Mainstreaming ecosystem based approaches to climate change adaption planning:

Experience from the Himalayas

Eric D Wikramanayake, PhD

Ecosystem-based Approaches as Adaptation Strategies to Climate Change

"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."

Convenient Solutions to an Inconvenient Truth : Approaches to Climate Change. *World Bank* (2009).

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

Ecosystem-based Approaches as Adaptation Strategies to Climate Change

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-based Approaches as Adaptation Strategies to Climate Change

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

IPCC, 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva, Switzerland,104 pp

Shrestha, U. B., S., Gautam, and K.S. Bawa. 2012. Widespread climate change in the Himalayas and associated changes in local ecosystems. PloS one 7, e36741 (2012).

Climate Change Vulnerability of the Himalaya

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

Xu, J. et al. 2009. The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. Conservation Biology. 23:520–30.

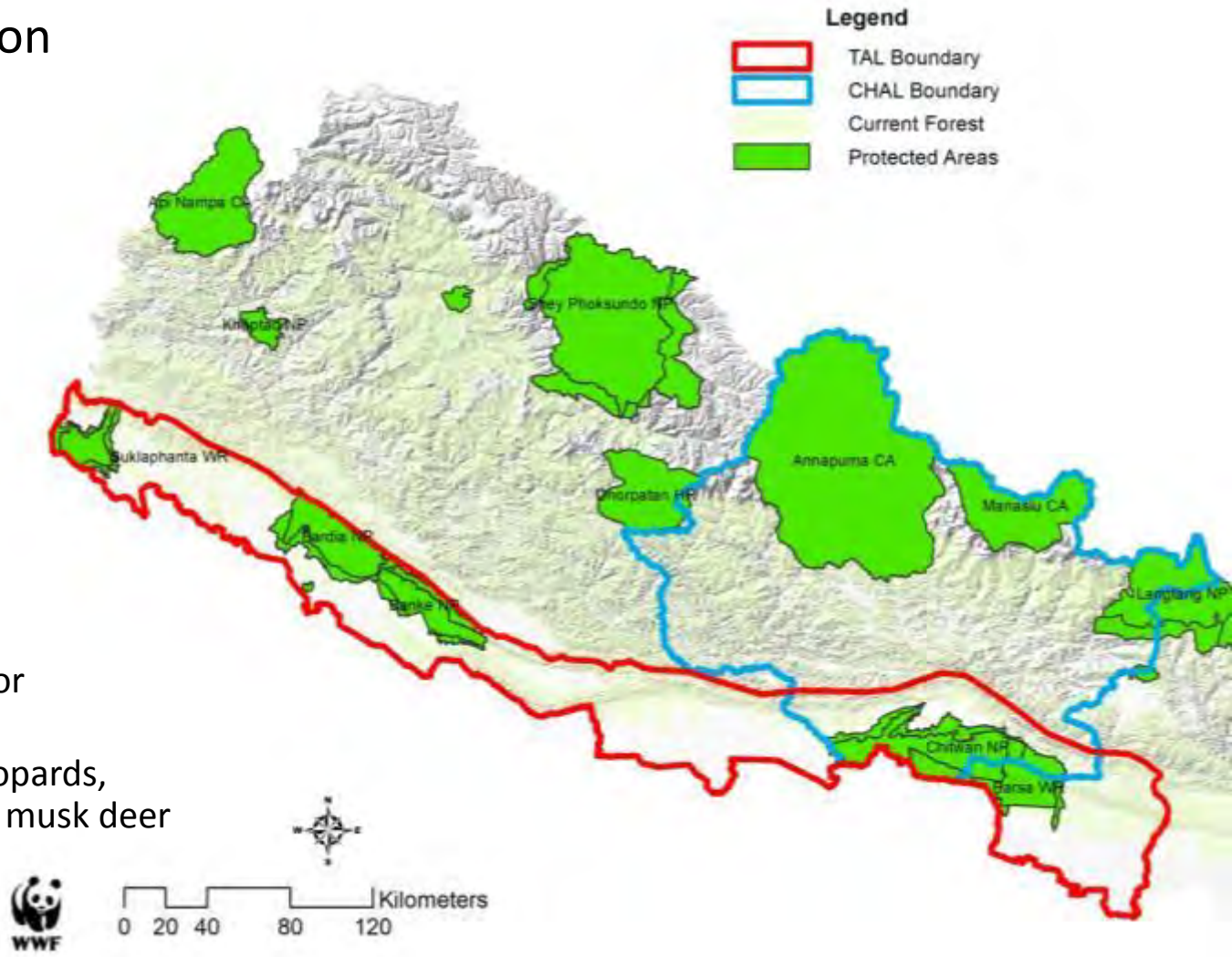
Climate Change-Integrated Conservation: Methods

- 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.

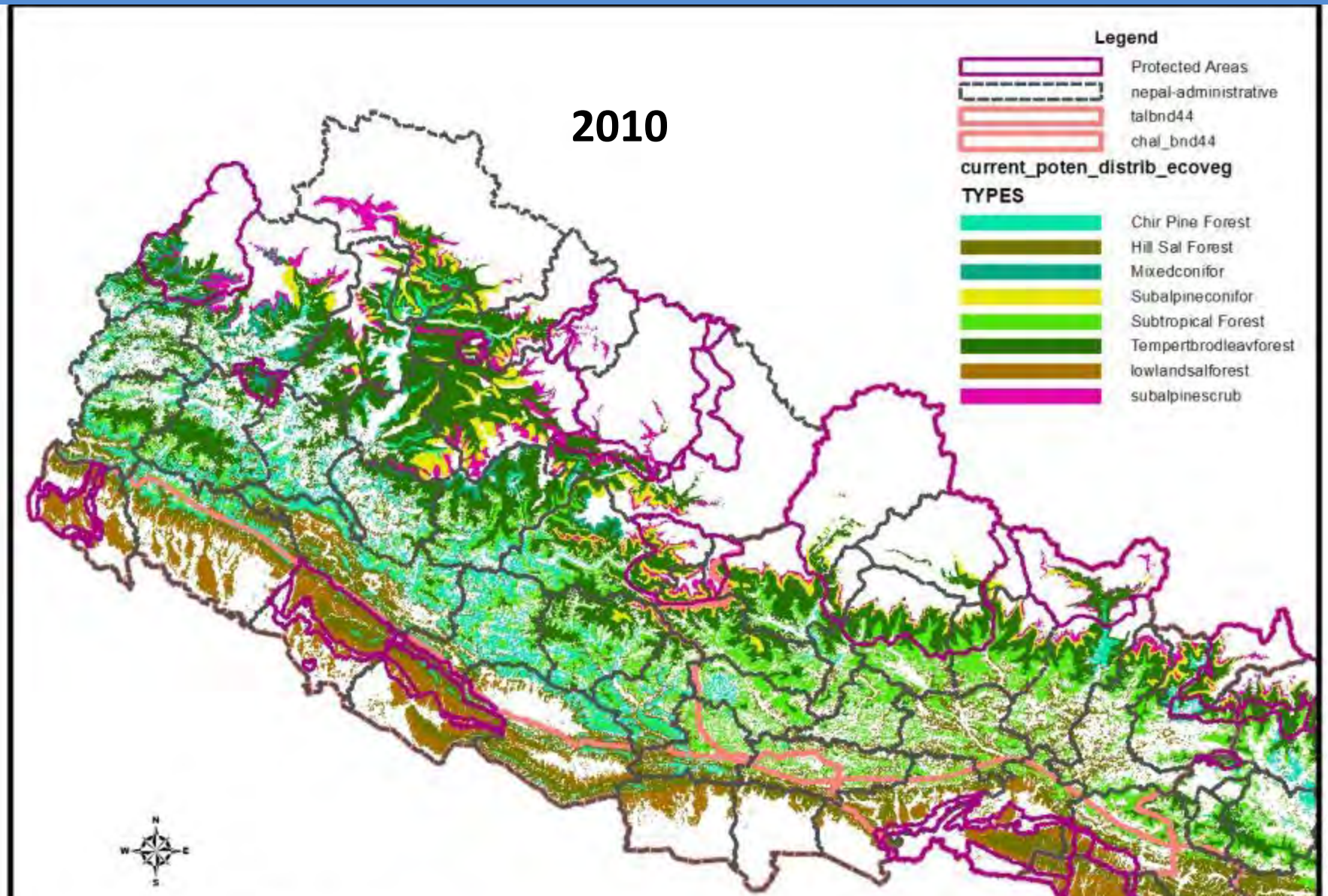
Climate Change-Integrated Conservation: Methods

Two priority conservation landscapes:

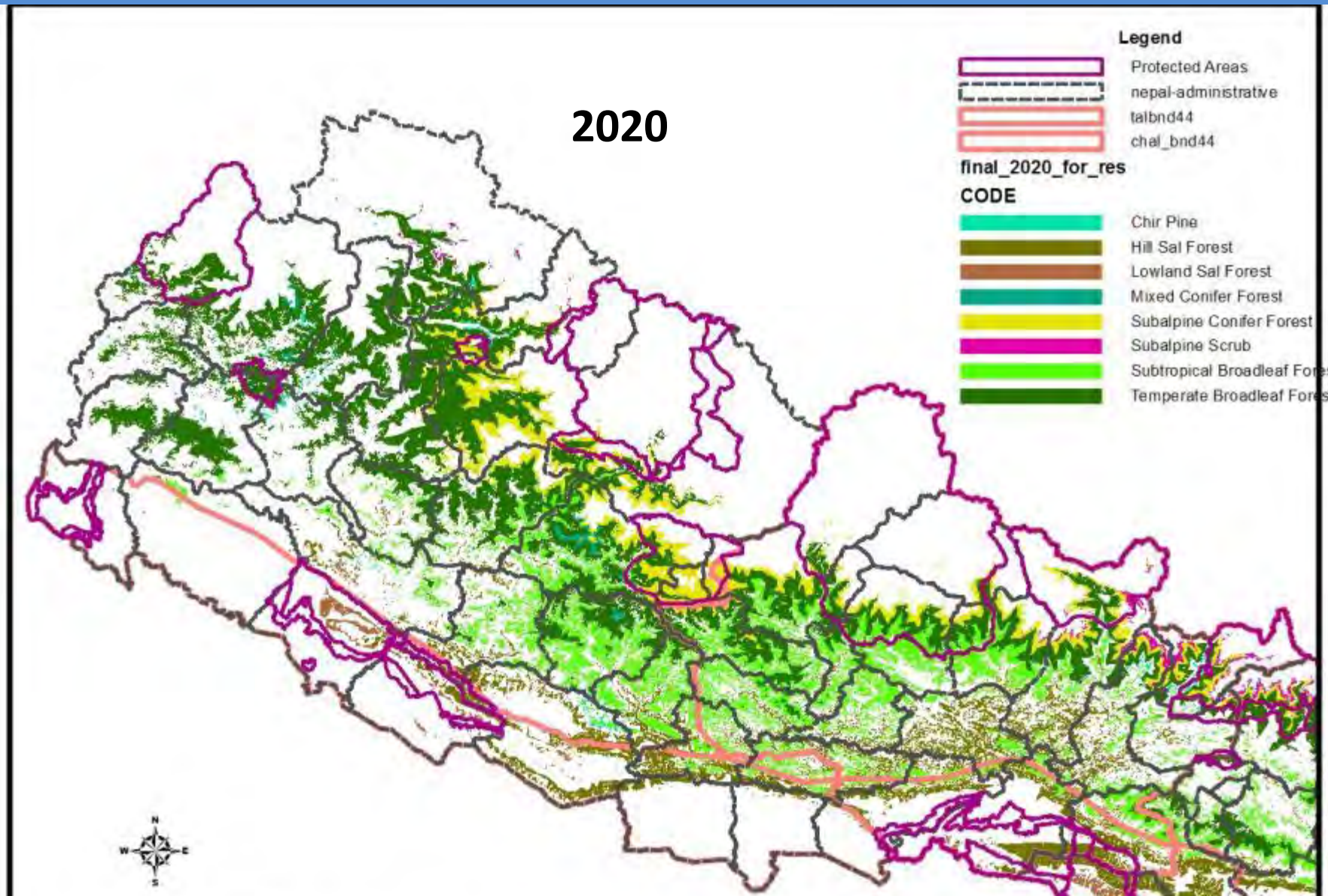
- Terai Arc Landscape
  - Tigers
  - Rhinoceros
  - Elephants
  - Churia water
- Chitwan Annapurna Landscape
  - water
  - North-south corridor for migratory birds
  - Red panda, clouded leopards, wild dogs, golden cats, musk deer
  - Pheasants, tragopans
  - hornbills
  - Snow leopards
  - Endemic plants



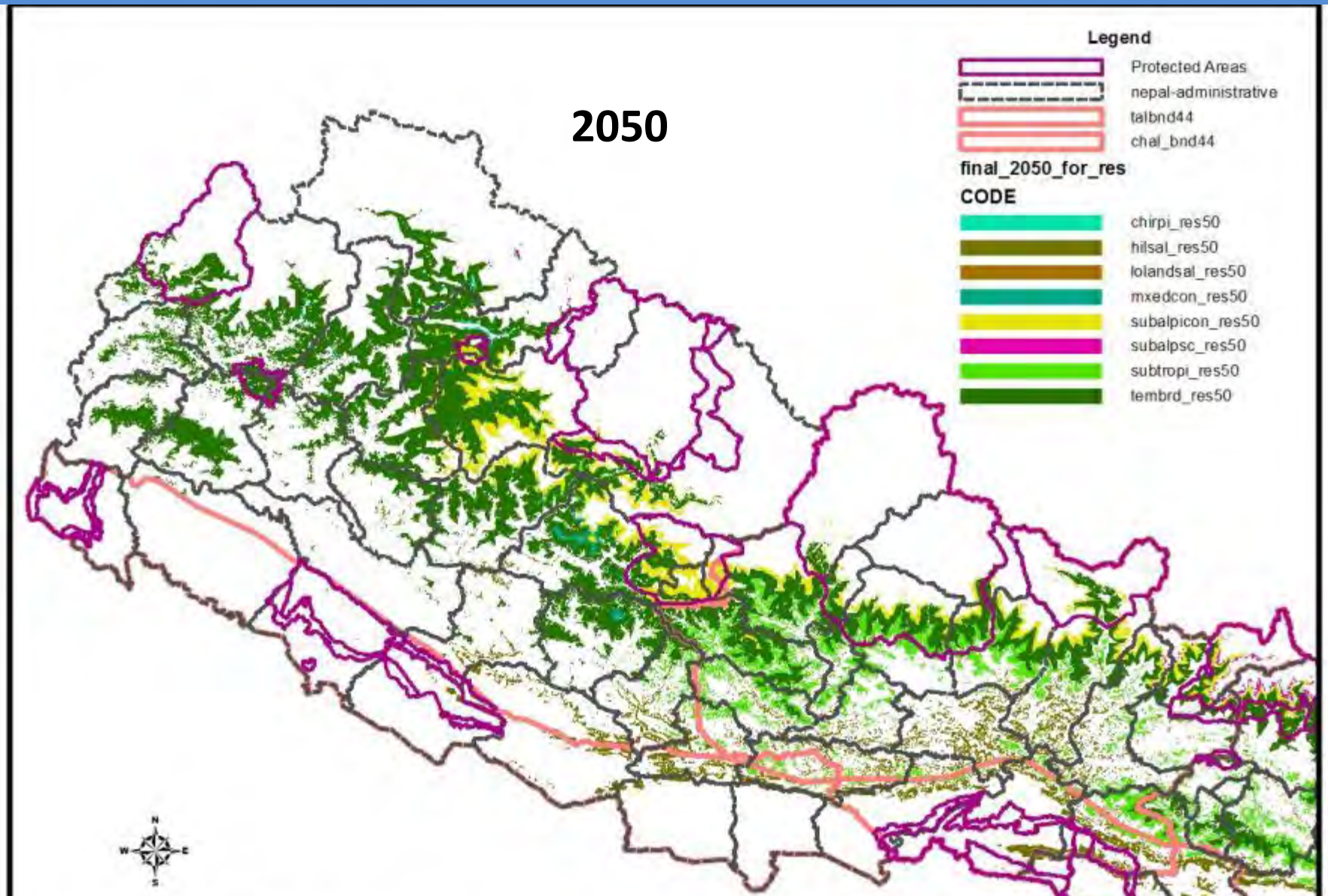
Climate Change-Integrated Conservation: Methods



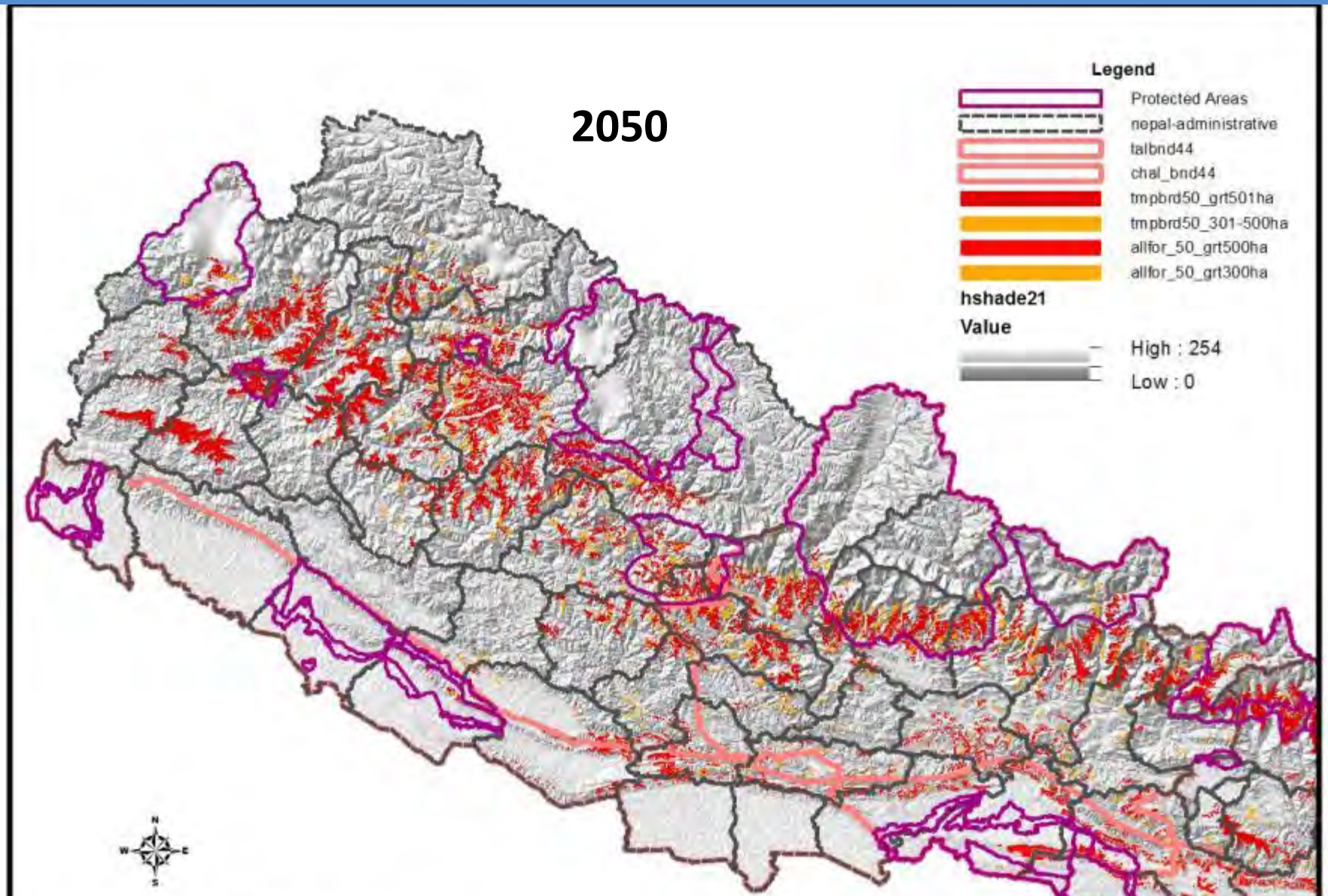
Climate Change-Integrated Conservation: Methods



Climate Change-Integrated Conservation: Methods



Climate Change-Integrated Conservation: Methods



Climate Change-Integrated Conservation: Methods

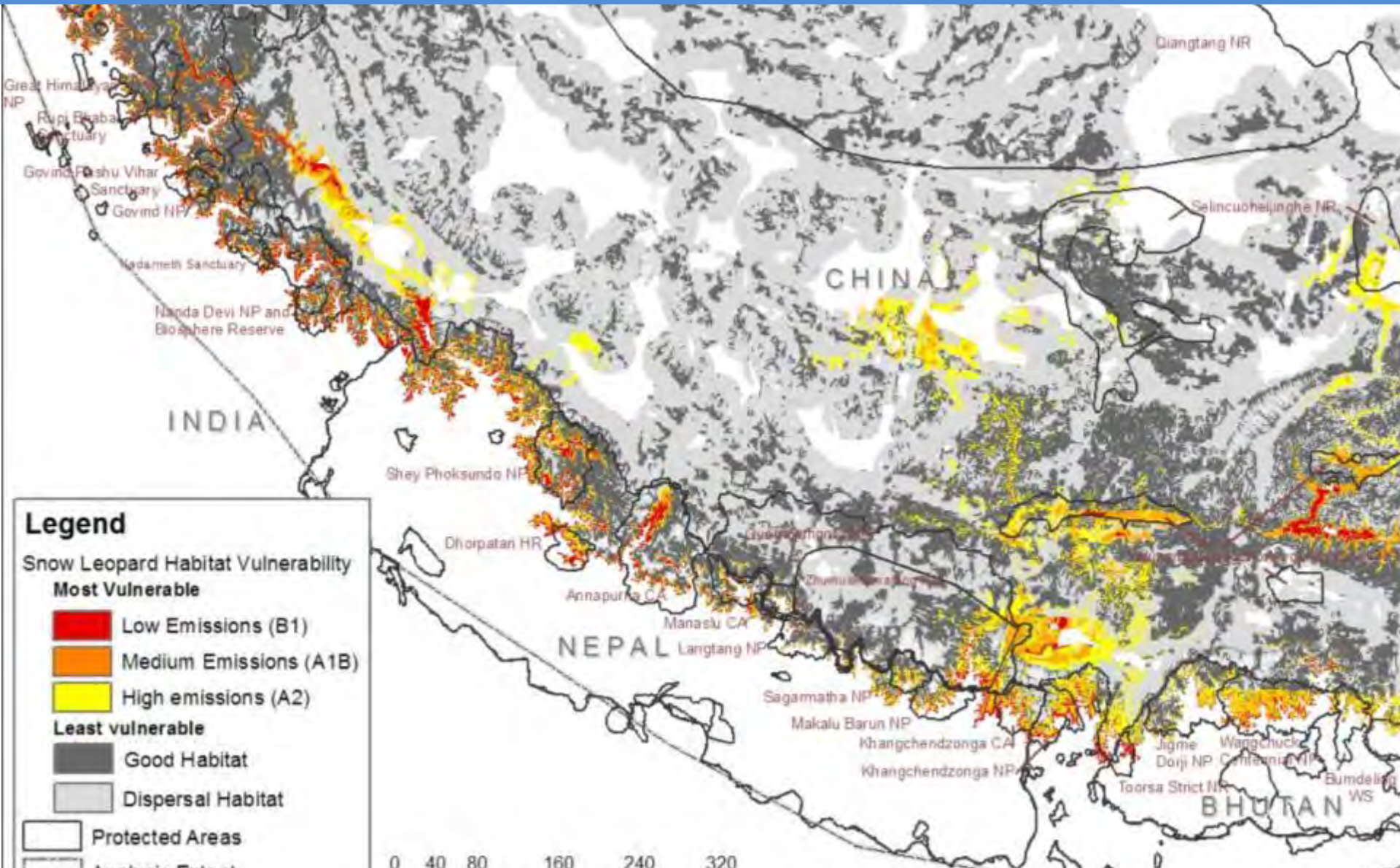
1. Modeled and mapped vulnerability of snow leopard and red panda habitat to climate change scenarios

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

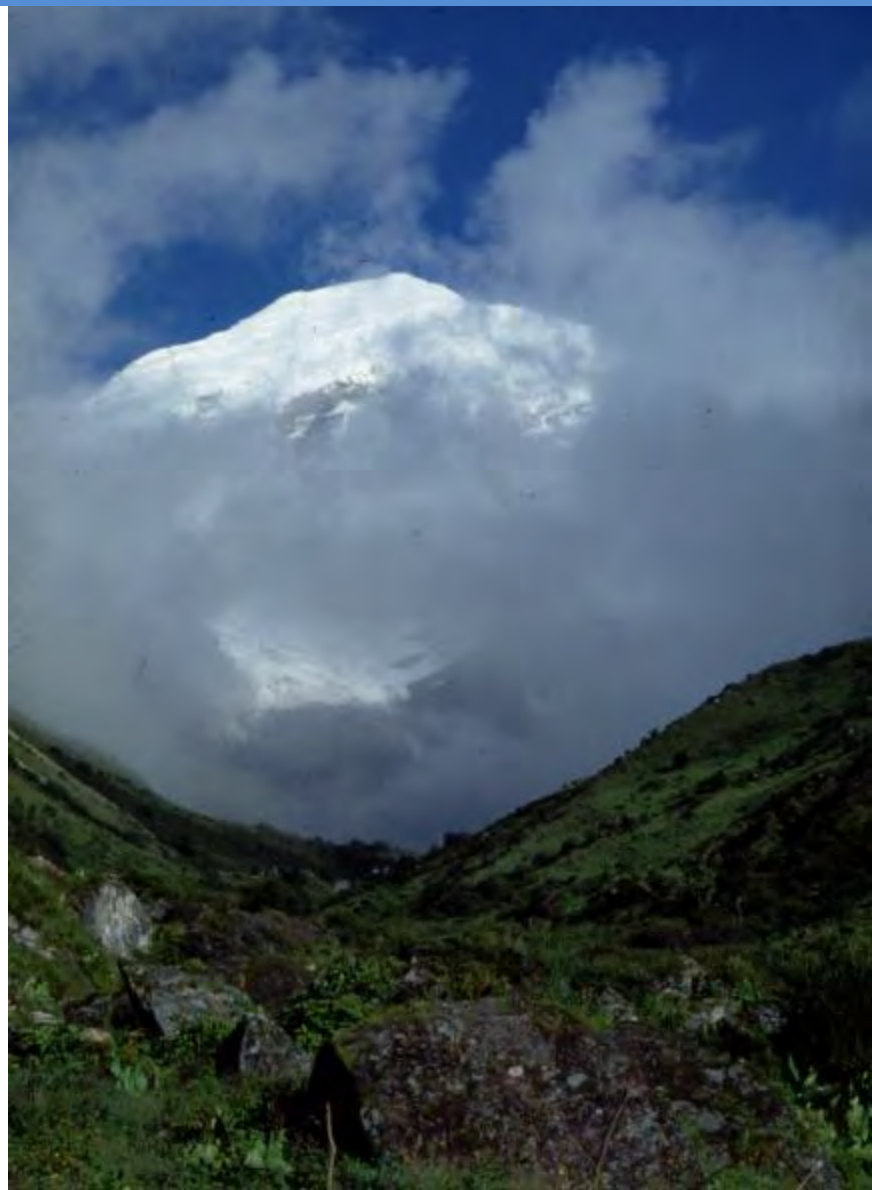
- Large patches of EH Temperate Broadleaf and Conifer Forests Global 200 ecoregions will remain

- 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

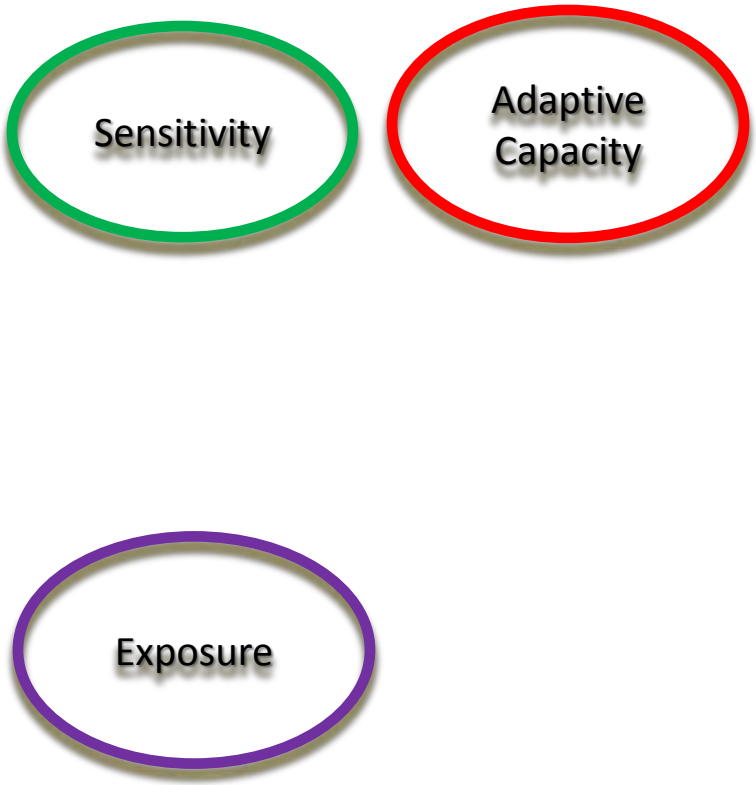
Flowing Forward: A Framework

- 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



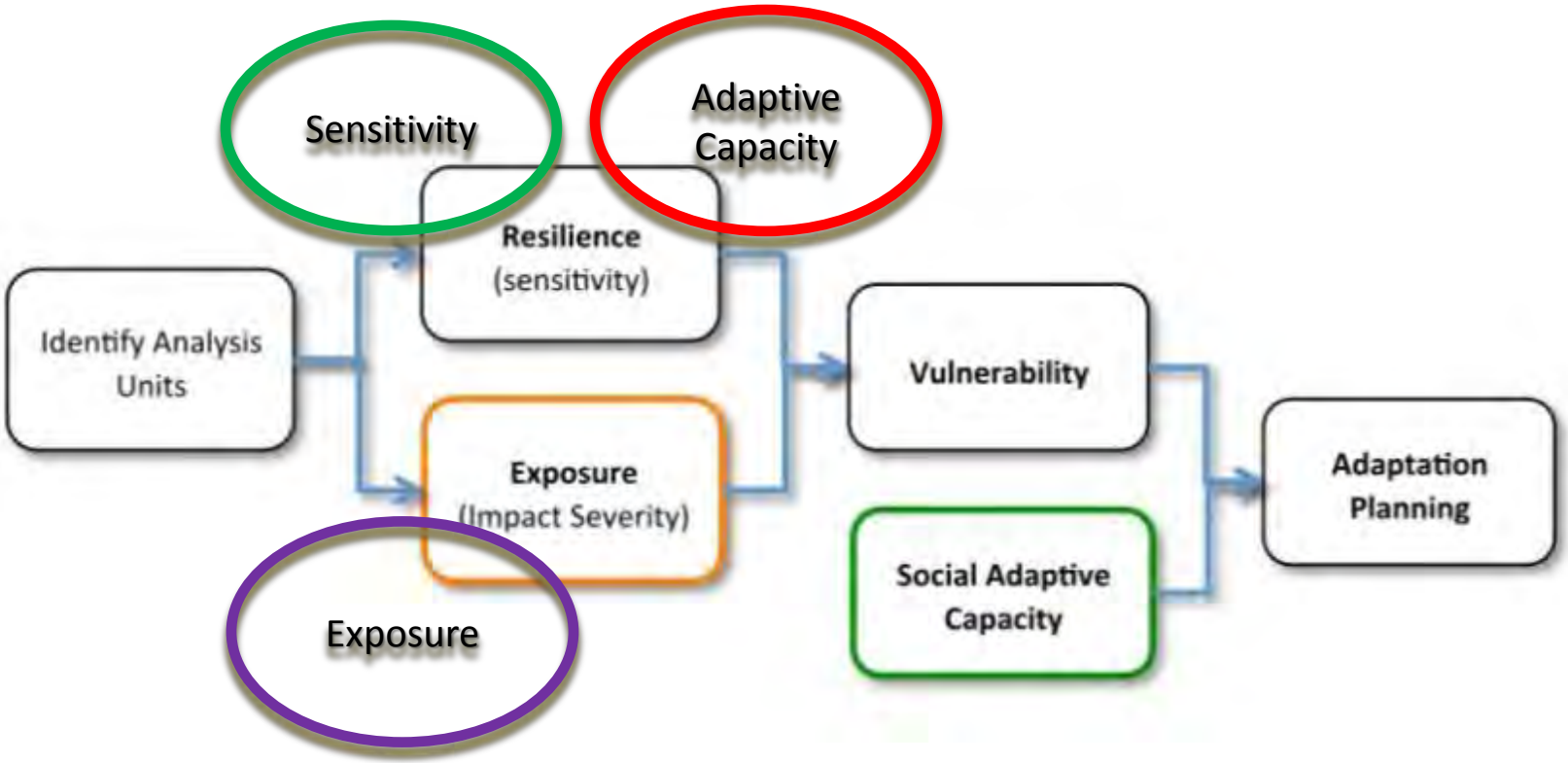
Flowing Forward: The Process

Process organized around the 3 components of IPCC defined vulnerability



Flowing Forward: The Process

These components contribute to **Resilience** and **Exposure**… to assess **Vulnerability**.



Flowing Forward: The Process

- 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

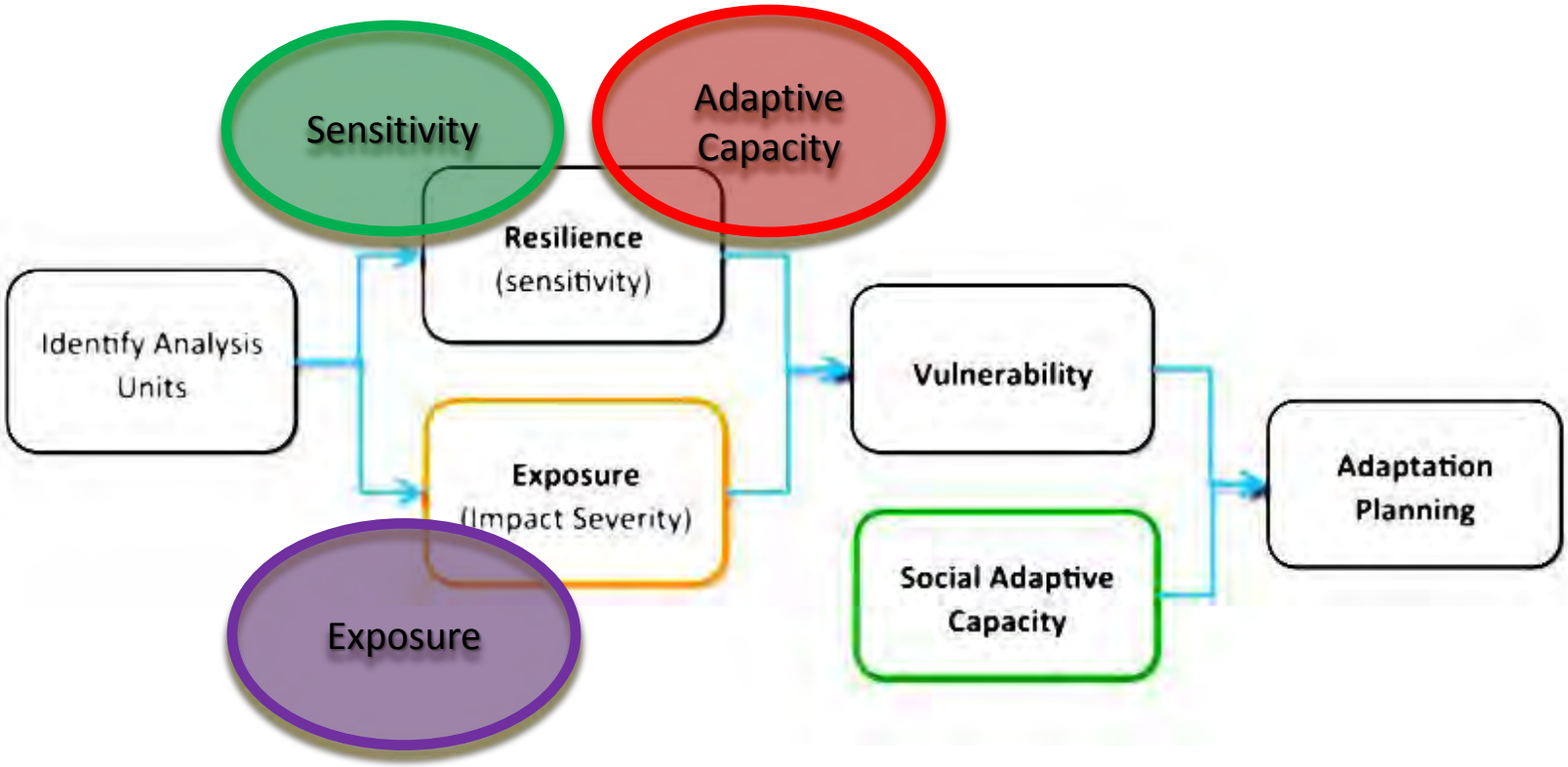
UNITS	SUBUNITS		
	Species	**LULC**	**Infrastructure**
Mahakali River Basin	Tiger	Protected Areas	Large cities
Karnali River Basin	Greater one-horned rhinoceros	Corridors	Rural settlements
Babai River Basin	Swamp deer	Agricultural Areas	Airports
Bagmati River Basin	Gangetic Dolphins	Plantations	National roads
East Rapti River Basin	Great Pied Hornbill	Livestock Grazing Areas	District roads
Bakaiya River Basin	Vultures	Watershed protection Forests	local roads
Tinau River Basin	Bengal Florican	Community managed forests	Hydro power
West Rapti River Basin	Saurus crane		Irrigation systems
Mahana River Basin	Gharial		Railroads
	Grassland birds		

Units and Subunits for CHAL

UNITS	SUBUNITS				
	Forest /Habitat Types	**Subcatch-ments**	**Agricul-ture**	**Infrastruc-ture**	**Species**
High Himalaya >5000m	Semi desert coniferous forests	Seti	Siwalik Khet	High Mtn Dist Roads	Snow Leopard
Trans Him Plateau Region (3000-5000m)	Alpine Scrub /mdw/ rangelands	Kali Gandaki	Mid Mtn Khet	Mid Mtn Dist Roads	Red Panda
High Mountains (3000-5000m)	Alpine coniferous forests	Trishuli	Siwalik Bari	Siwalik DistRoads	Brown Bear
Middle Mountains (1500-3000m)	Upper temperate broadleaf forests	Narayani	Mid Mtn Bari	Nat Roads	Musk Deer
Siwalik/Churia (900-1500m)	Lower temperate broadleaf forests	Madi	Trans Him Bari	Dams	Wild Dogs
	Temperate conifer	Rapti	Irrig Tar	Urb Setlmt	Orchids
	Subtropical brdlf for	Budhi Gandaki	Rainfed Tar	Rur Setlmt	Mahseer
	High Alt lakes		Siw Pakho	River mine	Hornbills

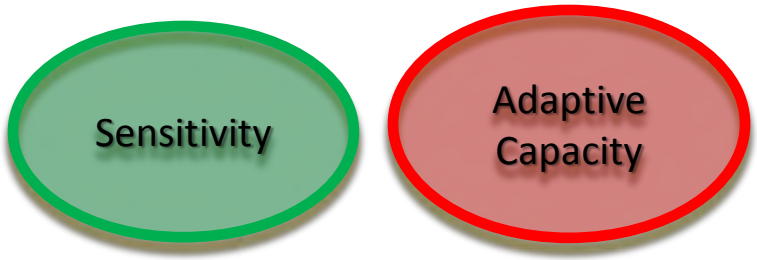
Flowing Forward: The Process

Vulnerability is assessed in a workshop setting, where participants analyze each of the Units and Subunits for:



Flowing Forward: The Process

Sensitivity and **Adaptive Capacity** is assessed through several criteria…



Natural Systems

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

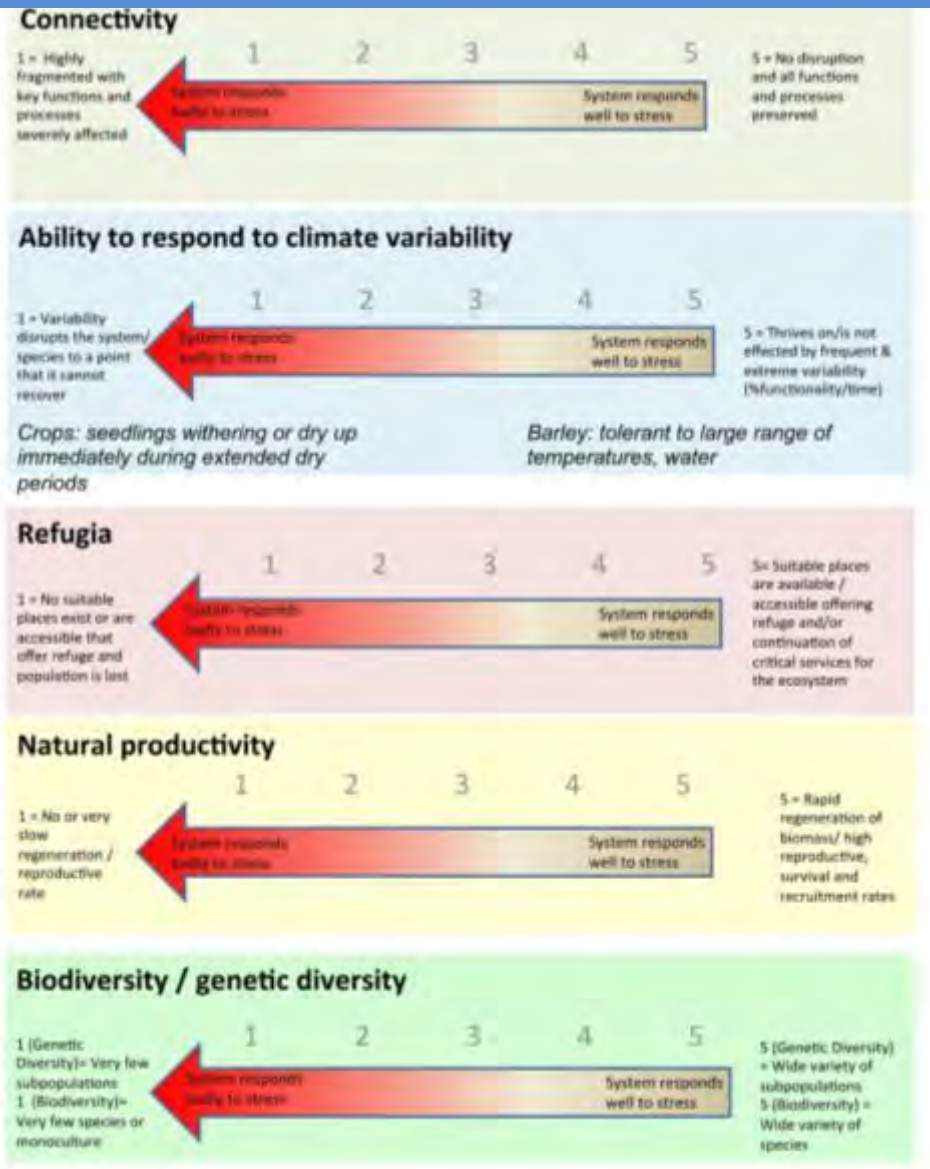
Man-made Systems

1. Connectivity
2. Climate variability in planning, design, and construction
3. Climate variability in maintenance

Flowing Forward: The Process

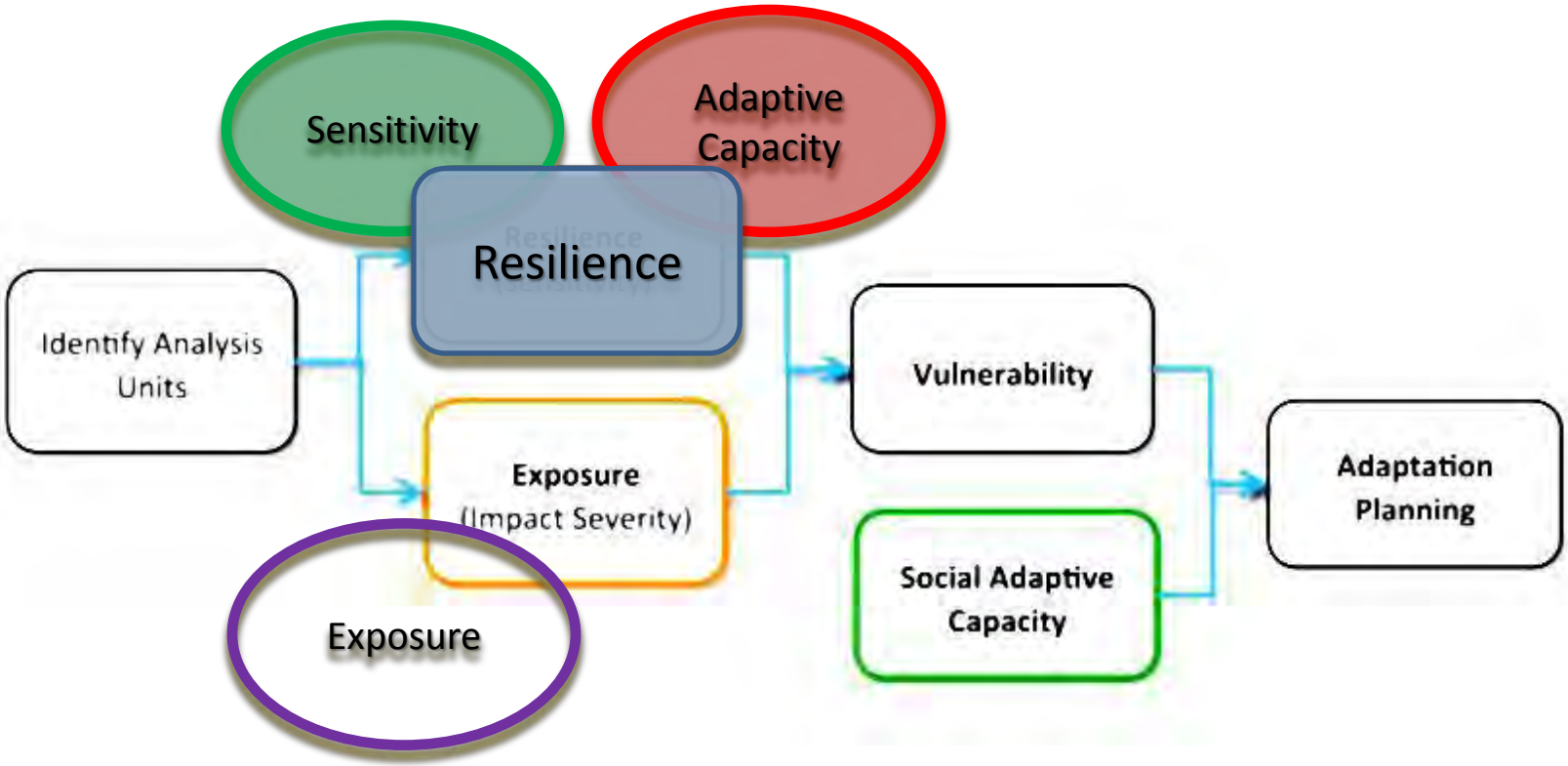
Index for scoring **Sensitivity** and **Adaptive Capacity** for **Resilience**…

Low score – low resilience
High Score – high resilience



Flowing Forward: The Process

Sensitivity and **Adaptive Capacity** assessments provide an index of **Resilience** of Units and Subunits…



Flowing Forward: The Process

Resilience:

Sub-Unit	Connectivity		Climate Variability		Refugia		Avg
Semi-desert coniferous forest (Trans-Himalayan)	Very sparse vegetation	1	System can well; can resist higher temperature	4	No place to move/shift	1	1.67
	Functional Redundancy		**Natural Productivity**		**Biodiversity/ Genetic Diversity**		
	No alternative available in current situation	1	Slow growing species	2	Single species dominated	1	

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

Flowing Forward: The Process

Resilience:

Sub-Unit	Connectivity		Climate Variability		Refugia		Avg
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	No alternative available in current situation	1	Slow growing species	2	Single species dominated	1	

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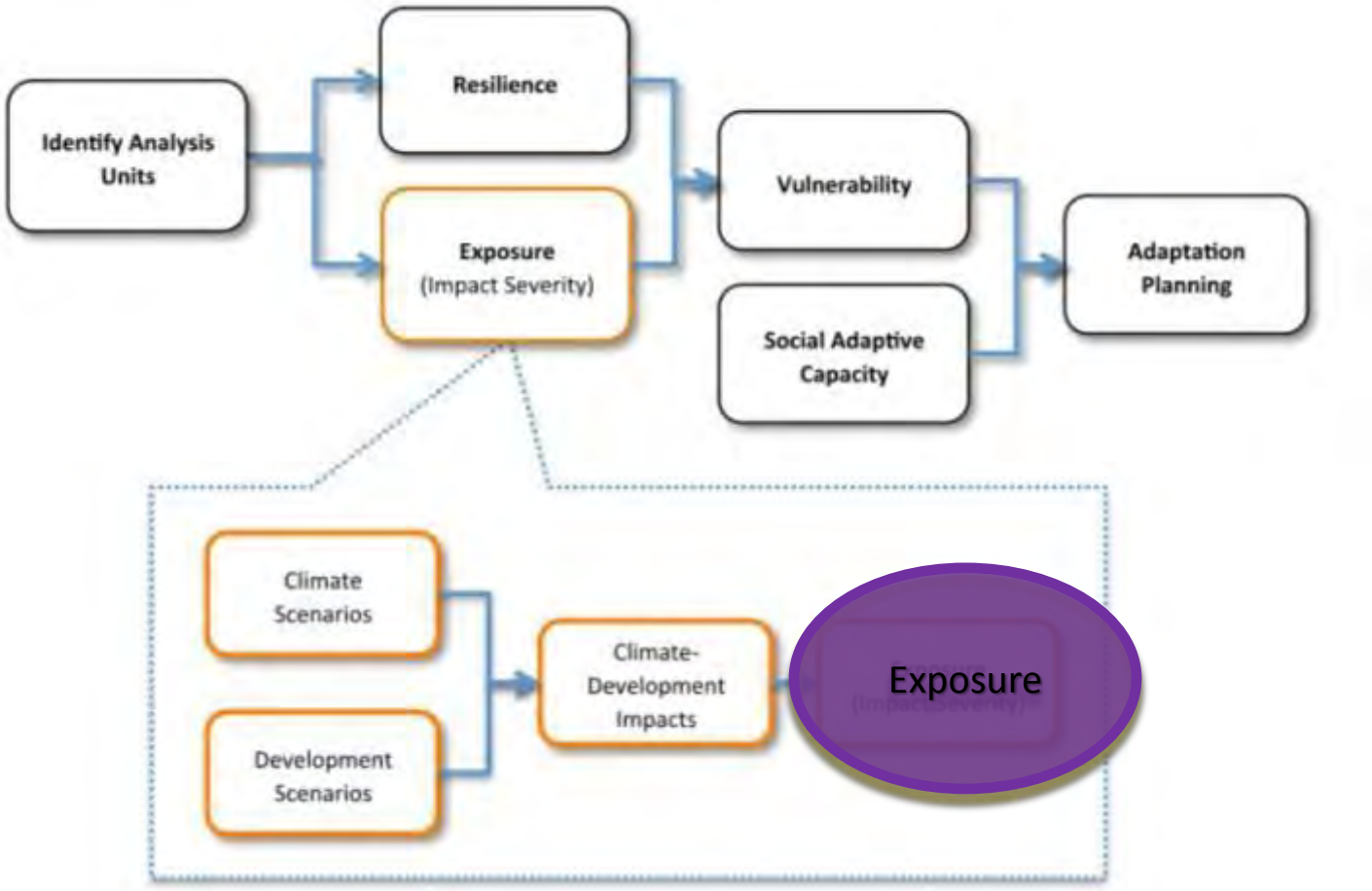
Sub-Unit	Connectivity		Climate Variability (Planning, Design, Construction)		Climate Variability (Maintenance)		Avg
District Roads	Development of district roads increases connectivity between economic centers and district HQ	5	Planning, design and construction of district roads might have sound engineering but that might not take into consideration climate change variability during the process.	3	Maintenance of district roads are slower and the amount of equipment and finances available are lower.	3	**3.67**

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.

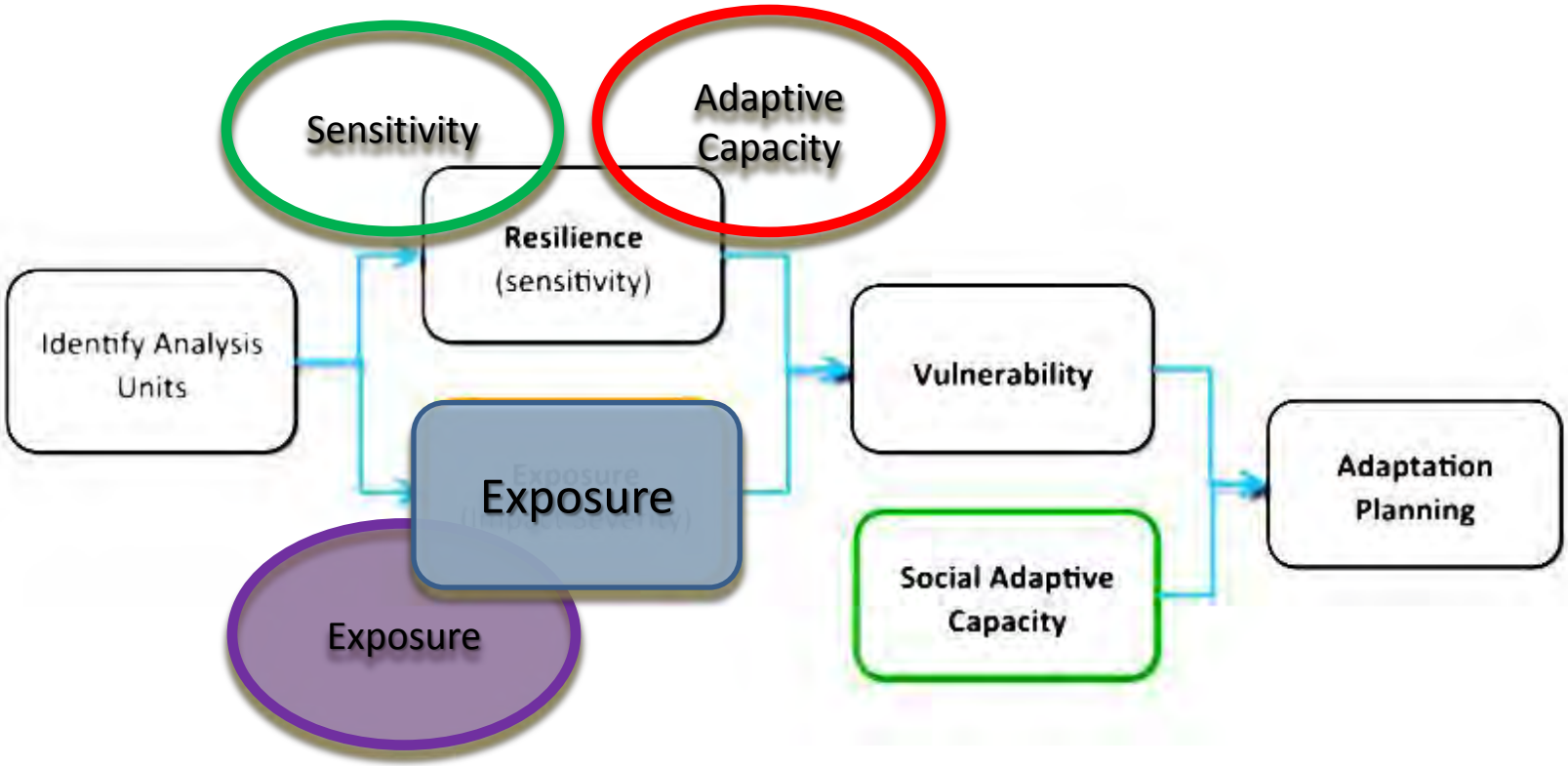
Flowing Forward: The Process

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…

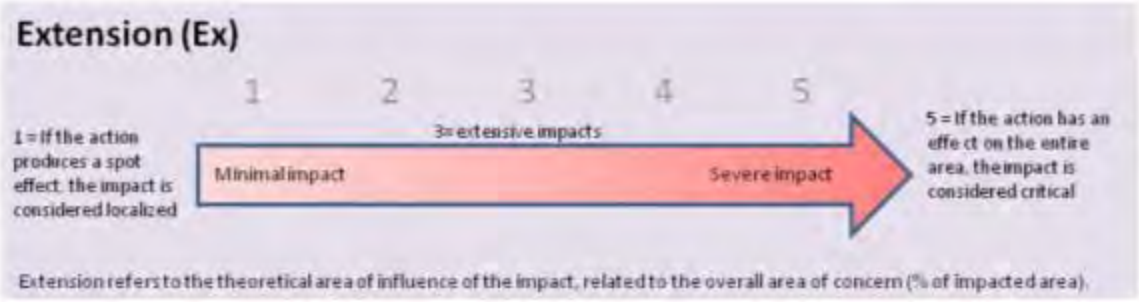


Flowing Forward: The Process

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



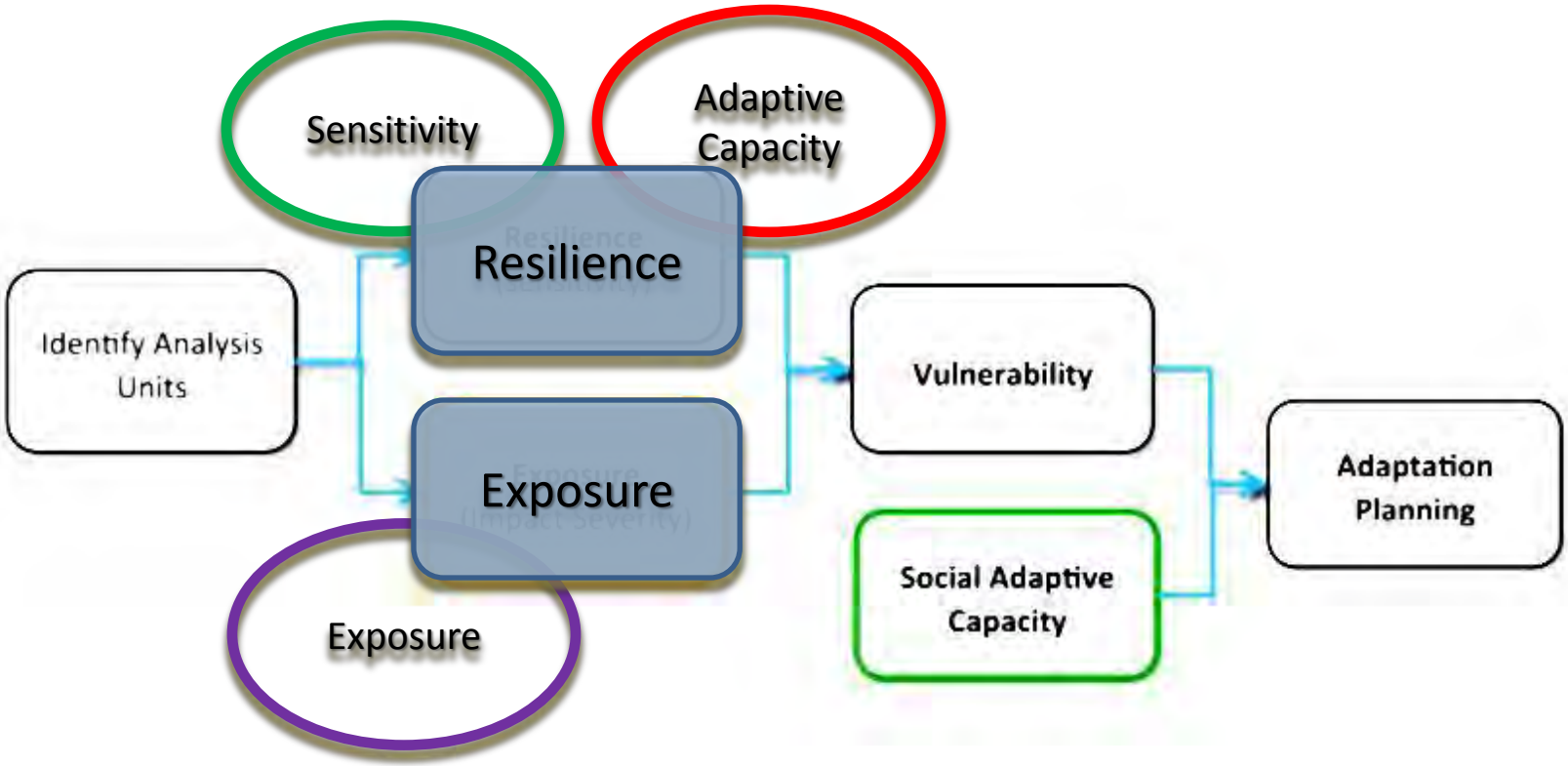
Flowing Forward: The Process

Table 5. Example Climate-Development Impact Rating, Infrastructure Breakout Group

Climate & Development Potential Impacts	Relevant Subunit	Severity		Extension		Manifestation		Avg
Increased intensity of rainfall causing increased soil erosion leading to rut formation and channeling of roads, resulting in rapid surface deterioration of roads	District Roads	Severe rainfall expected, no canals in existence to take water/ sediment away	4	There's damage but it's limited to certain places	3	Destruction and siltation immediately after rainfall; encroachment takes longer	4	**3.67**

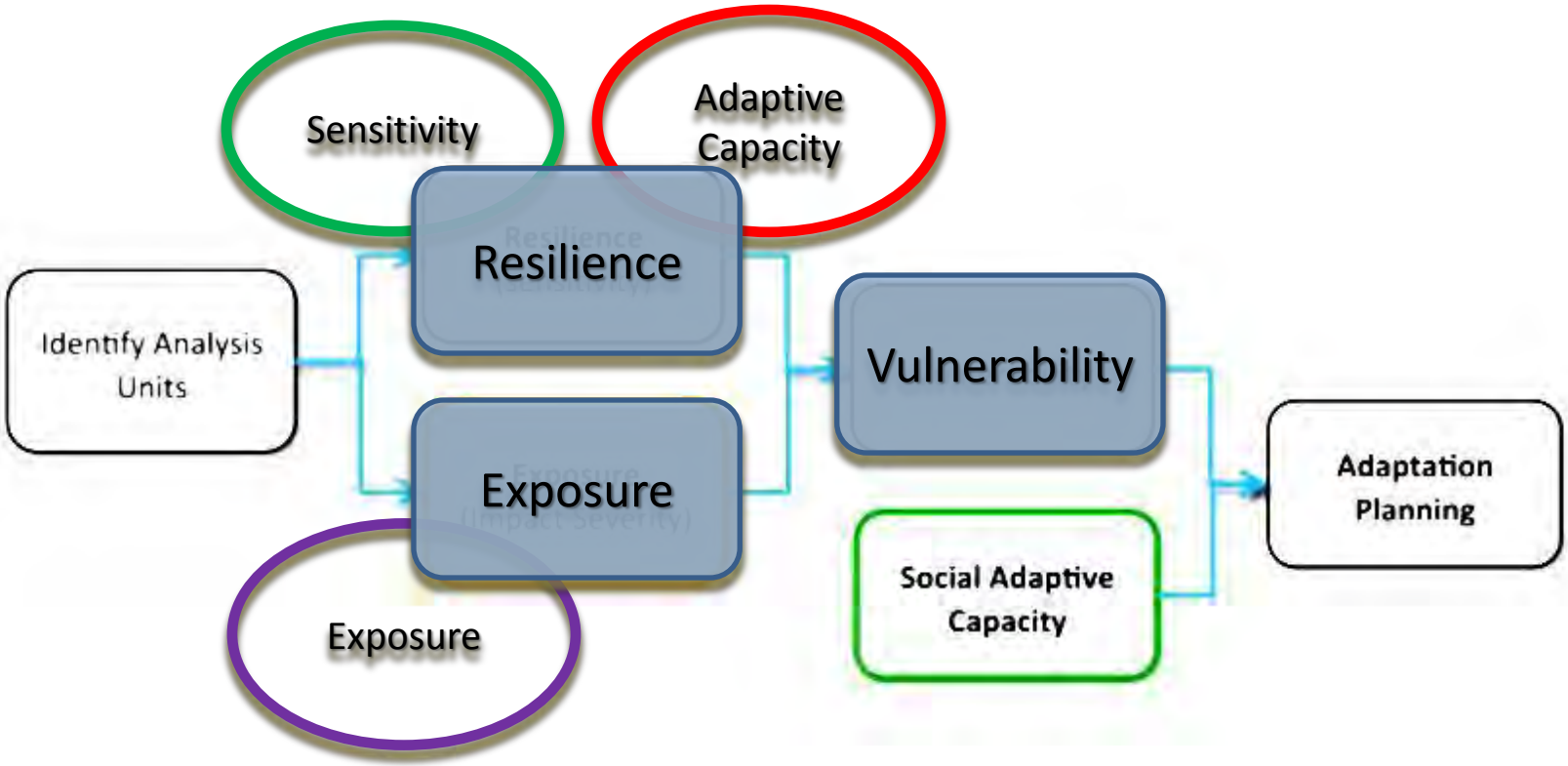
Flowing Forward: The Process

Indices of **Resilience** and **Exposure** are combined…



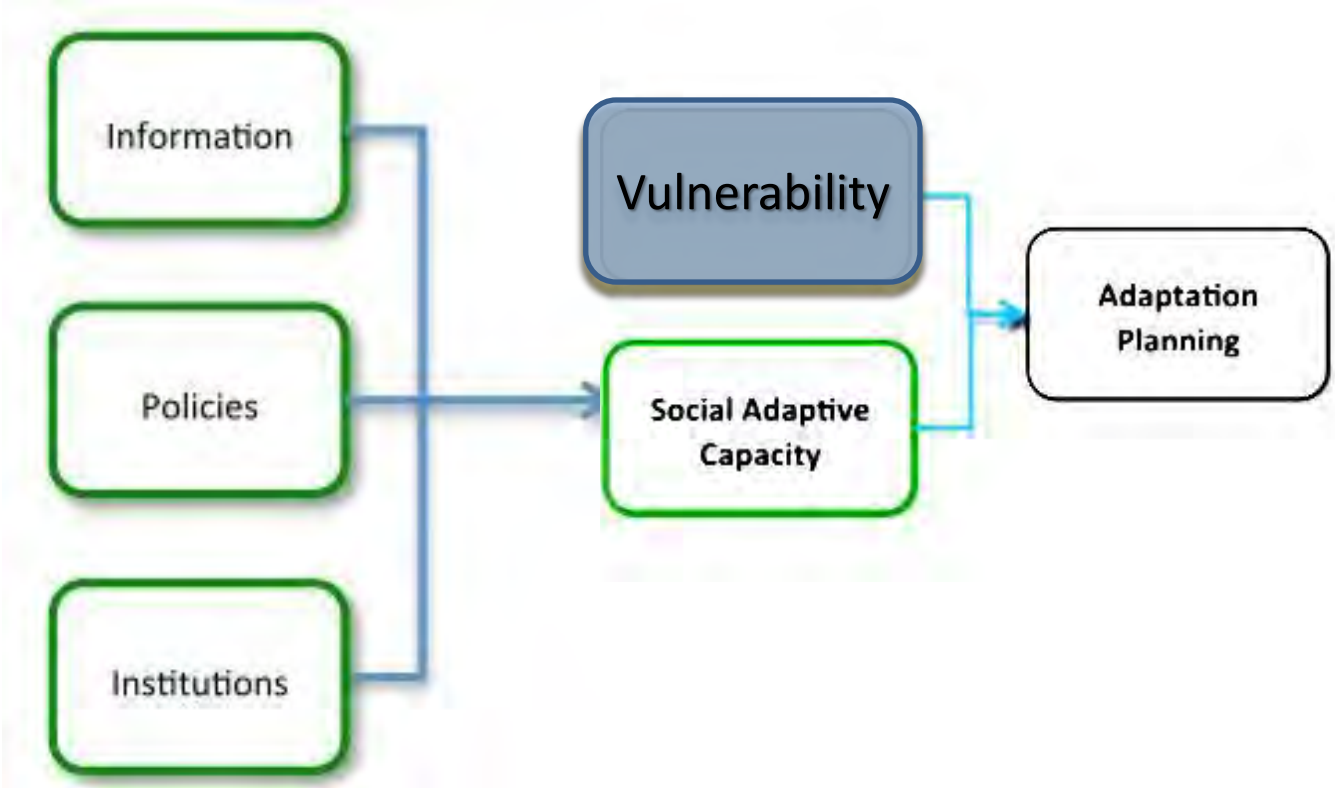
Flowing Forward: The Process

Indices of **Resilience** and **Exposure** are combined…for **Vulnerability** assessment…



Flowing Forward: The Process

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.

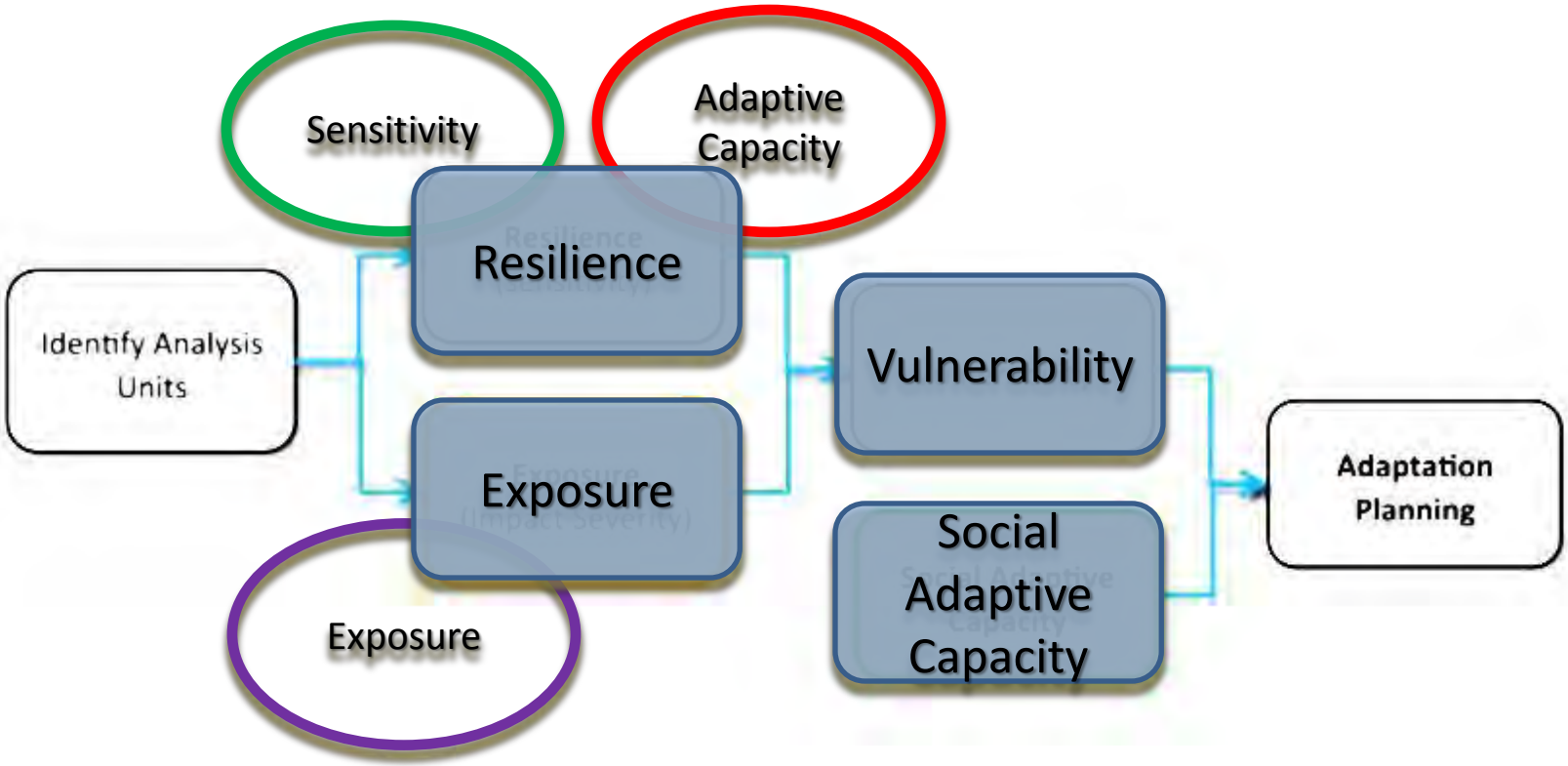
Flowing Forward: The Process

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

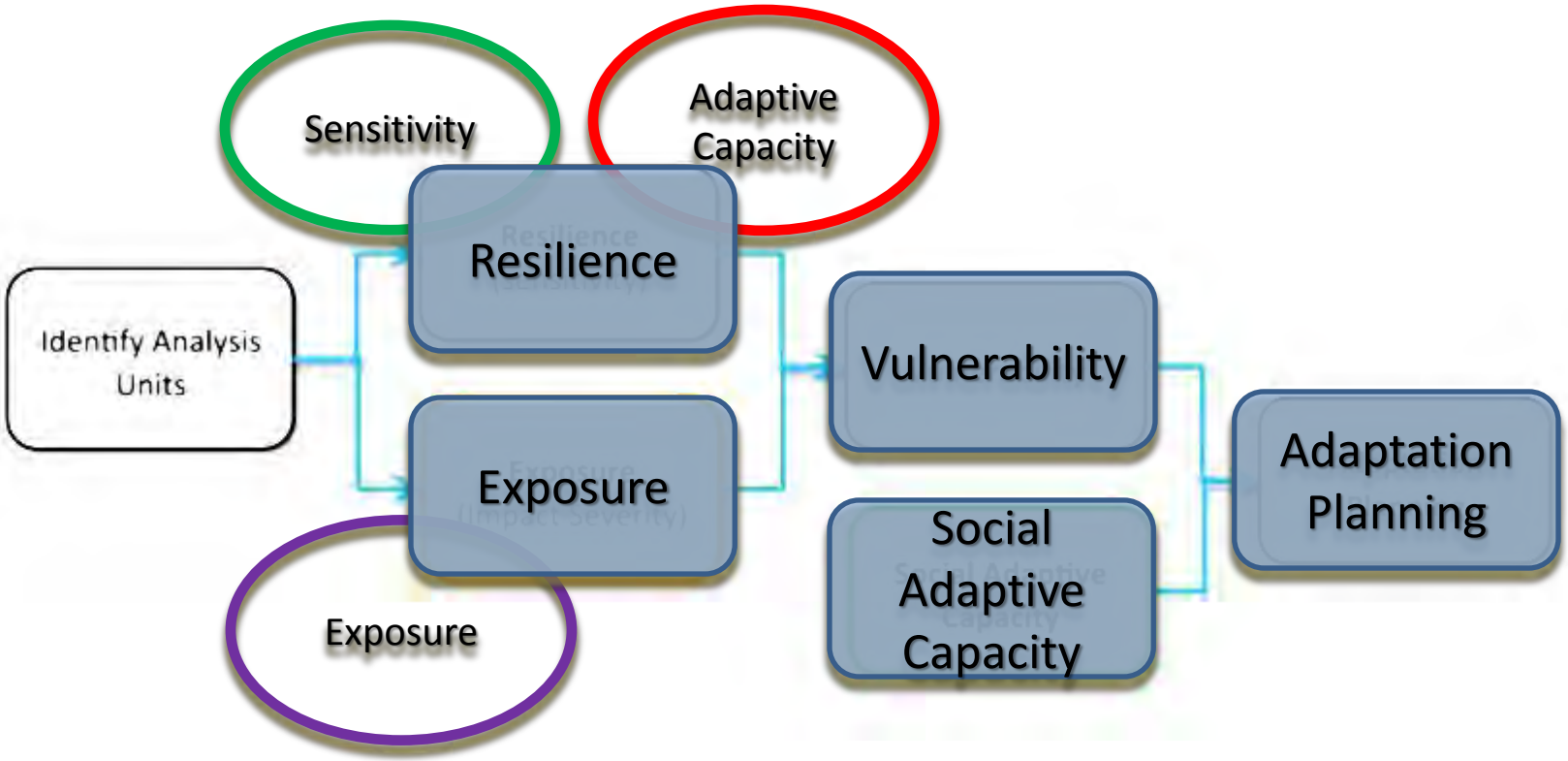
Flowing Forward: The Process

Vulnerability and **Social Adaptive Capacity** combine…



Flowing Forward: The Process

Vulnerability and **Social Adaptive Capacity** combine… for **Adaptation Planning** of high vulnerability Units and Subunits…



Flo

Adaptation planning for CHAL Subunit (Subtropical Broadleaf Forests) by workshop participant in Units/Subunits prioritized for high vulnerability

	Adaptation Intervention 1
Sub-Unit(s)/ Vulnerability:	Sub-tropical broadleaf forests (Siwalik/Terai)/ a. High immigration b. Shifting cultivation c. Geologically fragile/ ecologically young d. Dry; high forest fire incidences e. Prone to landslide, soil erosion f. High pressure on natural resources g. Importance to protect lower plain area for agriculture/water supply h. Rich in Biodiversity i. Important corridors for wildlife
Intervention:	Promote Community based forest management practice (control forest fire, regeneration promotion, plantation, conservation) 2. Promote alternate enegry program 9Biogas/Ics) 3. Forest based microenterprise
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

Ecosystems, Biodiversity, Climate and Socio-economics

"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."

Cowan, C., Epple, C. & Korn, H. 2009. Working with Nature to Tackle Climate Change. Report of the ENCA / BfN Workshop on "Developing ecosystem-based approaches to climate change – why, what and how" International Academy for Nature Conservation, Isle of Vilm, Germany