Mainstreaming ecosystem based approaches to climate change adaptation planning: Experience from the Himalayas

Eric D Wikramanayake, PhD
“Biodiversity is the foundation and mainstay of agriculture, forests, and fisheries. Biological resources provide the raw materials for livelihoods, agriculture, medicines, trade, tourism, and industry. Forests, grasslands, freshwater, and marine and other natural ecosystems provide a range of services, often not recognized in national economic accounts but vital to human welfare: regulating water flows and water quality, flood control, pollination, decontamination, carbon sequestration, soil conservation, and nutrient and hydrological cycling.”

Ecosystem-based Approaches as Adaptation Strategies to Climate Change

Healthy ecosystems increase climate resilience and reduce vulnerability of biodiversity and human of communities to climate change impacts.

Therefore, conservation to maintain healthy ecosystems, biodiversity and ecosystem services will also help human communities adapt to climate change.
Ecosystem-based Approaches as Adaptation Strategies to Climate Change

- Maintaining genetic and species diversity is important for ecosystem function.

- Key species and groups of species play a major role in delivering ecosystem services.

- Conservation should provide for the ecological requirements of these species.
Ecosystems can better include the spatial scales at which important ecological process and services that sustain socio-ecological systems operate.

So, use of biodiversity and ecosystem services as an approaches to climate adaptation is becoming an important part of development agenda.
Ecosystem-based Approaches as Adaptation Strategies to Climate Change

- Generate social, economic, cultural benefits
- Disaster risk reduction
- Improve livelihood sustenance and food security
- Carbon sequestration
- Sustainable water management
- Safety nets for vulnerable communities
- Increase ecosystem buffering capacities
- Build resilience and adapt to disruptive shocks and trends
August 2008: Koshi River flood.
~ 500 lives lost in Nepal and Bihar
~ 3 million people displaced/affected
Inundated > 650 sq km
Economic losses > US $ 300 million
Ecosystem services are usually divided into the following categories

• Supporting services (basic infrastructure for life on Earth; e.g., formation of soils, water cycling, etc.)

• Regulating services (maintain environment in a fit condition for habitation and society; e.g., regulating climate, mitigating pollution and flood control)

• Provisioning services (e.g., providing food, clean water, energy, etc.)

• Cultural services, which connect people with the environment.
Climate Change Vulnerability of the Himalaya

- IPCC 2007 predicts the Himalayas temperature will increase by 3 °C by 2050 and 5 °C by 2100.

- But more recent assessments predict greater increases

- Precipitation expected to be greater, but erratic, and unpredictable


Projected and predicted impacts of increased temperature and precipitation:

- shifts, changes, and loss of forest type, quality, and community composition
- species extinctions
- changes to ecosystem service delivery
- increased vulnerability to livelihoods, lives, agriculture, infrastructure...
- cascading, downstream impacts

Climate Change-Integrated Conservation: Methods

- Climate envelopes widely used to predict future distribution of habitats and species
- Use a combination of ecological and biogeographical information, spatial analyses, and climate models to get some sense of expected changes and integrate into conservation plans for ‘no-regrets’ strategies
- Issues: cannot accurately predict climate trajectories and unable to accurately represent complex ecosystem dynamics
- But, provide some guidance and use with caution, constant monitoring.
Two priority conservation landscapes:

- **Terai Arc Landscape**
  - Tigers
  - Rhinoceros
  - Elephants
  - Churia water

- **Chitwan Annapurna Landscape**
  - Water
  - North-south corridor for migratory birds
  - Red panda, clouded leopards, wild dogs, golden cats, musk deer
  - Pheasants, tragopans
  - Hornbills
  - Snow leopards
  - Endemic plants
Climate Change-Integrated Conservation: Methods

Legend
- Protected Areas
- nepal-administrative
current_poten_distrib_ecoveg
- Chir Pine Forest
- Hill Sal Forest
- Mixedconifer
- Subalpineconifer
- Subtropical Forest
- Temperbroadleavforest
- lowlandsalforestrsubalpinescrub

2010
Climate Change-Integrated Conservation: Methods
Climate Change-Integrated Conservation: Methods
Climate Change-Integrated Conservation: Methods

2050
Climate Change-Integrated Conservation: Methods

1. Modeled and mapped vulnerability of snow leopard and red panda habitat to climate change scenarios

2. Spatially projected future forest and alpine habitat zones based on future climate IPCC GHG emissions scenarios

3. Identified areas most and least vulnerable to climate change impacts

4. Propose conservation strategies based on climate impact scenarios
Climate Change-Integrated Conservation: Methods
Climate Change-Integrated Conservation: Recommendations

• Temperate Broadleaf and Subalpine Conifer forests more resilient to CC even under A2A GHG scenarios

• Large patches of EH Temperate Broadleaf and Conifer Forests Global 200 ecoregions will remain

• Mid- and lower-hill forests vulnerable, but most lowland forests already converted.

• Maintain habitat connectivity:
  • Snow Leopards: north-south connectivity critical
  • Red Panda: protect resilient forest for climate refugia
  • Also important for water towers
Flowing Forward: A Framework

- A systematic approach to assess the vulnerability of socio-ecological systems to climate change

- Impacts assessed at ecosystem-scales: landscapes or the river basins

- Analyze relationships between key man-made systems and ecosystems that provide critical services

- Understand the drivers of vulnerability and develop interventions
Flowing Forward: The Process

Process organized around the 3 components of IPCC defined vulnerability

- Sensitivity
- Adaptive Capacity
- Exposure
These components contribute to **Resilience** and **Exposure**... to assess **Vulnerability**.
Collect, collate information on assets (and gaps), including ecosystems and infrastructure; trends in climate (temp and precipitation), economic development, socioeconomics and demographics

Identify key socio-ecological systems in the landscape or river basin; i.e., **Units**, and **Subunits**, representative of the human and natural systems within the landscape or basin and that are used to determine vulnerability

Because of their central role in the process, Units and Subunits are selected carefully to reflect the socio-ecological (livelihood and biodiversity) priorities
## Units and Subunits for TAL

<table>
<thead>
<tr>
<th>UNITS</th>
<th>Species</th>
<th>LULC</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahakali River Basin</td>
<td>Tiger</td>
<td>Protected Areas</td>
<td>Large cities</td>
</tr>
<tr>
<td>Karnali River Basin</td>
<td>Greater one-horned rhinoceros</td>
<td>Corridors</td>
<td>Rural settlements</td>
</tr>
<tr>
<td>Babai River Basin</td>
<td>Swamp deer</td>
<td>Agricultural Areas</td>
<td>Airports</td>
</tr>
<tr>
<td>Bagmati River Basin</td>
<td>Gangetic Dolphins</td>
<td>Plantations</td>
<td>National roads</td>
</tr>
<tr>
<td>East Rapti River Basin</td>
<td>Great Pied Hornbill</td>
<td>Livestock Grazing Areas</td>
<td>District roads</td>
</tr>
<tr>
<td>Bakaiya River Basin</td>
<td>Vultures</td>
<td>Watershed protection Forests</td>
<td>local roads</td>
</tr>
<tr>
<td>Tinau River Basin</td>
<td>Bengal Florican</td>
<td>Community managed forests</td>
<td>Hydro power</td>
</tr>
<tr>
<td>West Rapti River Basin</td>
<td>Saurus crane</td>
<td></td>
<td>Irrigation systems</td>
</tr>
<tr>
<td>Mahana River Basin</td>
<td>Gharial</td>
<td></td>
<td>Railroads</td>
</tr>
<tr>
<td></td>
<td>Grassland birds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Units and Subunits for CHAL

<table>
<thead>
<tr>
<th>UNITS</th>
<th>SUBUNITS</th>
<th>SPECIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Himalaya &gt;5000m</strong></td>
<td><strong>Subcatchments</strong></td>
<td><strong>Infrastructure</strong></td>
</tr>
<tr>
<td>Forest /Habitat Types</td>
<td>Semi desert coniferous forests</td>
<td>Seti</td>
</tr>
<tr>
<td></td>
<td>Alpine Scrub /mdw/rangelands</td>
<td>Kali Gandaki</td>
</tr>
<tr>
<td><strong>Trans Him Plateau Region (3000-5000m)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Mountains (3000-5000m)</td>
<td>Alpine coniferous forests</td>
<td>Trishuli</td>
</tr>
<tr>
<td></td>
<td>Upper temperate broadleaf forests</td>
<td>Narayani</td>
</tr>
<tr>
<td><strong>Middle Mountains (1500-3000m)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siwalik/Churia (900-1500m)</td>
<td>Lower temperate broadleaf forests</td>
<td>Madi</td>
</tr>
<tr>
<td></td>
<td>Temperate conifer</td>
<td>Rapti</td>
</tr>
<tr>
<td></td>
<td>Subtropical brdlf for</td>
<td>Budhi Gandaki</td>
</tr>
<tr>
<td></td>
<td>High Alt lakes</td>
<td>Siw Pakho</td>
</tr>
</tbody>
</table>
Vulnerability is assessed in a workshop setting, where participants analyze each of the Units and Subunits for:
Sensitivity and Adaptive Capacity is assessed through several criteria...

1. Connectivity
2. Climate variability
3. Refugia
4. Functional redundancy
5. Natural Productivity
6. Biodiversity

Natural Systems

Man-made Systems
1. Connectivity
2. Climate variability in planning, design, and construction
3. Climate variability in maintenance

Flowing Forward: The Process
Index for scoring

**Sensitivity** and **Adaptive Capacity** for Resilience...

Low score – low resilience
High Score – high resilience
Sensitivity and Adaptive Capacity assessments provide an index of Resilience of Units and Subunits...
# Resilience:

<table>
<thead>
<tr>
<th>Sub-Unit</th>
<th>Connectivity</th>
<th>Climate Variability</th>
<th>Refugia</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-desert coniferous forest (Trans-Himalayan)</td>
<td>Very sparse vegetation</td>
<td>System can well; can resist higher temperature</td>
<td>No place to move/shift</td>
<td>1.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functional Redundancy</th>
<th>Natural Productivity</th>
<th>Biodiversity/ Genetic Diversity</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>No alternative available in current situation</td>
<td>1</td>
<td>Slow growing species</td>
<td>2</td>
</tr>
</tbody>
</table>
Resilience:

<table>
<thead>
<tr>
<th>Sub-Unit</th>
<th>Connectivity</th>
<th>Climate Variability</th>
<th>Refugia</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-desert coniferous forest (Trans-Himalayan)</td>
<td>Very sparse vegetation</td>
<td>System can well; can resist higher temperature</td>
<td>No place to move/shift</td>
<td>1.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional Redundancy</td>
<td>No alternative available in current situation</td>
<td>Slow growing species</td>
<td>Single species dominated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Resilience factors are rated 1-5, with 5 indicating the factor results in high resilience and 1 indicating the factor results in low resilience. Scores for each of the factors are then averaged to produce a final sensitivity score.

<table>
<thead>
<tr>
<th>Sub-Unit</th>
<th>Connectivity</th>
<th>Climate Variability (Planning, Design, Construction)</th>
<th>Climate Variability (Maintenance)</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>District Roads</td>
<td>Development of district roads increases connectivity between economic centers and district HQ</td>
<td>Planning, design and construction of district roads might have sound engineering but that might not take into consideration climate change variability during the process.</td>
<td>Maintenance of district roads are slower and the amount of equipment and finances available are lower.</td>
<td>3.67</td>
</tr>
</tbody>
</table>

Note: Resilience factors are rated 1-5, with 5 indicating the factor results in high resilience and 1 indicating the factor results in low resilience. Scores for each of the factors are then averaged to produce a final sensitivity score.
**Exposure** is determined by analysis of Climate and Development scenarios that determine impacts on Units and Subunits...
Flowing Forward: The Process

..for an index of Exposure...
Exposure Criteria:

- **Intensity**: the degree of damage caused by an impact

- **Manifestation**: when the impact will occur (now, short, long term)

- **Extension**: the size of the Subunit affected

Low score – low resilience
High Score – high resilience
## Table 5. Example Climate-Development Impact Rating, Infrastructure Breakout Group

<table>
<thead>
<tr>
<th>Climate &amp; Development Potential Impacts</th>
<th>Relevant Subunit</th>
<th>Severity</th>
<th>Extension</th>
<th>Manifestation</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased intensity of rainfall causing increased soil erosion leading to rut formation and channeling of roads, resulting in rapid surface deterioration of roads</td>
<td>District Roads</td>
<td>Severe rainfall expected, no canals in existence to take water/ sediment away</td>
<td>4</td>
<td>Destruction and siltation immediately after rainfall; encroachment takes longer</td>
<td>4</td>
</tr>
</tbody>
</table>
Indices of **Resilience** and **Exposure** are combined...
Indices of **Resilience** and **Exposure** are combined...for **Vulnerability** assessment...
Assessing Social Adaptive Capacity: 3 inputs...
Flowing Forward: The Process

Information
• Frequency – how often data are collected through time
• Iterative Process – repetition for trend analysis
• Quality – Data gaps? How reliable are the data?
• Accessibility – How easy is it to get the data from other institutions?
• Communications – Data understandable?

Policies
• forward thinking, consider future conditions
• flexible approaches and planning for multiple future scenarios.
• implemented and enforced effectively to achieve goals,
• reviewed and revised periodically to meet objectives and changing conditions
• informational, technical, and financial resources and capacity
• be coherent and consistent with other policies across all scales.
Flowing Forward: The Process

Institutions

- mandates to meet the goals of the institution
- authority and leadership to set priorities, make decisions, and carry out responsibilities efficiently and effectively
- resources and capacities to function effectively
- transparency and consultation with other stakeholders
- collaborate and coordinate with other relevant institutions
Vulnerability and Social Adaptive Capacity combine...
Vulnerability and Social Adaptive Capacity combine... for Adaptation Planning of high vulnerability Units and Subunits...
Adaptation planning for CHAL Subunit (Subtropical Broadleaf Forests) by workshop participant in Units/Subunits prioritized for high vulnerability.

<table>
<thead>
<tr>
<th>Sub-Unit(s)/ Vulnerability:</th>
<th>Adaptation Intervention 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. High immigration</td>
<td></td>
</tr>
<tr>
<td>b. Shifting cultivation</td>
<td></td>
</tr>
<tr>
<td>c. Geologically fragile/ ecologically young</td>
<td></td>
</tr>
<tr>
<td>d. Dry; high forest fire incidences</td>
<td></td>
</tr>
<tr>
<td>e. Prone to landslide, soil erosion</td>
<td></td>
</tr>
<tr>
<td>f. High pressure on natural resources</td>
<td></td>
</tr>
<tr>
<td>g. Importance to protect lower plain area for agriculture/water supply</td>
<td></td>
</tr>
<tr>
<td>h. Rich in Biodiversity</td>
<td></td>
</tr>
<tr>
<td>i. Important corridors for wildlife</td>
<td></td>
</tr>
</tbody>
</table>

| Intervention: | Promote Community based forest management practice (control forest fire, regeneration promotion, plantation, conservation) |
|              | 2. Promote alternate energy program 9Biogas/Lcs Forest based microenterprise |
|              | 3.                                             |

| Why that intervention: | To address the problem of over exploitation of forest, minimize shifting cultivation through income from micro enterprise, to control soil erosion/land slide and to increase forest cover |

| Where to implement: | Chitwan, Nawalparasi, Tanahu, Makwanpur, lower best of Palpa |

| Who to implement: | District forest office, CFUG, DSCO |

| How it connects to NAPA: | Forest and biodiversity conservation; control climate induced disaster, contribute to water resource and energy; food security |

| Timeframe: | 2013-2023 |

| Funding? (y/n) | GON; CFUGs, DDC, VDC, Projects |

| Are there any risks/drawbacks: | Community interest/participation (HH involved in shifting cultivation); alternatives for forest based livelihoods |

| Synergies/ Opportunities to work with others: | DDC-VDC-GON and projects |
“There is strong overlap between the drivers of climate change and those of biodiversity loss...We must work in synergy to address these underlying pressures and thereby improve the well-being of society overall.

To effectively tackle biodiversity loss we also need to address climate change, yet equally we should tackle climate change while also addressing biodiversity loss.”