Introduction to Cumulative Impact Assessment and Management.

Presented by: Pablo Cardinale, Ph.D.
Thalath, Lao PDR.
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Objective

Common understanding of principles, basic concepts and terminology of Cumulative Impact Assessment and Management.
Cumulative Impacts

“The environmental and social impacts that result from the incremental impacts of one action/activity when added to past, present, and reasonably foreseeable future actions/activities.”

“death by a thousand cuts”
The major environmental and social management challenges that we face today – loss of biodiversity, the decline of ocean fisheries, and climate change - are all the result of cumulative impacts from a large number of activities that are for the most part individually insignificant, but which together have had global repercussions.
Find the order?

18 5 41 9 1 76 3 22

Eighteen, five, forty-one, nine, one, seventy six, three, twenty two

CIA: We use same tools as ESIA, same information, data, similar uncertainties, knowledge, **BUT** a different perspective
Logical Framework

• Scoping.
• Description of Environment and Social characteristic/ Potential Impacts.
• Determination of Consequences: Significance of Impacts.
• Effect/Impact Management: Mitigation Hierarchy: avoid, minimize, mitigate or compensate.
ESIA vs CIA

Basic Conceptual Assessment Paradigm Change.

1. Focus: Project Impacts vs Condition of Valued Environmental and Social Components (VECs).

2. Scope: Expanded spatial and temporal boundaries for the analysis.
Valued Environmental and Social Components (VECs)

Sensitive environmental or social receptors, affected resource, ecosystem, or human community:

- Air shed.
- Watershed.
- Forest resource.
- Resident wildlife.
- Migratory wildlife.
- Fisheries resource.
- Historic / Socio-cultural resource.
- Land use.
- Community Structure.
- Coastal zone.
- Recreational.
1. Focus:
Project Centered vs VEC centered

ESIA

CIA
2. Scope:
Expanded Temporal and Spatial Boundaries

CIA

ESIA - Present

T °C > ok

Algal bloom
Reduce Water Quality
Fishkill

Nutrients

Foreseeable Future

present......foreseeable future
The different views taken in ESIA and CIA can be seen in how indicators are used to characterize an impact. In the case of ESIA indicators may be chosen to reflect the incremental change in a VEC, while in CIA indicators are chosen to reflect the resulting condition of the VEC.
### Types of Cumulative Impacts

<table>
<thead>
<tr>
<th>Type</th>
<th>Main Characteristic</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time crowding</td>
<td>Frequent and repetitive</td>
<td>Fish passing through cascading turbines.</td>
</tr>
<tr>
<td>Time lags</td>
<td>Delayed effect</td>
<td>Exposure to carcinogens</td>
</tr>
<tr>
<td>Space crowding</td>
<td>High density of effect on VECs</td>
<td>Discharges into stream from several mines</td>
</tr>
<tr>
<td>Cross-boundary</td>
<td>Away from the source</td>
<td>Acid rain</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>Change in landscape pattern</td>
<td>Migratory routes fragmentation from cascading dams.</td>
</tr>
<tr>
<td>Compounding effects</td>
<td>Effects from multiple sources or pathways</td>
<td>Synergism among pesticides</td>
</tr>
<tr>
<td>Indirect effects</td>
<td>Secondary effects</td>
<td>Induced development after highway construction</td>
</tr>
<tr>
<td>Triggers and thresholds</td>
<td>Changes in systems or structure</td>
<td>Climate change</td>
</tr>
</tbody>
</table>

Reference: CEQ NEPA (1997)
<table>
<thead>
<tr>
<th>VEC</th>
<th>Cumulative Effect / Change of condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>• Health hazard, poor visibility from elevated levels of ozone or particulates.</td>
</tr>
<tr>
<td>Surface Water</td>
<td>• Water quality degradation from multiple point-source discharges.</td>
</tr>
<tr>
<td></td>
<td>• Water shortages from uses that exceed capacity</td>
</tr>
<tr>
<td>Ground Water</td>
<td>• Aquifer depletion</td>
</tr>
<tr>
<td>Land and Soil</td>
<td>• Diminished land fertility / productivity</td>
</tr>
<tr>
<td>Wetlands</td>
<td>• Diminished flood control capacity</td>
</tr>
<tr>
<td>Ecosystems</td>
<td>• Habitat fragmentation</td>
</tr>
<tr>
<td></td>
<td>• Loss of fish and wildlife populations</td>
</tr>
<tr>
<td>Socioeconomics</td>
<td>• Overburden services</td>
</tr>
<tr>
<td></td>
<td>• Unstable labor markets</td>
</tr>
<tr>
<td>Community structure</td>
<td>• Changes in community dynamics as a result of displacement of critical community members.</td>
</tr>
<tr>
<td>Cultural Resource</td>
<td>• Cultural site degradation / vandalism</td>
</tr>
<tr>
<td></td>
<td>• Fragmentation of historic district</td>
</tr>
</tbody>
</table>
Any questions?
CIAM - Six Step Process

- **Step 1**: Scoping.
- **Step 2**: Identification of Other Activities and Drivers.
- **Step 3**: VECs Baseline.
- **Step 4**: Assess Cumulative Impacts on VECs.
- **Step 5**: Assess Significance of Predicted Cumulative Impacts.
- **Step 6**: Design Management Strategies.
Step 1: Scoping

Objectives:

- Identify and agree on VEC consulting with all relevant stakeholders.
- Include past, present and foreseeable future activities.
- Establish the geographic scope of analysis.
- Focus on meaningful impacts/ effects.

Questions to answer:

- Who needs to be involved?
- Which are the resources, ecosystem or human activities affected (i.e. VECs)?
- Which of these effects may be important from a cumulative effect perspective?
Boundaries are expanded to the point at which the resource is no longer affected significantly or the effects are no longer of interest to the affected parties.
Step 1: How is this done?

- Sector/Regional assessment.
- Known cumulative impacts within a Region.
- Concerns from stakeholders/affected communities – Consultation.
- ESIA/CIA from other developments.
- Information from NGOs.
- Good common sense!!!!
Step 1: Expected Outcome

• List of VECs to be analyzed:
  – Few, agreed by stakeholders, relevant.

• Define boundaries:
  – Geographical limits.
  – Timeframe of analysis.
Step 1: Closing Remarks

• Scoping has to be reasonable – but at the same time it has to provide assurance that cumulative environmental and social impacts will not threaten the project or that the project will not contribute to serious long-term degradation of environmental and social conditions;

• Scope creep should be prevented; expansion of the CIA scope beyond the impacts and risks related to a project is not good practice;

• Focus on a small number of key VECs. But to identify the correct issues, careful analysis, skilled expertise and effective engagement and input from stakeholders all are needed to do scoping well.
Step 2: Identification of Stressors

Objectives:
– Identify other past, existing, or planned activities within the analytical boundaries.
– Assess potential present of natural influences/stressors. (e.g. droughts, extreme climatic events).

Questions to answer:
– Are there any other existing or planned activities affecting the same VEC?
– Are there any natural forces / phenomena affecting the same VECs?
Step 2: How is it done?

- Types, distribution, and intensity of key activities.
- Classify activities / common characteristic / triage importance – impossible and impractical to do an inventory of all activities.
- Based on existing knowledge (e.g. increase population greater pressure on biodiversity or water withdrawals greater impact during droughts).
Step 2: Expected Outcome:

- List of potential stressors on selected VECs:
  - Past, existing, and planned activities that could affect/stress the condition of the VEC.
  - Natural drivers that could exert an influence on VEC condition.
Step 3: VEC Status / Baseline

Objectives:
– Define existing condition of VEC.
– Understand its potential reaction to stress - resilience / recovery time.
– Assess trends.

Questions to answer:
– What is the existing condition of the VEC?
– What are the indicators used to assess such condition?
– What additional data is needed? Who may already have this information?
Step 3: How is this done?

- Data intensive – but many sources available (e.g. EISA, schools/universities, research institutes, government agencies, historical societies, NGO, individuals, etc).
- Define appropriate indicators.
- Refer to existing regulations (e.g. water quality/ air quality).
- Understand VECs – trends / thresholds.
Step 3: Indicators

- **Exposure oriented:**
  - Contaminant concentration level.

- **Effect oriented:**
  - Loss of biodiversity.
  - Population characteristics.
Step 3: Indicators

- **Effect Oriented:**
  - Biological Indexes: good integrators of multiple stresses over time.
  - Habitat fragmentation: ground cover, patterns, connectivity.
  - Landscape Metrics.
  - GIS/remote sensing/satellite imagery.
  - Social Indexes: quality of life, social service coverage, accessibility, etc.
<table>
<thead>
<tr>
<th>Chironomidae. Family known to be pollution tolerant</th>
<th>RED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plecoptera. Family characteristic of good water quality.</td>
<td>GREEN</td>
</tr>
</tbody>
</table>
## BMWP Index

### River Colne Water Quality Testing Sites

#### Water Quality Index
- **4.0-4.9 = Good Quality**
- **3.1-3.9 = Moderately Good Quality**
- **2.1-3.0 = Poor Quality**
- **1.1-2.0 = Bad Quality**

#### Table: BMWP Testing Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
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<tbody>
<tr>
<td>El Manzano</td>
<td>Regular</td>
<td>Regular</td>
<td>Mala</td>
<td>Regular</td>
<td>Mala</td>
<td>Regular</td>
<td>Buena</td>
</tr>
<tr>
<td>E2</td>
<td>6.6</td>
<td>5.4</td>
<td>5.8</td>
<td>6.8</td>
<td>7.2</td>
<td>6.1</td>
<td>7.0</td>
</tr>
<tr>
<td>E3</td>
<td>7.3</td>
<td>6.1</td>
<td>6.0</td>
<td>4.0</td>
<td>6.6</td>
<td>3.8</td>
<td>7.0</td>
</tr>
<tr>
<td>El Rápido</td>
<td>4.6</td>
<td>5.6</td>
<td>5.8</td>
<td>6.8</td>
<td>3.6</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>E4</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.7</td>
<td>5.6</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>E5</td>
<td>6.0</td>
<td>5.6</td>
<td>4.8</td>
<td>5.1</td>
<td>5.7</td>
<td>4.9</td>
<td>5.3</td>
</tr>
<tr>
<td>Portal Círculo</td>
<td>3.5</td>
<td>5.2</td>
<td>5.0</td>
<td>5.0</td>
<td>4.6</td>
<td>5.2</td>
<td>4.8</td>
</tr>
<tr>
<td>Portal Tigrina</td>
<td>5.0</td>
<td>6.0</td>
<td>6.4</td>
<td>4.1</td>
<td>5.5</td>
<td>3.6</td>
<td>6.5</td>
</tr>
<tr>
<td>E1</td>
<td>1.9</td>
<td>1.5</td>
<td>1.1</td>
<td>1.5</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>E2</td>
<td>3.4</td>
<td>4.5</td>
<td>4.3</td>
<td>3.7</td>
<td>5.3</td>
<td>4.9</td>
<td>3.9</td>
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<td>5.7</td>
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<td>5.7</td>
<td>4.7</td>
<td>4.6</td>
</tr>
<tr>
<td>H4</td>
<td>1.5</td>
<td>3.2</td>
<td>NA</td>
<td>5.7</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>H1</td>
<td>6.3</td>
<td>7.7</td>
<td>4.6</td>
<td>4.5</td>
<td>5.8</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>


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[Note: The table above is a snapshot of BMWP (British Methods for Water Pollution) testing sites for various water quality parameters. Each parameter is rated on a scale from 1 to 7, with higher numbers indicating better water quality. The table includes sites like El Manzano, El Rápido, Portal Círculo, and Portal Tigrina, with various ratings for each parameter across different months.]
Step 3: Trends

• Need to assess if VEC’s condition is stable, deteriorating, improving?

• Concept of thresholds
  – State beyond which the VEC condition is unsustainable / unviable / degraded.

• Concept of recovery / resilience
  – Capacity of VEC to sustain itself and remain productive.
  – Effects accumulate when second perturbation occurs before the VEC can rebound from the first.
Step 3: Expected Outcome:

- Definition of Indicators.
- Characterization of VECs:
  - Existing condition/status.
  - Historical/expected trends.
  - Expected reaction to stress.
- Identify data gaps/additional information need.
Step 4: Impact Assessment

Objectives:
- Identify potential environmental and social impacts and risks.
- Address expected impacts over the condition of the VEC (i.e. sustainability).
- Identify any potential additive, countervalling, and/or synergistic affects.

Questions to answer:
- What are the key potential impacts and risks that could affect the long term sustainability/viability of the VEC?
- Are there known/predictable cause-effect relationships?
- Can these impacts/risks interact with each other?
How is it done?

- Alternative analysis.
  - Hydro vs Thermal vs Nuclear

- Cause effect-curves.
  - Linear (e.g. additive)
  - Non linear (e.g. synergies)

- Environmental Changes/Modeling Analysis of resource affectation.
Fish egg successful emergence

Cause-Effect Curve

Links stress to a resource
VEC condition
Simple Model Analysis

Hydropower Operation

- Fluctuating Flows
  - Substrate Erosion

- Minimum Flow
  - Substrate Exposure

Productivity of Aquatic Food Base

- Quality of Spawning areas
- Location of Spawning areas

VEC - Size and Health of Fish Population
More Complex Models

Hydraulic Models or Habitat Preference Models
Step 4: Expected Outcome

- Impact Matrix.
- Cause effect analysis.
- Identification of potential linear and non-linear cause-effect relationships (antagonistic/synergies).
Step 5: Determination of Significance

Objectives:
- Determine impact and risk magnitude and significance in the context of past, present and future actions.
- Define appropriate “threshold” and indicators.
- Identify trade-off.

Questions to answer:
- Does these impacts affect the sustainability/viability of the resource / VEC?
- What are the consequences / trade-off of action/ no action?
How is it done?

- Appropriate baseline/thresholds/indicators. (e.g. levels of acceptable change)
- Historic Trends. (e.g. 50% of wetland gone – further depletion can significantly reduce the capacity of a watershed to withstand floods)
- Ambient Quality. (e.g. degraded vs. non-degraded air-sheds)
- Scientific/traditional knowledge. (e.g. colder water good for trout / warm good for bass)
- Experience from similar projects/areas. (e.g. additive – stress from passing through turbines, slow fish down, more vulnerable to predation / pollution)
Step 5: Expected Outcome:

- Definition of acceptable / non acceptable level of impact -> degraded VEC condition.
- Agreement on potential trade-off.
- Thresholds.
Step 6: Impact Management

Objectives:
- Use mitigation hierarchy.
- Design management strategies to address significant cumulative impacts over selected VECs.
- Propose monitoring program.
- Manage uncertainties with informed adaptive management.

Questions to answer:
- How can cumulative impacts be avoided, minimized or mitigated?
- How can effectiveness of proposed management measures be assessed?
- What are the triggers for specific adaptive management decisions?
Step 6: Expected Outcome:

- Series of tools/plans to manage Cumulative Impacts agreed and to be used by all parties involved.
- Acceptance of “uncertainties”.
- Monitoring Program.
- Adaptive Management Strategy.

Expected Outcomes CIAM

- Identification of relevant VECs that may be potentially affected by the development (*Stakeholders engagement*);
- Assessment/estimation of the future condition of affected VECs, as the result of the cumulative impact of the project with other reasonably predictable projects and natural influences;
- Evaluation of the future condition of the VECs relative to threshold(s) of VEC condition (*Stakeholders engagement*);
- Avoidance and minimization of the development’s impact on the VECs for the life of the development;
- Monitoring and management of impacts and risks to the project over its life-span from VECs reaching their limits (*Stakeholders engagement*);
- Compilation and sharing of project-related monitoring and VEC condition data to governments and other stakeholders for the life of the development.
Thank You
Gracias
Grazie
គឺសុីវា