Plant Solutions for climate change

Lecture 1

What is climate change?

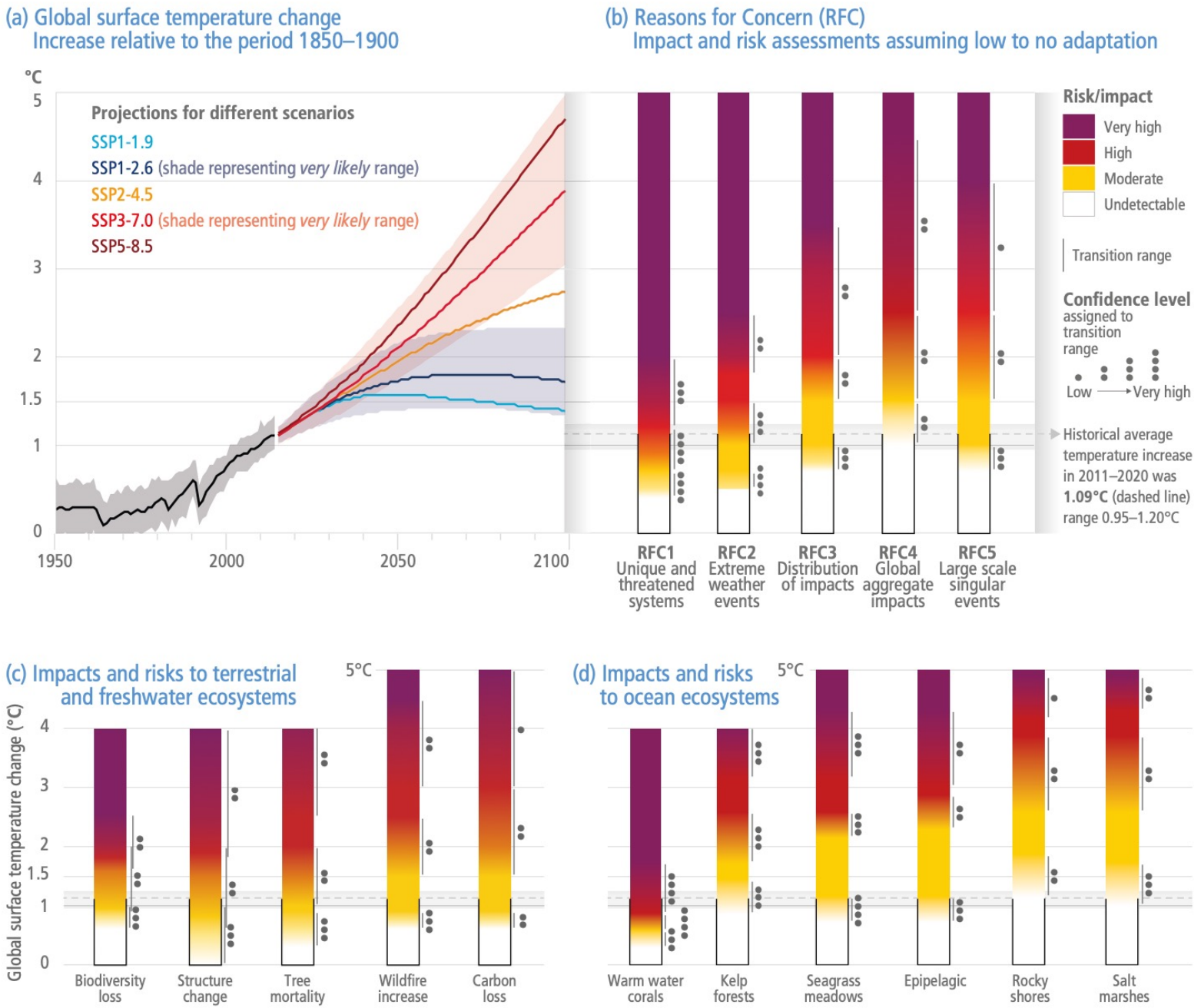
- Climate change is caused by an accumulation of greenhouse gases (GHGs) (e.g. CO_2, methane; rise $CO_{2\ level}$ is now ~50% larger than before the industrial revolution) in the atmosphere leading to increased planetary heat-trapping and global warming.
- The IPCC (an intergovernmental panel on climate change established by the World Meteorological Organization and the United Nations), Sixth assessment report (IPCC, 2022) strongly suggests that limiting global warming to 1.5ºC above pre-industrial levels will be needed to avoid severe climate change effects
- This will require halving global CO_2 emissions by 2030 and cutting them to net zero by 2050, as well as removing an additional 2–10 billion metric tons (Gt) of CO_2 each year.

RESOURCES

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryVolume.pdf

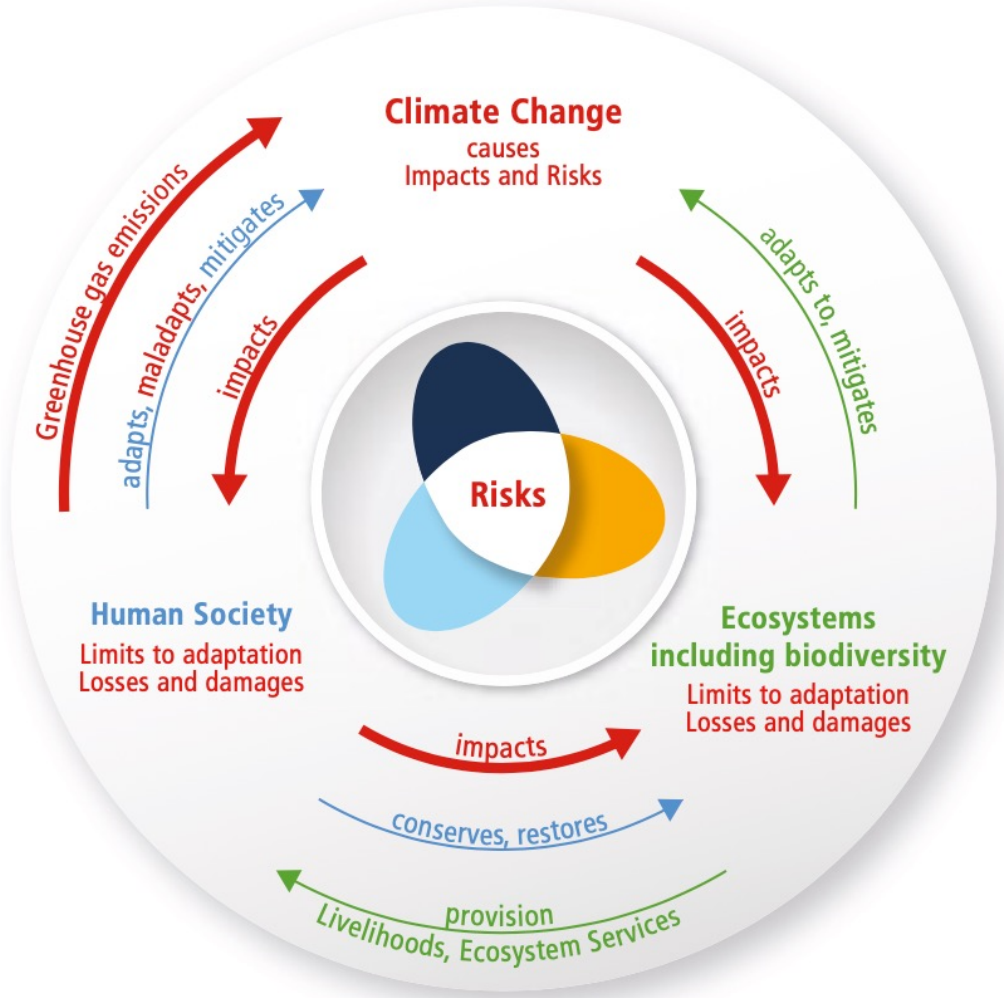
https://academic.oup.com/plcell/article/35/1/24/6759373

SSPs Shared socio-economic pathways: Sustainability, Middle of the Road, Regional Rivalry, Inequality, Fossil-fuel Development. (https://www.sciencedirect.com/topics/earth-and-planetary-sciences/shared-socioeconomic-pathways#:~:text=These%20pathways%20were%20named%2C%20from,%2C%20and%20Fossil%2Dfuel%20Development.)



From climate risk to climate resilient development: climate, ecosystems (including biodiversity) and human society as coupled systems

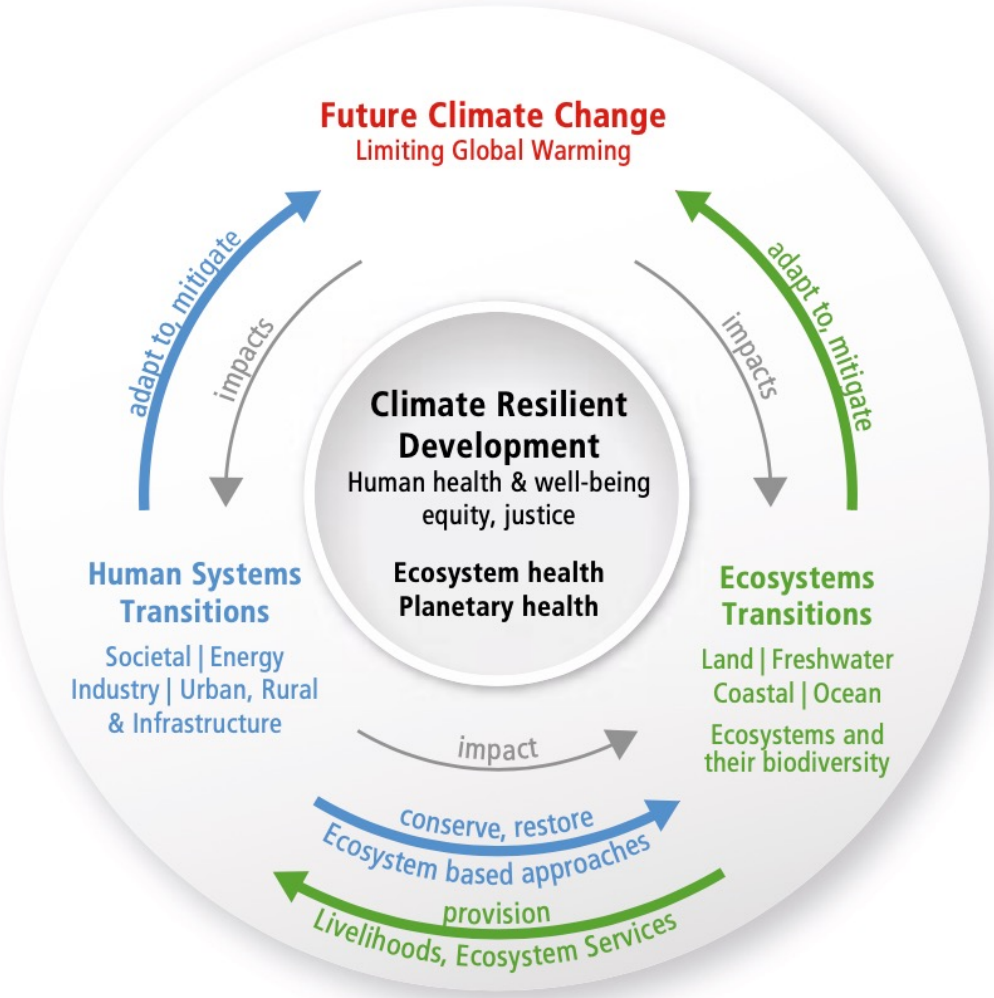
(a) Main interactions and trends



From urgent to timely action

Governance
Finance
Knowledge and capacity
Catalysing conditions
Technologies

(b) Options to reduce climate risks and establish resilience



The risk propeller shows that risk emerges from the overlap of:

Climate hazard(s)

Vulnerability

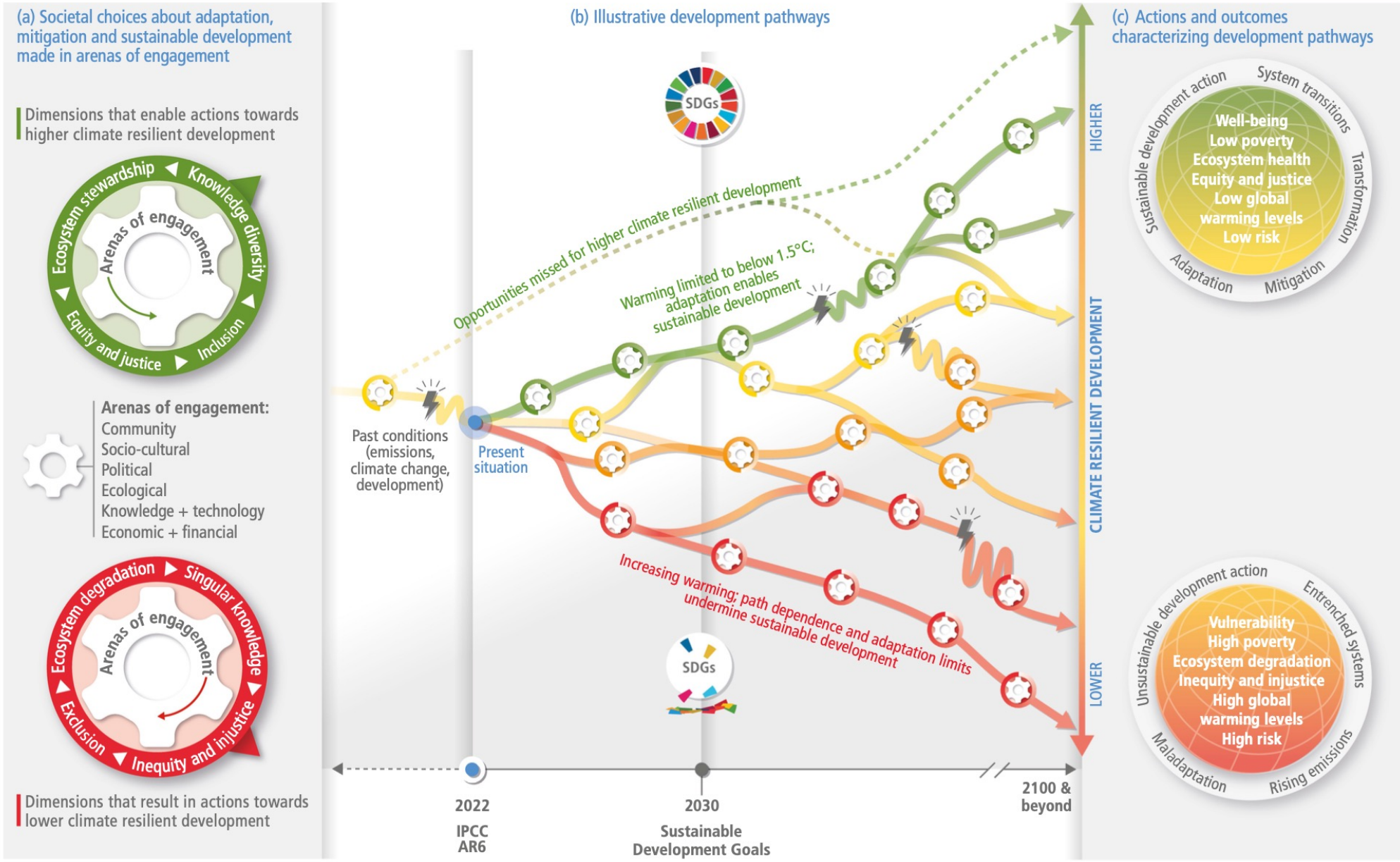
Exposure

...of human systems, ecosystems and their biodiversity

What is climate resilient development (CRD)?

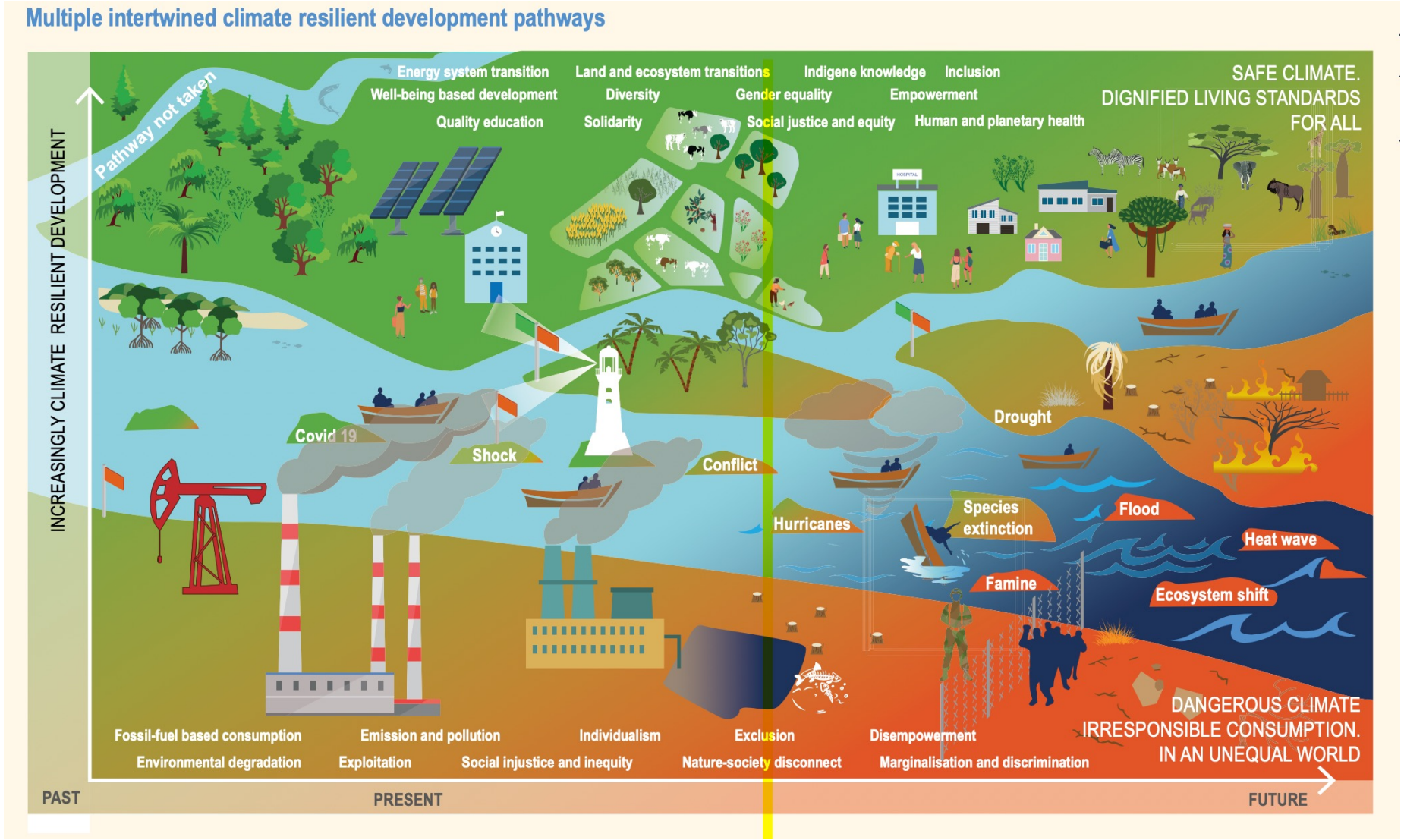
- Climate resilient development (CRD) is a process of implementing greenhouse gas mitigation and adaptation options to support sustainable development for all in ways that support human and planetary health and well-being, equity and justice.
- CRD addresses the relationship between greenhouse gas emissions, levels of warming and related climate risks.
- Hence, CRD represents development that deliberately adopts mitigation and adaptation measures to secure a safe climate on earth, meet basic needs for each human being, eliminate poverty and enable equitable, just and sustainable development.

There is a rapidly narrowing window of opportunity to enable climate resilient development



SDGs - Sustainable Development Goals

Plant solutions are just part of CRD



COURSE PROGRAMME

1. Basic concepts of climate and climate change
2. Effects of changing climatic conditions (such as increased CO_2, rising temperatures, flooding, lower N levels) on plant growth, development and physiology. Examples from the current literature
3. Molecular mechanisms of plant adaptation to major factors associated with climate change (elevated CO_2, temperature, drought and salinity). Plant memory of climate fluctuations.
4. Recent biotechnological approaches for harnessing plants to mitigate climate change effects (enhancing resilience to harsh conditions, such as heat, drought, salt stress, flooding, disease outbreaks; engineering efficient carbon-capturing and carbon-sequestering plants).

COURSE PROGRAMME

ME

1. Basic concepts of climate and climate change
2. Effects of changing climatic conditions (such as increased CO_2, rising temperatures, flooding, lower N levels) on plant growth, development and physiology. Examples from the current literature
3. Molecular mechanisms of plant adaptation to major factors associated with climate change (elevated CO_2, temperature, drought and salinity). Plant memory of climate fluctuations.
4. Recent biotechnological approaches for harnessing plants to mitigate climate change effects (enhancing resilience to harsh conditions, such as heat, drought, salt stress, flooding, disease outbreaks; engineering efficient carbon-capturing and carbon-sequestering plants).

YOU

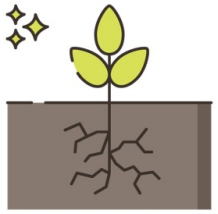
Topics chosen for this year – part 1-2

- Effects, perception and signaling of water deficit
- Effects, perception and signaling of temperature increase
- Effect of increasing CO_2, on the regulation of stomatal apertures and water-use efficiency of plants
- Integration of climate signals
- Other issues : Effects of trade off (example: carbon gain and water loss during photosynthesis: when stomata open to absorb CO_2, they lose H_2O); growth vs stress response balance. How can laboratory stress research be applied to continuously stressed plants in the field?

Harnessing plants to mitigate climate change effects - examples

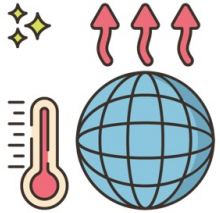
Nitrogen Use Efficiency of crops.

The N fertilizer supply chain currently contributes >2% GHG. Agriculture is both a victim and culprit of global climate change as between 20-25% of GHGs are released through agricultural activities. A switch to agro-systems utilizing crops with high nitrogen use efficiency represents an urgent priority.



Soil-Plant Health.

Soil microorganisms form beneficial symbiotic associations with plants and help plant roots in nutrient uptake and control of diseases. In the future, holistic approaches of the soil-plant-microbe ecosystem must be considered to achieve sustainable solutions related to climate change.



Carbon sequestration.

Anthropogenic climate change is irreversible over the next 10 generations at least, unless rapid measures are taken to sequester carbon dioxide from the atmosphere. Plant photosynthesis is the initial step of carbon "removal" from the atmosphere and provides a great lever to mitigate climate change.

Resilience and food security.

Growing global populations, shifting dietary patterns towards greater meat consumption, and increased food waste and spoilage at both the consumer and supply chain levels, are major factors impacting the stability and resilience of global food systems. Adopting plant-based diets remains the most efficient option. Plant scientists could contribute to the development of alternative plant-based protein sources by working with food and social scientists.