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Risk Assessment Frameworks for Resilient Infrastructure

2021 ADB Resilience Learning Month

December 3, 2021

:vivideconomics

Agenda

- Introduction
- Brief overview of the project
- Risk assessment example
- Panel discussion
- Close and next steps



Brief overview of project



Context: need for resilient infrastructure

- Infrastructure investment needs in DMCs are projected to be **USD26 trillion from 2016 to 2030**
- Providing an opportunity for achieving **resilient infrastructure systems and users**



Objective: disseminate knowledge on resilient infrastructure

- Articulate aspects of the problem and relevance to DMCs
literature review & expert consultations
- Consolidate best practice and identify knowledge gaps
case study review & risk modelling
- Assess key challenges for DMCs
DMC-wide survey & focus groups discussions
- Develop recommendations for govts, MDBs, other stakeholders
MDB research & expert interviews



Output: two reports

- Opportunities for MDBs to support infrastructure resilience
January 2022
- State of play of disaster-resilient infrastructure in Asia-Pacific
February 2022

Expert consultations reveal barriers for decision-relevant risk assessment ...

- **Risk is assessed at the asset level** rather than developing sector-wide resilience strategies
- **The complex nature of risks means models may not capture it robustly**, capacity and data are limited
- **Model outputs can be difficult to interpret** and do not link to decision criteria



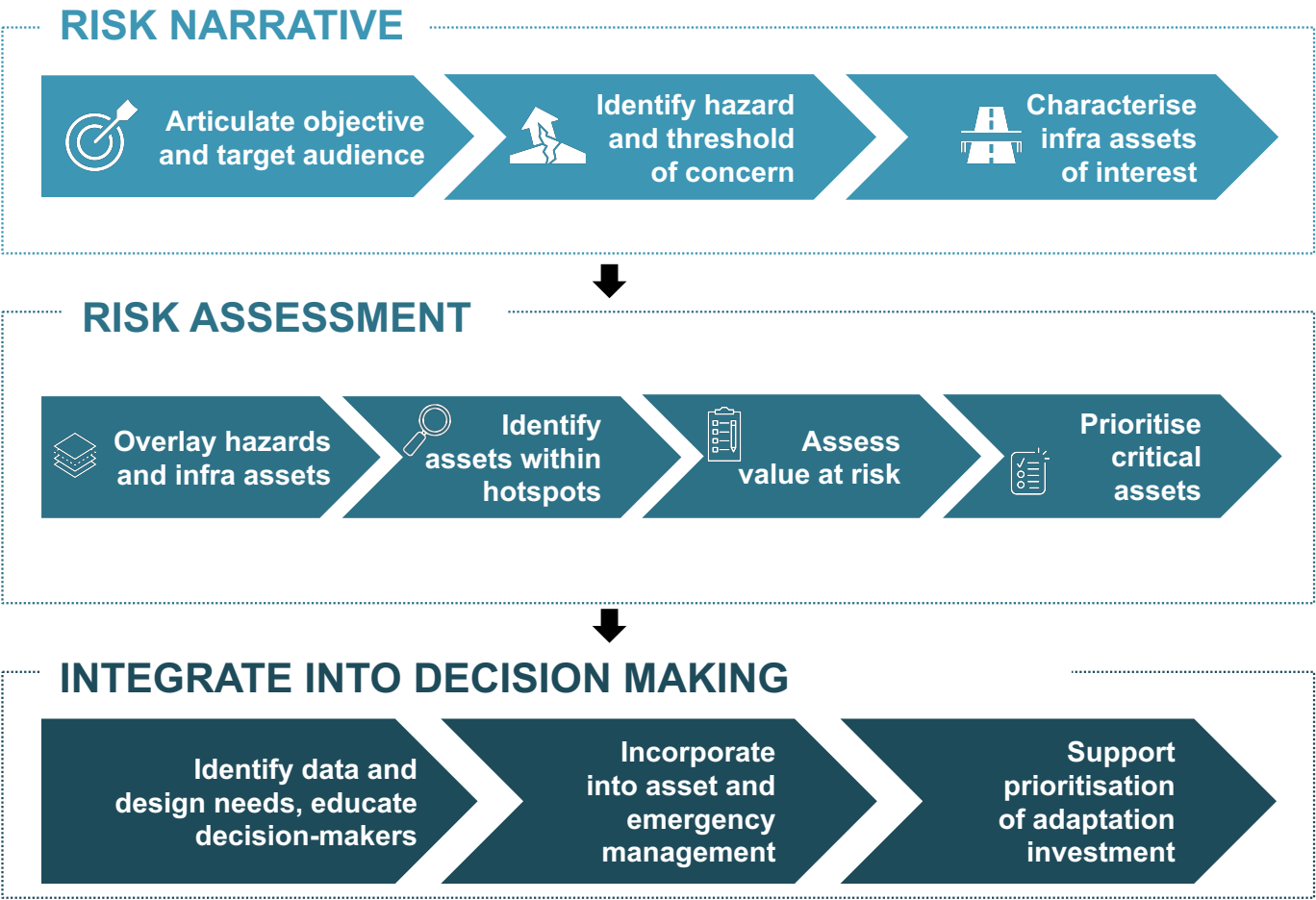
... and opportunities to address them

- **Improve early-stage/ sector-level funding** for risk assessments
- **Improve understanding** of how simple, open-source models and data sets can be used to make effective decisions
- **Demonstrate how risk assessments can be made decision-relevant**, and how uncertainty can be incorporated, for example through adaptive pathways



Proposed risk framework for critical infrastructure is modular, scalable and participatory ...

Framework:



... and works in data-sparse environments

Applied in Pakistan:

Transport exposure to earthquakes

Vulnerable road infrastructure in Pakistan, particularly major arterial roads to earthquakes



Assess critical road infrastructure

Identify roads whose disruption or downtime puts significant value at risk



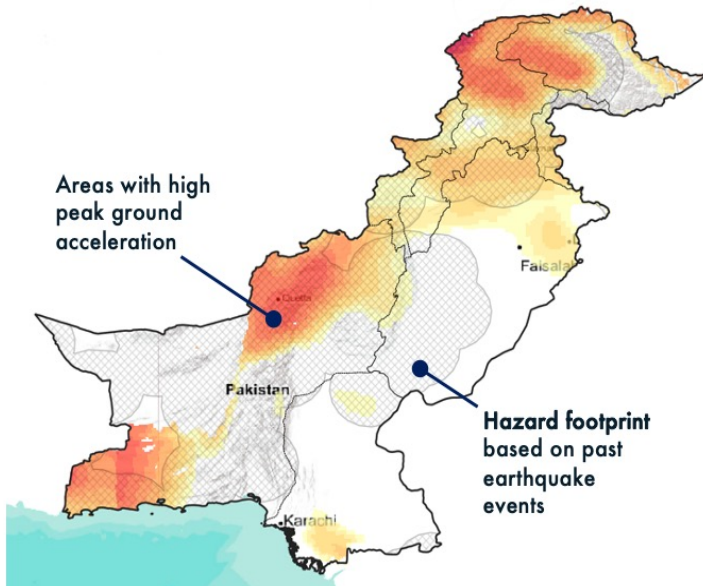
Prioritise regional resilience investment

Where should road resilience investments be prioritised?

Identify the **hazard footprint** by assessing areas likely to be affected by earthquakes

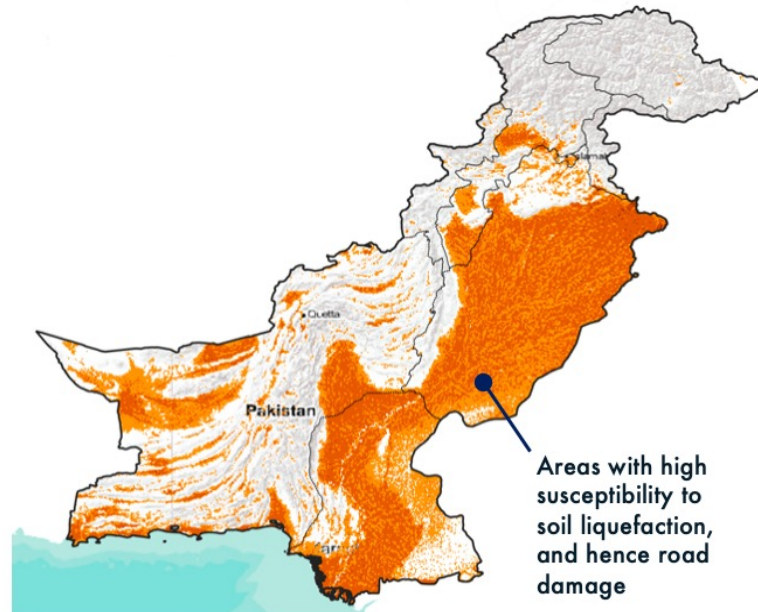
Areas where earthquakes are more likely

- Areas around historical epicenters and past events (shaded)
- Areas with high peak ground acceleration, or high intensity of shaking (orange)



Areas where susceptibility of damage is high

- Areas with high soil liquefaction
- High susceptibility to topsoil losing strength and caving in, irrespective of intensity (orange)



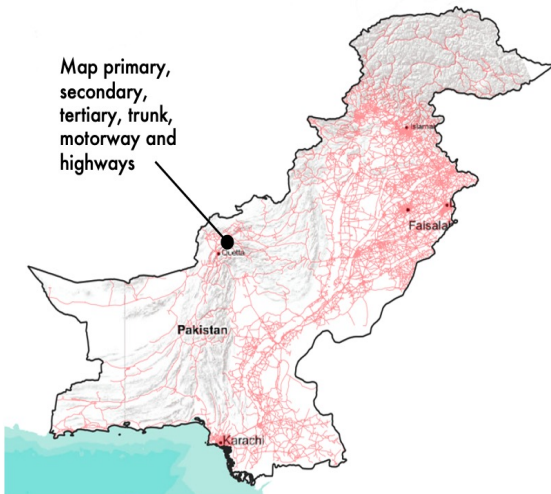
Generate earthquakes hazard footprint

- Where earthquakes are likely to occur and inherent vulnerability to hazard is high
- Deterministic scenario-based or probabilistic footprints
- Spatial overlap of historical epicenter regions, high PGA and high soil liquefaction – worst case scenario

Assign value at risk to road segments by **assessing socio-economic exposure** impacts of their downtime

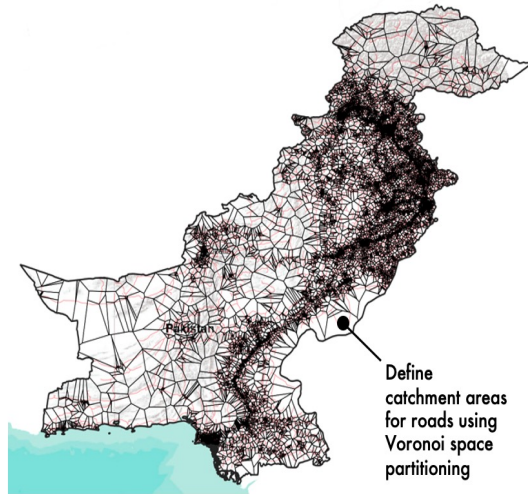
Assemble road assets

- Map the major roads of interest – primary, secondary, tertiary, trunk
- Spatial overlay with hazard footprint to identify vulnerable assets



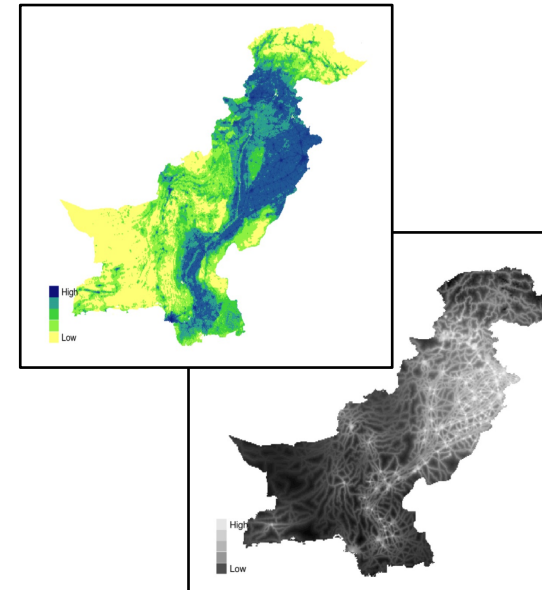
Define catchment areas

- Generate network model of junctions and road segments
- Assign 'spheres of influence' for each road segment



Assess value at risk

- Estimate socio-economic value at risk over catchment areas
- Produce network specific critical measures (remoteness, accessibility)



Index of infrastructure criticality

ECONOMIC

Exposed GDP at risk of being affected by service downtime

SOCIAL

Share of vulnerable population at risk of being affected by service disruption

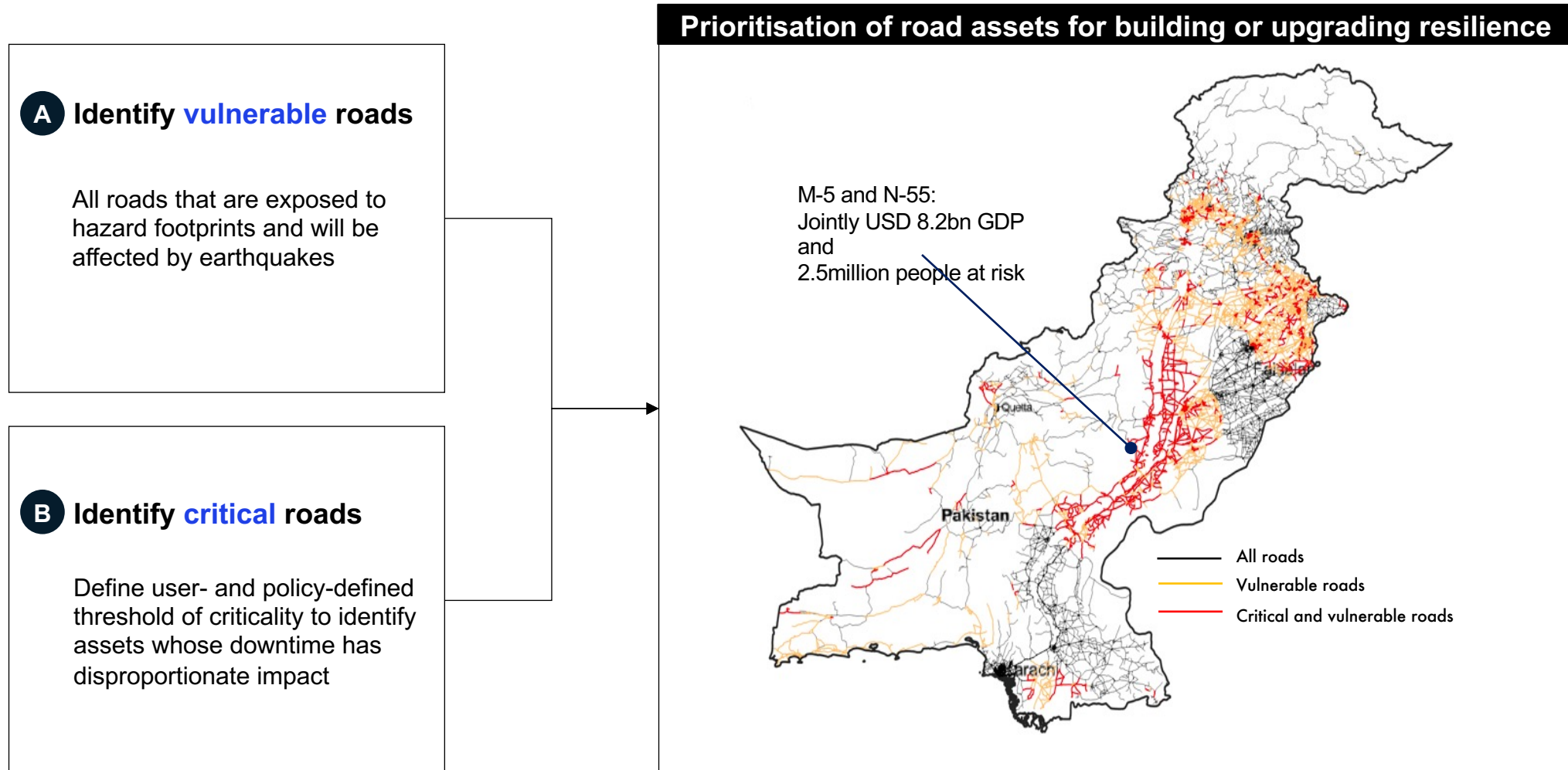
CONNECTIVITY

Other critical infrastructure (eg. hospitals) that would be stranded or cut-off by downtime

REMOTENESS

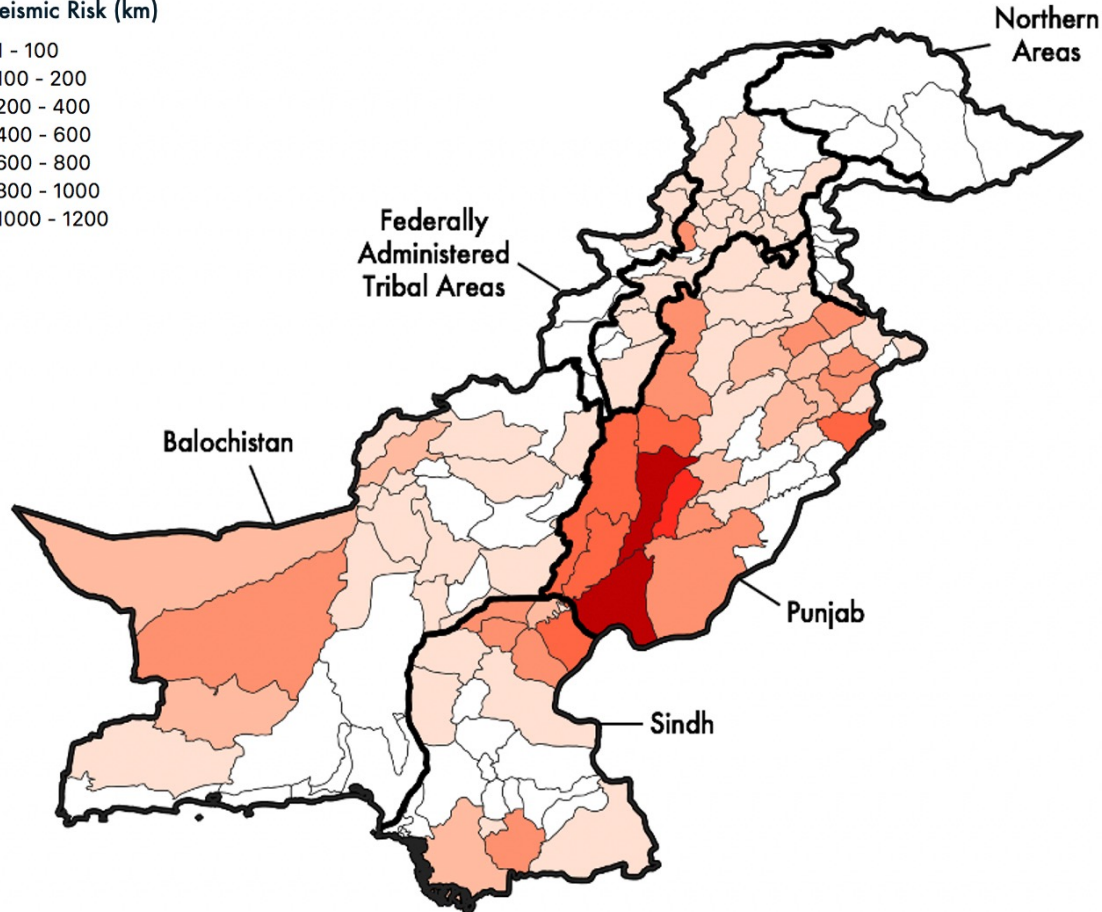
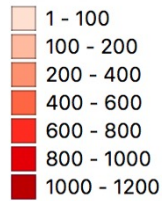
Remote population who depend solely on the road for access to wider region

Identify **critical roads to prioritise** for resilience against earthquakes



Identify **geographic hotspots** of critical road infrastructure ...

Critical roads exposed to Seismic Risk (km)



... to support regional resilience investment priorities

Low-regret investment in road resilience can protect a significant share of population and GDP

- **USD 16.5 million** of low-regret investment is estimated to make Pakistan's most critical and vulnerable roads resilient to seismic risk
- **16.6% of GDP** and **35.5 million people** could be at risk if this investment is not undertaken

Some regions are higher priority for resilience investments

- Punjab province has the highest concentration of vulnerable, critical roads
- **USD 11.2 million** of low-regret resilience investment is needed in Punjab

Q&A and discussion



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