Disaster and Climate Change Risk Assessment Methodology for IDB Projects

Developing climate resilient infrastructure PPPs
Webinar 2: An introduction to the tools and how to use them to prepare resilient projects

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1. Institutional Background

2. Methodology
   • 3 phases
   • 5 steps

3. Lessons Learned
**OP-704**

**Disaster Risk Management Policy**

Approach focused on **Prevention**

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**Directive A-1**

**Programming**

Disaster Risk Management Projects

- Investment Loans
- Policy Based Loans
- Contingent Credit Lines

**Directive A-2**

**Preparation and Execution of Projects**

Risk and project viability

- Screening and DRA

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Inter-American Development Bank
Figure 1: The Four Dimensions of Infrastructure Sustainability

- Economic & Social Returns
- Financial Sustainability
- Poverty, Social Impact, and Community Engagement
- Human & Labor Rights
- Cultural Preservation

- Economic & Financial Sustainability
- Institutional Sustainability

- Environmental Sustainability including Climate Resilience
  - Climate and Natural Disasters
  - Pollution
  - Preservation of the Natural Environment
  - Efficient Use of Resources

- Governance & Systemic Change
- Management Systems & Accountability
- Capacity Building
Objective: establish a **unified methodology** for the identification, evaluation and management of **climate and disaster risks** for IDB projects
LESSONS LEARNED

Integrated approach to risk

Sequential and gradual process

Time flexibility in the project cycle, qualitative & quantitative

There are common principles, but it should be tailored to the institution

It's good to have/or obtain in-house capacity: on engineering and risk
Methodology

1 Screening & Classification
   - Step 1 Hazard exposure: Preliminary classification based on location and hazards
   - Step 2 Criticality & vulnerability: Revision of classification based on criticality & vulnerability

2 Qualitative Assessment
   - Step 3 Narrative: Simplified qualitative risk assessment (narrative with diagnostic) & management plan

3 Quantitative Assessment
   - Step 4 Qualitative analysis: Complete qualitative risk assessment (workshop to identify failures, causes and solutions) & management plan
   - Step 5 Quantitative analysis: Quantitative risk assessment (scientific assessment quantifying risk) & management plan

Identification ➤ Preparation ➤ Implementation (These steps may be completed during execution)
System level

Replicate this logic to other systems (country’s systems), adapting it to their own conditions

Project level

How to apply an identification and evaluation process in specific projects
Country systems
# DISASTER AND CLIMATE CHANGE RISK ASSESSMENT METHODOLOGY

## Methodology

<table>
<thead>
<tr>
<th>Phase</th>
<th>1 Screening &amp; Classification</th>
<th>2 Qualitative Assessment</th>
<th>3 Quantitative Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>?</td>
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<tr>
<td>Step 2</td>
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<td>Step 3</td>
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<td>Step 4</td>
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<td>?</td>
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<tr>
<td>Step 5</td>
<td>?</td>
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</tr>
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</table>

## Project Cycle

?
Step 1

Hazard Screening
HAZARD SCREENING

A questionnaire embedded in the Bank’s system

Support tools
HAZARD SCREENING

QUESTIONNAIRE example
These answers trigger (or not) the policy and determine if CC staff is needed

The **operation** is in a geographical area exposed to natural hazards. (Climate change may increase the frequency and/or intensity of some hazards).

The **sector** of the operation is vulnerable to natural hazards. (Climate change may increase the frequency and/or intensity of some hazards).

The operation has the **potential to exacerbate risk** to human life, property, the environment or cause economic disruption.

The **specific objective** of the operation is **climate change adaptation**.

The operation **includes activities** related to climate change adaptation, but these are not the primary objective of the operation.
HAZARD SCREENING

QUESTIONNAIRE con’t
These answers provide a disaster risk classification

Exposure of project to natural hazards?

- Seismic events
- Coastal flooding
- Inland flooding
- Hurricanes
- Landslides
- Drought
- Volcanic activity
- Sea level rise
- Wildfires, heatwaves, blizzards
- Glacial retreat
- Other slow-onset climate related changes (temp, precipitation, insolation, seasonal patterns)

[ ] YES  [ ] NO
HAZARD SCREENING

Support tool – hazard component

- Earthquakes
- Hurricane - wind
- Storm Surge
- Drought
- Sea Level Rise
- Volcanoes
- Precipitation
- Wildfires
- Landslides
- Tsunami
- Heat waves
- Riverine flooding

+ CC

Natural Hazard layers:
- Riverine Flooding hazard
- Sea Level Rise - End of Century with Climate Change
- Tsunami hazard
- Volcanic hazard
- Water Supply Scarcity hazard - End of the Century with Climate Change

Climate Change Symbols:
- Precipitation change - End of Century with Climate Change
- Precipitation changes - End of the Century with Climate Change
- Drought
- + CC
- + CC
- + CC
- + CC

Where is a Climate Model?

General Circulation Models, also known as Global Climate Models (GCM in both cases) are complex numerical simulation tools that are based on our best scientific understanding of the climate system that includes the atmosphere, hydrosphere, biosphere and lithosphere. These models operate on the foundation of well-established physics of the atmosphere, fluid dynamics, coupled ocean-atmosphere processes, ocean circulation, atmospheric and oceanic radiative transfer, land surface and biogeochemistry.
Step 2

Criticality & Vulnerability
Support tool: vulnerability component

Identify a project’s characteristics that make it more or less vulnerable to natural hazards

¿Operation scope – new design/build, modernization/upgrading, planning or others?
¿What is the expected life span of the different project components?
¿If any of the project components were to fail, is there potential for loss of lives?
¿How many people will the project serve?
¿Are there redundant systems that may be used if any component were to fail?
Phase 2
Qualitative disaster and climate change risk assessment
Methodology

1 Screening & Classification
   - Step 1: Hazard exposure
     Preliminary classification based on location and hazards
   - Step 2: Criticality & vulnerability
     Revision of classification based on criticality & vulnerability

2 Qualitative Assessment
   - Step 3: Narrative
     Simplified qualitative risk assessment (narrative with diagnostic) & management plan
   - Step 4: Qualitative analysis
     Complete qualitative risk assessment (workshop to identify failures, causes and solutions) & management plan

3 Quantitative Assessment
   - Step 5: Quantitative analysis
     Quantitative risk assessment (scientific assessment quantifying risk) & management plan

Identification ─► Preparation ─► Implementation

(These steps may be completed during execution)
Step 3

Narrative
Existing studies
¿Are there previous risk studies? (¿Have the impacts of natural hazards on the operation and of the operation on the risk conditions of the area been considered?)

Hazard evaluation
¿Has the local meteorology, hydrology and climate change been studied and how? (¿Local gauges? ¿GCM/RCM? ¿Official standards to incorporate climate change projections?)
¿Has the local geology and seismicity been studied? (¿Have the hills been studied? ¿Have faults been studied? ¿Is there a seismic catalogue?)

Design considerations
¿What hydrological and hydraulic parameters were used to design culverts and drainage? (¿Types of analyses, methods, return periods, climate change?)
¿Have slope stabilization measures been studied?
¿What seismic design code was used? (¿Is there a local code?)

Response systems
¿Does an Early Warning System exist or planned?
Is there an institution in charge of managing and centralizing all disaster and climate risk efforts?
Step 4

Qualitative assessment
En escenarios hidrológicos, se produce la inundación pluvial o fluvial de algunos tramos de la RNS. Debido a la falta de sensibilización y formación en riesgo de inundación de la población residente en estas viviendas, los ciudadanos desconocen los protocolos de actuación y los sistemas de aviso, por lo que no han abandonado sus viviendas para ir a una zona segura cuando llega la inundación. Por este motivo, las inundaciones producen mayores pérdidas humanas.

*Risk Assessment Matrix*

<table>
<thead>
<tr>
<th>Probabilidad</th>
<th>Catastrophic</th>
<th>Critical</th>
<th>Marginal</th>
<th>Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frente (4)</td>
<td>High</td>
<td>High</td>
<td>Serious</td>
<td>Medium</td>
</tr>
<tr>
<td>Probable (3)</td>
<td>High</td>
<td>High</td>
<td>Serious</td>
<td>Medium</td>
</tr>
<tr>
<td>Occasional (2)</td>
<td>High</td>
<td>Serious</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Remoto (1)</td>
<td>Serious</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Improbable (5)</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Eliminado (F)</td>
<td>Eliminated</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Efectos que aumentan el riesgo**
- Problemas de sensibilización y concienciación de gran parte de la población urbana, que no quieren abandonar su casa por miedo a perder sus pertenencias.
- Bajo nivel educativo de parte de la población en las zonas afectadas.
- Los planes, campañas y normativas tienen dificultad en llegar a todos los habitantes, especialmente a los residentes en los asentamientos informales.
- Inseguridad ciudadana puede dificultar terrenos de aviso y evacuación.

**Efectos que disminuyen el riesgo**
- Tras los daños causados por los huracanes Ike y Hanna en 2008, es posible que una campaña de sensibilización surja mayor efecto sobre la población local.
Phase 3
Quantitative disaster and climate change risk assessment
Step 5

Quantitative assessment
QUANTITATIVE EVALUATION

Create hazard, exposure and vulnerability models...

... and calculate risk
QUANTITATIVE EVALUATION

Alternative 1
Loss = 6‰

Alternative 2
Loss = 5‰
Example: Rehabilitation of a road

<table>
<thead>
<tr>
<th>Section</th>
<th>Return Period</th>
<th>Current conditions</th>
<th>Damage (%)</th>
<th>Current + CC Measures 1</th>
<th>Measures 2</th>
<th>Measures 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>16%</td>
<td>12%</td>
<td>55%</td>
<td>30%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>16%</td>
<td>28%</td>
<td>63%</td>
<td>40%</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>23%</td>
<td>35%</td>
<td>68%</td>
<td>45%</td>
<td>41%</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>30%</td>
<td>40%</td>
<td>71%</td>
<td>48%</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>35%</td>
<td>43%</td>
<td>73%</td>
<td>50%</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>39%</td>
<td>46%</td>
<td>75%</td>
<td>52%</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>63%</td>
<td>50%</td>
<td>84%</td>
<td>55%</td>
<td>54%</td>
<td></td>
</tr>
</tbody>
</table>

BS3-BS4

<table>
<thead>
<tr>
<th>Loss (US$)</th>
<th>Probability of annual exceedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1%</td>
<td>10,000,000</td>
</tr>
<tr>
<td>1%</td>
<td>10,000,000</td>
</tr>
<tr>
<td>5%</td>
<td>1,000,000</td>
</tr>
<tr>
<td>25%</td>
<td>100,000</td>
</tr>
<tr>
<td>100%</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Change in daily precipitation (%)

- RCP2.6
- RCP4.5
- RCP8.5

Peak discharge (m³/s)

- TR
- TR
- TR

Water height (m)

- r-avea road
- unpavea road

Original design under CC

Measures 3 under CC
**QUANTITATIVE EVALUATION**

Incorporation of Climate Change in standard analyses

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analysis of historical local precipitation&lt;br&gt;Collect and statistically analyze historical daily precipitation data from local gauges in the study area</td>
</tr>
<tr>
<td>2</td>
<td>Identification of climate models&lt;br&gt;Identify global climate models (GCM) or regional climate models (RCM) that may exist for the study area</td>
</tr>
<tr>
<td>3</td>
<td>Analysis of historical climate model data&lt;br&gt;Compare the modeled historical data to the local data and select the model(s) or ensembles(s) to use</td>
</tr>
<tr>
<td>4</td>
<td>Statistical downscaling&lt;br&gt;Obtain future climate time series from the selected models using statistical downscaling methods to adjust them to the study area</td>
</tr>
<tr>
<td>5</td>
<td>Frequency analysis&lt;br&gt;Use the time series to perform a statistical and frequency analysis and assign a probability distribution</td>
</tr>
<tr>
<td>6</td>
<td>Intensity-Duration-Frequency curves&lt;br&gt;Use the frequency analysis to compute IDF curves</td>
</tr>
<tr>
<td>7</td>
<td>Generate design storm&lt;br&gt;Use the generated IDF curves to generate design hyetographs</td>
</tr>
<tr>
<td>8</td>
<td>Basin characterization&lt;br&gt;Characterize the basin’s morphometry and drainage</td>
</tr>
<tr>
<td>9</td>
<td>Hydrological modeling&lt;br&gt;Input the design storm into a hydrological model to obtain the design discharge hydrograph</td>
</tr>
<tr>
<td>10</td>
<td>Channel characterization&lt;br&gt;Characterize the river channel</td>
</tr>
<tr>
<td>11</td>
<td>Hydraulic modeling&lt;br&gt;Characterize the inundation extent and depths for the design return period</td>
</tr>
</tbody>
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Integrated approach to risk

Sequential and gradual process

Time flexibility in the project cycle, qualitative & quantitative

There are common principles, but it should be tailored to the institution

Its good to have/or obtain in-house capacity: on engineering and risk
Thank you!

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