Work and Process of IPCC Sixth Assessment Cycle and Special Report on 1.5 °C (SR15)

Abdalah Mokssit, Secretary/IPCC

Benguerir, Morocco

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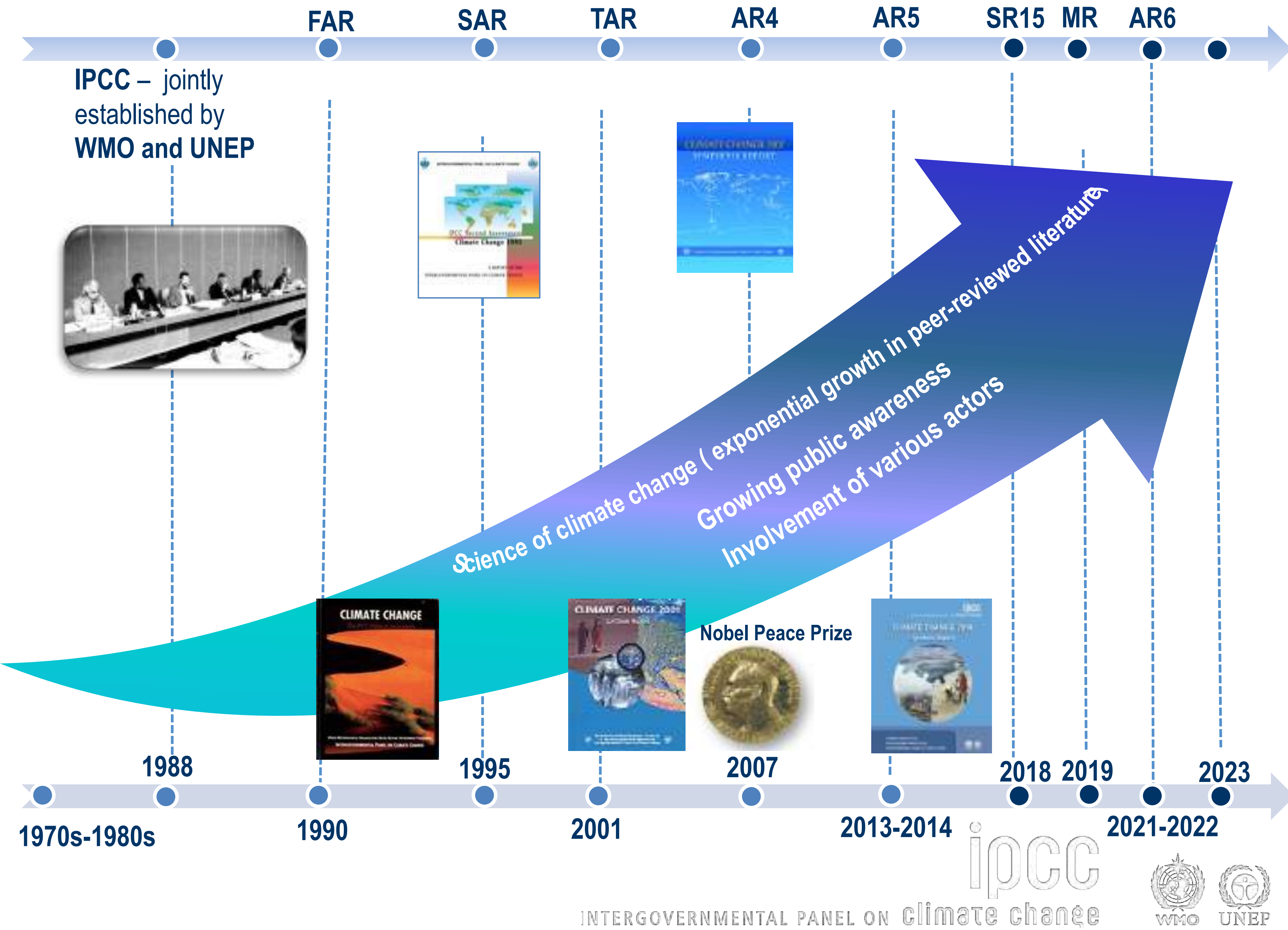
FAR
SAR
TAR
AR4
AR5
SR15
MR
AR6
IPCC – jointly established by WMO and UNEP
Science of climate change (exponential growth in peer-reviewed literature
Growing public awareness
Involvement of various actors
CLIMATE CHANGE
Nobel Peace Prize
1988
1995
2007
2018
2019
2023
1970s-1980s
1990
2001
2013-2014
2021-2022
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WMO
UNEP

The role of the IPCC is …

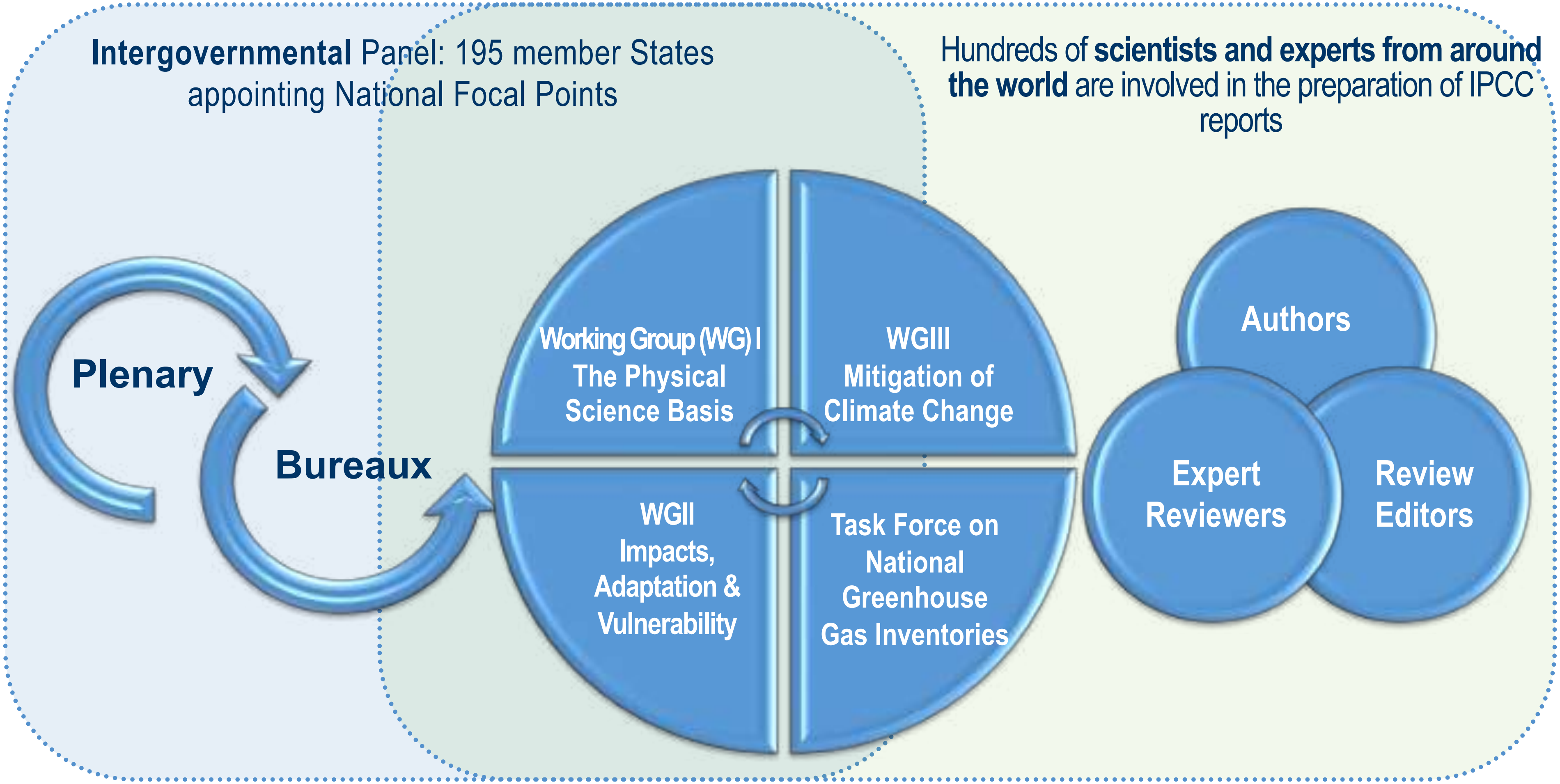
"… to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation."

"IPCC reports should be neutral with respect to policy, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies."

Principles Governing IPCC Work, paragraph 2
Source: http://www.ipcc.ch/pdf/ipcc-principles/ipcc-principles.pdf

Science/Policy Interface

IPCC – jointly established by **WMO and UNEP**, action endorsed by the **UN General Assembly**



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Sixth Assessment Cycle (AR6)

3 Special Reports

Global Warming of 1.5 °C (SR15)

Climate Change and Land (SRCCL)
August 2019 - Morocco

Ocean and Cryosphere (SROCC)
September 2019 - Monaco

UNFCCC COP24 - Talanoa (facilitative) dialogue

Methodology Report update

May 2019: 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Cities

Attention on cities in AR6 including a conference and special report on cities in AR7

AR6 Main Report

2021: Working Group I, II, and III contribution to the Sixth Assessment Report
April 2022: Synthesis Report to the Sixth Assessment Report

UNFCCC global stocktake 2023

IPCC Sixth Assessment (AR6)

Some overarching preliminary aspects for the Synthesis Report

- *Global Stocktake*
- *Interaction among emissions, climate, risks and development pathways*
- *Economic and social costs and benefits of mitigation and adaptation in the context of development pathways*
- *Adaptation and mitigation actions in the context of sustainable development*
- *Finance and means of support*

Oct. 2018 — Global warming of 1.5 °C

Talanoa dialogue UNFCCC

May 2019 — Emission inventories

Sept. 2019 — Oceans and cryosphere

Aug. 2019 — Land

April 2021 — The Physical Science Basis

July 2021 — Mitigation of Climate Change

October 2021 — Climate Change Impacts, Adaptation and Vulnerability

April 2022 — The Synthesis Report

Global stocktake 2023 UNFCCC

March 2018 — Cities and Climate Change Science Conference

May 2018 — Expert Meeting on Assessing Climate Information for Regions

May 2018 — Expert Meeting on Short Lived Climate Forcers

**** Dates are subject to change***

How IPCC Reports are Produced

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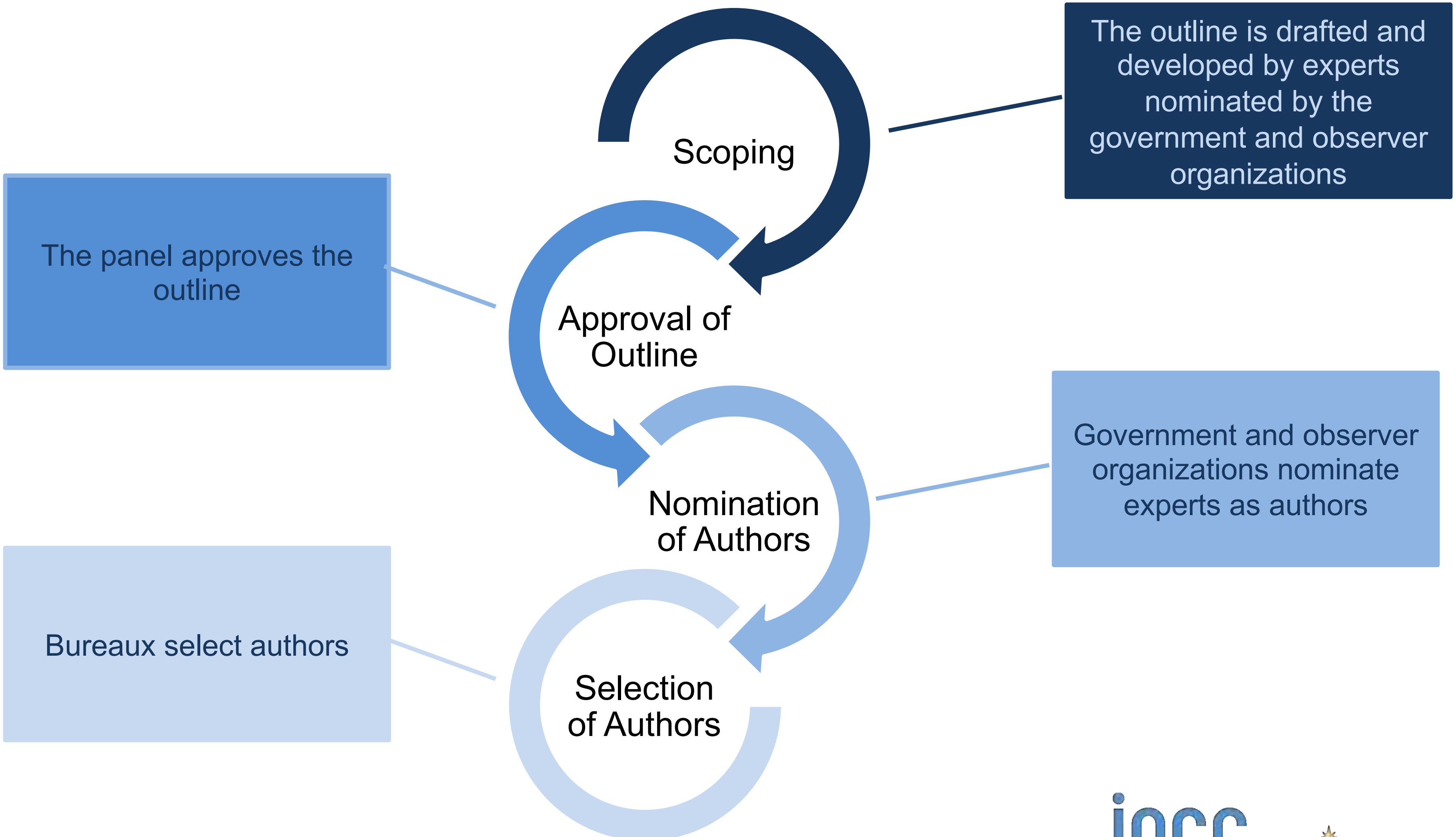
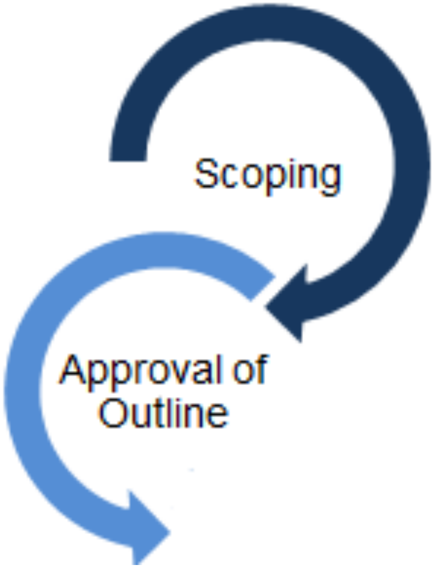
Preparatory Phase



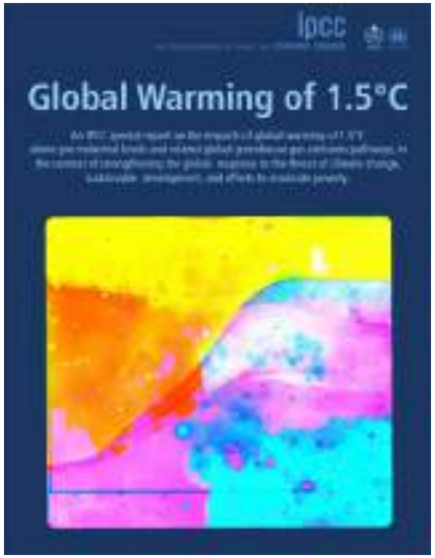
Outline for SR15



Chapter 1: Framing and context

Chapter 2: Mitigation pathways compatible with 1.5°C in the context of sustainable development

Chapter 3: Impacts of 1.5°C global warming on natural and human systems



Chapter 4: Strengthening and implementing the global response to the threat of climate change

Chapter 5: Sustainable development, poverty eradication and reducing inequalities

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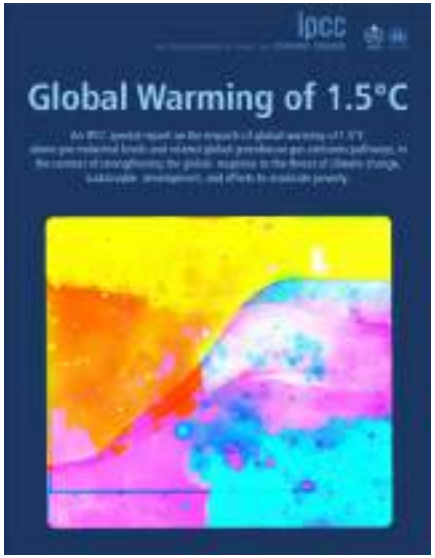
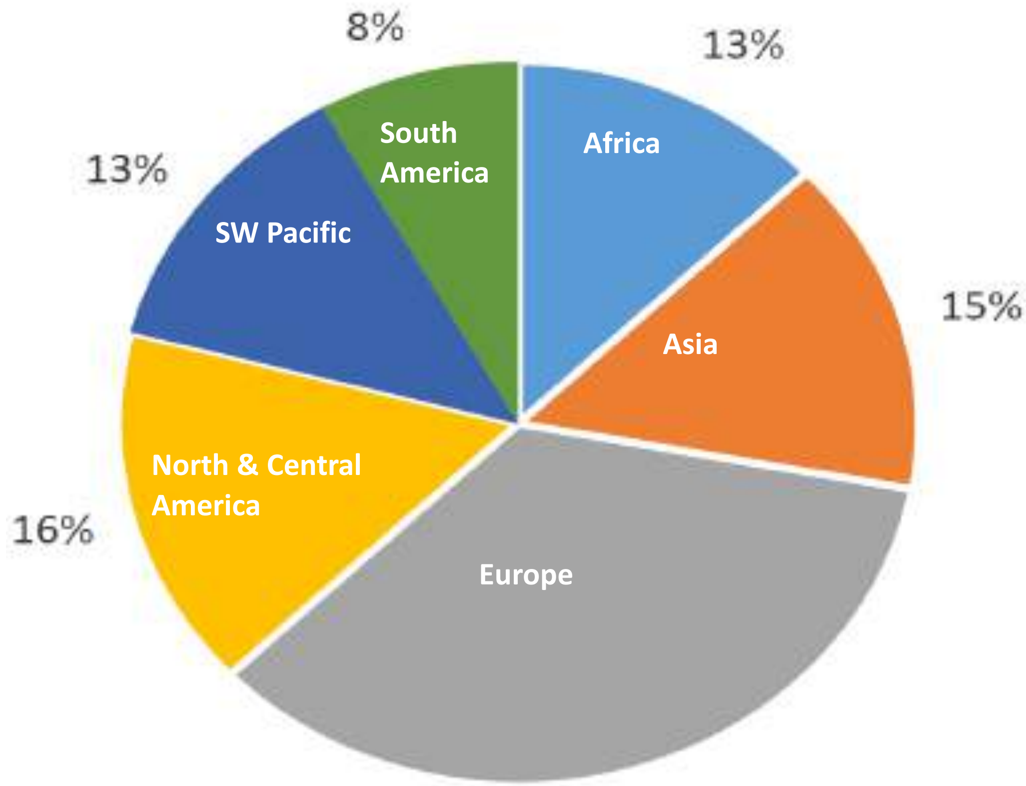
Report in Numbers

560 nominations, 91 authors from 44 countries

38% women, 51% from developing countries and EIT





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Drafts

The 1st order draft is reviewed by experts (anyone can register)

The 2nd draft of the report and 1st draft of the SPM is reviewed by governments and experts

Authors prepare final drafts of the report and SPM which hare sent to governments

Governments review the final draft SPM in preparation for its approval

Review Process

First Order Draft

Expert Review:
12 895 comments
489 experts
61 countries

Second Order Draft

Governement and Expert Review

25 590 comments

570 experts

71 countries

Final Government Draft

Governement Review

3630

Total Comments: 42001

Final Report
Summary for Policy Makers

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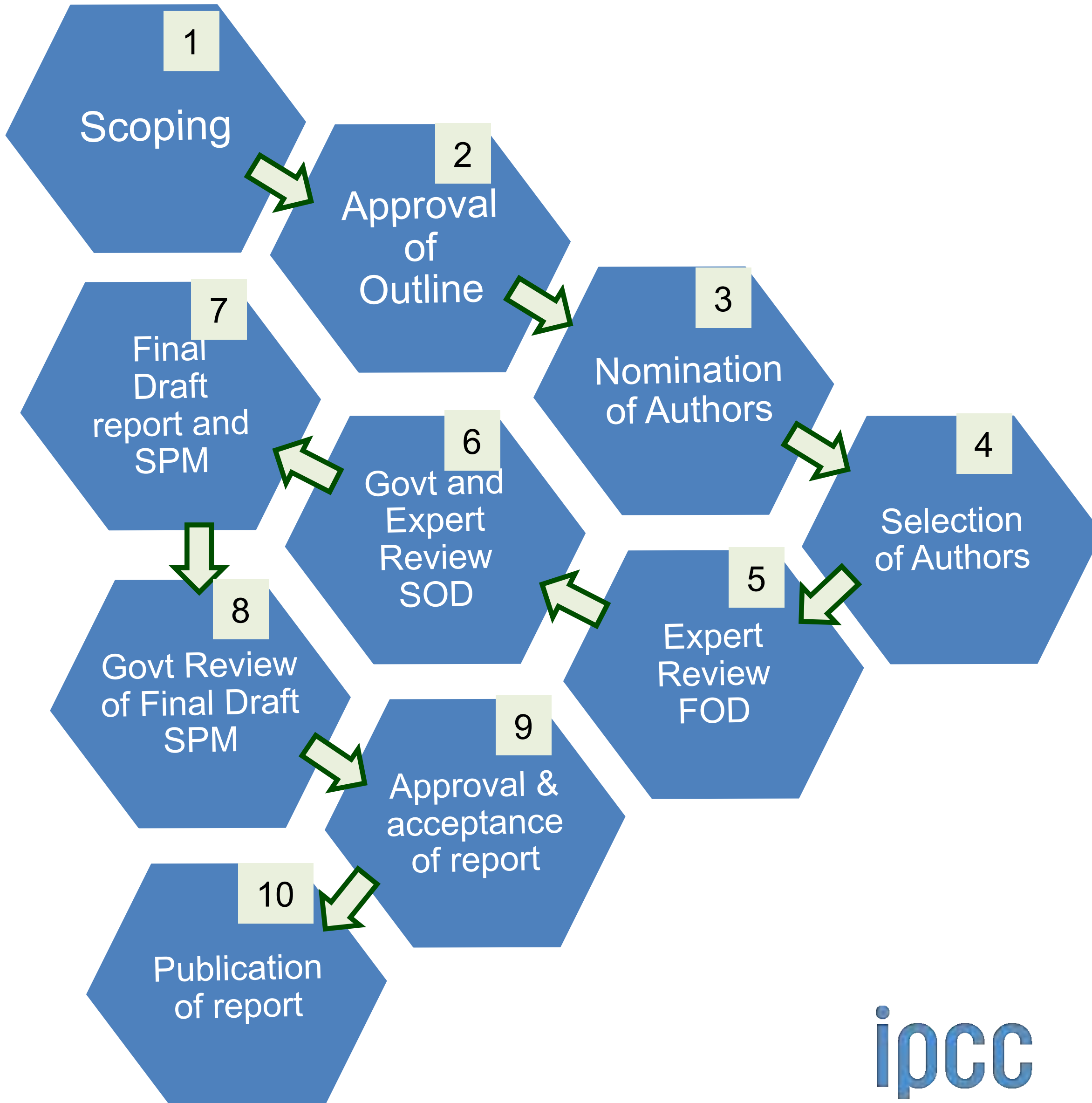
10 Steps in creating IPCC reports



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Special Report on Global Warming 1.5 °C

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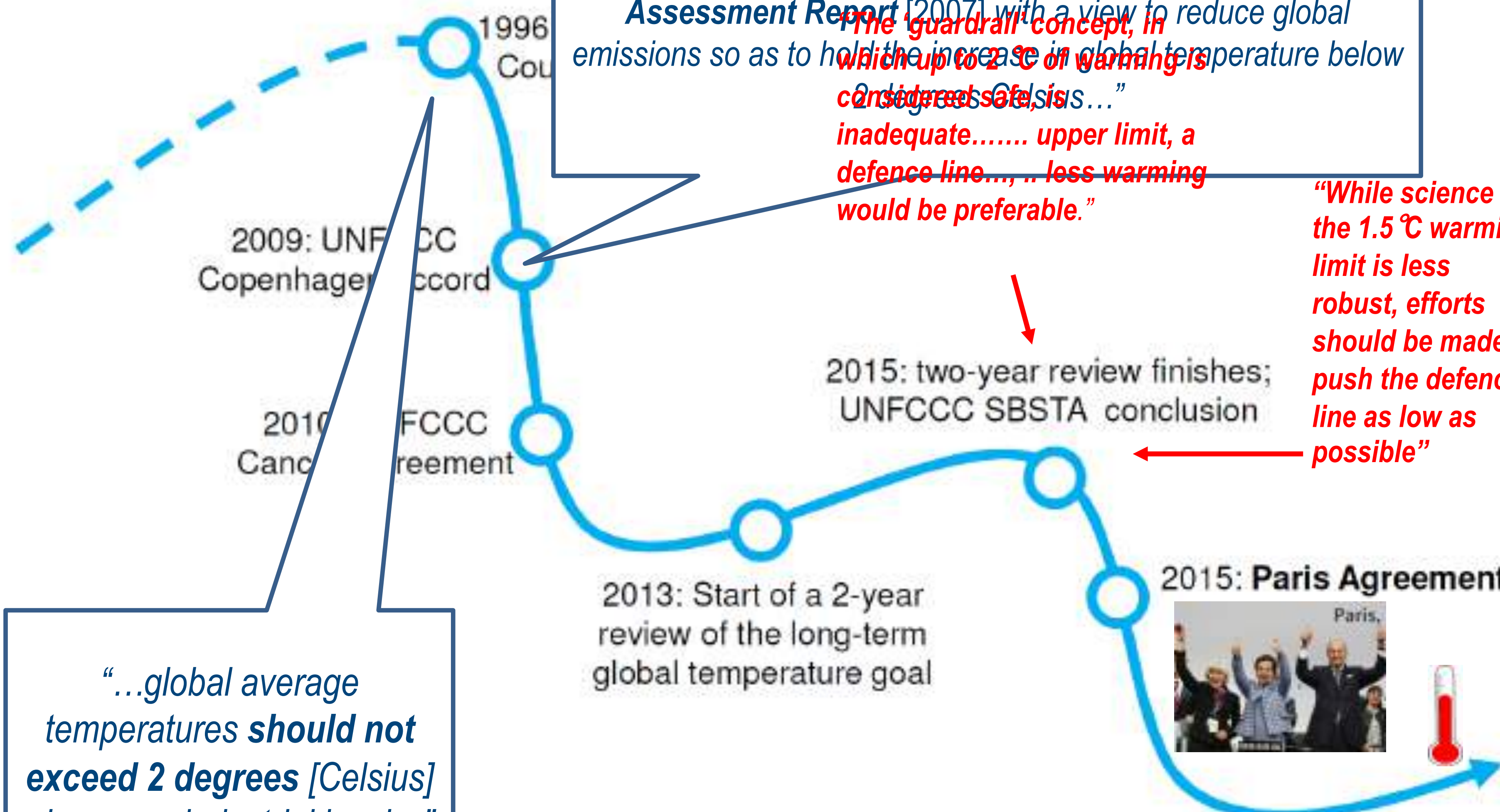
Glimpses from the Plenary

The long-term temperature goal:

"…we agree that deep cuts in global emissions are required according to science, and as documented by the ***IPCC Fourth Assessment Report*** *[2007] with a view to reduce global emissions so as to hold the increase in global temperature below 2 degrees Celsius…"*

"The 'guardrail' concept, in which up to 2 °C of warming is considered safe, is inadequate……. upper limit, a defence line…, .. less warming would be preferable."

"While science on the 1.5 ℃ warming limit is less robust, efforts should be made to push the defence line as low as possible"



"…global average temperatures ***should not exceed 2 degrees*** *[Celsius] above pre-industrial level…"*

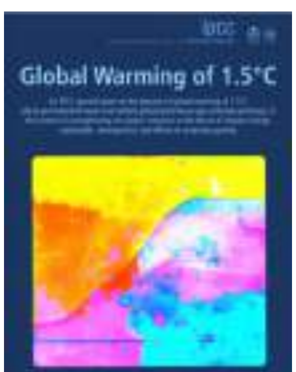
PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

Invites the Intergovernmental Panel on Climate Change to provide a special report in 2018 on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways;

SR5 - Key Messages - Summary

1. Climate change is already affecting people, ecosystems and livelihoods all around the world
2. Limiting warming to 1.5C is not impossible but would require unprecedented transitions in all aspects of society.
3. There are clear benefits to keeping warming to 1.5C compared to 2C, or higher. Every bit of warming matters.
4. Limiting warming to 1.5C can go hand-in-hand with achieving other world goals.



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The main findings of the IPCC SR 1.5

Fatima Driouech, UM6P
IPCC WGI Vice Chair

Ashley Cooper / Aurora Photos

Where are we now?

Since pre-industrial times, human activities have caused approximately 1.0°C of global warming.

- Already seeing consequences for people, nature and livelihoods
- At current rate, would reach 1.5°C between 2030 and 2052
- Past emissions alone do not commit the world to 1.5°C

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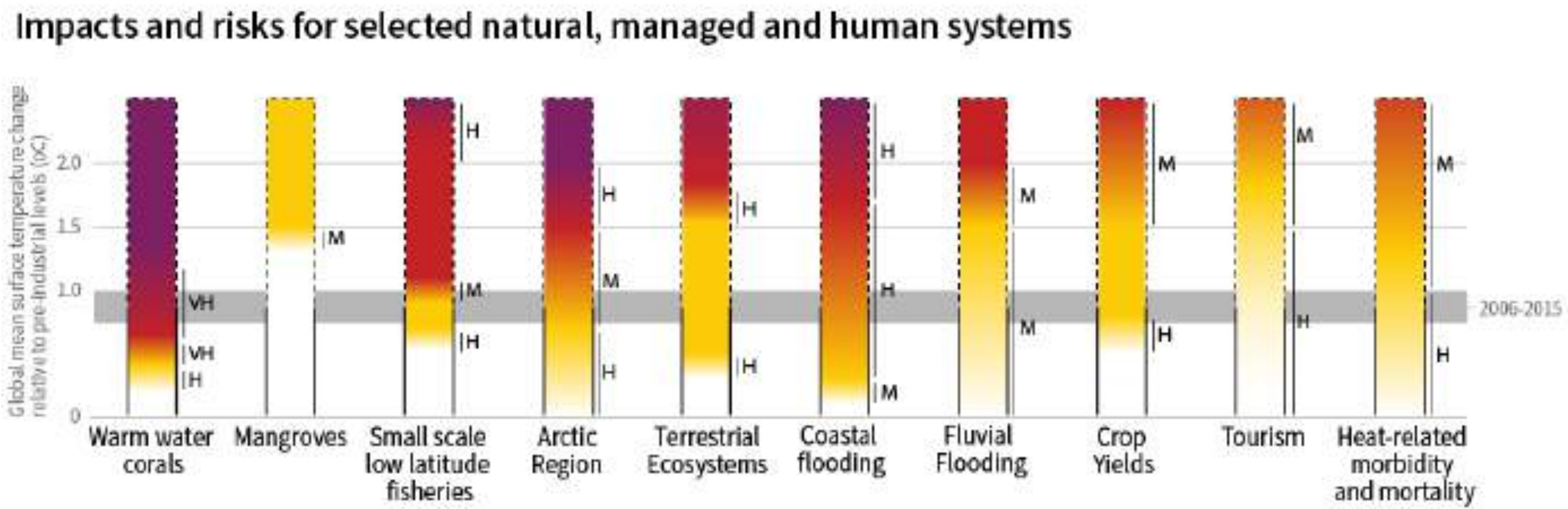
How the level of global warming affects impacts and/or risks associated with selected natural, managed and human systems



Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high

Impacts of global warming 1.5°C

At 1.5°C compared to 2°C:

- Less extreme weather where people live, including extreme heat and rainfall
- By 2100, global mean sea level rise will be around 10 cm lower but may continue to rise for centuries
- 10 million fewer people exposed to risk of rising seas

Impacts of global warming 1.5°C

At 1.5°C compared to 2°C:

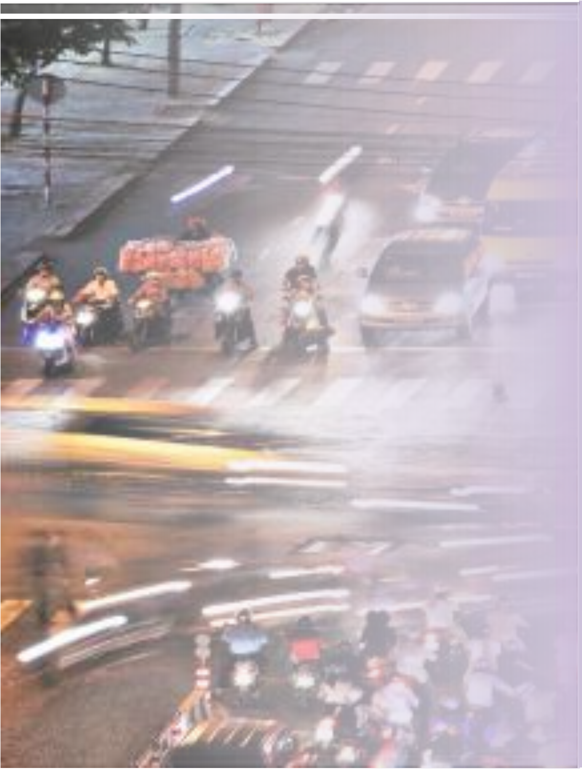
- Lower impact on biodiversity and species
- Smaller reductions in yields of maize, rice, wheat
- Global population exposed to increased water shortages is up to 50% less

Impacts of global warming 1.5°C

At 1.5°C compared to 2°C:

- Lower risk to fisheries and the livelihoods that depend on them

- Up to several hundred million fewer people exposed to climate-related risk and susceptible to poverty by 2050

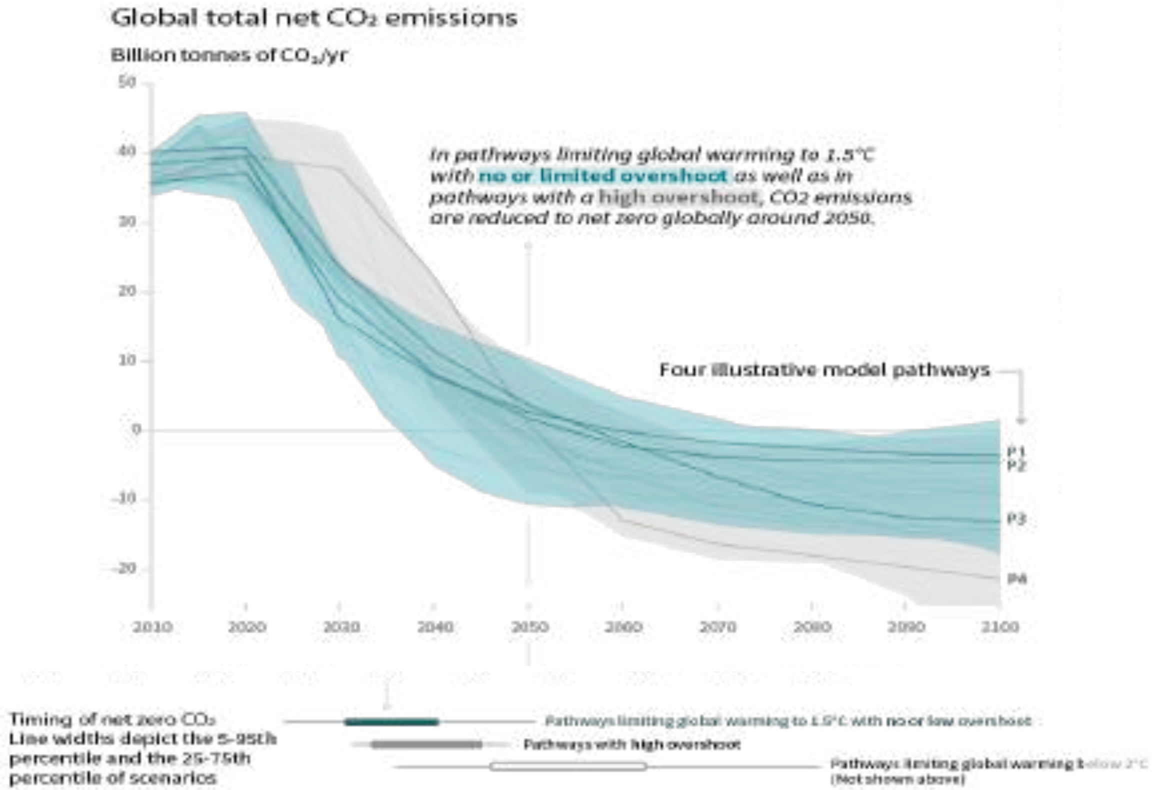


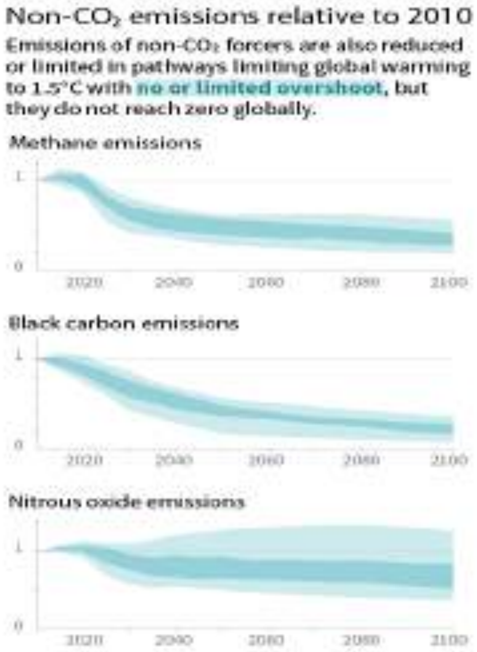
Gerhard Zwerger-Schoner / Aurora Photos

Greenhouse gas emissions pathways

- To limit warming to 1.5°C, CO_2 emissions fall by about 45% by 2030 (from 2010 levels)
  - → Compared to 20% for 2°C
- To limit warming to 1.5°C, CO_2 emissions would need to reach ‘net zero’ around 2050
  - → Compared to around 2075 for 2°C
- Reducing non-CO_2 emissions would have direct and immediate health benefits

Global emissions pathway characteristics





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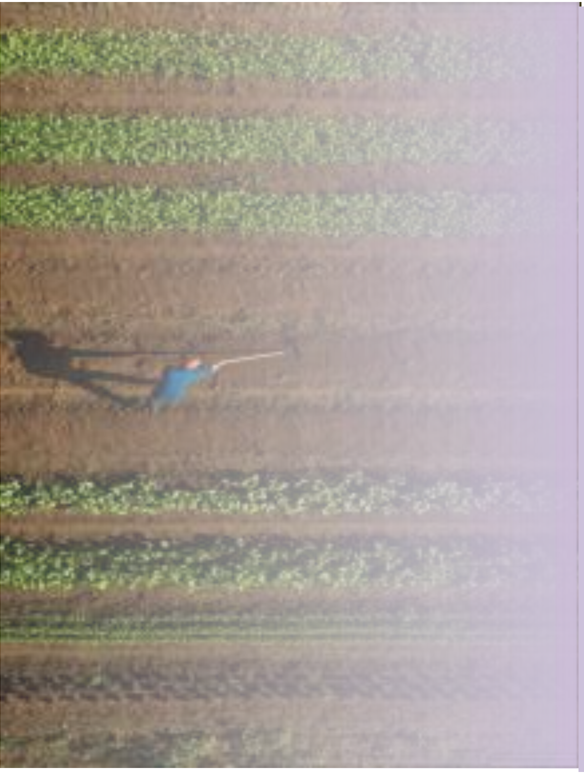
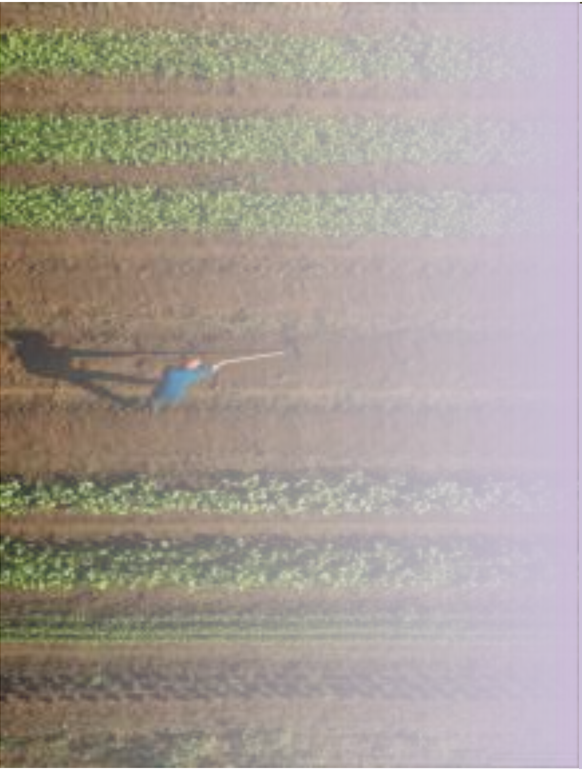
Greenhouse gas emissions pathways



Peter Essick / Aurora Photos

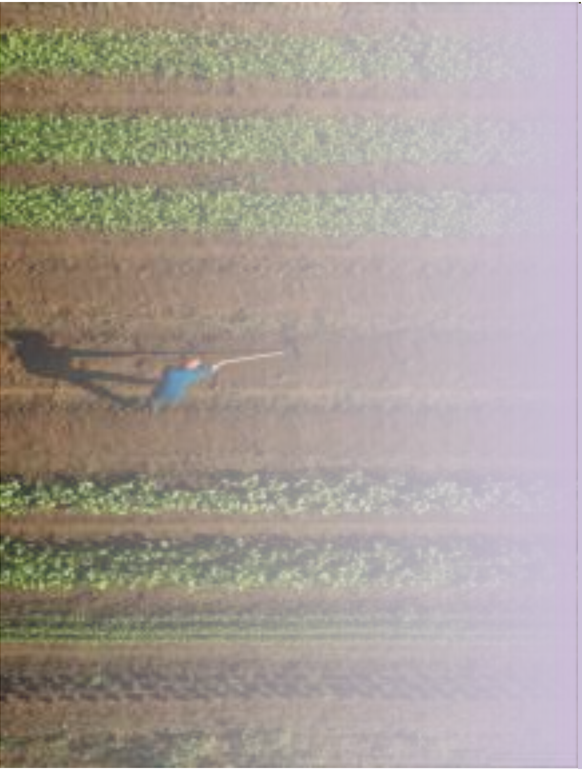
- Limiting warming to 1.5°C would require changes on an unprecedented scale
  - → Deep emissions cuts in all sectors
  - → A range of technologies
  - → Behavioural changes
  - → Increased investment in low carbon options



Peter Essick / Aurora Photos

Greenhouse gas emissions pathways

- Progress in renewables would need to be mirrored in other sectors
- We would need to start taking carbon dioxide out of the atmosphere
- Implications for food security, ecosystems and biodiversity



Peter Essick / Aurora Photos

Greenhouse gas emissions pathways

- National pledges are not enough to limit warming to 1.5°C
- Avoiding warming of more than 1.5°C would require CO_2 emissions to decline substantially before 2030

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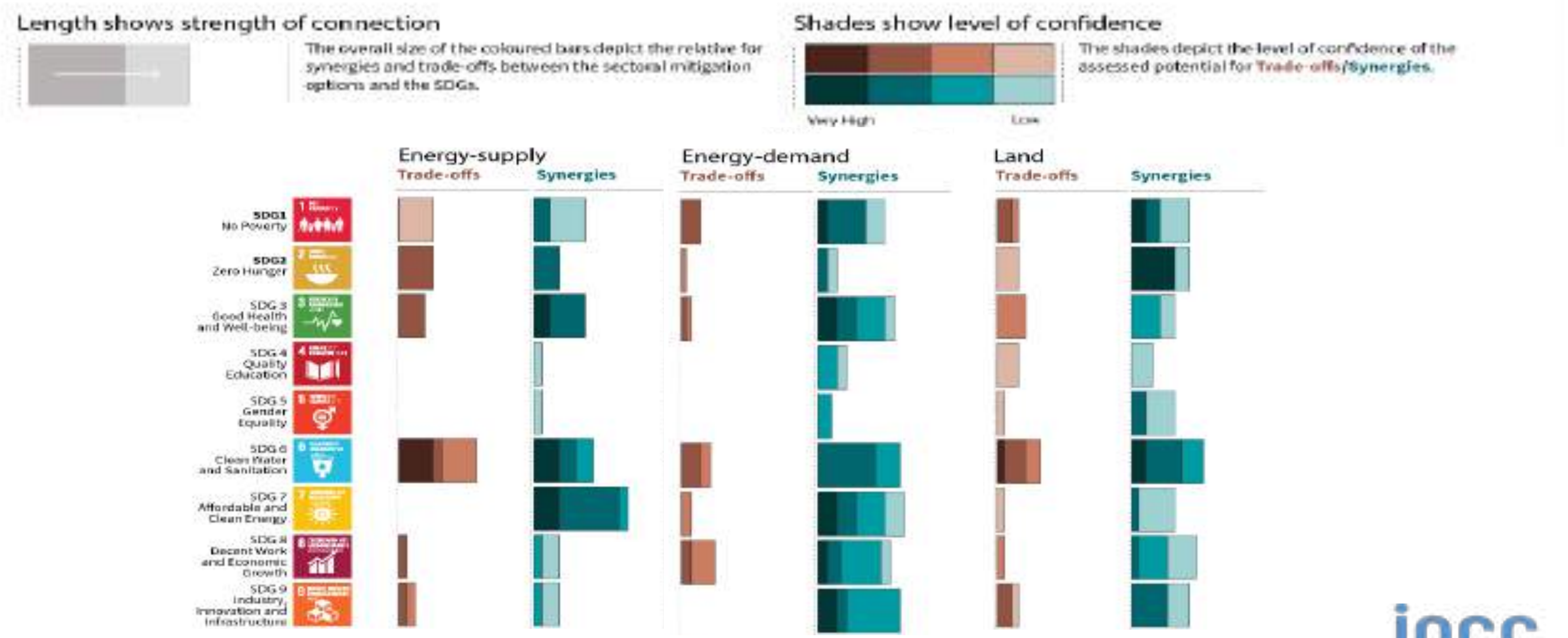
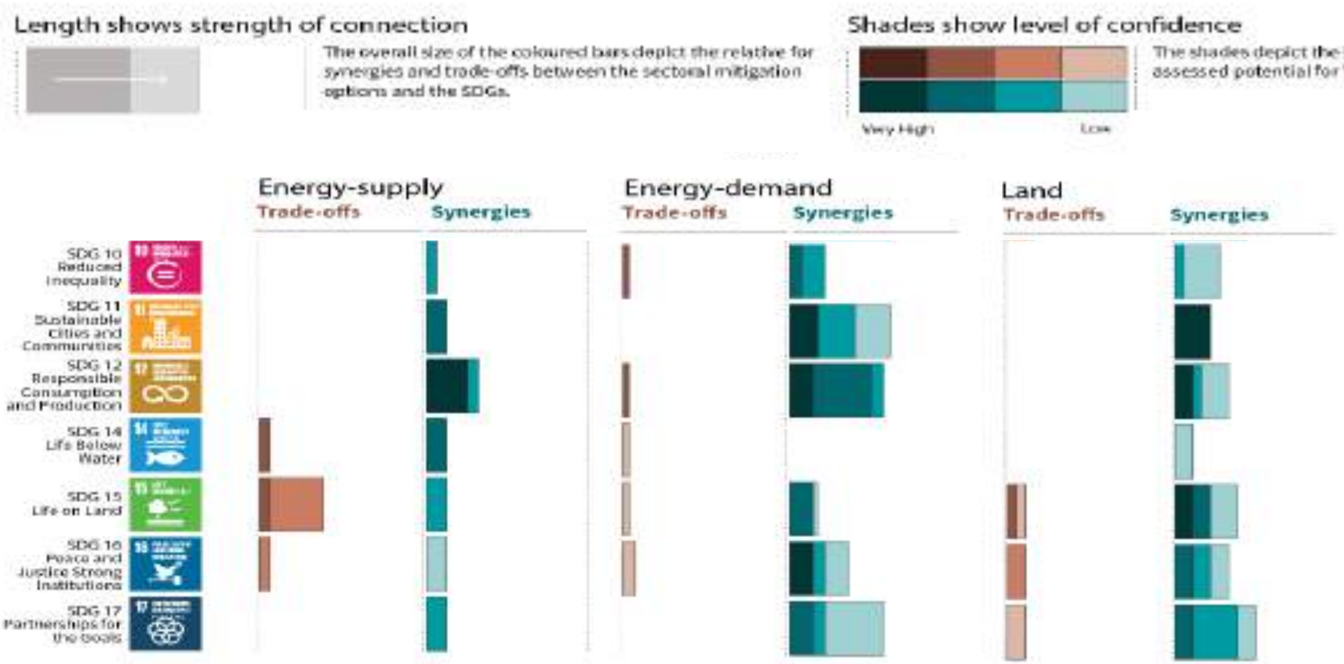
Indicative linkages between mitigation and sustainable development using SDGs (the linkages do not show costs and benefit)



Indicative linkages between mitigation and sustainable development using SDGs (the linkages do not show costs and benefit)



Strengthening the Global Response in the Context of Sustainable Development and Efforts to Eradicate Poverty

Climate change and people

- Close links to United Nations Sustainable Development Goals (SDGs)
- Mix of measures to adapt to climate change and reduce emissions can have benefits for SDGs
- National and sub-national authorities, civil society, the private sector, indigenous peoples and local communities can support ambitious action
- International cooperation is a critical part of limiting warming to 1.5°C

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Adaptation is always needed

Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C.

These risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and **implementation of adaptation and mitigation options**

Adaptation is always needed

A wide range of adaptation options are available to reduce the risks to natural and managed ecosystems and the risks to health, livelihoods, food, water, and economic growth, especially in rural landscapes and urban areas.

Feasibility assessment of examples of 1.5°C-relevant adaptation options

System	Adaptation option	Evidence	Agreement	Ec	Tec	Inst	Soc	Env	Geo	Context
Energy system transitions	Power infrastructure, including water	Medium	High							Depends on existing power infrastructure, all generation sources and with intensive water requirements
Land & ecosystem transitions	Conservation agriculture	Medium	Medium							Depends on irrigated/rainfed system, ecosystem characteristics, crop type, other farming practices
	Efficient irrigation	Medium	Medium							Depends on agricultural system, technology used, regional institutional and biophysical context
	Efficient livestock	Limited	High							Dependent on livestock breeds, feed practices,and biophysical context (e.g. carrying capacity)
	Agroforestry	Medium	High							Depends on knowledge, financial support, and market conditions
	Community-based adaptation	Medium	High							Focus on rural areas and combined with ecosystems-based adaptation, does not include urban settings
	Ecosystem restoration & avoided deforestation	Robust	Medium							Mostly focused on existing and evaluated REDD+ projects
	Biodiversity management	Medium	Medium							Focus on hotspots of biodiversity vulnerability and high connectivity
	Coastal defense & hardening	Robust	Medium							Depends on locations that require it as a first adaptation option
	Sustainable aquaculture	Limited	Medium							Depends on locations at risk and socio-cultural context
Urban & infrastructure system transitions	Sustainable land-use & urban planning	Medium	Medium							Depends on nature of planning systems and enforcement mechanisms
	Sustainable water management	Robust	Medium							Balancing sustainable water supply and rising demand especially in low-income countries
	Green infrastructure & ecosystem services	Medium	High							Depends on reconciliation of urban development with green infrastructure

Feasibility assessment of examples of 1.5°C-relevant adaptation options

	Building codes & standards	Limited	Medium							Adoption requires legal, educational, and enforcement mechanisms to regulate buildings
Industrial system transitions	Intensive industry infrastructure resilience and water management	Limited	High							Depends on intensive industry, existing infrastructure and using or requiring high demand of water
Overarching adaptation options	Disaster risk management	Medium	High							Requires institutional, technical, and financial capacity in frontline agencies and government
	Risk spreading and sharing	Medium	Medium							Requires well developed financial structures and public understanding
	Climate services	Medium	High							Depends on climate information availability and usability, local infrastructure and institutions, national priorities
	Indigenous knowledge	Medium	High							Dependent on recognition of Indigenous rights, laws, and governance systems
	Education and learning	Medium	High							Existing education system, funding
	Population health and health system	Medium	High							Requires basic health services and infrastructure
	Social safety nets	Medium	Medium							Type and mechanism of safety net, political priorities, institutional transparency
	Human migration	Medium	Low							Hazard exposure, political and socio-cultural acceptability (in destination), migrant skills and social networks

Limits to adaptive capacity exist at 1.5°C of global warming, become more pronounced at higher levels of warming and vary by sector, with site-specific implications for vulnerable regions, ecosystems, and human health

→ **Efficient Adaptation is always needed**

International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

science for global insight

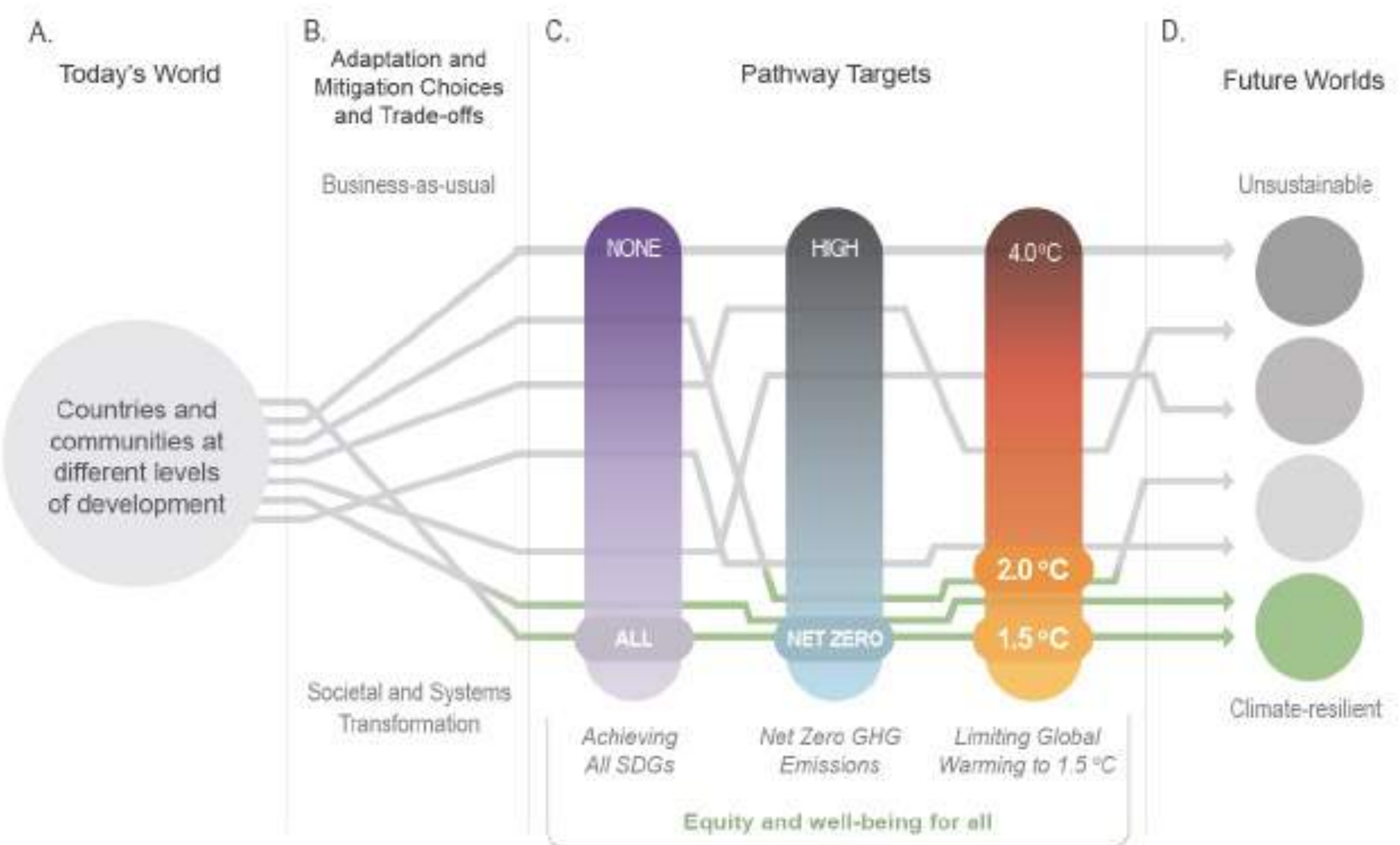
Adaptation in the context of the IPCC SR15.
Water and Agriculture

Reinhard Mechler

October 26, 2018

International Conference on
Adaptation Metrics for Agriculture, Water and Resilient Cities
Mohammed VI University, Benguerir, Morocco

Climate-resilient development pathways (CRDP)



Roy et al. 2018
(IPCC SR15, Ch. 5)

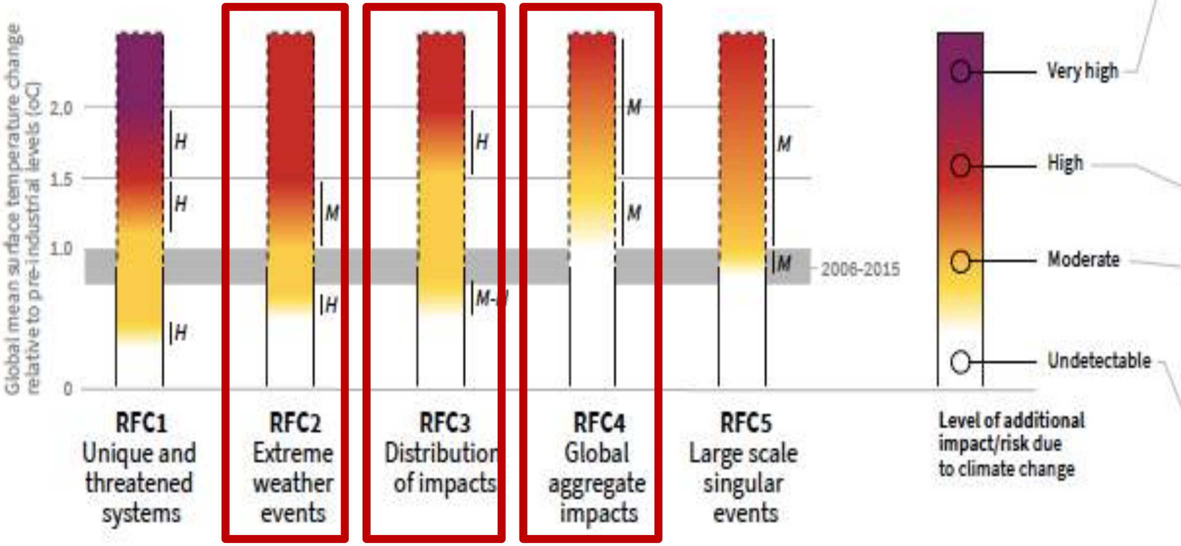
Mitigation and risks at 1°C - 1.5°C - 2 C°

- **SPM Statement C2.** Pathways limiting global warming to 1.5°C require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (*high confidence*)…. **systems transitions are unprecedented in terms of scale, but not necessarily in terms of speed, and imply deep emissions reductions** in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options (*medium confidence*).
- **A3.** Climate-related risks for natural and human systems **are higher for global warming of 1.5°C than at present, but lower than at 2°C** (*high confidence*).
- **B5.1**. Populations at disproportionately higher risk of adverse consequences of global warming of 1.5°C and beyond include **disadvantaged and vulnerable populations, some indigenous peoples, and local communities** dependent on agricultural or coastal livelihoods (*high confidence*).

Risks in the IPCC SR15
The Reasons for Concern

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

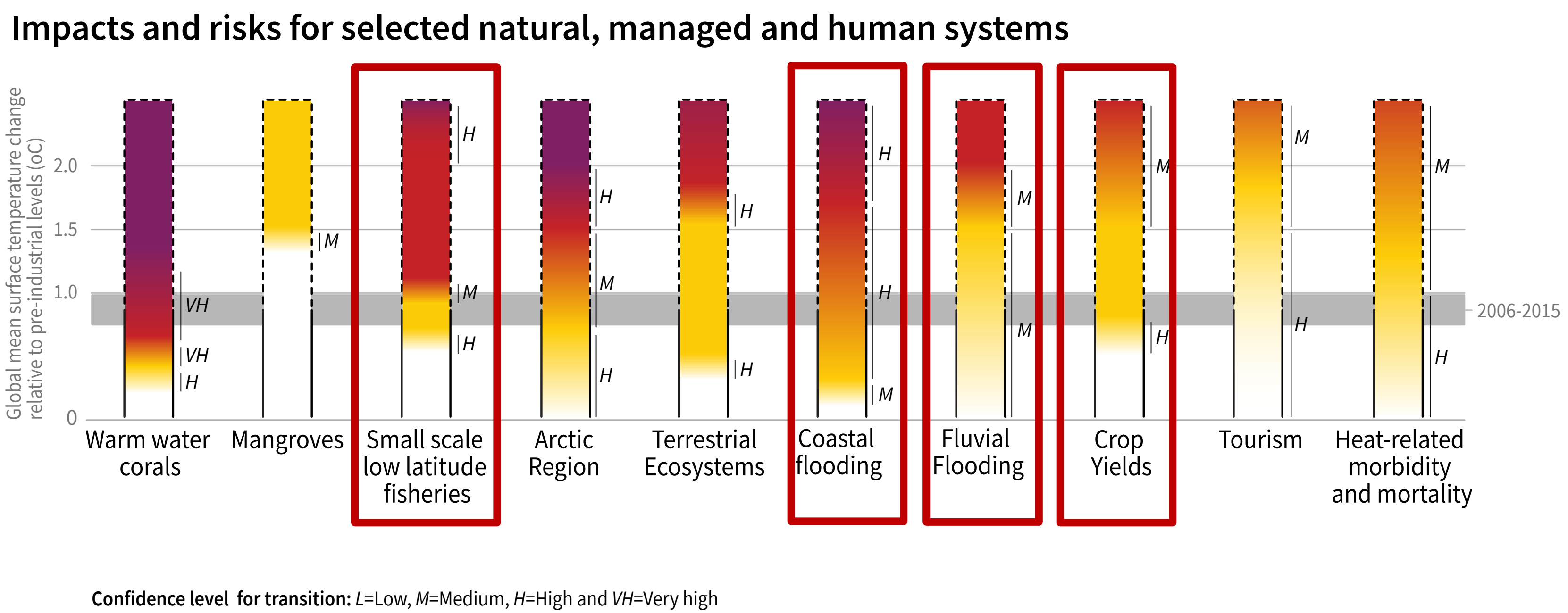
Impacts and risks associated with the Reasons for Concern (RFCs)



Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.
Red indicates severe and widespread impacts/risks.
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.
White indicates that no impacts are detectable and attributable to climate change.

SPM IPCC SR15

Risks in the IPCC SR15
The Reasons for Concern



Source: IPCC Special Report on Global Warming of 1.5°C

SPM IPCC SR15

Agriculture (food production and security) in a 1.5°C world vs. 2°C

- **B5.3.** …**smaller net reductions in yields of maize, rice, wheat, and potentially other cereal crops**, particularly in sub- Saharan Africa, Southeast Asia, and Central and South America; and in the CO^2 dependent, **nutritional quality of rice and wheat** (*high confidence*).
- **Reductions in projected food availability** are larger at 2ºC than at 1.5°C of global warming in the Sahel, southern Africa, the Mediterranean, central Europe, and the Amazon (*medium confidence*).
- **Livestock** projected to be **adversely affected** with rising temperatures, depending on the extent of changes in feed quality, spread of diseases, and water resource availability (high *confidence*).

Water in a 1.5°C world

- **B5.4.** Limiting global warming to 1.5°C, compared to 2°C, to reduce proportion of the world population exposed to a climate-change induced increase in **water stress by up to 50%,** with considerable variability between regions (*medium confidence*).

- For global warming from 1.5°C to 2°C, **risks across energy, food, and water sectors could overlap spatially and temporally**, creating **new and exacerbating current hazards, exposures, and vulnerabilities** that could affect increasing numbers of people and regions (*medium confidence*).

Risk, Adaptation, Limits, SDGs

System (RFC)	Regions	1.5°C	2°C	Adaptation	Adaptation-potential	SDG
Agriculture and Food security (2,4)	**Global, Africa, Asia**	**32-36 million people affected by reduced yields**	**330-396 million people with reduced yields**	**Climate resistant varieties, irrigation**	**Medium, higher in high latitudes than in low latitudes**	
Water resources (3)	**Global, Africa, Mediterra-nean**	**496 million people waterstressed**	**590 million people waterstressed**	**Rationing Wells Rainwater tanks**	**Low**	
Coral reefs (1)	Tropics	70-90% at risk of loss	99% at risk of loss	-	Very limited	
Coastal settlements (2,3)	Global, Asia, SIDS	31-69 million people at risk	32-79 million people at risk	Coastal , Mangrove	Low-medium. Some atolls may become uninhabitable at 1.5°C/2°C	
Health (2,3,4)	Global,part. tropics	+ 350 million people exposed to deadly heatwaves in megacities by 2050		Hydration, cooling zones, green roofs	Medium, low in tropics	

Building on IPCC SR15 2018 (ch.3,4, 5)

Risks at 1.5° C vs. 2 C°

B6. Most adaptation needs lower for global warming of 1.5°C compared to 2°C (*high confidence*). There are a wide range of adaptation options that can reduce the risks of climate change (high confidence).

- There are **limits to adaptation and adaptive capacity** for some human and natural systems at global warming of 1.5°C, with associated losses (*medium confidence*).
  - become more pronounced at higher levels of warming and vary by sector, with site-specific implications for vulnerable regions, ecosystems, and human health (*medium confidence*).

- A3. Future climate-related risks would be reduced by upscaling and acceleration of far-reaching, multi-level and cross-sectoral climate mitigation and by both **incremental and transformational adaptation** (*high confidence*).

Adaptation agriculture

- **Changing agricultural practices effective**: a diversity of options exists, including mixed crop-livestock production systems …a cost-effective adaptation strategy in many global agriculture systems (*robust evidence, medium agreement*).

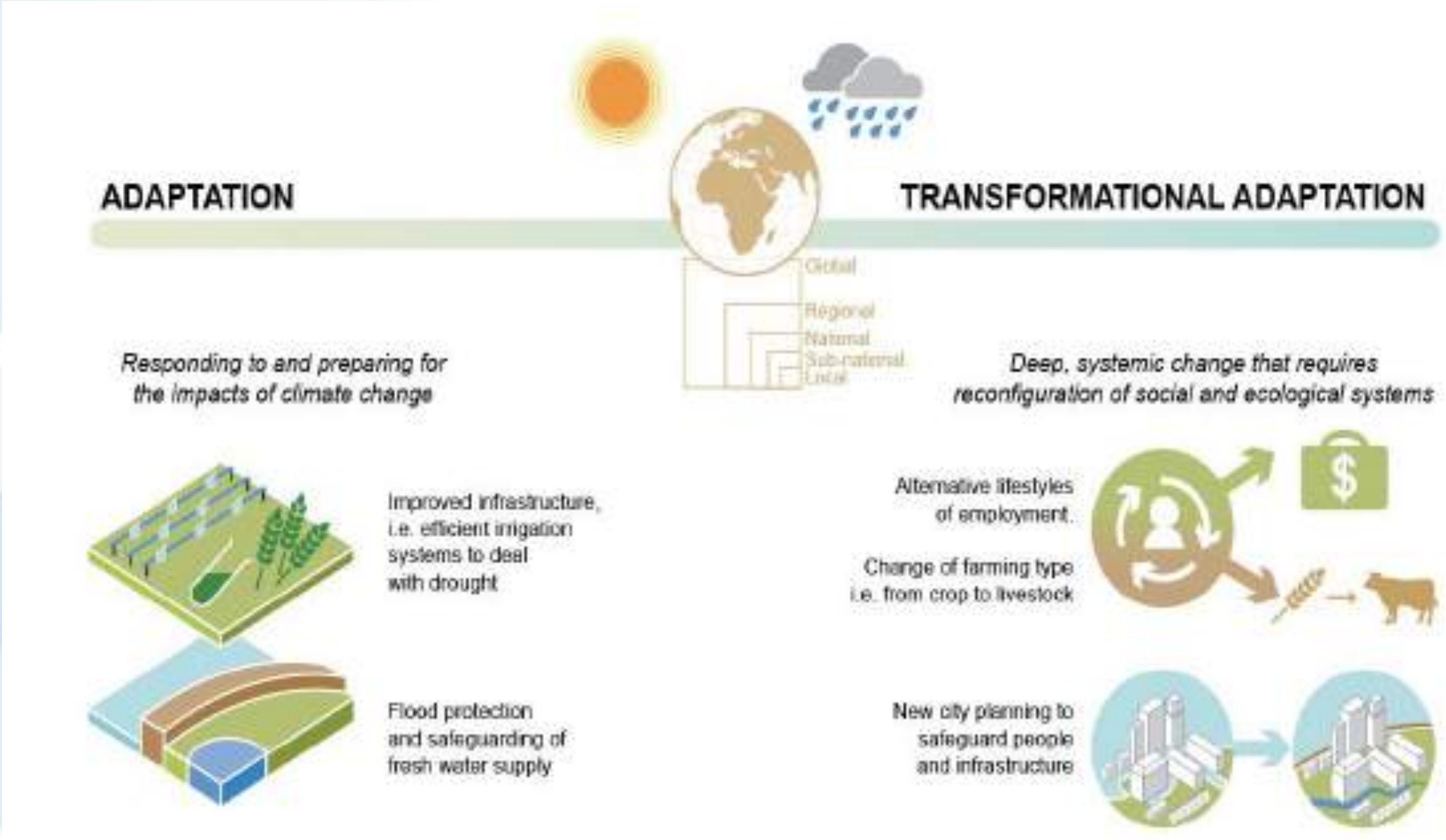
- **Improving irrigation efficiency** to effectively deal with changing global water endowments, especially if achieved via farmers adopting new behaviour and water-efficient practices rather than through large-scale infrastructure (*medium evidence, medium agreement*).

- Improving the efficiency of food production and closing yield gaps have potential to reduce **emissions from agriculture, reduce pressure on land and enhance food security** and future mitigation potential (*high confidence*).

Adaptation water

- Cities to integrate sustainable water resource management and the supply of water services in ways to support mitigation, adaptation and development through **waste-water recycling and storm water diversion.**
- Urban design in many cities now seeks to **mediate run-off, encourage groundwater recharge and enhance water quality.**
- Growing evidence suggests that investing in **behavioural shifts** towards using irrigation technology such as **micro-sprinklers or drip irrigation**, is an effective and quick adaptation strategy **as opposed to large dams** which have high financial, ecological and social costs.

Incremental and transformational adaptation



De Coninck et al. 2018
(IPCC SR15, Ch. 4)

Soft and hard limits

Table 5.2: Soft and hard adaptation limits in the context of 1.5°C and 2°C of global warming

System/Region	Example	Soft Limit	Hard Limit
Coral reefs	Loss of 70-90% of tropical coral reefs by mid-century under 1.5°C scenario (total loss under 2°C scenario) (se Chapter 3, Sections 3.4.4 and 3.5.2.1, Box 3.4)		✓
Biodiversity	6% of insects, 8% of plants and 4% of vertebrates lose over 50% of the climatically determined geographic range at 1.5°C (18% of insects, 16% of plants, 8% of vertebrates at 2°C) (see Chapter 3, Section 3.4.3.3)		✓
Poverty	24-357 million people exposed to multi-sector climate risks and vulnerable to poverty at 1.5°C (86-1,220 million at 2°C) (see Section 5.2.2)	✓	
Human health	Twice as many megacities exposed to heat stress at 1.5°C compared to present, potentially exposing 350 million additional people to deadly heat wave conditions by 2050 (see Chapter 3, Section 3.4.8)	✓	✓
Coastal livelihoods	Large-scale changes in oceanic systems (temperature, acidification) inflict damage and losses to livelihoods, income, cultural identity and health for coastal-dependent communities at 1.5°C (potential higher losses at 2°C) (see Chapter 3, Sections 3.4.4, 3.4.5, 3.4.6.3, Box 3.4, Box 3.5, Cross-Chapter Box 6; Chapter 4, Section 4.3.5; Section 5.2.3)	✓	✓
Small Island Developing States	Sea level rise and increased wave run up combined with increased aridity and decreased freshwater availability at 1.5°C warming potentially leaving several atoll islands uninhabitable (see Chapter 3, Sections 3.4.3, 3.4.5, Box 3.5; Chapter 4, Cross-Chapter Box 9)		✓

Roy et al. 2018 (IPCC SR15 ch. 5)

Synergies with sustainable development

- **D6.** Sustainable development **supports, and often enables**, the fundamental societal and systems transitions and transformations that help limit global warming to 1.5°C.

- **Facilitates pursuit of climate-resilient development pathways** that achieve ambitious mitigation and adaptation in conjunction with poverty eradication and efforts to reduce inequalities (*high confidence*).

- **Social justice and equity core aspects** of climate-resilient development pathways: address challenges and inevitable trade-offs, widen opportunities, and ensure options, visions, and values are deliberated, between and within countries and communities, without making the poor and disadvantaged worse off.

Synergies and trade-off: Agriculture and Food Security

- Stringent climate mitigation pathways in line with ‘well below 2°C’ or ‘1.5°C’ goals often rely on deployment of large-scale land-related measures, like afforestation and/or bioenergy supply.

- **Given trade-offs with food security**, mitigation policies to be designed so that shields population at risk of hunger, including through the **adoption of different complementary measures**
  - Investment needs of complementary food price support policies globally relatively much smaller than the associated mitigation investments of 1.5°C pathways.
  - Other measures include improving productivity and efficiency of agricultural production systems and programs focusing on forest land-use change lead to additional benefits of mitigation, improving resilience and livelihoods.

Synergies and trade-offs: Water

- Transformations towards l**ow-emissions energy and agricultural systems** can have major **implications for freshwater demand as well as water pollution**.
- Scaling up of **renewables** and energy efficiency as depicted by low emissions pathways generally **lower water demands for thermal energy supply facilities (‘water-for-energy**’) compared to fossil energy technologies.
- However, some l**ow-carbon options such as bioenergy, centralised solar power, and hydropower technologies** could, if not managed properly, have counteracting effects that **compound existing water-related problems** in a given locale.

Summary

- Stabilizing at 1.5°C requires transformational mitigation as well as ramping up incremental and sometimes transformative adaptation
- Risks substantially lower at 1.5°C than at 2 °C, but higher than at 1°C
- Food production and security as well as water sectors affected: variety of adaptation options at hand
- Some limits to adaptation and adaptive capacity
- Considerations for equity and international support for those at risk and in need for upscaling adaptation

Resilient cities and 1.5C climate change

Diana Urge-Vorsatz

Vice Chair, Working Group III

Professor, Central European University

INTERGOVERNMENTAL PANEL ON climate change

Cities are especially important

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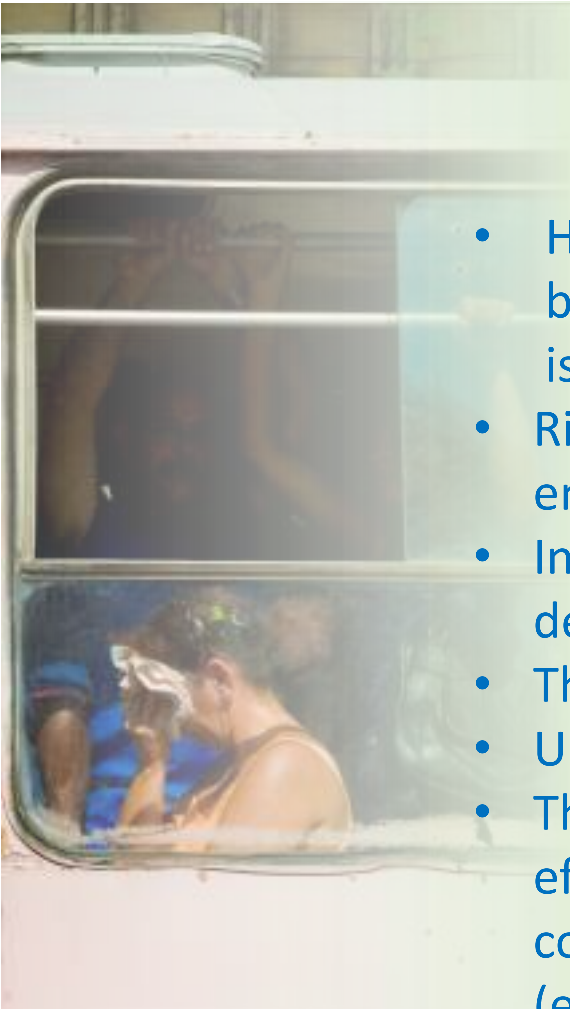
- Are among the most affected by CC:
  - “Small islands, **megacities**, coastal regions and high mountain ranges”
- 70 million new urban residents per year until mid-century
- The majority will reside in hazard-prone small and medium sized cities in low- and middle-income countries
- Among the worst affected by warming are **poor urban dwellers**, **esp. in African cities**
- Cities are where heat stress, terrestrial and coastal flooding, new disease vectors, air pollution and water scarcity, will **coalesce**
- Cities are at the **frontline of adaptation**:
  - reducing and managing disaster risks due to extreme and slow-onset weather and climate events,
  - installing flood and drought early warning systems
  - improving water storage and use
  - Reducing health impacts

Cities are especially affected by the additional 0.5C warming



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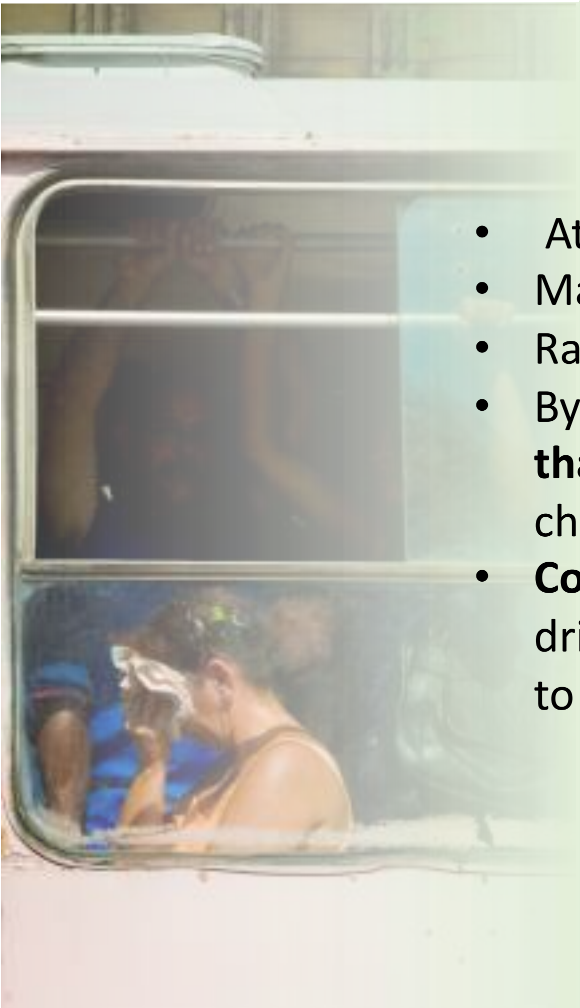
- Health risks – e.g. heat related mortality and morbidity - will be especially reduced with 0.5C less warming due to the heat island effect
- Risks for ozone-related mortality if the ozone precursor emissions remain the same
- Increased risks for vector borne diseases such as malaria and dengue fever
- The impact of storms is aggravated in cities
- Undernutrition
- The extent of additional risk depends on vulnerability and the effectiveness of adaptation for regions (coastal and non-coastal), informal settlements, and infrastructure sectors (energy, water, and transport)

Cities and sea level rise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- At least 136 mega cities are at risk from flooding due to SLR
- Many of these cities are located in south and south-east Asia
- Raising existing dikes helps to protect against SLR
- By 2300, dike heights under a no-mitigation scenario could be **more than 2 m higher** (on average for 136 mega cities) than under climate change mitigation scenarios at 1.5°C or 2°C
- **Compound flooding** (the combined risk of flooding from multiple drivers) has increased significantly in major coastal cities and is likely to increase with further development and SLR at 1.5°C

Heat stress


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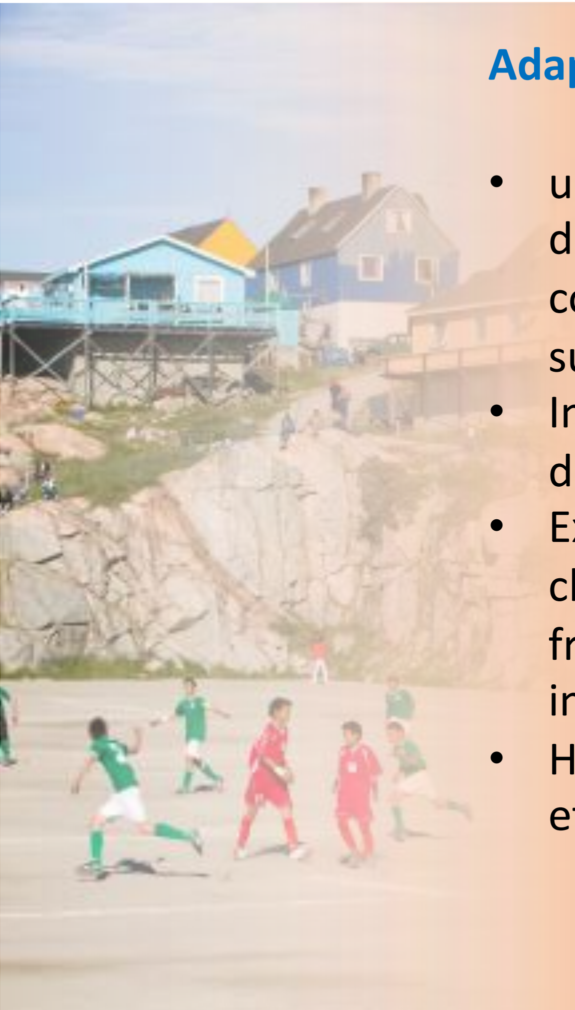
- ozone related mortality increases in cities with warming
- @ 1.5°C, **twice as many megacities will become heat-stressed,** exposing more than 350 million more people by 2050
- At +2°C warming, Karachi (Pakistan) and Kolkata (India) could expect **annual conditions equivalent to their deadly 2015 heatwaves**
- The urban poor is expected to be especially affected
- Increases in the intensity of UHI could exacerbate warming of urban areas, with projections ranging **from a 6% decrease to a 30% increase for a doubling of CO_2**
- Increases in population and city size, in the context of a warmer climate, are projected to increase UHI



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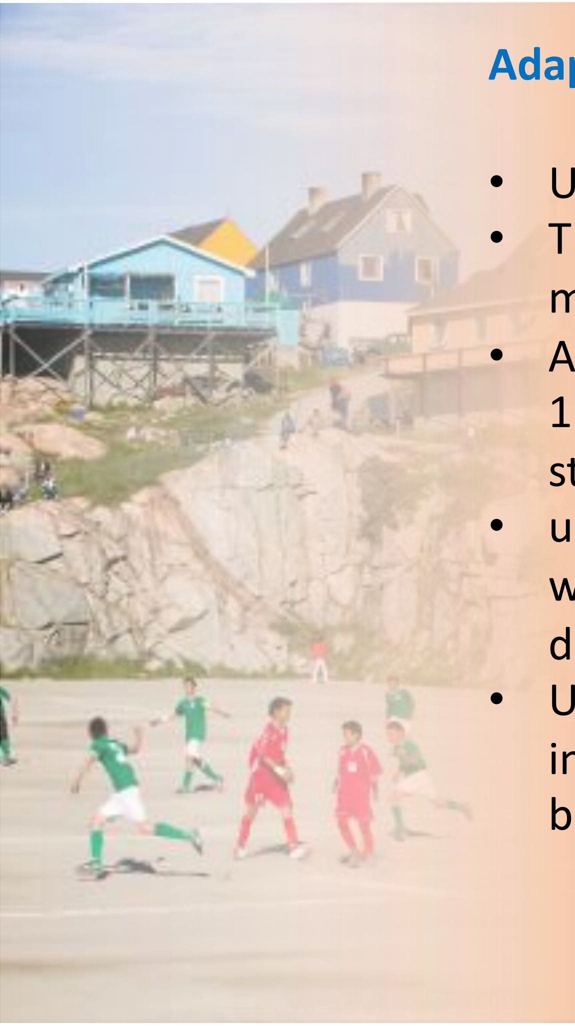
Adaptation: opportunities for cities

- urban systems can harness the mega-trends of urbanisation, digitalisation, financialization and growing sub-national commitment to smart cities, green cities, resilient cities, sustainable cities and adaptive cities
- Increase in urban climate responses driven by cost-effectiveness, development, work creation and inclusivity considerations
- Expanding networks of cities sharing experiences on coping with climate change and drawing economic and development benefits from climate change responses represent a recent institutional innovation
- However, the literature is divided on whether these have been effective in inducing *additional* emission reductions



Adaptation: resilient infrastructure

- Urban land use influences risk exposure and adaptive capacity
- Thus good urban land-use planning can contribute to climate mitigation and adaptation
- Adaptation plans can reduce exposure to urban flood risk that, in a 1.5°C world, could double relative to 1976–2005, reduce heat stress, fire risk, sea level rise
- urban design and spatial planning policies should consider extreme weather conditions and reduce displacement by climate related disasters
- UHI can be mitigated through reflective surfaces, green infrastructure, good urban design in terms of land use, zoning and building codes and the reduction in mechanical cooling needs

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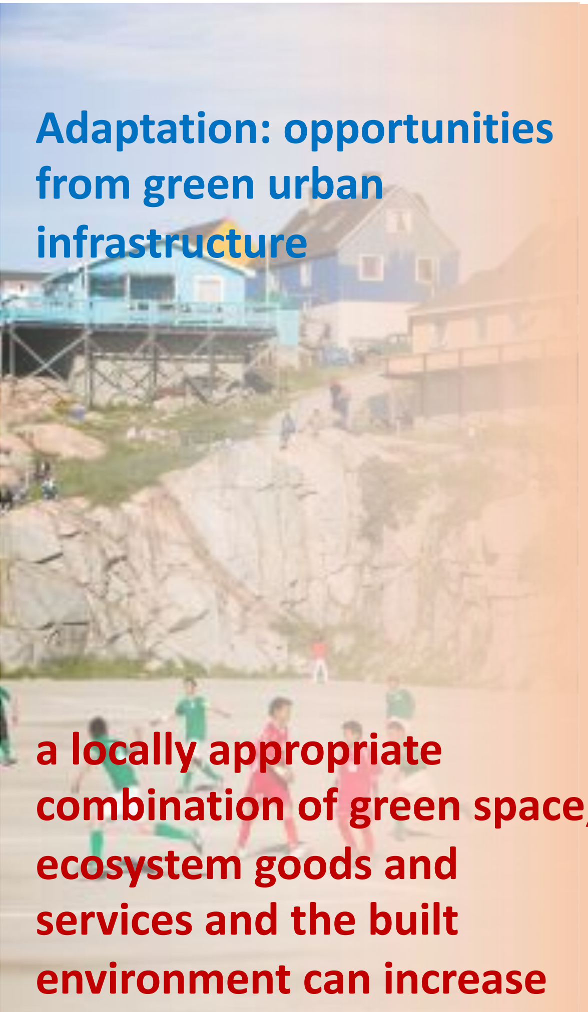


Adaptation: opportunities from green urban infrastructure

a locally appropriate combination of green space, ecosystem goods and services and the built environment can increase the set of urban adaptation options

Green infrastructure	Adaptation benefits	Mitigation benefits
Urban trees planting, urban parks	Reduced heat island effect, psychological benefits	Less cement, reduced air-conditioning
Permeable surfaces	Water recharge	Less cement in city, some bio-sequestration, less water pumping
Forest retention, and urban agricultural land	Flood mediation, healthy lifestyles	Air pollution reduction
riparian buffer zones	skilled local work, Sense of place	energy spent on water treatment
Biodiverse urban habitat	Psychological benefits, inner-city recreation	Carbon sequestration

Selected key climate change related risks relevant to African cities and opportunities for adaptation

Climate-related drivers of impacts							
Warming trend	Extreme temperature	Extreme precipitation	Precipitation	Damaging cyclone	Sea level	Ocean acidification	Sea surface temperature

Level of risk & potential for adaptation

Potential for additional adaptation to reduce risk

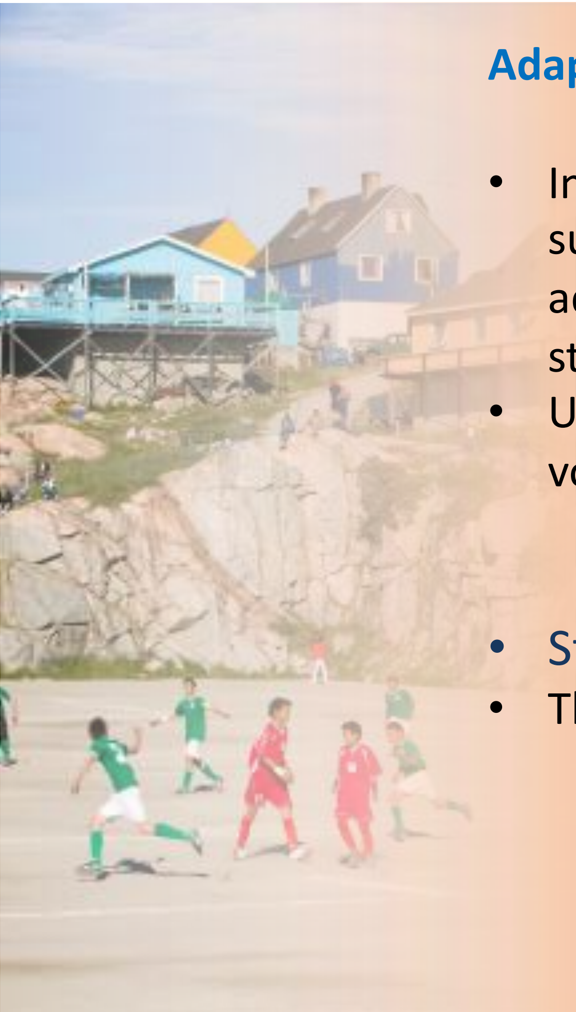
Risk level with **high** adaptation — Risk level with **current** adaptation

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation (Very low – Medium – Very high)
Changes in the incidence and geographic range of vector- and water-borne diseases due to changes in the mean and variability of temperature and precipitation, particularly along the edges of their distribution *(medium confidence)* [22.3]	• Achieving development goals, particularly improved access to safe water and improved sanitation, and enhancement of public health functions such as surveillance • Vulnerability mapping and early warning systems • Coordination across sectors • Sustainable urban development	Warming trend, precipitation, extreme precipitation	Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	
Undernutrition with its potential for life-long impacts on health and development and its associated increase in vulnerability to malaria and diarrheal diseases, can result from changing crop yields, migration due to weather and climate extremes, and other factors *(medium confidence)*. [22.3.5.2]	Early warning systems and vulnerability mapping (for targeted interventions); diet diversification; coordination with food and Agriculture sectors; improved public health functions to address underlying diseases	Warming trend, precipitation, extreme temperature, extreme precipitation	Present Near term (2030–2040) Long term (2080–2100) 2°C 4°C	

Continued next page →

Adaptation: sustainable water resource management

- Integration of sustainable water resource management and the supply of water services in ways that support mitigation, adaptation and development through waste-water recycling and storm water diversion
- Urban surface sealing with impervious materials affects the volume and velocity of run-off and flooding
  - but urban design in many cities now seeks to mediate run-off, encourage groundwater recharge and enhance water quality
- Still, urban flooding is expected to increase at 1.5°C warming
- This risk falls disproportionately on urban women and urban poor



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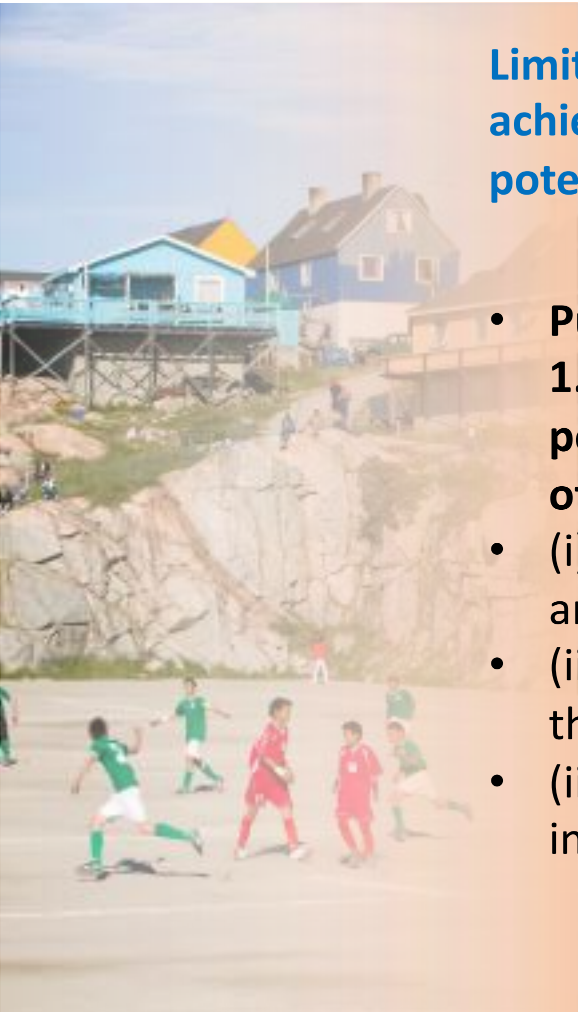

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Limiting global warming to 1.5°C rather than 2°C makes it easier to achieve many aspects of sustainable development, with greater potential to eradicate poverty and reduce inequalities in cities

- **Pursuing place-specific adaptation pathways toward a 1.5°C warmer world has the potential for significant positive outcomes for well-being, in countries at all levels of development.**
- (i) diversity of adaptation options based on people's values and trade-offs they consider acceptable,
- (ii) maximise synergies with sustainable development through inclusive, participatory, and deliberative processes
- (iii) facilitate equitable transformation. entrenched social inequalities

SR1.5C Feasibility Assessment of Adaptation Options

Outreach Event on the IPCC Special Report on 1.5C
Mohammed VI Polytechnic University, Morocco

Aromar Revi
CLA, Chapter 4 IPCC SR1.5C
Director, Indian Institute for Human Settlements

26 authors from 19 countries: Mustafa Babiker, Amir Bazaz, Tim Benton, Paolo Bertoldi, Marcos Buckeridge, Anton Cartwright, Heleen de Coninck, Joana Correia de Oliveira de Portugal Pereira, Kristie Ebi, James Ford, Sabine Fuss, Adriana Grandis, Eamon Haughey, Ove Hoegh-Guldberg, Jean-Charles Hourcade, Kiane de Kleijne, Deborah Ley, Maria del Mar Zamora Dominguez, Reinhard Mechler, Peter Newman, Andy Reisinger, Aromar Revi, Chandni Singh, Raphael Slade, Linda Steg, Taishi Sugiyama

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SR1.5C Adaptation Feasibility Assessment: Sources

I. Chapter 4: Strengthening & implementing the Global response

- **Section 4.5 (Tables 4.11 and Table 4.12**)
- Analysis of Synergies & Trade-offs (4.5.4, Supp. Table 4.E)
- Knowledge Gaps & Key Uncertainties (Table 4.13)

http://report.ipcc.ch/sr15/pdf/sr15_chapter4.pdf

- **Supplementary Material 4.D**

http://report.ipcc.ch/sr15/pdf/sr15_chapter4_supplementary_materials.pdf

II Chapter 1: Framing and Context

- Cross-Chapter Box 3 in Chapter 1: Framing feasibility

http://report.ipcc.ch/sr15/pdf/sr15_chapter1.pdf

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SR1.5C: Adaptation Feasibility Assessment - I

System	Adaptation option	Evidence	Agreement	Ec	Tec	Inst	Soc	Env	Geo	Context
Energy system transitions	Power infrastructure, including water	Medium	High							Depends on existing power infrastructure, all generation sources and with intensive water requirements
Land & ecosystem transitions	Conservation agriculture	Medium	Medium							Depends on irrigated/rainfed system, ecosystem characteristics, crop type, other farming practices
	Efficient irrigation	Medium	Medium							Depends on agricultural system, technology used, regional institutional and biophysical context
	Efficient livestock	Limited	High							Dependent on livestock breeds, feed practices.and biophysical context (e.g. carrying capacity)
	Agroforestry	Medium	High							Depends on knowledge, financial support, and market conditions
	Community-based adaptation	Medium	High							Focus on rural areas and combined with ecosystems-based adaptation, does not include urban settings
	Ecosystem restoration & avoided deforestation	Robust	Medium							Mostly focused on existing and evaluated REDD+ projects
	Biodiversity management	Medium	Medium							Focus on hotspots of biodiversity vulnerability and high connectivity
	Coastal defense & hardening	Robust	Medium							Depends on locations that require it as a first adaptation option
	Sustainable aquaculture	Limited	Medium							Depends on locations at risk and socio-cultural context
Urban & infrastructure system transitions	Sustainable land-use & urban planning	Medium	Medium							Depends on nature of planning systems and enforcement mechanisms
	Sustainable water management	Robust	Medium							Balancing sustainable water supply and rising demand especially in low-income countries
	Green infrastructure & ecosystem services	Medium	High							Depends on reconciliation of urban development with green infrastructure

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SR1.5C: Adaptation Feasibility Assessment - II

System	Adaptation option	Evidence	Agreement	Ec	Tec	Inst	Soc	Env	Geo	Context
	Building codes & standards	Limited	Medium							Adoption requires legal, educational, and enforcement mechanisms to regulate buildings
Industrial system transitions	Intensive industry infrastructure resilience and water management	Limited	High							Depends on intensive industry, existing infrastructure and using or requiring high demand of water
Overarching adaptation options	Disaster risk management	Medium	High							Requires institutional, technical, and financial capacity in frontline agencies and government
	Risk spreading and sharing	Medium	Medium							Requires well developed financial structures and public understanding
	Climate services	Medium	High							Depends on climate information availability and usability, local infrastructure and institutions, national priorities
	Indigenous knowledge	Medium	High							Dependent on recognition of Indigenous rights, laws, and governance systems
	Education and learning	Medium	High							Existing education system, funding
	Population health and health system	Medium	High							Requires basic health services and infrastructure
	Social safety nets	Medium	Medium							Type and mechanism of safety net, political priorities, institutional transparency
	Human migration	Medium	Low							Hazard exposure, political and socio-cultural acceptability (in destination), migrant skills and social networks

Feasibility Context: Mitigation & Adaptation Options to enable Four Systems Transitions

1. Energy System Transitions
2. Land and Ecosystem Transitions
3. Urban and Infrastructure System Transitions
4. Industrial System Transitions

+

Enabling Conditions &

Assess Synergies, Trade-offs & Knowledge Gaps

Feasibility Assessment Framework

- Systematize the global assessment of adaptation and mitigation options, using a multi-dimensional feasibility framework

- Feasibility: The degree to which climate goals and response options are considered possible and/or desirable (SR1.5 Glossary)

- Assessed along six dimensions of feasibility
  - Economic
  - Technological
  - Institutional
  - Socio-cultural
  - Environmental/ecological
  - Geophysical

- Context-dependent: assessed for each option

- Strongly grounded in peer-reviewed literature

Feasibility Indicators for Mitigation & Adaptation differ slightly, *based on underlying literature*

Dimensions	Adaptation indicators	Mitigation indicators
Economic	Micro-economic viability Macro-economic viability Socio-economic vulnerability reduction potential Employment & productivity enhancement potential	Cost-effectiveness Absence of distributional effects Employment & productivity enhancement potential
Technological	Technical resource availability Risks mitigation potential	Technical scalability Maturity Simplicity Absence of risk
Institutional	Political acceptability Legal & regulatory feasibility Institutional capacity & administrative feasibility Transparency & accountability potential	Political acceptability Legal & administrative feasibility Institutional capacity Transparency & accountability potential
Socio-cultural	Social co-benefits (health, education) Socio-cultural acceptability Social & regional inclusiveness Intergenerational equity	Social co-benefits (health, education) Public acceptance Social & regional inclusiveness Intergenerational equity Human capabilities
Environmental / ecological	Ecological capacity Adaptive capacity/ resilience building potential	Reduction of air pollution Reduction of toxic waste Reduction of water use Improved biodiversity
Geophysical	Physical feasibility Land use change enhancement potential Hazard risk reduction potential	Physical feasibility (physical potentials) Limited use of land Limited use of scarce (geo)physical resources Global spread
	Total:19 indicators	**Total: 24 indicators**

Feasibility assessment approach

I. Selection of options assessed as part of global systems transitions

- Relevant to 1.5°C
- Focus on options that have seen development and change since AR5
- For adaptation, based on AR5 WGII Chapter 14, for mitigation AR5 WGIII

II. Each indicator was assessed (based on the literature):

- A (light): If the indicator could potentially block the feasibility of this option
- B (middle): If the indicator has neither a positive, nor a negative effect on the feasibility of the option, or the evidence is mixed
- C (dark): If the indicator does not pose barriers to the feasibility of this option

III. Except when:

- LE or NE: Limited or no evidence (one or fewer papers)
- NA: Not applicable

Comprehensive Feasibility Assessment

- **23 adaptation options**
- Based on **19 indicators in six dimensions**
- Underpinned by **603 references**

- Rigorous uncertainty guidance & identification of knowledge gaps:

  Out of **437 indicator-level** assessments: 37 not applicable; 72 limited or no evidence

Assessing options by dimensions and context

- Step 1: How many indicators in one dimension are effective (applicable)?

  #effective indicators = #indicators - #not applicable

- Step 2: How many indicators have sufficient literature?

  #effective indicators - #NE&LE

- Step 3: Average of the effective indicators with sufficient evidence

$$\frac{(1*A + 2*B + 3*C)}{(\#effective\ indicators - \#NE\&LE)}$$

- Step 4: Assign colour to dimension

- Step 5: Add context, evidence and agreement to table

Legend of Feasibility Assessment Tables	Legend criteria for the overall feasibility of each of the dimension-option combinations
	$\#indicators = \#NA$
	$\#NE\&LE > 0.5 * \#effective\ indicators$
	$AVG \leq 1.5$ $\#NE\&LE \leq 0.5 * \#effective\ indicators$
	$1.5 < AVG \leq 2.5$ $\#NE\&LE \leq 0.5 * \#effective\ indicators$
	$AVG > 2.5$ $\#NE\&LE \leq 0.5 * \#effective\ indicators$

SR1.5C Adaptation behind the scenes: Economic Feasibility of Land & Ecosystem Transitions

		Conservation agriculture	Efficient irrigation	Efficient livestock	Agroforestry	Community-based adaptation
	Evidence	Medium	Medium	Limited	Medium	Medium
	Agreement	Medium	Medium	High	High	High
Economic	Micro-economic viability	(Grabowski and Kerr, 2014; Jat et al., 2014; Pittelkow et al., 2014; Thierfelder et al., 2015, 2017; Smith et al., 2017b)	(Olmstead, 2014; Roco et al., 2014; Venot et al., 2014; Varela-Ortega et al., 2016; Bjornlund et al., 2017; Herwehe and Scott, 2017; Mdemu et al., 2017)	(Thornton and Herrero, 2014; Herrero et al., 2015; Weindl et al., 2015; Ghahramani and Bowran, 2018)	(Valdivia et al., 2012; K Murthy, 2013; Lasco et al., 2014; Mbow et al., 2014a, 2014b; Brockington et al., 2016; Iiyama et al., 2017; Jacobi et al., 2017; Hernández-Morcillo et al., 2018)	(Mannke, 2011; Archer et al., 2014; Wright et al., 2014a; Fernández-Giménez et al., 2015; Dodman et al., 2017a)
	Macro-economic viability	(Ndah et al., 2015; Thierfelder et al., 2015; Smith et al., 2017b)	(Elliott et al., 2014; Kirby et al., 2014; Olmstead, 2014; Girard et al., 2015; Kahil et al., 2015; Varela-Ortega et al., 2016; Bjornlund et al., 2017; Herwehe and Scott, 2017)	(Herrero et al., 2015; Weindl et al., 2015; Garcia de Jalón et al., 2017)	(Valdivia et al., 2012; Lasco et al., 2014; Jacobi et al., 2017; Hernández-Morcillo et al., 2018)	NE
	Socio-economic vulnerability reduction potential	(Bhan and Behera, 2014; Pittelkow et al., 2014; Stevenson et al., 2014; Prosdocimi et al., 2016; Smith et al., 2017b)	(Burney and Naylor, 2012; Levidow et al., 2014; Roco et al., 2014; Venot et al., 2014; Ashofteh et al., 2017; Bjornlund et al., 2017)	(Herrero et al., 2015; Garcia de Jalón et al., 2017; Thornton et al., 2018)	(Valdivia et al., 2012; Brockington et al., 2016; Coq-Huelva et al., 2017; Coulibaly et al., 2017; Iiyama et al., 2017; Jacobi et al., 2017; Quandt et al., 2017)	(Mannke, 2011; Archer et al., 2014; Reid and Huq, 2014; Wright et al., 2014a; Fernández-Giménez et al., 2015; Ensor et al., 2016, 2018; Ford et al., 2018)

Adaptation example: Economic Feasibility of Sustainable Land-use

Indicators	*Line of Sight*	*Assessment*
Micro-economic viability	(Eberhard et al., 2011; Kiunsi, 2013; Watkins, 2015; Archer, 2016; Eberhard et al., 2016; Eisenberg, 2016; Ewing et al., 2016; Ziervogel et al., 2016a; Hess and Kelman, 2017; Mavhura et al., 2017; Ziervogel et al., 2017)	**B**
Macro-economic viability	(Eberhard et al., 2011; Measham et al., 2011; Aerts et al., 2014; Jaglin, 2014; Beccali et al., 2015; Boughedir, 2015; Watkins, 2015; Eberhard et al., 2016; Ziervogel et al., 2016a; Chu et al., 2017; Hess and Kelman, 2017; Ziervogel et al., 2017)	**B**
Socio-economic vulnerability reduction potential	(Measham et al., 2011; Eberhard et al., 2011, 2016; Kiunsi, 2013; Aerts et al., 2014; Jaglin, 2014; Boughedir, 2015; Broto et al., 2015; Carter et al., 2015; Archer, 2016; Shi et al., 2016; Ziervogel et al., 2016a, 2017; Hetz, 2016; Mavhura et al., 2017)	**B**
Employment & productivity enhancement potential	(Eberhard et al., 2011; Measham et al., 2011; Watkins, 2015; Archer, 2016; Eberhard et al., 2016; Ziervogel et al., 2016a)	**A**
Total economic feasibility		**B**

- Here, the economic feasibility of the adaptation option ‘sustainable land use and urban planning’ under urban and infrastructure system transitions is assessed
- Within that each of the four indicators is assigned A, B or C
- There are no NA, NE or LE, therefore all four indicators contribute to the feasibility at the economic dimension
- Context: The feasibility of this option depends on the nature of planning systems and enforcement mechanisms

Adaptation: example of guiding questions for economic dimension

Adaptation indicators	Guiding questions for adaptation indicators
Micro-economic viability (benefits, costs, trade-offs & lock-ins)	What are the costs and trade-offs of the adaptation option (to what extent are vulnerable people, systems benefitted)?
Macro-economic viability (investment and financial, consumption, investment, inflation & trade)	Would the option lead to higher productivity? Does it lead to employment generation? Does it cost jobs?
Socio-economic vulnerability reduction potential	To what extent is the option reducing inequalities and enhancing economic opportunities?
Employment & productivity enhancement potential	How many people that can be employed or how much can a system's productivity increase under the option (without distorting employment generation potential and causing loss of jobs)

Adaptation: References informing the assessment

System	Adaptation option	No. of unique references
Energy system transitions	Power infrastructure, including water	13
Land & ecosystem transitions	Conservation agriculture	25
	Efficient irrigation	23
	Efficient livestock	12
	Agroforestry	24
	Community-based adaptation	16
	Ecosystem restoration & avoided deforestation	18
	Biodiversity management	31
	Coastal defense & hardening	42
	Sustainable aquaculture	35
Urban & infrastructure system transitions	Sustainable land-use & urban planning	39
	Sustainable water management	37
	Green infrastructure & ecosystem services	33
	Building codes & standards	18
Industrial system transitions	Intensive industry infrastructure resilience and water management	15
Overarching adaptation options	Disaster risk management	40
	Risk spreading and sharing	31
	Climate services	36
	Indigenous knowledge	50
	Education and learning	36
	Population health and health system	33
	Social safety nets	21
	Human migration	32
Total references (not a sum as duplicates have been excluded)		**603**

SR1.5C Adaptation: Enabling Conditions example

Adaptation option	Feasibility	Enabling conditions	Constraints	Examples
Disaster risk management (DRM)	*Medium evidence (high agreement)*	Pools resources and expertise for risk reduction (Howes et al., 2015; Kelman et al., 2015; Wallace, 2017) Integrates adaptation into existing management (Howes et al., 2015) Supports post-disaster recovery and reconstruction (Kelman et al., 2015; Kull et al., 2016) Engagement of local and Indigenous knowledge can improve preparedness and response (McNamara and Prasad, 2014; Mawere and Mubaya, 2015; Kaya et al., 2016; Chambers et al., 2017; Granderson, 2017)	Uncertainty over projected climate impacts, absence of downscaled climate projections (van der Keur et al., 2016; de Leon and Pittock, 2017; Wallace, 2017) Limited institutional, technical, and financial capacity in frontline agencies (de Leon and Pittock, 2017; Kita, 2017; Wallace, 2017) Adaptation and DRM communities operate separately (Kelman et al., 2015; Serrao-Neumann et al., 2015; de Leon and Pittock, 2017)	*Glacial lake outburst floods (GLOFs)* 1.5°C will increase risk of GLOFs (Cogley, 2017; Kraaijenbrink et al., 2017). Infrastructural measures technically and economically unfeasible in many regions (Muñoz et al., 2016; Schwanghart et al., 2016; Watanabe et al., 2016; Haeberli et al., 2017) Early warning systems (Anacona et al., 2015), and monitoring of dangerous lakes and surrounding slopes (including using remote sensing) offer DRM opportunities (Emmer et al., 2016; Milner et al., 2017) Institutional leadership and community engagement essential for effectiveness (Anacona et al., 2015; Watanabe et al., 2016)

SR1.5C Adaptation: Synergies & Trade-Offs example

System	Adaptation option	Synergies	Trade-offs
Energy system transitions	Power infrastructure, including water	Some adaptation options can help improve system efficiency and reliability (Cortekar and Groth, 2015; van Vliet et al., 2016) Synergies with Sustainable Development Goals, poverty, and well being (Dagnachew et al., 2018; Fuso Nerini et al., 2018; Gi et al., 2018).	A shift from open-loop to closed-loop cooling technologies could decrease withdrawals, with the trade-off of increasing water consumption for power generation (DeNooyer et al., 2016)
Land & ecosystem transitions	Conservation agriculture	Agro-ecological practices can reduce farm-scale carbon footprint significantly (Rakotovao et al., 2017). Practices such as improved soil conservation practices in coffee agroforestry systems and improved slash and mulch agroforestry in bean-maize cultivation, have low carbon footprint reduction potential (CFRP) and medium carbon sequestration potential (CSP) (Rahn et al., 2014). Land and water management adaptation measures have mitigation co-benefits through soil/atmospheric carbon sequestration, reduced emissions, soil nitrification and reduced use of inorganic fertilisers (Chandra et al., 2016). Conservation agriculture agricultural reduces yields 3–5 years after adoption, but enhances productivity and carbon sequestration over longer periods (Harvey et al., 2014). For conservation agriculture and efficient irrigation, synergies are regionally differentiated: (Lobell et al., 2013).	Technologies enhancing farm productivity (such as adding fertilizers) might improve adaptive capacity through higher incomes but at the same time drive GHG emissions (Harvey et al., 2014; Thornton et al., 2017). In some cases, conservation agriculture practices can increase emissions (Gupta et al., 2016).

Conclusions

1. It is possible to undertake a rigorous multi-dimensional global feasibility assessment of both adaptation and mitigation options for 1.5C

2. This provides a scaffolding to:

- Identify key options that can enable system transitions
- Start prioritisation of implementation actions for feasible option
- Identify enabling conditions to enable accelerated implementation
- Identify synergies & trade-offs between adaptation options & with mitigation options
- Define knowledge gaps and hence priorities for action research

3. However, large knowledge and publication gaps exist at regional and country-level that need to be filled during AR6

The Adaptation Dilemma for Africa in a 1.5°C

Johnson Nkem

Regional Policy Advisor Climate Resilient Agriculture

International Conference on Adaptation Metrics & Techniques for Water, Agriculture & Resilient Cities

26-27 October 2018

Morocco

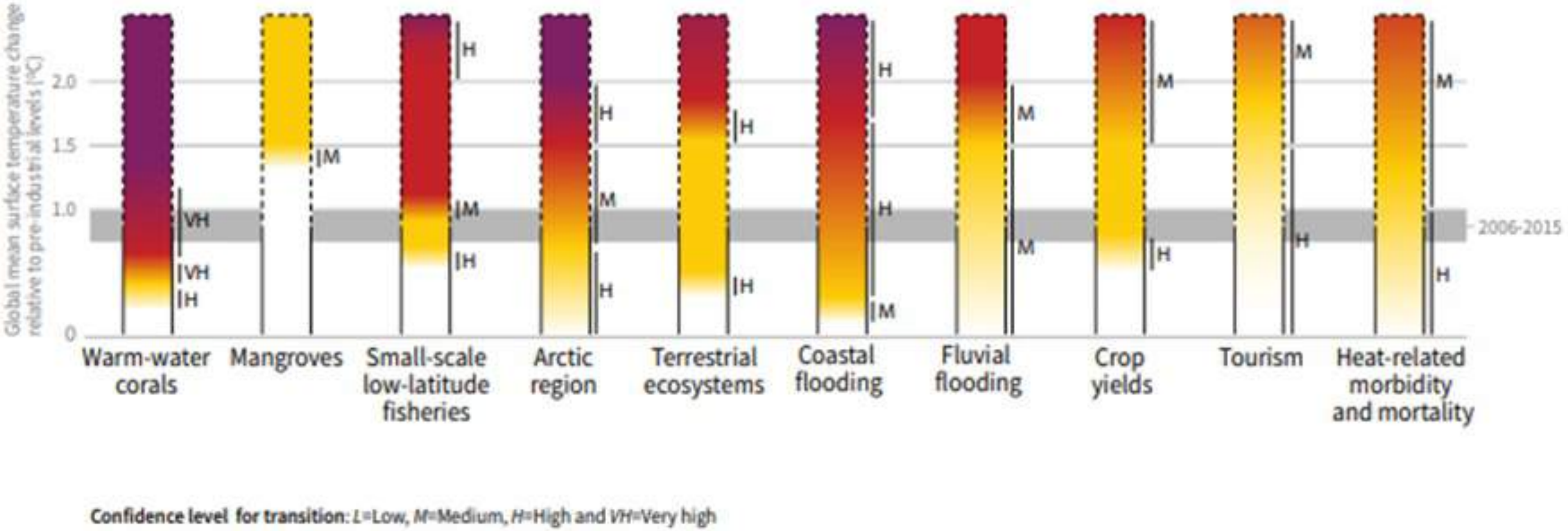
UN WOMEN

Some Key Messages in the SR 1.5C ……

- Warming greater than the global average has already been experienced in many regions and seasons, with average warming over land higher than over the ocean (high confidence).
- …**20-40%** of the global human population live in regions that, by the decade 2006-2015, had already experienced warming of more than 1.5°C above pre-industrial in at least one season (medium confidence).
- **Adaptation implementation** faces **several barriers** including unavailability of up-to-date and locally-relevant information, lack of finance and technology, social values and attitudes, and institutional constraints (high confidence).

Reasons for Concern (RFCs): how the level of global warming affects selected natural, managed and human systems

Impacts and risks for selected natural, managed and human systems



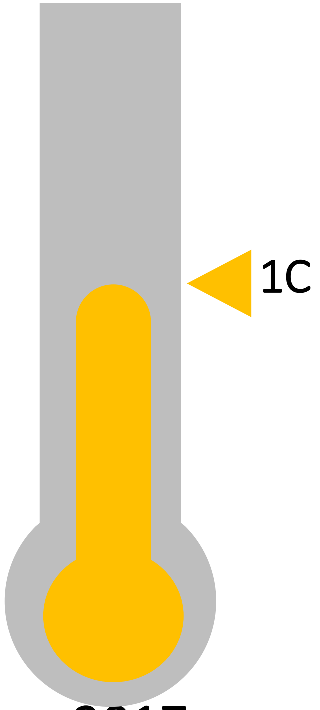
Source: IPCC Special Report on Global Warming of 1.5°C

The challenges for adaptation especially in the tropics are clearly highlighted

		1.5 °C	2 °C	
Heat wave (warm spell) duration [month]				
	Global	**1.1** [1;1.3]	**1.5** [1.4;1.8]	Tropical regions up to 2 months at 1.5 °C or up to 3 months at 2 °C
Reduction in annual water availability [%]				
	Mediterranean	**9** [5;16]	**17** [8;28]	Other dry subtropical regions like Central America and South Africa also at risk
Increase in heavy precipitation intensity [%]				
	Global	**5** [4;6]	**7** [5;7]	Global increase in intensity due to warming; high latitudes (>45 °N) and monsoon regions affected most.
	South Asia	**7** [4;8]	**10** [7;14]	
Global sea-level rise				
	in 2100 [cm]	**40** [30;55]	**50** [35;65]	1.5 °C end-of-century rate about 30 % lower than for 2 °C reducing long-term SLR commitment.
	2081–2100 rate [mm/yr]	**4** [3;5.5]	**5.5** [4;8]	
Fraction of global coral reefs at risk of annual bleaching [Constant case, %]				
	2050	**90** [50;99]	**98** [86;100]	Only limiting warming to 1.5 °C may leave window open for some ecosystem adaptation.
	2100	**70** [14;98]	**99** [85;100]	
Changes in local crop yields over global and tropical present day agricultural areas including the effects of CO_2-fertilization [%]				
Wheat	Global	**2** [-6;17]	**0** [-8;21]	Projected yield reductions are largest for tropical regions, while high-latitude regions may see an increase. Projections not including highly uncertain positive effects of CO_2-fertilization project reductions for all crop types of about 10 % globally already at 1.5 °C and further reductions at 2 °C.
	Tropics	**-9** [-25;12]	**-16** [-42;14]	
Maize	Global	**-1** [-26;8]	**-6** [-38;2]	
	Tropics	**-3** [-16;2]	**-6** [-19;2]	
Soy	Global	**7** [-3;28]	**1** [-12;34]	
	Tropics	**6** [-3;23]	**7** [-5;27]	
Rice	Global	**7** [-17;24]	**7** [-14;27]	
	Tropics	**6** [0;20]	**6** [0;24]	

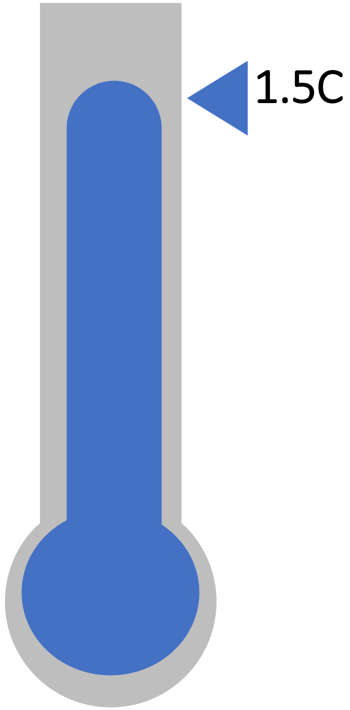
Schleussner et al. 2016

1.5C will be a dilemma in ‘***leaving no one behind***’ by 2030



2017

- **20-40%** of people leave in regions already experiencing warming more than 1.5C.
- The prevalence of undernourishment has risen from **20.8 to 22.7%** between 2015 and 2016 (FAO)



By 2040

- Experience the strongest increase in land area covered by heat extremes
- Reduction in water availability
- Increase frequency and intensity of drought


What does 1.5C means for adaptation in the Sahel?

The Sahel Context

150 million people live in the Sahel region*

300 million people expected to live in the Sahel by 2045.

30 million people face food insecurity - 12 million people expected to need food assistance

4.7 million children under five are acutely malnourished

3°C-6°C Projected increase in temperatures in the Sahel by the end of the 21st century (IPPC report V)

20% expected average loss of production for main cereals crops by 2050

4 in 5 relying on agriculture are particularly vulnerable to climate change

40% drop on water availability per inhabitant over the past 20 years

Data on Burkina Faso, Chad, The Gambia, Mali, Mauritania, Niger, Northern Cameroon and Nigeria, and Senegal

SAHEL

SUPPLEMENTING ADAPTATION COSTS

Food Insecurity

Ecological depletion

Socio-economic challenges

Poverty

Unemployment

Policy and Investment Challenges

10% increase in yields will reduce poverty by 7%

Increase in agricultural productivity is crucial in reducing poverty and achieving SDGs 1 & 2 in Sub-Saharan Africa. However, SR1.5C highlights a reduction in yield of major food crops

Economic Cost

- **91%** of all disasters that occurred between 1998 and 2017were caused by floods, storms, droughts, heatwaves and other extreme weather events (UNISDR 2018)
- Direct economic losses of climate-related disasters constituted or **77%** of the total economic losses.
- Overall, reported losses from extreme weather events rose by **151%** between these two 20-year periods.

Urban Climate Information for Decision Making in Cities

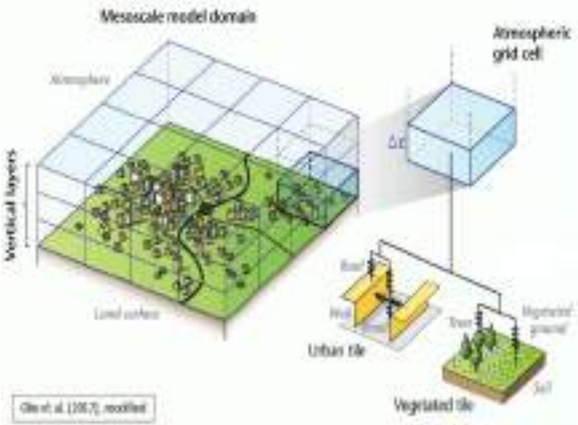
Local to Global Decisions and Policies

1. The Problem

The need for cities to adapt to, and mitigate, global climate change is driving demand for detailed information on urban climates at scales that cannot be easily met with current observing networks, regional and global climate models (RCMs and GCMs).

2. What is needed from Urban Climate Science?

1. Simulations of future urban climate at fine spatial scales:
   →integrated with urban expansion and population growth scenarios; uncertainty estimates
   →including coastal hazards for coastal cities
2. Urban climate observations, especially in Global South cities
3. High spatial resolution data on urban structure and form; human behaviour; energy consumption



3. Essential Climate Variables for Adaptation

Adaptation is needed to reduce risk and increase resilience of urban areas in the face of climate change.

A session at the IPCC Cities and Climate Change Science Conference in March 2018 strongly supported the need to identify one or more Essential Climate Variables (ECVs) that can be used to monitor adaptation progress in cities.

Robust bio-physical and/or socio-economic ECVs will feed directly into local and global climate change policy; e.g. through monitoring urban environmental adaptation progress through time and (possibly) against targets

WCRP World Climate Research Programme | WMO | IOC | ICSU International Council for Science

UCCRN Urban Climate Change Research Network | RM | belspo.be

Urban Climate Information for Decision Making in Cities

Local to Global Decisions and Policies

Urban-scale climate information needs:

Impact assessments and adaptation plans for our cities requires high spatial resolution climate projections along with ....

- models that represent urban processes
- ensemble dynamical and statistical downscaling
- local-impact models

Several potential urban adaptation ECVs have been identified, mainly related to the biophysical characteristics of the urban environment

Forthcoming IPCC scientific assessments will need input from new research to identify, and address, critical gaps in our knowledge of translating global climate change to cities. This includes how to assess and reduce uncertainties.