PLANNING FOR ENERGY SYSTEM RESILIENCE TO ENSURE ENERGY ACCESS AND GHG MITIGATION: A FOCUS ON HYDROPOWER

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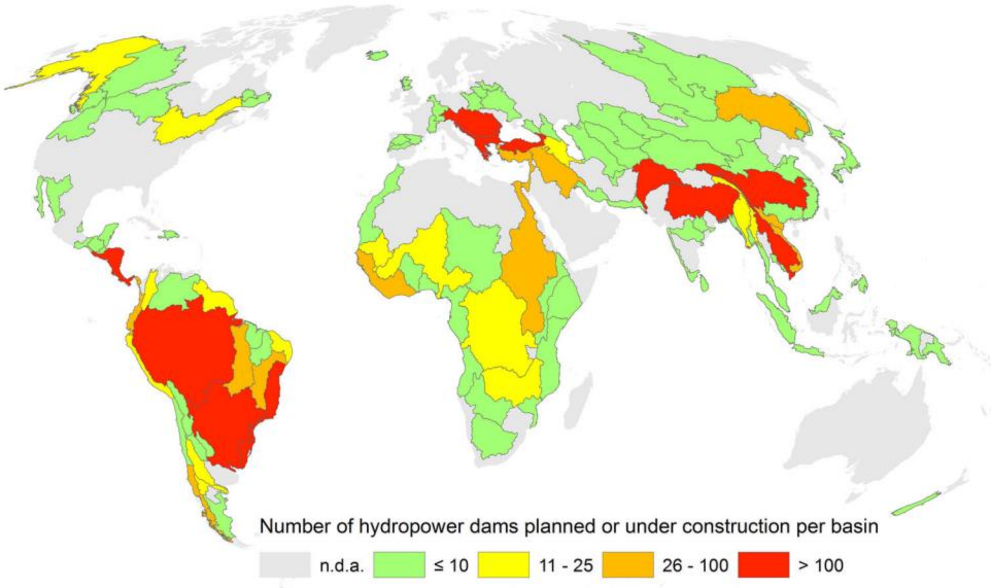
Hydropower in a changing climate

- Key to low emission development strategies, hydropower investment is booming
- Yet hydropower itself faces challenges associated with climate change, preventing them from reaching their expected potential



- When hydropower facilities underperform, utilities often substitute higher GHG emitting fuels, which are costly to the utility, the consumer, and the environment
- To-date, most investors, managers, and operators of hydropower facilities do not yet consider projected changes in climate and weather as part of a business risk analysis or in power planning

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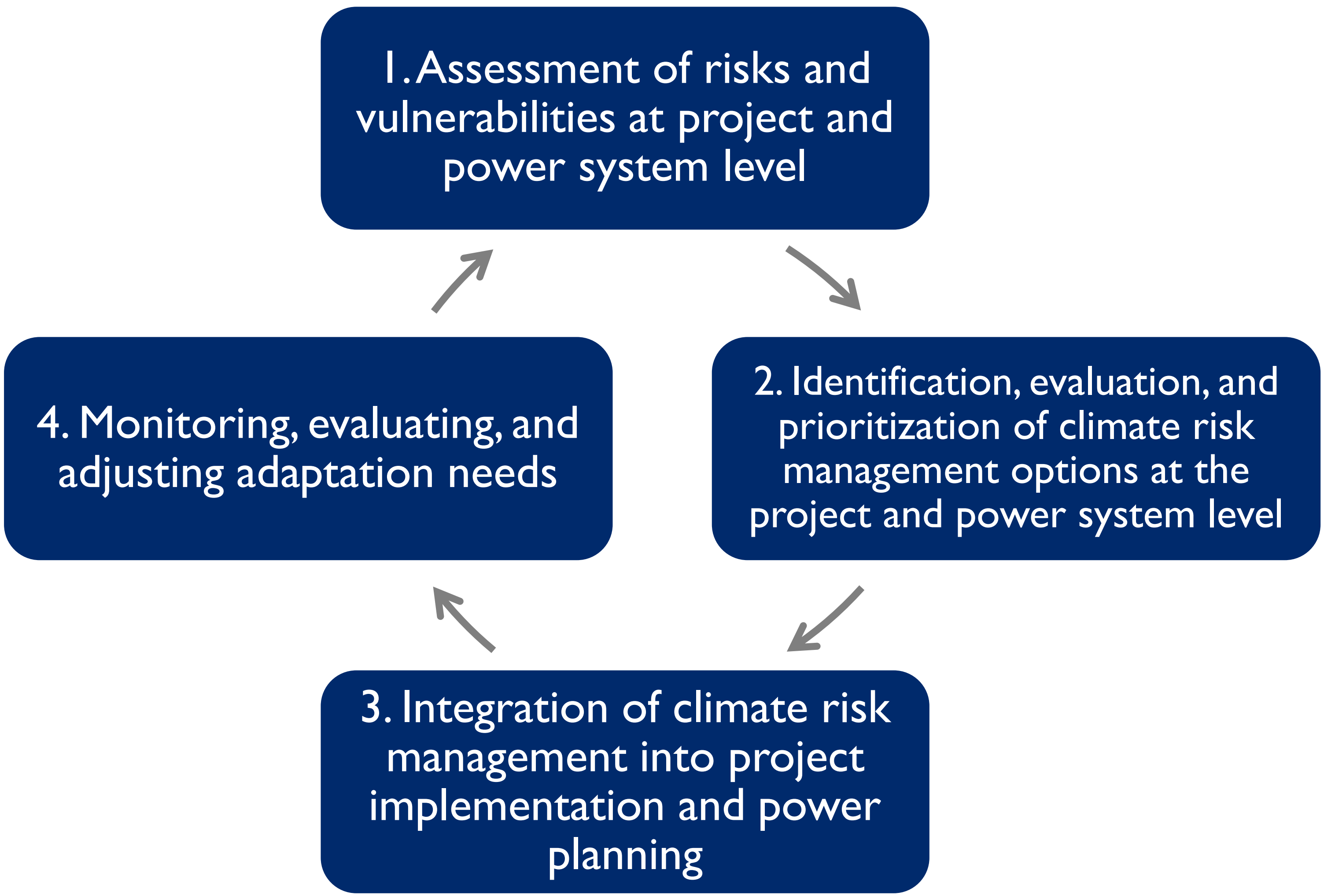
Climate Change risks faced by hydropower plants: Rufiji Basin, Tanzania Example

Projected Change	Risks to Hydropower Generation
↑ extreme precipitation	Undesired spillage/ increased generation
↑ temperature	Direct infrastructure damage, including access to plants
↑ consecutive dry days	Decreased generation
↓ annual rainfall	
↑ sedimentation	Reduced storage capacity
↑ sea level	Increased salinity and subsidence

Hydropower plant managers in Tanzania identified **current climate impacts to hydropower plants** as: increased fuel costs (substitution during drought), uncertainty in annual planning and budgeting, increased dredging, reduced access to plants, and damaged turbines (sedimentation) and spillways (flooding).

How to address climate change risks and build resilience?



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Step 1. Assessment of risks and vulnerabilities at project and power system level

- Purpose: Help managers determine how climate variability and change may affect an existing or planned power sector strategy or project
- Example: USAID-ACTI Hydropower Climate Risk Screening Framework

1. Describe facility, climate, and non-climate conditions
2. Select environmental, financial, and social performance objectives
3. Assess risk to performance objectives
   - Repeat for each objective:
     - Rate potential impact from climate and non-climate factors
     - Rate adaptive capacity
     - Rate risk to objective
4. Assess overall business risks
5. Recommendations and next steps

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Hellmuth, M., Hino, M., Bhat, C. 2017. Screening Hydropower Facilities for Climate Change Risks to Business Performance: A Framework. Prepared for the U.S. Agency for International Development (USAID), the Regional Development Mission for Asia, ASEAN Connectivity through Trade and Investment (US-ACTI) Project.

US-ACTI Hydropower Climate Risk Screening Framework: Tool Output

	Environmental Performance				Financial Performance						Social Performance			
	Meet Instream Flow		Respect Water Ramping		Maximize Revenue		Maintain Efficient Operations		Meet Peak Demands		Positive Impact		Ensure Safety	
Current | Future	C	F	C	F	C	F	C	F	C	F	C	F	C	F
Climate Stressors														
Temperature														
Flow volume and timing														
Sedimentation														
Extreme events														
Salinity														
Non- Climate Drivers														
Land use / land cover														
Up/downstream hydro														
Population growth														
Energy demand														
Adaptive Capacity														
Insurance														
Early warning system														
Operational flexibility														
Storage														
Access to quality forecasts														
Climate-sensitivity of grid														
Overall Risk	**M**	**H**	**M**	**M**	**L**	**L**	**L**	**M**	**L**	**L**	**L**	**M**	**L**	**M**

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Step 2. Identification, evaluation, and prioritization of climate risk management options

- Purpose: Prioritize strategies to manage risk at the project and power system level, considering effectiveness, technical feasibility, and cost
- Risk management strategy types
  - **No-regrets:** Offer benefits regardless of climate change
    - Example: Payment for watershed services
    - Oftentimes based in policy, planning, and operations
  - **Climate-justified:** Benefits are dependent upon climate change scenario
    - Example: modify reservoir design to handle expected changes in water flows
    - Oftentimes based on design or structural changes
    - Requires that decisions balance political, economic, social, and environmental costs of action versus non-action, given an uncertain future

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Examples of building resilience into power generation in Tanzania

JUSTIFI-CATION	TYPE	ADAPTATION STRATEGY	ALREADY PURSUING?
No-regrets	Technology	Invest in improved weather prediction to improve operational management.	N
	Policy & Planning	Acquire standby energy equipment and backup restoration supplies.	N
		Seek out new peak generation and purchasing sources for summer months.	Y
Low-regrets	Policy & Planning	Choose generation infrastructure sites that are not at high current exposure risk and account for projected changes in coastal and riverine flooding.	N
	Structural	Install backup systems for critical hospital and home needs.	N
		Invest in decentralized power generation (e.g., rooftop PV or household geothermal).	Y
		Expand networks, network protection, and energy storage to enhance reliability.	N
		Build additional generation capacity to account for decreased generation efficiency or increased customer loads due to climate impacts.	Y
Climate-justified	Policy & Planning	Ensure adequate backup generation and cooling systems for plants facing increased exposure to flooding, drought, and other extremes.	N
		Revise infrastructure design thresholds using climate change projections.	N
	Structural	Relocate or reinforce key generation infrastructure to reduce exposure and sensitivity to sea level rise, storm surge, extreme precipitation and floods, drought, extreme temperature, and other extreme weather events.	N

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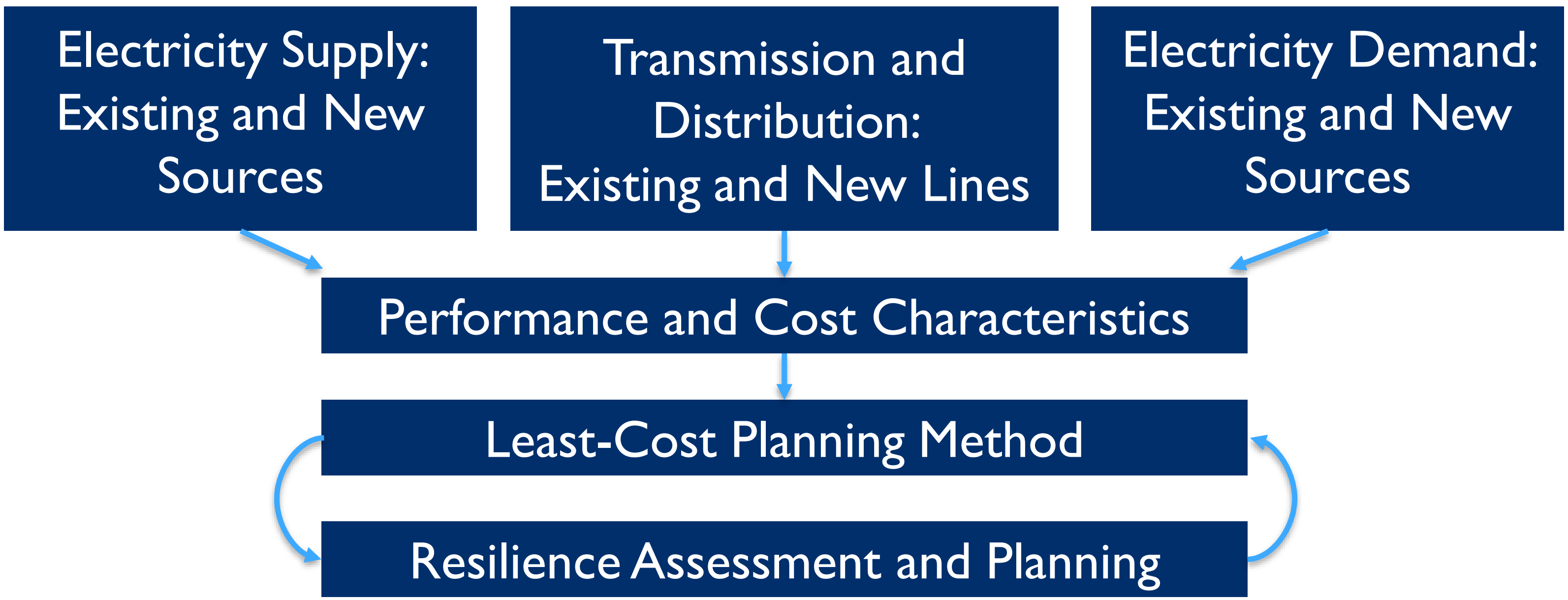
Step 3. Integration of climate risk management into project implementation and power planning

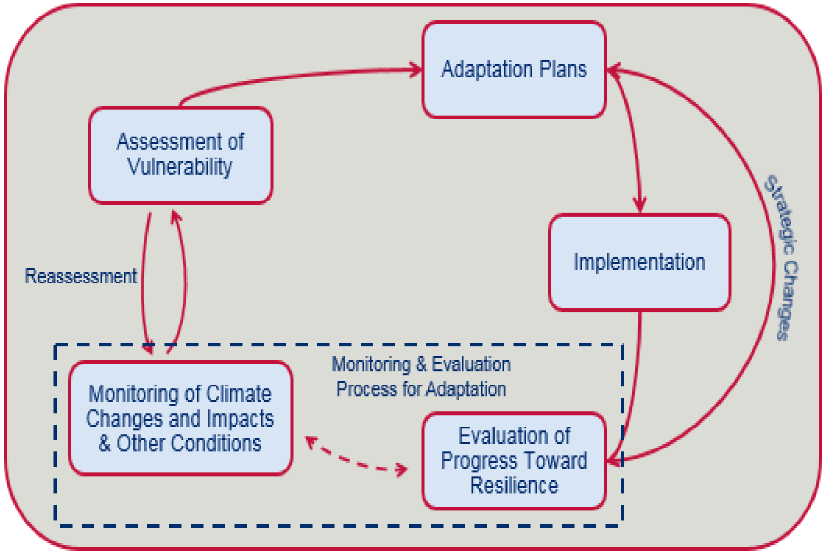
- Purpose: To build resilience and flexibility into project and better direct and coordinate power sector investments so that "surprises" are anticipated and development objectives (e.g., lowering GHG emissions) are met over time
- Example: Integrated Resource and Resiliency Planning (IRRP)



Step 4. Monitoring, evaluating, and adjusting adaptation needs

- Purpose: To create an ongoing process of identifying, measuring, and addressing possible risks, incorporating new information about conditions and performance in order to reduce risk and improve performance

- Why? Climate Resilience Is an Ongoing Process:
  – Adaptation measures take time and resources to implement
  – Achieving "zero risk" to climate vulnerabilities is challenging
  – Reducing risk over time is the key to success
  – Our understanding of future climate conditions continues to improve and change
  – Power system objectives and challenges change over time



The need for climate resilient low emissions development

Addressing climate risks to low emissions development projects can help power planners and investors **better understand and manage climate risks** to hydropower and power system performance, in order to more effectively **ensure energy security** and **meet low emission objectives** over time

Thank you for your time

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