
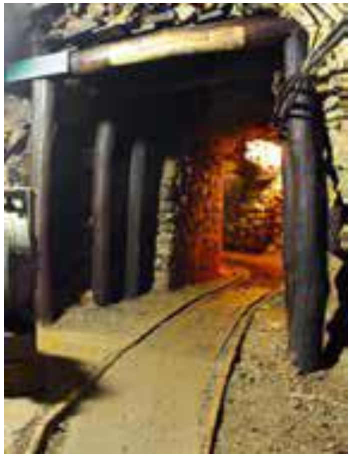


Climate Change Impacts and Adaptation in the Mining Sector

Sean Capstick, Golder Associates

Climate Change and Risk Management: Infrastructure Case Studies

IAIA Sustainable Mega-Infrastructure and Impact Assessment

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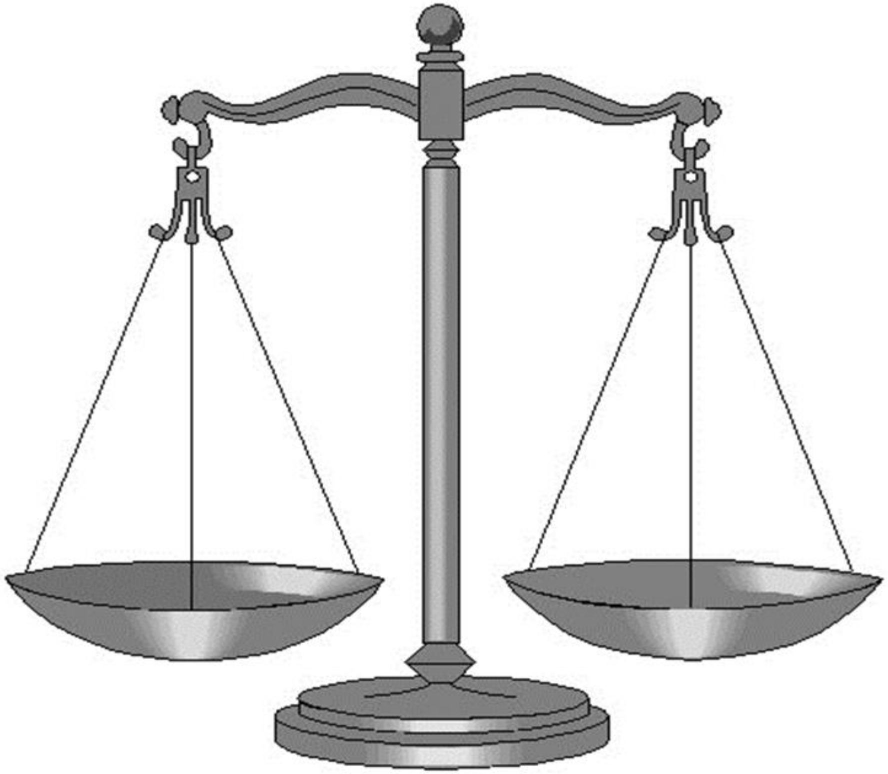
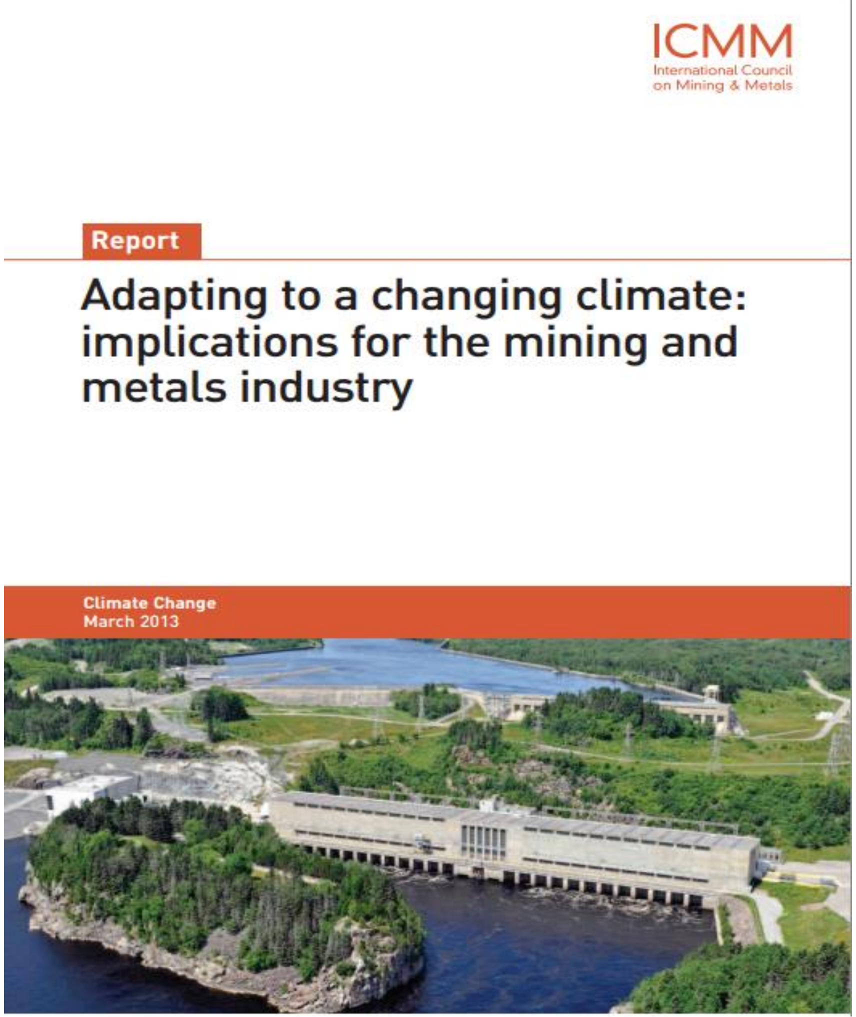
Climate Change Adaptation

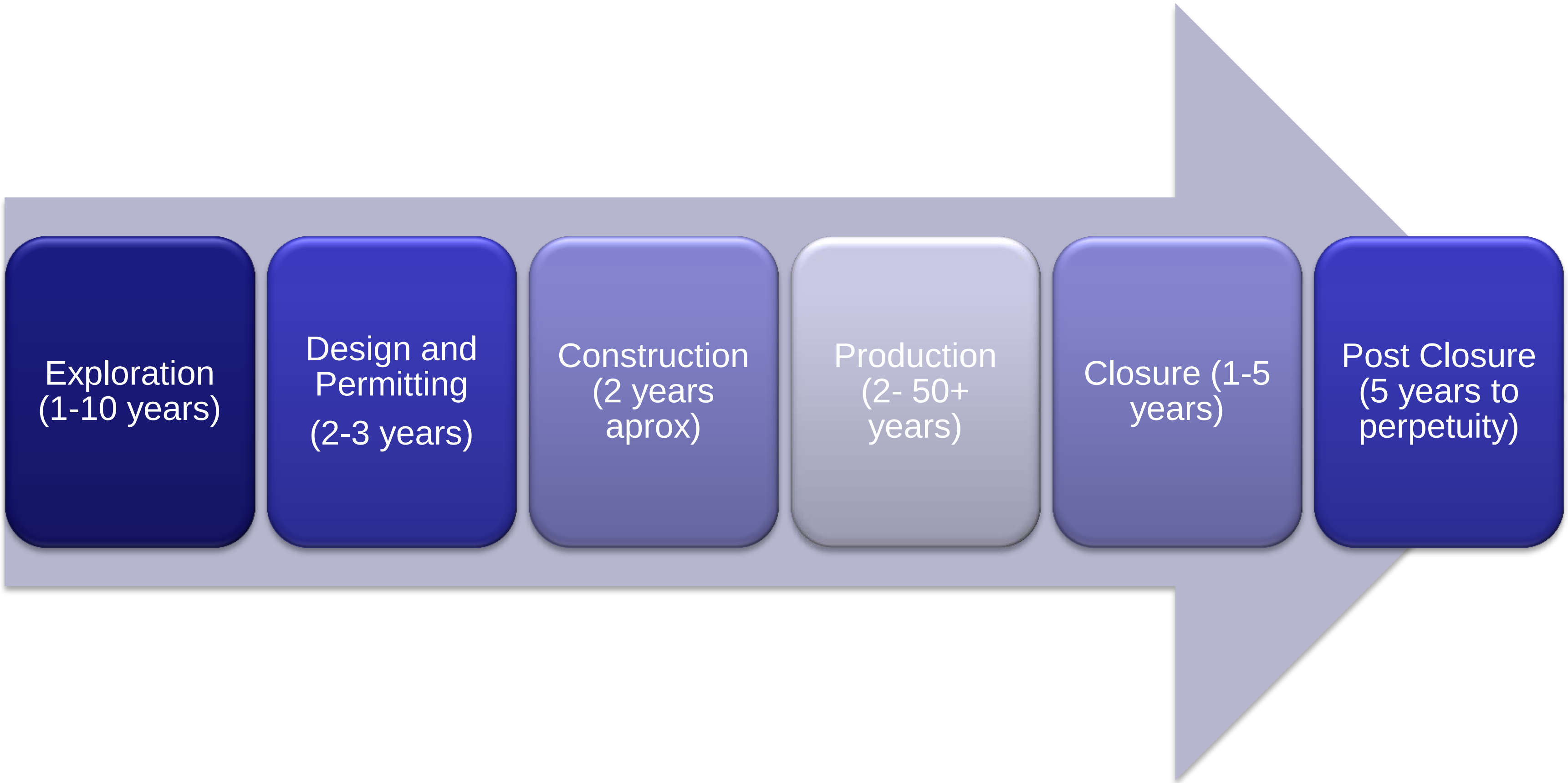


Industry Recognition of the Problem



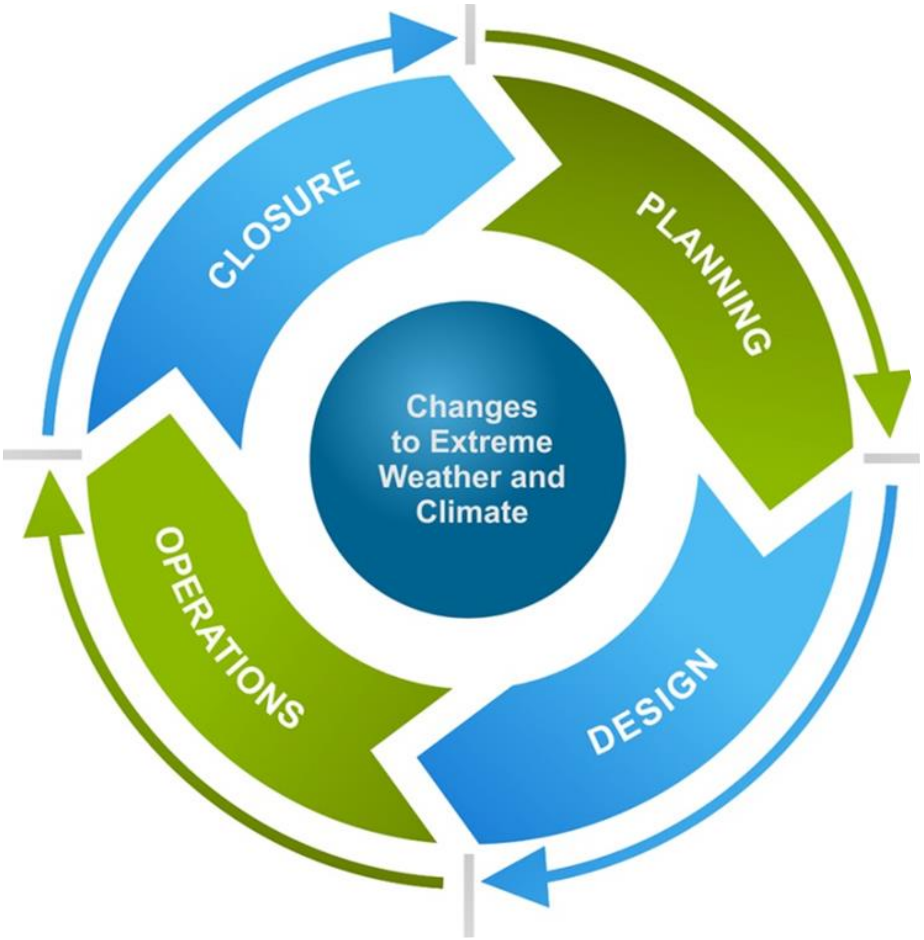
- Mines are often located in areas with extreme weather and challenging conditions
- ICMM identified a growing awareness that a changing climate and its impacts can affect the mining industry
- Report identifies potential climate impacts and how mining and metals companies can evaluate risks
- Provides available options for adapting to climate change impacts

Typical Mine Life Cycle



Incorporating Climate Change into Project Life Cycle

- Climate data is incorporated in most facets of Mining Projects and Infrastructure Design
- Design is generally based on historic climate data
  - Foundation Design
  - Material Specification
  - Tailings Dam Design
  - Outflow structures
  - Dewatering Requirements
  - Power Requirements
  - Water Supply / Water Balance
  - Closure Design
  - Transportation



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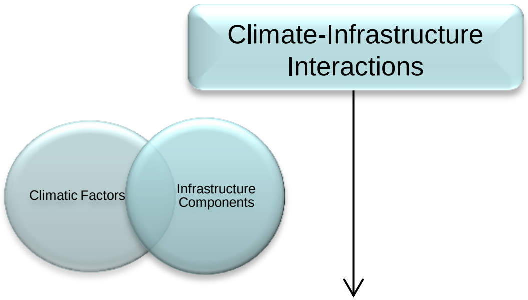
Risk Based Assessment Tools

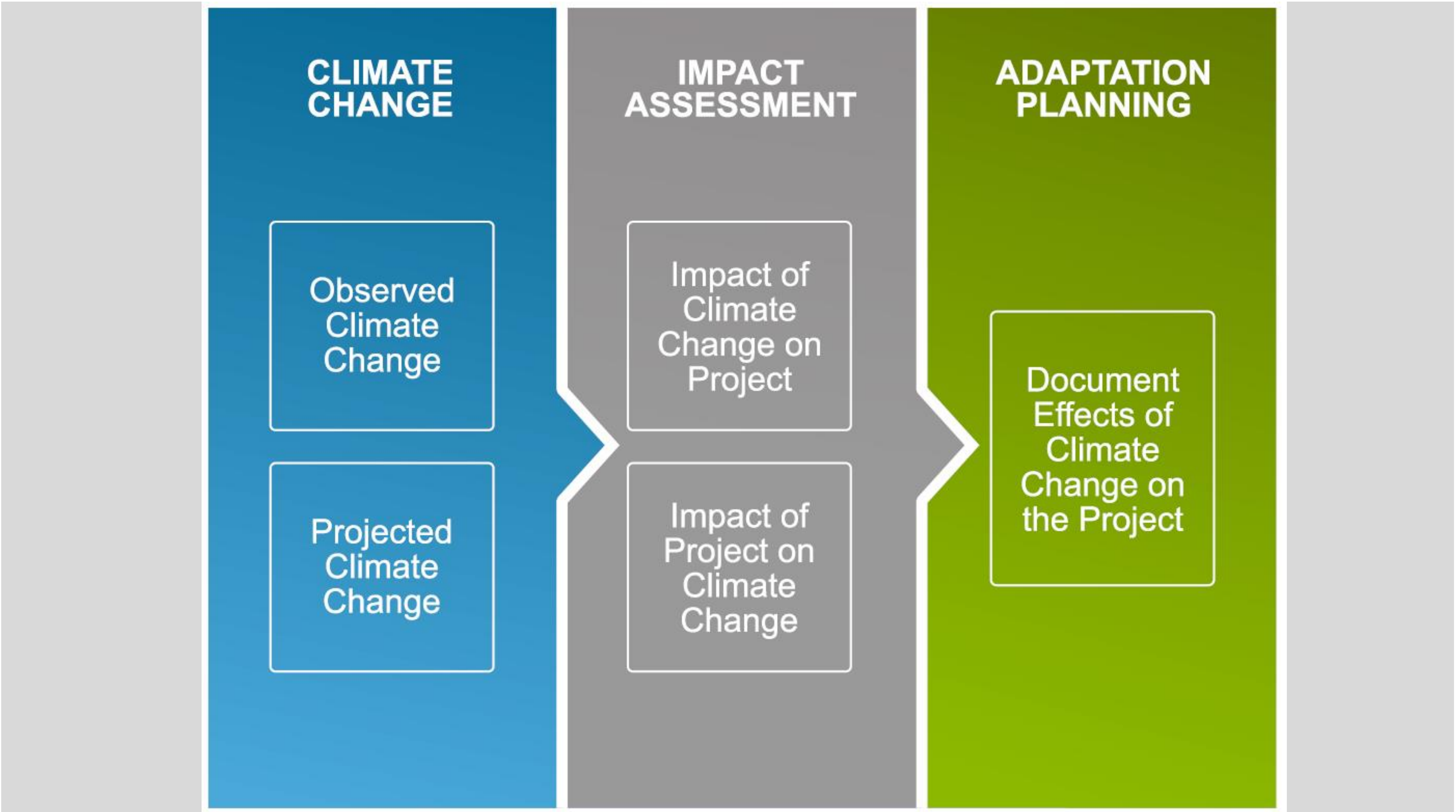
Infrastructure Component	Climate Factor				
	Temperature	Rain	Snow	Wind	Mixed Events
Stormwater, Wastewater Treatment and Collection Systems	Y	Y	Y	Y	Y
Water Resource Systems	Y	Y	Y	N	N
Ground Transportation	N	Y	Y	N	Y
Buildings and Infrastructure	N	N	N	N	Y
Environmental Compliance	Y	Y	Y	N	Y
Biodiversity	Y	Y	N	N	N
Public Infrastructure	N	N	N	N	Y



$$R = C \times P$$

R = Risk
C = Consequence
P = Probability

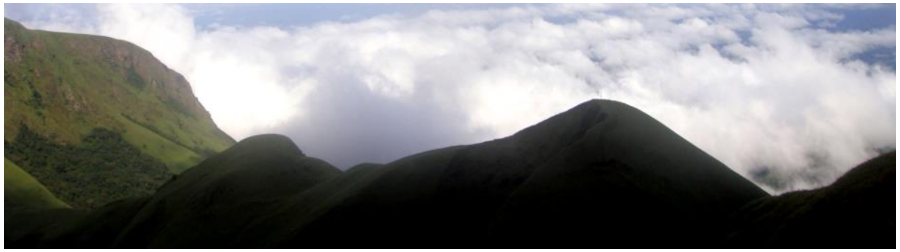
Incorporating Climate Change in to ESIA’s



Case Study: Meliadine Mine, Rankin Inlet, NU, Canada

- Project located in Canadian Arctic
- Golder completed a ESIA in 2013
- Climate Change impact assessment was an important Technical Supporting Document
- Hearings held in Nunavut in 2014
- Assessment of significance on tailings design and bio-diversity were of particular interest during the review

Case Study: Iron Ore Mine, South Eastern Guinea, West Africa



- Project located in a mountain range has an altitudinal gradient of over 1,000 m from lowland to summit
- Surrounded by an area classified under Guinean Law as a Strict Nature Reserve (SNR)
- Assessment of localized micro climate and effects of changes to topography and potential impacts to biodiversity

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Case Study: Copper Mine, Northern region of Argentina

- Project located at approximately 2,600 m asl in an arid area
- Investigation of meteorological trends that could affect the water balance, especially at closure
- Results showed that projected increases in total precipitation was within historical observations, however pan evaporation is projected to increase
- Availability of water identified as an issue

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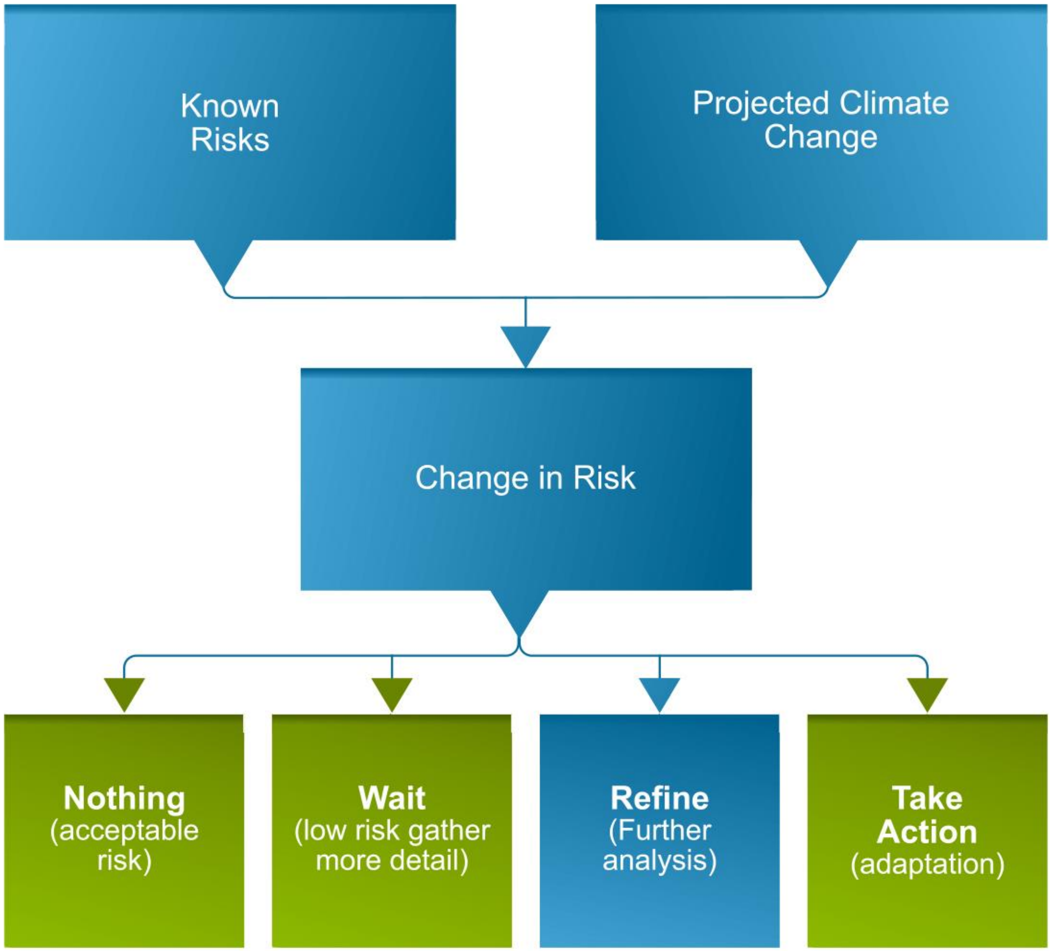
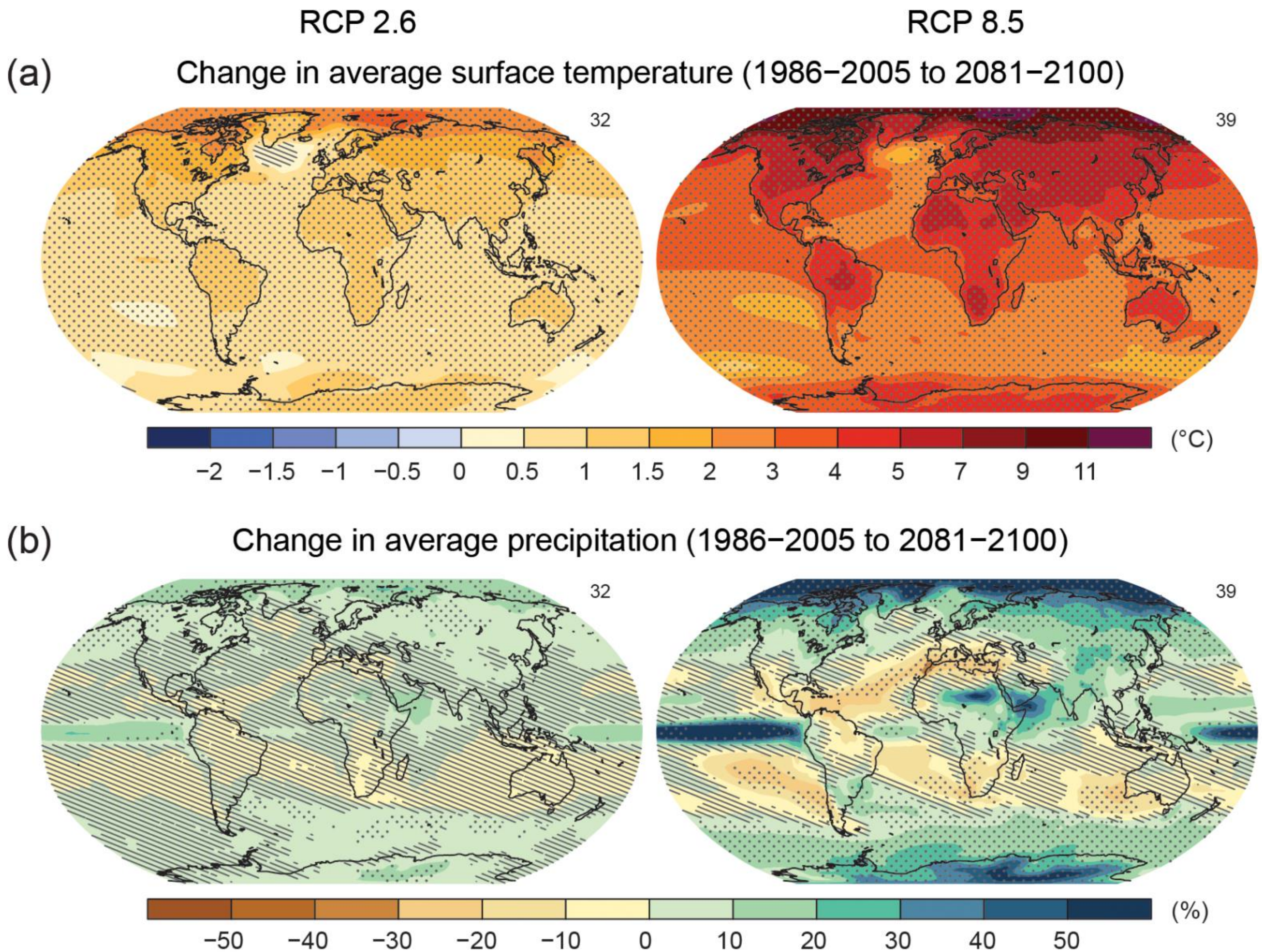
Operations and Closure



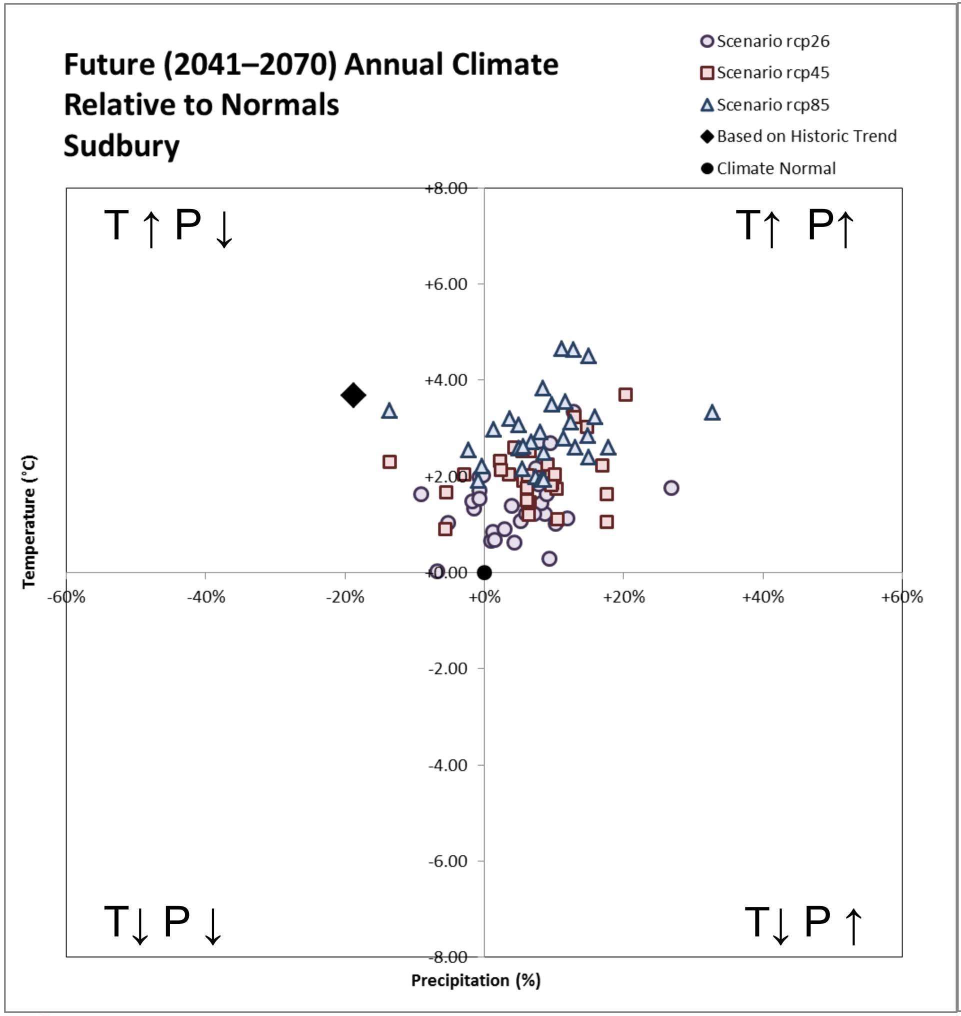
Case Study: Vulnerably Assessment, Sudbury INO ON, Canada

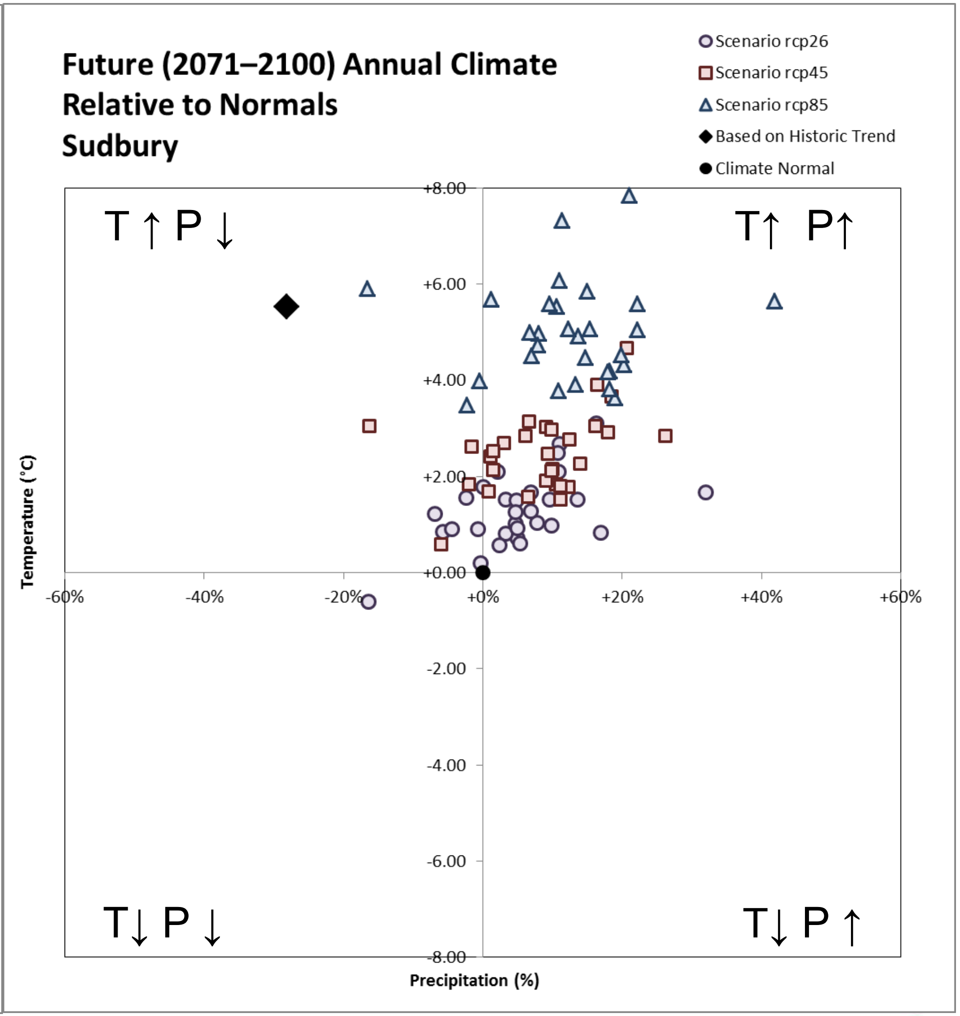
Climate-Related Risk: Adapting to What?



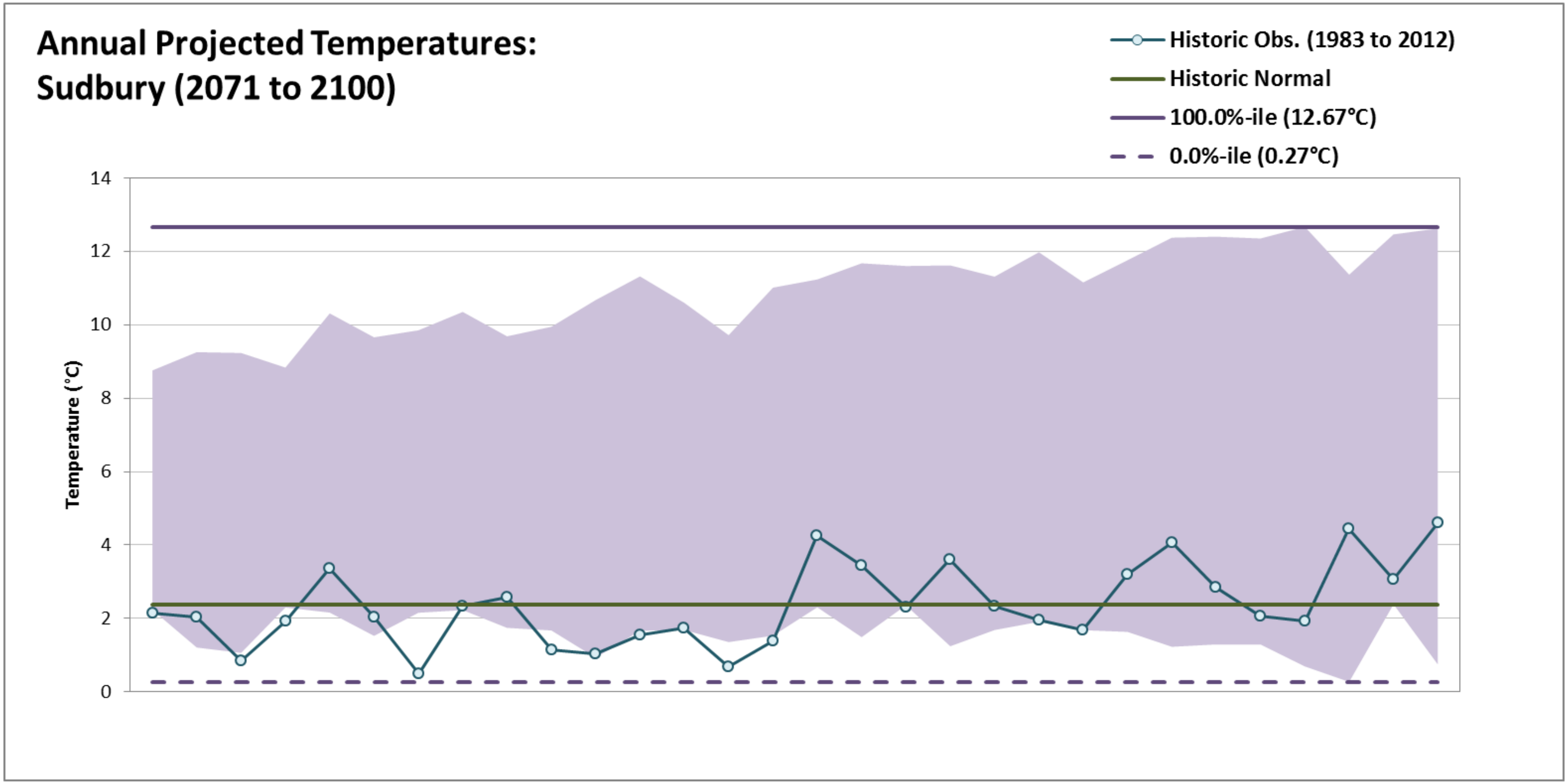
IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

GCM Output – Scatter Plot

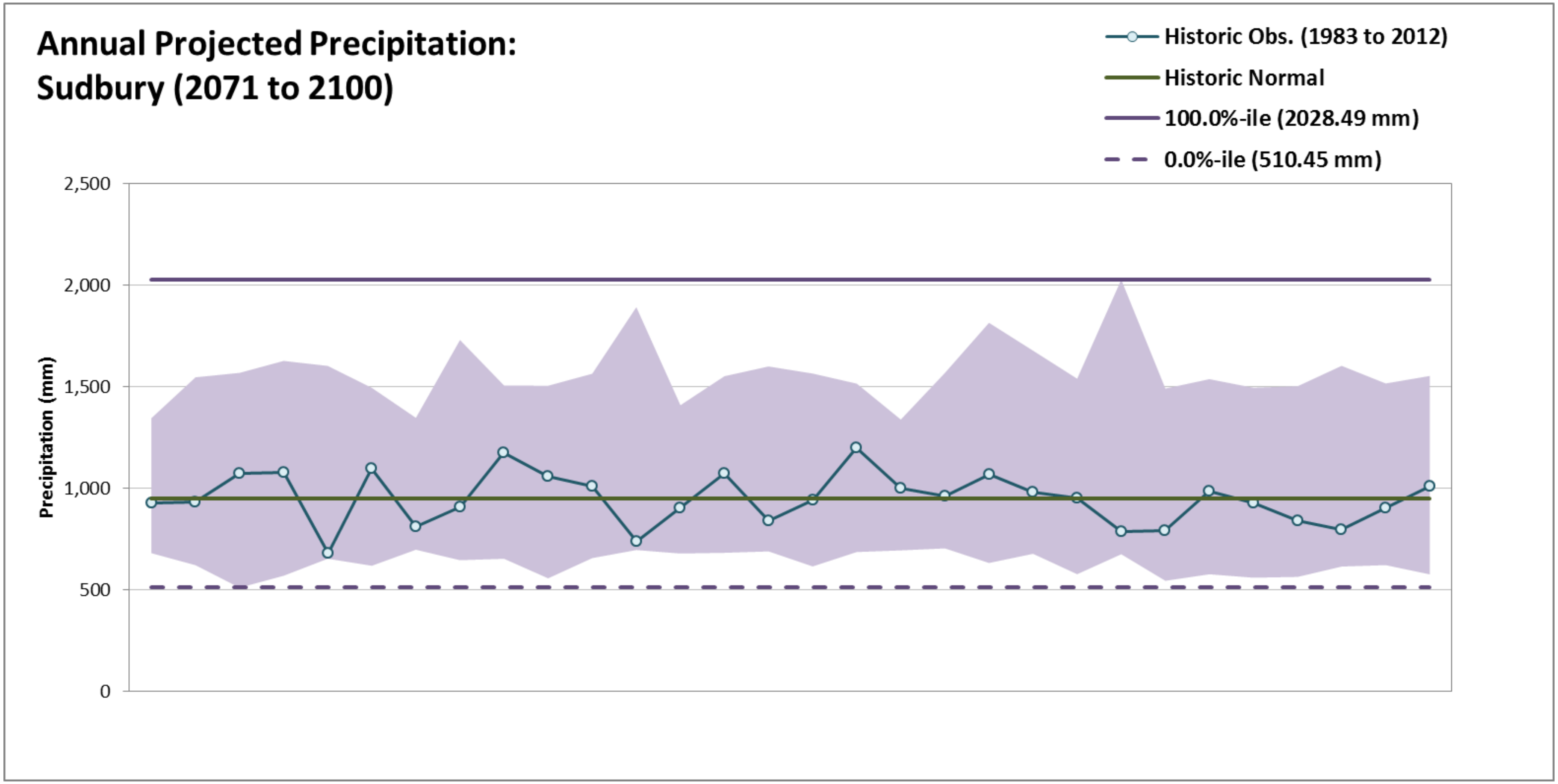




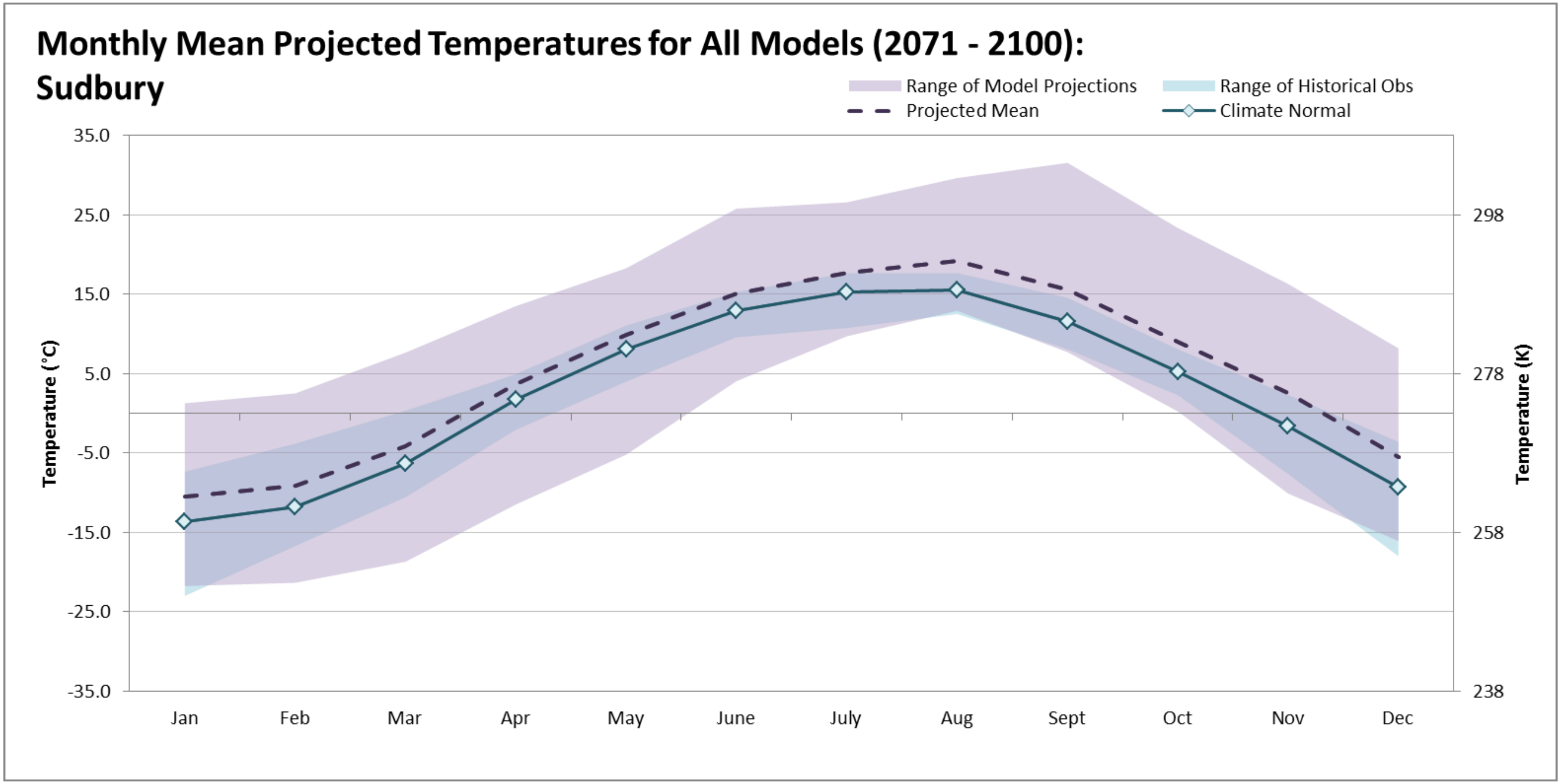
GCM Output – Cloud Graph



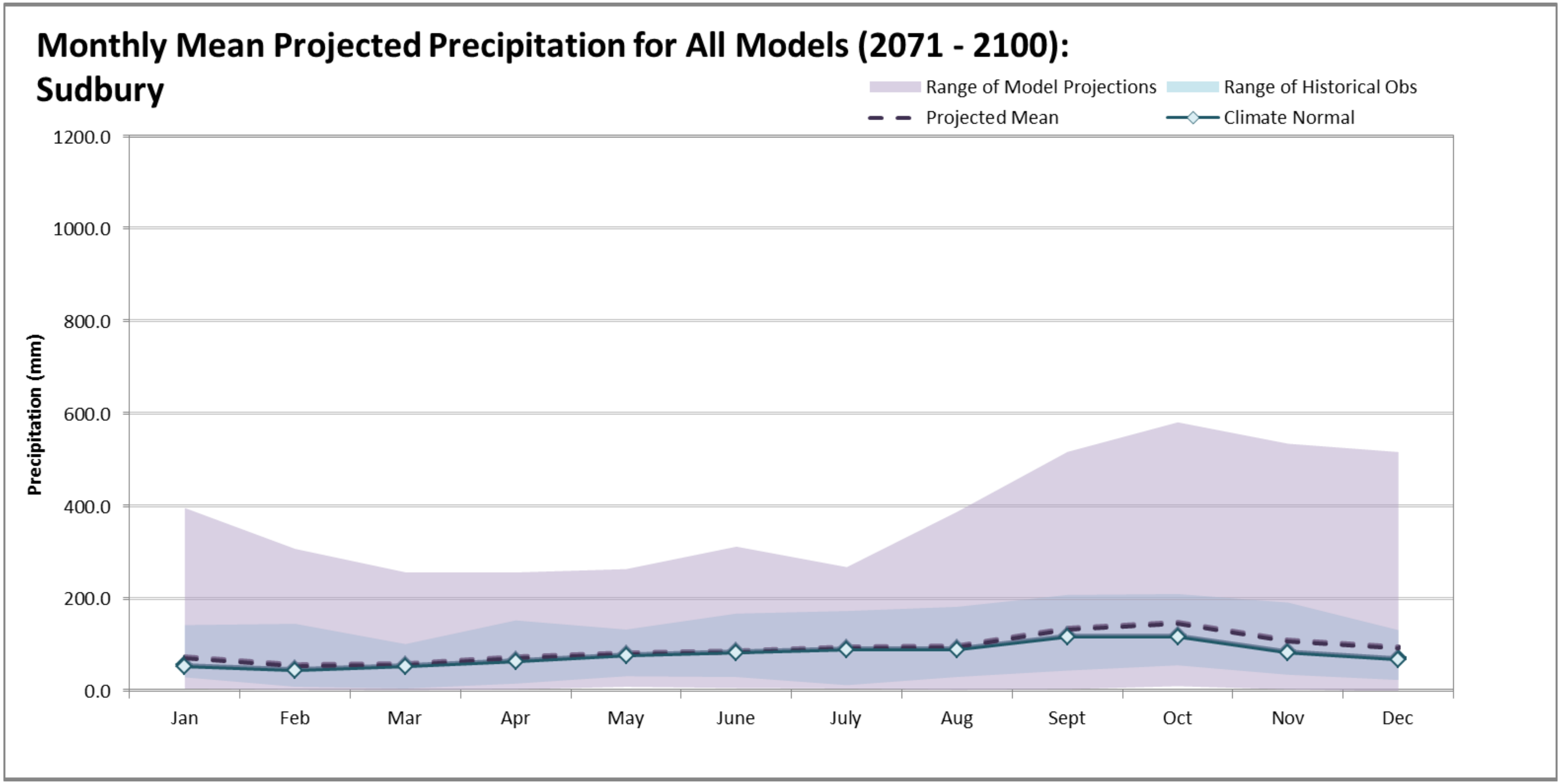
GCM Output – Cloud Graph



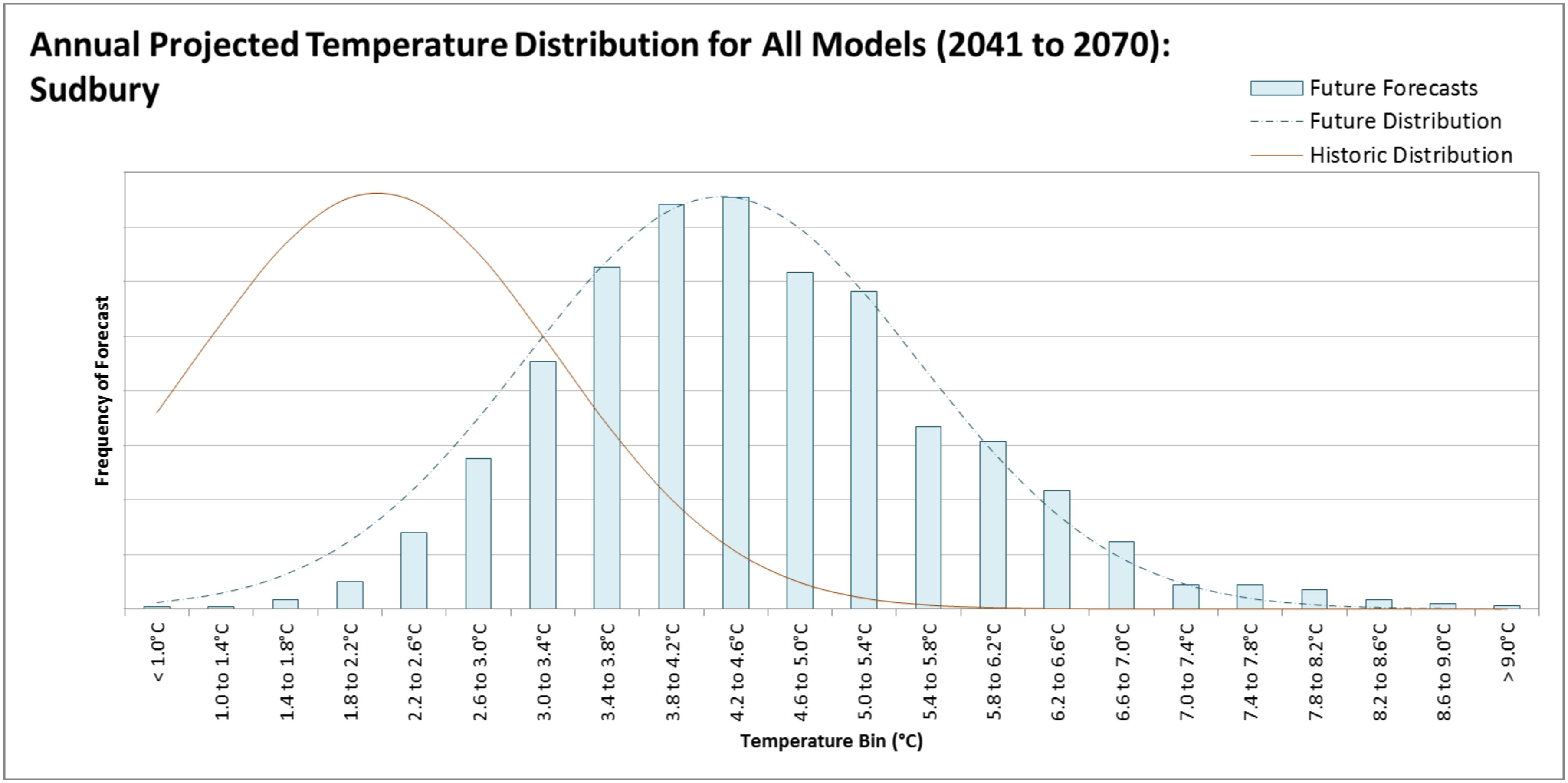
GCM Output – Cloud Graph



GCM Output – Cloud Graph

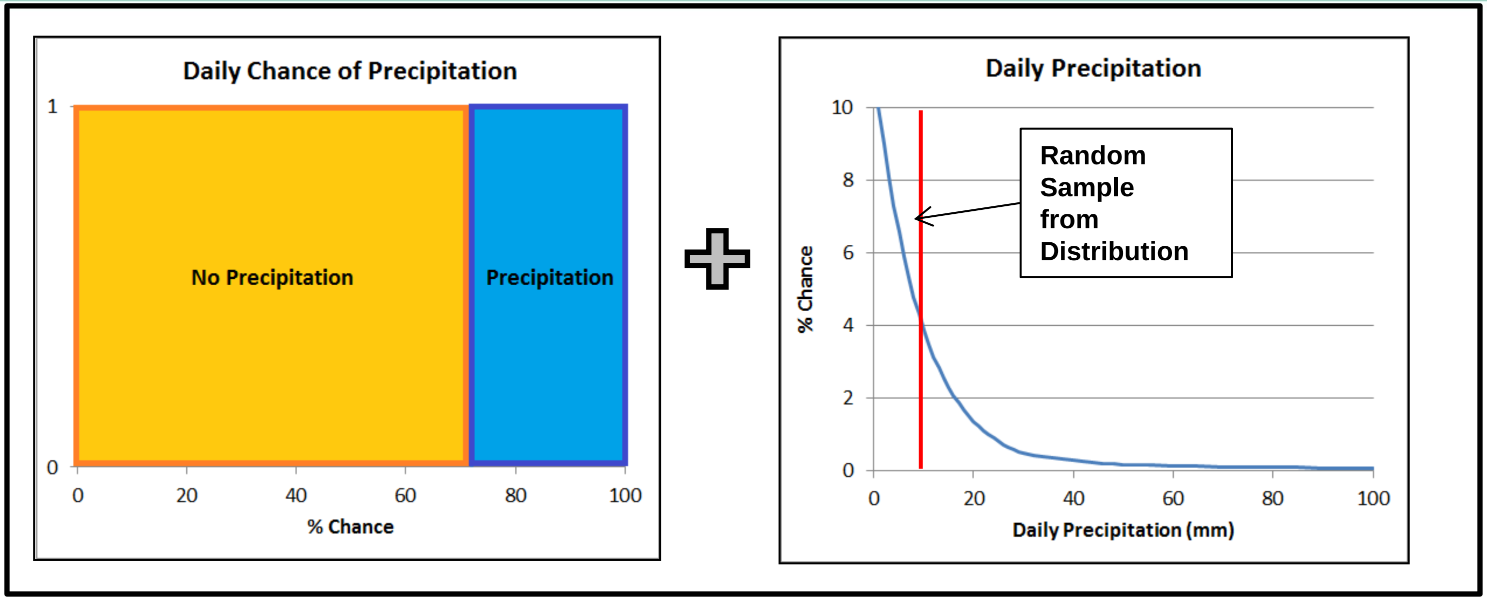


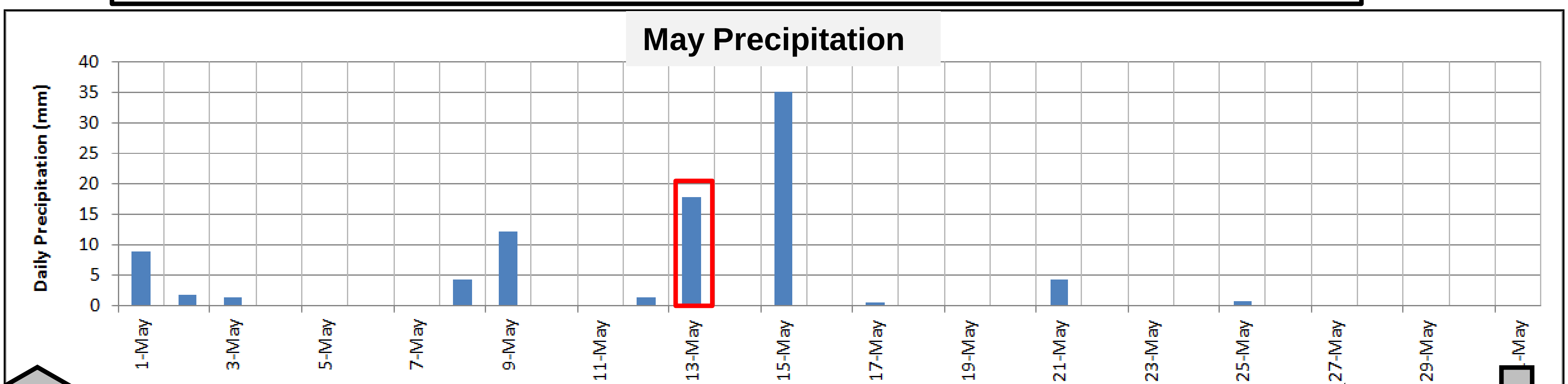
GCM Output – Histogram



The Future is Always Uncertain

Generating Climate (Precipitation)





If No, Restart

Does Sum of Daily Precipitation = Monthly Precipitation?

If Yes, Continue

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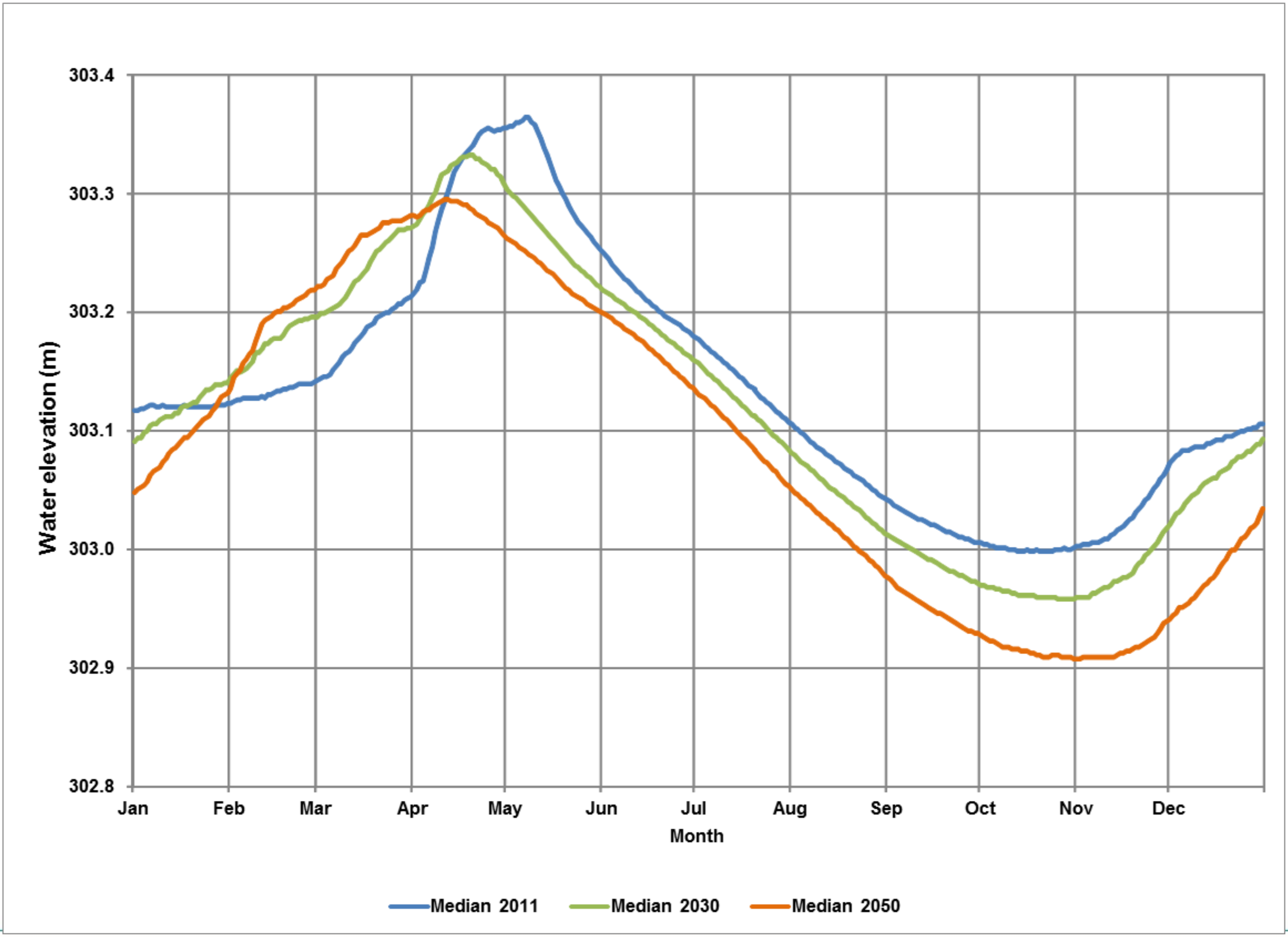
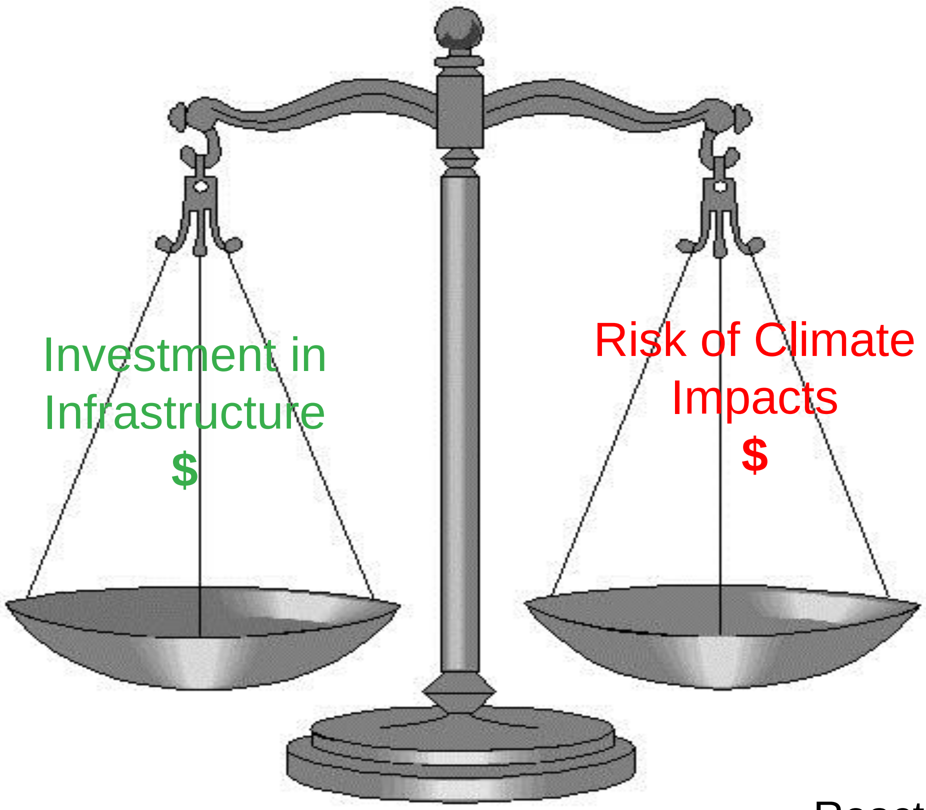
Water Management



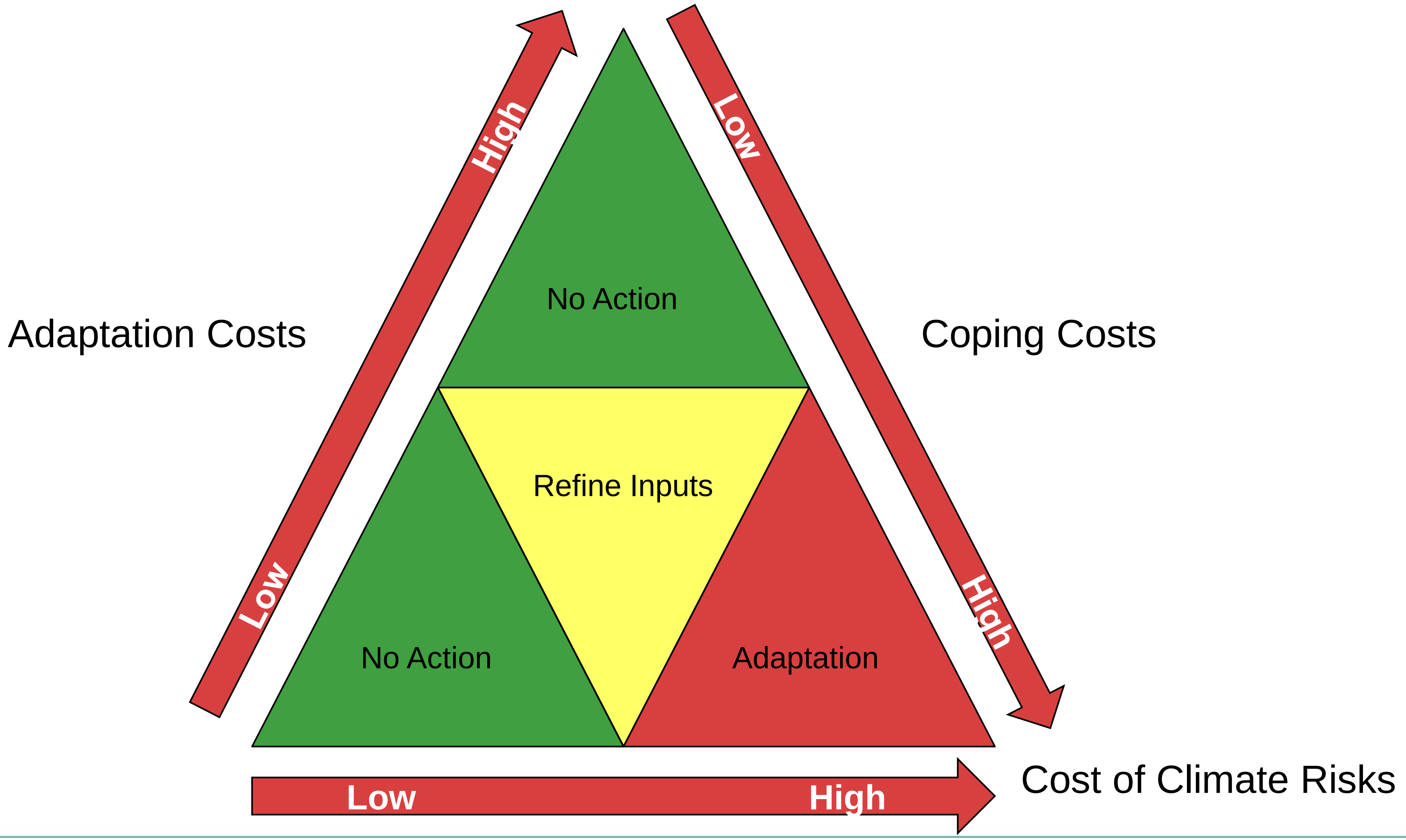
Economic Models



Planning for Future

React to impacts of climate change

CBA to Identify Adaptation Uncertainties



Summary of Results – 10 year

10 Year Period		Coping Preferred	Adaptation Preferred
		Payback Not Achieved	Payback Achieved
E1	Current Climate	89.5%	10.5%
	Future Climate	86.4%	13.6%
E2	Current Climate	13.2%	86.8%
	Future Climate	1.4%	98.6%
E3	Current Climate	92.6%	7.4%
	Future Climate	44.5%	55.5%
E4	Current Climate	100%	0%
	Future Climate	100%	0%
E5	Current Climate	96.6%	3.4%
	Future Climate	71.8%	28.2%

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Summary of Results 40 year

39 Year Period		Coping Preferred	Adaptation Preferred
		Payback Not Achieved	Payback Achieved
E1	Current Climate	83.1%	16.9%
	Future Climate	79.2%	20.8%
E2	Current Climate	0.2%	99.8%
	Future Climate	0%	100%
E3	Current Climate	73.8%	26.2%
	Future Climate	4.3%	95.7%
E4	Current Climate	100%	0%
	Future Climate	100%	0%
E5	Current Climate	88.6%	11.4%
	Future Climate	30.8%	69.2%

Moving Forward

- Climate Change Impact Assessments should:
  - Clearly document both baseline and future climate projections that will be used in the assessment
  - Use a multi model and multiple concentration pathways analysis to describe the range and uncertainties of the future climate projections
  - Clearly identify the Valued Components and climate interactions that are to be considered in the assessment
  - Document the significance assessment for the identified interactions
  - Identify the proposed design features or adaptation measures (mitigation measures) that are proposed
  - Better document Adaptive Management Strategies between coping and adaptation and rational why one is preferred over the other

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