Policies and Strategies for Sustainable Development

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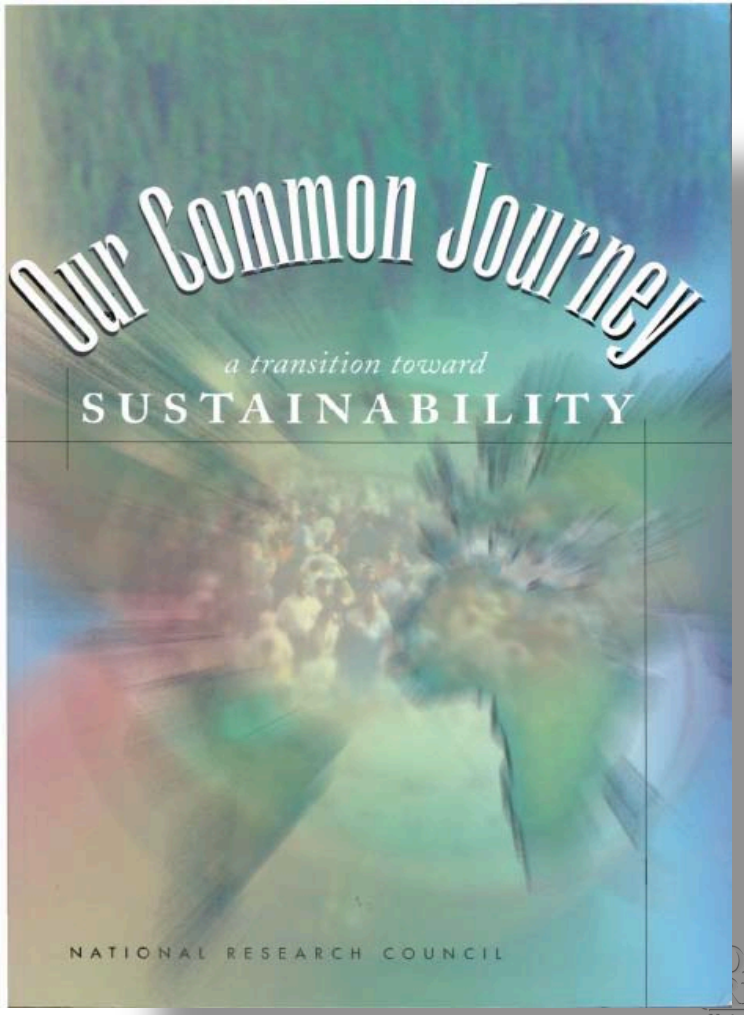
Sustainability/sustainable development has been an explicit global concern for a quarter of a century (I):

- **Generally traced back to the "Brundtland Report:"**
  - **Commissioned by the UN in 1983 and delivered in 1987, responding to a request for advice about environmental strategies for achieving sustainable development**
  - **Particular attention to limitations of existing technologies and institutions for meeting current and future needs**
- **Followed by the 1992 UN Conference on Environment and Development in Rio:**
  - **Aiming to develop principles to guide sustainable development**
  - **Led to a number of international environmental "conventions:" climate change, biodiversity, desertification, and others**
- **And later by the "Earth Summit" on Sustainable Development, Johannesburg, 2002 ("Rio + 10) and by "Rio + 20" in 2012**

Sustainability/sustainable development has been an explicit global concern for a quarter of a century (II):

- **Followed up in this country by NAS, through a pathbreaking report in 1999: *Our Common Journey – A Transition to Sustainability*:**
  - **Asked: How can basic needs of a global population at least half again as large as present be met in 50 years without undermining environmental services on which development depends in the longer run?**



Sustainability/sustainable development has been an explicit global concern for a quarter of a century (III):

- ***Our Common Journey – A Transition to Sustainability*:**
  - **Sketched a future in which sustainability is possible – but only with significant advances in basic knowledge, in the social capacity and technological capabilities to utilize it, and in the political will to turn this knowledge and know-how into action.**

Sustainability is associated with a distinctive view of the challenge both to knowledge and to action (I):

- **The general perspective is that if continued human progress is going to be possible, including closing gaps between the rich and the poor, development must find pathways that <u>both</u>:**
  - **Achieve continuing economic and social progress, without major sacrifices by the privileged**
  - **Find a sustainable balance with a physical environment that is already under stress**
- **Must be done through political strategies that are equitable between nations and regions now and between current actions and the needs of future generation**
- **Particular challenges with such nature/society linkages as food, energy services, materials, job creation, and education**
- **One of the great challenges of our time, where smart people need to find pathways that will both get the job done and *also be palatable to inclusive political processes across different sorts of interests***

Sustainability is associated with a distinctive view of the challenge both to knowledge and to action (II):

- **The NAS report identified five challenges to action:**
  - **Stabilizing global population through voluntary actions**
  - **Accommodating massive urban growth in a sustainable manner**
  - **Increasing energy and materials services while reducing environmental impacts**
  - **Restoring degraded ecosystems while conserving biodiversity**
  - **Reversing declining food production in Africa while sustaining trends elsewhere**
- **Priorities for <u>research</u> include integrative, place-based, interdisciplinary science focused on threats and pathways, attention to critical loads and carrying capacities, understanding and monitoring transitions, improving the understanding of consumption behavior, and developing incentives for technological innovation -- *increasing the focus on "usable knowledge,"* e.g.:**
  - **Linking research agendas to societal goals**
  - **Improving linkages between knowledge development and sustainability problem-solving**

Sustainability is associated with a distinctive view of the challenge both to knowledge and to action (III):

- **Also priorities for <u>action</u>, such as accelerating current trends in fertility reduction; accommodating an expected doubling or tripling of the world's urban population; reversing declining trends in agricultural production in Africa and sustaining historic trends elsewhere; accelerating improvements in the sustainability of energy and materials use; and restoring degraded ecosystems while conserving biodiversity elsewhere**

One consequence has been the emergence in the US of "sustainability science" as a sustainable trans-disciplinary field of study:

- **An NAS Roundtable on Science and Technology for Sustainability**
- **A AAAS Center for Science, Technology, and Sustainability**
- **A number of major university centers, including Arizona State and Harvard**
- **A recent on-line "Reader in Sustainability Science and Technology" (http://tinurl.com/sustsci-reader)**
- **A conference on Theory and Knowledge Systems for Sustainability, Santa Fe Institute, October 2013**

What does this emerging knowledge tell us about how to assure sustainability? (I)

- **Recognize that sustainable development is a pathway, not a state:**
  - **Must be resilient to a continuing flow of multiple driving forces and possible surprises that could undermine sustainability, e.g.:**
    - **Conflict**
    - **Globalization**
    - **Epidemics**
    - **Migration**
    - **Institutional change**
    - **Technological invention/change**
    - **Changes in economic demands**
    - **Climate change**

What does this emerging knowledge tell us about how to assure sustainability?(II)

- **View sustainable development as a <u>process</u>, not a <u>plan</u>:**
  - **An iterative, continually evolving process for managing change**
  - **Taking necessary steps to reduce vulnerabilities in the context of development needs and resources, building capacity to increase the options available for vulnerability reduction and coping with unexpected threats**
  - **Monitoring the effectiveness of vulnerability reduction efforts**
  - **And revising risk reduction responses on the basis of continuous learning**
- **But we should not underestimate the challenge of operationalizing and implementing such a fuzzy concept**

Sustainability cannot be separated from values:

- **Sustainability for what? For whom? Why?**
- **Wrapped up in choices and tradeoffs, e.g., in determining balances between environmental management goals and social and economic goals**
- **Often a matter of perspective, e.g.: do we want to sustain oil supplies or do we want to sustain transportation energy sources?**
- **Often a matter of scale, e.g., Millennium Ecosystem Assessment:**
  - **Sustainable local ecosystems within non-sustainable regional ecosystems**
  - **Non-sustainable local ecosystems within sustainable regional ecosystems**

Sustainability cannot be separated from profound conceptual and empirical challenges:

- **Has defied attempts to develop measurable metrics**
- **Overlaps other conceptual structures and research agendas, e.g., resilience, adaptation**
- **Deeply imbedded in multiple causation and complex feedbacks**
- **Closely related to episodic threats related to extremes/extreme events/tipping points – which are easier to assess after the fact than to anticipate**
- **Importance of social context: the sustainability of systems of interest is nested in the sustainability of social processes that shape driving forces and responses (e.g., equity, inclusive participation)**

I will use climate change as an example of a threat to sustainable development and possible responses to such a threat:

- **Sustainable development identified by IPCC a decade ago as the goal of climate change responses**
- **The focus of several IPCC special reports in the past decade**
- **The topic of a chapter in the Fifth Assessment Report of IPCC's Working Group II (Impacts, Adaptation, and Vulnerability): "Climate-resilient Pathways: Adaptation, Mitigation, and Sustainable Development" – international author team, including both China and US (Qingzhu Gao, Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, Beijing)**
- **An underlying issue in every one of the UNFCCC Conference of Parties (COP) meetings in recent years**

Assuring sustainability is not just a matter of climate change mitigation and adaptation; it is focused on broader development processes themselves:

- **Resolving tradeoffs between economic and environmental goals: seeking to avoid tensions between economic growth and environmental management, looking for strategies that provide co-benefits for both – if either must suffer, sustainability is jeopardized**
- **Assuring effective institutions for resolving problems and achieving agreed-upon goals in the face of a wide range of challenges, with broad societal support -- the *how* is critically important: not just quick fixes but sustainable mechanisms**
- **Enhancing the range of choices through innovations and effective approaches for deploying them, recognizing the importance of the "co-production" of knowledge – integrating general scientific knowledge with local, practical knowledge, experience, and expertise**

Assuring sustainability is focused on managing the magnitude of threats and impacts:

- **Assuring that the magnitude/rate of threats and impacts is within the capacity of systems to adapt**
  - **Every system – physical, natural, and human – is resilient to many kinds of modest/gradual changes but threatened by some kinds of severe/relatively rapid change**
  - **So one challenge is to identify kinds of contextual changes that appear to be threats to sustainability if their magnitude is/is projected to be/could be large: climate change, atmospheric pollution, population density/land use, conflict**
  - **And then to seek strategies and actions that would moderate the magnitude and rate of change**

If threats are of relatively large magnitude, sustainable development may require transformational change:

- **Transformational change (as contrasted with incremental change) is a means for reducing risks and vulnerabilities by making significant changes in fundamental attributes of a system: e.g., the scale or intensity of current components, the introduction of new components, or changes in places or locations**
- **Transformational change is familiar in the aftermath of catastrophes, but it can be difficult to implement in advance of projected disruptions in order to reduce losses and damages**
- **A current concern is that climate change may pose such disruptions to development in many locations, systems, and populations**

Concerns about climate change impacts have changed in recent years:

- **Impacts of climate change are no longer hypothetical: they are being observed, and some of them are already becoming serious**
- **Greenhouse gas emissions are continuing to rise, making severe climate change more likely than moderate climate change**
- **Meanwhile, in 2011 and 2012 the US experienced an unusual series of climate-related extreme events: severe storms (e.g. Sandy), droughts, floods, winter tornados, wildfires – some continuing in 2013**
- **Improving the ability to project future exposures and disruptions for critical infrastructures has become a high national priority in the US**

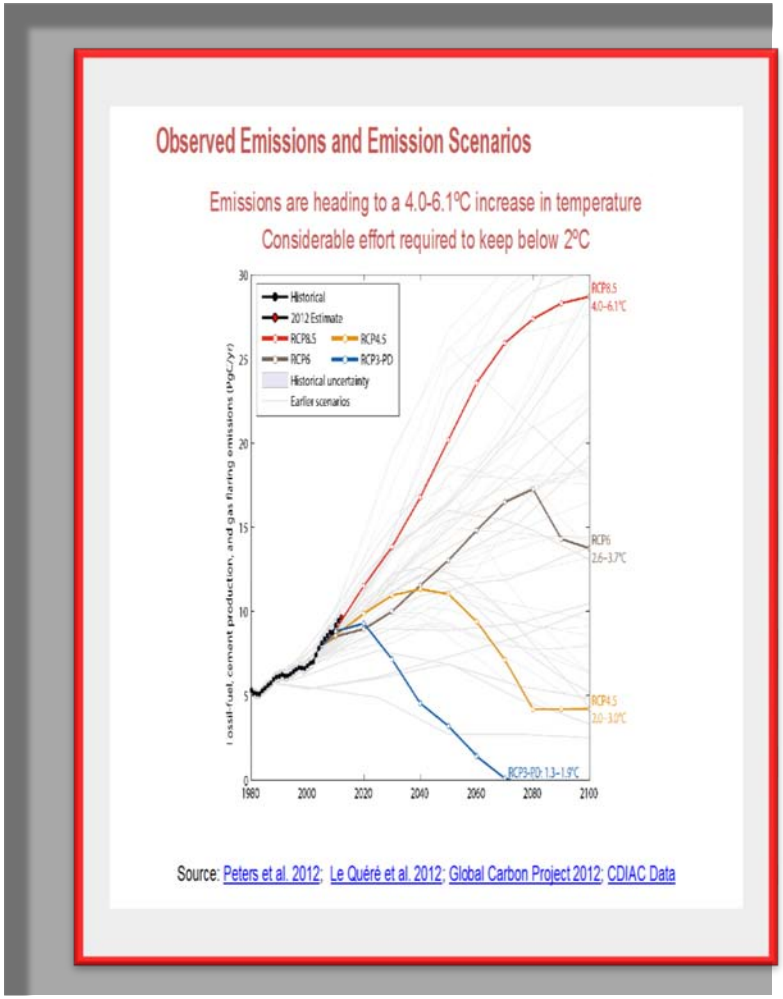


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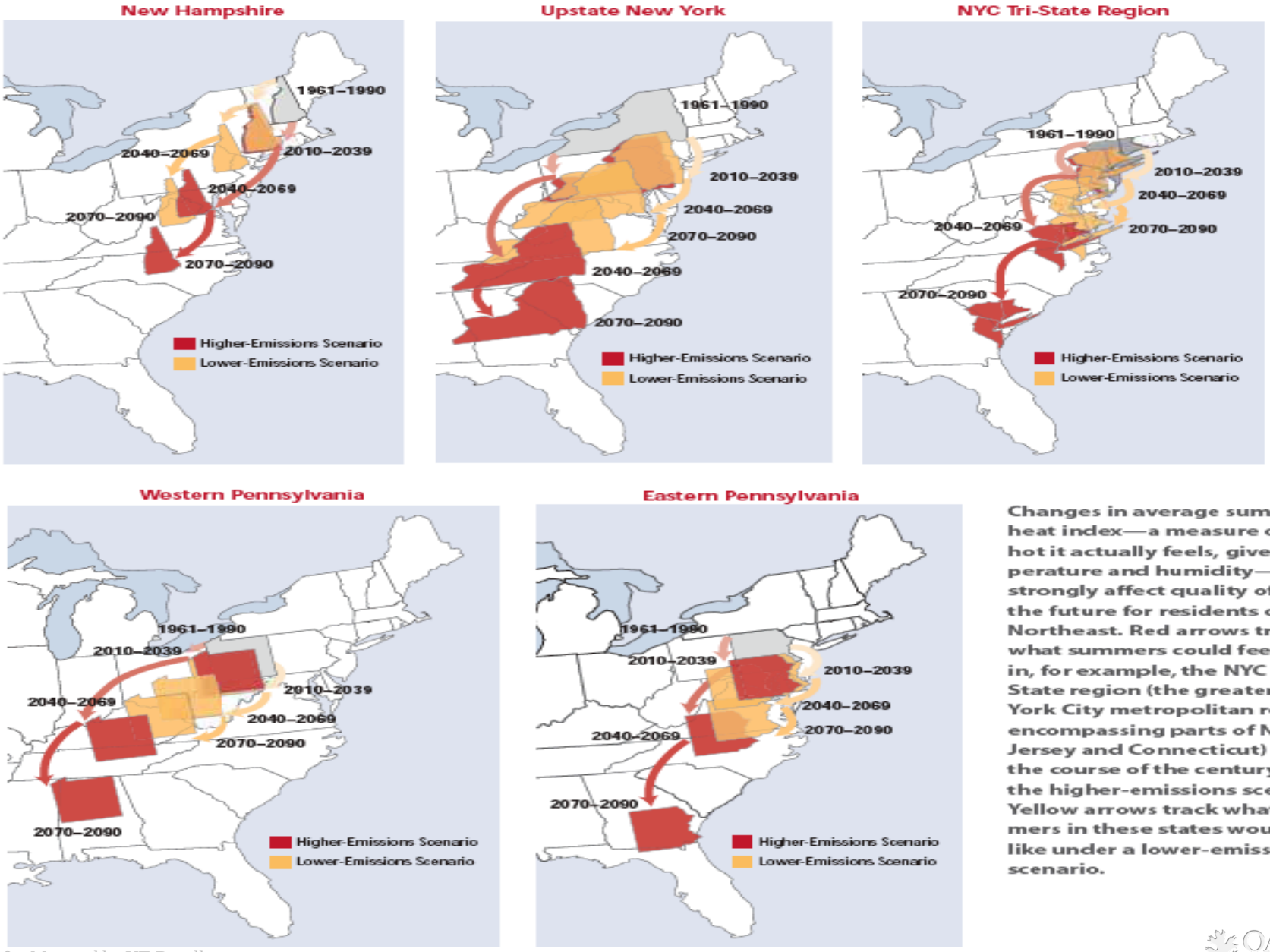
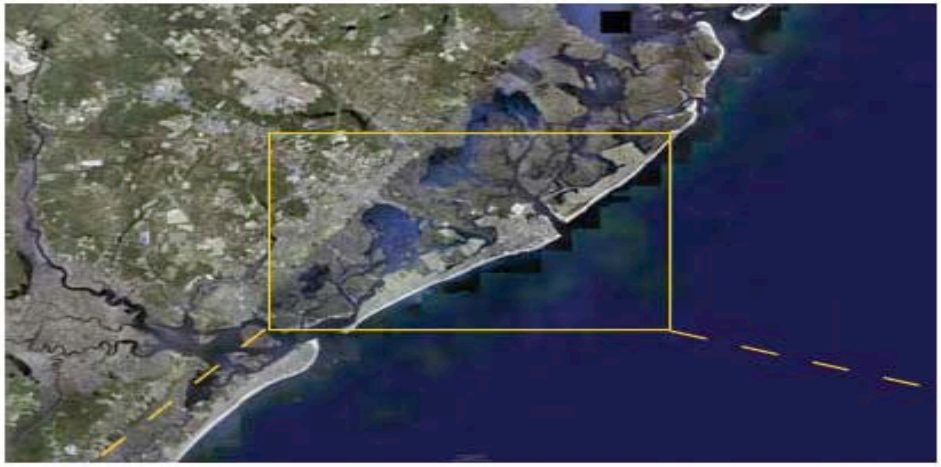
FIGURE 2: Migrating State Climates

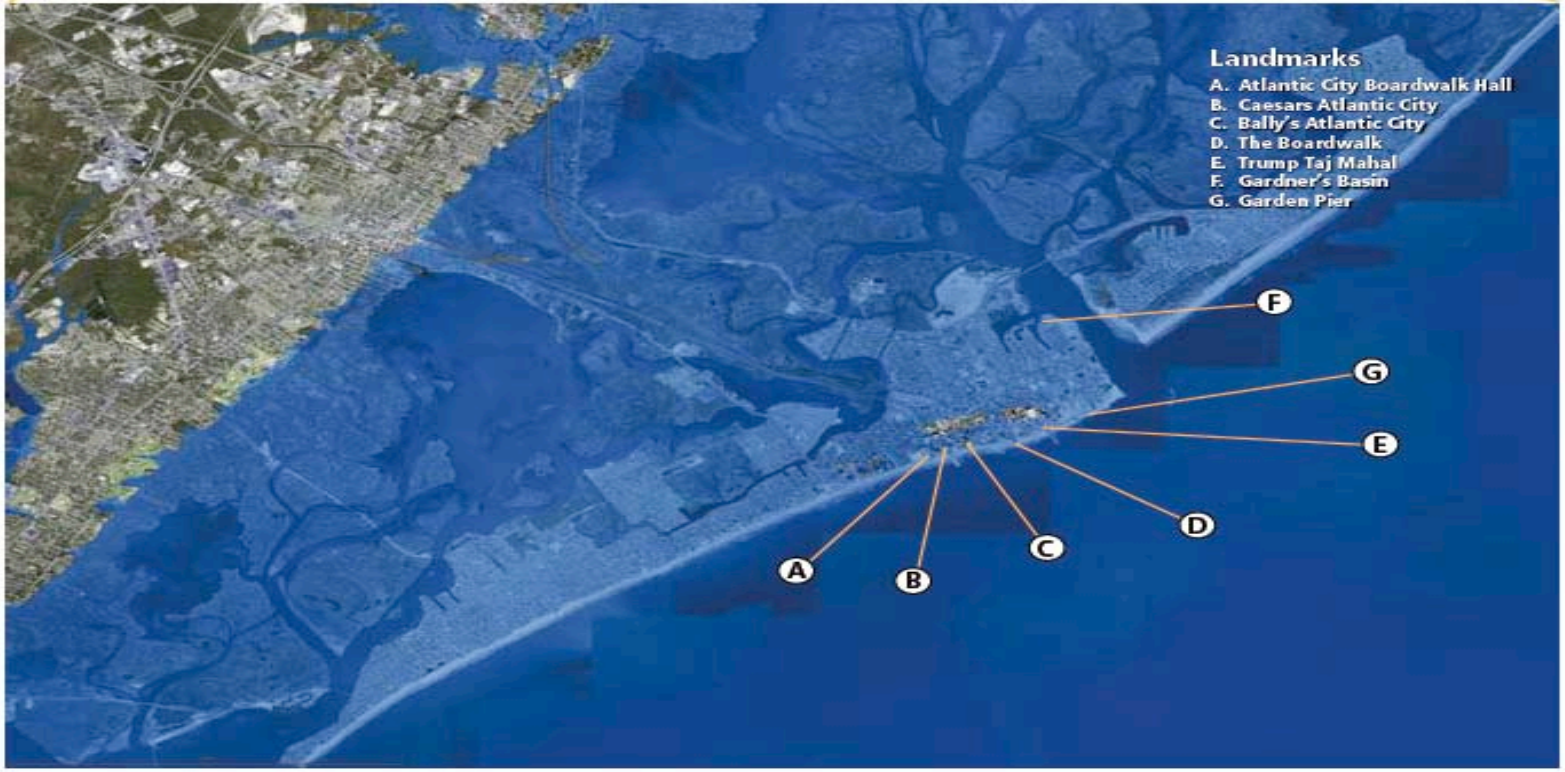


Changes in average summer heat index—a measure of how hot it actually feels, given temperature and humidity—could strongly affect quality of life in the future for residents of the Northeast. Red arrows track what summers could feel like in, for example, the NYC Tri-State region (the greater New York City metropolitan region, encompassing parts of New Jersey and Connecticut) over the course of the century under the higher-emissions scenario. Yellow arrows track what summers in these states would feel like under a lower-emissions scenario.

Atlantic City: Today's 100-Year Flood Could Become a Two-Year Flood by 2100



The top image shows the location of Atlantic City, NJ, on Absecon Island. The light blue area in the bottom image depicts today's FEMA 100-year flood zone (which extends beyond the area shown). Currently, this area has a 1 percent chance of being flooded in a given year. By 2100, this approximate area is projected to flood, on average, once every year or two under either emissions scenario, inundating high-tourist-value hotels and casinos. Under the higher-emissions scenario, the new 100-year flood height would be roughly four feet greater in 2100 than today, flooding a far greater area than the current FEMA flood zone.



This situation is very sobering for sustainable development:

- **The climate of 2030 has already been determined by emissions to date**
- **The climate of 2070 will be determined by emissions between now and 2030, but prospects for major changes in emission trends in the next two decades are not bright**
- **450 ppm stabilization (<3˚ C average warming) – traditionally considered the ceiling for coping – is almost certainly no longer achievable**
- **Current trends have us on a trajectory headed toward 5-6˚ C average warming, *or more* – and projections of impacts are often alarming**
- **Most likely, we have already accepted such impacts as the acidification of the oceans, the loss of Arctic ice, and the loss of a substantial number of species – losses and damages from climate change can no longer be avoided; the question is what losses are simply not acceptable and how to avoid them**

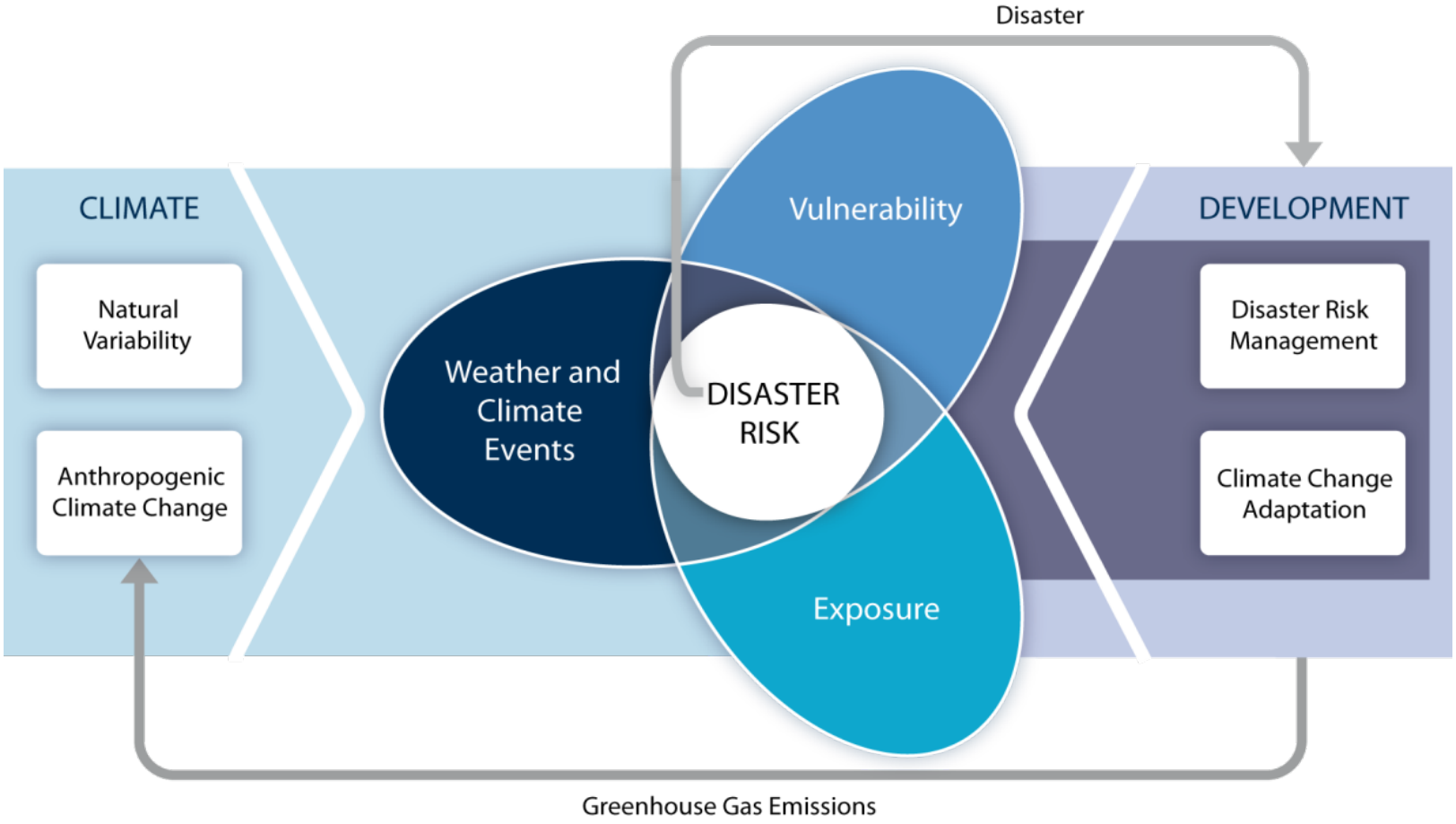
Given the host of uncertainties, a question is whether there are things that we can do now to improve our resilience to climate change and extreme weather events:

- **The focus of a recent IPCC Special Report on extremes and extreme events as particular challenges for climate change adaptation (SREX)**
- **Undertaken at the request of policymakers who observed that their greatest concerns are not with long-term gradual changes but with impacts of climate-related weather extremes and extreme events**
- **They asked: what should we consider doing to reduce risks and disruptive events?**

Since the bottom line from climate science is that we face growing risks of climate extremes and extreme events, SREX makes 3 basic points about adaptation:

- **We need to be developing adaptive responses to potential changes in extremes and extreme events in order to reduce risks of disasters**
- **Some of the increased weather/climate risks are likely to make it difficult for some systems to adapt sustainably without *transformational* changes, especially if climate change is relatively severe**
- **Although uncertainties are too great for adaptation requirements to be defined precisely, a process of iterative monitoring, evaluation, learning, innovation, and contingency planning will reduce disaster risks and promote adaptive management**

Increasing vulnerability, exposure, or severity and frequency of climate events increases disaster risk



Disaster risk management and climate change adaptation can influence the degree to which extreme events translate into impacts and disasters

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Since the bottom line from climate science is that we face growing risks of climate extremes and extreme events:

- **We need to be developing adaptive responses to reduce risks of disasters**
- **Some of the increased weather/climate risks are likely to make it difficult for some systems to adapt sustainably without *transformational* changes, especially if climate change is relatively severe, but:**
  - **Few "one size fits all" answers**
  - **Risks deeply rooted in development pathways, tradeoffs, and values**
- **Although uncertainties are too great for adaptation requirements to be defined precisely, a process of iterative monitoring, evaluation, learning, innovation, and contingency planning will reduce disaster risks and promote adaptive management**

Effective risk management and adaptation are tailored to local and regional needs and circumstances

- **Changes in climate extremes vary across regions**
- **Each region has unique vulnerabilities and exposure to hazards**
- **Effective risk management and adaptation address the factors contributing to exposure and vulnerability**

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There are strategies that can help manage disaster risk now and also help improve people's livelihoods and well-being

The most effective strategies offer development benefits in the relatively near term and reduce vulnerability over the longer term

How can effective climate change responses be mobilized? (I)

- **Pay attention to geographic scale in determining what makes sense:**
  - **Both large and small scales offer strengths: local scales offer local knowledge, flexibility, and innovativeness; large scales offer resource mobilization and cost-sharing**
  - **But integration is impeded by powerful obstacles: bureaucratic rules and procedures surrounding access to top-down resources; lack of options, resources, perspectives, and leadership bottom-up**
  - **Meanwhile, efforts in the US related to a national climate service and a continuing process of national climate change assessments recognize that it is essential to integrate top-down and bottom-up roles, agendas, and communications – but we do not know how to structure the bottom-up part….**

How can effective climate change responses be mobilized? (II)

- **Integration in a place-based context**
  - **A fundamental perspective of sustainability science is that integration of diverse factors and forces is almost always necessarily "place-based"**
  - **An example was an ORNL study of climate change vulnerabilities and responses in Cochin, India, 2001-2003**
  - **We are finding that attention to climate change responses, such as adaptation planning, at relatively local scales:**
    - **Refuses to separate mitigation and adaptation responses**
    - **Refuses to separate climate change responses from community development aims and aspirations**
  - **In fact, climate change can be an opportunity for SD:**
    - **Triggering greater awareness of SC issues and aims: e.g., AIACC**
    - **Stimulating resource allocations that also meet SD needs: "co-benefits," especially related to CC adaptation**

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Relating sustainable development and ecosystem management involves two related concerns:

- **The sustainability of ecosystem trajectories themselves**
  - **The viability of particular ecosystems under multiple stresses, along with the services that they provide: e.g., geographically defined biosphere preserves as climate parameters shift…**
  - **The viability of societal structures related to sustainable cosystem management: who cares and who fixes…**
- **Relationships between ecosystem trajectories and development goals and pathways**
  - **Goals of ecosystem management as development priorities**
    - **Sustainable ecosystem services as a priority: how high?**
    - **Protection of ecosystems and species of particular value: acceptable losses?**
  - **Tradeoff resolution where choices are required**

How can technological change be accelerated as an essential part of the answer?

- **Accelerating technological change is an essential part of the answer: a need for transformational innovation to reduce society/nature tradeoffs:**
  - **The issue is how to induce discoveries, not just incremental deployment of known options**
  - **Chances of a technology breakthrough are greater if we can reach and mobilize the best talent globally in the discovery process**
  - **This requires transferring to them what current science and technology knows and does, to be integrated with local knowledge to stimulate distributed discovery and innovation**
  - **The information technology revolution can be a powerful enabler of access to S&T knowledge, if intellectual property rights obstacles can be overcome**

Why is research and development so important?

- **The challenge is to significantly reduce differences between the rich and the poor in 50 years or so while at the same time reducing pressures on our environment**
  - **For example, increasing the supply of energy services to the world while sharply reducing total GHG emissions from energy production and use (we do not know how to do this…)**
  - **This and other sustainability challenges require better knowledge, tools, and technologies – and putting them into practice**
  - **The NAS/NRC Sustainability Transition report suggests that either we S&T experts meet this challenge or else the world faces futures that are highly undesirable: e.g., rich in enclaves while the poor suffer, or chronic conflict and instability**

What are the central R&D challenges for ecosystem management?

- **Basic research challenges include:**
  - **Improving the understanding of consumption behavior**
  - **Improving the understanding of institutional behavior**
  - **Improving understandings of thresholds/tipping points in order to anticipate and respond**
- **Realizing potentials for improving capacities to connect projections with observations, e.g.:**
  - **Enhancing monitoring of threatened systems**
  - **Improving understandings of the consequences of ecosystem losses and damages: concrete valuations, not just philosophical perspectives**
  - **Learning from early experiments with change/risk management: what is working and why**
  - **Simulation modeling of future trajectories: imagining the unimaginable...**
- **Preparing to consider transformational changes if needed – from assisted ecosystem migration to gene banks: we do not have to propose major changes in order to start discussing and analyzing them**

Summarizing a diverse and heterogeneous landscape:

- **Sustainable development should be our aim, not ecosystem preservation or climate change management**
- **But climate change, if it is severe rather than moderate, represents a very serious threat to ecosystem management and sustainable development in many places, sectors, and populations in the U.S., China, and the world**
- **Even moderate climate change threatens sustainable development in some places, sectors, and populations: prices are already being paid**
- **In many ways, given the political complexity of both sustainability and climate change responses, it is up to the S&T community to come up with ideas and options that improve prospects for success**
  - **By discovering new and better options**
  - **By accelerating the movement of knowledge into use**

THANK YOU !

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