PIARC Activities on
Climate Change Adaptation and Resiliency

Climate Change: From Desk to Road

CEDR Call 2015 Climate Change – Final Conference

November 19-20, 2018 - Utrecht, Netherlands

J. Krieger – Division Bridges and structural Technology, Federal Highway Research Institute (BASt), Germany

PIARC - Strategic Plan 2016-2019

The Strategic Plan for 2016-2019 sets the organization structure of the Technical Committees according to five Strategic Themes:

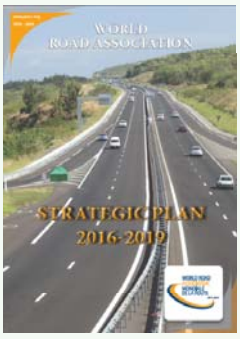
Strategic Theme A - Management and Finance

Strategic Theme B - Access and Mobility

Strategic Theme C – Safety

Strategic Theme D – Infrastructure

Strategic Theme E - Climate Change, Environment and Disasters



PIARC - Strategic Plan 2016-2019

ST E - Climate Change, Environment and Disasters

- **TC E.1 Adaptation Strategies / Resiliency**
- TC E.2 Environment Considerations in Road Projects and Operations
- TC E.3 Disaster Management

The goal of this Strategic Theme is to increase resiliency and protect investments in transportation infrastructure from impacts of climate change events while lessening the impact of road transportation on the environment.

Challenges for Owners and Operators of Roads

- Increase in traffic
- Ageing infrastructure (beyond design limits)
- **Climate Change and Extreme Weather**
- Disasters will continue to occur, whether natural or human-induced

Procedures, Methodologies to ensure availability, safety and security

Resilience Management/Resilience Engineering (all-hazard)

Climate Change

Key IPCC projections are that:

- The Earth will become warmer,
- Some regions will become wetter overall and some will become drier,
- Sea levels will rise and storm surge height will increase,
- Snow cover and the extent of sea-ice will reduce, and
- The frequency and severity of extreme weather events (such as storms, heat waves, drought and periods of prolonged and heavy precipitation) will increase.

These changes are set to have significant impacts on the design, construction, maintenance and operation of global road infrastructure.

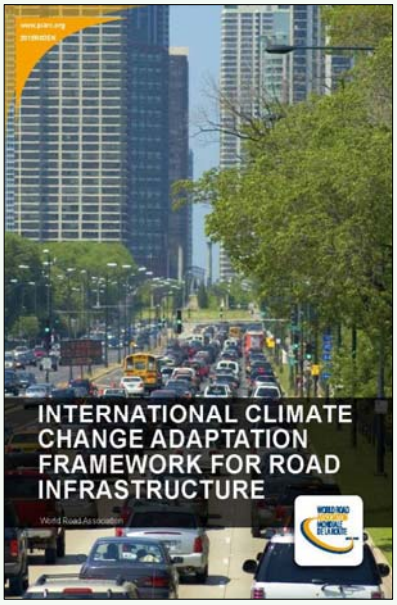
PIARC Adaptation Framework

Author(s): KIDNIE Murray; MARCHESE April; MARUNTU Cristina; MURPHY Helen; SEBILLE Robin; THOMSON Stephen
TOPLIS Caroline, AECOM Project Manager

Domain(s): Environment / Risk management

PIARC Ref.: 2015R03EN

ISBN: 978-2-84060-362-7



PIARC Adaptation Framework

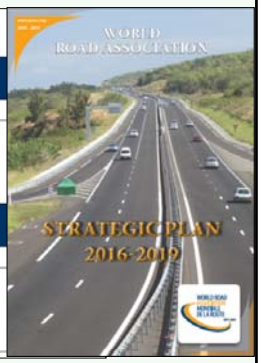
The framework guides road authorities through the process of increasing the resilience of their networks and assets through the following stages:

- Stage 1 - Identifying scope, variables, risks and data
- Stage 2 - Assessing and prioritising risks
- Stage 3 - Developing and selecting adaptation responses and strategies
- Stage 4 - Integrating findings into decision making processes

PIARC - Strategic Plan TC E.1

TC E.1 Adaptation Strategies/Resiliency

Issue E.1.1 Adaptation strategies to increase resiliency	
Strategies	***Outputs***
To investigate and disseminate information about current adaptation strategies to increase the resiliency of road infrastructure.	Report based on case studies
Issue E.1.2 Climate Change Adaptation Framework	
Strategies	***Outputs***
Refinement of the Climate Change Adaptation Framework (based on the Special Project developed in the 2011-2015 cycle) and follow-up of its implementation.	Report based on case studies



Resiliency - Characteristics

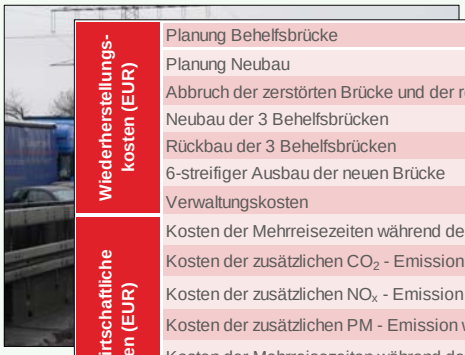
A resilient system shows:*

- reduced failure probabilities,
- reduced consequences from failures, in terms of lives lost, damage, and negative economic and social consequences,
- reduced time to recovery (restoration of a specific system or set of systems to their “normal” level of functional performance)

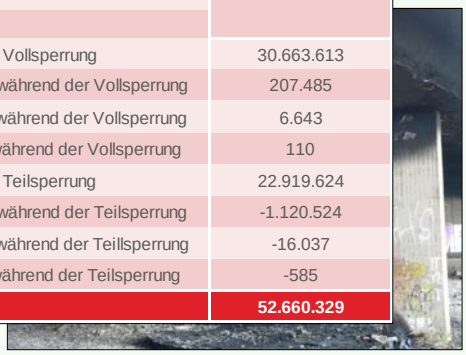
* *Bruneau. M.; Reinhorn, A.- Exploring the Concept of Seismic Resilience for Acute Care Facilities*

Motorway bridge in the course of the A57

Motorway bridge in the course of the A57



Wiederherstellungs-kosten (EUR)	Planung Behelfsbrücke	geschätzte Kosten: 3,5+6,5 Mio. EUR
	Planung Neubau	
	Abbruch der zerstörten Brücke und der restlichen Unterbauten	
	Neubau der 3 Behelfsbrücken	
	Rückbau der 3 Behelfsbrücken	
	6-streifiger Ausbau der neuen Brücke	
	Verwaltungskosten	
Gesamtwirtschaftliche Kosten (EUR)	Kosten der Mehrreisezeiten während der Vollsperrung	30.663.613
	Kosten der zusätzlichen CO_2 - Emission während der Vollsperrung	207.485
	Kosten der zusätzlichen NO_x - Emission während der Vollsperrung	6.643
	Kosten der zusätzlichen PM - Emission während der Vollsperrung	110
	Kosten der Mehrreisezeiten während der Teilsperrung	22.919.624
	Kosten der zusätzlichen CO_2 - Emission während der Teilsperrung	-1.120.524
	Kosten der zusätzlichen NO_x - Emission während der Teillsperrung	-16.037
	Kosten der zusätzlichen PM - Emission während der Teilsperrung	-585
Summe gesamtwirtschaftliche Kosten (EUR)		**52.660.329**



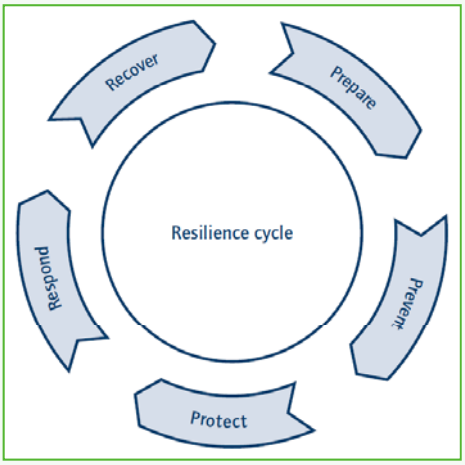
Resiliency – Definition*(one of many)

Resilience is the ability to repel, prepare for, take into account, absorb, recover from and adapt ever more successfully to actual or potential adverse events.

Those events are either catastrophes or processes of change with catastrophic outcome which can have human, technical or natural causes.

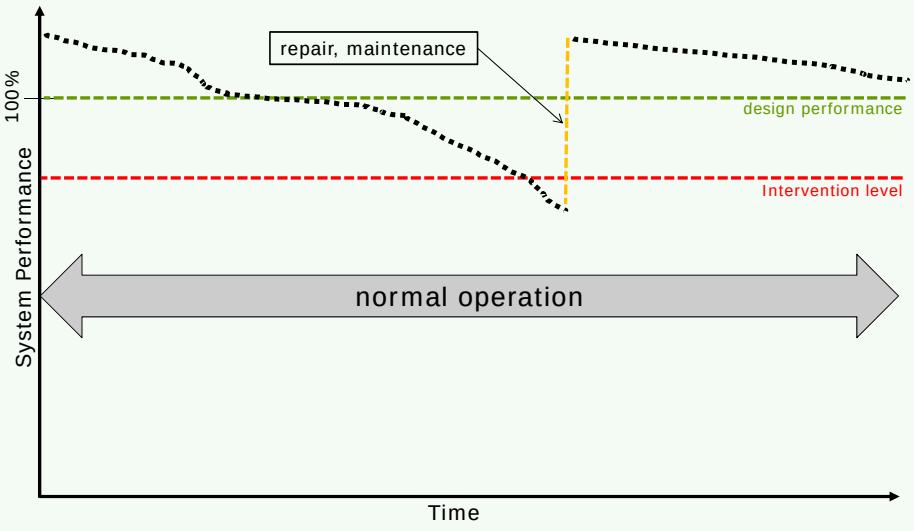
* Scharte, Benjamin/Hiller, Daniel/Leismann, Tobias/Thoma, Klaus (2014): Introduction - Thoma, Klaus (Hrsg.): Resilien Tech. Resilience by Design: Strategy for the technology issues of the future (acatech STUDY). München: Herbert Utz Verlag, 17.

Resilience – Cycle*

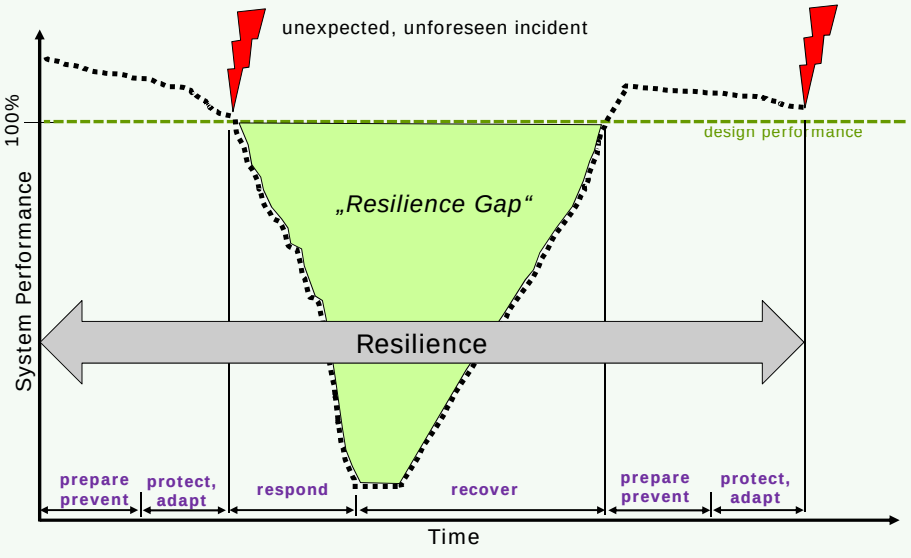


*K. Thoma, "'Resilience-by-Design': Strategie für die technologischen Zukunftsthemen, acatech STUDIE," 2014.

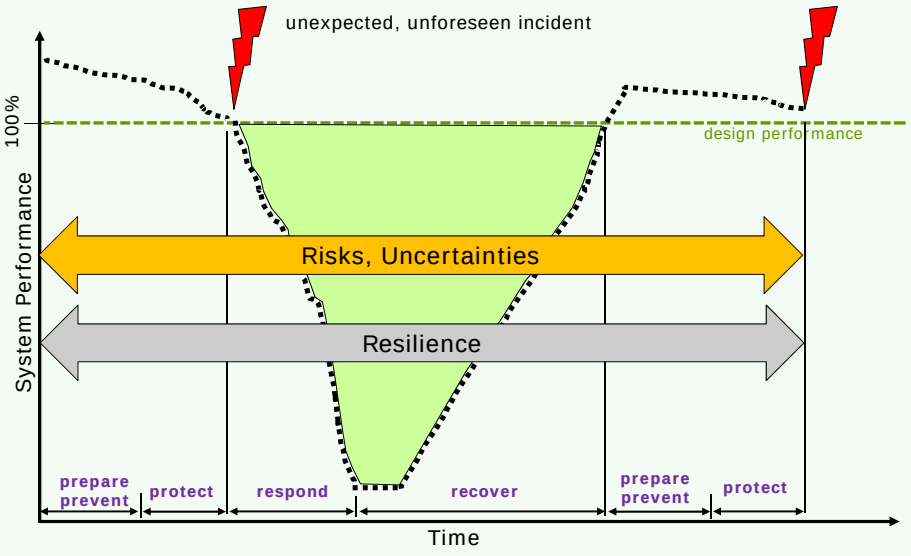
Operation of Road Infrastructure



Resilience of Road Infrastructure



Resilience of Road Infrastructure



"There are things that we know that we know;

there are things that we know that we don't know;

*there are things that we don't know that we don't know."**

Levels of Uncertainty

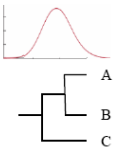
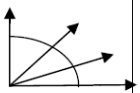
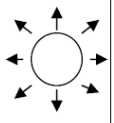
* *Donald Rumsfeld, 12 February 2002*

Levels of Uncertainty

Climate Change

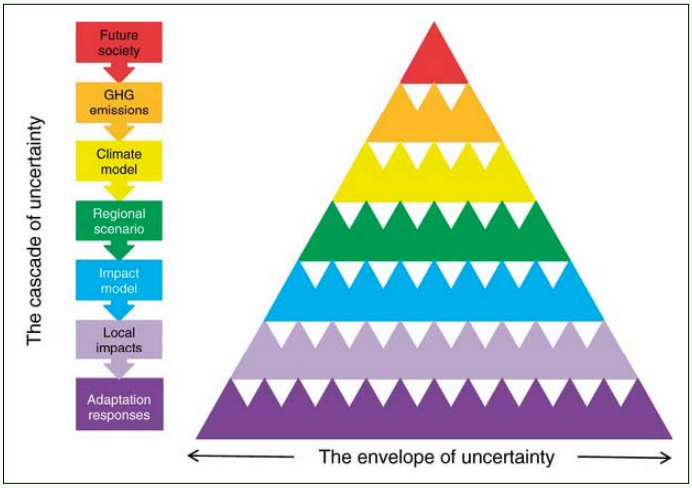
Complete Certainty

Total Ignorance

	Level 1	Level 2	Level 3	Level 4	Level 5
Context	A clear enough future (with sensitivity) 	Alternate futures (with probabilities) 	Alternate futures (with ranking) 	A multiplicity of plausible futures (unranked) 	Unknown future 
Systemmodel	A single system model	A single system model with a probabilistic parameterization	Several system models, one of which is most likely	Several system models, with different structures	Unknown system model; know we don't know

Warren E. Walker et al: Deep Uncertainty

Cascading Uncertainty – Climate Change Adaptation



Wilby, R. , Dessai, S. (2010)

Ingrid and Manuel Storms in Mexico

DAMAGE TO ROADS	
Total closure	17 roads and highways
Severe damage	57 roads, 15 highways and 980 rural roads
Total kilometers affected	5,000 km
Total bridges with damage	134
Collapsed bridges	9
Repair costs	$1,200,435,414 US Dollars

Uncertainties

Decision-making and (deep) uncertainty:*

- Robust project design despite uncertainties
- Limited usability of future forecasts (climate projections, extreme weather)

- Question: „What are the future boundary conditions that could affect the function of my system?“
- Stress Tests under consideration of all plausible and thinkable future boundary conditions
- Identification of relevant risks and specific vulnerability levels
- Analysis and assessment of options for risk reduction

*Warren E. Walker et al: Deep Uncertainty

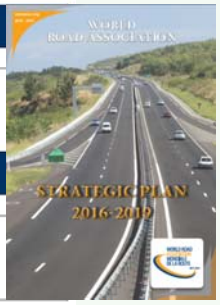
Adaptation Pathways

- Adaptation should entail a portfolio of response options
- Analysis of the possible extension over time of feasible options
- Adaptation paths enable decision making through:
  - Use of object-related thresholds;
  - Dealing with uncertainty in the main drivers;
  - Structuring a variety of adaptation options;
  - Identification of possible lock-ins; and
  - Inclusion of multiple stakeholder preferences

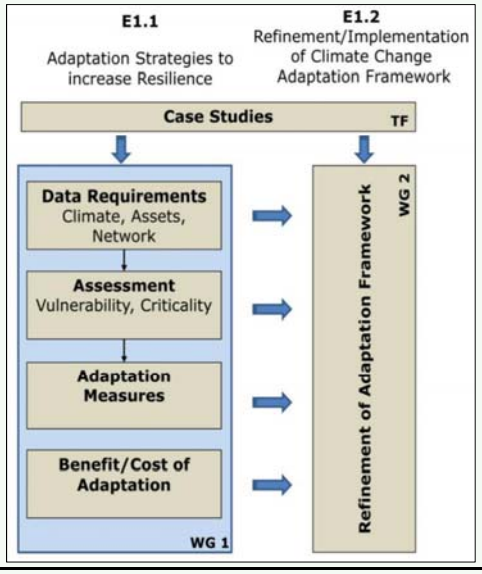
PIARC - Strategic Plan TCE.1

TC E.1 Adaptation Strategies/Resiliency

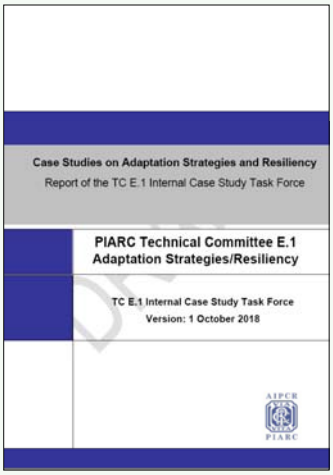
Issue E.1.1 Adaptation strategies to increase resiliency	
Strategies	***Outputs***
To investigate and disseminate information about current adaptation strategies to increase the resiliency of road infrastructure.	Report based on case studies
Issue E.1.2 Climate Change Adaptation Framework	
Strategies	***Outputs***
Refinement of the Climate Change Adaptation Framework (based on the Special Project developed in the 2011-2015 cycle) and follow-up of its implementation.	Report based on case studies

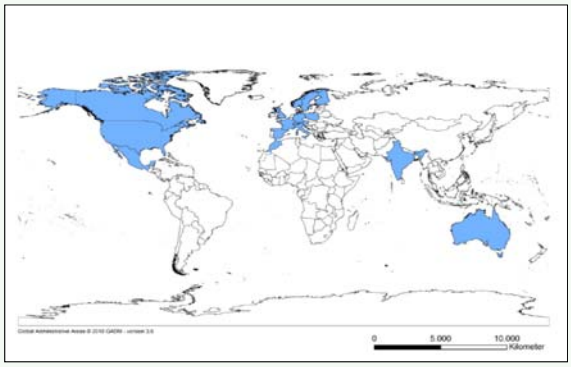


TC E.1 – Work Plan 2016 - 2019



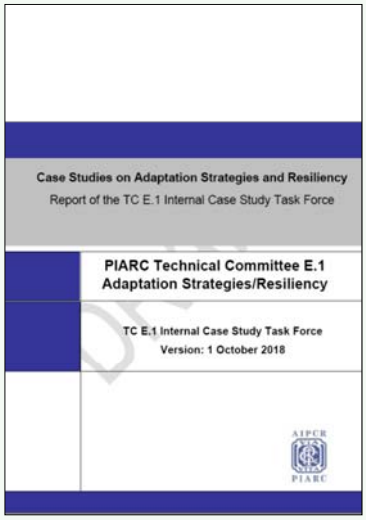
Work Plan – Task Force Case Studies

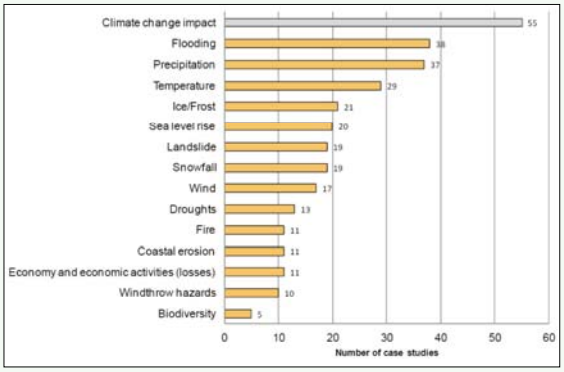




Countries (in blue) for which case studies were classified in this survey

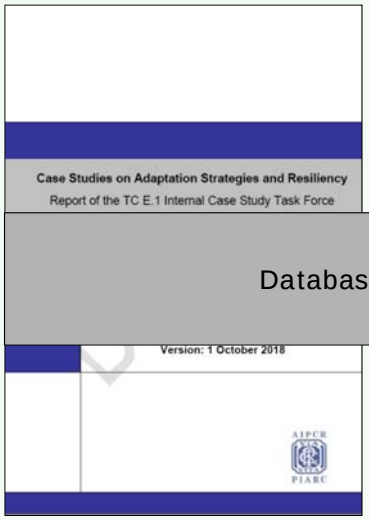
Work Plan – Task Force Case Studies



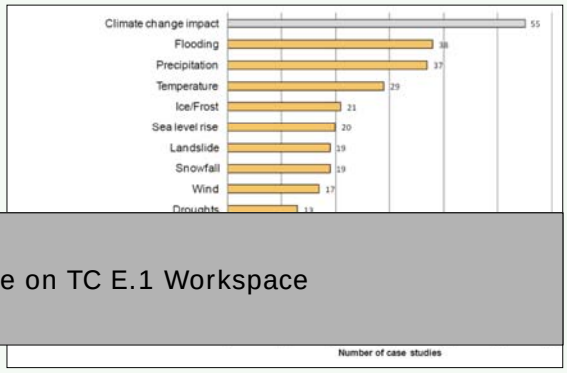


Number of case studies classified to the category "Climate change impact" and number of case studies per subcategory of "Climate change impact".

Work Plan – Task Force Case Studies

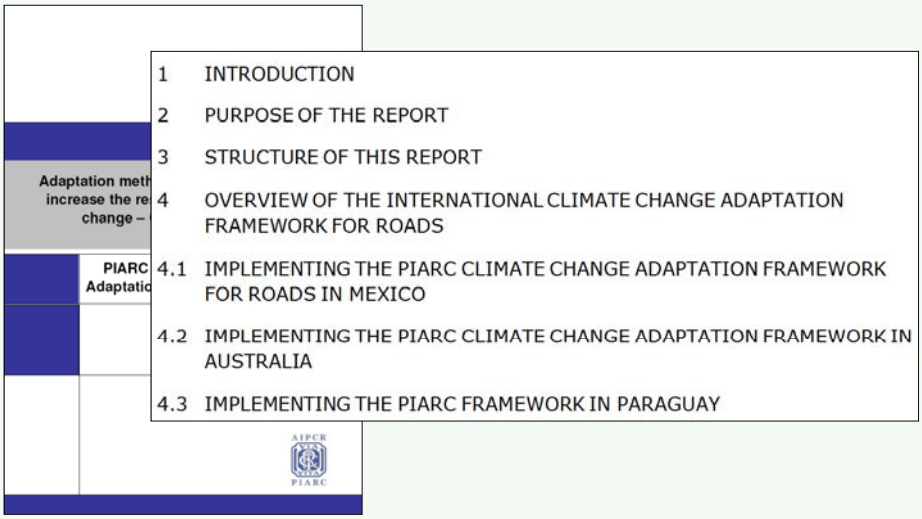


Database on TC E.1 Workspace



Number of case studies classified to the category "Climate change impact" and number of case studies per subcategory of "Climate change impact".

TC E.1 – WG1 Deliverable



1 INTRODUCTION

2 PURPOSE OF THE REPORT

3 STRUCTURE OF THIS REPORT

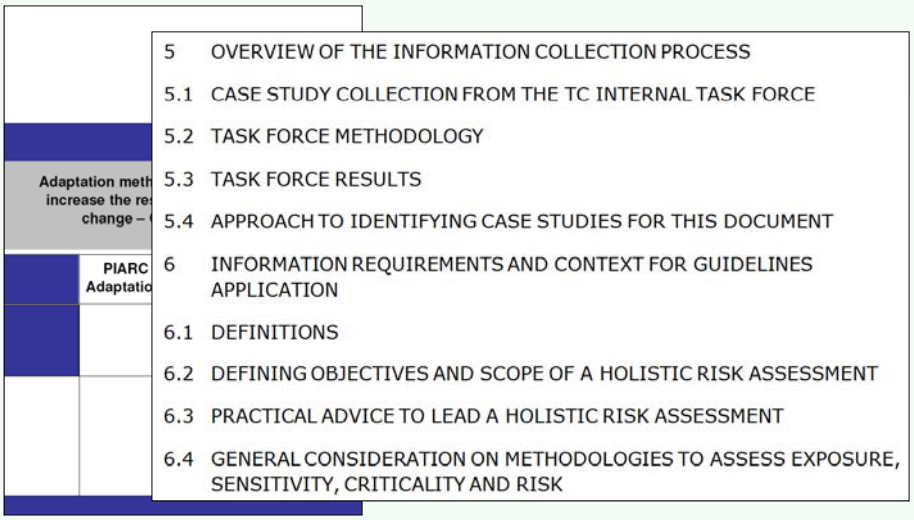
4 OVERVIEW OF THE INTERNATIONAL CLIMATE CHANGE ADAPTATION FRAMEWORK FOR ROADS

4.1 IMPLEMENTING THE PIARC CLIMATE CHANGE ADAPTATION FRAMEWORK FOR ROADS IN MEXICO

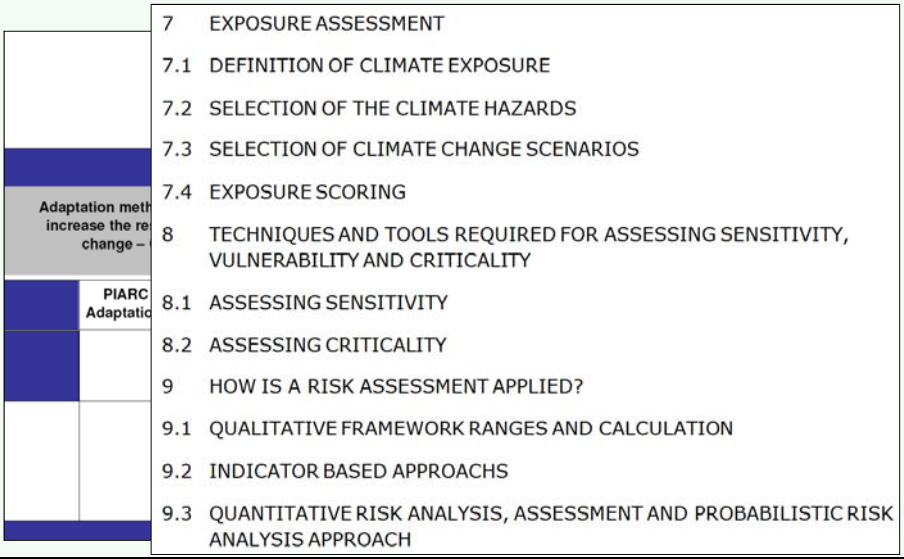
4.2 IMPLEMENTING THE PIARC CLIMATE CHANGE ADAPTATION FRAMEWORK IN AUSTRALIA

4.3 IMPLEMENTING THE PIARC FRAMEWORK IN PARAGUAY

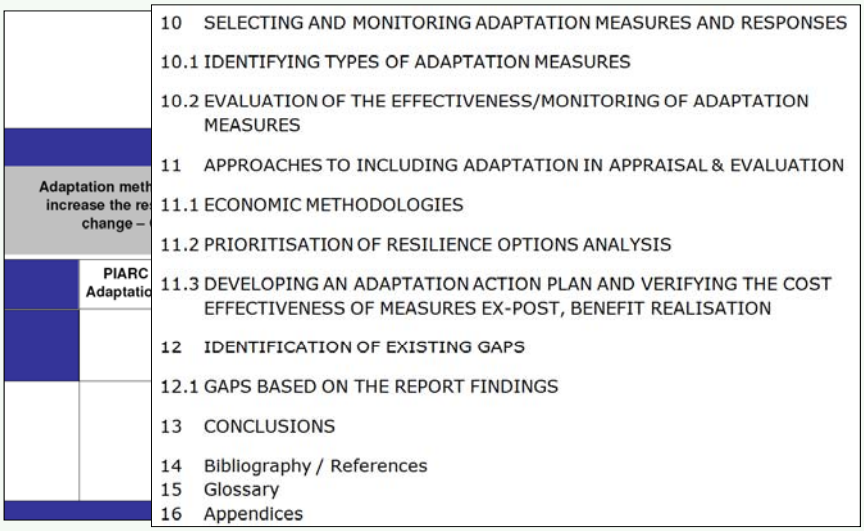
TC E.1 – WG1 Deliverable



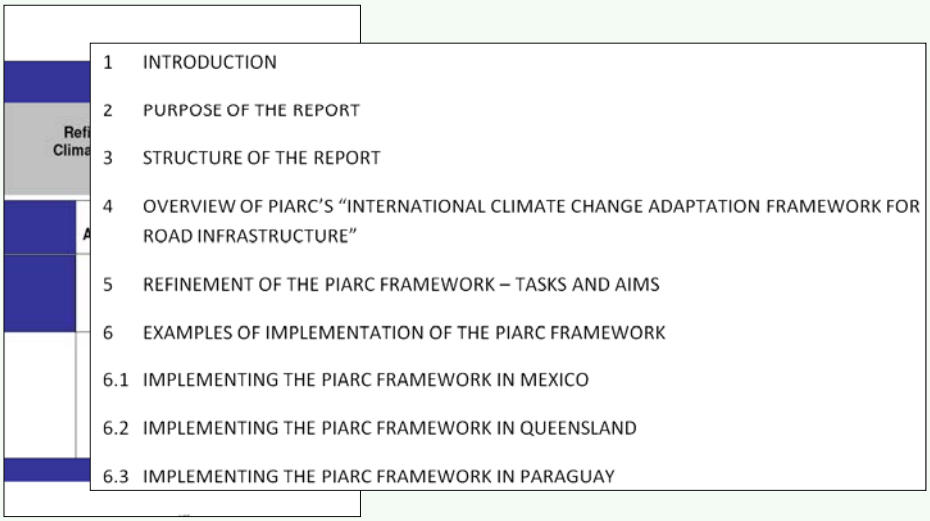
TC E.1 – WG1 Deliverable



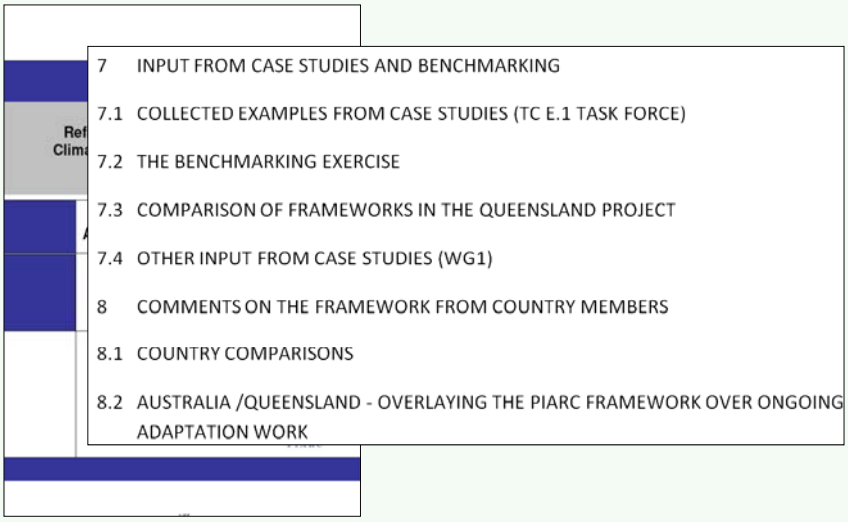
TC E.1 – WG1 Deliverable



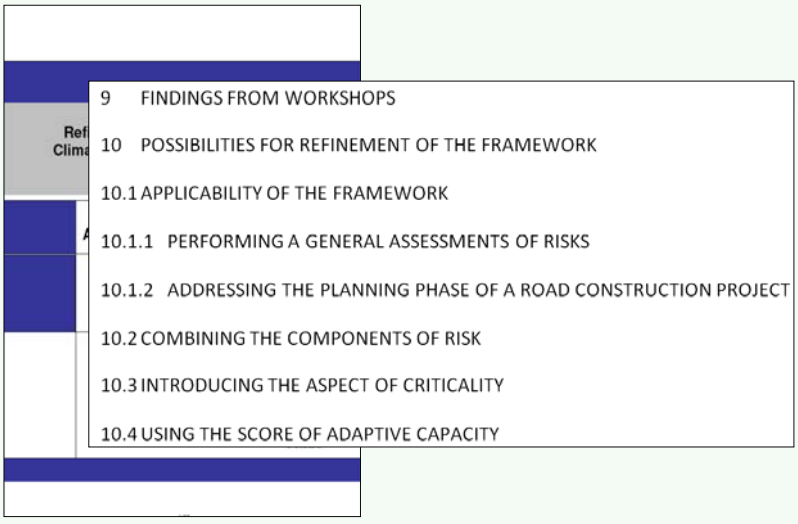
TC E.1 – WG2 Deliverable



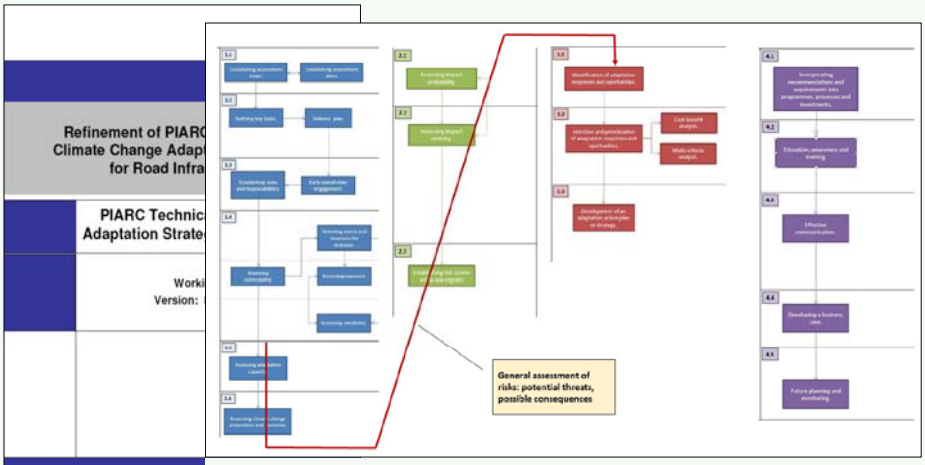
TC E.1 – WG2 Deliverable



TC E.1 – WG2 Deliverable



TC E.1 – WG2 Deliverable



Schematic presentation of the use of the Framework for a general assessment of risks

TC E.1 Adaptation Strategies / Resiliency – next steps?

Fundamental update of the PIARC Climate Change Adaptation Framework

Points to be addressed:

- Strict separation of processes and methodologies
- Division of the framework into two separate parts:
  - Part 1 should contain only processes and their description
  - Part 2 should include possible methodologies, their data requirements and application limits
- The work will be based on the more than 100 case studies already available by the end of this cycle.
- Collection and analysis of further case studies.
- Consideration of new and innovative methodological approaches and standards

Thank You very much for your kind attention!