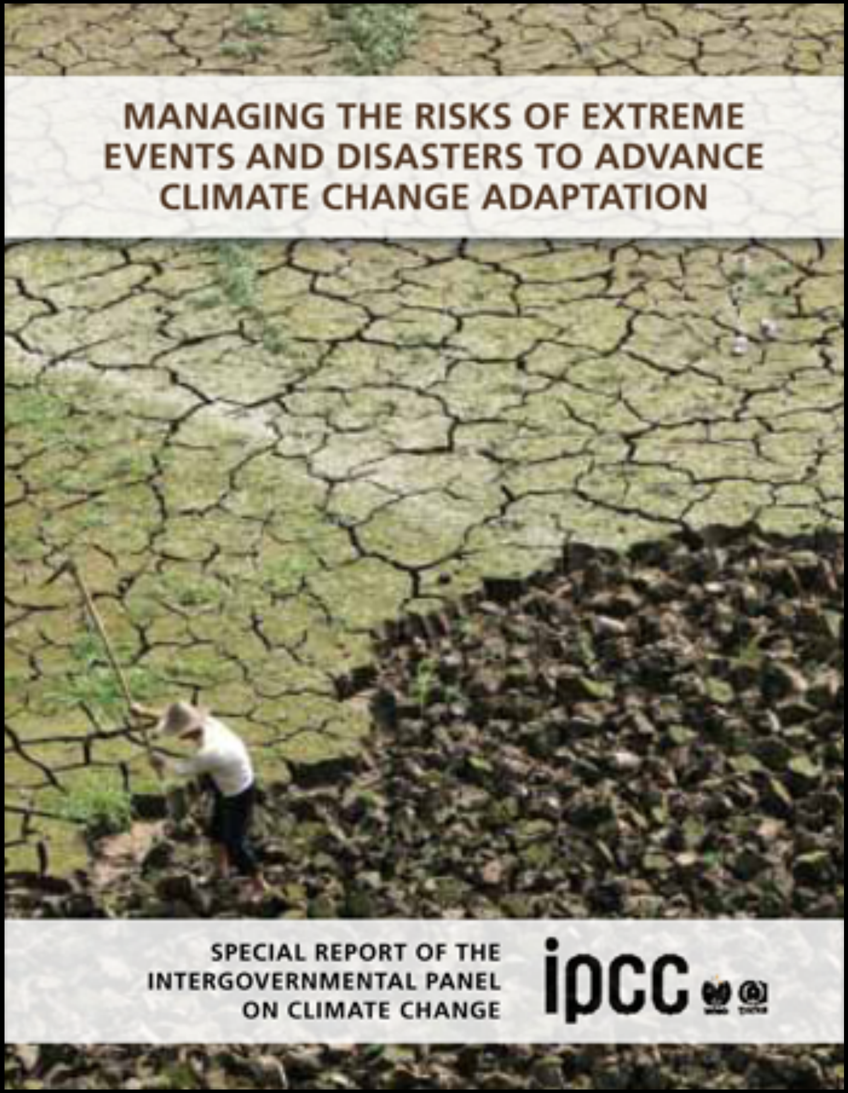
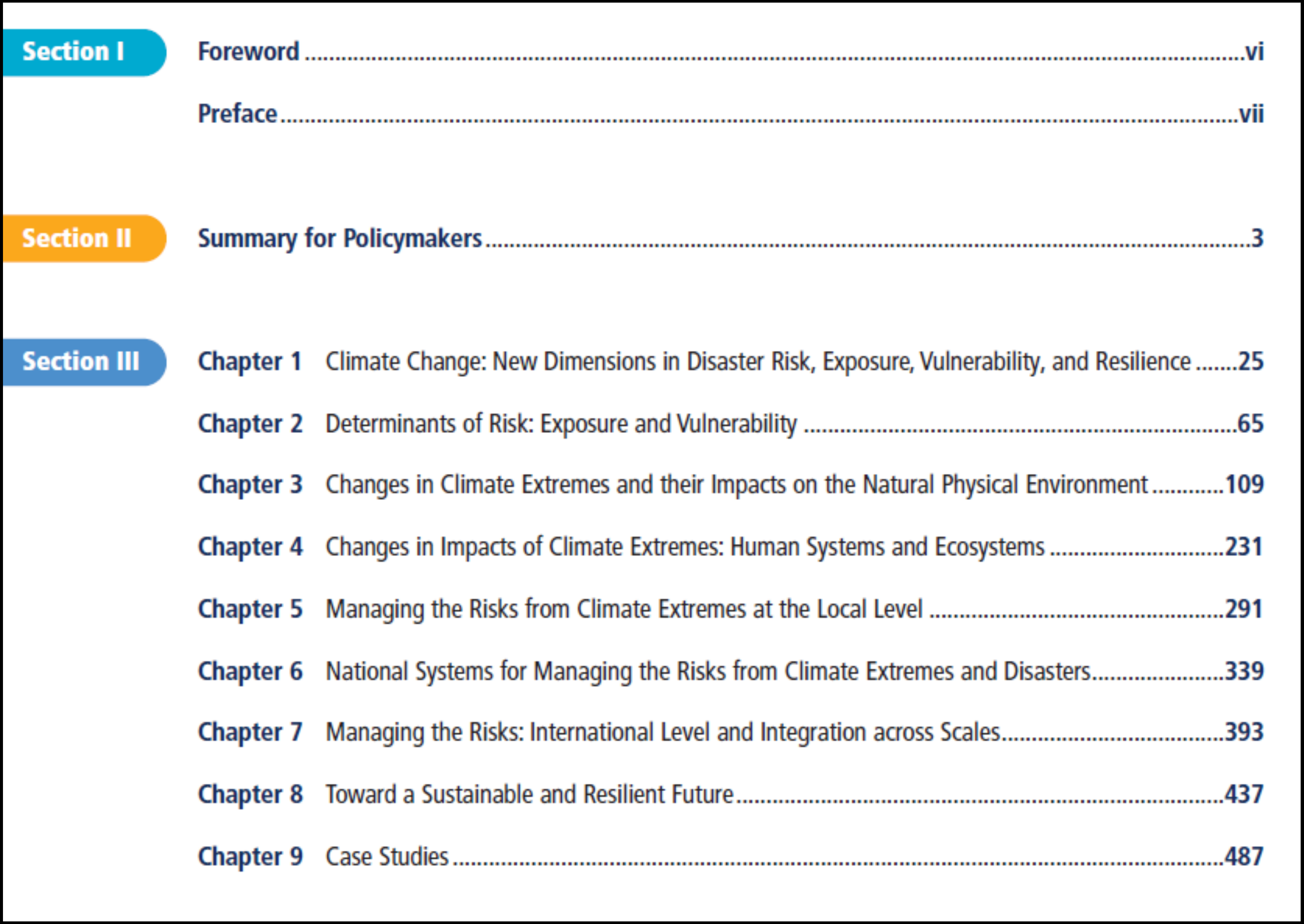
SREX:
Some thoughts of an eager reader



MANAGING THE RISKS OF EXTREME EVENTS AND DISASTERS TO ADVANCE CLIMATE CHANGE ADAPTATION

SPECIAL REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



Section I

Section II

Section III

Some Positives

- Useful to bring Natural Hazards and Climate Change fields together
- High confidence attributions/ projections for a few hazards might be the marginal additional incentive to evoke better adaptation now.
- Detailed, realistic, and *humbling* assessment of the challenge of projecting changes in extremes: even the sign (+/-) of change is uncertain just 2-3 decades out, and at 2100 model choice and emission scenario dominate uncertainty (see p. 177 for floods)
- The best, richest and well-organized review of hazards and disasters literature available (though of course with a weather and climate focus)
- The effort to search out adaptations useful today that bridge to an uncertain future climate ("Low Regrets")

Some Criticisms

- The report lacks focus on key nexus of <u>anthropogenic climatic change</u> and hazards; curious for an *IPCC report*
- Lengthy review of hazards reduction and sustainable development principles adds little to our understanding of the problem
- *Summary for Policy Makers (SPM) Section E* offers bland truisms and gently understates what we know about the complex interactions of hazards and development---partly an effect of the IPCC assessment format
- The "low regrets" options (e.g., in Table SPM.1) are lists of general mitigation meta-adaptations, with only a hazy evaluation of their efficacy in a changing climate (that's the loss of hazards/climate change focus)
- Oddly little attention to the potential for <u>*low probability/ high consequence*</u> outcomes: rapid, large and abrupt climate change, which is not addressed in standard hazards literature

adaptation approaches to manage risks.

The severity of the impacts of climate extremes depends strongly on the level of the exposure and vulnerability to these extremes (*high confidence*). [2.1.1, 2.3, 2.5]

Trends in exposure and vulnerability are major drivers of changes in disaster risk (*high confidence*). [2.5] Understanding the multi-faceted nature of both exposure and vulnerability is a prerequisite for determining how weather and climate events contribute to the occurrence of disasters, and for designing and implementing effective adaptation and disaster risk management strategies. [2.2, 2.6] Vulnerability reduction is a core common element of adaptation and disaster risk management. [2.2, 2.3]

Development practice, policy, and outcomes are critical to shaping disaster risk, which may be increased by shortcomings in development (*high confidence*). [1.1.2, 1.1.3] High exposure and vulnerability are generally the outcome of skewed development processes such as those associated with environmental degradation, rapid and unplanned urbanization in hazardous areas, failures of governance, and the scarcity of livelihood options for the poor. [2.2.2, 2.5] Increasing global interconnectivity and the mutual interdependence of economic and ecological systems can have sometimes contrasting effects, reducing or amplifying vulnerability and disaster risk. [7.2.1] Countries more effectively manage disaster risk if they include considerations of disaster risk in national development and sector plans and if they adopt climate change adaptation strategies, translating these plans and strategies into actions targeting vulnerable areas and groups. [6.2, 6.5.2]

Data on disasters and disaster risk reduction are lacking at the local level, which can constrain improvements in local vulnerability reduction (*high agreement, medium evidence*). [5.7] There are few examples of national disaster risk management systems and associated risk management measures explicitly integrating knowledge of and uncertainties in projected changes in exposure, vulnerability, and climate extremes. [6.6.2, 6.6.4]

Inequalities influence local coping and adaptive capacity, and pose disaster risk management and adaptation challenges from the local to national levels (*high agreement, robust evidence*). These inequalities reflect socioeconomic, demographic, and health-related differences and differences in governance, access to livelihoods

Table SPM.1 | Table SPM.1 (Continued)

Example	Exposure and vulnerability at scale of risk management in the example	Information on Climate Extreme Across Spatial Scales			Options for risk management and adaptation in the example
		GLOBAL Observed (since 1950) and projected (to 2100) global changes	REGIONAL Observed (since 1950) and projected (to 2100) changes in the example	SCALE OF RISK MANAGEMENT Available information for the example	
Impacts of **heat waves** in urban areas in Europe	Factors affecting exposure and vulnerability include age, pre-existing health status, level of outdoor activity, socioeconomic factors including poverty and social isolation, access to and use of cooling, physiological and behavioral adaptation of the population, and urban infrastructure. [2.5.2, 4.3.5, 4.3.6, 4.4.5, 9.2.1]	**Observed:** *Medium confidence* that the length or number of warm spells or heat waves has increased since the middle of the 20th century, in many (but not all) regions over the globe. *Very likely* increase in number of warm days and nights at the global scale. **Projected:** *Very likely* increase in length, frequency, and/or intensity of warm spells or heat waves over most land areas. *Virtually certain* increase in frequency and magnitude of warm days and nights at the global scale. [Table 3-1, 3.3.1]	**Observed:** *Medium confidence* in increase in heat waves or warm spells in Europe. *Likely* overall increase in warm days and nights over most of the continent. **Projected:** *Likely* more frequent, longer, and/or more intense heat waves or warm spells in Europe. *Very likely* increase in warm days and nights. [Table 3-2, Table 3-3, 3.3.1]	Observations and projections can provide information for specific urban areas in the region, with increased heat waves expected due to regional trends and urban heat island effects. [3.3.1, 4.4.5]	Low-regrets options that reduce exposure and vulnerability across a range of hazard trends: • Early warning systems that reach particularly vulnerable groups (e.g., the elderly) • Vulnerability mapping and corresponding measures • Public information on what to do during heat waves, including behavioral advice • Use of social care networks to reach vulnerable groups Specific adjustments in strategies, policies, and measures informed by trends in heat waves include awareness raising of heat waves as a public health concern; changes in urban infrastructure and land use planning, for example, increasing urban green space; changes in approaches to cooling for public facilities; and adjustments in energy generation and transmission infrastructure. [Table 6-1, 9.2.1]
Increasing losses from **hurricanes** in the USA and the Caribbean	Exposure and vulnerability are increasing due to growth in population and increase in property values, particularly along the Gulf and Atlantic coasts of the United States. Some of this increase has been offset by improved building codes. [4.4.6]	**Observed:** *Low confidence* in any observed long-term (i.e., 40 years or more) increases in tropical cyclone activity, after accounting for past changes in observing capabilities. **Projected:** *Likely* that the global frequency of tropical cyclones will either decrease or remain essentially unchanged. *Likely* increase in average tropical cyclone maximum wind speed, although increases may not occur in all ocean basins. Heavy rainfalls associated with tropical cyclones are *likely* to increase. Projected sea level rise is expected to further compound tropical cyclone surge impacts. [Table 3-1, 3.4.4]	See global changes column for global projections.	Limited model capability to project changes relevant to specific settlements or other locations, due to the inability of global models to accurately simulate factors relevant to tropical cyclone genesis, track, and intensity evolution. [3.4.4]	Low-regrets options that reduce exposure and vulnerability across a range of hazard trends: • Adoption and enforcement of improved building codes • Improved forecasting capacity and implementation of improved early warning systems (including evacuation plans and infrastructures) • Regional risk pooling In the context of high underlying variability and uncertainty regarding trends, options can include emphasizing adaptive management involving learning and flexibility (e.g., Cayman Islands National Hurricane Committee). [5.5.3, 6.5.2, 6.6.2, Box 6-7, Table 6-1, 7.4.4, 9.2.5, 9.2.11, 9.2.13]
Droughts in the context of food security in West Africa	Less advanced agricultural practices render region vulnerable to increasing variability in seasonal rainfall, drought, and weather extremes. Vulnerability is exacerbated by population growth, degradation of ecosystems, and overuse of natural resources, as well as poor standards for health, education, and governance. [2.2.2, 2.3, 2.5, 4.4.2, 9.2.3]	**Observed:** *Medium confidence* that some regions of the world have experienced more intense and longer droughts, but in some regions droughts have become less frequent, less intense, or shorter. **Projected:** *Medium confidence* in projected intensification of drought in some seasons and areas. Elsewhere there is overall *low confidence* because of inconsistent projections. [Table 3-1, 3.5.1]	**Observed:** *Medium confidence* in an increase in dryness. Recent years characterized by greater interannual variability than previous 40 years, with the western Sahel remaining dry and the eastern Sahel returning to wetter conditions. **Projected:** *Low confidence* due to inconsistent signal in model projections. [Table 3-2, Table 3-3, 3.5.1]	Sub-seasonal, seasonal, and interannual forecasts with increasing uncertainty over longer time scales. Improved monitoring, instrumentation, and data associated with early warning systems, but with limited participation and dissemination to at-risk populations. [5.3.1, 5.5.3, 7.3.1, 9.2.3, 9.2.11]	Low-regrets options that reduce exposure and vulnerability across a range of hazard trends: • Traditional rain and groundwater harvesting and storage systems • Water demand management and improved irrigation efficiency measures • Conservation agriculture, crop rotation, and livelihood diversification • Increasing use of drought-resistant crop varieties • Early warning systems integrating seasonal forecasts with drought projections, with improved communication involving extension services • Risk pooling at the regional or national level [2.5.4, 5.3.1, 5.3.3, 6.5, Table 6-3, 9.2.3, 9.2.11]

Managing the risks: hurricanes in the USA and Caribbean

Risk Factors

- population growth
- increasing property value
- higher storm surge with sea level rise

Hurricane Katrina, 2005

Risk Management/ Adaptation

- better forecasting
- warning systems
- stricter building codes
- regional risk pooling

Projected globally: *likely* increase in average maximum wind speed and associated heavy rainfall (although not in all regions)

Really low regret? What kinds of stricter building and land use codes? in the face of uncertainty over future of climate change effects on hurricanes?

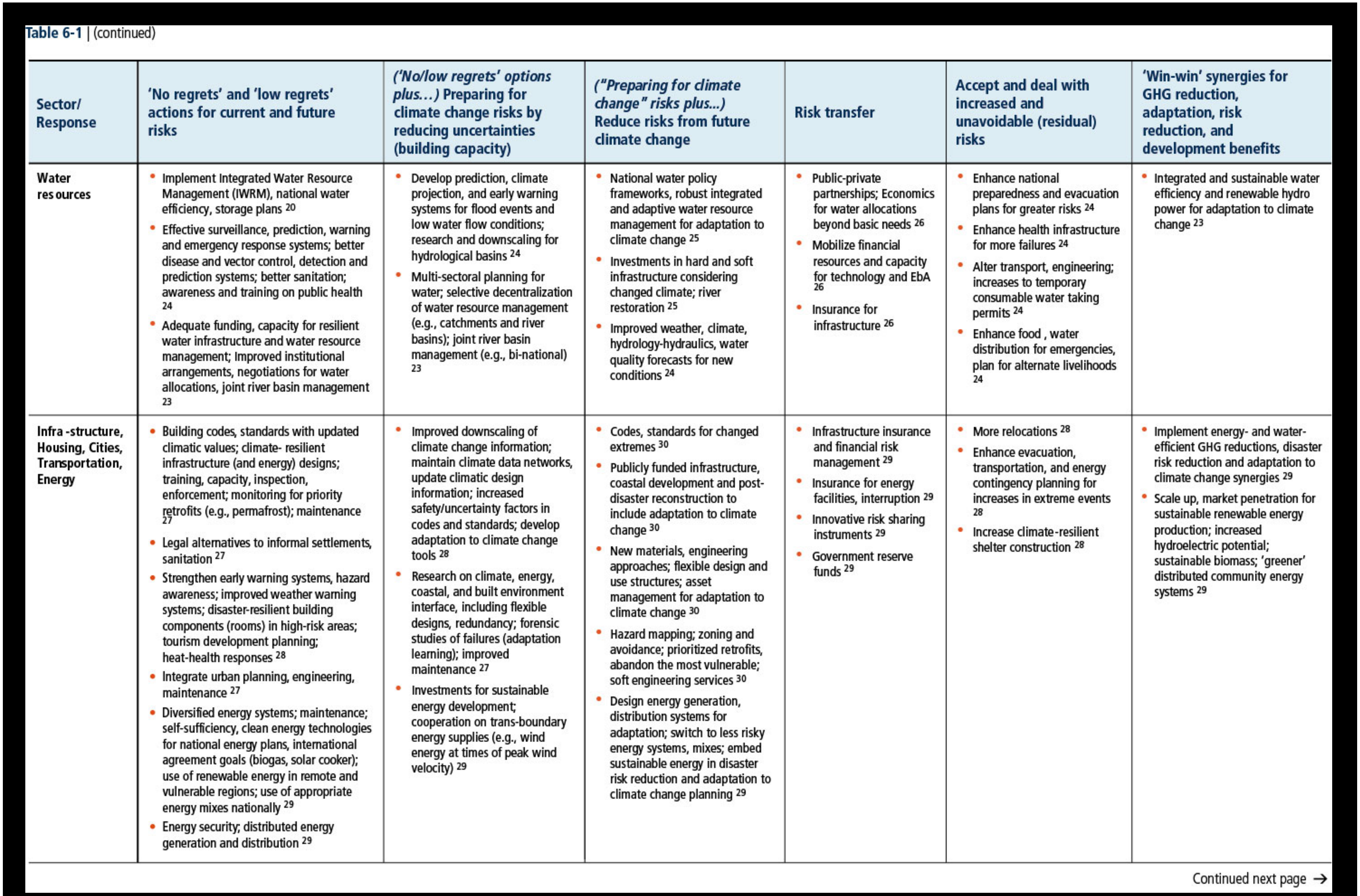


Table 6-1 | (continued)

Sector/ Response	'No regrets' and 'low regrets' actions for current and future risks	*('No/low regrets' options plus…)* Preparing for climate change risks by reducing uncertainties (building capacity)	*("Preparing for climate change" risks plus...)* Reduce risks from future climate change	Risk transfer	Accept and deal with increased and unavoidable (residual) risks	'Win-win' synergies for GHG reduction, adaptation, risk reduction, and development benefits
Water resources	• Implement Integrated Water Resource Management (IWRM), national water efficiency, storage plans[20] • Effective surveillance, prediction, warning and emergency response systems; better disease and vector control, detection and prediction systems; better sanitation; awareness and training on public health[24] • Adequate funding, capacity for resilient water infrastructure and water resource management; Improved institutional arrangements, negotiations for water allocations, joint river basin management[23]	• Develop prediction, climate projection, and early warning systems for flood events and low water flow conditions; research and downscaling for hydrological basins[24] • Multi-sectoral planning for water; selective decentralization of water resource management (e.g., catchments and river basins); joint river basin management (e.g., bi-national)[23]	• National water policy frameworks, robust integrated and adaptive water resource management for adaptation to climate change[25] • Investments in hard and soft infrastructure considering changed climate; river restoration[25] • Improved weather, climate, hydrology-hydraulics, water quality forecasts for new conditions[24]	• Public-private partnerships; Economics for water allocations beyond basic needs[26] • Mobilize financial resources and capacity for technology and EbA[26] • Insurance for infrastructure[26]	• Enhance national preparedness and evacuation plans for greater risks[24] • Enhance health infrastructure for more failures[24] • Alter transport, engineering; increases to temporary consumable water taking permits[24] • Enhance food , water distribution for emergencies, plan for alternate livelihoods[24]	• Integrated and sustainable water efficiency and renewable hydro power for adaptation to climate change[23]
Infra -structure, Housing, Cities, Transportation, Energy	• Building codes, standards with updated climatic values; climate- resilient infrastructure (and energy) designs; training, capacity, inspection, enforcement; monitoring for priority retrofits (e.g., permafrost); maintenance[27] • Legal alternatives to informal settlements, sanitation[27] • Strengthen early warning systems, hazard awareness; improved weather warning systems; disaster-resilient building components (rooms) in high-risk areas; tourism development planning; heat-health responses[28] • Integrate urban planning, engineering, maintenance[27] • Diversified energy systems; maintenance; self-sufficiency, clean energy technologies for national energy plans, international agreement goals (biogas, solar cooker); use of renewable energy in remote and vulnerable regions; use of appropriate energy mixes nationally[29] • Energy security; distributed energy generation and distribution[29]	• Improved downscaling of climate change information; maintain climate data networks, update climatic design information; increased safety/uncertainty factors in codes and standards; develop adaptation to climate change tools[28] • Research on climate, energy, coastal, and built environment interface, including flexible designs, redundancy; forensic studies of failures (adaptation learning); improved maintenance[27] • Investments for sustainable energy development; cooperation on trans-boundary energy supplies (e.g., wind energy at times of peak wind velocity)[29]	• Codes, standards for changed extremes[30] • Publicly funded infrastructure, coastal development and post-disaster reconstruction to include adaptation to climate change[30] • New materials, engineering approaches; flexible design and use structures; asset management for adaptation to climate change[30] • Hazard mapping; zoning and avoidance; prioritized retrofits, abandon the most vulnerable; soft engineering services[30] • Design energy generation, distribution systems for adaptation; switch to less risky energy systems, mixes; embed sustainable energy in disaster risk reduction and adaptation to climate change planning[29]	• Infrastructure insurance and financial risk management[29] • Insurance for energy facilities, interruption[29] • Innovative risk sharing instruments[29] • Government reserve funds[29]	• More relocations[28] • Enhance evacuation, transportation, and energy contingency planning for increases in extreme events[28] • Increase climate-resilient shelter construction[28]	• Implement energy- and water-efficient GHG reductions, disaster risk reduction and adaptation to climate change synergies[29] • Scale up, market penetration for sustainable renewable energy production; increased hydroelectric potential; sustainable biomass; 'greener' distributed community energy systems[29]

Continued next page →

Good advice: More detailed links between current and future options, but still a bit ambiguous given uncertain climate future.

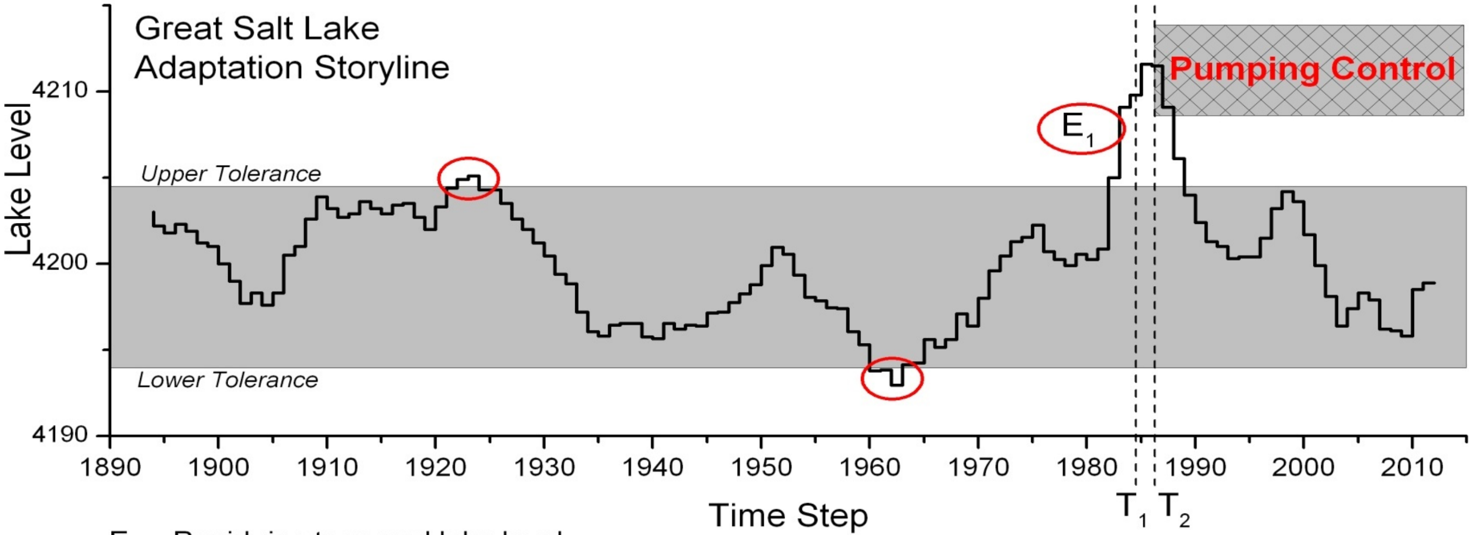
Short-term actions don't always provide long term risk reduction

Case Study: Northern Canada

Permafrost thaw

- permafrost requires sub zero temperatures
- melt affects roads, building foundations, airport infrastructure
- infrastructure maintenance needed
- short-term risk reduction won't eliminate long-term melt risk

Linking current and future adaptations: An important theme, though less addressed in the report than I would hope: the sometimes interference relationship between short- and long-term adaptations.



E_1 = Rapid rise to record lake level

T_1 = State begins to consider alternatives for controlling lake levels

T_2 = Pump system emplaced and started; ran for 1.5 years before lake dropped naturally

Help needed: More guidance on how to respond to episodic extremes in an era of concern and uncertainty about climate change. Would/should 1983 Utah floods and rise of Great Salt Lake be interpreted and managed differently today?

NEWSFOCUS

Pushing the Scary Side Of Global Warming

Greenhouse warming might be more disastrous than the recent international assessment managed to convey, scientists are realizing. But how can they get the word out without seeming alarmist?

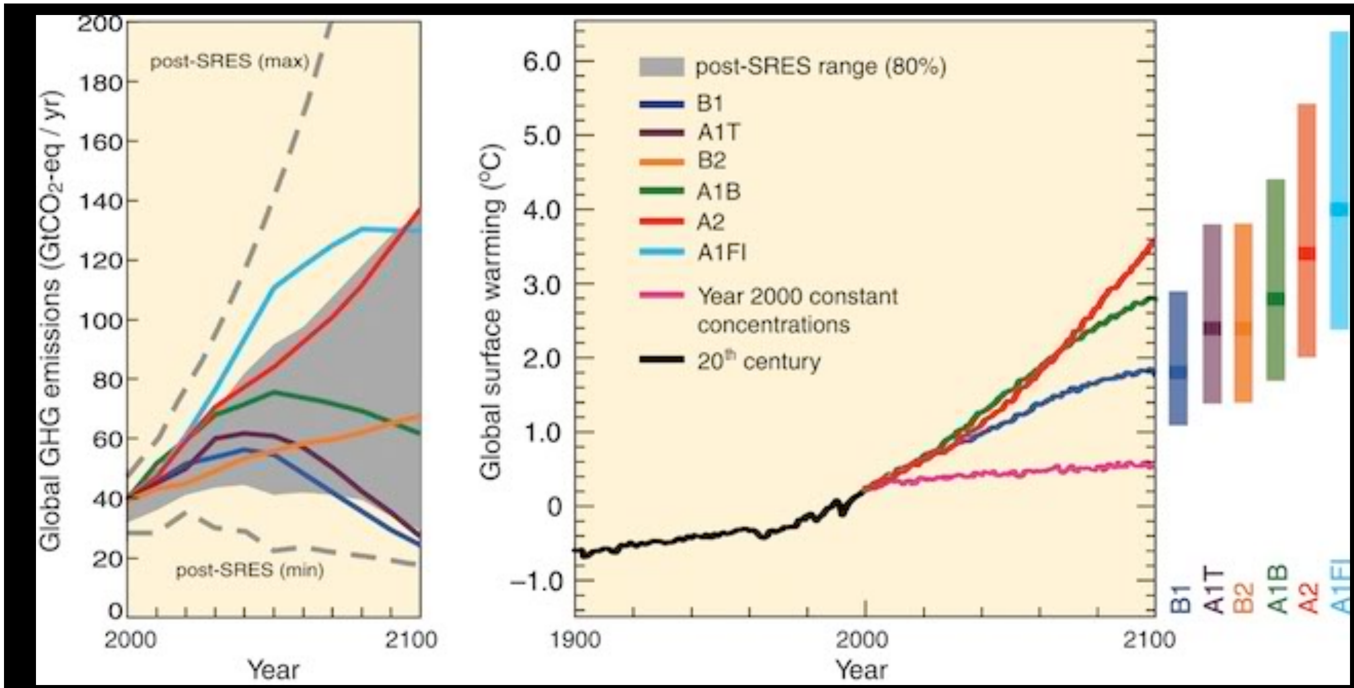
Abrupt Climate Change

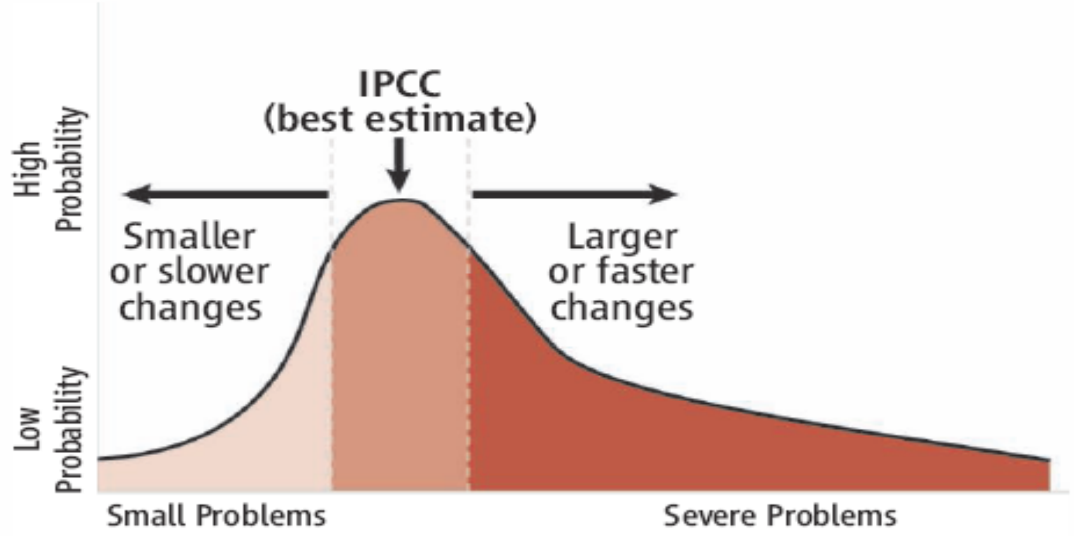
Inevitable Surprises

NATIONAL RESEARCH COUNCIL

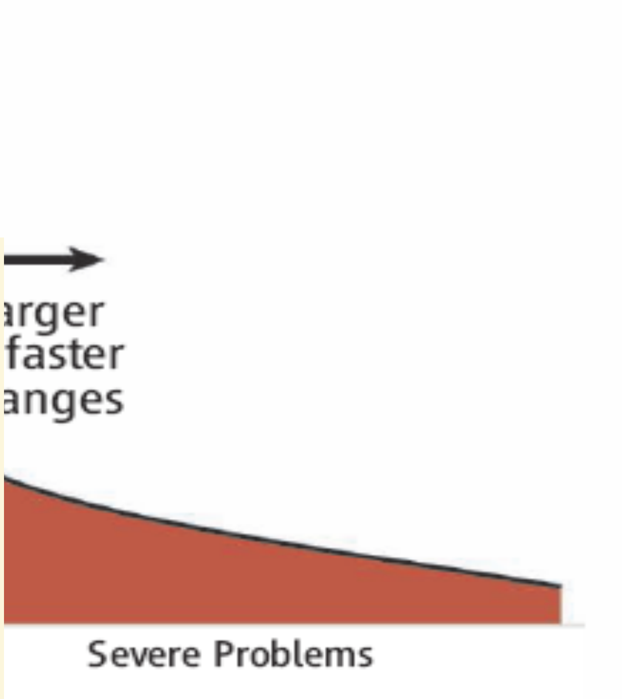
Science magazine, AAAS

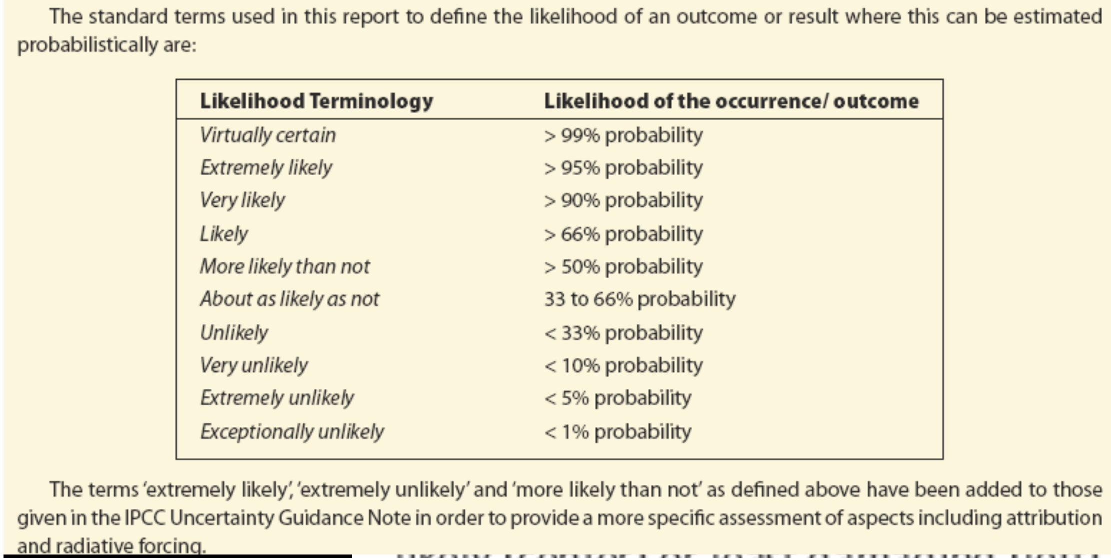
What about *EXTREME* climate change *per se*? What if the climate sensitivity is something like 4 degrees or more?





Asymmetry. The climate debate has focused on problems judged most likely (center) or least damaging (left), but the greatest risk may be at the extreme (right).



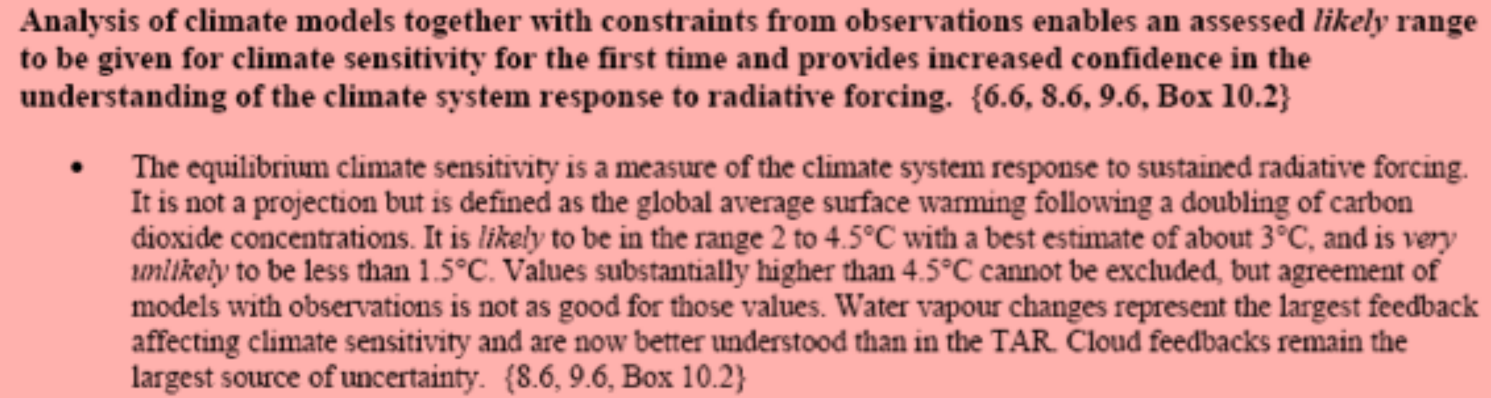


The standard terms used in this report to define the likelihood of an outcome or result where this can be estimated probabilistically are:

Likelihood Terminology	**Likelihood of the occurrence/ outcome**
Virtually certain	> 99% probability
Extremely likely	> 95% probability
Very likely	> 90% probability
Likely	> 66% probability
More likely than not	> 50% probability
About as likely as not	33 to 66% probability
Unlikely	< 33% probability
Very unlikely	< 10% probability
Extremely unlikely	< 5% probability
Exceptionally unlikely	< 1% probability

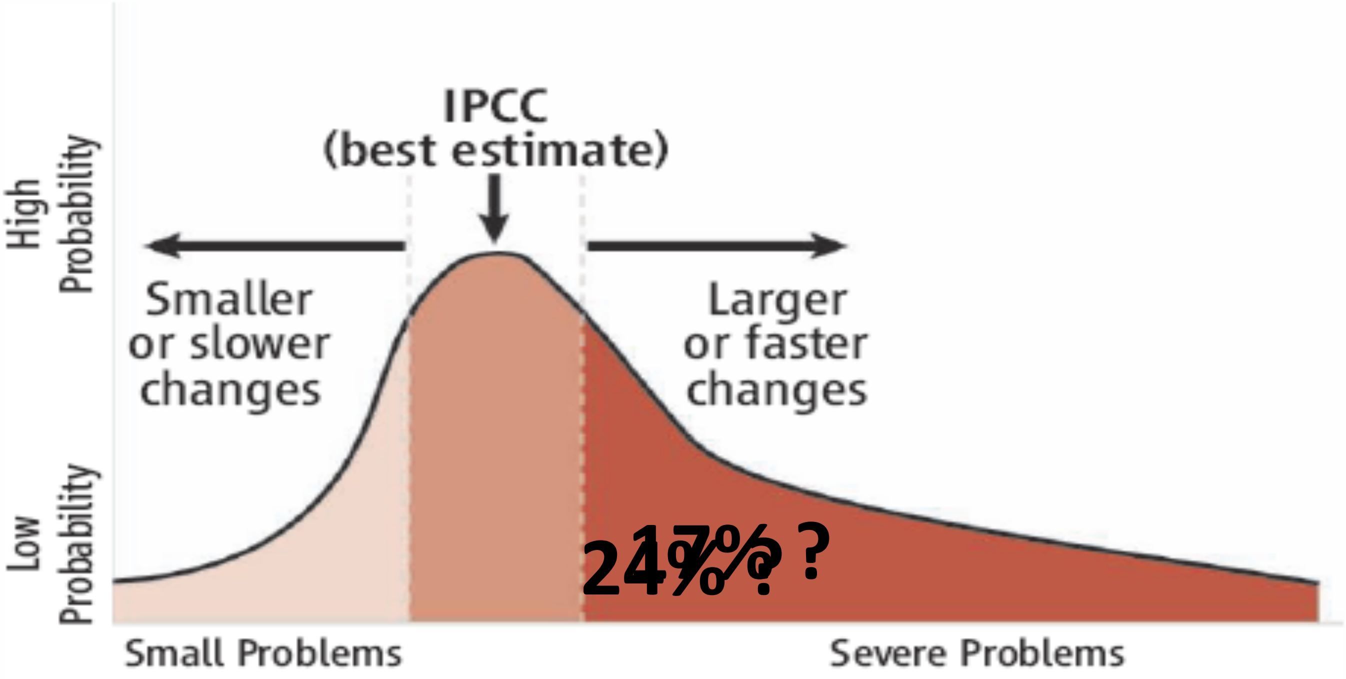
The terms 'extremely likely', 'extremely unlikely' and 'more likely than not' as defined above have been added to those given in the IPCC Uncertainty Guidance Note in order to provide a more specific assessment of aspects including attribution and radiative forcing.

cused on problems judged most likely (center) or least damaging (left), but the greatest risk may be at the extreme (right).



Analysis of climate models together with constraints from observations enables an assessed *likely* range to be given for climate sensitivity for the first time and provides increased confidence in the understanding of the climate system response to radiative forcing. {6.6, 8.6, 9.6, Box 10.2}

- The equilibrium climate sensitivity is a measure of the climate system response to sustained radiative forcing. It is not a projection but is defined as the global average surface warming following a doubling of carbon dioxide concentrations. It is *likely* to be in the range 2 to 4.5°C with a best estimate of about 3°C, and is *very unlikely* to be less than 1.5°C. Values substantially higher than 4.5°C cannot be excluded, but agreement of models with observations is not as good for those values. Water vapour changes represent the largest feedback affecting climate sensitivity and are now better understood than in the TAR. Cloud feedbacks remain the largest source of uncertainty. {8.6, 9.6, Box 10.2}



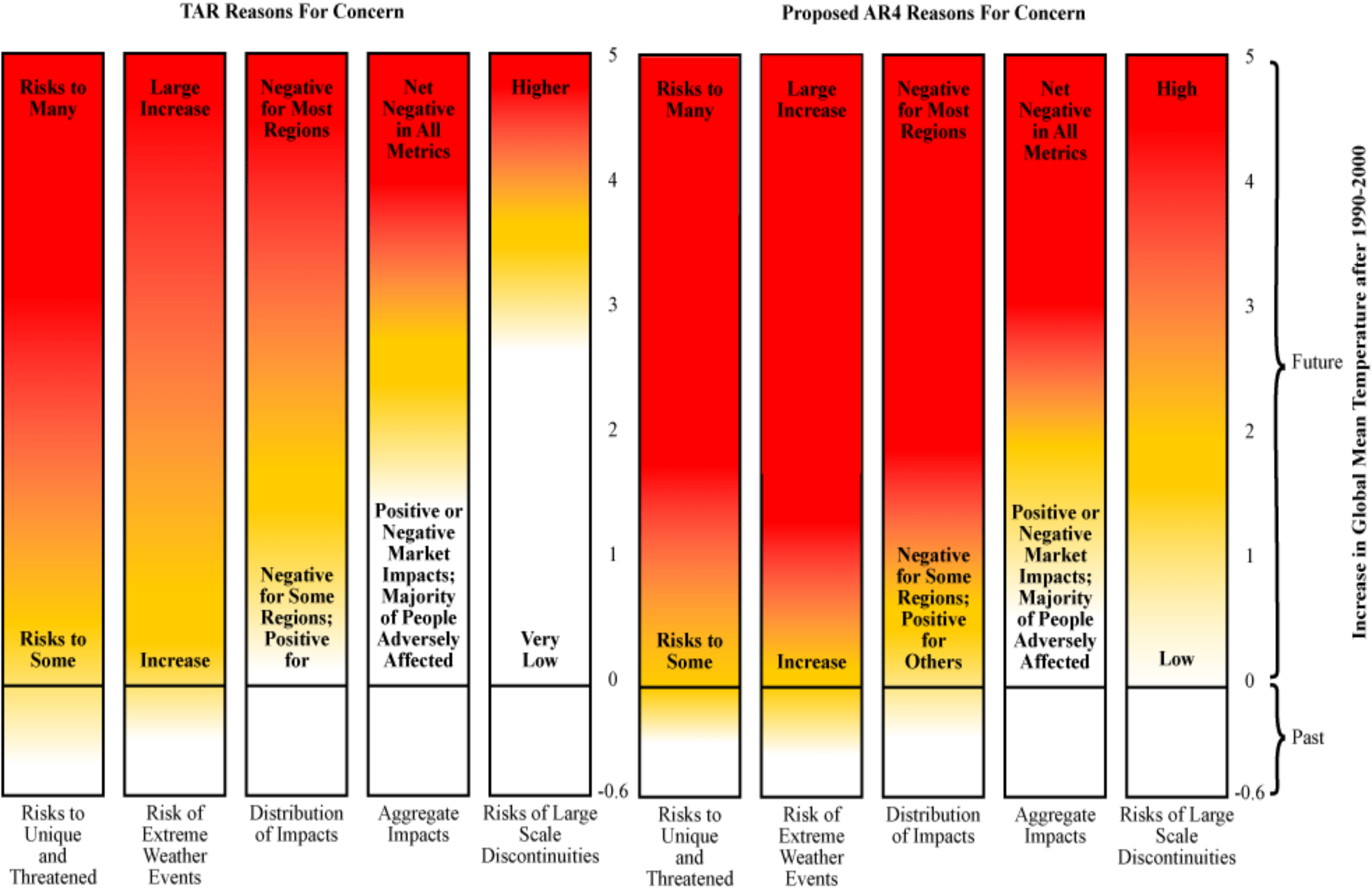
17% ?

24% ?

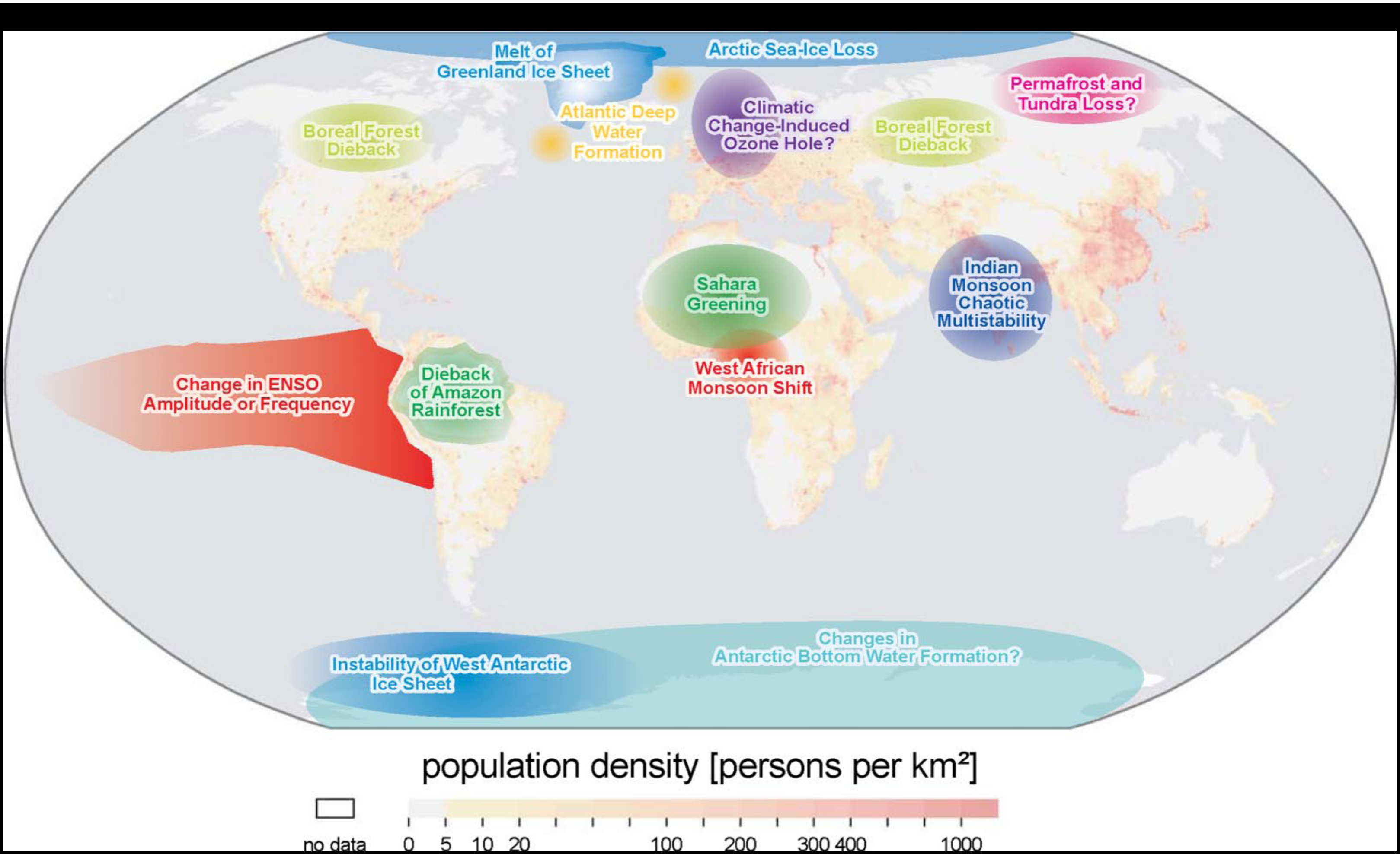
Asymmetry. The climate debate has focused on problems judged most likely (center) or least damaging (left), but the greatest risk may be at the extreme (right).

"Values substantially higher than 4.5° C cannot be excluded".

Smith et al. (2009) up-date of the "Reasons for Concern " assessment, aka "burning embers.



Odd inattention to the small but non-zero risks of very large and/or abrupt climate change and extreme outcomes



Tipping elements in the Earth's climate system

Timothy M. Lenton[*,†], Hermann Held[‡], Elmar Kriegler[‡,§], Jim W. Hall[¶], Wolfgang Lucht[‡], Stefan Rahmstorf[‡], and Hans Joachim Schellnhuber[‡,‖,]**

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Give “due attention” to low

International Climate Conference
28-30 September 2009, Oxford, UK

Implications of a global climate change of 4+ degrees for people, ecosystems and the earth-system

Presentation Downloads

The conference contained 35 oral presentation and 18 poster presentations. All available presentations and audio recordings are below. A selection of the keynote presentations are available to watch in video format via iTunesU. Watch the videos (Please note, you will need iTunes on your computer for this to work).

Oral presentations last approximately 20 minutes.

Download a full programme, including detailed timings.

Download speaker abstracts

Session 1, Conference Opening

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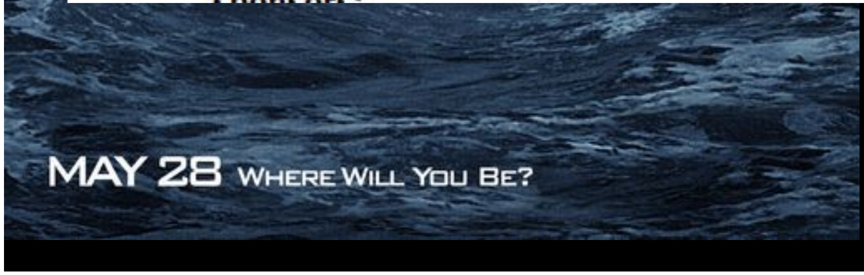


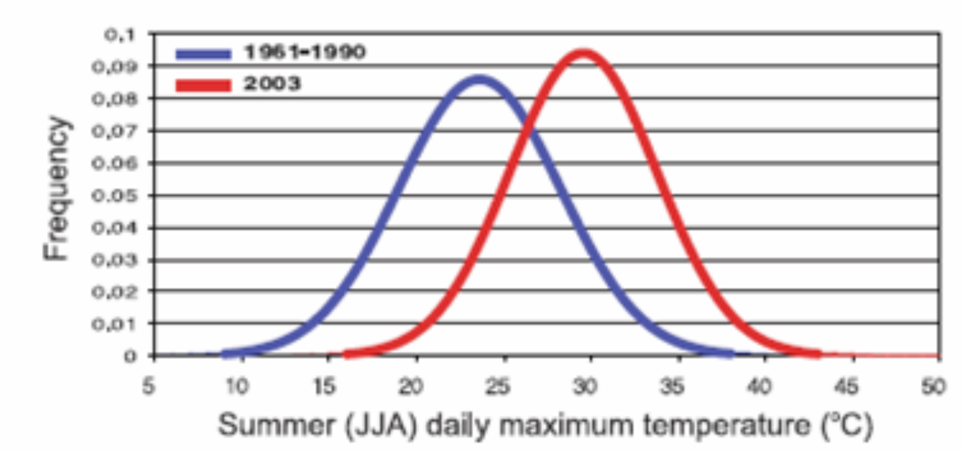
is

sudden and larger changes such as Amazon drying or global temperature increases above 4 degrees for example. Parallel investigations of possible socio-economic discontinuities are almost non-existent.”

SREX

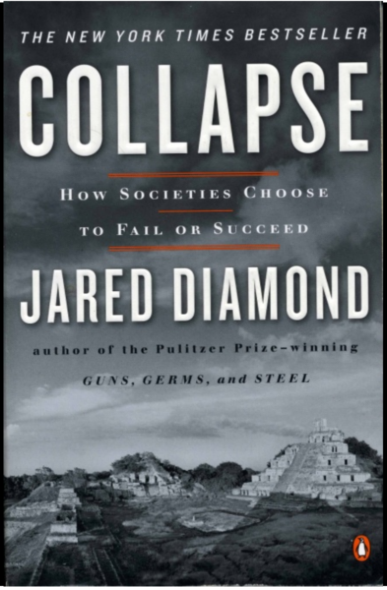
Climate Change Severity Index	Description	Example Climate Phenomena	Social Responses	Additional population at Risk (billions)
ZERO	Means and extremes common to the recent (e.g., 30 year) climate	Current means and extremes	Those arrayed (more or less effectively) to absorb current variability	0
I	Small but statistically significant shifts away from the reference climate	Scientific detection of climate change (signal surpassing noise) not necessarily sufficient to elicit social responses	Little to none as first small changes are absorbed by excess capacity and buffer built into socio-technical systems	0
II	Palpable changes in the frequency - intensity - duration of climate events that begin to surpass informal and formal socio-technical adaptations	Noticeably more frequent, and more intense, climate events: like the 1988 U.S. drought and 2003 Europe heatwave	Adjustments in regulatory and technical systems such as shifted floodplain boundaries; storm surge evacuation zones; levee and dam enlargement, and changes in insurance coverage	.1 to .3
III	Extreme climate episodes rare in the past become typical; emergence of new types of extreme climate events or syndromes	Atlantic hurricane seasons like 2004/05, and the 2003 and 2005 European heat waves, become “typical” events. Frequent continental “mega-droughts” in North America and Asia and “exceptional droughts” in China; sea level rise .2-2 m / century.	Enlarged and novel intervention (e.g., weather modification) and protection schemes (e.g., new, encompassing sea walls; species relocation, and intra-continental water transfers)	.1 to 3
IV	New climate epochs: Large-scale discontinuities and permanent change in regional climates	Ocean circulation break down with significant cooling in N. Europe; intensified aridity in SW North America; sea level rise of 2+ m/century	Geo-engineering attempts to cool the climate and prevent discontinuities, reverse trends like ice sheet melting, or even to restore past conditions	3 to maximum future global population ($\text{GloPop}_{\text{max}}$)
V	Catastrophic climate change	Run-away greenhouse; Permian-like warm epoch	Social and ecological collapse	$\text{GloPop}_{\text{max}}$

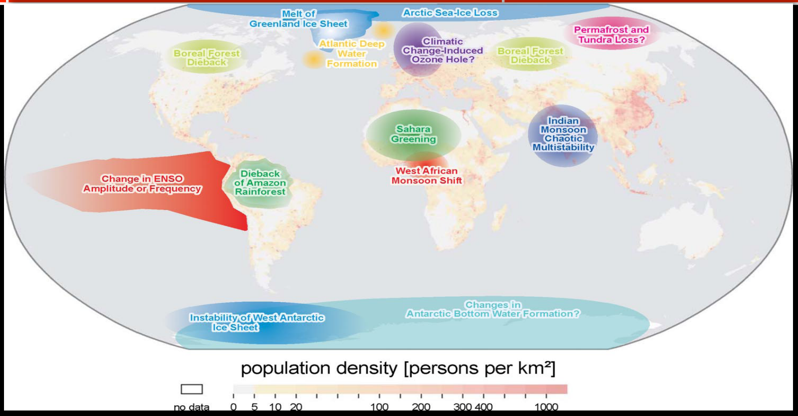
Climate Change Severity Index	Description	Example Climate Phenomena	Social Responses
III	Extreme climate episodes rare in the past become typical; emergence of new types of extreme climate episodes or syndromes	Atlantic hurricane seasons like 2004/05, and the 2003 and 2005 European heat waves, become “typical” events. Frequent continental “mega-droughts” in North America and Asia and “exceptional droughts” in China; sea level rise .2-2 m / century.	Enlarged and novel intervention (e.g., weather modification) and protection schemes (e.g., new, encompassing sea walls; species relocation, and intra-continental water transfers)



2003 European heat wave (Benniston and Diaz, 2004) and the 2005/05 hurricane seasons (Hurricane Wilma SS Cat. 5)

Climate Change Severity Index	Description	Example Climate Phenomena	Social Responses
IV	New climate epochs: Large-scale discontinuities and permanent change in regional climates	THC break down yielding significant cooling in N. Europe, enduring "intensified aridity" in SW North America; sea level rise of 2+ m/century	Geo-engineering attempts to cool the climate and prevent discontinuities, reverse trends like ice sheet melting, or even to restore past conditions
V	Catastrophic climate change	Run-away greenhouse; Permian-like warm epoch	Social and ecological collapse





Tipping elements in the Earth's climate system

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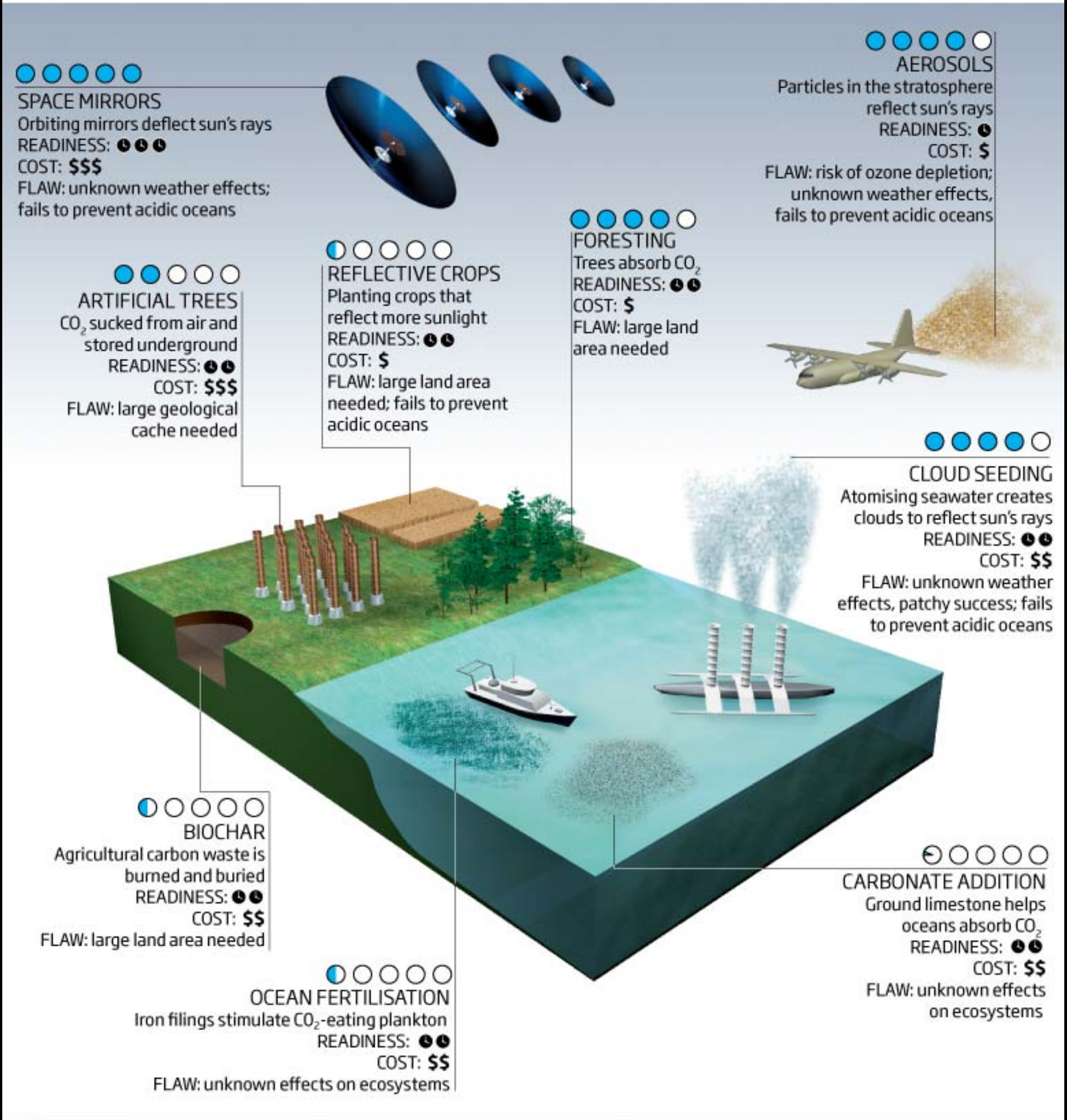
Geoengineering weighed up



●●●●●
SPACE MIRRORS
Orbiting mirrors deflect sun's rays
READINESS: ◷◷◷
COST: **$$$**
FLAW: unknown weather effects; fails to prevent acidic oceans

●●●●○
AEROSOLS
Particles in the stratosphere reflect sun's rays
READINESS: ◷
COST: **$**
FLAW: risk of ozone depletion; unknown weather effects, fails to prevent acidic oceans

●●○○○
ARTIFICIAL TREES
CO_2 sucked from air and stored underground
READINESS: ◷◷
COST: **$$$**
FLAW: large geological cache needed

◐○○○○
REFLECTIVE CROPS
Planting crops that reflect more sunlight
READINESS: ◷◷
COST: **$**
FLAW: large land area needed; fails to prevent acidic oceans

●●●●○
FORESTING
Trees absorb CO_2
READINESS: ◷◷
COST: **$**
FLAW: large land area needed

●●●●○
CLOUD SEEDING
Atomising seawater creates clouds to reflect sun's rays
READINESS: ◷◷
COST: **$$**
FLAW: unknown weather effects, patchy success; fails to prevent acidic oceans

◐○○○○
BIOCHAR
Agricultural carbon waste is burned and buried
READINESS: ◷◷
COST: **$$**
FLAW: large land area needed

◔○○○○
CARBONATE ADDITION
Ground limestone helps oceans absorb CO_2
READINESS: ◷◷
COST: **$$**
FLAW: unknown effects on ecosystems

◐○○○○
OCEAN FERTILISATION
Iron filings stimulate CO_2-eating plankton
READINESS: ◷◷
COST: **$$**
FLAW: unknown effects on ecosystems

● **Cooling factor:** potential to change Earth's energy budget

Readiness:
◷ - Within years
◷◷ - Within decades
◷◷◷ - Within centuries

Cost:
$ - Cheap relative to cutting emissions
$$ - Significant compared to cost of cutting emissions
$$$ - Cutting emissions might be cheaper

Catch 22’s

- Chap. 3 stresses the uncertainties about future climate change, and the SPM offers only the most general prescriptions in keeping with this uncertainty….. yet the body of the report delves into quite specific adaptations some of which might not pay off if the climate changes as suggested in the extensive review (e.g., TCs shifting poleward)---what is the message?

- If “low regrets” adaptations are truly low regret (e.g., useful even if the climate does not change significantly), why haven’t they been implemented, <u>and what aspect of climate change, or this report, would make them more likely</u>?

Thanks!