Ecosystem and Community Resilience to Climate Induced Disasters in Annapurna Region, Nepal

"A Study from Panchase Protected Forest Ecoregion"

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Shakti Gurung, PhD Scholar
Central Department of Environment Science
Tribhuvan University

Presentation Outline

- Introduction
- Conceptual Framework
- Objectives
- Materials and Methods
- Results and Discussions
- Conclusion and Recommendations

Introduction

- **Human-caused climate change is already affecting** many weather and climate extremes in every region across the globe (IPCC, 2023), adverse impact and related loss and damage to human and nature
- **Approximately 3.3 to 3.6 billion people live in contexts** that are highly vulnerable to climate change and human & ecosystem vulnerability are interdependent (IPCC, 2023)
- **Cascading hazards** are getting more prevalent in the Central Himalayas (Sharma et al., 2022), e.g: Melamchi flood (2021), Seti Flood (2005)
- Global Climate Risk Index (2021): **Nepal as the 10th most vulnerable** country to the impact of climate change,
- Climate Risk Country Profile of Nepal, ADB (2021) informs the **increasing maximum and minimum temperature,** likely to intensify the pressure on human health, livelihoods, and ecosystems,

Introduction Cont.

- Multisectoral impact of climate change (water, forest, agriculture etc.) likely to undermine the livelihood of local people and **prohibits development goals** (MoFE, 2021)
- **More than 90% of total population**: risk of death due to two or more than two types of disasters (MoHA, 2018)
- Resilience building of the ecosystems and communities is inevitable to reduce the vulnerabilities in present climate change context
- Policy interventions require **prior knowledge on relative status of resilience** of communities and ecological systems that are exposed to hazards
- There is found **research gap on community and ecosystem resilience studies**: UNDRR disaster resilience score card for cities in 2017, Seti river basin (2015), Hariyo Ban Program
- Ecosystem management is a potential ecologically focused approach towards mitigating the hazard events and reducing vulnerabilities (nature's contribution to people-NCP).

Conceptual Framework

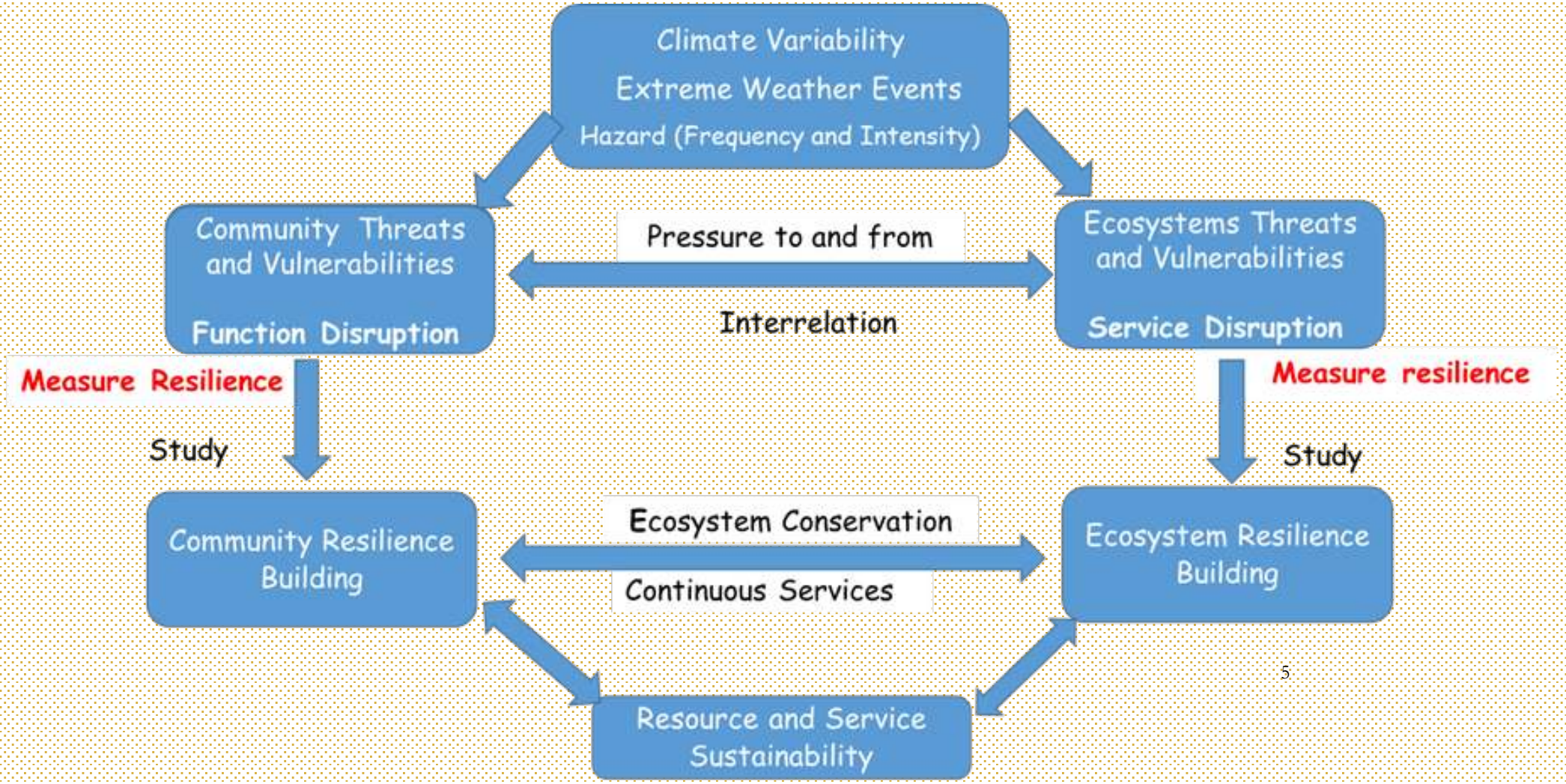


Figure 1: Conceptual Framework on Climate Induced Disasters and Resilience Building.

Socio-Ecological Production Landscapes (SEPLs)

- Human-nature longer term harmonious relationship
- Fosters well-being, maintains biodiversity and ecosystem services
- Ecosystems (forest, watersheds, agriculture land, grassland) and human settlements
- Focuses on comprehensive landscape resilience

(Gu & Subramanian, 2012)

Pic: Socio-ecological Production Landscape (Balthali Village)

Objectives

- **Assessing resilience of Panchase Protected Forest (PPF) ecosystem** studying its key components (*plant diversity, soil quality analysis and climate parameters*),
- **Studying resilience of the communities adjoining Panchase Protected Forest (PPF) Ecoregion** using indicators of resilience in Socio-Ecological Production Landscapes (SEPLs), UNU-IAS, Institute of Advanced Studies (2013),
- **Policy recommendation for evidence-based resilience planning** through identification of gaps considering specific ecological and social elements of landscape resilience in studied area,
- **Advancement of the comprehensive socio-ecological system approach for community resilience building**

Materials and Methods

A. Study Area

- Protected Forest: the juncture of Kaski, Parbat and Syangja districts (Gandaki Province)
- Area: 5,775.73 ha (DoF, 2012)
- Biological Corridor in Chitwan Annapurna Landscape (CHAL)
- Elevation: 900m-2517m
- Subtropical and Temperate climatic zone
- Moderate to steep terrain topographically (30° to 90°)
- Rich biodiversity, 589 plant species, (113 species of Orchids, 2 species endemic to Nepal), 107 species of herbs, 56 species of mushroom, 98 ferns

Pic: Panchase Protected Forest Region

Materials and Methods

Study Area Cont….

Protected forest is divided into two zones:

- Inner **Core area, the Protected Zone**
- Forests part adjoining settlements is designated as **Fringe Area, the Intensive Management Zone** (Community Forest)

Human settlements outer zone designated **as Impact Area** (nine former VDCs from three districts)

- **Landslides and soil erosion:** major hazards of the PPF region
- 6,799 HHs (3 districts)

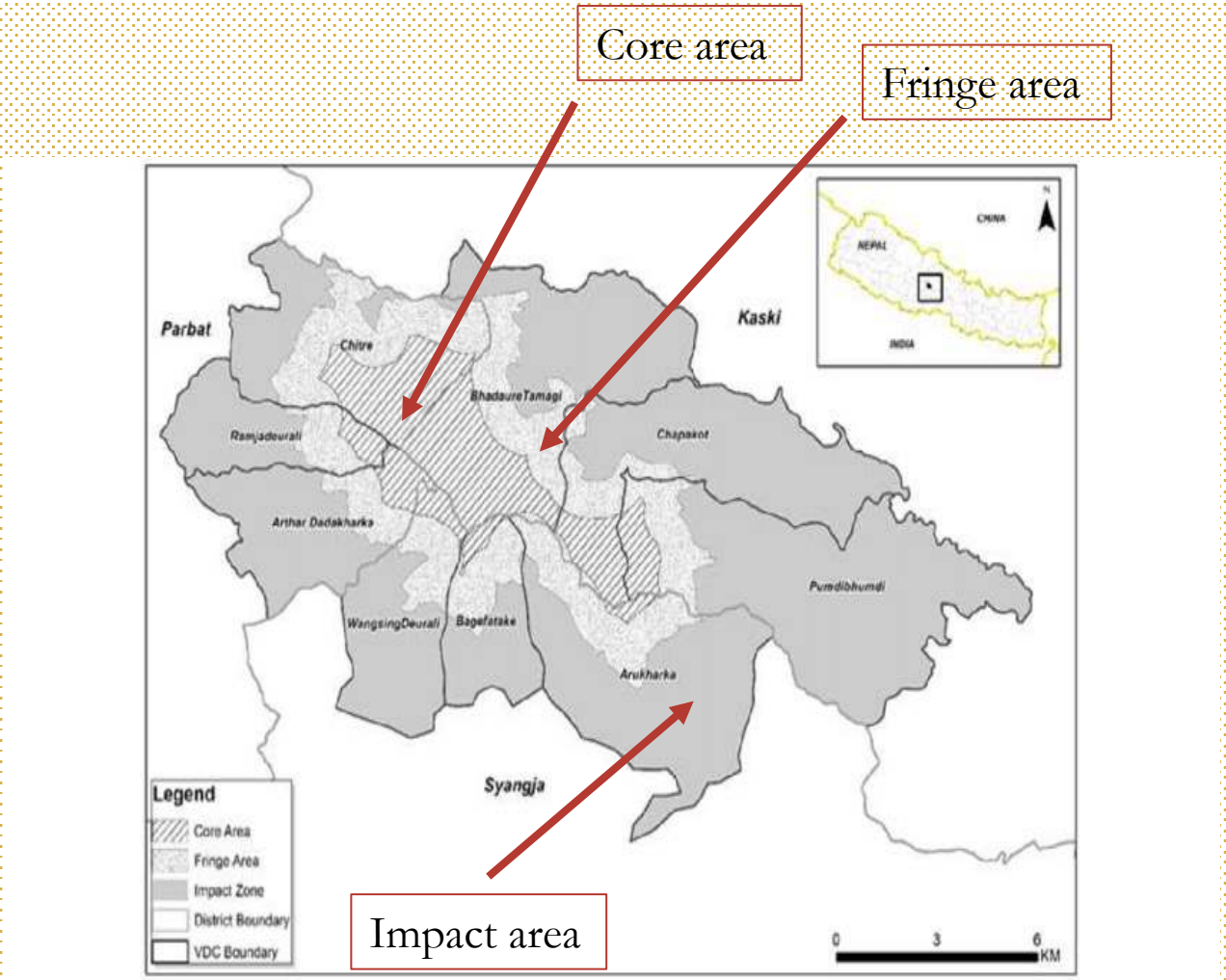


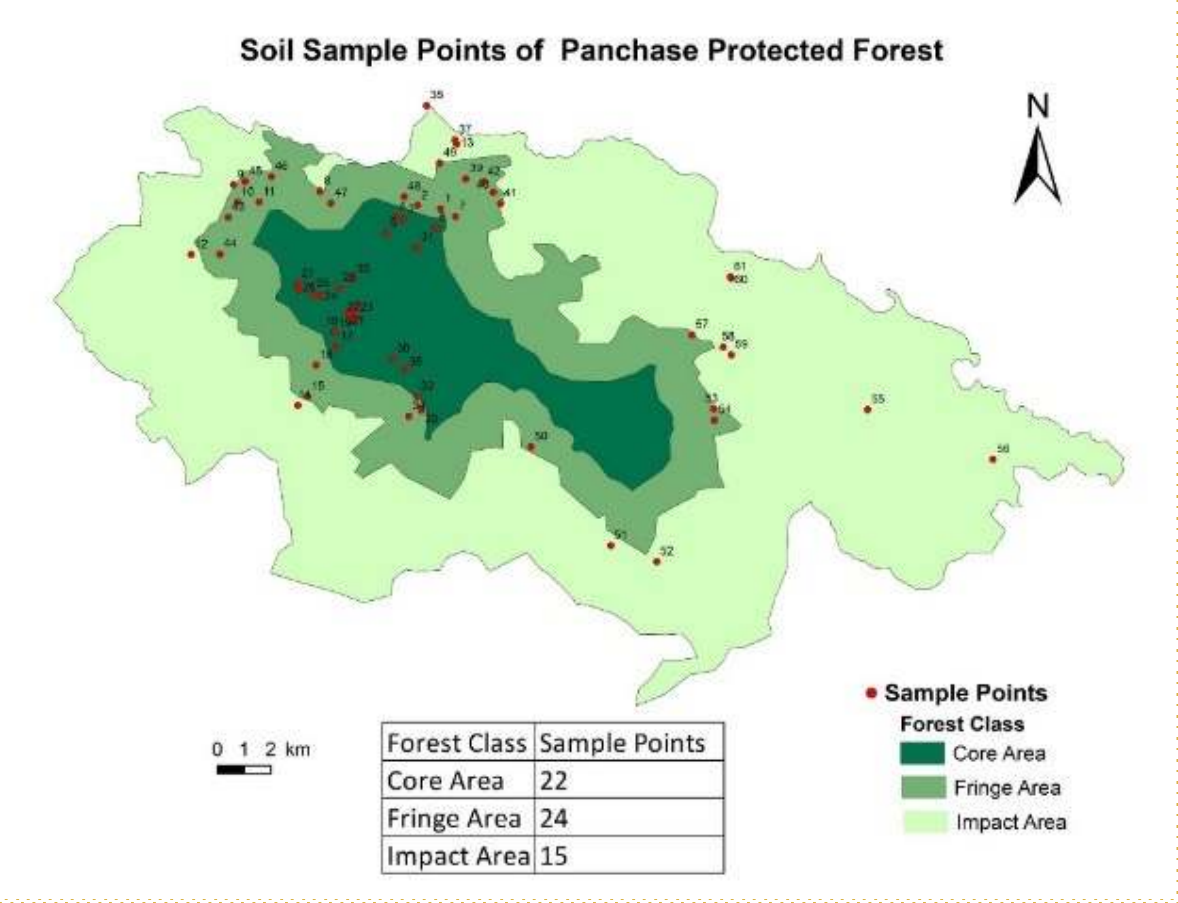
Fig3: Panchase Protected Forest boundary and adjoining villages

Materials and Methods

B. Indicators and Data Sources

i. Ecosystem Resilience

- Soil Quality Rating: physiochemical parameters (Soil sampling and Analysis)
- Plant diversity (literature review and field observation)
- Rainfall (IMERG GPM and secondary sources)



Forest Class	Sample Points
Core Area	22
Fringe Area	24
Impact Area	15

Figure 2: Soil sample collection points in three areas

Materials and Methods

Taking plant diversity as an indicator of resilience to climate stressors

- **Diversity is strength:** species with different hydraulic traits enhance resilience to drought (Anderegg et al., 2018), paper published in **Nature (high impact factor journal)**
- Tree diversity with deep root system with grasses with intense fine root system provides **highest hill slope and riverbank stability** (Hairiah et al., 2020).
- The understory species richness can **mitigate severity of forest fire** (Richter et al., 2019).
- Higher tree diversity in forest help **mitigating the defoliation in drought condition** (Silva et al., 2018).
- The monoculture stand with single tree species may have extremely low or high slope stability because of dominance of the species suited or unsuited for the particular location or landscape (Kobayashi & Mori, 2017).
- Plant biodiversity significantly **reduces the fluvial erosion by 23% in comparison to monoculture stands** (Allen et al., 2016)
- More than 30 published literatures reviewed

Materials and Methods

ii. Community Resilience (Socio-Ecological Landscape)

Indicators of Resilience in Socio-Ecological Production Landscapes (UNU-IAS, 2013)
Ecological and Social Indicators, 20 indicator questions
(5-point scale scoring and trend analysis)

- Ecosystem Protection and the Maintenance of Biodiversity
- Agricultural Biodiversity (ABD)
- Knowledge, Learning and Innovation
- Social Equity and Infrastructure

3 Socio-ecological production landscapes (Panchase Region)

- Bhadaure/Tamagi (Kaski)
- Arther Dandakharka (Parbat)
- Arukharka (Syangja)

KII, Field Observations, Secondary sources

Results and Discussions (Ecosystem)

Core Area

- SQR (0.80): Good
- Organic Carbon (5.34%)
- Bulk Density (0.76gm/cm^3)
- N (0.21%)
- Divers forest
- Low anthropogenic disturbances
- Tree species *Michaelia champaca* in danger of extinction (New Era, 2000 & MDO, 2005) and field observation

Fringe Area

- SQR (0.78): Fare
- Organic carbon (4.46%)
- Bulk Density (0.78gm/cm^3)
- N (0.17%)
- Diverse forest
- Interference by human and animals (rural road constructions, open grazing, fodder, fuelwoods)

Impact Area

- SQR (0.71): Fare
- Organic Carbon (3.53%)
- Bulk density (0.86 gm/cm^3)
- N(0.11%)
- Plantation forests are monoculture stands
- High human interference in daily basis

Soil Quality Analysis (pH, Texture, Organic Carbon, NPK) basic soil parameters (NARC)

SQR = [(a*RSTC) + (b*RpH) + (c*ROM) + (d*RNPK)] (Bajracharya et al., 2006)

($P<0.05$), one way ANNOVA)

Results and Discussions

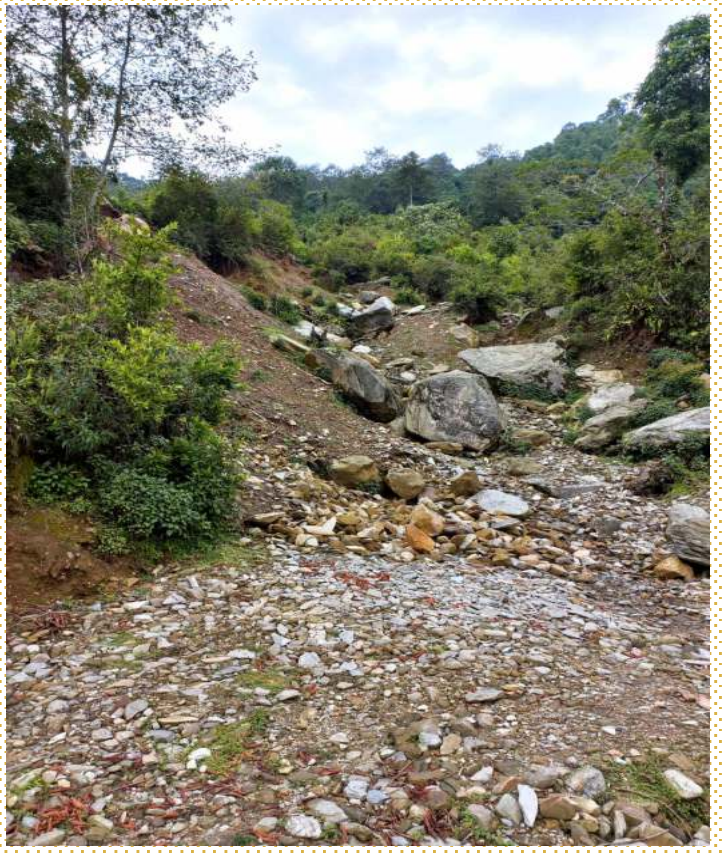
Temperature and Precipitation

- 30 yrs. Precipitation trend (1981-2011) reveals increasing max and min average temperature by 0.81°c and 0.2°c, whereas winter rainfall has decreased from 30mm to 17mm per day, and total rainfall days have decreased from 135 to 120 days (Sharma et al., 2013).
- The rainfall pattern (1981-2021) retrieved from NASA.gov reveals average rainfall approx. 2500mm/yr. (validation is difficult as no rain gauge stations in the area).
- Panchase Mountian Ecological Region does not show any discernable trends in precipitation except some delay in both onset and withdrawal of summer monsoons by a few days (Dixit, A. et al 2015; Gautam & Regmi, 2013).
- Local people feeling erratic rainfall patterns, dry winter and late monsoon, and feeling more hotter days in summer (**Orange cultivation started in Kaule village, Arther).**

Results and Discussions

Slope failure near streams

Landslides along road sides



- Steep terrain (30°-90°), significant rainfall (average precipitation above 2500mm/yr., increasing temperature, erratic rainfall, haphazard rural road construction
- Land receiving rainfall greater than 4,000 mm, land with an elevation range from 1000m-1500m, slopes steeper than 30°, south facing part, near the road, near streams : **greater influence of landslide hazard** (Budha et al., 2020)

Results and Discussion (community resilience scoring)

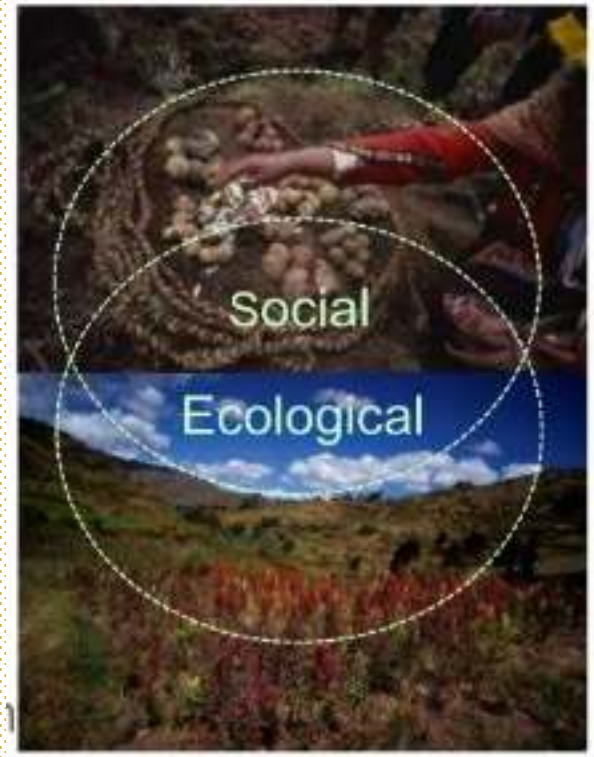
Bhadaure/Tamagi	Arther Dandakharka	Arukharka	Recommended strategies
Element 1: Ecosystem Protection and Maintenance of Biodiversity in the Landscapes (4)			
16	**14**	**15**	Protected forest management, community forest, diversity in land use (ecosystem, grassland, cultivated land, gardens etc.),
Element 2: Agricultural Biodiversity (2)			
8	**7**	**7**	Crop diversification, drip irrigation, agriculture training, sensitization
Element 3: Knowledge, Learning and Innovation (8)			
20	**14**	**14**	Biodiversity information centers, community seed centers, documentations (registers)
Element 4: Social Equity, Infrastructure and Livelihoods (6)			
31	**31**	**30**	Biodiversity based livelihoods, eco-tourism, micro-enterprises

Conclusions and Recommendations

- Significantly good quality soil in core area and species diversity facilitates resilience to climate stressors and provision of various ecosystem services to the communities and environmental regulation
- Continue protection measures for maintaining biodiversity and soil quality, not allowing engineered construction works, eco-tourism management
- The fringe area of the protected forest designated as intensive management zone, soil quality, organic carbon and nitrogen value indicates the increasing threat to soil fertility loss, it may be due to increasing human interference and climatic factors
- Special attention should be given to haphazard rural road constructions, slope failures nearby roads needs mitigation measures
- Forest of impact area with higher bulk density, lower-medium nitrogen and low organic carbon reveals decreasing soil fertility, possibility of biodiversity loss
- Species diversity in plantation forest improves soil bulk density and management of organic matter in soil is important

Conclusions and Recommendations

- The consideration of socio-ecological production landscape (SEPLs) resilience approach in assessing the resilience of studied communities identifies the interrelationship of human and ecological systems in the landscape level and facilitates sustainable ecosystem services and biodiversity conservation
- Resilience of communities must be seen in the perspective of its social, ecological and cultural aspects, and indicator based assessment identifies gaps and supports evidence based planning for building resilience of communities and ecological system facilitating the whole landscape level resilience
- In SEPLs resilience approach the studied communities themselves identifies their relative resilience and develop resilience building strategies to adopt



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Thankyou for listening...