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PIEVC WEBINAR SERIES:
PIEVC Green

February 16, 2023
PIEVC Program Webinar Series – Webinar #7
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Building resilient communities

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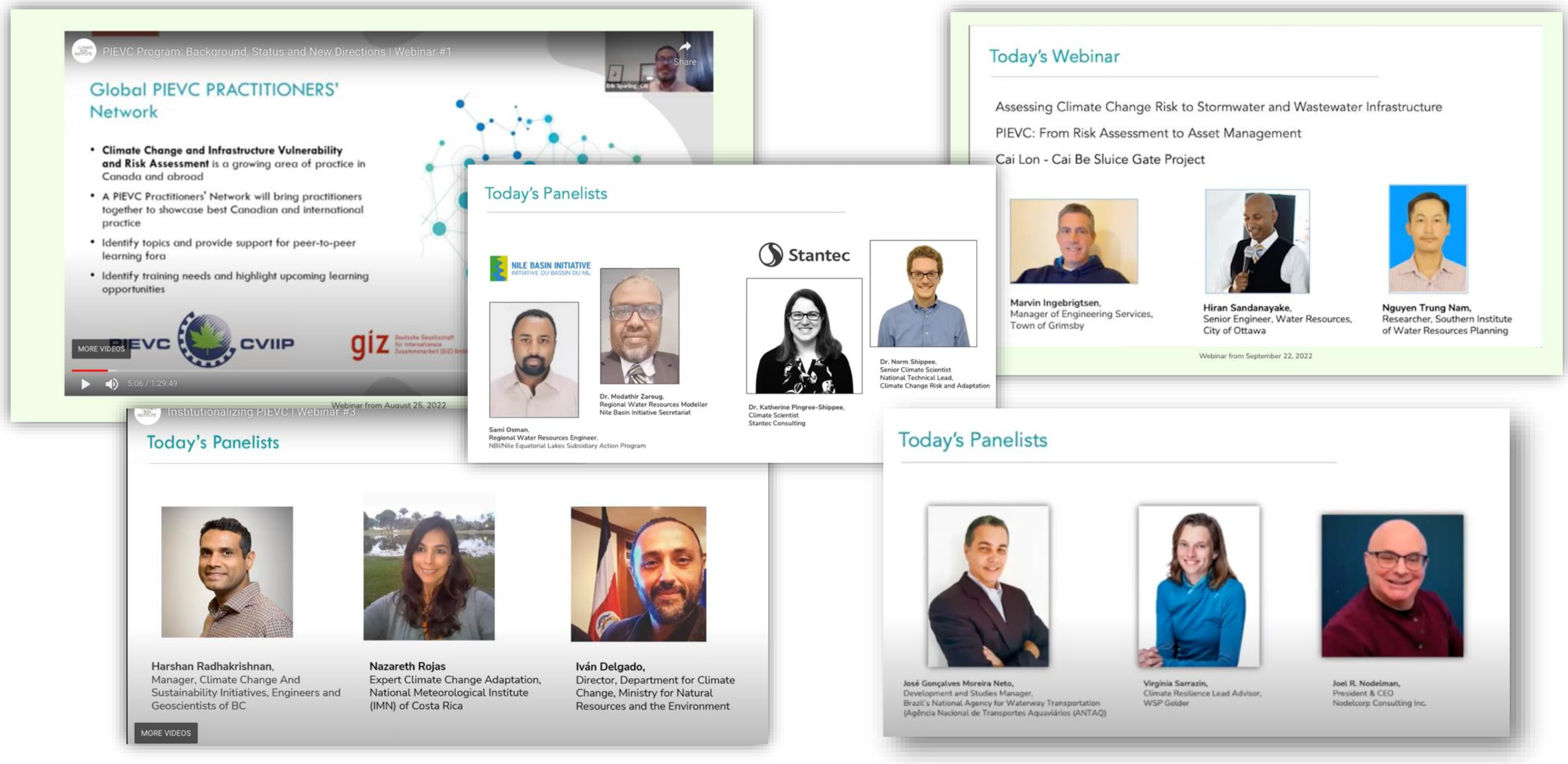
2022 - 2023 WEBINAR SERIES

Date	Topic
August 25, 2022	PIEVC Program: Background, Status and New Directions
September 22, 2022	From Assessment to Implementation of Adaptation Action
October 20, 2022	Institutionalizing Climate Change and Infrastructure Vulnerability and Risk Assessment (CCVRA): PIEVC in Adaptation Plans, Professional Practice, and other Mechanisms
November 17, 2022	Climate services for CCVRA: Lessons learned and new tools supporting steps 1 and 2 of the PIEVC Protocol
December 15, 2022	Large Portfolio Analyses using PIEVC Process
January 19, 2023	PIEVC High Level Screening Guide ….. February 9th HLSG Part Two!
February 16, 2023	**PIEVC GREEN**
March 16, 2023	Integration of PIEVC into Asset Management Toolkits
April 18 – 20, 2023	Join us for the GLOBAL FORUM in Vancouver, BC

For recordings of previous webinars and for updates on future speakers, go to CRI website: climateriskinstitute.ca or CRI YouTube page



PREVIOUS WEBINARS IN THIS SERIES

PIEVC GLOBAL FORUM

VANCOUVER, BC

April 18-20, 2023

climateriskinstitute.ca/events

Infrastructure and climate change risk professionals from Canadian and international governments, development agencies, NGOs, and the private sector are assembling in Vancouver to share their experiences with PIEVC, and learn from leading experts.

REGISTRATION NOW OPEN

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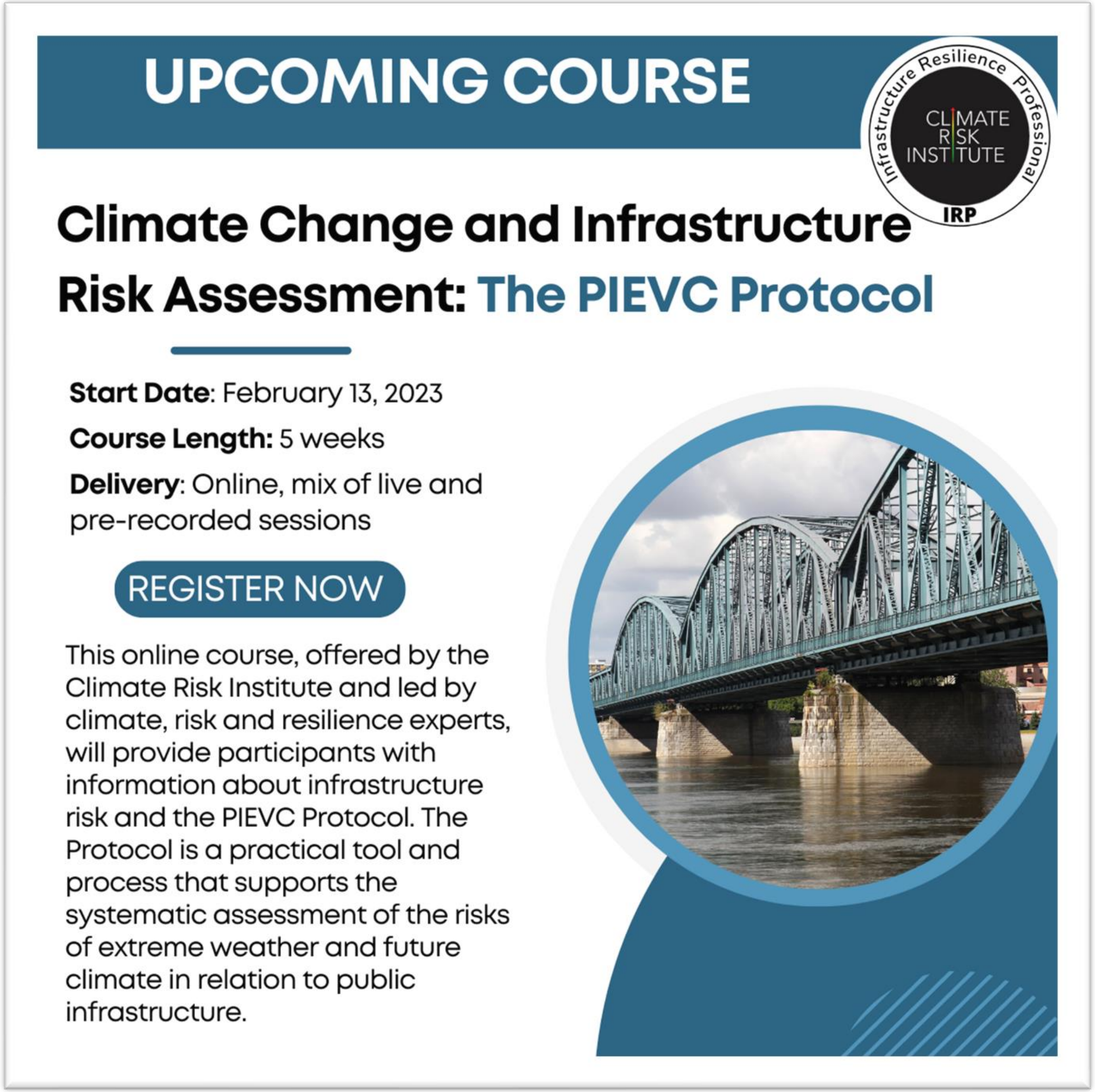
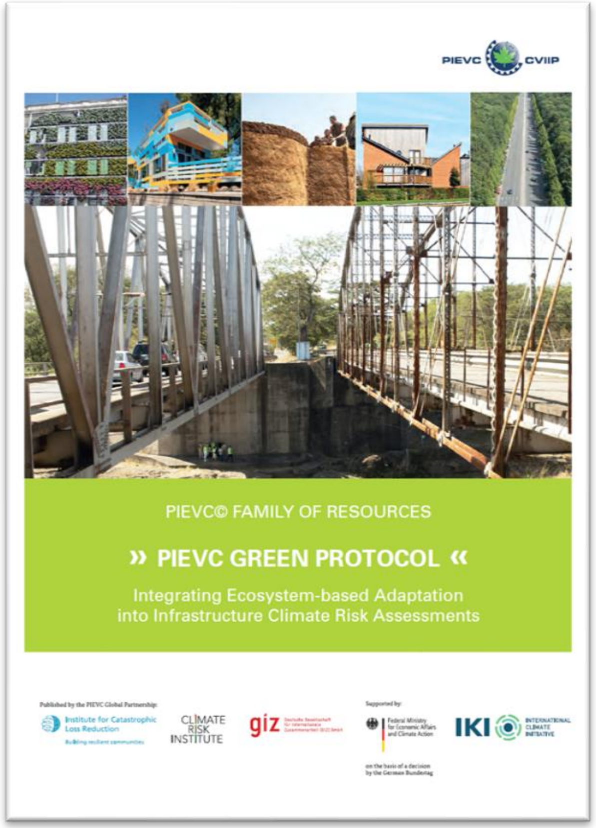


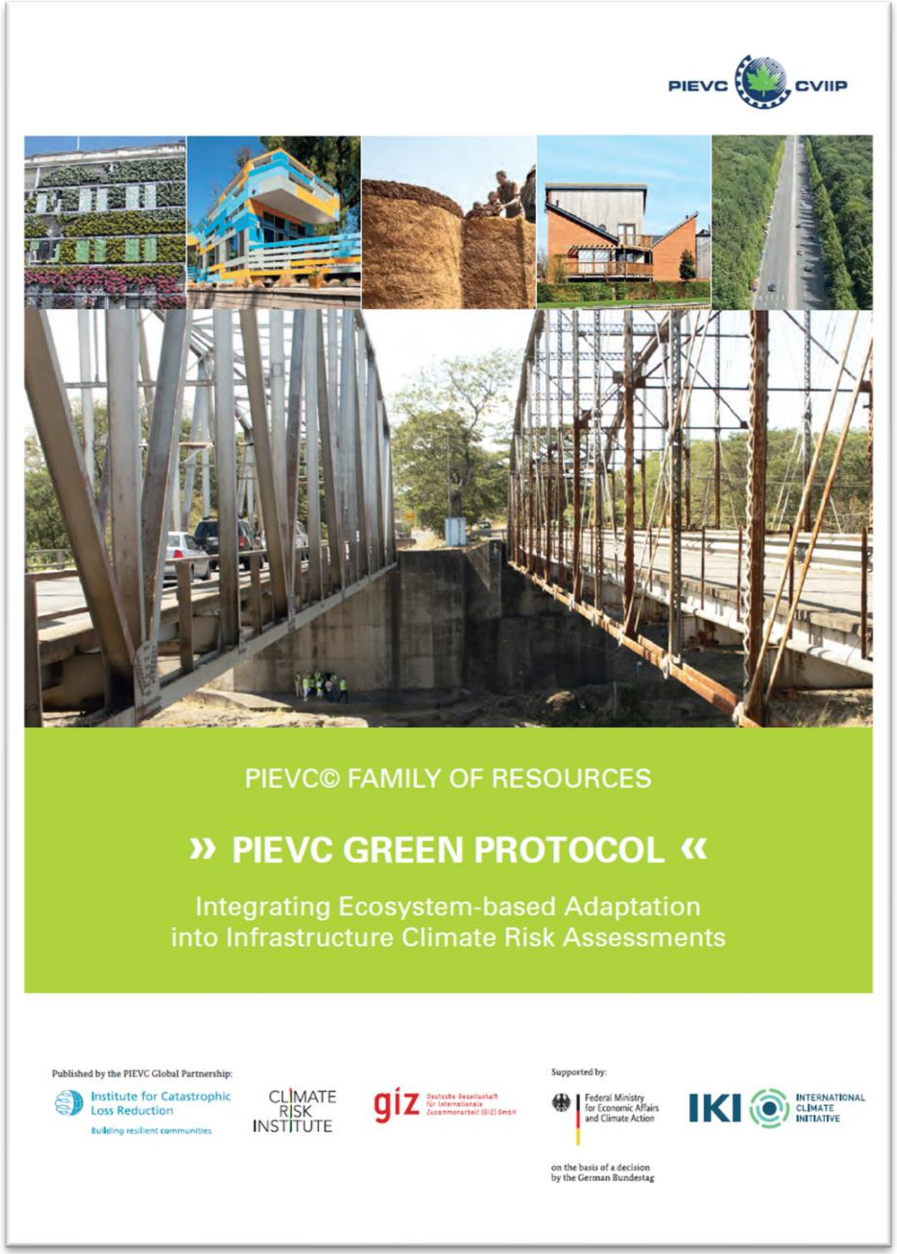
Next course:
May 1, 2023 – June 2, 2023

https://climateriskinstitute.ca/training-and-credentialing/

Today's Webinar

- **PIEVC Green Protocol –** Stephanie Austin, NIRAS-IP
- **Case Study from Lesotho –** Migwi Matsolo, Deputy Coordinator, Ministry of Water





PIEVC Green Protocol:

EbA as an entry point for systems thinking in the engineering community

(beta version)

Webinar Series: Climate Change Vulnerability and Risk Assessments for Infrastructure

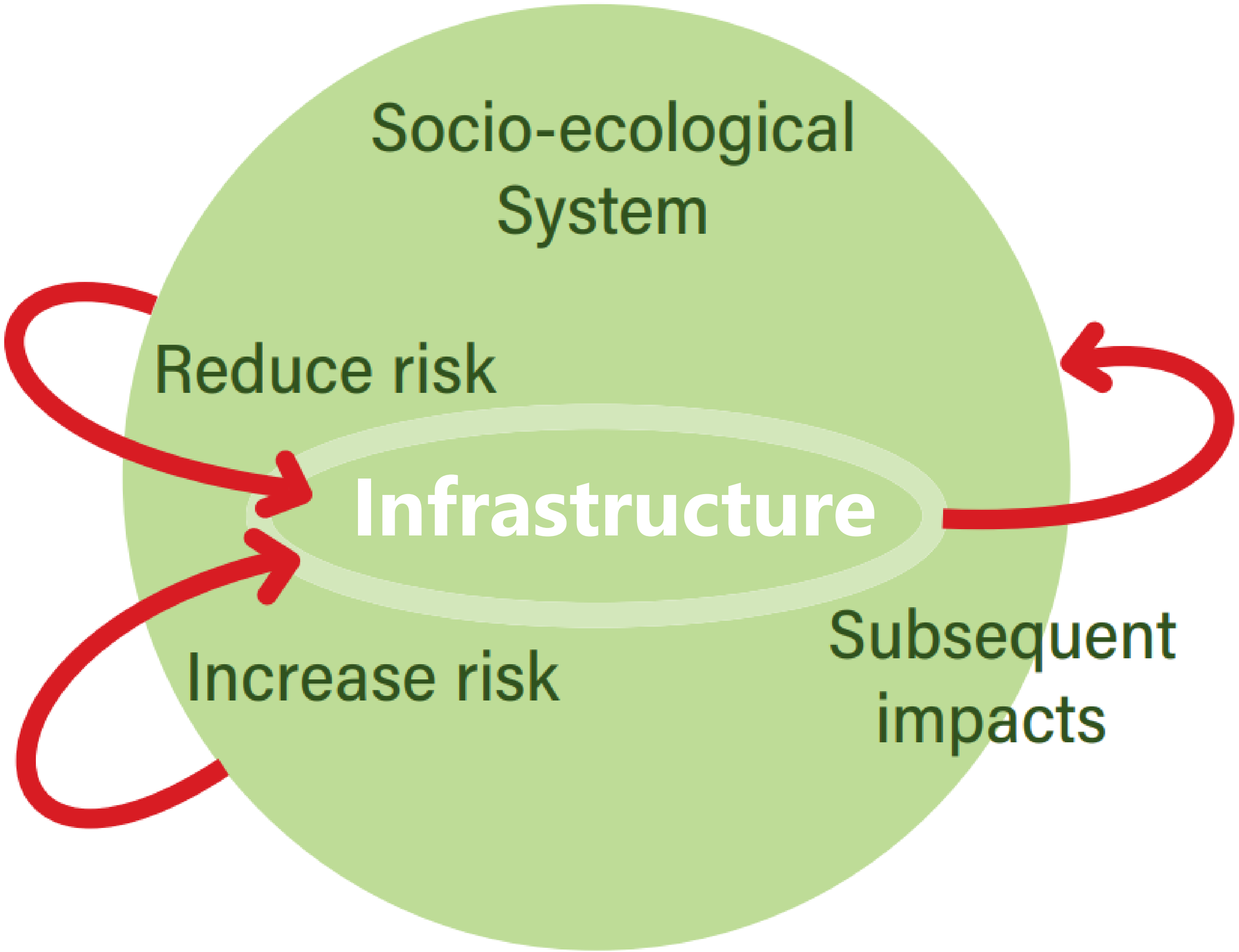
November 23, 2022

NIRAS-IP Consult and GIZ

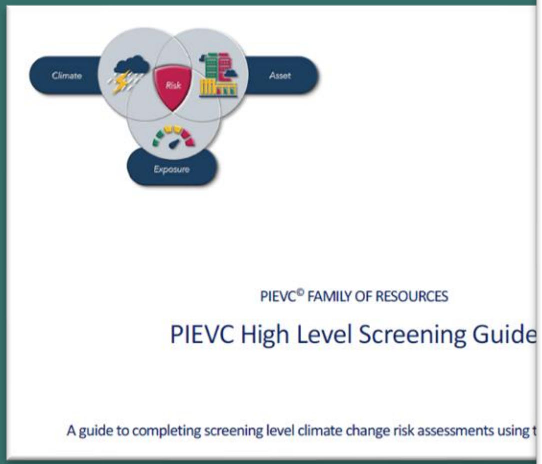
Stephanie Austin

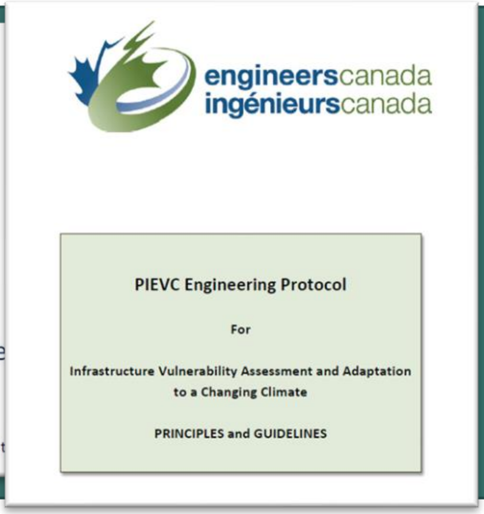
Wolfram Lange

Purpose of the PIEVC Green Protocol



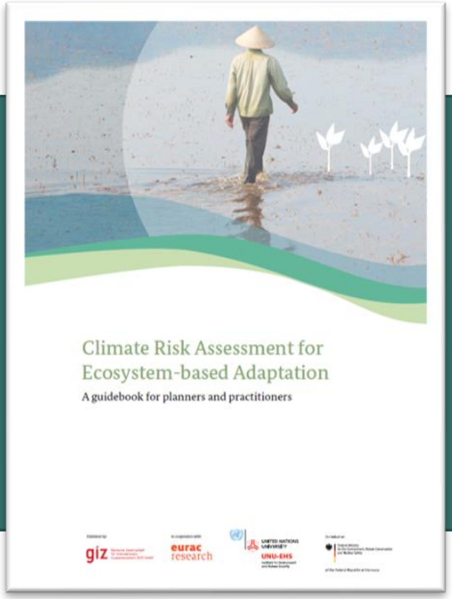
Integrating PIEVC and EbA Concepts



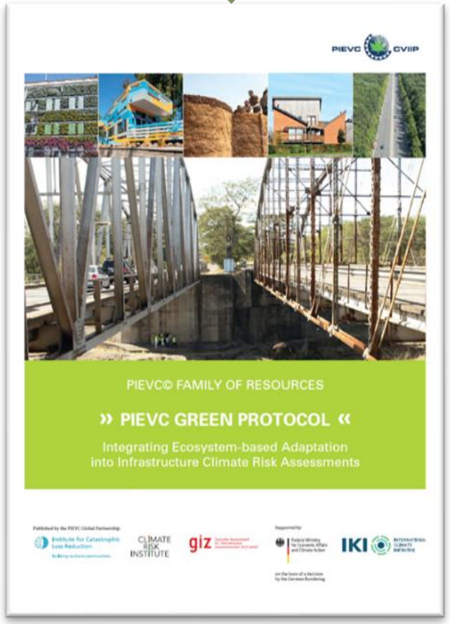


Severity of impact					
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	8	10
2	2	4	6	8	10
1	1	2	3	4	5
	Likelihood				
	1	2	3	4	5

From original PIEVC Protocol and High-Level Screening Guide:
- Base for PIEVC Green Protocol
- Core steps and activities (e.g. risk matrix)
- Infrastructure lens



From GIZ EbA CRA Guide:
- Systems thinking, EbA and SES concepts
- Rationale for systems approach
- Key methodology: impact chains and vulnerability indicators



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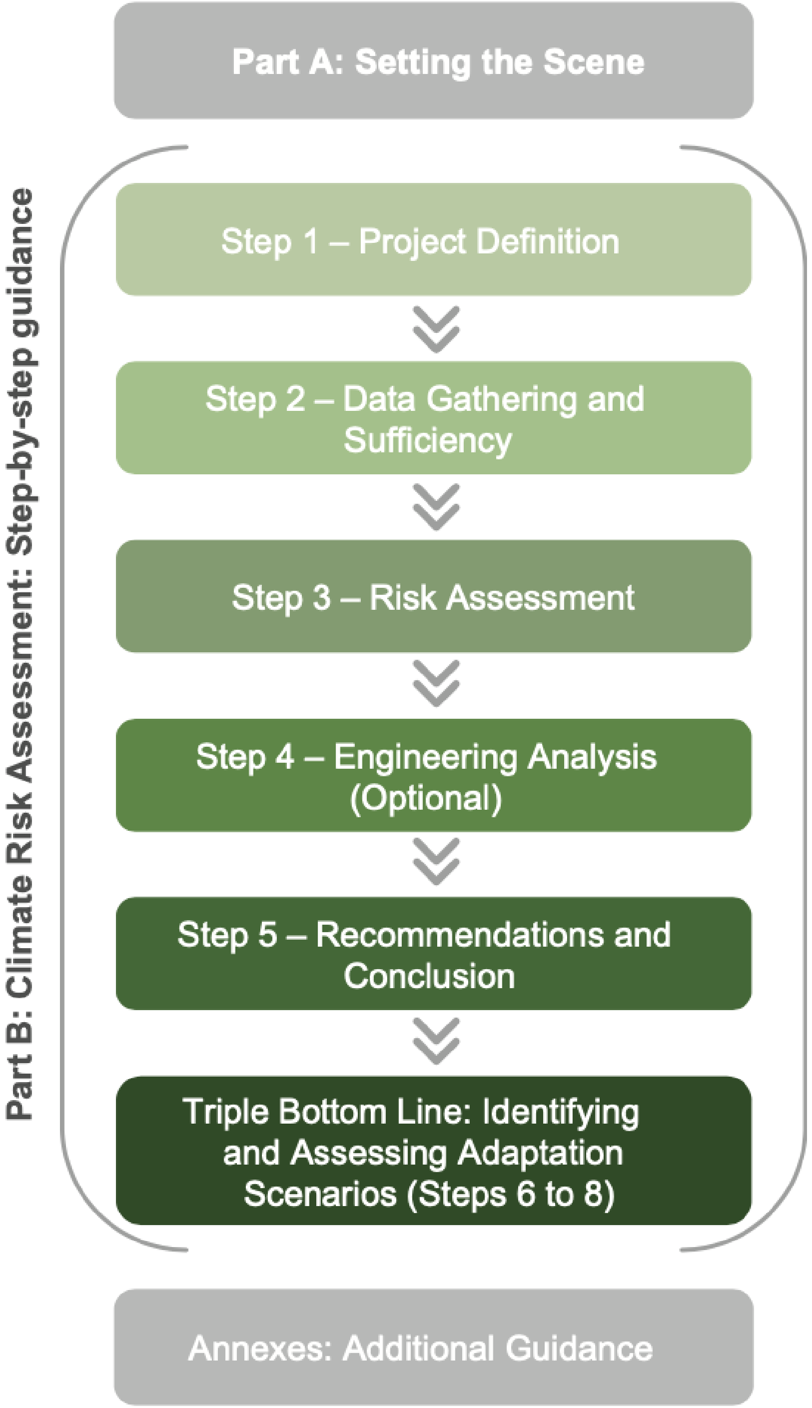
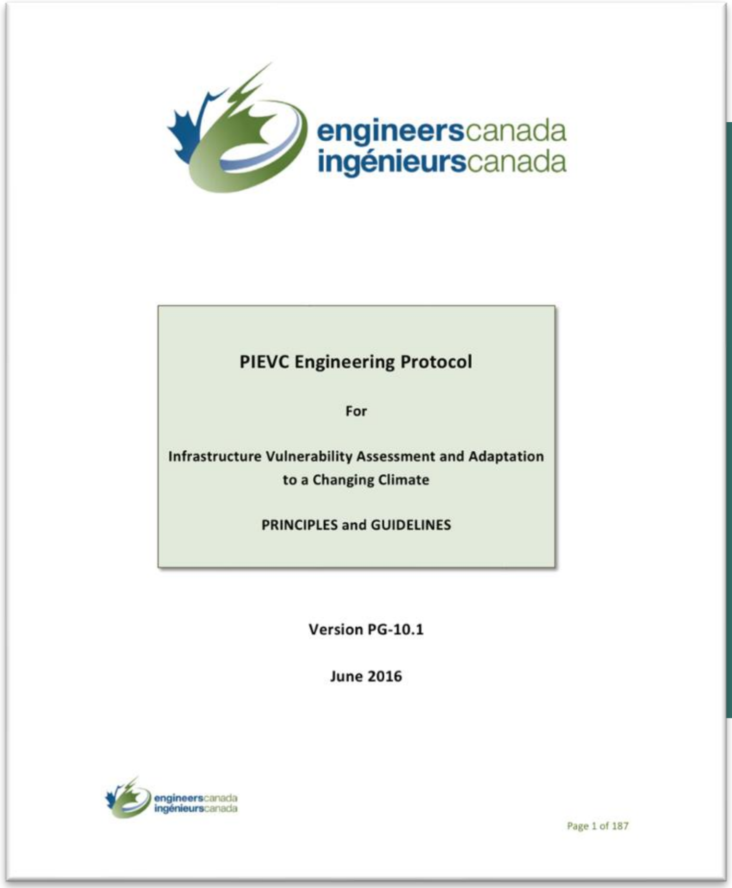
PIEVC Green Protocol Content

- **Part A: Setting the Scene *(20 pages)***
  - Key concepts in PIEVC Green
  - Fundamentals of a climate risk assessment
  - Managing an interdisciplinary team
- **Part B: Climate Risk Assessment: Step-by-step guidance *(36 pages)***
  - Core 5-step protocol
  - Triple Bottom Line module (steps 6-8)
- **Annexes *(27 pages)***
  - Additional guidance
  - Glossary



Evolution from the Original PIEVC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PIEVC Engineering Protocol

For

Infrastructure Vulnerability Assessment and Adaptation to a Changing Climate

PRINCIPLES and GUIDELINES

Version PG-10.1

June 2016

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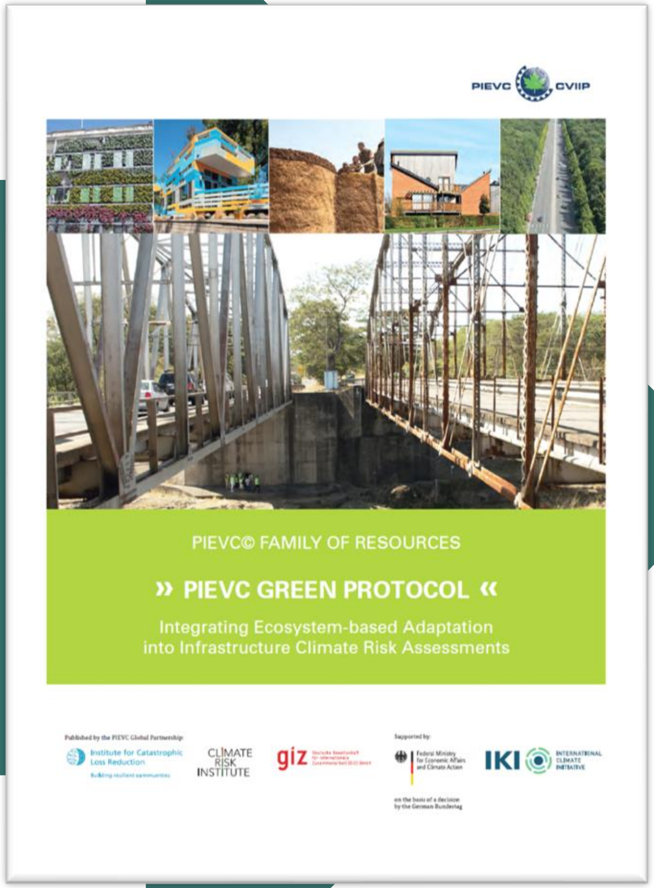
Page 1 of 187

- Social-Ecological Systems approach
- Broadened scope of CRA
- Emphasis on ecosystem-based adaptation (EbA) and co-benefits for adaptation
- Updated climate risk concepts that align with IPCC AR6
- Incorporates aspects of PIEVC's vulnerability assessment module, Triple Bottom Line module, and HLSG
- Shortened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» PIEVC GREEN PROTOCOL «

Integrating Ecosystem-based Adaptation into Infrastructure Climate Risk Assessments

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Step 1 Project Definition

Step 1 involves defining:

- Which infrastructure is being assessed
- The infrastructure's location
- Uses of the infrastructure
- Climate and geographic considerations
- Severity of climate impacts and potential risks to be assessed in detail

➢ Additional emphasis on the social-ecological system

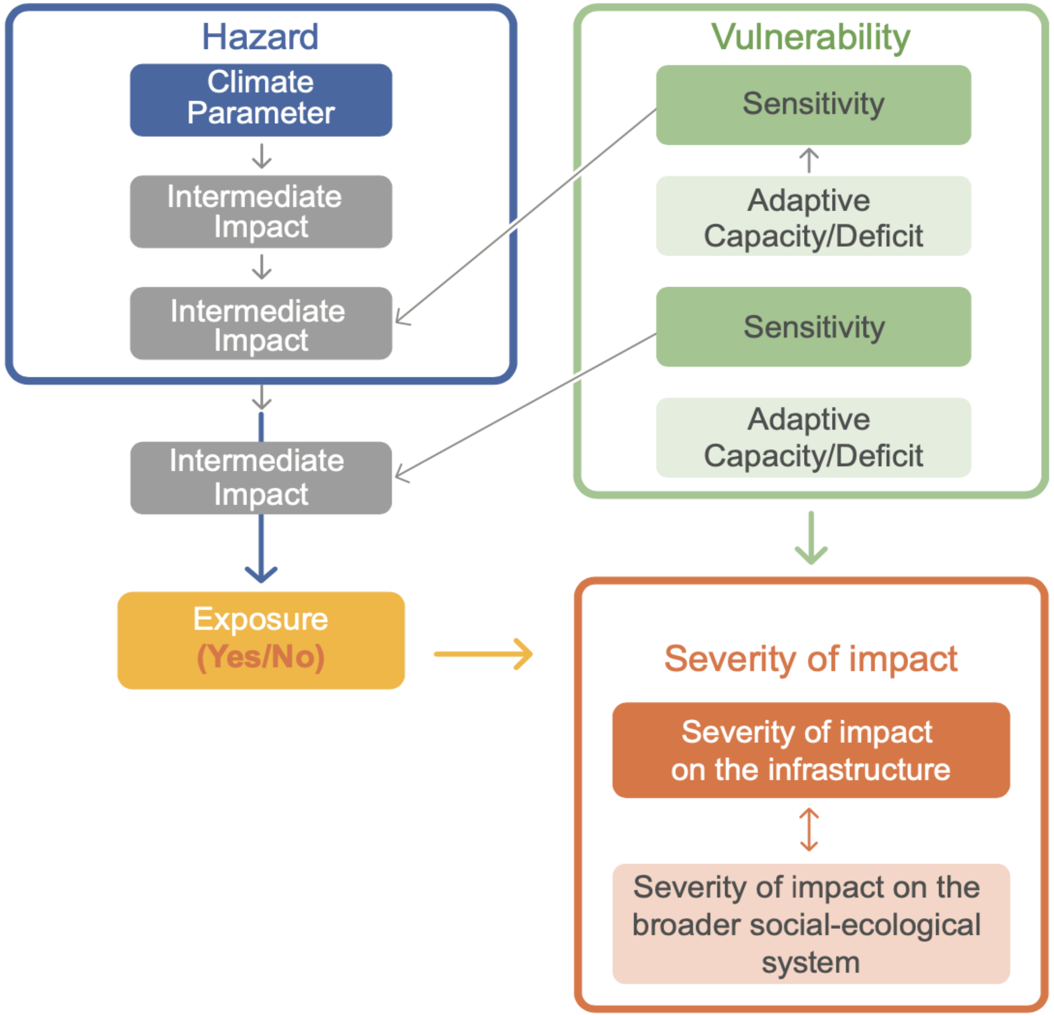
Figure 10 Step 1 key activities

Step 2 Data Gathering and Sufficiency

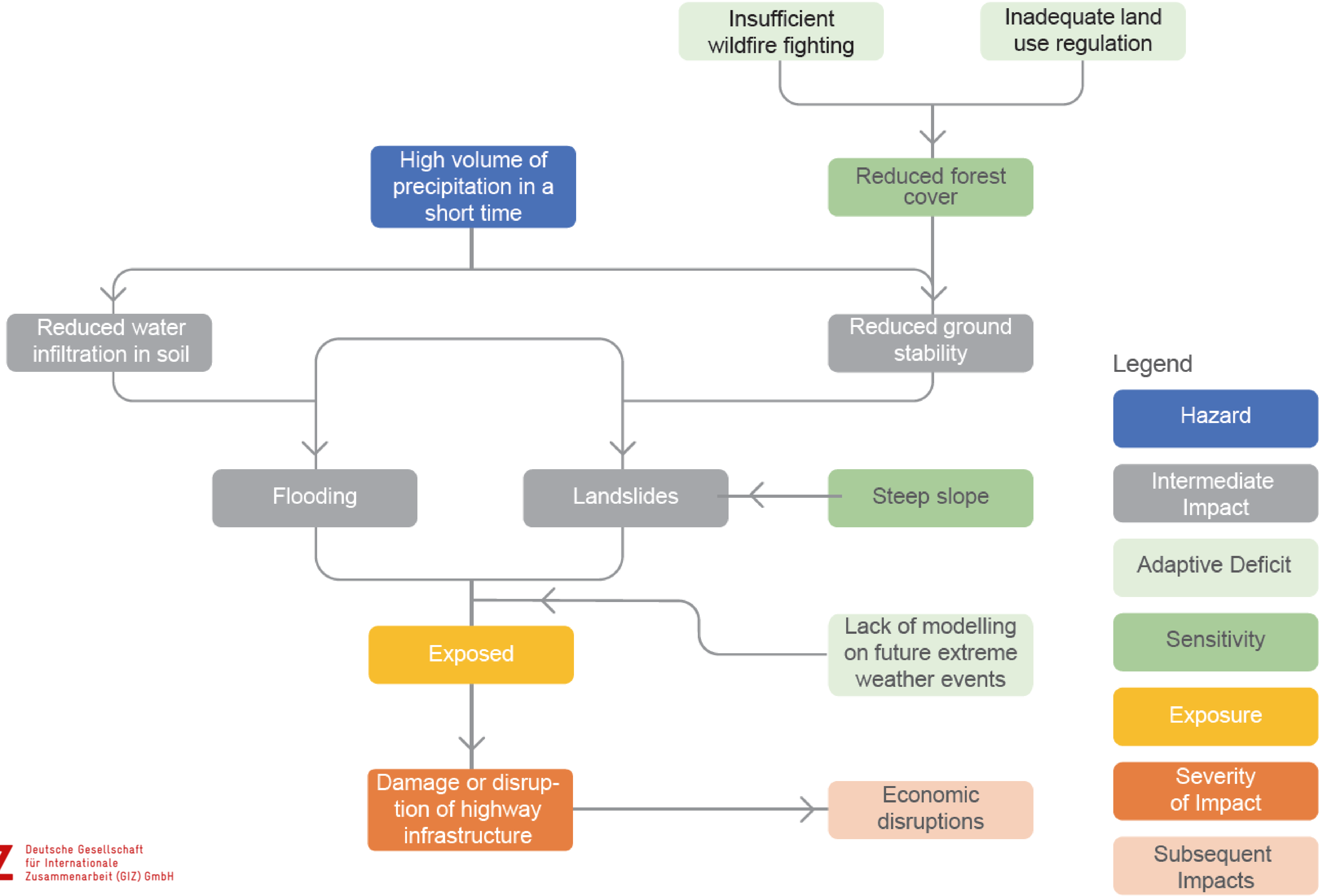
Step 2 involves data acquisition of infrastructure and climate components

Key additions to Step 2:

- Developing the Impact Chain
- Selecting vulnerability indicators (sensitivity and adaptive capacity)
- Normalize vulnerability indicators



The Impact Chain


Insufficient wildfire fighting
Inadequate land use regulation
High volume of precipitation in a short time
Reduced forest cover
Reduced water infiltration in soil
Reduced ground stability
Flooding
Landslides
Steep slope
Exposed
Lack of modelling on future extreme weather events
Damage or disrup-tion of highway infrastructure
Economic disruptions
Legend
Hazard
Intermediate Impact
Adaptive Deficit
Sensitivity
Exposure
Severity of Impact
Subsequent Impacts

Step 2 Data Gathering and Sufficiency

Key addition to Step 2:

- Establish likelihood scoring using the “Middle-Baseline” approach from the PIEVC HLSG

Table 3 Example scoring methodology

Likelihood Score (L)	Middle Baseline Approach – Establish Base	Method	Suggested Rationale
1	↑	Likely to occur less frequently than current climate	50 – 100% reduction in frequency or intensity with reference to Baseline Mean
2			10 – 50% reduction in frequency or intensity with reference to Baseline Mean
3	Establish Current Climate Normal per Parameter	Likely to occur as frequently as current climate	Baseline Mean Conditions or a change in frequency or intensity of ±10% with reference to the Baseline Mean
4	↓		10 – 50% increase in frequency or intensity with reference to Baseline Mean
5		Likely to occur more frequently than current climate	50 – 100%+ increase in frequency or intensity with reference to Baseline Mean

Step 3 Climate Risk Assessment

Step 3 involves performing the risk assessment by combining vulnerability, exposure, and likelihood

- Risk assessment workshop

Key addition to Step 3:

- Weigh and aggregate vulnerability indicators

$$VI = \frac{(I_1 * W_1 + I_2 * W_2 + \cdots I_n * W_n)}{\sum_1^n W}$$

where:

VI = vulnerability indicator

I = indicator (of sensitivity or adaptive deficit)

W = weight

Step 3 Climate Risk Assessment

Exposure yes (1) or no (0)

Severity of Impact = Exposure * Vulnerability

Figure 16 Example risk matrix

Severity of impact	Likelihood 1	Likelihood 2	Likelihood 3	Likelihood 4	Likelihood 5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Likelihood score was determined in Step 2

low risk; medium risk; high risk

Risk Score for each Climate-Infrastructure Interaction

Risk = Severity of Impact * Likelihood

Step 4 and 5 of PIEVC Green

Step 4 involves the Optional Engineering Analysis

- Similar to the Original PIEVC Protocol
- References PIEVC Vulnerability Assessment Module

Step 5 involves recommendations and conclusions

- Similar to Original PIEVC Protocol
- Can include social-ecological system considerations

Steps 6-8 The Triple Bottom Line

Step 6 involves Identifying Adaptation Scenarios

Step 7 involves Assessment of Adaptation Scenarios

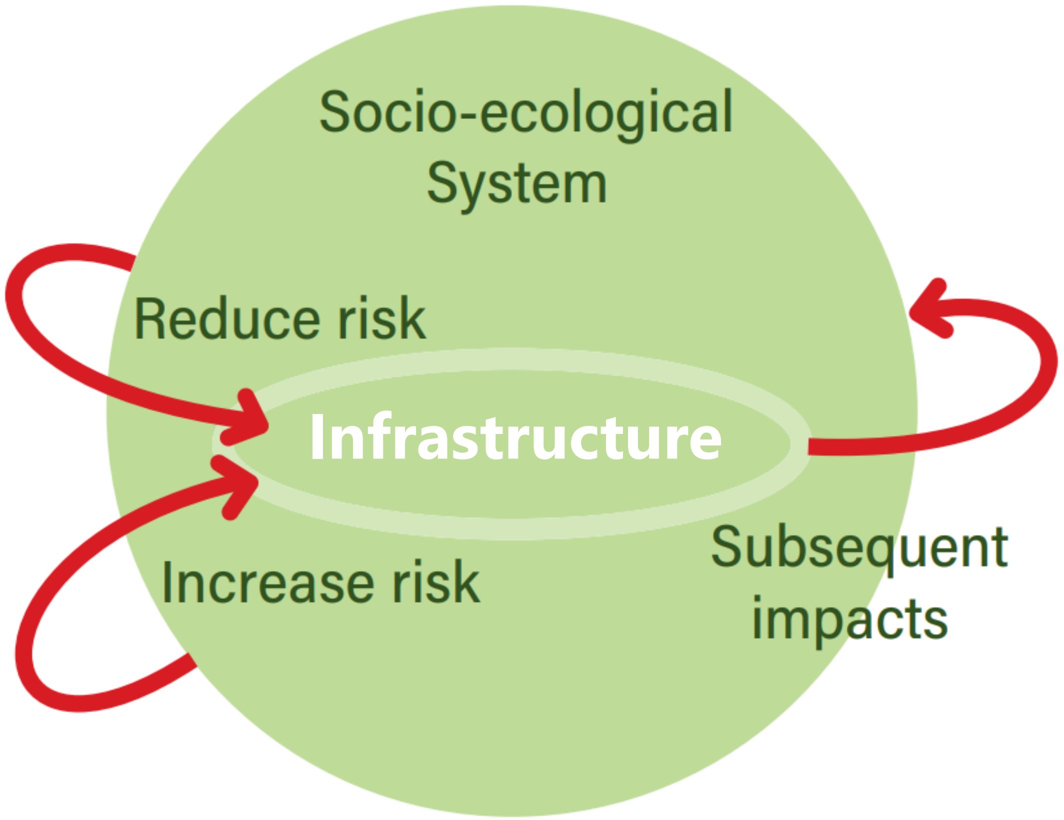
Step 8 involves Recommendations and Follow-Up

Changes in PIEVC Green:

- Use the Impact Chain for guidance
- Develop adaptation scenarios that address risk to the overall system
- Identify co-benefits and unintended consequences
- Consideration of Ecosystem-based Adaptation (EbA) measures
- Mainstream consideration of social-ecological system throughout

Summary: PIEVC Green Protocol

- ✓ Support more robust CRAs through consideration of social-ecological systems approaches
- ✓ Aligned with IPCC AR6
- ✓ Promote collaboration across disciplines and professions
- ✓ Shortened, more globally applicable
- ✓ Core content, steps and approach true to PIEVC Protocol
- ✓ Integrated approaches and concepts from:
    - GIZ CRA for EbA
    - PIEVC Family of Resources: HLSG, TBL Module, Large Portfolio Guide



More questions on the PIEVC Green Protocol?

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Image Source: LHDA. (2020). Bathymetric survey at the Metolong Dam

PIEVC Webinar Series

Assessing green infrastructure climate risks in Lesotho in pursuit of climate resilient water supply

February 16, 2023

Matsolo Migwi, Integrated Catchment Management Unit Lesotho
Ministry of Natural Resources, Lesotho

german cooperation
DEUTSCHE ZUSAMMENARBEIT

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Structure of the presentation

- ✓ **Context of the Assessment**
- ✓ **Objectives of the assessment**
- ✓ **The role of green infrastructure**
- ✓ **Risk Assessment approach**
- ✓ **Results & Recommendations**
- ✓ **Key messages**

Abundant water, along with high altitude and geographic proximity to major demand centers in southern Africa, is one of Lesotho's most valuable renewable and sustainable natural assets

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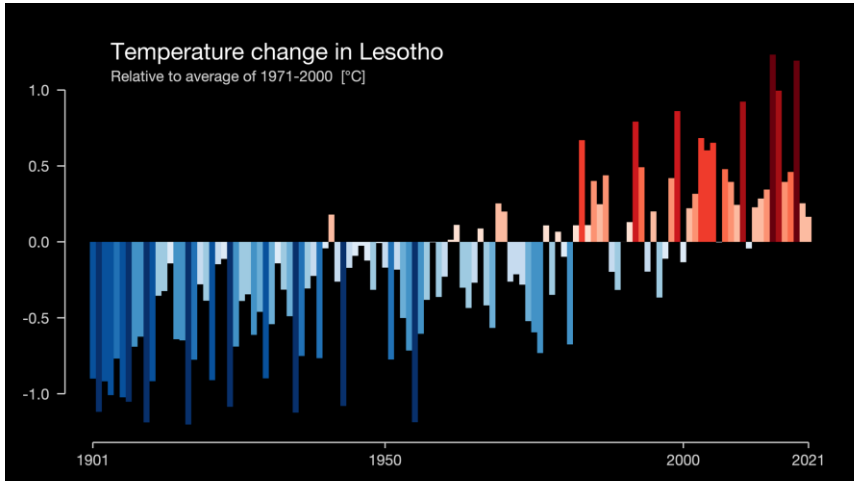
Anticipated Climate Change (Impacts) in Lesotho



More extreme weather conditions will likely increase the number and scale of hazards.Hence, climate change increases the risk of damaged physical infrastructure assets and interruption of services reliability for many sectors that are directly reliant on water supplies from these assets.

Climate Indicator *	2050s	2080s
Temperature		
Annual average temperature	↑ 2.7°C	↑ 5.1°C
Very hot days (+35°C)	7 times more	22 times more
Hot nights	1.5 times more	11 times more
Duration of extreme heat waves	28% more	48% more
Very cold days (<10°C)	69% less	88% less
Frost days	2 times less	4 times less
Date of first frost	5 days later	11 days later
Precipitation		
Wet days	↓ Decrease	↓ Decrease
Dry days	7 times more	13 times more
Annual precipitation total	↑ 4%	↑ 3.9%
Spring precipitation total	↑ 5%	↑ 6.5%
Fall precipitation total	↑ 4%	↑ 3.9%
Summer precipitation total	↓ -1.6%	↓ -6.5%
Winter precipitation total	↓ -11%	↓ -19%
Extremely wet days	1.5 times more	1.8 times more
Design precipitation (100-year)	3 times more	8 times more
Multi-day accumulated precipitation	↑ 8.5%	↑ 12%
Severe drought	1.4 times more	2.8 times more

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The exposed Metolong Dam System

The Metolong Dam and Water Supply Programme (MDWSP) aims to increase access to water and improve the reliability of water supply to urban and peri-urban areas in Maseru (capital city of Lesotho).

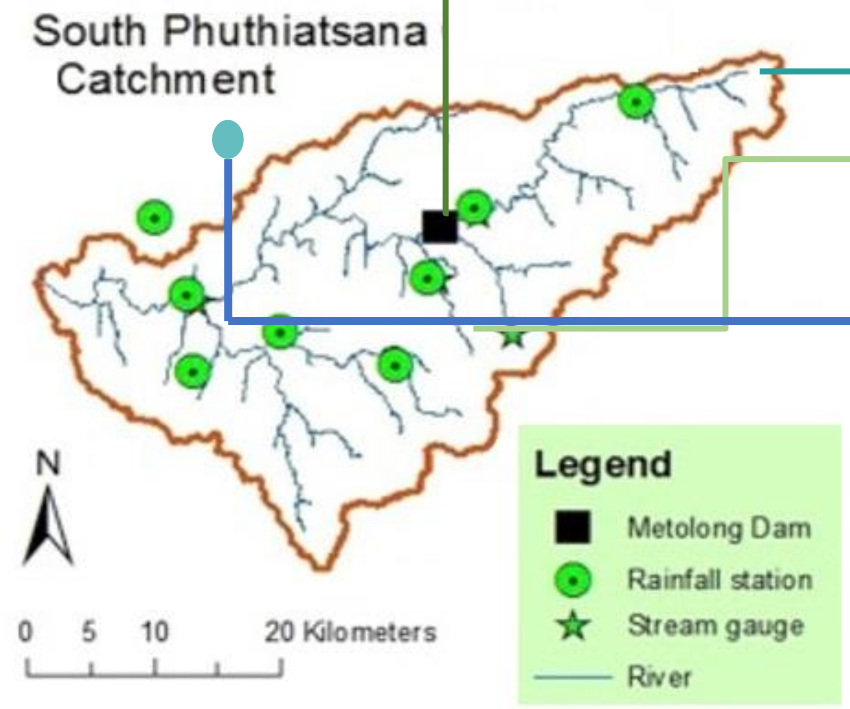
Key facts:

- Put into operation in 2016
- Supplied people: more then 500.000
- Max. Amount of water discharged every day: 1671 masl
- Reservoir capacity 63.686 Million m3
- Catchment Area of the dam: 268 km2

OBJECTIVES of the PIEVC Assessment

1. Build capacity on Risk Informed Development for resilient water supply
2. Apply the PIEVC green protocol to understand water security in Lesotho
3. Set the baseline for advancing on Integrated Catchment Management (ICM)

Assessment scales to depict the dam system

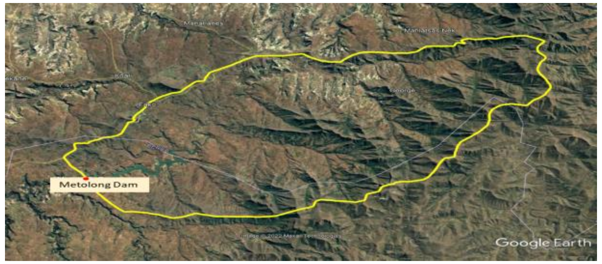


1. Watershed Scale

2. Reservoir Scale

3. Dam Scale

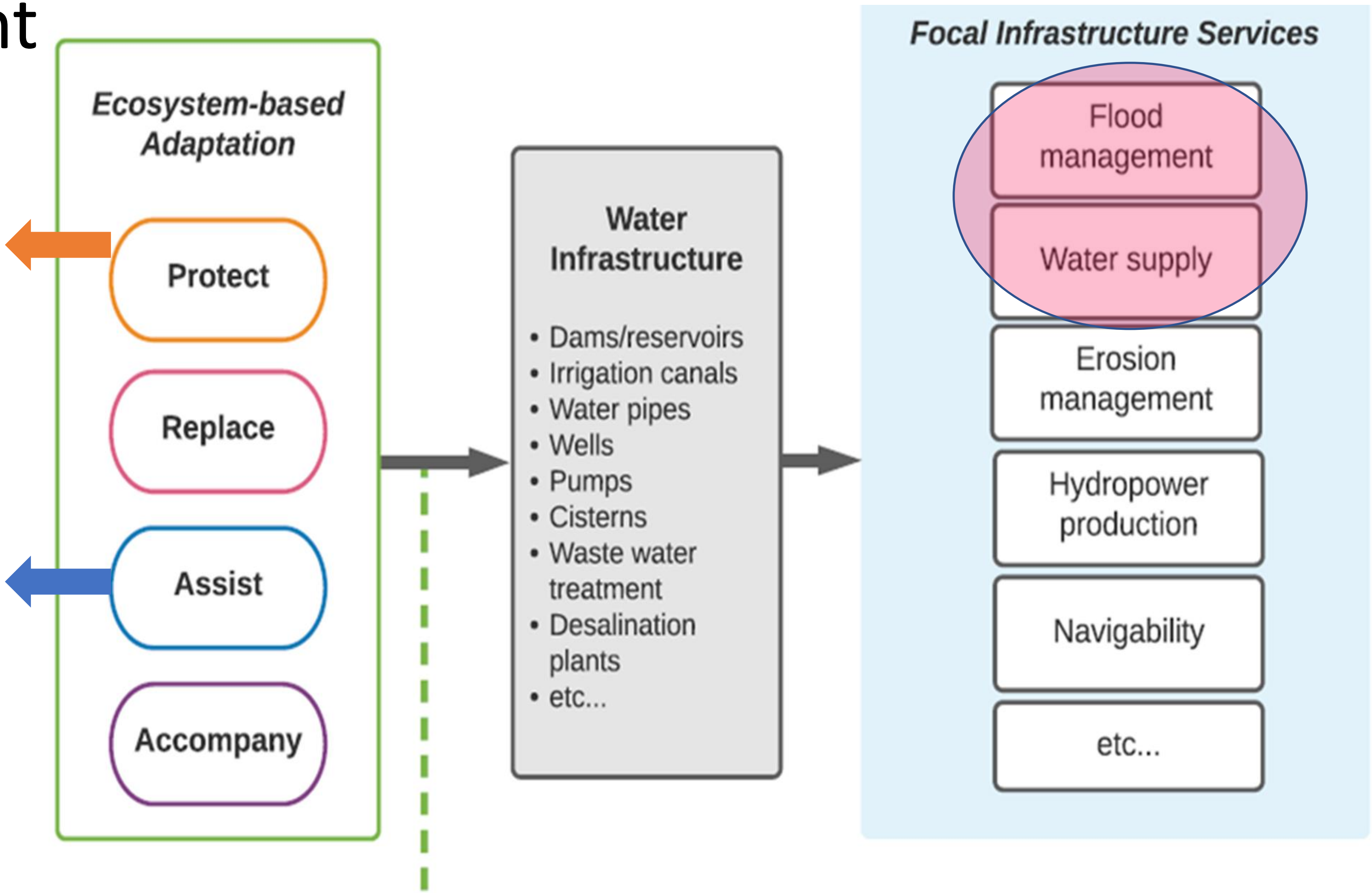
4. Water users, community downstream



Role of the watershed for resilient water supply in the Metolong catchment

Protecting function: supply ecosystem services that directly protect the reservoir and the dam from climate hazards, increasing its lifespan and reducing operating/maintenance costs, while also providing co-benefits.

Assisting function supply ecosystem services that complement a hard/grey infrastructure project by increasing focal service provision beyond what could be provided by the project alone, thereby improving capacity to continue service provision when impacted by climate hazards, while also providing co-benefits.



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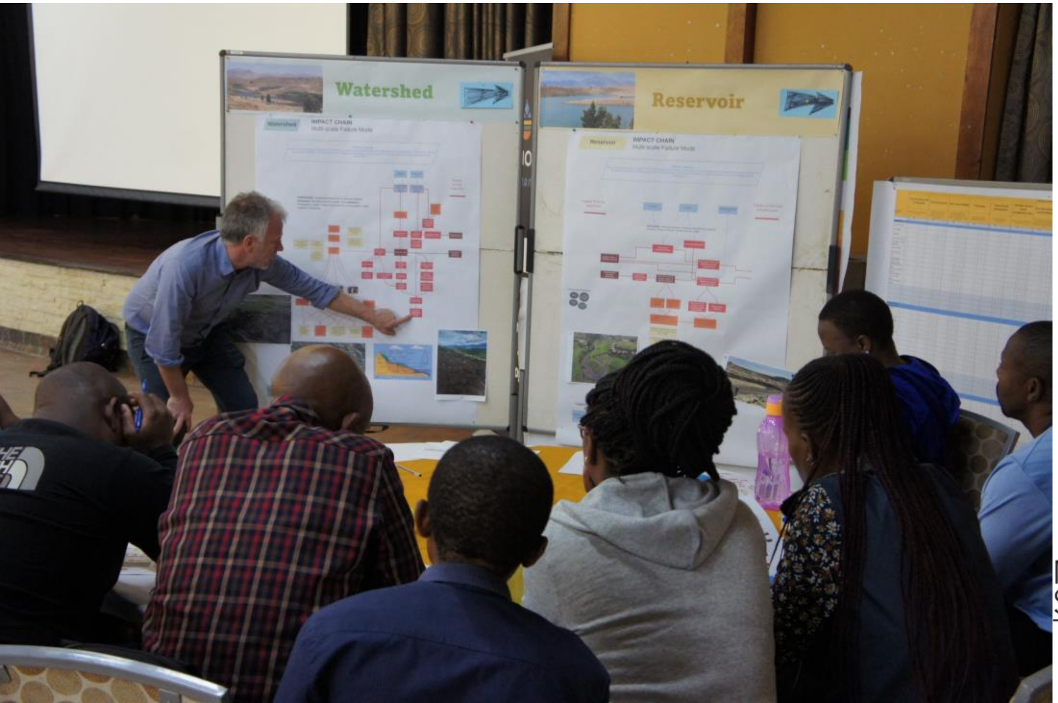
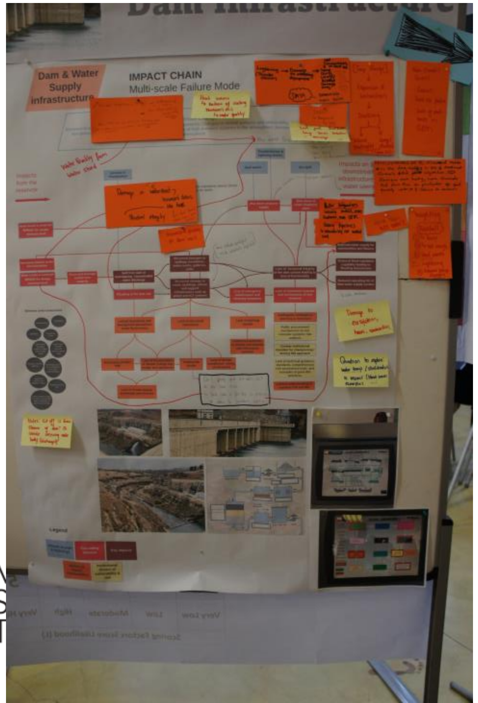
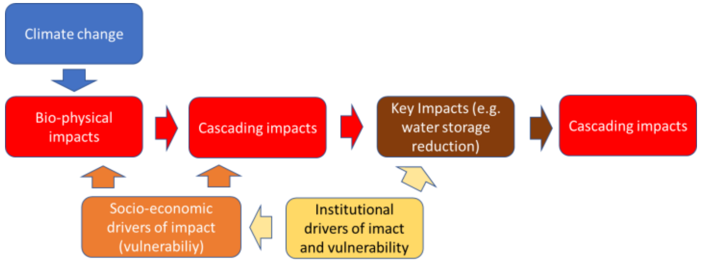
Stakeholder driven assessment

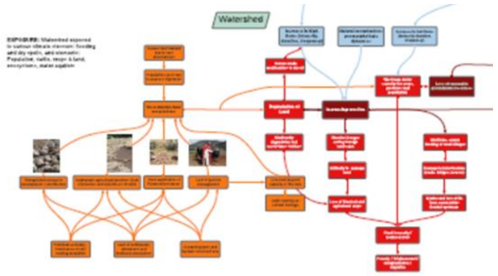




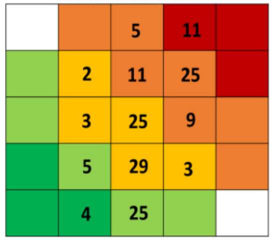
Methodological approach

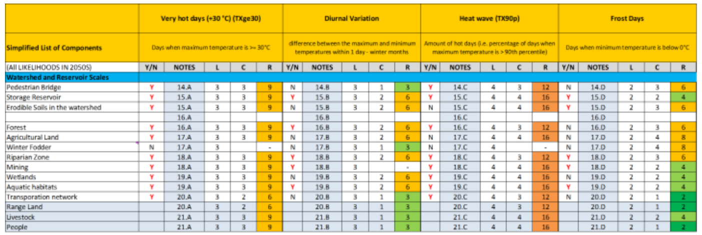
01 **Impact chain** assessment



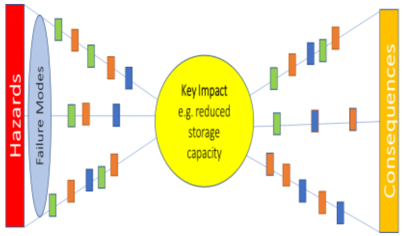


02 **Risk Screening** by components





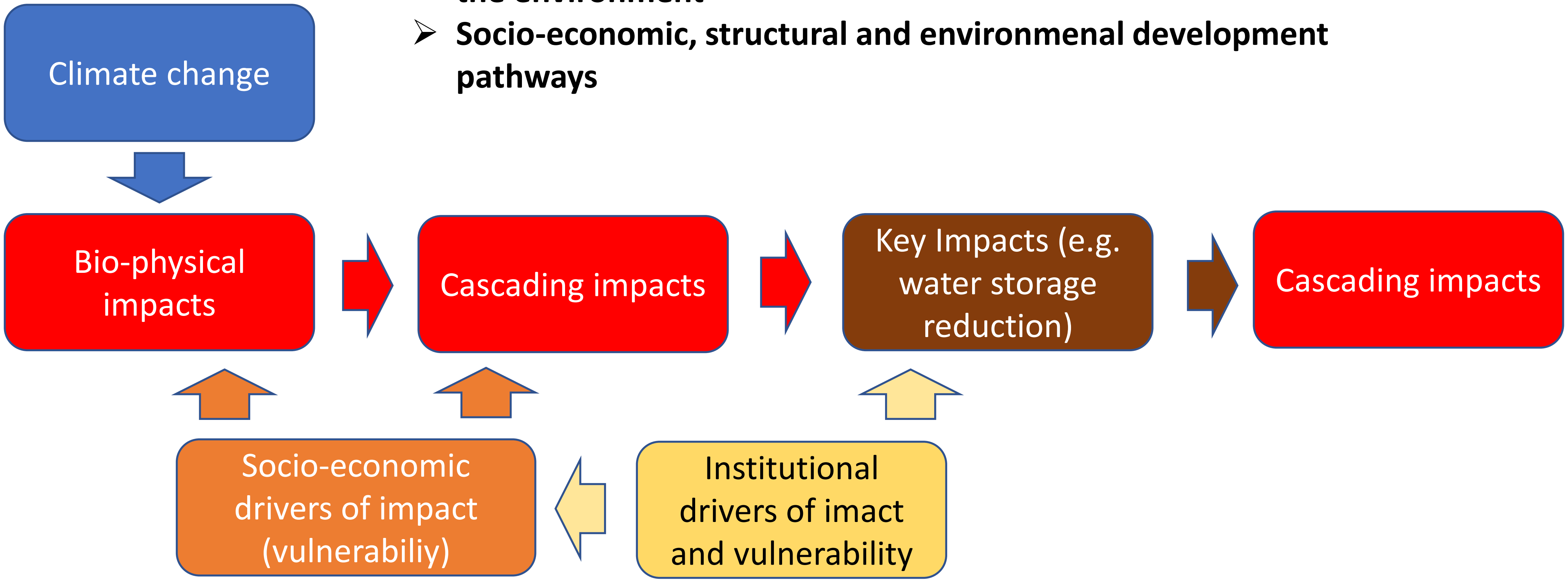
03 **In-depth assessment** of key impacts



(1) Impact chains as an entry point for PIEVC risk assessment

Understanding the **context and drivers of systemic risks** for **R**isk **I**nformed **D**evelopment (**RID**)

- **Climate change signals, extreme events and bio-physical impacts on the environment**
- **Socio-economic, structural and environmenal development pathways**



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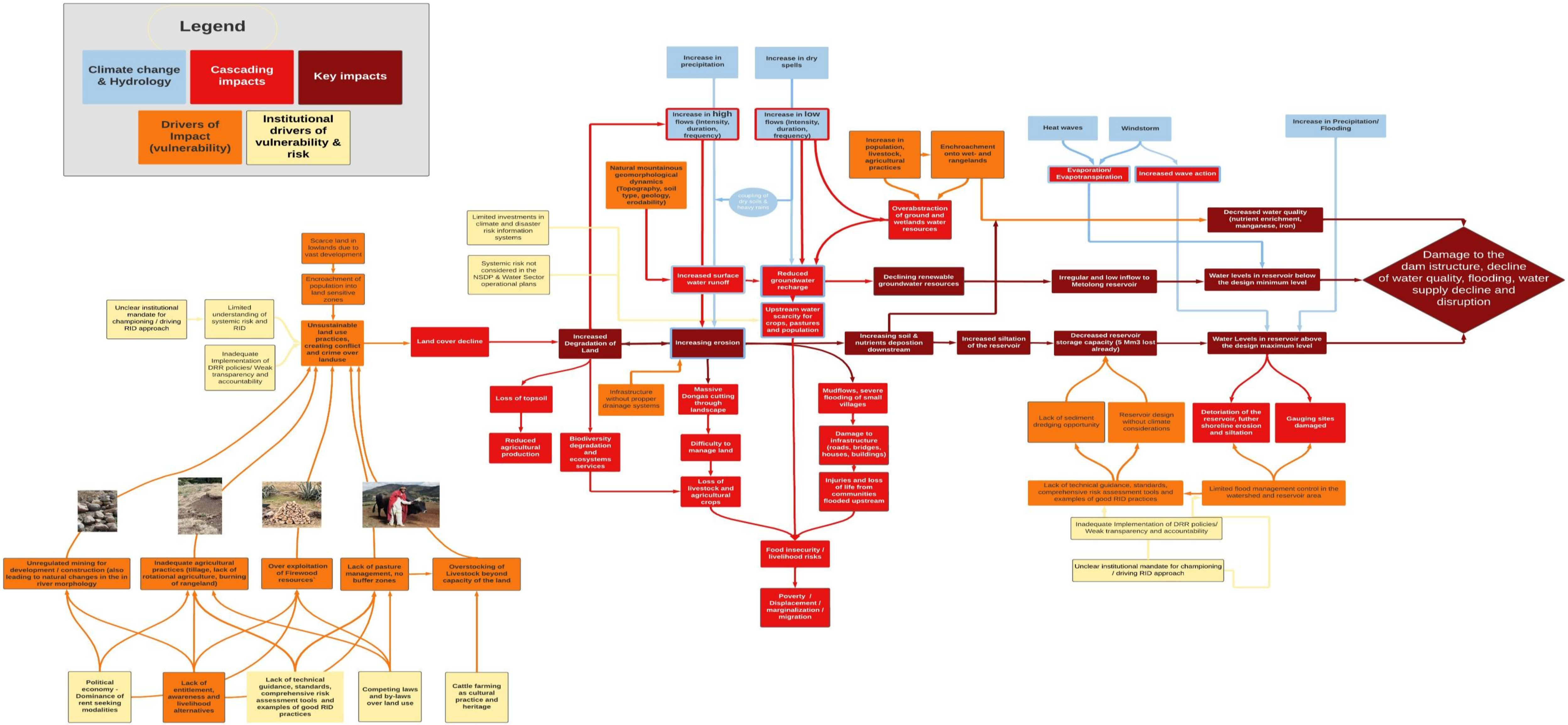
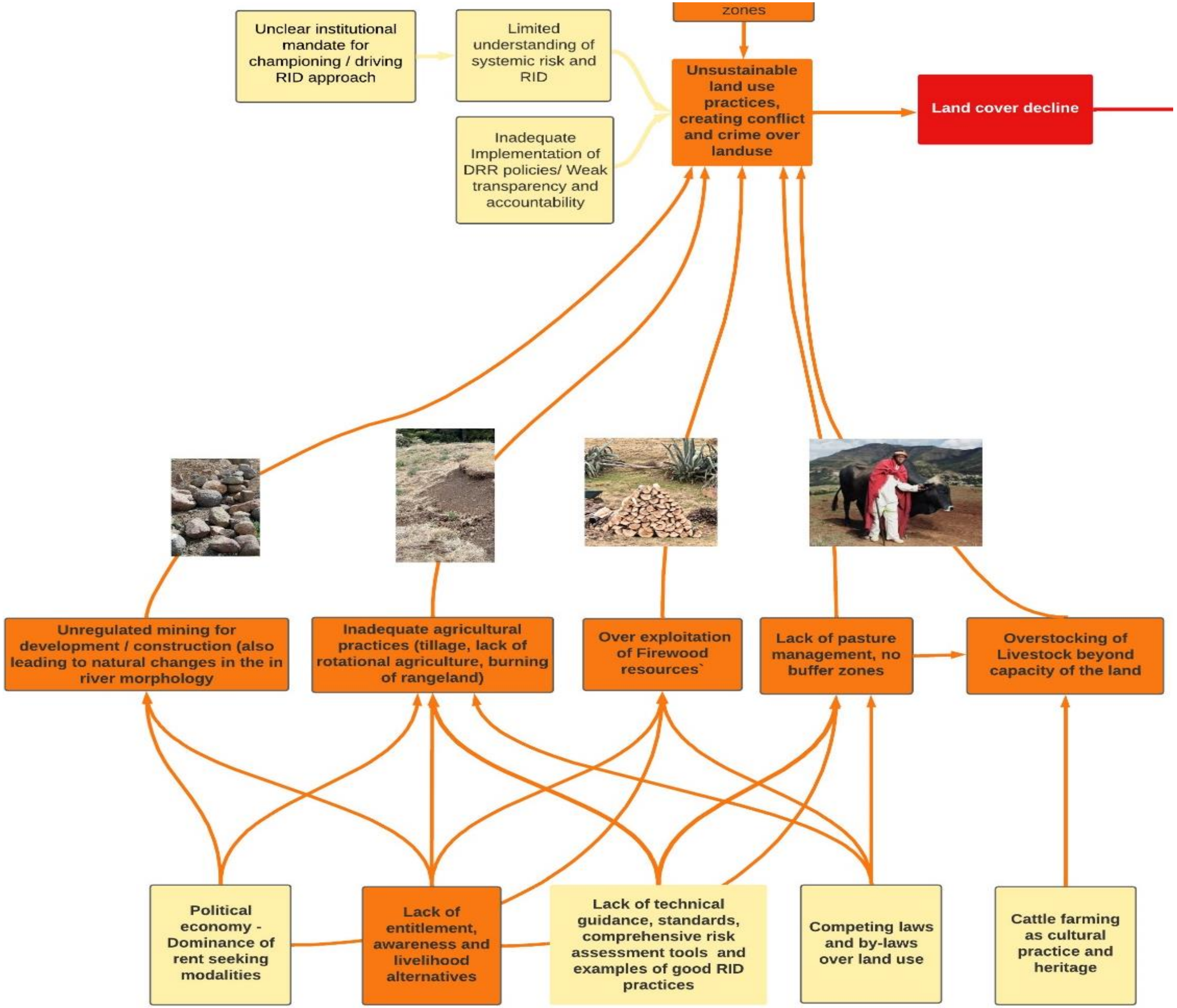
Green Infrastructure - Watershed and Infrastructure

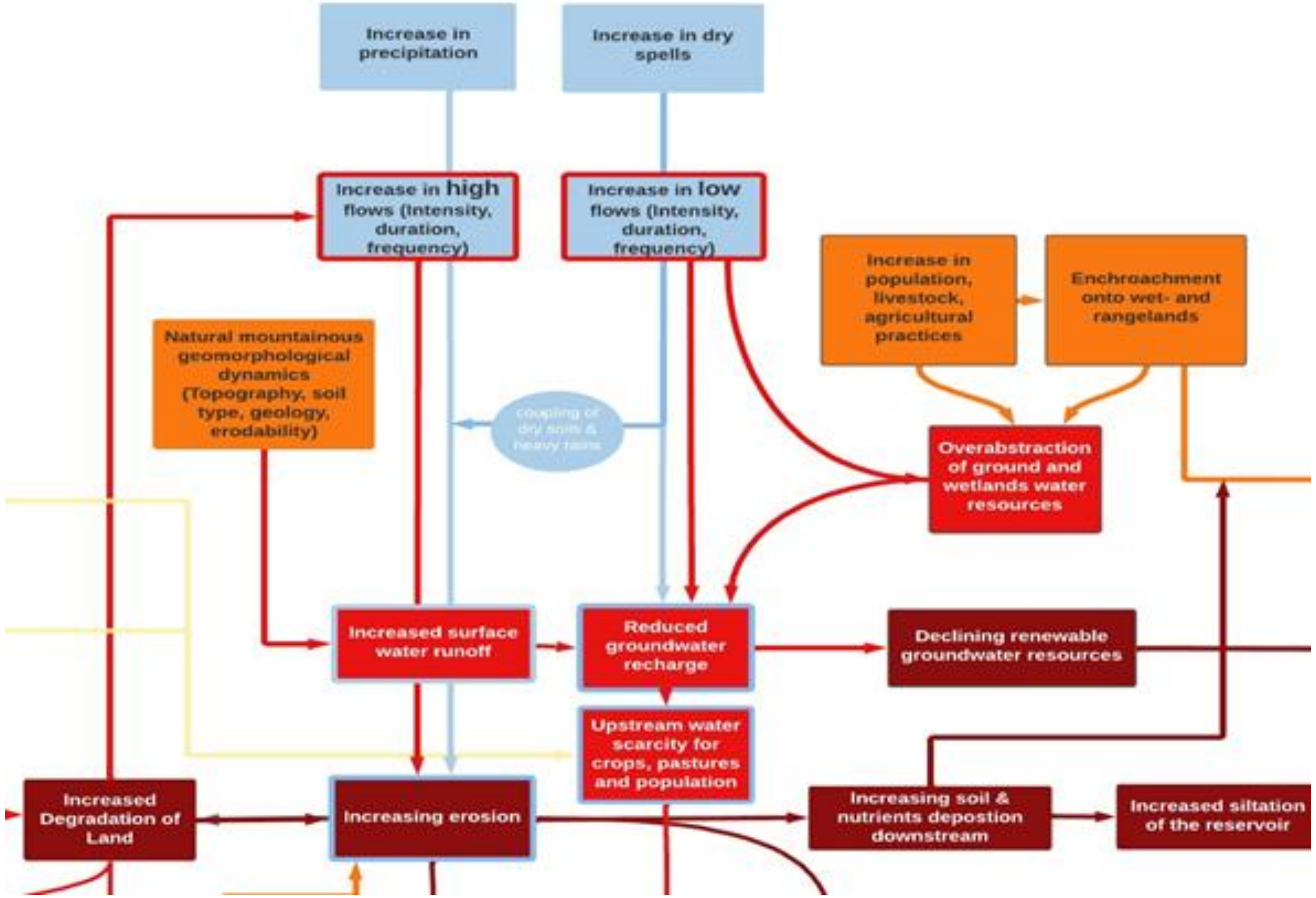
IMPACT CHAIN
Multi-scale Failure Mode

EXPOSURE
- **exposed elements**: Population, vegetation, livestock, crops & arable land, water aquifers, wetlands and economic assets, riparian zones, reservoir structure, including embankments
- **exposed to climate stressors**: flooding, flash floods, dry spells, low flows, high wind speeds





Drivers of unsustainable land use practices leading to land cover decline



Compounding effects of Climate change and water ressource degration on siltation rates of the reservoir

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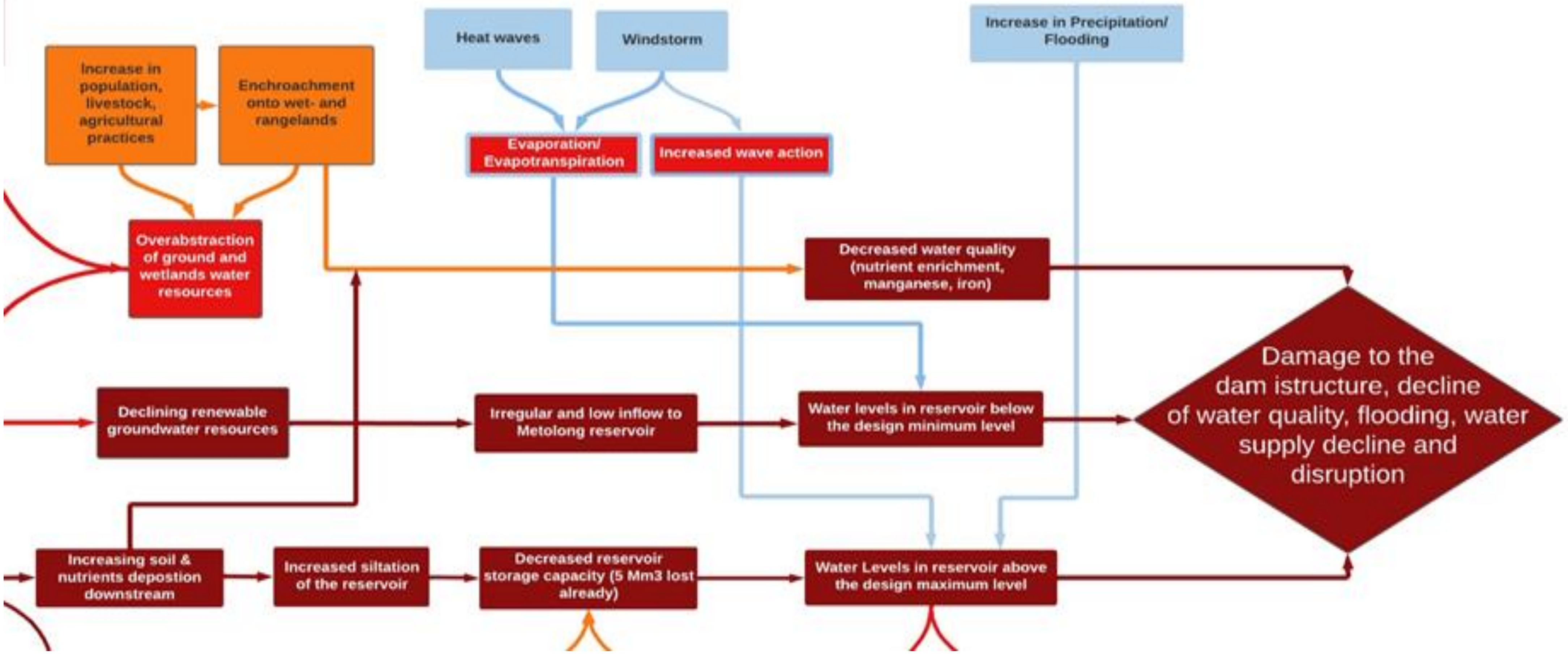
Impacts on the reservoir lifecycle and the grey infrastructure



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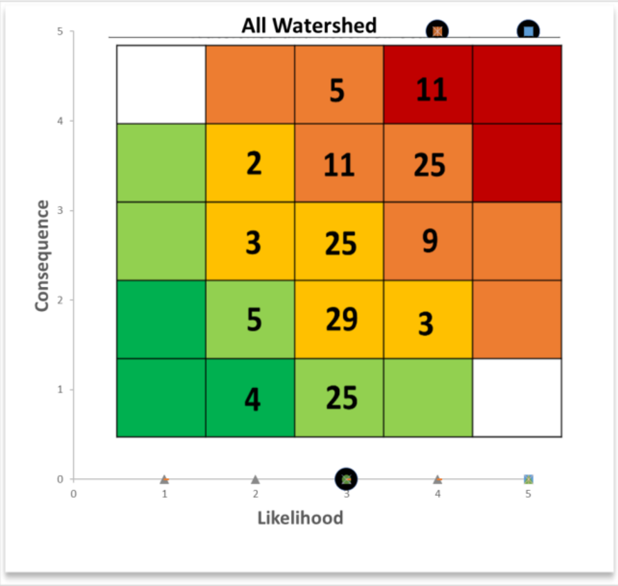
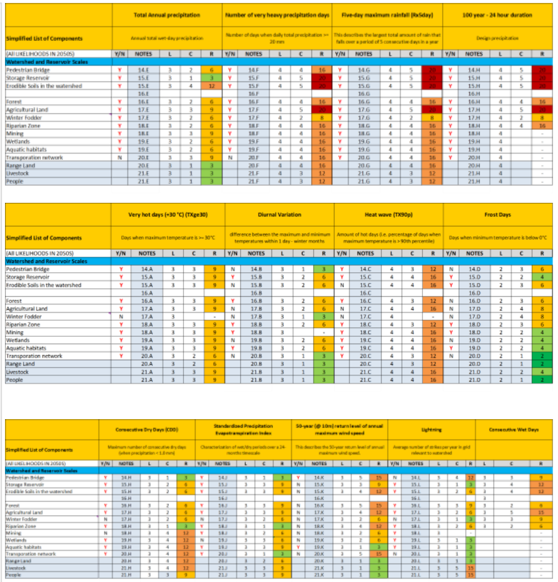
(2) Risk Screening of green components

(High risk) elements considered in the watershed & reservoir that are of relevance for water security:

- ✓ **Storage reservoir** (**heavy precipitation**, **heat wave**)
- ✓ **Erodible soils in the watershed** (**heavy precipitation**, **heat wave**)
- ✓ Forests
- ✓ Fodder
- ✓ **Riparian zone** (**heavy precipitation**, **heat wave**)
- ✓ Mining areas
- ✓ **Wetlands** (**heat wave**)
- ✓ Aquatic habitats
- ✓ Transport network
- ✓ **Agricultural land** (**heavy precipitation**, **heat wave**)
- ✓ **Rangelands** (**heavy precipitation, heat wave, consecutive dry days**)
- ✓ Livestock
- ✓ People





Climate variables and indicators used for likelihood:

- ✓ Very hot days, + 30°c
- ✓ Dirunal variation
- ✓ Heat wave **(likelihhood increase)**
- ✓ Consecutive dry days
- ✓ Frost days **(likelihood decrease)**
- ✓ Total annual precipitation
- ✓ Number of very heavy precipitation days **(likelihood increase)**
- ✓ Five-day-Maximum rainfall **(likelihood increase)**
- ✓ 100 year – 24 hour duration **(likelihood increase)**
- ✓ Wind speed
- ✓ Lightning

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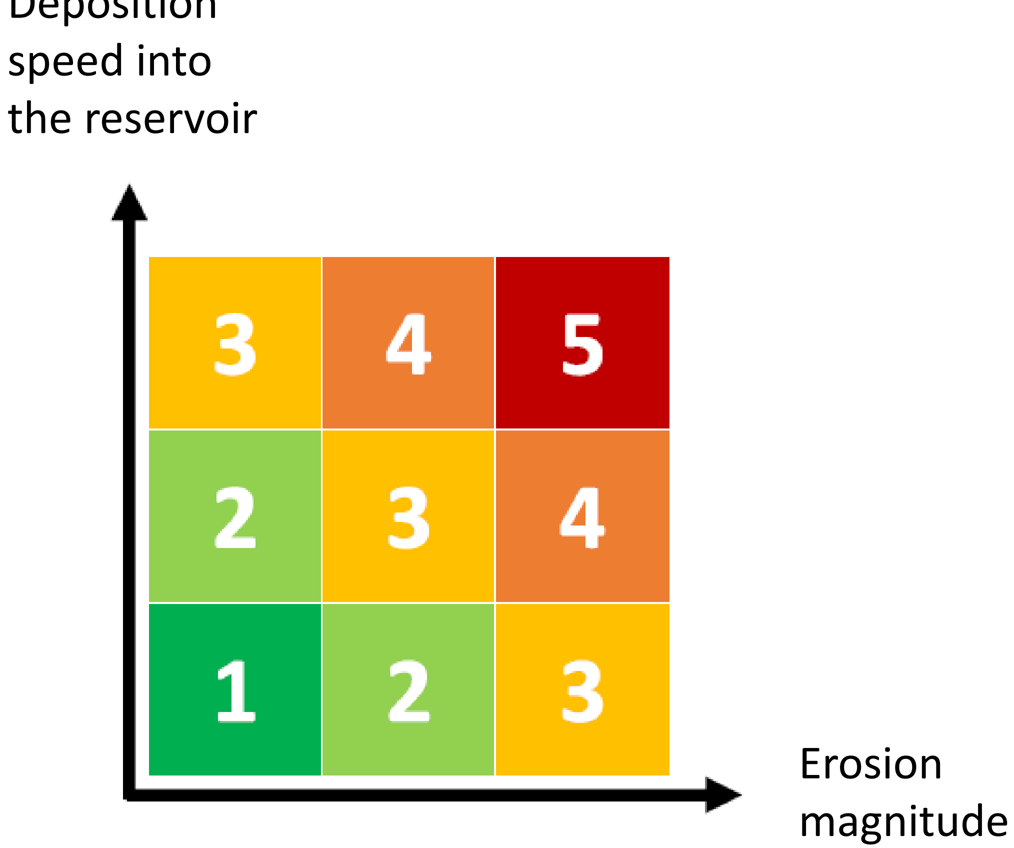
(3) In-depth Assessment of Key Impacts: Lifecycle reduction of the reservoir (still be elaborated on)

Impact Cubes



Consequence Scoring Level	Service Reliability (Municipal / Industrial Water Demand)
(1) Insignificant	<30% reduction in water supply for up to 1-3 consecutive days/year
(2) Minor	<30% reduction in water supply for up to 3-7 consecutive days/year **or** 30-70% reduction for up to 1-3 consecutive days per year
(3) Moderate	<30% reduction in water supply for >7 consecutive days/year **or** 30-70% reduction for 3-7 consecutive days/year **or** >70% reduction for 1-3 consecutive days/year
(4) Major	30-70% reduction in water supply for >7 consecutive days/year **or** >70% reduction for 3-7 consecutive days/year
(5) Extreme	>70% reduction water supply for >90 consecutive days/year

Further study needed:

- Battymetric survey
- Hydrological modelling

Recommendations for Risk Informed Development

Elements	Remedial Action

Erodible soils	• Sustainable soil management
	• Improve soil cover
	  • Biological (vegetation,)
	  • Mechanical (stone bunds, check dam terraces, diversions)

Riparian Zones	• Delineation of riparian zones • protection/rehabilitation • Reduced encroachment • Conduct awareness campaigns about risks
Agricultural land	• Conduct awareness campaigns about risks • Reduce encroachment
Wetlands	• Conduct awareness campaigns about risks • Provide livestock watering points • Water supply and sanitation services to communities upstream of Metolong Dam • Rehabilitation of wetlands • Groundwater recharge measures
Rangelands	• Conduct awareness campaigns about risks • Development of grazing plans • Stall feeding and supplementary feeding • Payment for ecosystems services (eg grazing fees)

Additional studies:
Develop hotspot maps using existing data and maps for prioritization of interventions

Management actions

- Inclusive soil governance
- Adoption of ICM planning guidelines
- Adoption of Compendium of soil and water conservation measures
- Develop and capacitate community structures
- Review and harmonise policies and legal documents
- Development of by-laws

Project Roadmap 2023 – next steps

Jan / Feb 2023

PIEVC In-person Assessment Workshop (drafts)

Impact chain validation, risk screening and recommendations

Feb-June 2023

Further Validation by Working groups

Virtual sessions to validate findings and recommendations.

End of April, 2023

PIEVC Global Forum – Participation from Lesotho

Building a global network of PIEVC practitioners

May

Draft final report

submission for revision and approval

May 2023

Upscaling PIEVC approach to ORASECOM / SADC level

Workshop

June 2023

Final PIEVC Report Launching and Upcaling in Lesotho

Virtual event

Mainstreaming risk consideration into ICM Lesotho






Thank you!

2022 - 2023 WEBINAR SERIES

Date	Topic
August 25, 2022	PIEVC Program: Background, Status and New Directions
September 22, 2022	From Assessment to Implementation of Adaptation Action
October 20, 2022	Institutionalizing Climate Change and Infrastructure Vulnerability and Risk Assessment (CCVRA): PIEVC in Adaptation Plans, Professional Practice, and other Mechanisms
November 17, 2022	Climate services for CCVRA: Lessons learned and new tools supporting steps 1 and 2 of the PIEVC Protocol
December 15, 2022	Large Portfolio Analyses using PIEVC Process
January 19, 2023	PIEVC High Level Screening Guide
February 16, 2023	PIEVC GREEN
March 16, 2023	**Integration of PIEVC into Asset Management Toolkits**
April 18 – 20, 2023	Join us for the GLOBAL FORUM in Vancouver, BC

For recordings of previous webinars and for updates on future speakers, go to CRI website: climateriskinstitute.ca or Practitioners' Network

PIEVC CVIIP

Thank You for Joining Us!

February 16, 2023
PIEVC Program Webinar Series – Webinar #7

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