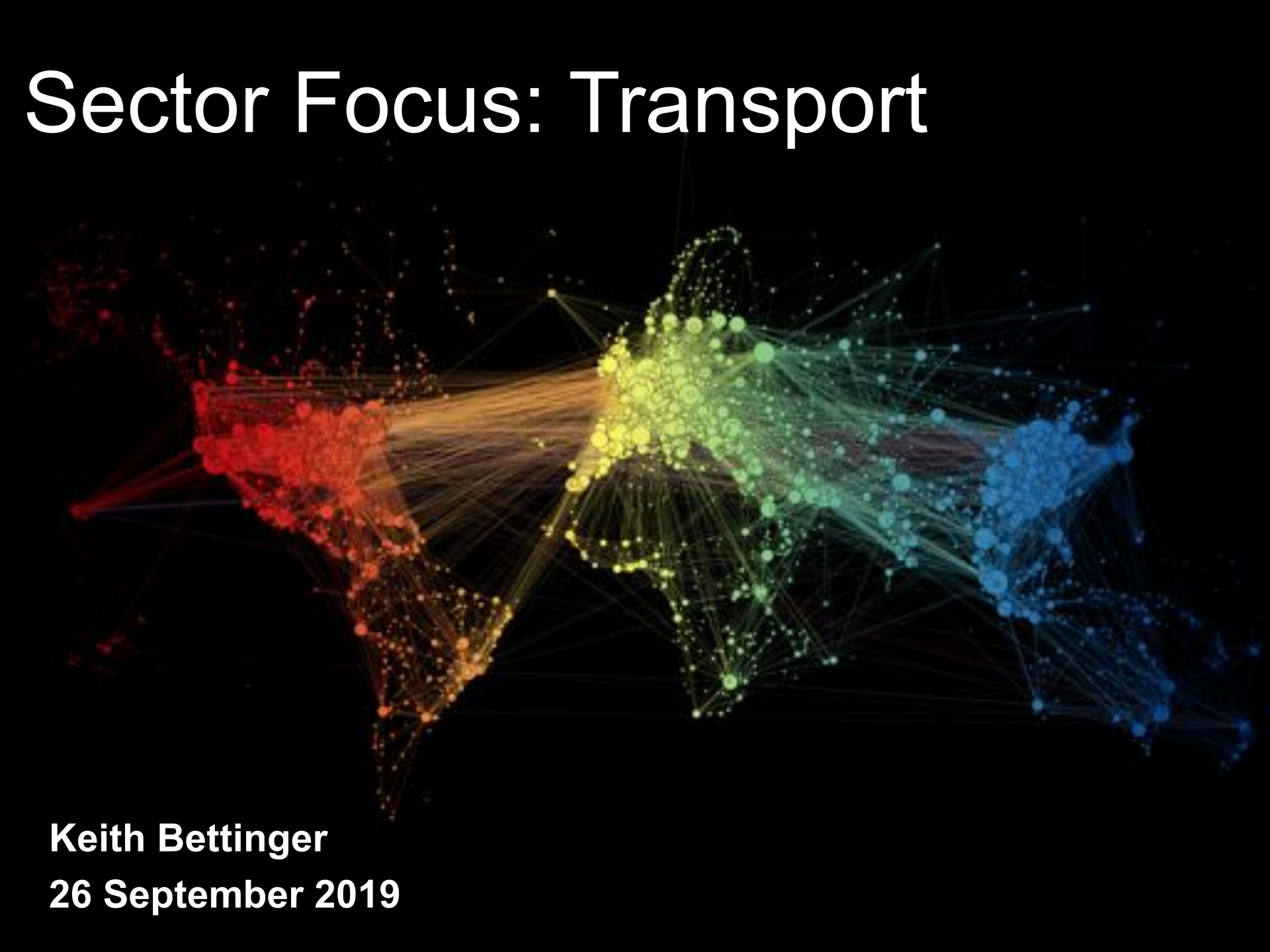
Sector Focus: Transport



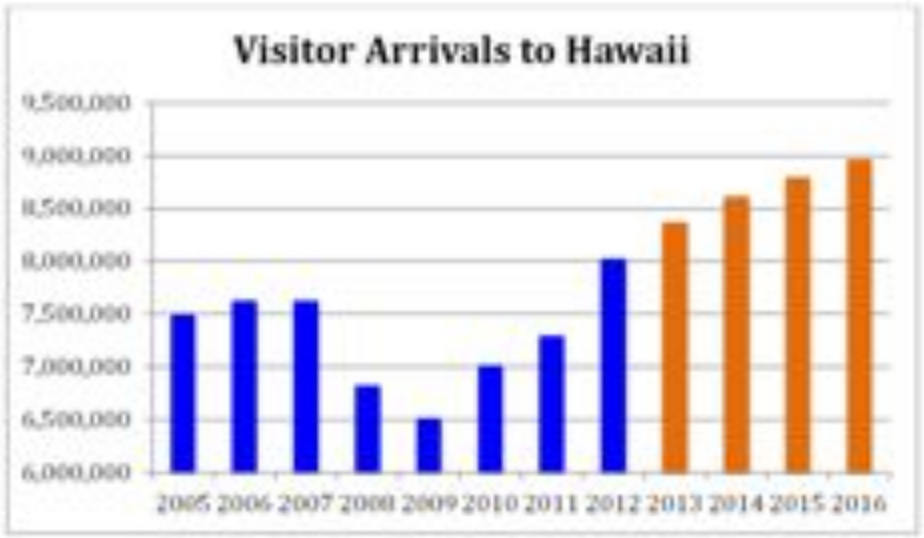
Keith Bettinger

26 September 2019

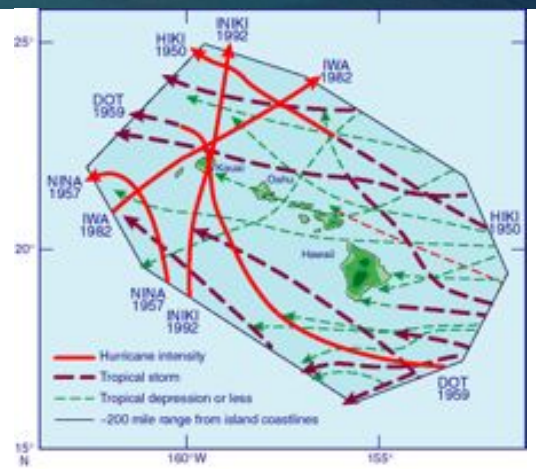
Overview

- **A story about Hawaii**
- **Global infrastructure vulnerability to hazards**
- **Climate change and investment decisions**
- **What's happening around the world in terms of managing risks to transport**
- **Some ways forward**

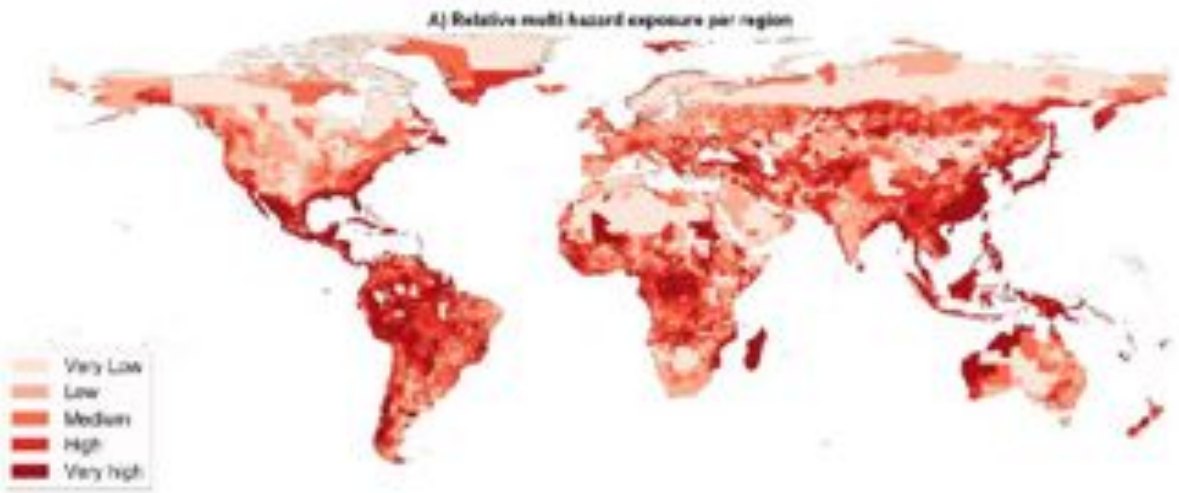
E Komo Mai!!!



Source: DBED&T, State of Hawaii



Global multi-hazard road and railway infrastructure exposure



Global Expected Annual Damages (EAD) range from 3.1 to 22 billion US dollars, of which approximately 73% is caused by surface and river flooding.

Many coastal areas show high exposure to risk

ARTICLE

https://doi.org/10.1038/s41467-019-10442-3 OPEN

A global multi-hazard risk analysis of road and railway infrastructure assets

E.E. Koks[1,2], J. Rozenberg[3], C. Zorn[1], M. Tariverdi[3], M. Vousdoukas[4,5], S.A. Fraser[3], J.W. Hall[1] & S. Hallegatte[3]

Dominant hazards

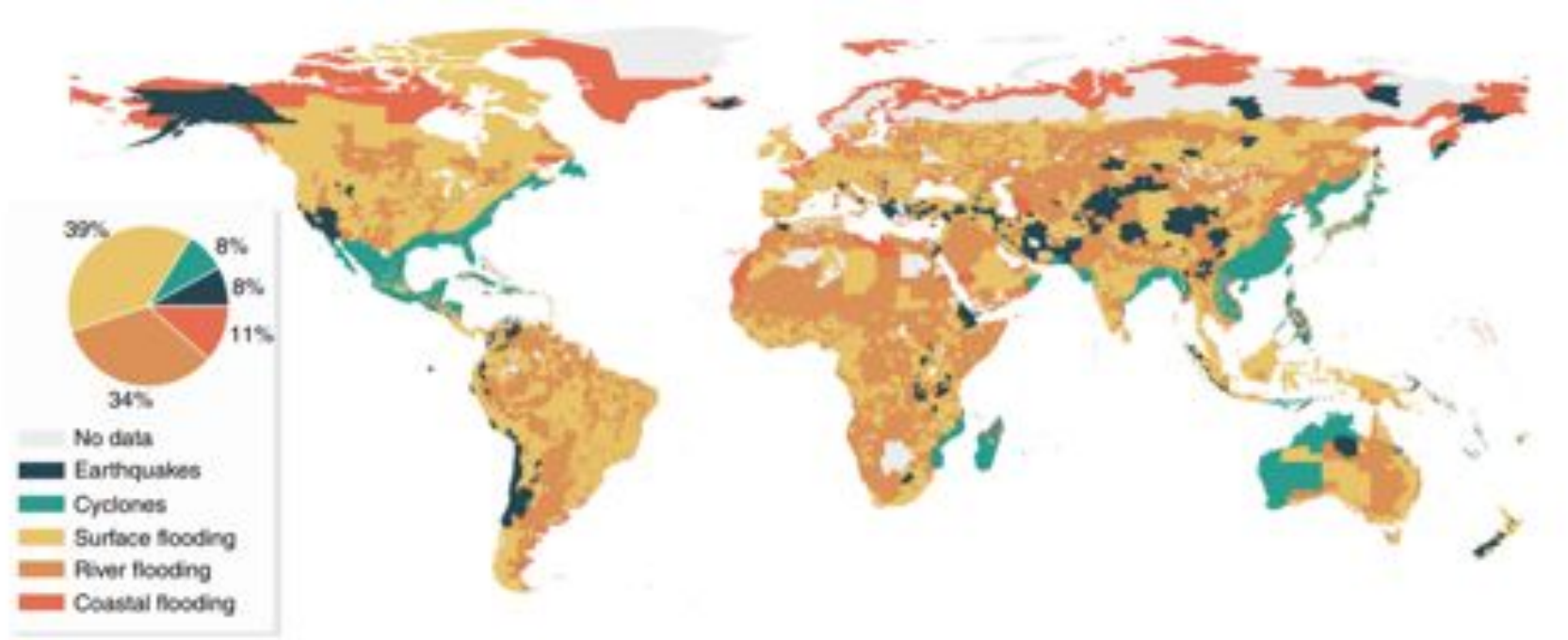
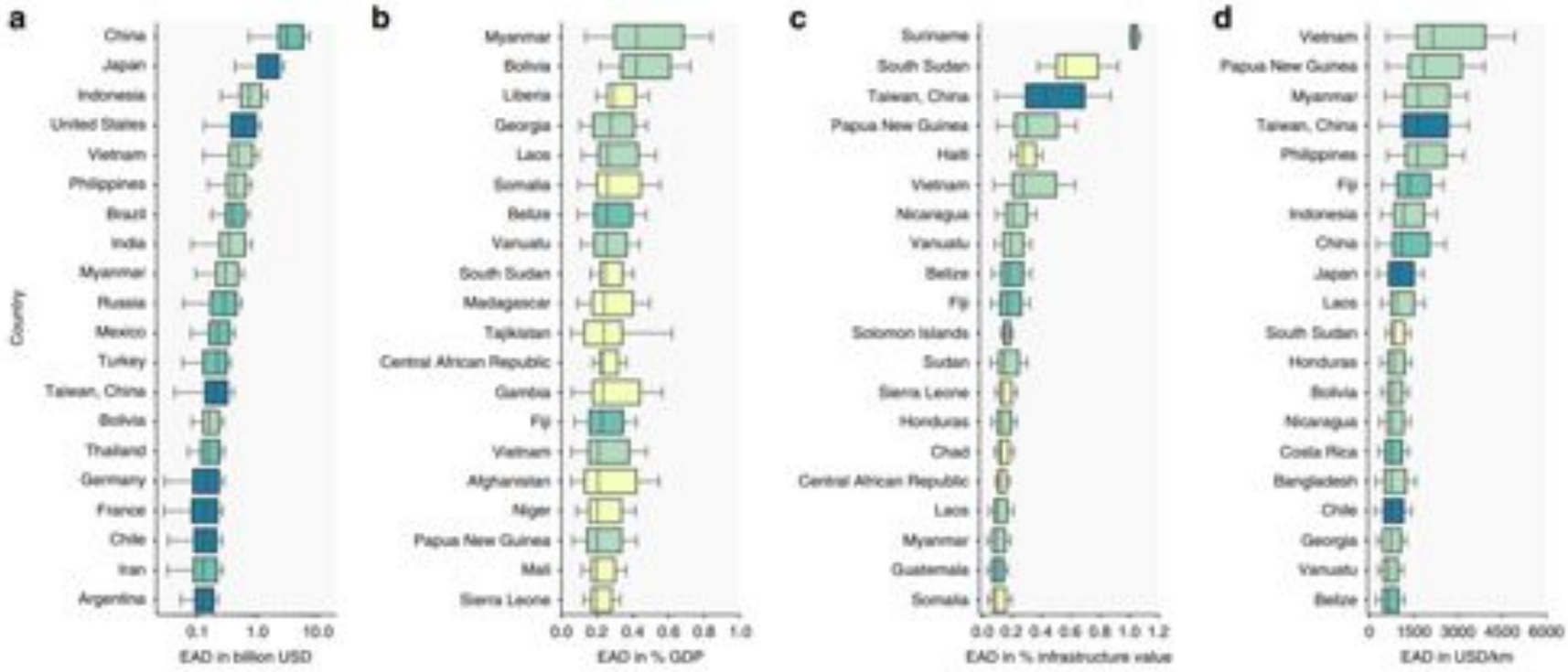
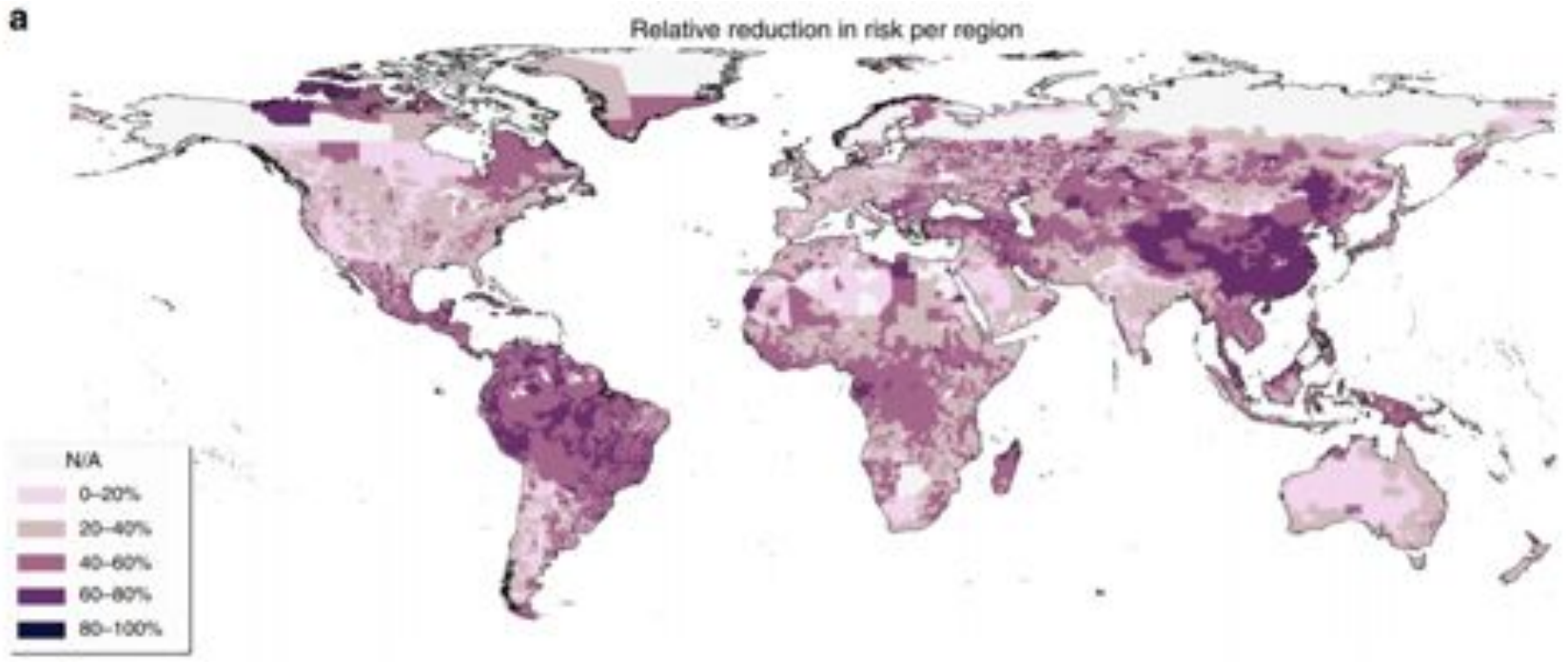


Fig. 2 Dominant hazard per region. This figure presents the hazard causing the highest transport infrastructure exposure in each region. The pie chart shows the relative percentage of land area (excluding areas with insufficient data) where that specific hazard causes the highest exposure

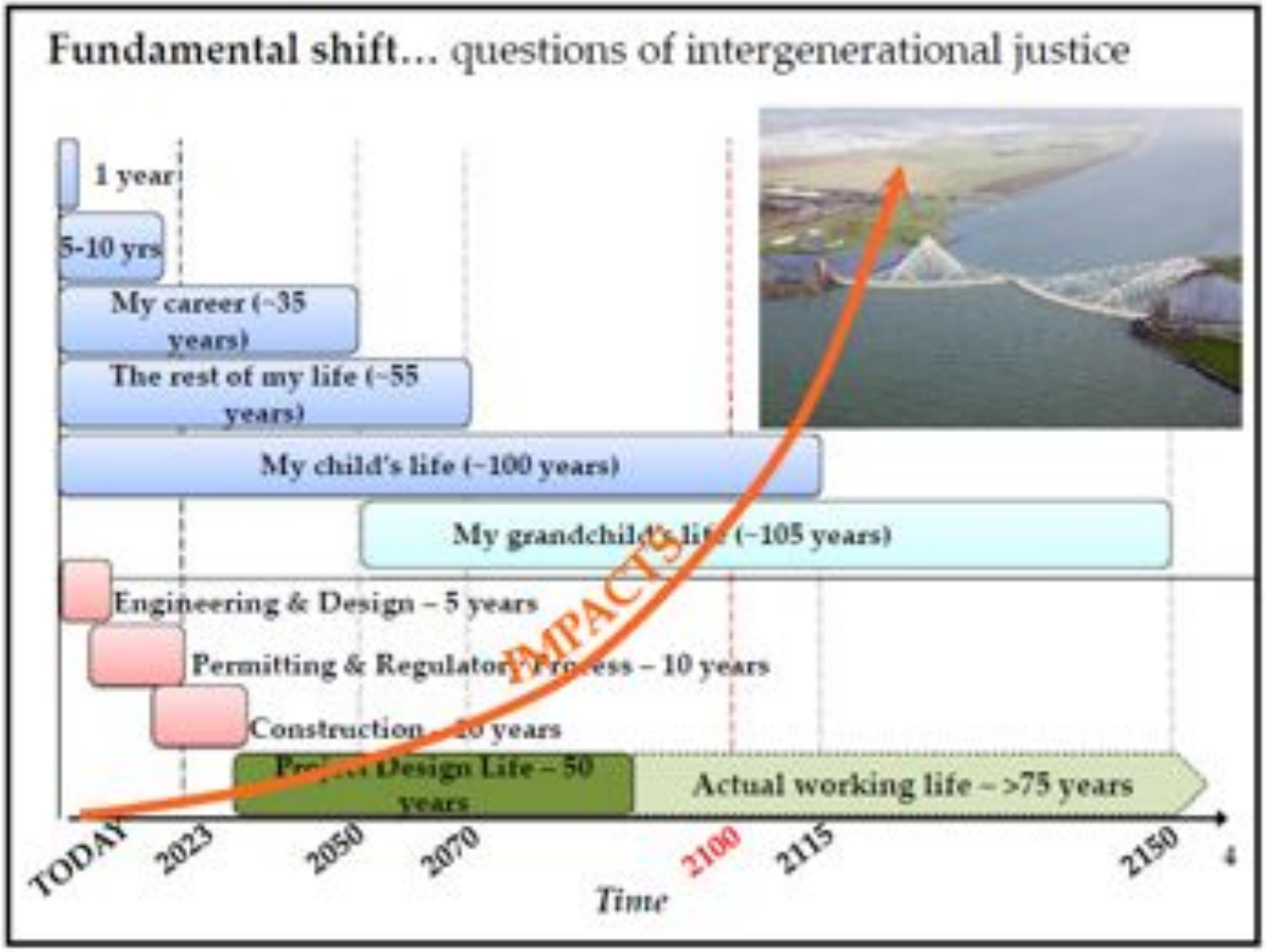
Expected Annual Damages (EAD)



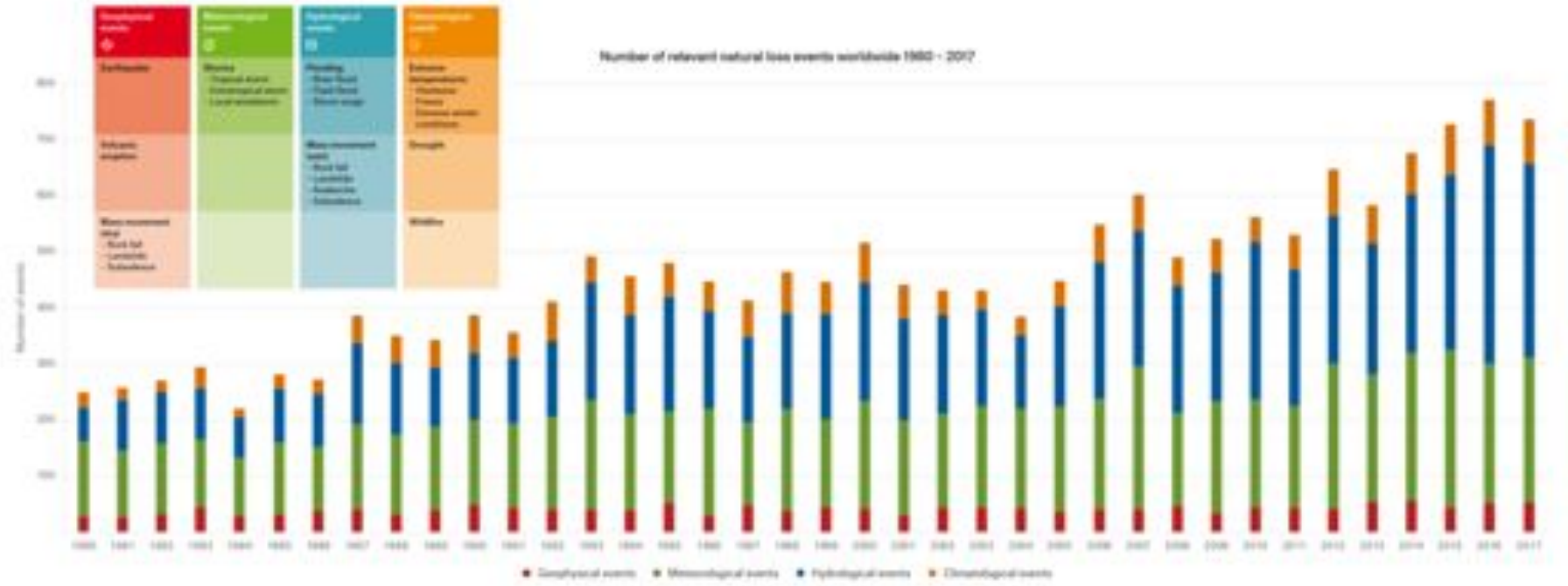
Benefits of design standards upgrades



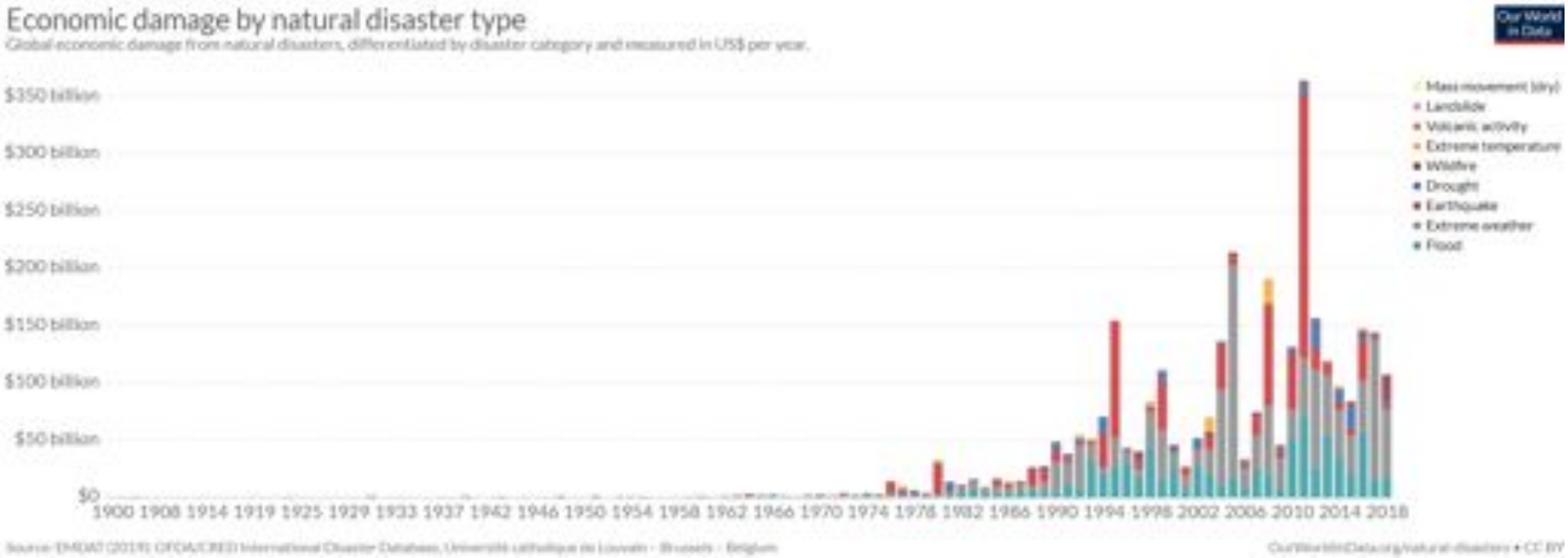
Impacts and infrastructure



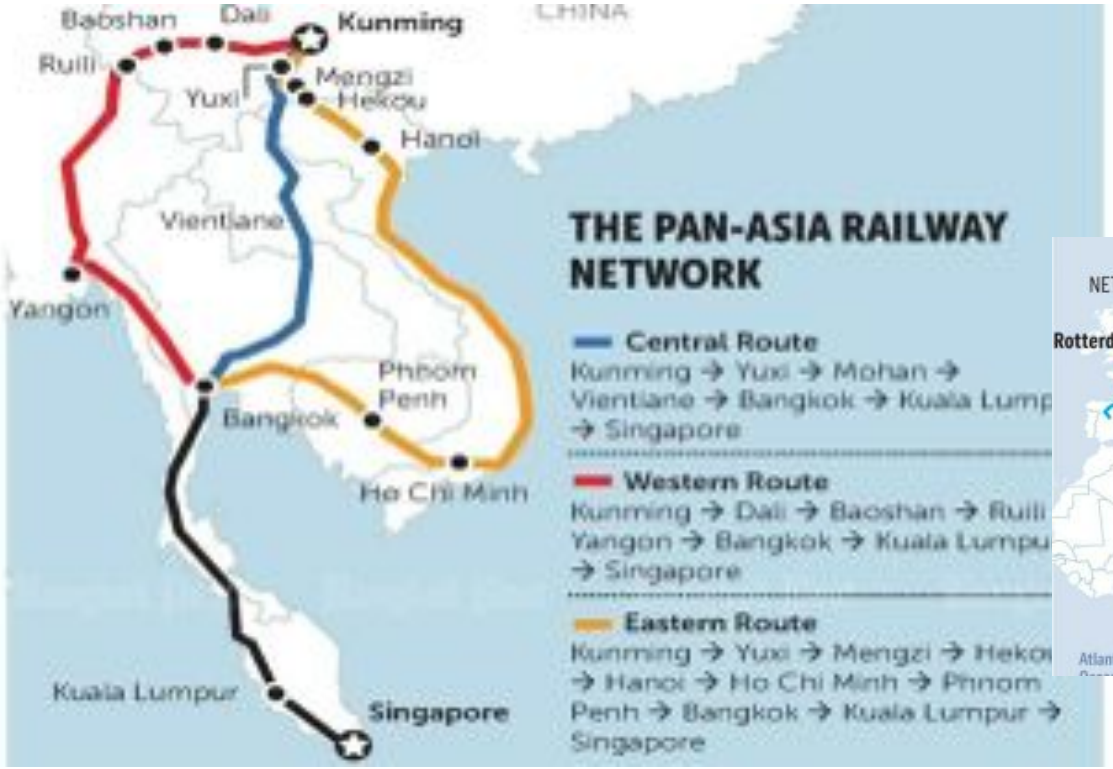
Number of natural loss events worldwide 1980 – 2017

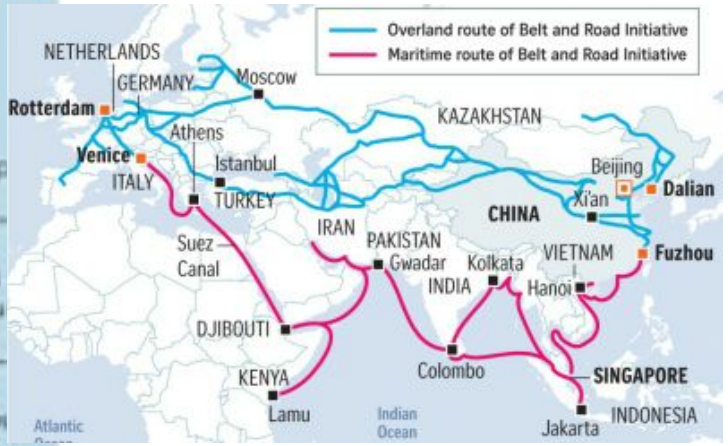


Economic damage



Asia and the future


Baoshan
Dali
Kunming
Ruili
Yuxi
Mengzi
Hekou
Hanoi
Vientiane
Yangon
Phnom Penh
Bangkok
Ho Chi Minh
Kuala Lumpur
Singapore
CHINA
THE PAN-ASIA RAILWAY NETWORK
Central Route
Kunming → Yuxi → Mohan → Vientiane → Bangkok → Kuala Lump → Singapore
Western Route
Kunming → Dali → Baoshan → Ruili Yangon → Bangkok → Kuala Lumpu → Singapore
Eastern Route
Kunming → Yuxi → Mengzi → Heko → Hanoi → Ho Chi Minh → Phnom Penh → Bangkok → Kuala Lumpur → Singapore


Overland route of Belt and Road Initiative
Maritime route of Belt and Road Initiative
NETHERLANDS
GERMANY
Moscow
Rotterdam
KAZAKHSTAN
Athens
Venice
ITALY
Istanbul
TURKEY
Beijing
Dalian
Xi'an
CHINA
IRAN
PAKISTAN
Gwadar
Kolkata
VIETNAM
Fuzhou
Suez Canal
INDIA
Hanoi
DJIBOUTI
Colombo
SINGAPORE
KENYA
Lamu
Jakarta
INDONESIA
Atlantic Ocean
Indian Ocean


NEPAL
BHUTAN
INDIA
Nepal Subregional Transport Facilitation Project
Nepal Air Transport Expansion and Improvement

Climate change impacts on roads

Event	Impact on Road Infrastructure
Increased temperature Heat waves	Damage to concrete and bridge expansion joints; Buckling, fissuring of asphalt pavement Rutting
Fewer colder days and shorter winters	Reduced snow removal but increased freeze-thaw degradation of asphalt
Sea levels rise and tidal surges	Intermittent or permanent flooding Surface damaged Weakening of key infrastructure support (bridge pilings) Damage to critical drainage infrastructure Increased costal erosion – road collapse Exacerbate salinity (corrosive effect)
Extreme precipitations	May overwhelm drainage infrastructure Erosion, scouring, slop failure, flooding
Extreme winds and storms	Wind damages bridges, gantries, signs, electricity networks, lightning Storm surge means damage from increased wave height and strength

Impacts on other modalities

- **Consider sudden and slow, direct and indirect**
- **Cascading failures disrupt operations**
- **Higher temperatures require longer runways**
- **Heat/frost-thaw impacts on roads, bridges, railway beds**
- **Greater corrosion from periodic salt-water inundation, wetter ground and reverse infiltration**

Impacts on air operations

AIRPORT OPERATORS

Precipitation change

- Disruptions to operations (e.g. airfield flooding, ground subsidence)
- Reduction in airport throughput
- Inundation of transport access (passengers and staff)
- Loss of local utilities provision (e.g. power)
- Inadequate drainage system capacity
- Inundation of underground infrastructure (e.g. electrical)

Sea-level rise

- Loss of airport capacity
- Loss of airport infrastructure

Temperature change

- Changes in noise impact due to changes in aircraft performance
- Heat damage to airport surface (e.g. runway, taxiway)
- Increased heating and cooling requirements

Wind changes

- Convective weather: disruption to operations
- Local wind patterns: potential disruption to operations and changes to distribution of noise impact
- Crosswinds: reduction in capacity

Extreme events

- Disruptions to operations
- Disruption to ground transport access
- Disruption to supply of utilities

AIR NAVIGATION SERVICE PROVIDERS

Precipitation change

- Disruptions to operations (e.g. airfield flooding, ground subsidence)
- Reduction in airport throughput
- Inundation of transport access (passengers and staff)
- Loss of local utilities provision (e.g. power)

Sea-level rise

- Loss of airport capacity
- Impacts on en-route capacity due to lack of ground capacity
- Loss of ground transport access

Temperature change

- Changes in aircraft performance
- Changes in noise impacts due to changes in aircraft performance

Wind changes

- Convective weather: disruptions to operations
- Convective weather: route extensions

Extreme events

- Disruptions to operations
- Disruption to ground transport access
- Disruption to supply of utilities

Investment considerations 1

- **Private sector investment depends on infrastructure availability**
  - **Availability/condition of infrastructure affects competitiveness**
- **Infrastructure investment decisions based on cost-benefit analysis**
  - **Long-term benefit streams guide decisions**
- **Bond rating, interest rates, insurance all affect costs of infrastructure investment**
- **Changing environmental conditions (CLIMATE CHANGE) potentially affect benefit streams**

Investment considerations 2

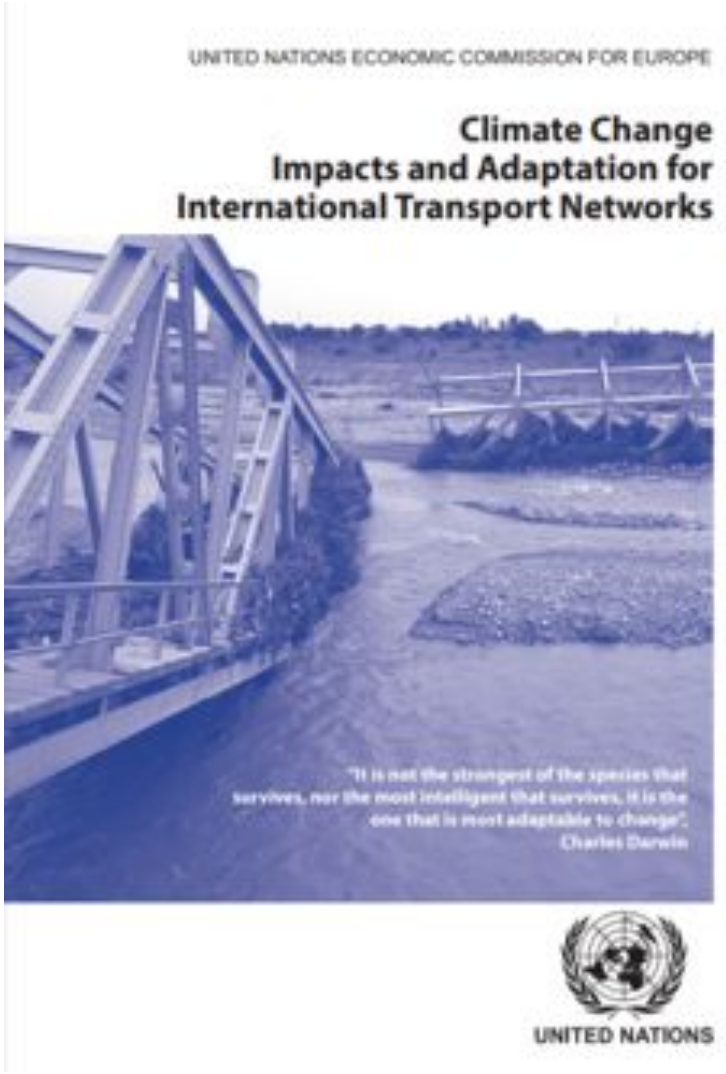
- **ADB, WB, other MFIs requirement climate screening and climate proofing**
- **Bond raters, insurance companies now care about climate change**
- **RoI for projects depends on total network performance**
- **Lack of adaptation = competitive disadvantage**

BONDS NEWS SEPTEMBER 25, 2019 / 1:56 AM / A DAY AGO

Climate change poses credit risk as U.S. Midwest, Southeast heat up -Moody's

What is happening globally?

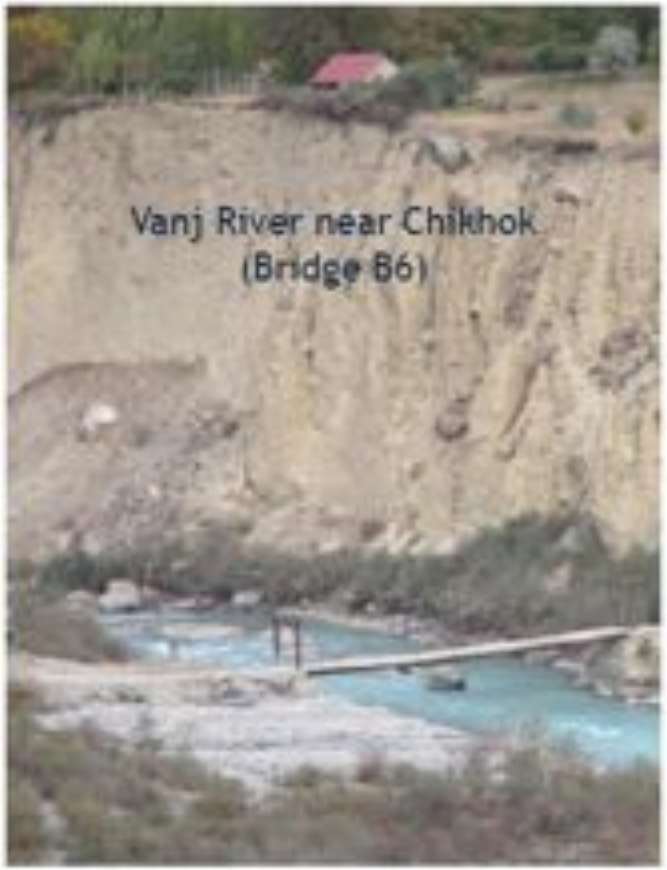
- **Marrakech Partnership on Global Climate Action: "Navigating a Changing Climate"**
- **Assessing vulnerabilities/risks to international transportation systems and producing guidance…**
  - **ICAO, PIANC, IAPH, IRF, others…**
- **Altering standards at the national level (e.g. FRANCE, NORWAY)**
- **Developing international standards for assessment and adaptation planning…**
  - **ISO, CEN/CENELEC**
- **MLIs prioritizing infrastructure adaptation and network resilience**



Network Assessment

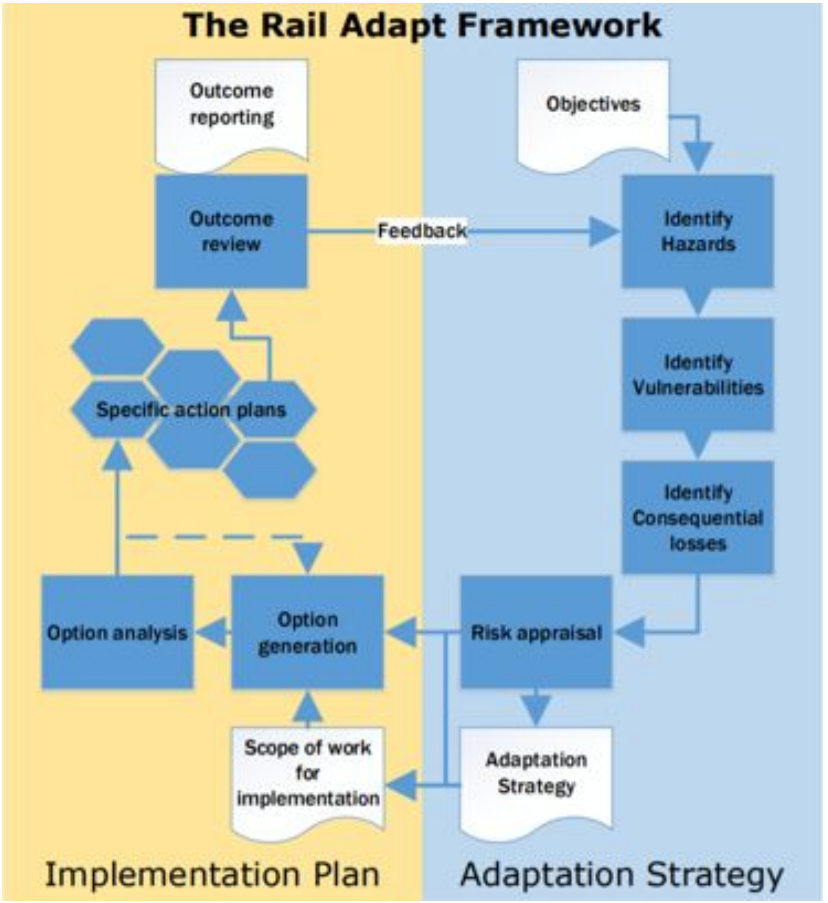
Risk Assessment: Strengthening Critical Infrastructure against Natural Hazards in Tajikistan

Bridge	Glacial Lake Outburst	Flood	Landslide	Snow Avalanche
B1				
B2				
B3				
B4				
B5				
B6				
B7				
B8				
B9				
B10				
B11				



RailAdapt: UIC

- **Framework for adapting rail systems management, operations, procurement (mainstreaming)**
- **Consider range of current and future weather conditions**
- **Develop adaptation plans**
- **Compiles best practices**



"…a transport system in which the worlds railways have acquired the flexibility to intelligently adjust to climate change, thereby providing their economies and societies with reliable and cost-efficient transportation services".

ISO 14090

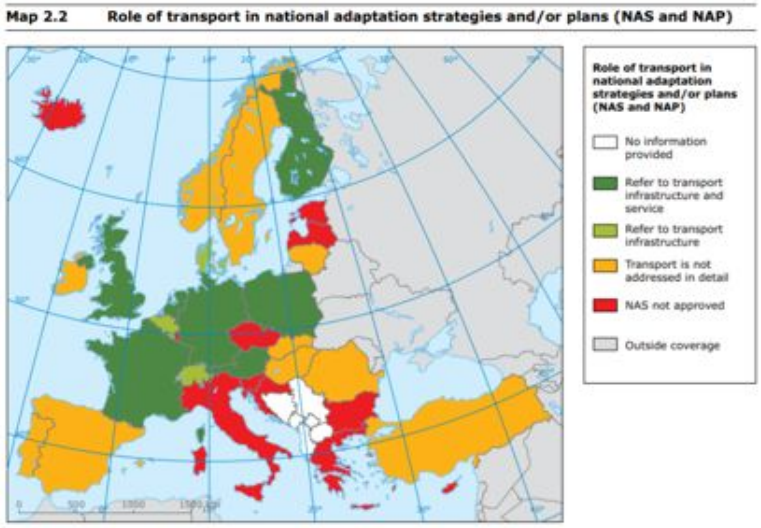
- **"…to provide organizations with a consistent, structured and pragmatic approach to prevent or minimize the harm that climate change could cause and also take advantage of opportunities."**
- **Includes**
  - **Assessing CC impacts**
  - **Adaptation planning**
  - **Implementation**
- **Additional guidance to be developed includes ISO 14091 (adaptation pathways)**

ISO 14090:2019

Adaptation to climate change — Principles, requirements and guidelines

General Steps Forward

- Conduct vulnerability assessments of transportation networks
- Governments, private sector, international organizations should establish inventories of critical and sensitive nodes
  - Share regionally and internationally
- Mainstream CC into procurement, management, m&o, design of routes and facilities
  - Including EIA
- Improve and strengthen regulations and enforcement
- Develop better CBA tools for estimating benefits and incremental costs



Mahalo…Mahalo Nui Loa

- keithb@hawaii.edu