Road Asset Management (RAM)

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Session: Climate Resilient Road Management

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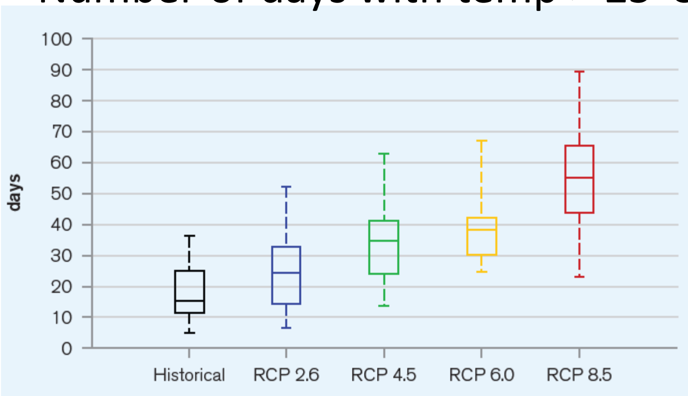
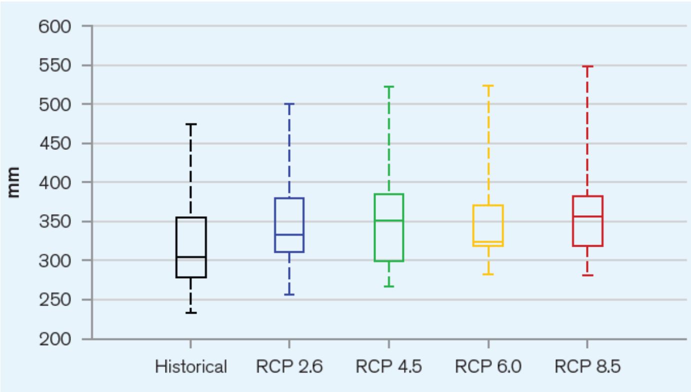
Expected Climate Impacts on Kazakhstan

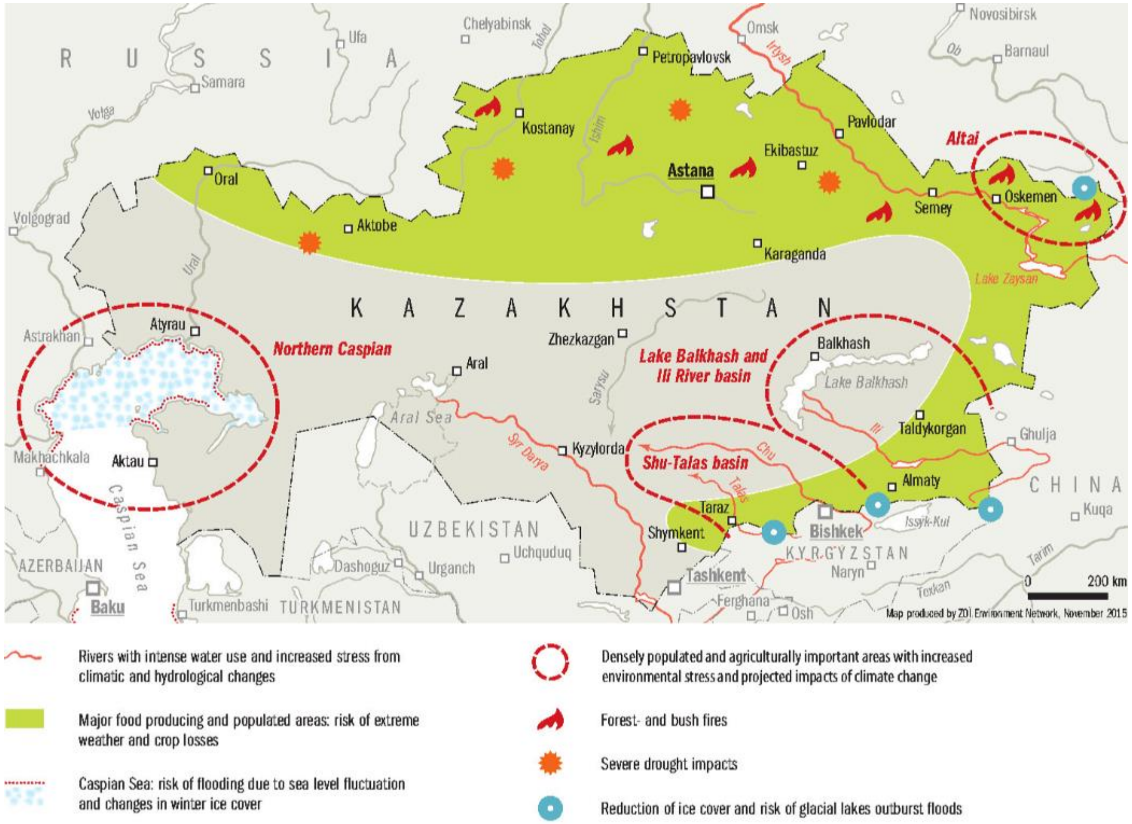
Number of days with temp > 25°C



Average annual rainfall



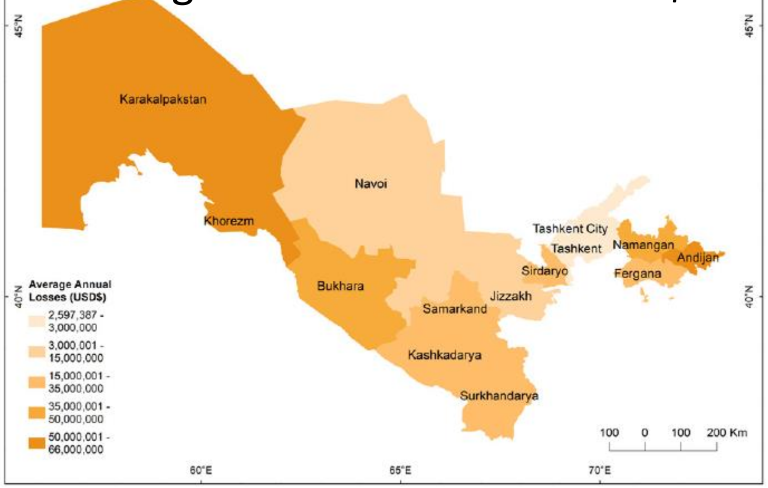
Source: World Bank



Source: Zoï Environment Network

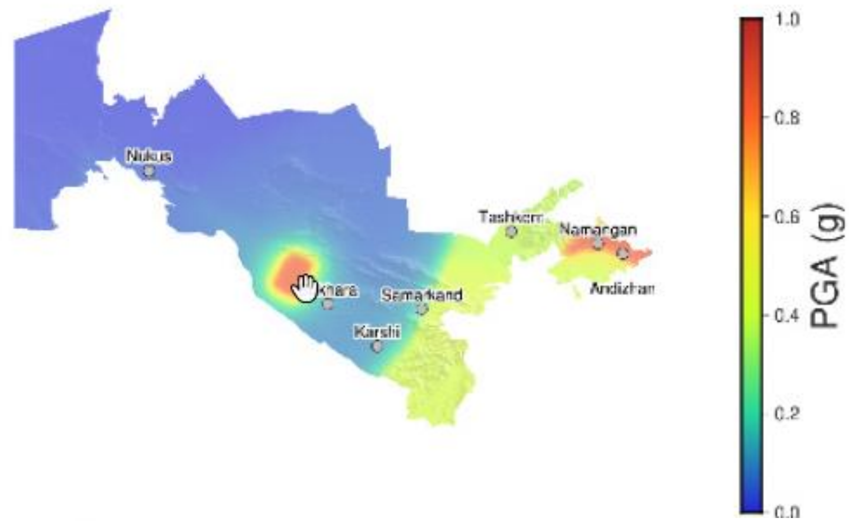
Expected Climate Impacts on Uzbekistan

Average annual flood losses US$



Flooding 1:200 years

Figure 19: Seismic hazard map for PGA with a 2% probability of exceedance in 50 years.

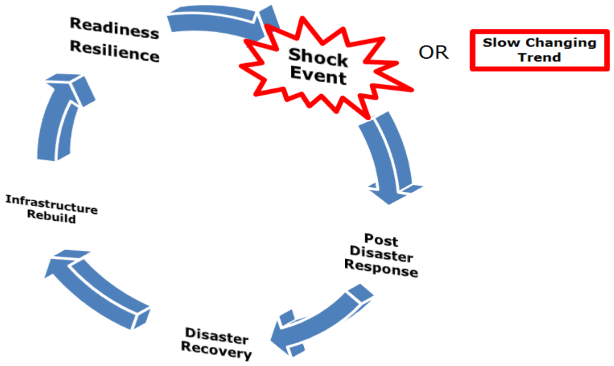


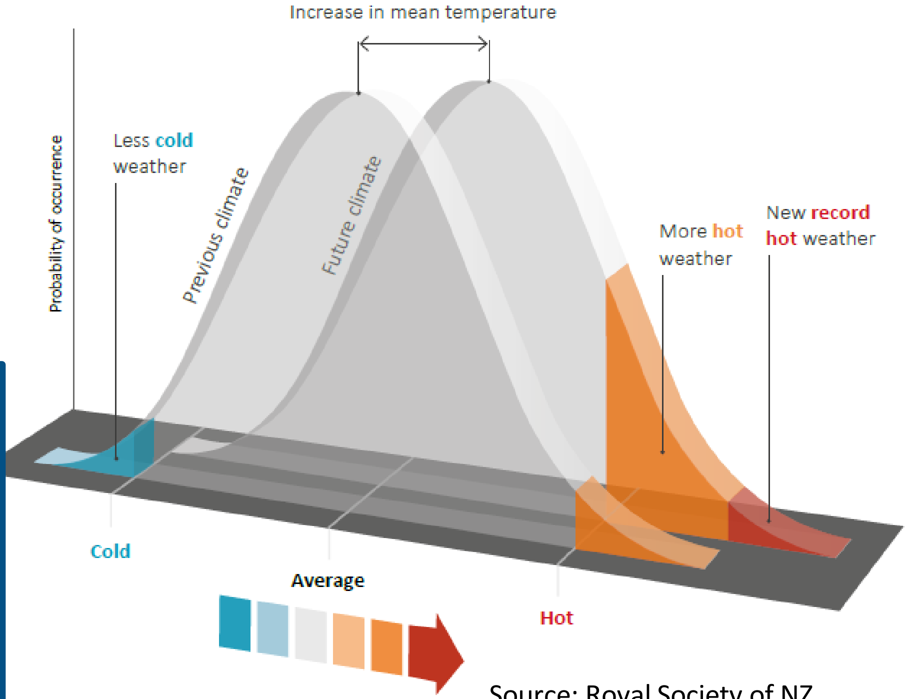
Source: CAREC

The adaptation questions we want to answer

- What level of adaptation is needed within a city/region
- Where are the priority risk exposure areas
- Where will our investment have the greatest impact to reduce damage and harm
- How could we integrate the resilience improvements with maintenance and renewals
- How could we respond and recover better from disasters

The Expected Changes on networks





Source: Royal Society of NZ

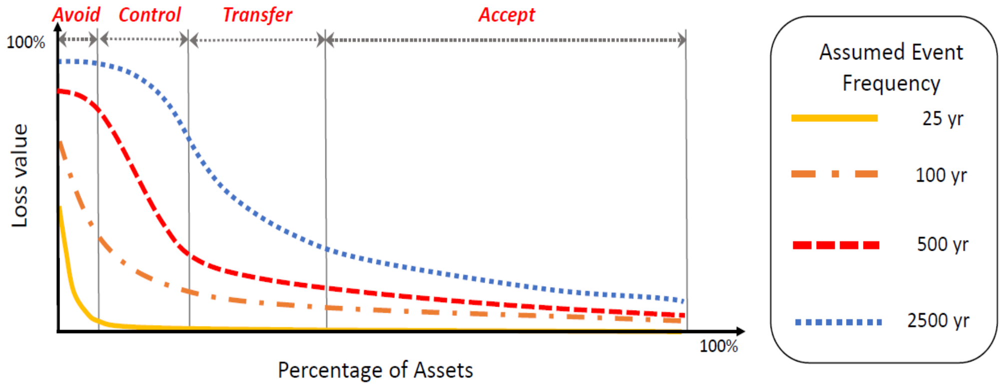
Context –The Problem we are Trying to Solve

AVOID - Reduce exposure

CONTROL - Mitigate physical impact

TRANSFER – Limit financial loss and aid recovery

ACCEPT - Adaptive response arrangements



Consider multiple possible futures, where risk(s) change with time

Source: Hugh Cowen

A Criticality framework is key for this analysis

- Avoid ->Very small portion of the infrastructure where avoiding the risks may be appropriate – e.g. coastal infrastructure that gets damaged with every storm or high tidal event.
- Accept ->large portion of most infrastructure networks where the likely loss would be minimal and investing in adaptation for these parts would be uneconomical or even unnecessary.
- Control vs Transfer -> AM system helps us answer
  - Control->portion of the infrastructure where adaptation projects will control the potential losses from events. (Good return on investment)
  - Transfer - different financing instruments such as insurance or bonds may be more practical

Financial Decision Making for Improved Resilience

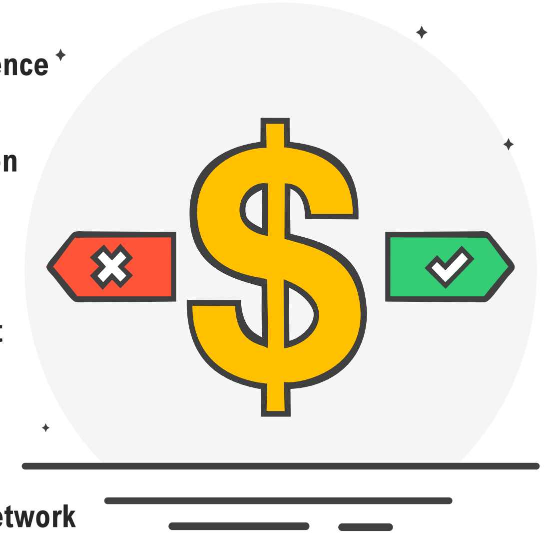
Delay Investment or Manage Risk Differently

01 **Avoid** - Extreme Risks where investment will not make a difference

02 **Transfer risk** for low risk reduction return on investment (e.g. insurance)

03 **Delay** significant investment that that is not required now (e.g. bridge relocation)

04 **Accept Risk** for majority of the network having low probability or consequences



No Regret Investment

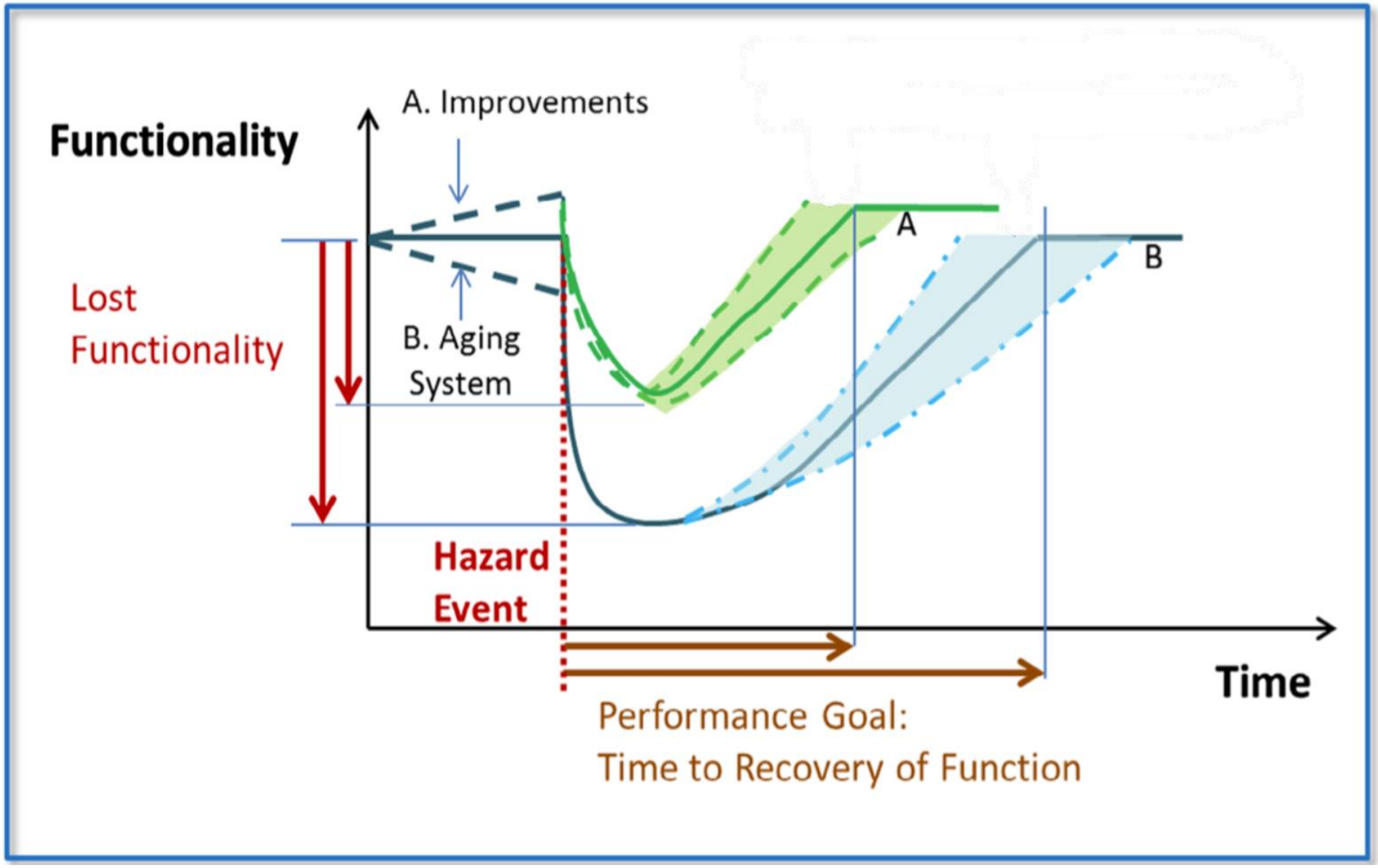
01 **Harden and protect** critical Infrastructure components

02 **Harden and protect** projects having a high risk reduction return for investment

03 **Improve emergency** and response protocols and resources

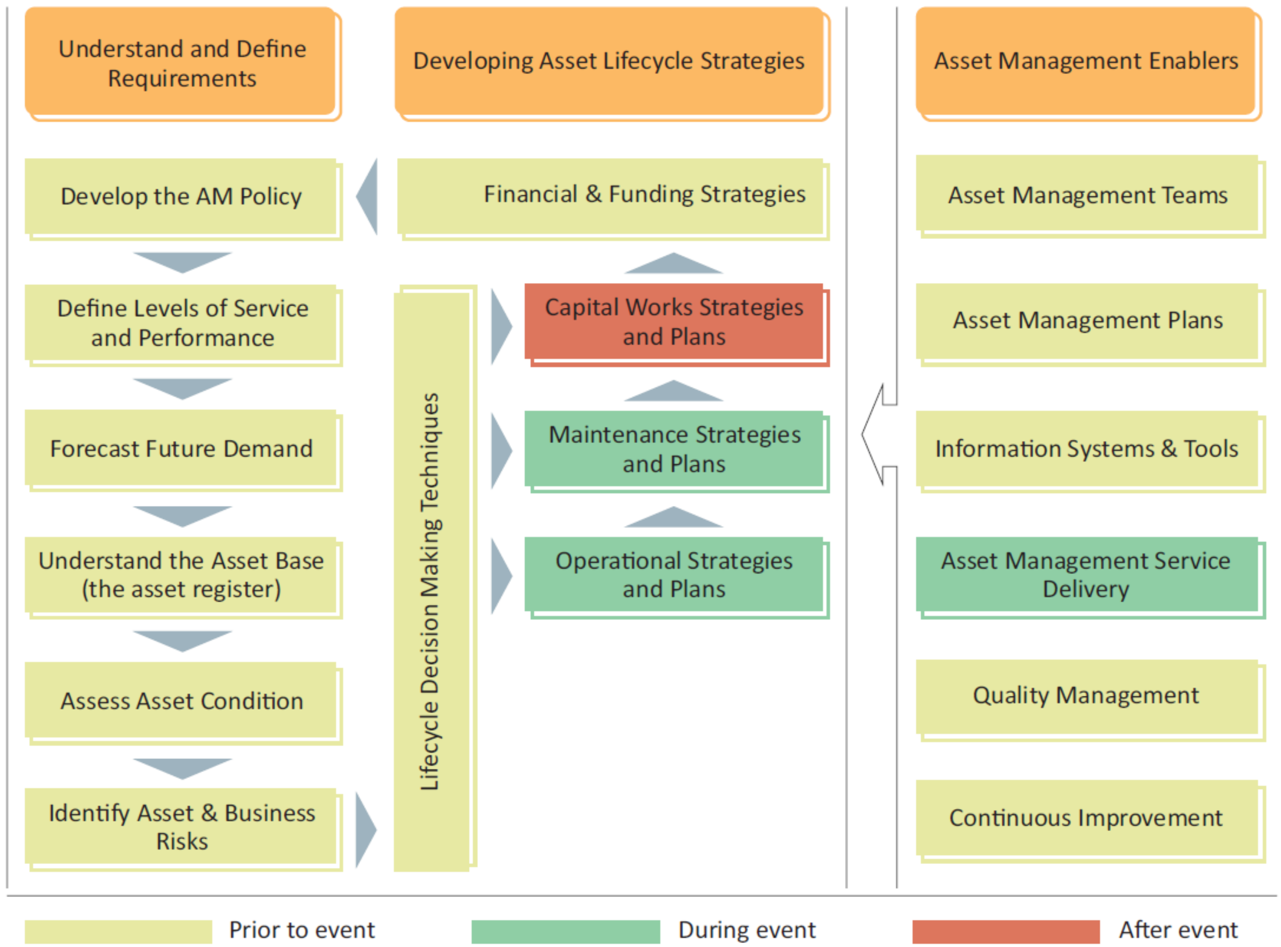
04 Post-disaster **Build-Back-Better/ Different**

Fundamentals of Resilience



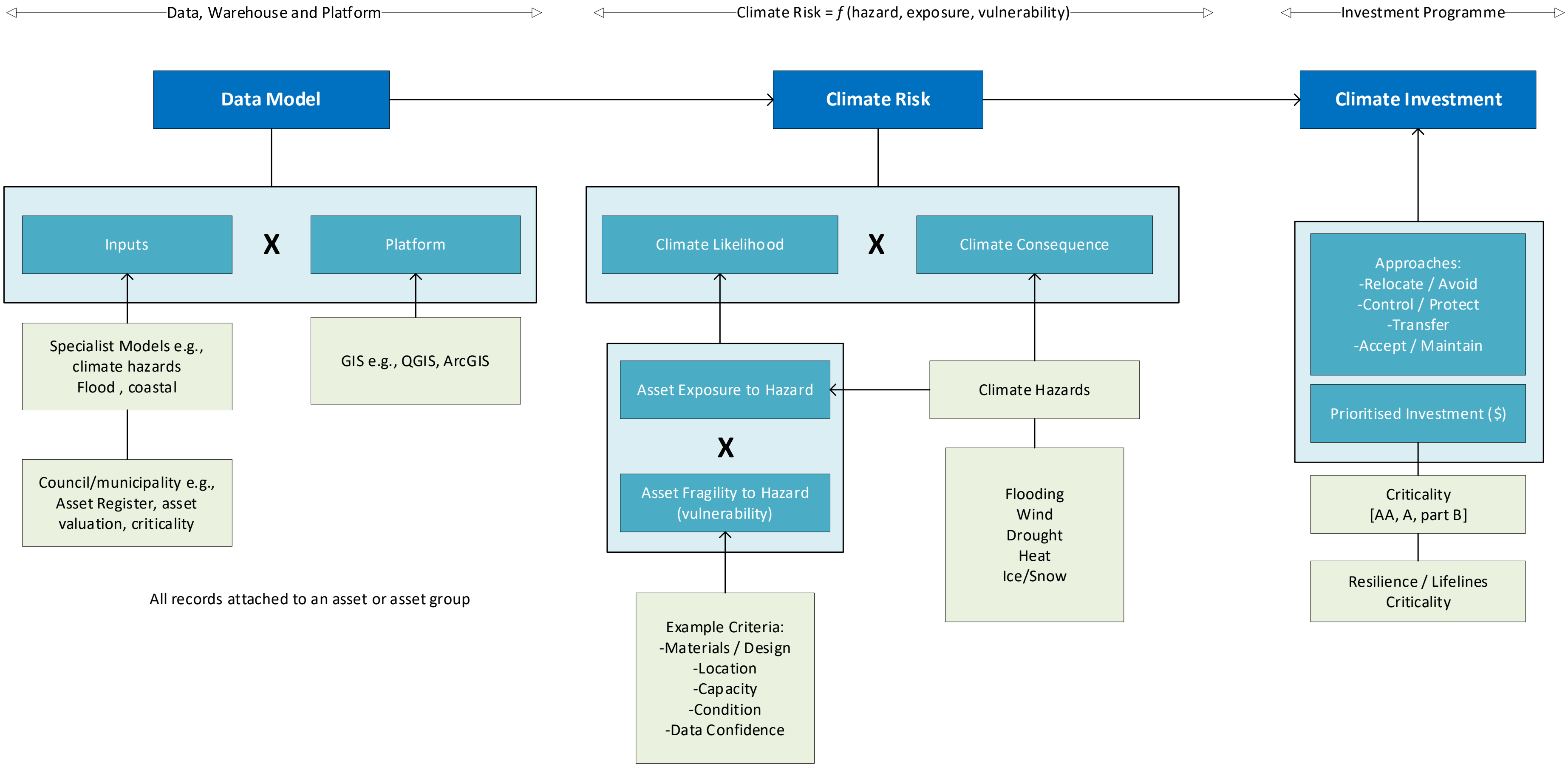
Source: https://imgur.com/gallery/3F82Ot1

Climate Resilient Road Asset Management



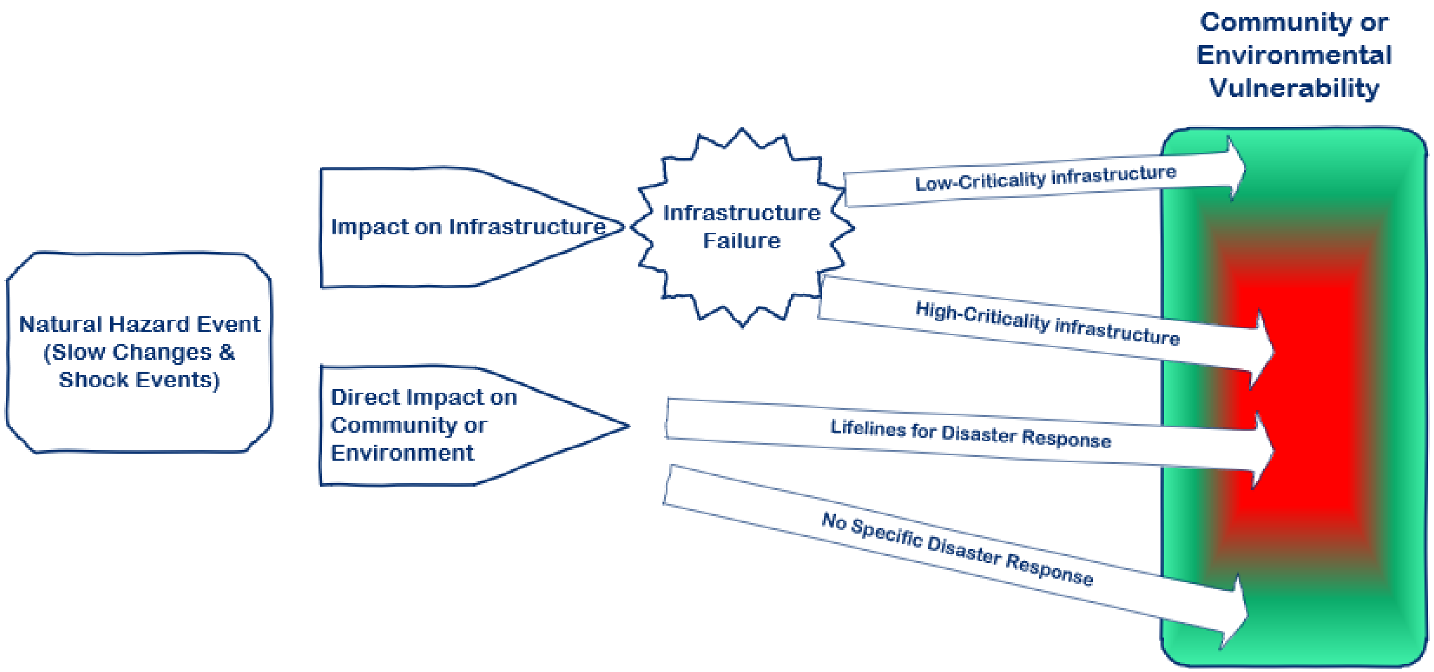
Source: Integrating Climate Change into Asset Management

Implementation of Climate Risk Assessment



Source: Blake-Manson and Henning

Asset Criticality



Criticality Factors

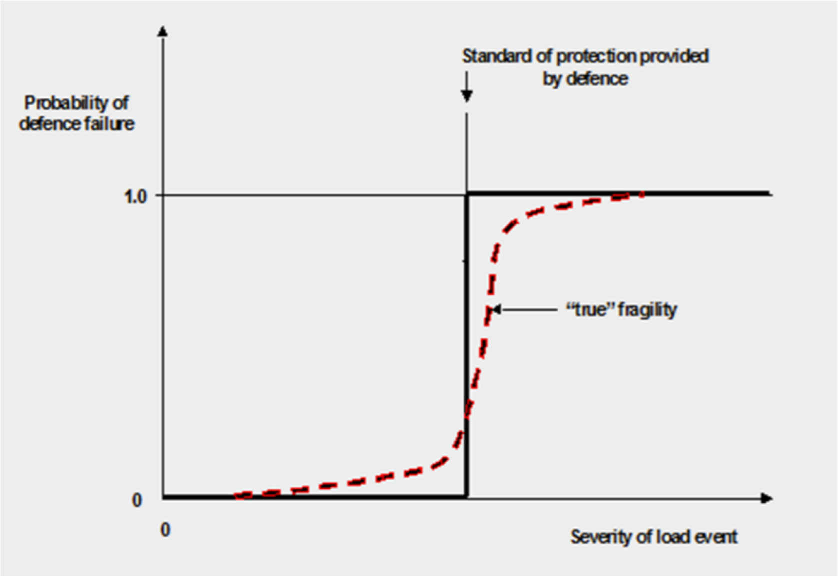
- **Strategic importance/significance** – Indication of the strategic importance at a national, regional or local level.
- **Inter-dependencies between different infrastructures** – In itself, an asset component may not be deemed critical, but there may be co-dependency with another asset component that is critical. For example, a powerline may not be highly used, but it may feed into a large wastewater treatment plant, thus making it critical.
- **Lifelines –** The significance of infrastructure in terms of linking emergency services, hospitals and essential utilities. Lifeline considerations also include emergency response activities such as evacuation routes and temporary safe havens.
- **Redundancy** – The capacity and redundancy in the system to cope with the loss of specific links in the services system

Infrastructure Fragility / Physical Vulnerability for Shock Events

Grade	Description	Condition x (Capacity or Utilisation)
Grade 1	withstand substantially more significant climate events compared to design standard	**< 4**
Grade 2	withstand more significant climate events compared to design standard	**4 to 7**
Grade 3	withstand the design standard climate event	**8 to 11**
Grade 4	not able to withstand the design standard climate event	**12 to 18**
Grade 5	not able to withstand minor climate events	**> 19**

Basic Level

Advanced Level



Slips and Landslides

- In may countries, this is the #1 issue
- Normally very costly to restore
- Creating the perfect storm -> moisture + seismic activities

Rockfall attenuators protecting the road and preventing accidents. Photo courtesy of Michel Di Tommaso.

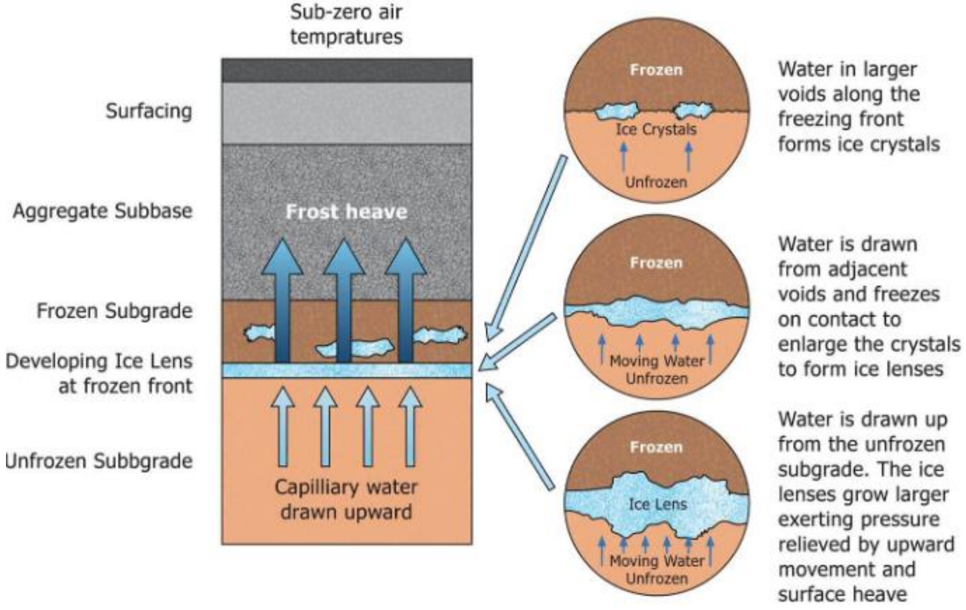
Gabion walls are used to control erosion. Photo courtesy of Michel Di Tommaso.

Flooding

- Spring flooding
- Increased moisture conditions in pavements and subgrade
- Traffic interruption
- Loosing bridges

Freeze Thaw

- Varying patterns on freeze-thaw
- Some countries have issues with losing permafrost



Source: Tensar

Treatment Categories

Adaptation Approach	Description	Examples
Avoid damage	In cases of extreme hazard exposure, or places where there is a certainty of infrastructure loss, the damage could be avoided by relocating infrastructure to less exposed areas.	Coastal roads that are low-lying thus prone to overtop, and moving inland is a more practical option.
Protecting road assets or construction new features	Various protection strategies exist to avoid hazards impacting road assets.	Flood protection structures Slope stabilisation techniques
Retrofitting existing infrastructure	Retrofitting involves strengthening or changing infrastructure to be less vulnerable to most likely hazard impacts.	Bridges could be retrofitted to withstand floods and seismic activities better. E.g. clippings to strengthen bridge deck's lateral stability on beams.
Catchment area improvements	Taking a more holistic approach to reducing the hazard exposure for a geographic area.	Improving overall catchment/stormwater drainage or improving run-off characteristics
Do minimum or nothing	Don't take any resilient specific actions other than increased maintenance and renewals.	Situations where higher priorities elsewhere or funding constraints prohibited investment into resilient options.
Delay adaptation to post-event	In some more costly adaptation options, it may be more economical to delay an adaptation strategy until after an event.	Bridge structures that will require costly relocation could still be functional until the next significant events. A new bridge is constructed elsewhere or at an increased height or strength on destruction.

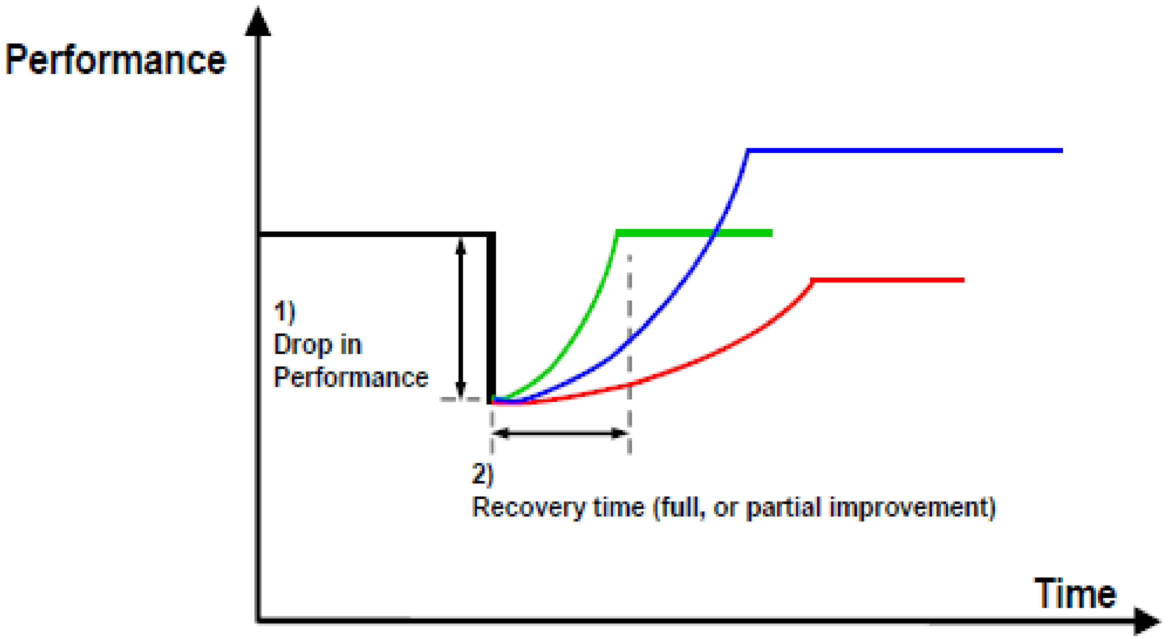
Climate Impact on Road Surfaces

Some General guidance is provided on climate impact on surfaces and ways to deal with it

Impacts on the Road Surface	Characteristics Required of the Surface	Potential Technologies
Mechanical damage to the road surface from wind-borne debris (e.g. trucks overturning)	• More robust surface (it is not often that specific allowance is made for high winds)	• Modified mixtures such as epoxy-modified surfaces, fibre-reinforced binder
Delamination of the surface	• Surfaces less prone to delamination	• Use of prime coats or tack coats • Single-layer asphalt
Water ingress through the surface	• Using less permeable surfaces (e.g. a dense graded asphalt less permeable than, say a single layer chip seal surface).	• Close/dense-graded asphalt mixture options or cape seal • Crack-resistant surfaces
Decreasing viscosity of the bitumen binder leads to flushing Increased hardening of the bitumen (oxidation)	• Temperature-resistant surfaces	• Modified binders used in epoxy asphalt and chip seals • Use of warm mix asphalt to reduce oxidation during mixing and to improve long-term durability

Source Road Note 31

Reducing the Impact of Climate Change



Green is more resilient than Red

- Faster recovery time
- Higher level of service

Blue is a hardened [2] system as it has a higher final performance level

Resilience with respect to an event (e.g. Flooding, fire, earthquake, etc) is characterized by two parameters:

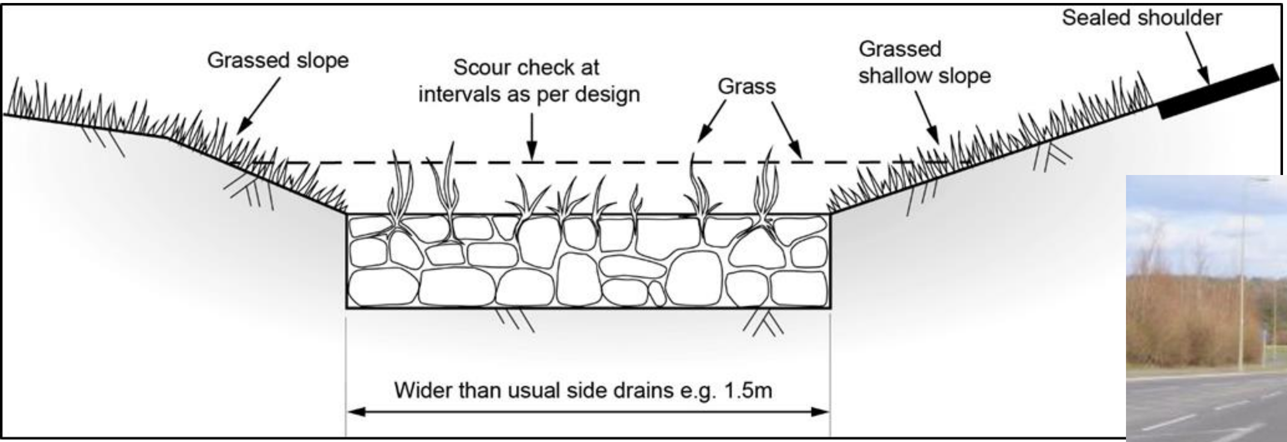
1. Drop in performance, induced by the event (e.g. reduced ability to carry load).
2. Recovery time to reinstate or improve performance.

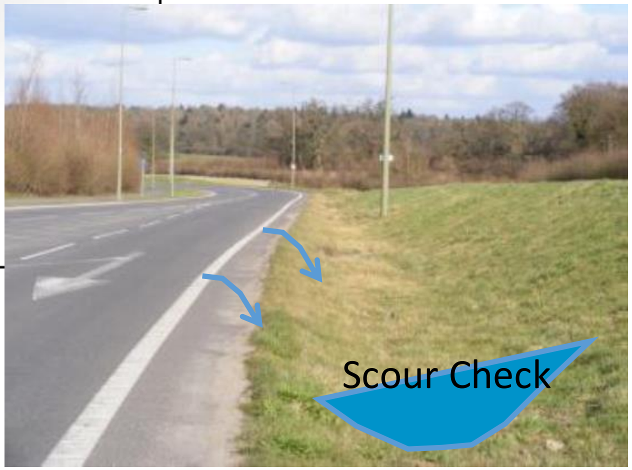
Allowance for Climate change

Parameter	Year			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+ 5%	+ 10%	+ 20%	+ 30%
Peak river flows	+ 5%	+ 10%	+ 20%	+ 30%
Sea surface water rise	10 cm	15 cm	25 cm	35 cm

Source Road Note 31

Grassed Swale

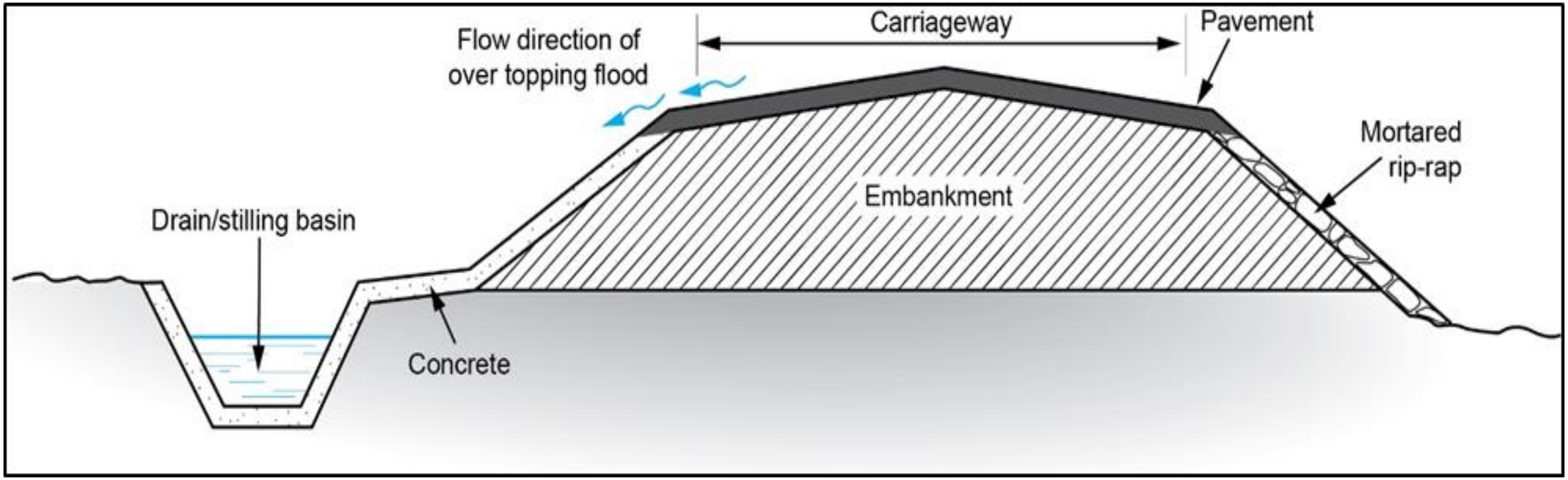




Source Road Note 31

Climate- Resilient Road Design

Raised formation level

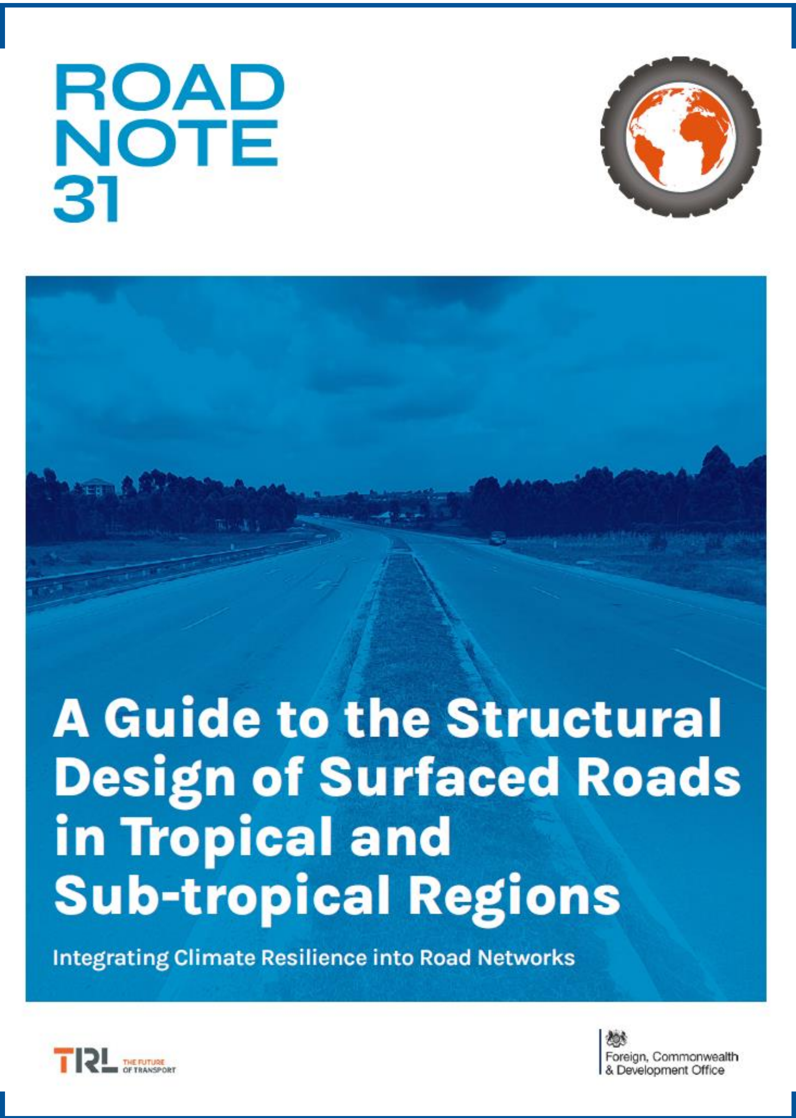


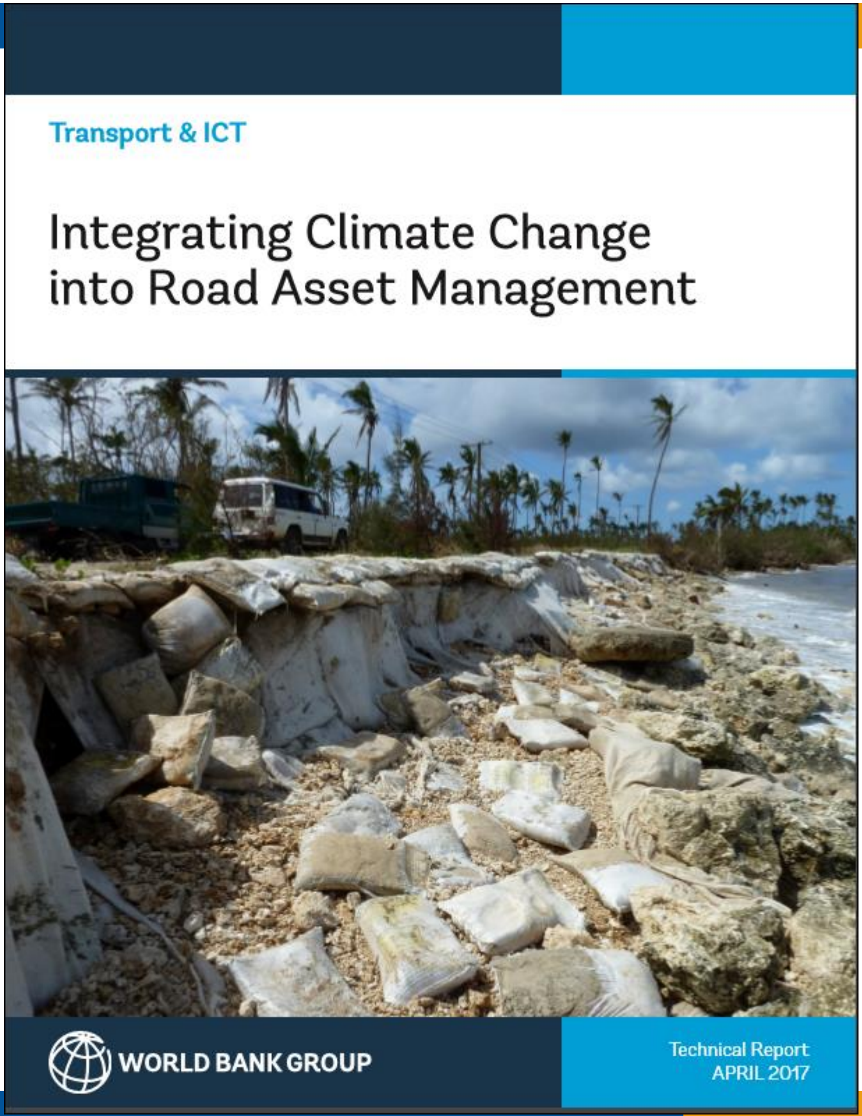
Source Road Note 31

Maintenance

- Adequate road maintenance is the most critical and efficient way of reducing the impact of a changing climate on the road system.
- In the absence of an adequate maintenance regime, the damage caused by climactic events is exacerbated
- Thus, maintenance of pavements and sealing activities; regular maintenance of bridges, culverts and drainage structures to ensure they are functional and not obstructed;
- maintenance and improvement of slope protection works; and
- systematic assessments to identify and incrementally address vulnerable and critical road sections are the first defence against climate risks.

For More Information …





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