

Pipeline Research Council International, Inc.

Extreme Events Hydrotechnical Strategic Research Priority

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DMC: Geohazard Management Vice-Chair

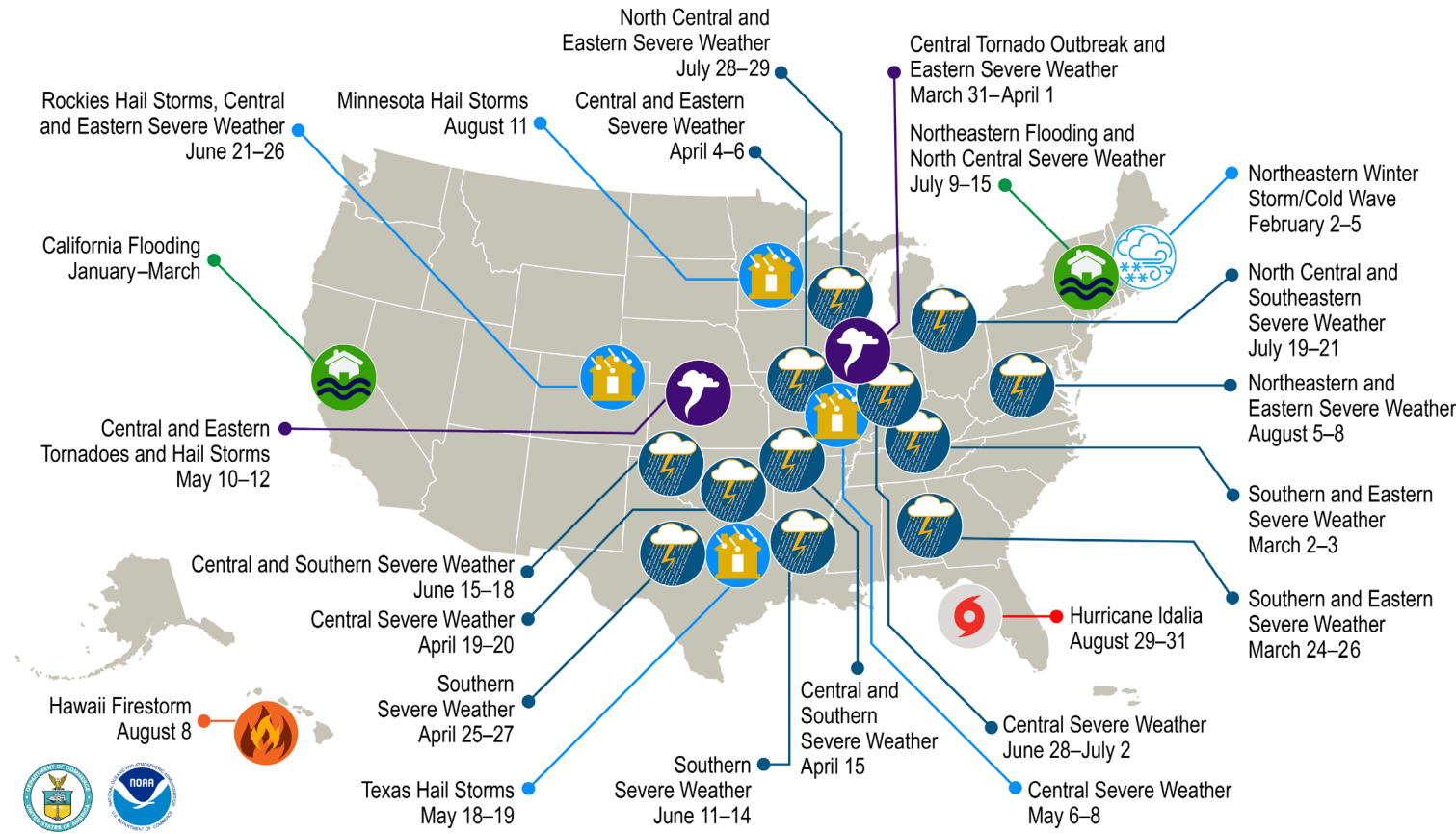
October 31, 2023



Impacts of Climate Change

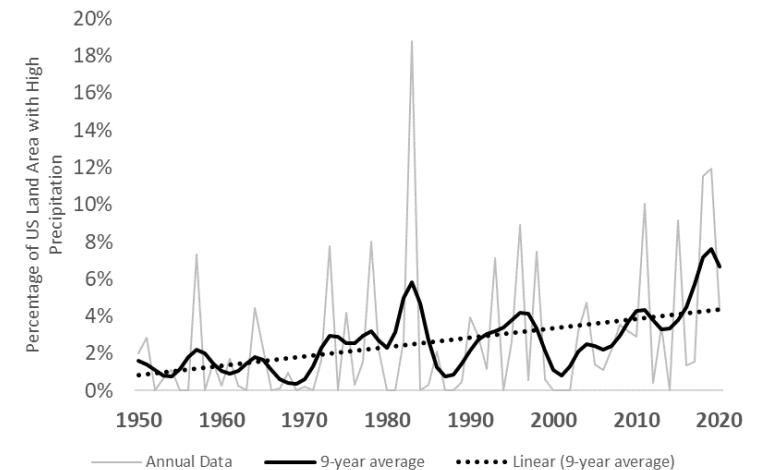
U.S. 2023 Billion-Dollar Weather and Climate Disasters

- Drought/Heat Wave
- Flooding
- Hail
- Hurricane
- Severe Weather
- Tornado Outbreak
- Wildfire
- Winter Storm/Cold Wave



This map denotes the approximate location for each of the 23 separate billion-dollar weather and climate disasters that impacted the United States through August 2023.

High Precipitation Events

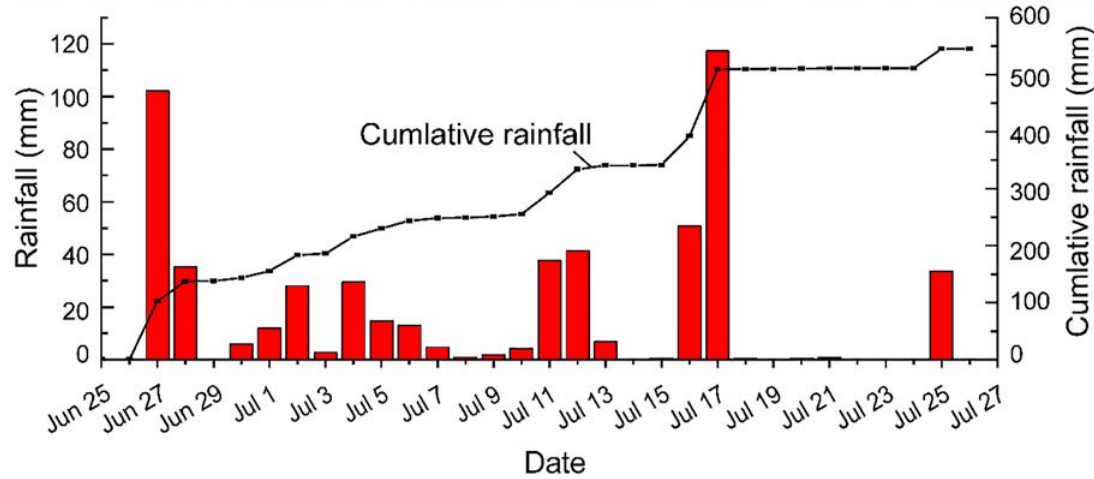
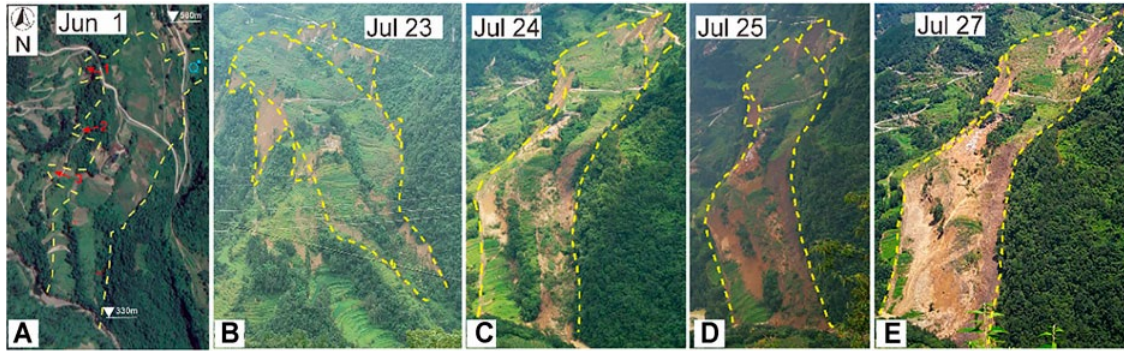


References

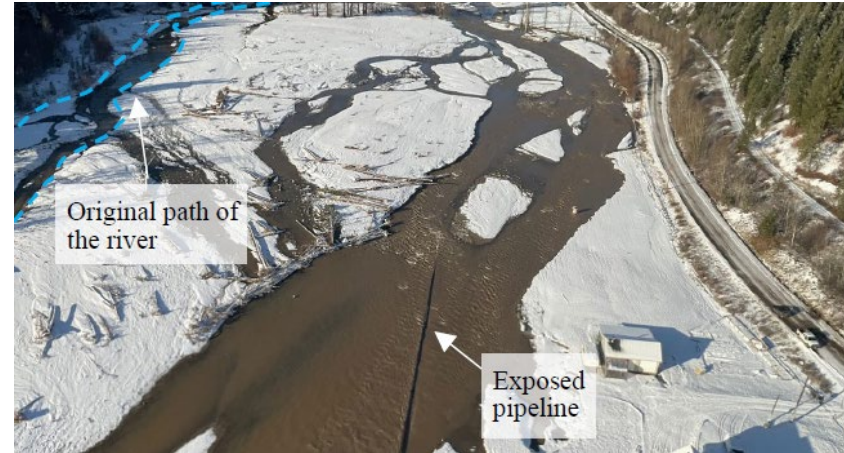
- <https://www.ncei.noaa.gov/access/billions/>
- <https://www.epa.gov/climate-indicators/climate-change-indicators-heavy-precipitation>

Geohazard Impacts of Extreme Precipitation Events

Landslides



Water Crossings



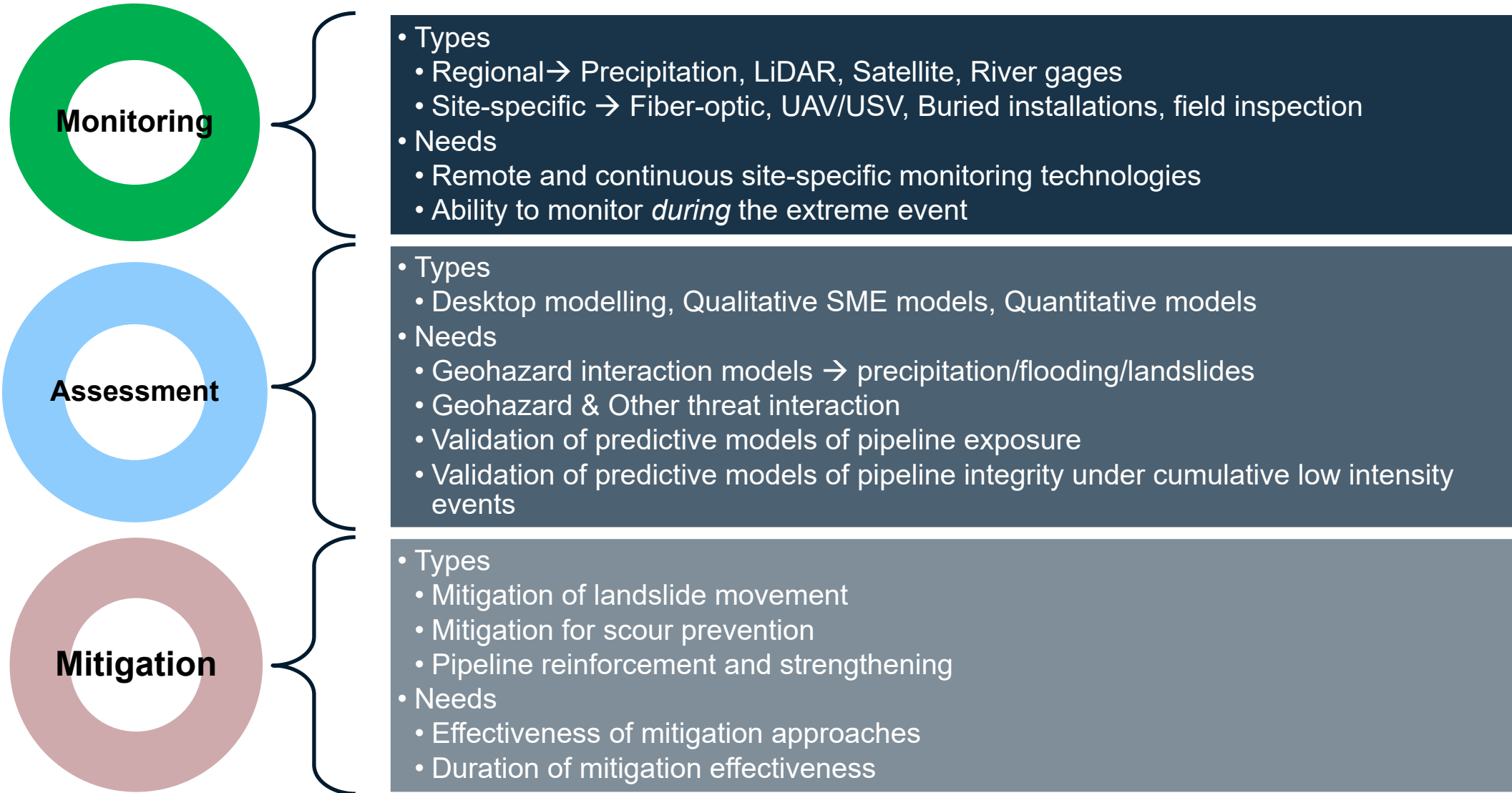
References

<https://www.frontiersin.org/articles/10.3389/feart.2021.774200/full>

The November 2021 British Columbia, Canada Storm: Observations and lessons learned from assessing pipeline infrastructure subject to natural disasters. Alex Baumgard et al. Proceedings of the ASME 2022 14th International Pipeline Conference, 2022

Key Components of Geohazard Management

4



Research Gaps to Address Extreme Event Geohazards

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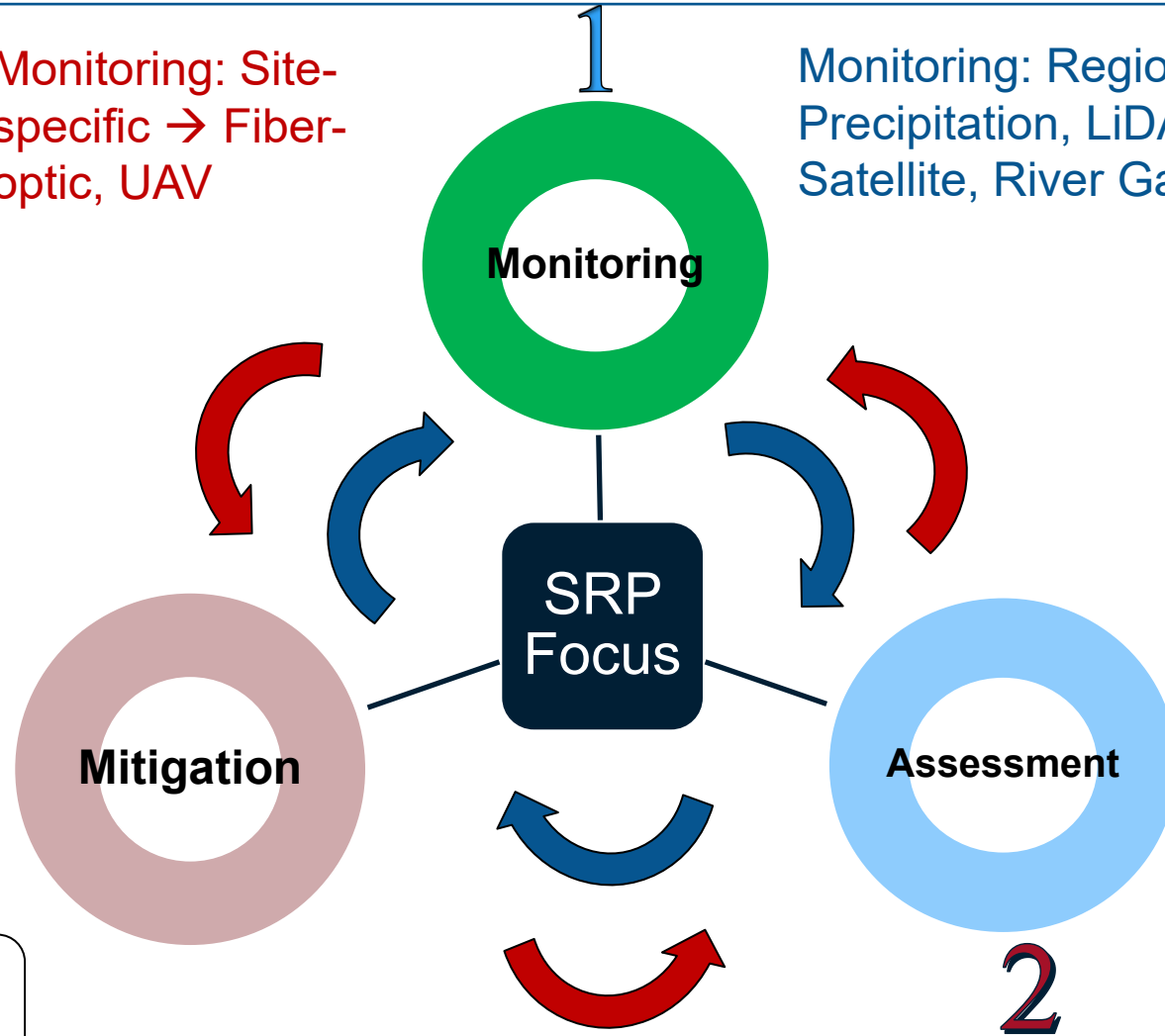
- **Pipeline operator and geohazard SME workshops: August 2022 & March 2023**
- **60 virtual attendees and knowledge sharing from multiple operator experiences**
- **Topic areas addressed**
 - **Monitoring →**
 - *What are the triggering events for geohazards?*
 - *What elements need monitoring for changes to channels, and scour depths?*
 - **Assessments**
 - *Geohazard modelling → outcome of events at the crossing*
 - *Pipeline integrity modelling → pipeline response to event and failure mechanisms, cumulative effects of frequent minor events, interaction of geohazard-induced loads with other threats*
 - *Data sharing → public domain data, incident & near-miss data*
 - **Mitigations**
 - *Prediction of remediation timelines*
 - *Validation of effectiveness of mitigation options*

Proposed PRCI SRP Scope

Remote and continuous site-specific monitoring

Monitoring: Site-specific → Fiber-optic, UAV

Monitoring: Regional → Precipitation, LiDAR, Satellite, River Gages



Mitigation: Type, Timing

Mitigation: Type, Timing, Performance

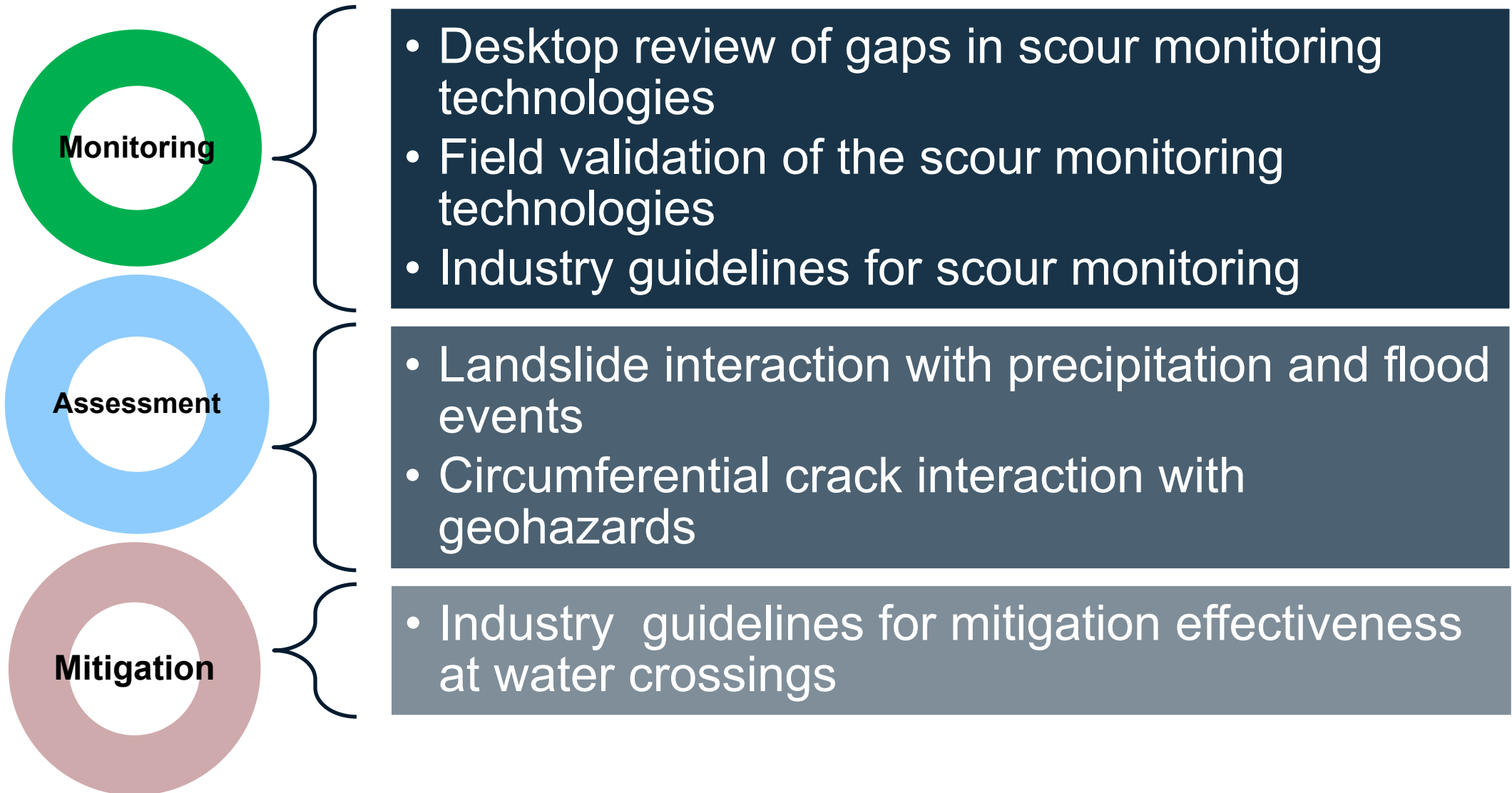
Assessment: Models, Input Data, Performance

Assessment: Field inspection, SME, Models

Mitigation effectiveness

Common data dictionary, desktop modelling, integrity

PRCI SRP Roadmap



Research Gaps & Challenges

8



Monitoring technologies that are remote and continuous across water crossings

- Field validation of performance during extreme events needs extensive installations and long-duration monitoring
- Lack of large-scale river flow research facilities
- **Regional scale threat interaction**
 - Limited understanding of the regional-scale interactions of the extreme event impacts, such as the effect of vegetation loss due to forest fires on debris flows and flash floods
- **Right-of-way impacts due to flash-floods**
 - Flash floods due to extreme events could result in erosion of right-of-way and hydrotechnical hazards
- **Validation of predictive models for onshore pipelines**
 - Limited test data and field validation of the pipeline response under as-built conditions (e.g., concrete weights, pipe bends, vintage girth welds)
- **Impacts of extreme events on coastal pipelines**
 - Limited understanding of pipeline response to changes to coastlines and soil conditions