

SECOND EDITION
WITH A NEW SECTION: “ON ROBUSTNESS & FRAGILITY”

NEW YORK TIMES BESTSELLER

THE BLACK SWAN

The Impact of the Highly Improbable

“The most prophetic voice of all.”
—GQ

Nassim Nicholas Taleb
Black Swan (and capitalize it) is an event with the following three attributes:

• First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility.

• Second, it carries an extreme impact (unlike the bird).

• Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable.
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Black Swan logic makes what you don’t know far more relevant than what you do know.*
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Accounting for Extremes

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Systems can be:
- Mediocristan
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Mediocristan example: weight of a person
Accounting for Extremes

Systems can be:
  ● Mediocristan
  ● Extremistan

Mediocristan example: weight of a person
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Accounting for Extremes

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Mediocristan example: weight of a person

Extremistan example: wealth of a person

Extremistan:
- economic system: 2008 crash
- social system: 1st world war
- political system: Donald Trump
- Technology: Internet, ?
Account for Extremes

Changes in the dynamics impact the extremes

Strong Jet Stream
- jet stream confined to higher latitudes
- zonal flow (W-E) dominates
- weather systems track quickly at surface

Weak Jet Stream
- jet stream extends farther from pole
- meridional flow (N-S) stronger
- weather systems tend to stall
- Omega Block (Q)
Mitigation and Adaptation Studies

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Adaptation to Slow (Global) Change

Energy Usage

Population

Carrying Capacity

Time

Plag, 2019
Adaptation to Slow (Global) Change

- Science is focused on avoiding Type I errors (false positives)
- Society is impacted by this focus
- Type II errors (false negatives) are critical in times of unsustainability and rapid changes
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- Recommendation: look for the lifeboats
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Adaptation to Slow (Global) Change

Jem Bendell:
- Deep Adaptation
- Who do we want to be after the total social collapse?
Adaptation to Slow (Global) Change
Adaptation to Slow (Global) Change

Crossing thresholds could lead to systemic changes …
Adaptation to Slow (Global) Change

Crossing thresholds could lead to systemic changes …
We're treating soil like dirt. It's a fatal mistake, as our lives depend on it

George Monbiot

War, pestilence, even climate change, are trifles by comparison. Destroy the soil and we all starve

To keep up with global food demand, the UN estimates, 6m hectares (14.8m acres) of new farmland will be needed every year. Instead, 12m hectares a year are lost through soil degradation. We wreck it, then move on, trashing rainforests and other precious habitats as we go.

- 2.6 billion people depend directly on agriculture, but 52% of the land used for agriculture is moderately or severely affected by soil degradation.
- Land degradation affects 1.5 billion people globally.
- Arable land loss estimated at 30 to 35 times the historical rate.
- Due to drought and desertification each year 12 million hectares are lost (23 hectares/minute!), where 20 million tons of grain could have been grown.
- 74% of the poor (42% of the very and 32% of the moderately poor) are directly affected by land degradation globally.
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Adaptation to Slow (Global) Change

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Generating three centimeters of top soil takes 1,000 years, and if current rates of degradation continue all of the world’s top soil could be gone within 60 years, a senior UN official said.
In the first paragraph of the landmark 1943 book Plowman’s Folly, Edward H. Faulkner said, “The truth is that no one has ever advanced a scientific reason for plowing.” Nonetheless, 40 years after that publication cracked the foundations of agricultural science, most farmers still plow. Why?

... no-till does preserve topsoil, but this advantage doesn't come without certain trade-offs. As it's currently practiced in the U.S., no-till farming might more appropriately be called no-till/chemical agriculture.
UN: Growing threat to food from decline in biodiversity

By Matt McGrath
Environment correspondent

The plants, animals, and micro-organisms that are the bedrock of food production are in decline, according to a UN study.
UN: Growing threat to food from decline in biodiversity

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Environment correspondent

22 February 2019

The plants, animals, and micro-organisms that are the bedrock of food production are in decline, according to a UN study.

Cultured lab meat may make climate change worse

By Matt McGrath
Environment correspondent

19 February 2019

Growing meat in the laboratory may do more damage to the climate in the long run than meat from cattle, say scientists.
Adaptation to Slow (Global) Change

Consequences for future generations …
Climate crisis: today’s children face lives with tiny carbon footprints

Next generation must keep their own carbon levels at a fraction of their grandparents’ in order to prevent catastrophe

Global emissions of CO2 need to decline precipitously over the next few decades, if the world is to meet the Paris Agreement goals of limiting global warming to “well below 2C” and, ideally, below 1.5C.
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One of the peculiarities of this complex, multiheaded crisis is that there appears to be no “other side” on to which we might emerge. It is hard to imagine a realistic scenario in which governments lose the capacity for total surveillance and drone strikes; in which billionaires forget how to manipulate public opinion; in which a broken EU reconvenes; in which climate breakdown unhappens, species return from extinction and the soil comes back to the land. These are not momentary crises, but appear to presage permanent collapse.
Resilient Thinking, four phases:

- \( r \): rapid growth
- \( K \): conservation
- \( \Omega \): release phase
- \( \alpha \): reorganization phase

Walker and Salt, 2006
Resilient Thinking, four phases:
r: rapid growth
K: conservation
Ω: release phase
α: reorganization phase

Is resilience the enemy of adaptation?

Walker and Salt, 2006
Coping with Risk and Uncertainty
Antifragility is beyond resilience or robustness. The resilient resists shocks and stays the same; the antifragile gets better.

Taleb, Nassim Nicholas. Antifragile: Things That Gain from Disorder
Coping with Risk and Uncertainty

Antifragility is beyond resilience or robustness. The resilient resists shocks and stays the same; the antifragile gets better.

Taleb, Nassim Nicholas. Antifragile: Things That Gain from Disorder.
Coping with Risk and Uncertainty

By grasping the mechanisms of antifragility we can build a systematic and broad guide to nonpredictive decision making under uncertainty in business, politics, medicine, and life in general—anywhere the unknown preponderates, any situation in which there is randomness, unpredictability, opacity, or incomplete understanding of things.

Taleb, Nassim Nicholas. Antifragile: Things That Gain from Disorder
Coping with Risk and Uncertainty
Which brings us to the largest fragilizer of society, and greatest generator of crises, absence of “skin in the game.” Some become antifragile at the expense of others by getting the upside (or gains) from volatility, variations, and disorder and exposing others to the downside risks of losses or harm. And such antifragility-at-the-cost-of-fragility-of-others is hidden …
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At no point in history have so many non-risk-takers, that is, those with no personal exposure, exerted so much control.
Coping with Risk and Uncertainty

NEW YORK TIMES BESTSELLING AUTHOR OF
THE BLACK SWAN

Nassim Nicholas Taleb

Antifragile

Things That Gain From Disorder
Coping with Risk and Uncertainty

Black Swans (capitalized) are large-scale unpredictable and irregular events of massive consequence—unpredicted by a certain observer, and such unpredictor is generally called the “turkey” when he is both surprised and harmed by these events.
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Black Swans hijack our brains, making us feel we “sort of” or “almost” predicted them, because they are retrospectively explainable. We don’t realize the role of these Swans in life because of this illusion of predictability.

An annoying aspect of the Black Swan problem— in fact the central, and largely missed, point— is that the odds of rare events are simply not computable.
Coping with Risk and Uncertainty

NEW YORK TIMES BESTSELLING AUTHOR OF
THE BLACK SWAN

Nassim Nicholas Taleb

Antifragile
Things That Gain From Disorder
Complex systems are full of interdependencies—hard to detect—and nonlinear responses. “Nonlinear” means that when you double the dose of, say, a medication, or when you double the number of employees in a factory, you don’t get twice the initial effect, but rather a lot more or a lot less.
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Man-made complex systems tend to develop cascades and runaway chains of reactions that decrease, even eliminate, predictability and cause outsized events.
Coping with Risk and Uncertainty

NEW YORK TIMES BESTSELLING AUTHOR OF
THE BLACK SWAN

Nassim Nicholas Taleb

Antifragile

Things That Gain From Disorder
It is of great help that Mother Nature—thanks to its antifragility—is the best expert at rare events, and the best manager of Black Swans; in its billions of years it succeeded in getting here without much command-and-control instruction from an Ivy League–educated director nominated by a search committee. Antifragility is not just the antidote to the Black Swan; understanding it makes us less intellectually fearful in accepting the role of these events as necessary for history, technology, knowledge, everything.
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Given the unattainability of perfect robustness, we need a mechanism by which the system regenerates itself continuously by using, rather than suffering from, random events, unpredictable shocks, stressors, and volatility.

The antifragile gains from prediction errors, in the long run.
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Systemic Changes
Sustainable Development:
Brundtland et al., 1987: “Development that meets the needs of the present without compromising the ability of future generations to meet their needs”
Systemic Changes

Sustainable Development: Brundtland et al., 1987: “Development that meets the needs of the present without compromising the ability of future generations to meet their needs.”

Of course not!
Sustainable Development: Brundtland et al., 1987: “Development that meets the needs of the present without compromising the ability of future generations to meet their needs.”

Systems Thinking

ECOSYSTEMS

Withdrawals from the ecosystems

Socio-Technical Systems providing social needs and value

Energy system
Food system
Mobility system

Environmental externalities

Ecosystem services

Policy
Industry
Market
Science
Technology

European Environment Agency
Sustainable Development: Brundtland et al., 1987: “Development that meets the needs of the present without compromising the ability of future generations to meet their needs.”
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Cars (EU) are more efficient but contribute to a range of negative impacts on people’s quality of life in cities
Sustainable Development:
Brundtland et al., 1987: “Development that meets the needs of the present without compromising the ability of future generations to meet their needs.”

Systemic Changes

Jevons Paradox (1906)

Cars (EU) are more efficient but contribute to a range of negative impacts on people’s quality of life in cities.

Fig. 1. Dimensions considered for the discussion of energy rebound and economic growth.
Sustainable Development: Brundtland et al., 1987: “Development that meets the needs of the present without compromising the ability of future generations to meet their needs.”

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... but also a different systemic (re-) thinking.
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See Class 28