Himalayas Forests, ecosystem services and people

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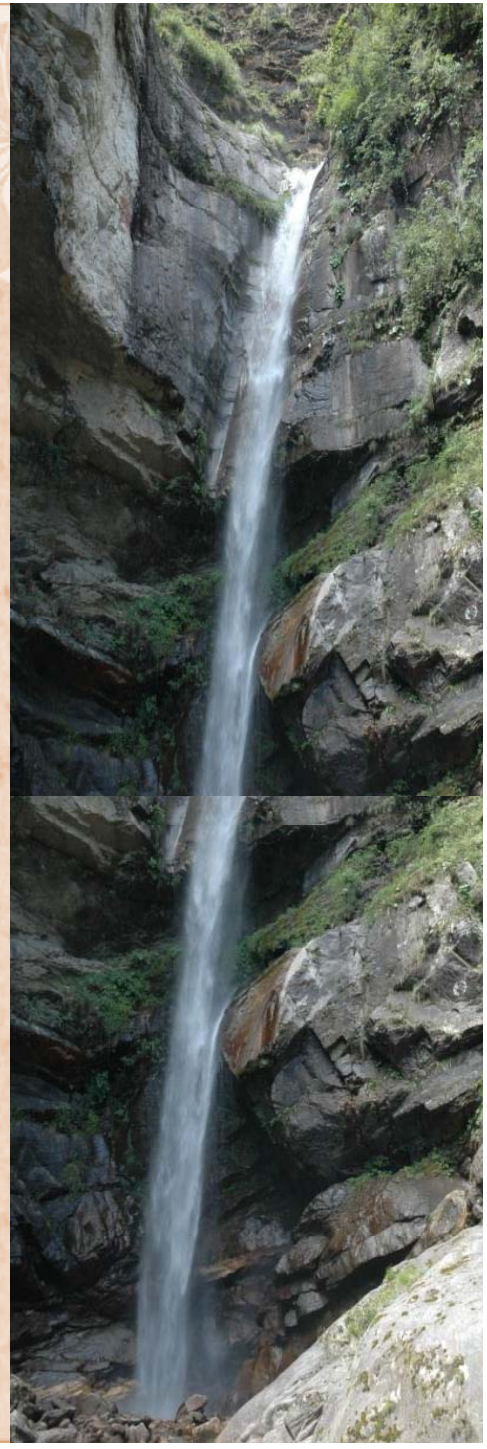


The Indian Himalayas

- Cover approximately 5,91,000 km^2 or 18% of India's land
- Source of 9 major river systems
- Lie at junction of three Biogeographic realms *viz*. Palaearctic, Afro-Tropical and Indo-Malayan, 1/3 forest cover of India
- Biodiversity hotspots (26% endemic)
- Asylum value for species migrating under the influence of climate change
- Spectacular and diverse landscape with rich cultural heritage and biodiversity
- Provide important ecosystem services for human well being

Lesser Himalayan Sal forest

Sub-tropical Chir Pine forest

Temperate: < 2800m
Sub alpine: 2800m-3800m
Alpine scrub land: 3800m-4500m
Alpine meadows: > 4500m

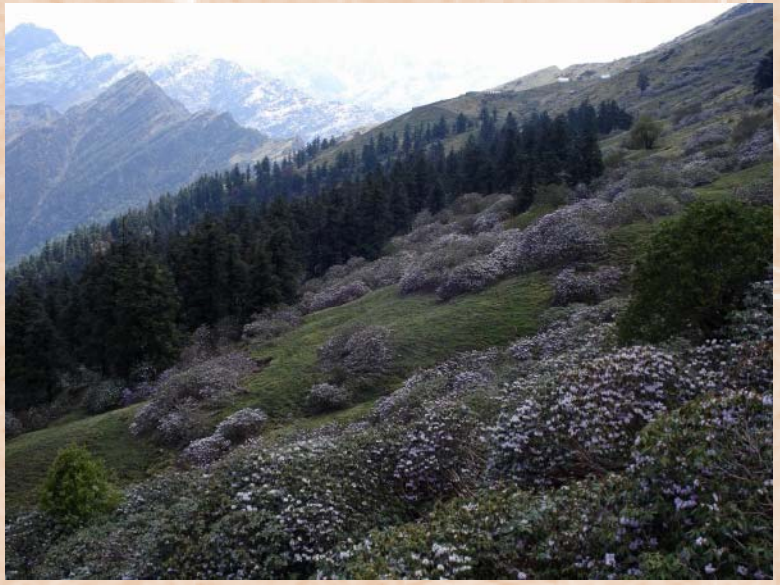
Warm temperate broadleaved forest-
***Quercus leucotrichophora* mixed**

Wide altitudinal range (1700 -7817 m) adds to the ecosystem and species level diversity within NDBR

Sub-alpine forest – *Quercus semecarpifolia- Abies pindrow*

Sub-alpine forest - *Pinus wallichiana*

Subalpine treeline Ecotone - *Abies spectabilis*



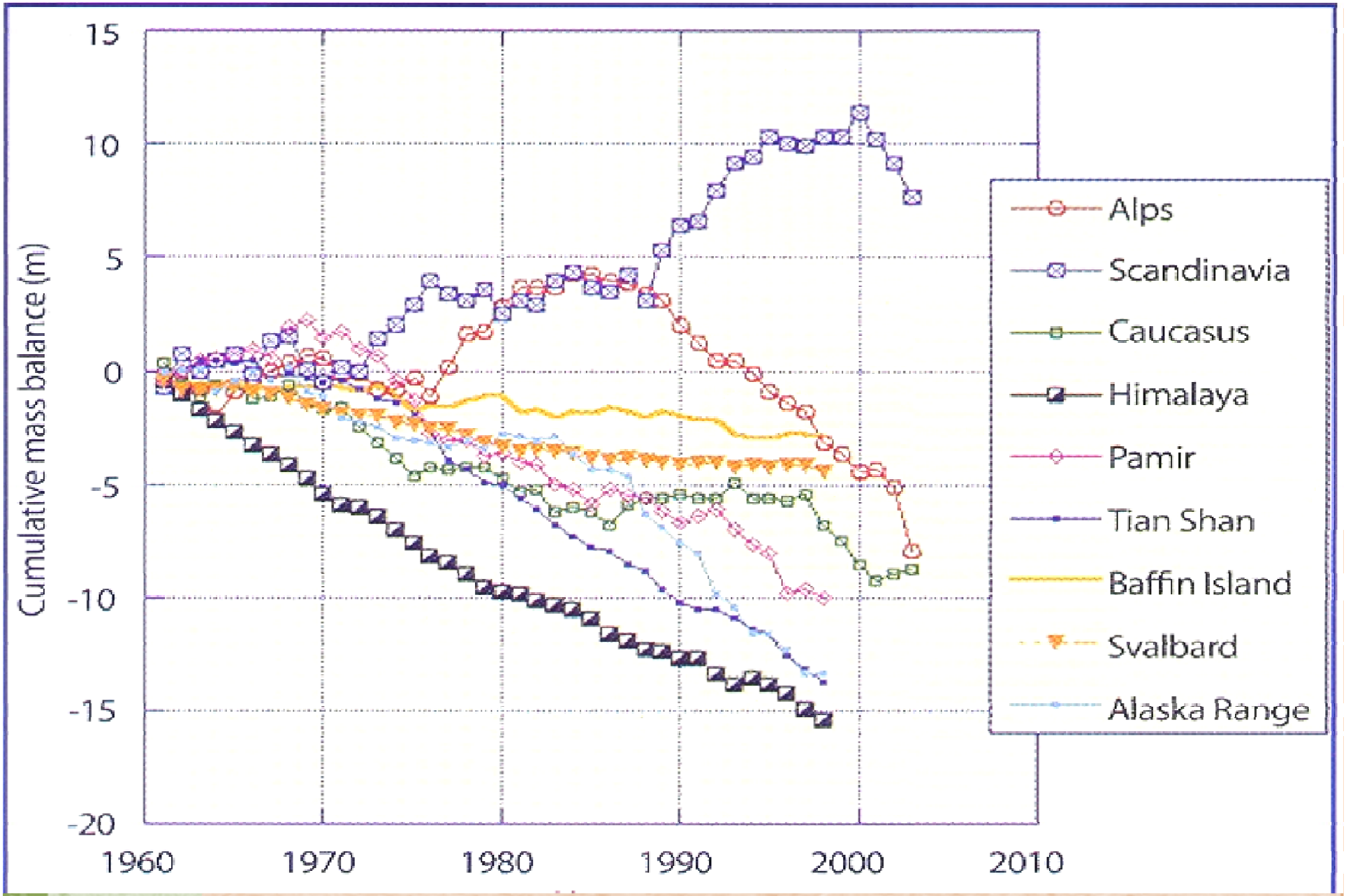
Krummholtz - *Rhododendron campanulatum*

Alpine herbaceous meadow

Alpine dry scrub – Juniper spp.

Climate change and development impacts in Himalayas

- Global warming and climate change is impacting IHR and the impact of CC occurs at a much higher rate than the rest of the Asia
- Loss of natural ecosystems due to development projects, urbanization, forest dependence…
- Extreme rainfalls as well as drought events are likely to increase
- CC a risk to the traditional crop-livestock mixed farming in the Himalaya, that is highly dependent on forests for fodder and manure, with a predicted large scale shifting in range and composition of forest biomes,
- Increase in incidences of pests and insects at high altitudes



Rapid retreat of greater Himalayan glaciers in comparison to the global average (Dyurgerov and Meier 2005

Key challenges…

- Loss of biodiversity of Medicinal and aromatic plants which provide the traditional and alternative system of medicine
- Increase in temp. will reduce the amount of snowfall, reducing the water flow in snow-fed rivers during summer months
- Uttarakhand, rainfed re-charge decreased 25% – 75% past 50 yrs (Report of the Task Force, 2010), drying up of springs, abandoned villages, hardship for women
- During monsoons, excessive rainfall leading to more intense flooding and landslides affect agriculture production and livelihoods of both mountain communities as well 407 m people in the Gangetic Basin

Key challenges…

- Traditional crops replaced by cash crops leading to loss agro biodiversity and increasing vulnerability to climatic and market changes
- LUC lead to reduction of high altitude pastoral lands, reducing capacity to produce food on marginal lands
- All four dimensions of food security are predicted to be affected by climate change: food availability, food accessibility, food utilization and food systems stability

Key challenges…

- The main source of energy for local people is biomass, mostly provided by fuel wood, sourced from forests
- Shortage of fuel wood and the high price of imported conventional fuels result in high energy vulnerability
- Poor communities more vulnerable, in particular those concentrated in high-risk areas as they have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies
- Threat to ecological security




Key challenges…

- Studies from Himalayas indicate that about 30% of snow leopard habitat may be lost due to a shifting treeline and consequent shrinking of the alpine zone (Forrest et al. 2012).
- Birds represent an important indicator group for learning about the effects of climate change – particularly in regard to the effects of climate change on tropical ecosystems.

Tibetan wolf

Himalayan monal

Species	Status	Reason for extinction and threats to existence	Reference
Pink-headed Duck (Rhodonessa caryophyllacea)	1935, extinct	Habitat loss and hunting	Ali, 1960; Bucknill, 1924
Himalayan Quail (Ophrysia superciliosa)	1876, extinct 2003 a recent set of possible sightings around Nainital	Hunting	Fuller et al., 2000
Siberian Crane (Grus leucogeranus)	Critically Endangered	Habitat loss, hunting, and lack of ‘‘conservation attention’’	BLI, 2000

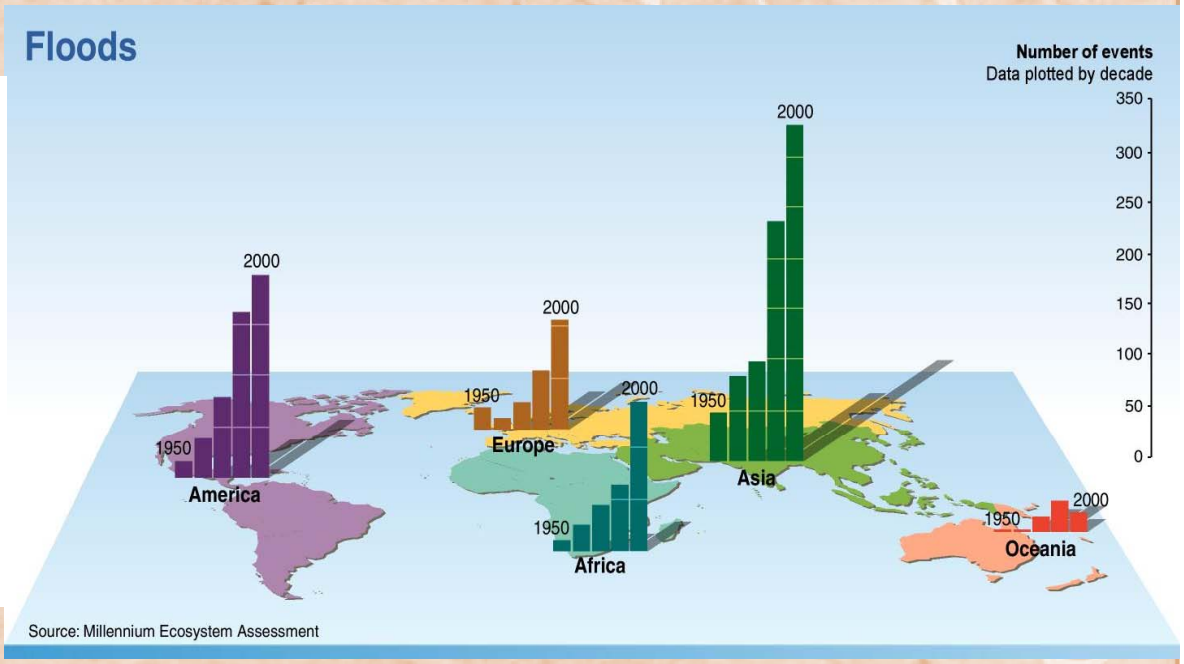
Pink-headed Duck

Himalayan Quail

Cinereous Vulture

Mammals

Animal	IUCN category	WPA, India
Urial	VU	I
Himalayan muskdeer	EN	I
Tibetan antelope	EN	I
Tibetan gazelle	NT	I
Markhor	EN	I
Mouflon	VU	
Kashmir muskdeer	EN	
Kashmir stag	LC	I
Kiang	LC	I
Himalayan musk deer	EN	I
Himalayan tahr	NT	I
Himalayan ibex	LC	I



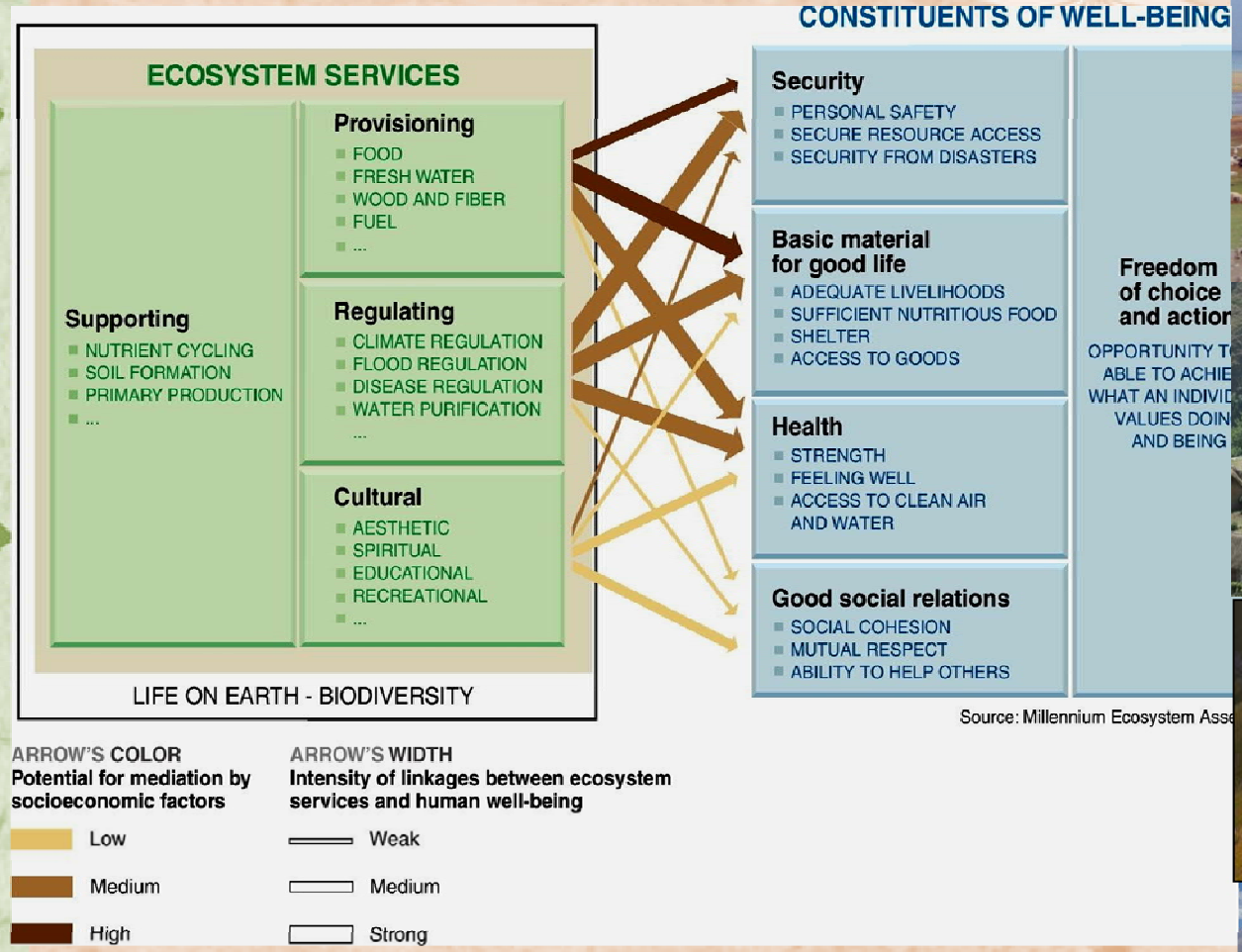
60% of Ecosystem Services are Degraded which *"…contributed to a significant rise in the number of floods and major wild fires on all continents since the 1940s". Economic losses from* climate disasters have increased ten-fold in 50 years

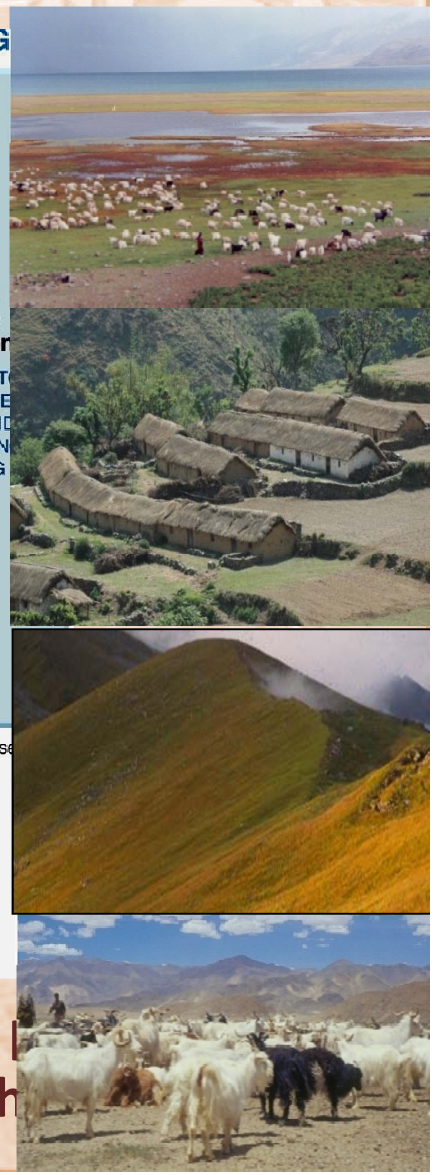
MEA 2005

Ecosystem functions and ecosystem services

- Ecosystem services are those ecosystem functions that are perceived to support human welfare
- The type, quality and quantity of services provided by an ecosystem are affected by the resource use decisions of individuals and communities

Ecosystem services and human well being





Degradation of ecosystem services often causes significant l well-being and represents a loss of a natural asset or wealth

Enhanced

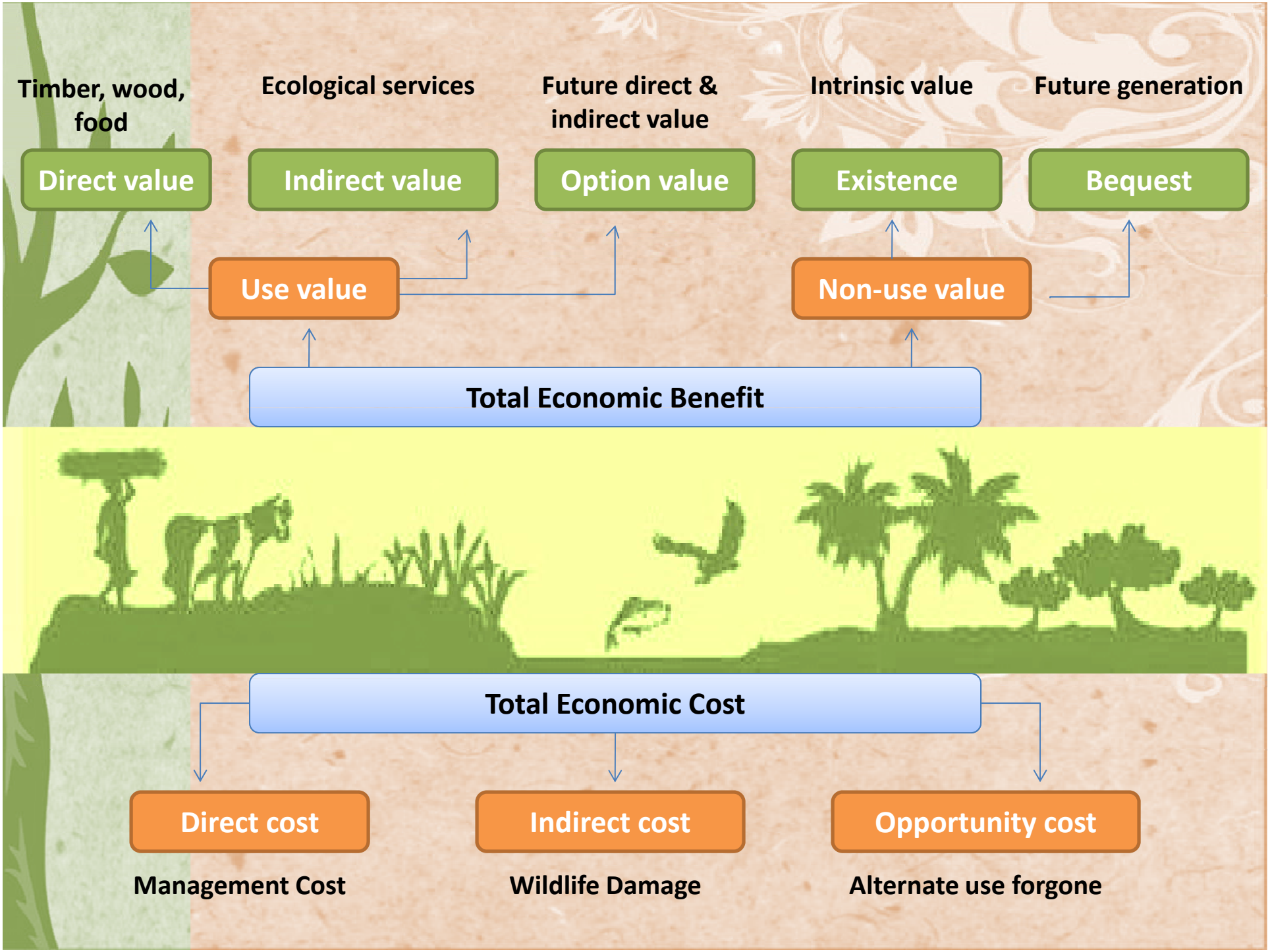
- Crops
- Livestock
- Aquaculture
- Carbon sequestration

Degraded

- Capture fisheries
- Wild foods
- Wood fuel
- Genetic resources
- Biochemicals
- Fresh Water
- Air quality regulation
- Regional & local climate regulation
- Erosion regulation
- Water purification
- Pest regulation
- Pollination
- Natural Hazard regulation
- Spiritual & religious
- Aesthetic values

Mixed

- Timber
- Fiber
- Water regulation
- Disease regulation
- Recreation & ecotourism


Timber, wood, food
Ecological services
Future direct & indirect value
Intrinsic value
Future generation
Direct value
Indirect value
Option value
Existence
Bequest
Use value
Non-use value
Total Economic Benefit
Total Economic Cost
Direct cost
Indirect cost
Opportunity cost
Management Cost
Wildlife Damage
Alternate use forgone

Causes of loss of natural ecosystems

Information failures

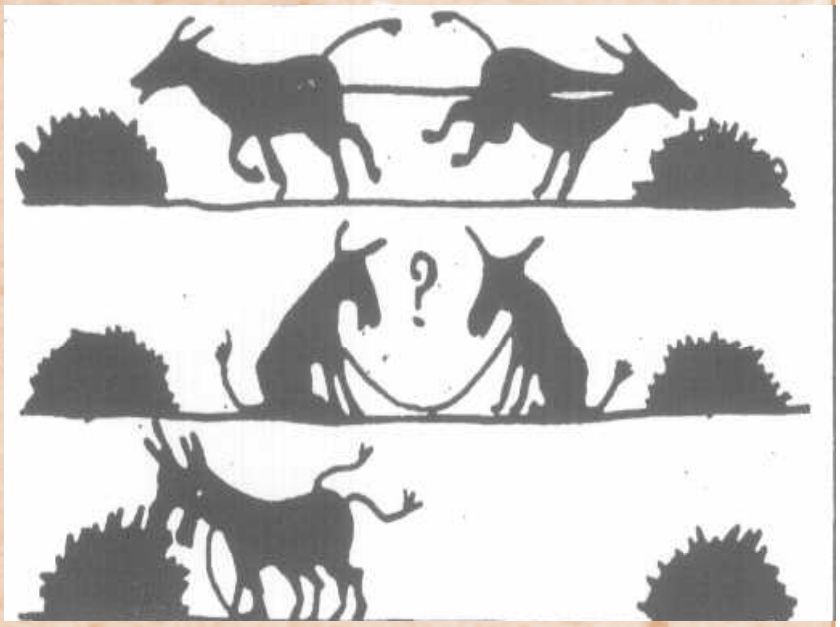
Lack of awareness among people about the values of conserved ecosystems

Market failures

The failure of markets to reflect the full or true cost of goods or services provided by conserved ecosystems

Intervention failures

Absence of appropriate integrated resource management policies and inter-sectoral policy inconsistencies



Addressing the failures

Information failure	Accounting of ecosystem services and understanding how and at what rates these are produced
Market failure	Motivate payments for these service Focusing on conservation of ecosystem services by involving local communities. Aligning conservation of ecosystem services with local economic activity
Intervention failure	Involving multi-disciplinary and trans disciplinary teams working closely Establishing close linkages between economic sectors and conservation agencies

Not being vulnerable means that people ...

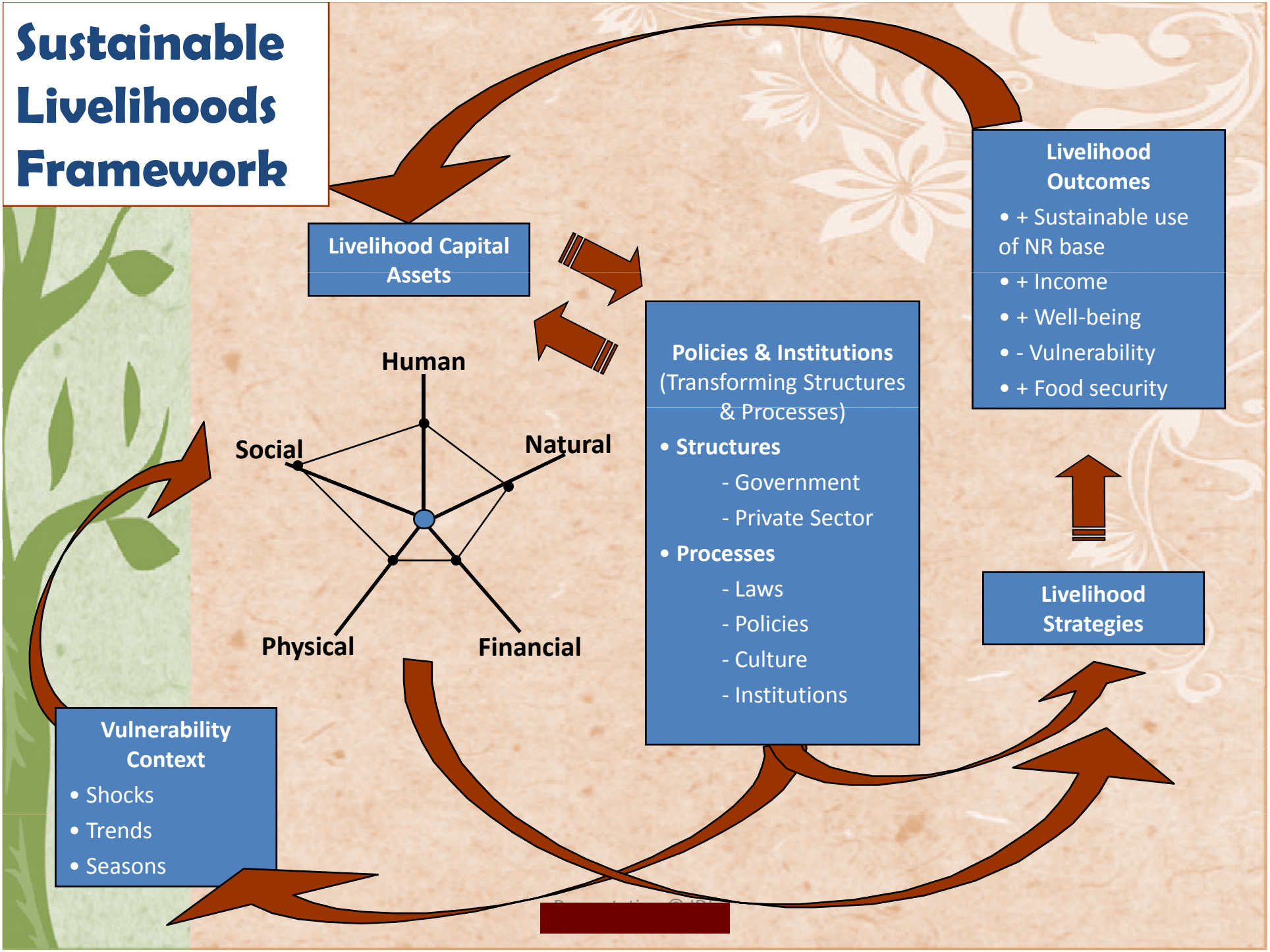
- can sustain the capabilities, assets, and activities required for a means of living,
- have the ability to cope with stresses and shocks,
- and can maintain and enhance those capabilities and assets
- without undermining the natural resource base

These are the characteristics of a

‘Livelihood’

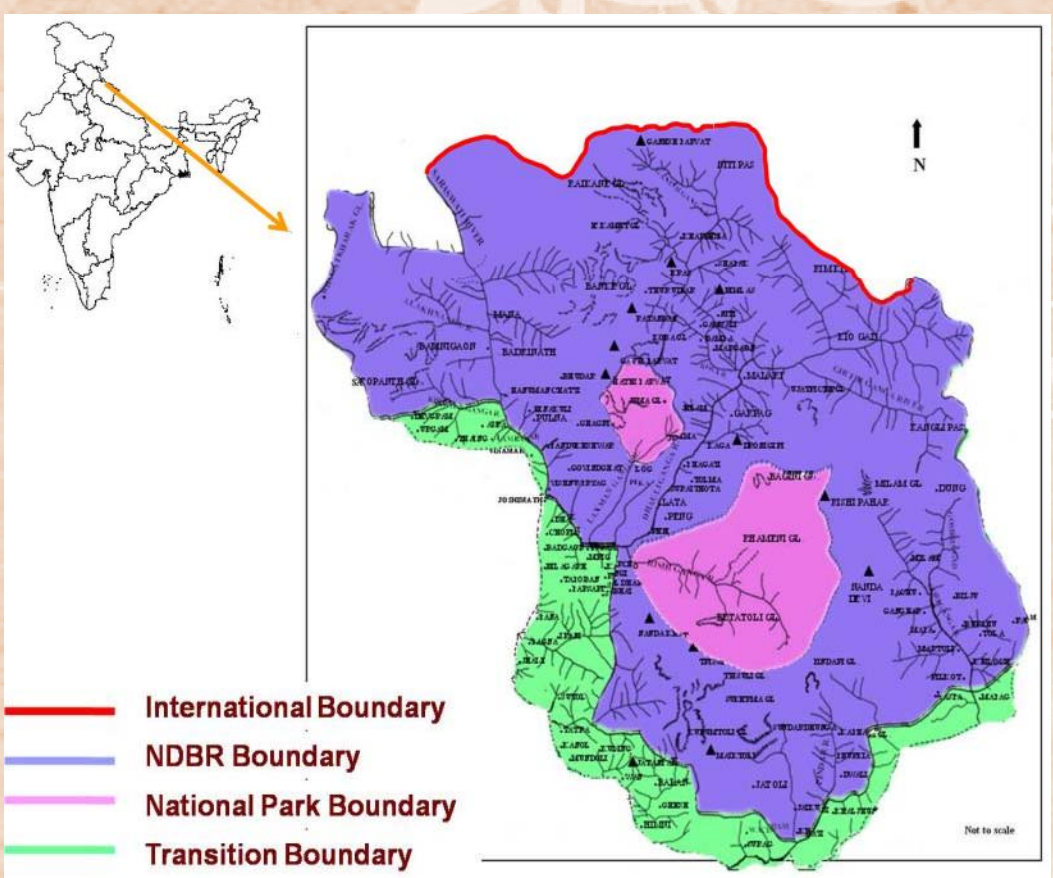
(Chambers & Conway, 1992)

Sustainable Livelihoods Framework



Nanda Devi Biosphere Reserve (NDBR)

Total area	5860.69 km^2
No. of villages in Transition zone	33
No. of villages in Buffer zone	47



FUNCTIONAL OUTPUTS OF DIFFERENT LU LC

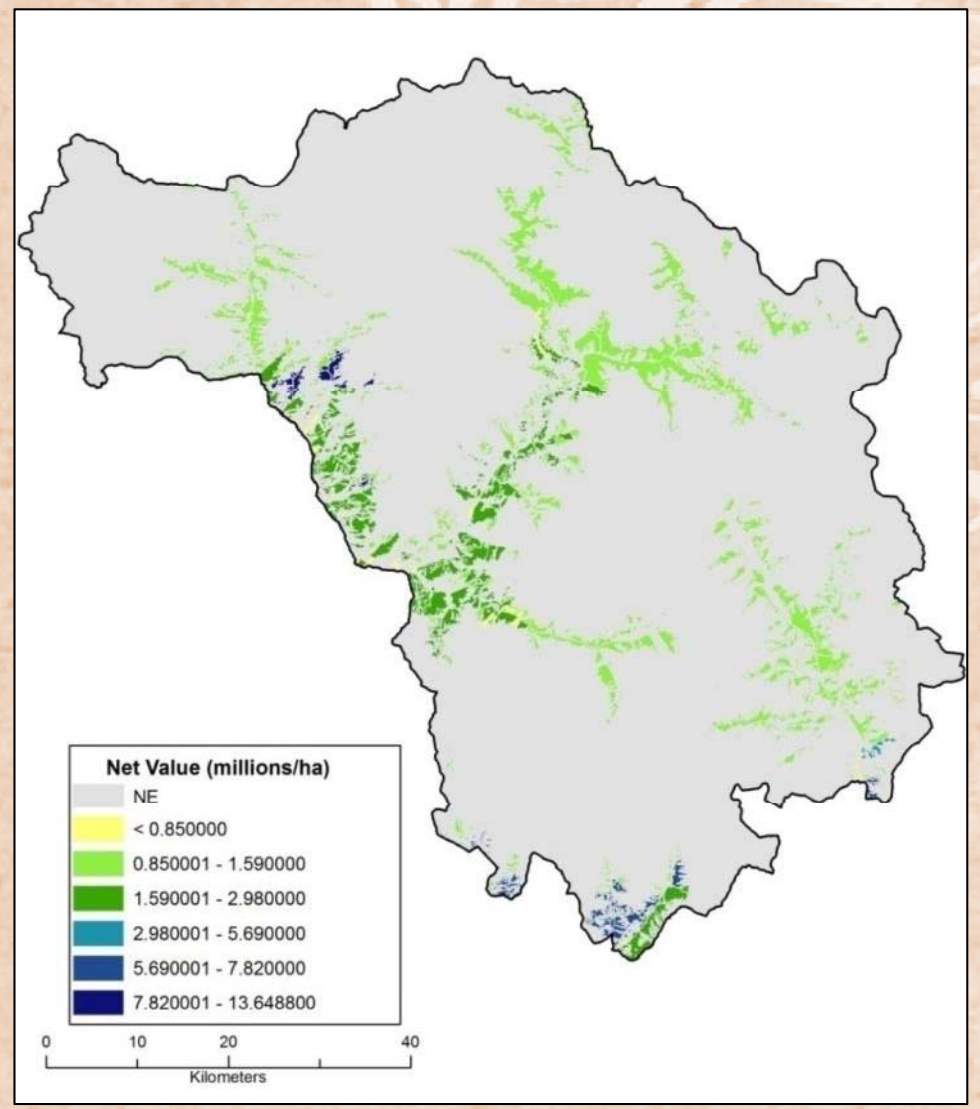
LU LC	CO2 (t/ha)	NPK (t/ha)	Soil moisture (HM)	Water yield (m^3/day)
Conifer mixed	4683.2±566.7	34.9 ± 12.1	17.0±5.1	230.2±50.8
Oak pine	3279.1±434.6	NE	13.6±4.3	109.5±24.6
Oak	2624.9±450.8	21.4 ± 9.5	19.6±7.8	44.4±11.5
Blue pine	1351.6±345.7	31.4 ±8.9	12.6±2.9	NE
Birch	1276.1±237.6	19.1 ± 6.6	8.2±1.5	NE
Deodar	1152.4±234.8	34.3 ± 11.7	13.8±3.8	NE
Chirpine	705.4±123.7	34.8 ± 14.9	1.6±0.4	NE
Alpine meadows	134.9±87.0	26.5 ± 12.5	17.3±9.7	NE
Agriculture	115.2±76.2	16.3± 8.3	9.5± 2.6	NE
Temperate grassland	113.4±73.6	16.9 ± 7.9	6.8±1.7	NE
Juniper	80.4±43.6	24.3±10.5	5.8±1.9	NE

ECONOMIC VALUE (m₹/ha) OF DIFFERENT LU LC

LULC	CO_2	Nutrients	Soil Moisture	Biomass used	Water yield
Conifer Mixed	19.6	0.6	0.0023	0.08	0.69
Oak pine	13.7	0	0.0019	0.08	0.33
Oak	11	0.3	0.0027	0.09	0.13
Blue Pine	5.6	0.4	0.0017	NE	NE
Birch	5.3	0.3	0.0011	NE	NE
Deodar	4.8	0.6	0.0019	0.07	NE
Chirpine	2.9	0.6	0.0002	NE	NE
Alpine meadows	0.6	0.4	0.0024	NE	NE
Agriculture	0.5	0.3	0.0013	NE	NE
Temprate grassland	0.5	0.3	0.0009	NE	NE
Juniper	0.3	0.4	0.0008	NE	NE

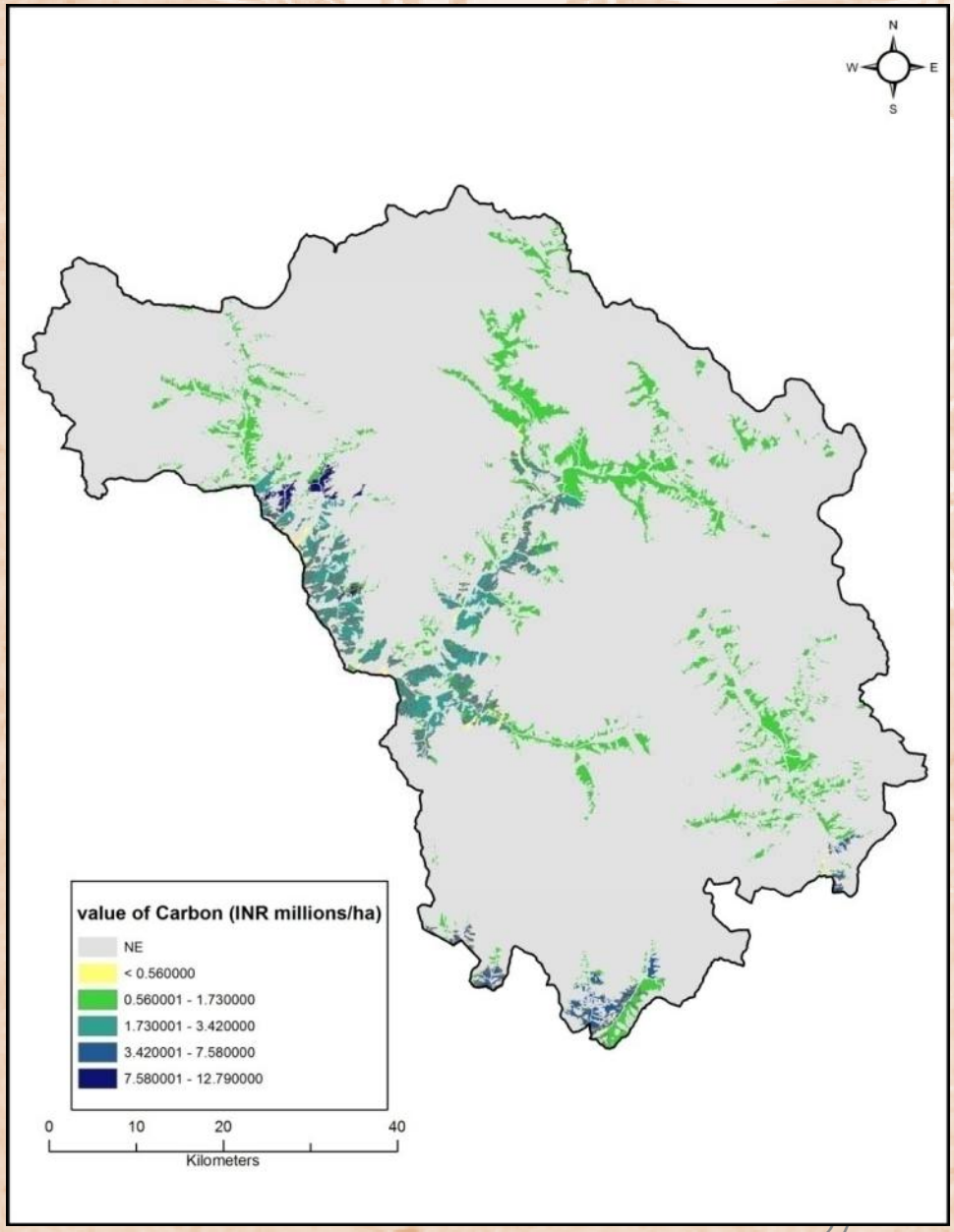
AGGREGATE VALUE OF ECOSYSTEM SERVICES

LULC	M₹/ha
Conifer Mixed	21.02
Oak pine	14.15
Oak	11.57
Blue Pine	6.11
Birch	5.69
Deodar	5.51
Chirpine	3.6
Alpine meadows	0.96
Agriculture	0.77
Temperate grassland	0.75
Juniper	0.73



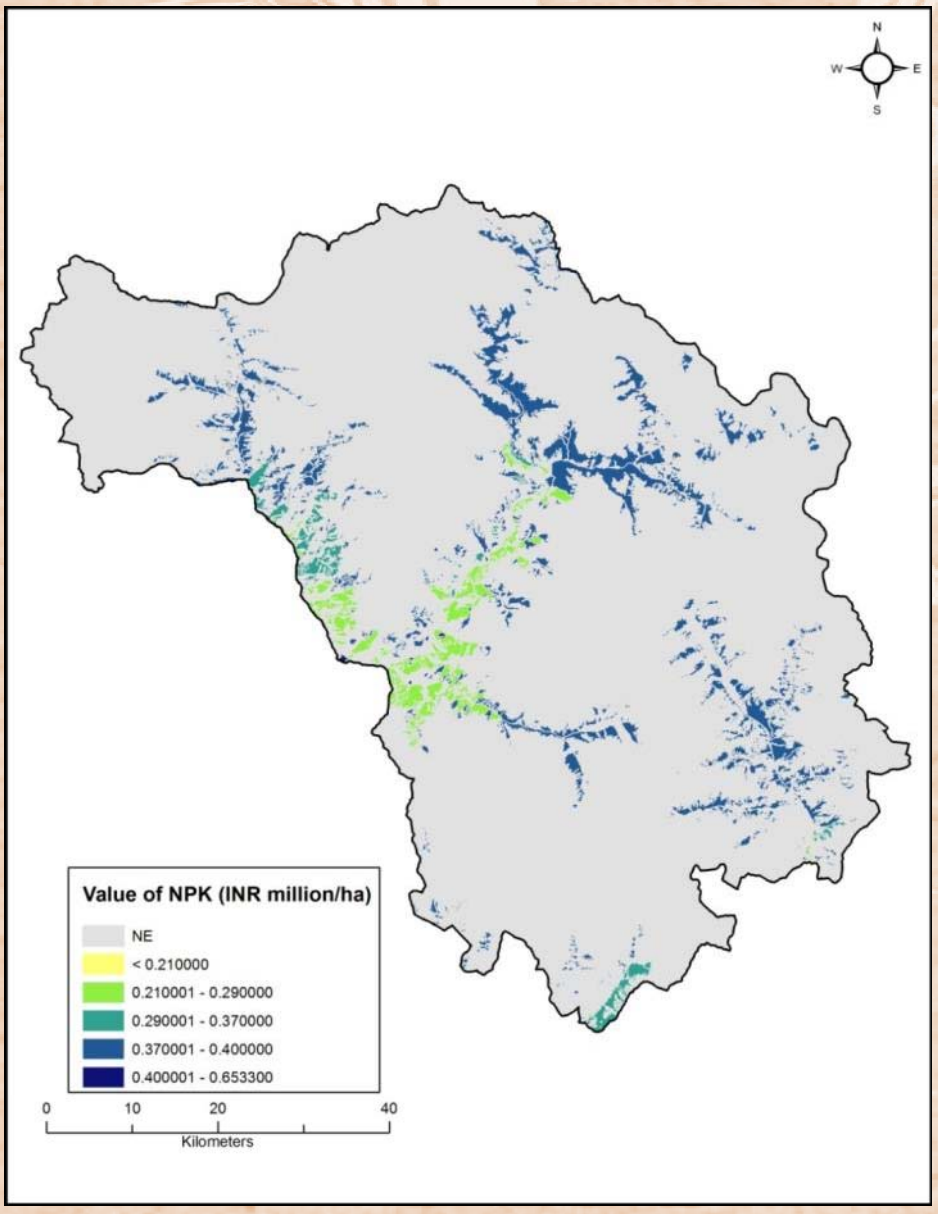
CARBON STOCK

LULC	M Tons
Oak pine	29.33
Blue pine	21.44
Conifer mixed	9.07
Deodar	8.39
Alpine meadows	6.31
Chirpine	2.24
Oak	1.41
Birch	0.93
Temperate grassland	0.16
Agriculture	0.14
Juniper	0.03



SOIL NUTRIENTS

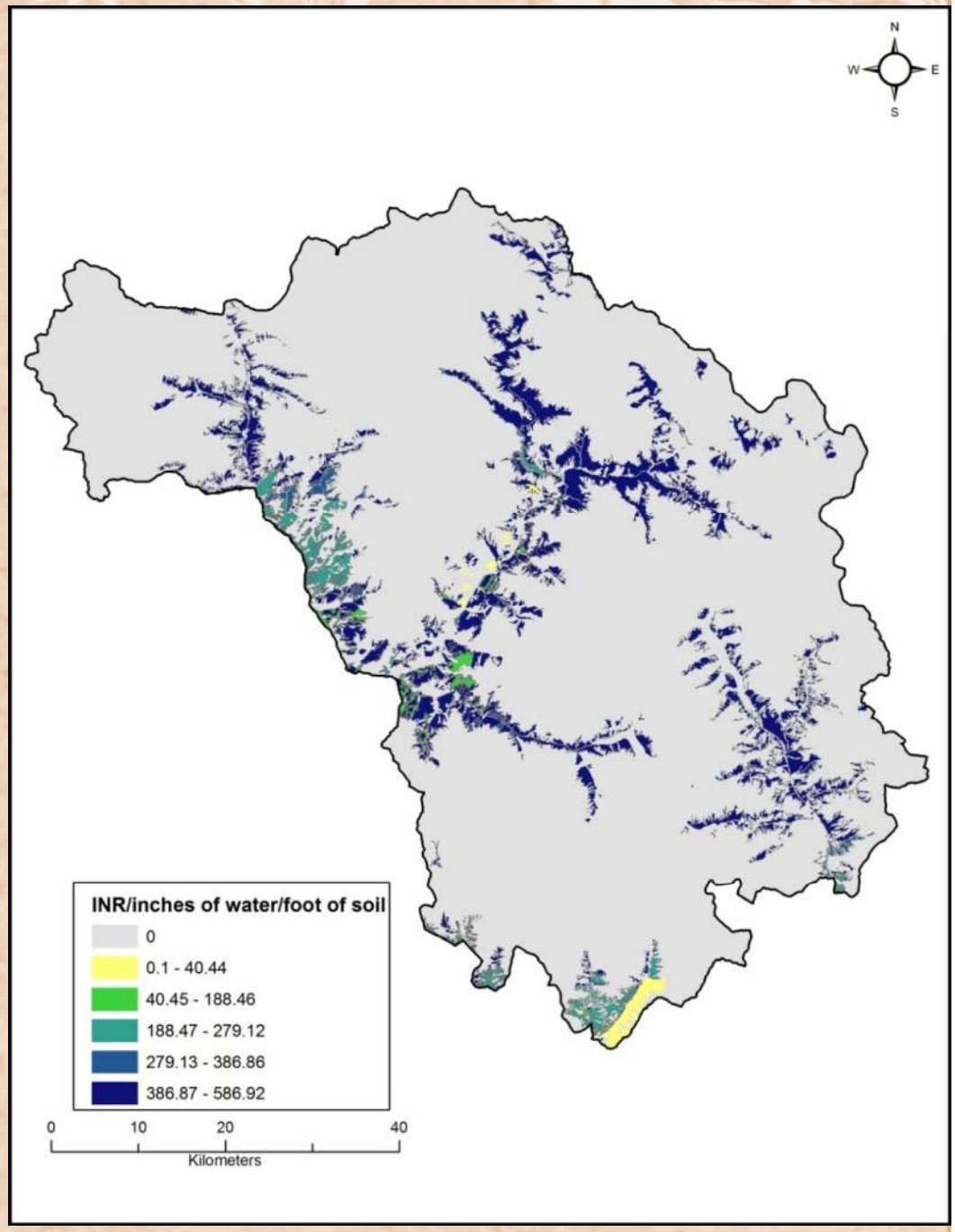
LULC	M Tons
Alpine meadows	1.24
Blue Pine	0.50
Deodar	0.25
Chir pine	0.11
Conifer Mixed	0.07
Temperate grassland	0.02
Cultivated areas	0.02
Birch	0.01
Oak	0.01
Juniper	0.01



SOIL MOISTURE

LU/LC	MHM
Alpine meadows	0.811
Blue pine	0.200
Oak pine	0.122
Deodar	0.100
Conifer mixed	0.033
Cultivated areas	0.012
Oak	0.010
Temperate grassland	0.010
Birch	0.006
Chirpine	0.005
Juniper	0.002

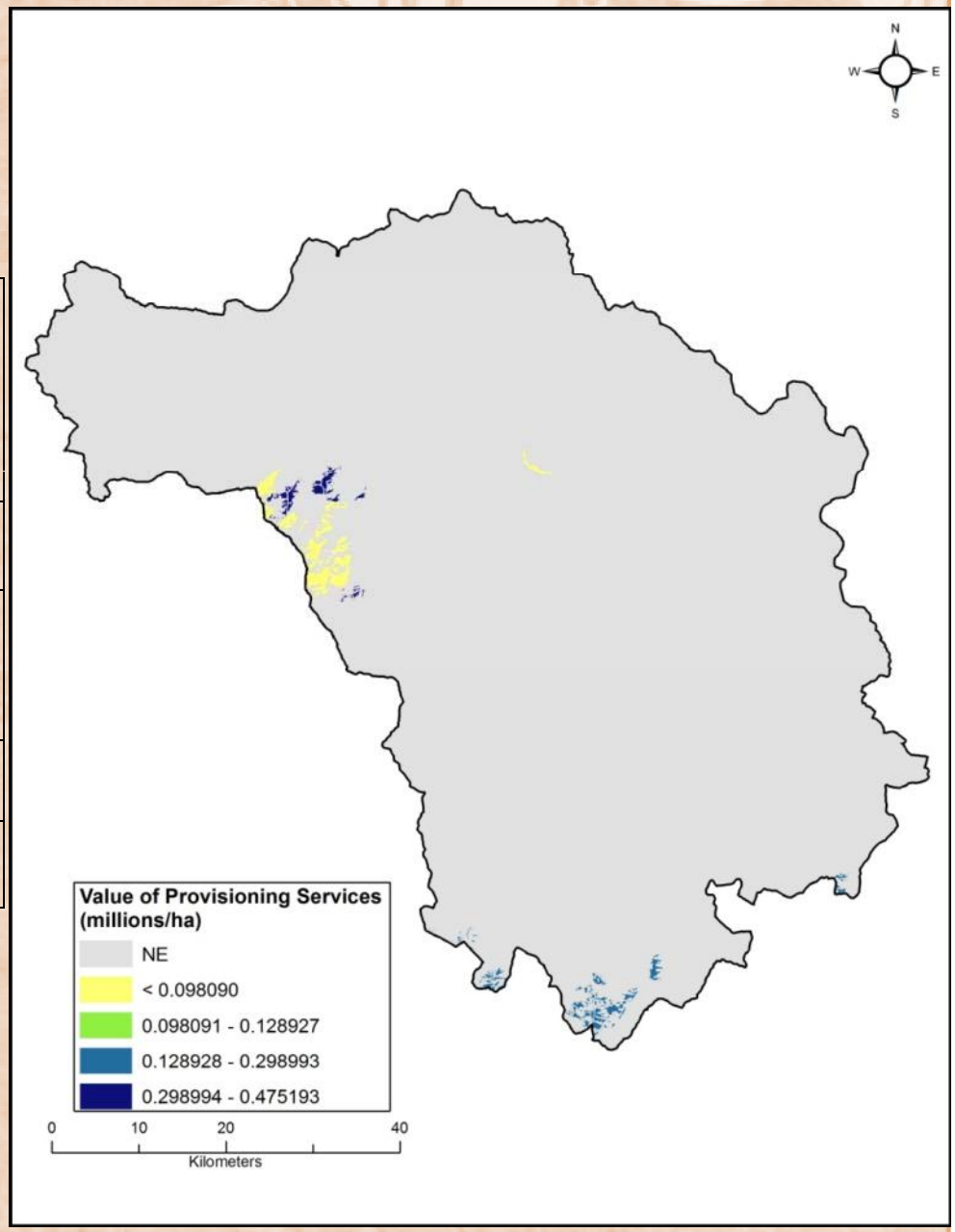
MHM = million hectare meter



PROVISIONING SERVICES

LU/LC	Biomass* (kg/hh/yr)	Water yield (m^3/day)
Oak	13036.46	44.4
Conifer mixed	11575.5	230.2
Oak pine	11187.4	109.5
Deodar	10708.14	NE

Quantity of biomass used (fuelwood, fodder, NTFP)



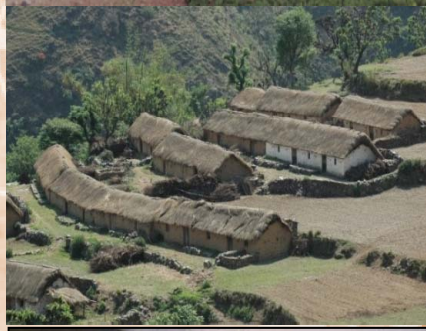
NET PRESENT ECONOMIC VALUE OF ECOSYSTEM SERVICES

Ecosystem Service	Billion ( )
Carbon stock	332.45
Soil nutrient	34.39
Soil moisture	0.04
Biomass used	1.43
Water yield	4.36
Recreation value	0.02

Excluding standing biomass value in terms of NTFP, timber, medicinal plants

SUMMARY

- The net ecosystem service value of these services was ₹3.98 ± 0.66 m/ha.
- Highest value was contributed by the conifer mixed (₹21.02 m/ha), while least was by juniper (₹0.73 m/ha).
- Carbon stock contributed most towards net ecosystem service value and was highest for conifer mixed forests (4683 t/ha).
- Oak and conifer mixed forests contributed the most towards provisioning services.
- Carbon stock in NDBR is 15.9% of the forests of Uttarakhand.



Communities

Results

Natural resources collected and used by local community of NDBR

Natural resource	No. of hh	Amount extracted (kg/hh/year)	Direct earning (INR /hh/year)
Fodder*	87.8	3648.73 ±67.04	7297.47 ±134.08
Fuelwood*	95.7	2510.29 ±67.36	3765.44 ±101.05
Leaf litter*	84.8	2321.07 ±41.31	3481.59 ±61.96
Thatching	5.4	75.5 ±9.21	15100 ±1843.84
Vegetables	38.0	2.87 ±0.08	57.69 ±5.2
Fruits	16.1	7.07±0.31	384 ±36.05
Medicinal plant	4.5	0.25 ±0.01	2125 ±125
Cordyceps sinensis	1.0	0.38 ±0.9	58750 ±29058.9

Water use and economic contribution

	Consumption	Economic contribution /hh/year	Consumption per capita/day	Economic contribution /hh/year
Total household consumption	217.78 +20.32 lts/hh/day	627.2 ±55.5	39.6 ±3.7	114.03 ±10.6
For domestic purpose	116.67 ±14.81 lts/hh/day	336 ±40.4	21.2 ±2.7	61.1 ±7.5
For livestock use	101.12 ±9.34 lts/hh/day	291.2 ±25.5	-	-
For agricultural use	826.06 ±33.7 m^3/hh/year	132170.4 ±269.7	-	-

Summary

- Functional output was found higher for streams originating from moist temperate deciduous forest followed by oak forest and mixed conifer forest
- More diverse forest patches can hold more soil moisture than the less diverse forests
- Oak have more water holding capacity than coniferous species resulting in higher surface flow
- Jackson et al. (2005), Sun et al. (2010) and Singh et al. (2007) have found similar results
- People living close to forest are getting freshwater for free
- The availability of water is influenced by type and condition of forests
- Water-related problems as scarcity, pollution, floods and drought are important challenges to sustainable development

Recreational value of NDBR

Results

Tourism profile of NDBR

Place	Type of tourism	No. interview	Season for visit
Auli	Nature & Adventure	242	Throughout the year
Valley of flowers	Nature	119	July-October
Badrinath	Cultural	220	May-Mid November
Hemkunt	Nature & Cultural	112	June-October

Average Group size

Nature based tourist - 6.36 ±0.31; Religious tourist 6.98 ±0.52

Contribution of tourism to local livelihood

Profession	No. of interview	% of interviews	Tourism income (INR/hh/year)
Tourist guide	14	7.0	107606.07 ±10430.45
Homestay + Porter	20	10.0	137162 ±18606.8
Work at Badrinath	12	6.0	112674.03 ±7501.3
Milk + Garland	26	13.0	133335.4 ±8901.1
Mule	30	15.0	135737 ±7534.5
Photography	16	8.0	82287.5 ±5804.7
Shop owners	16	8.0	198540 ±13175.0
Travel Agency + tourist guide	8	4.0	442977.5 ±92362.2
Vehicle owner	38	19.0	139990.5 ±12402.9
Indirectly involved	20	10.0	52404 ±5226.04

Contribution to local economic security

- A total of 200 hh sampled, those involved and dependent on tourism related activities for their livelihood
- 130 were directly and 70 were indirectly involved
- Average income for the hh involved in tourism was INR 155454.56 ±15083.8 per year/hh
- Contribution of tourism was INR 82133.33 ±10168.9/year/hh
- Tourism contributes 2% to 93% to the economy of hh involved
- Annual income was found to be higher to the hh involved in tourism ($p<0.005$)

…..Methodology

A subjective wellbeing index was developed using the indicators of education, economical, heath, political, social, work place and environmental wellbeing

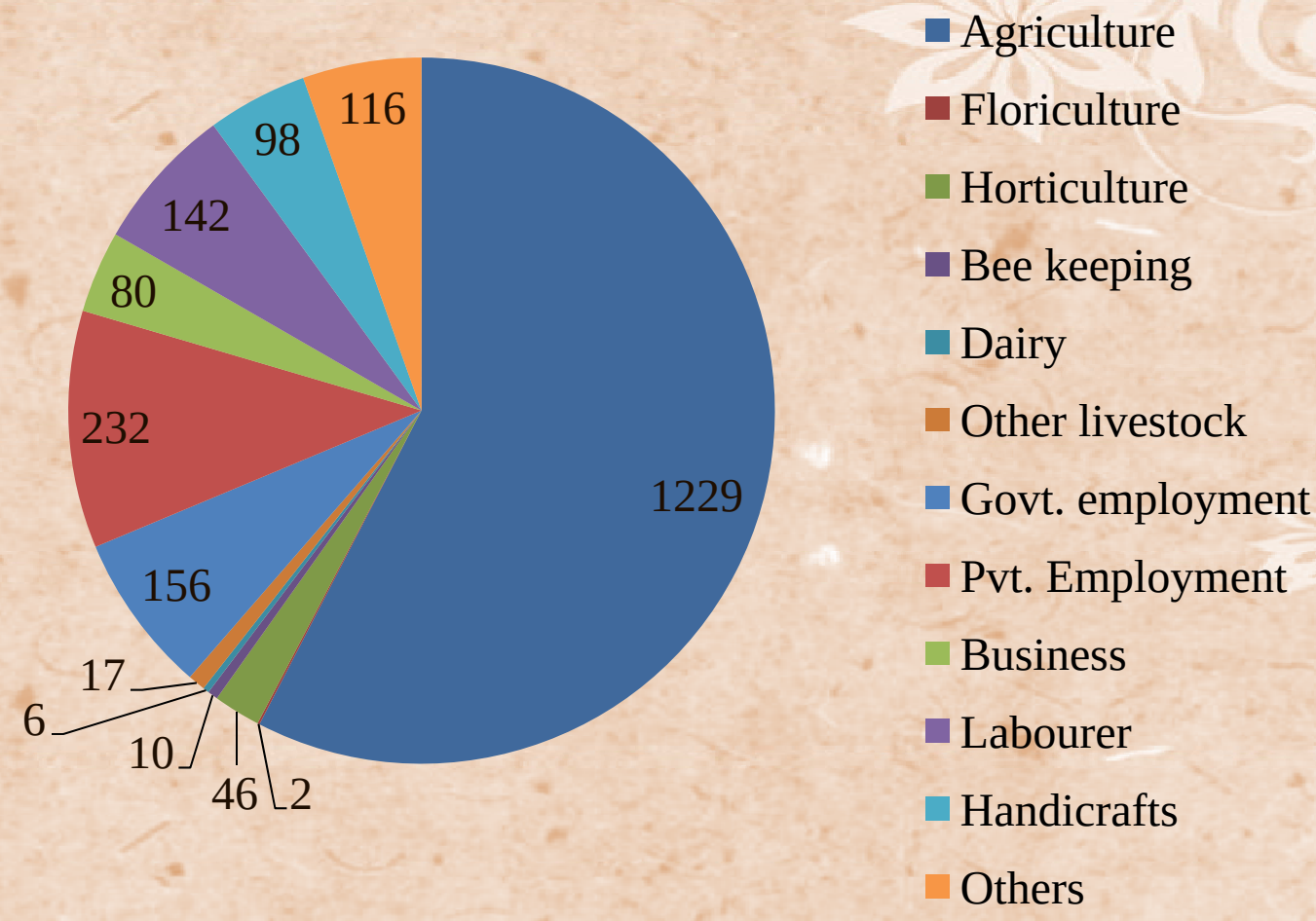
Average Income/ household/ year = Average {Income from (forest products + livestock + agriculture + salaries/ wages and government schemes/ labour)}

$$Wellbeing\ (OWB/\ SWB/\ HWB/\ PWB\ /\ WWB/\ ENVWB) = [\{(P_1 + P_2 + P_3 + \ldots + P_n)\} + \{-(N_1 + N_2 + N_3 + \ldots\ldots + N_n)\} / TI]$$

Where:
OWB is overall wellbeing of a household;
SWB is social wellbeing;
HWB is health wellbeing;
PWB is political wellbeing;
WWB is workplace wellbeing;
ENVWB is environmental wellbeing;
P is a positive;
N is a negative indicator;
TI is total number of indicators

Mann-Whitney U Test was used to know the difference between, wellbeing

Occupational pattern

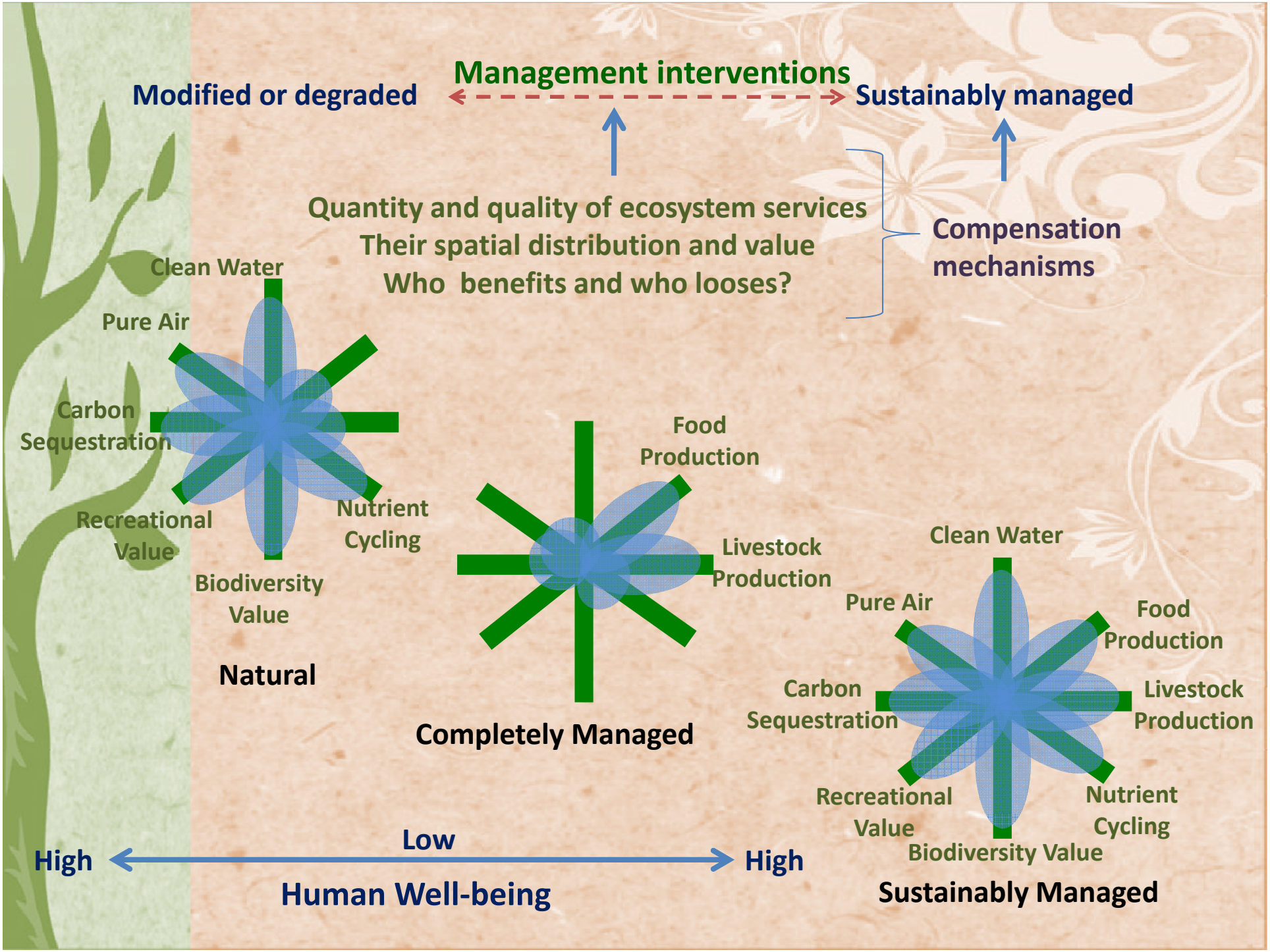


- Average household income- INR 80712.7 ±3301.4/hh/year without forest contribution; it was INR 95646.4 ±3332.4/hh/year with contribution of forest

Summary and conclusion

- Significant difference between level of overall wellbeing among hh close to and away from forests
- Access to wild nutrition for food security
- Access to forest resources for livelihood and economic security
- Access to medicinal plants add to health security
- Scarcity will affect the social and cultural capital
- US States Climate Change Program (CCSP, 2008) establishes that human wellbeing is positively associated with availability of forest resources

Conservation implications


Management interventions
Modified or degraded
Sustainably managed
Quantity and quality of ecosystem services
Their spatial distribution and value
Who benefits and who looses?
Compensation mechanisms
Clean Water
Pure Air
Carbon Sequestration
Recreational Value
Nutrient Cycling
Biodiversity Value
Natural
Food Production
Livestock Production
Completely Managed
Clean Water
Pure Air
Food Production
Carbon Sequestration
Livestock Production
Recreational Value
Nutrient Cycling
Biodiversity Value
Sustainably Managed
High
Low
High
Human Well-being

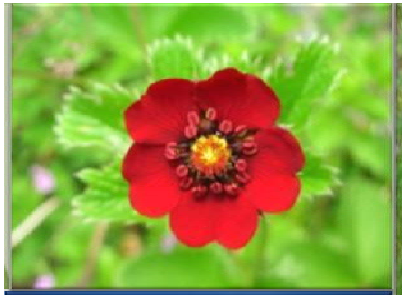
What is the basic dichotomy between Conservation and development

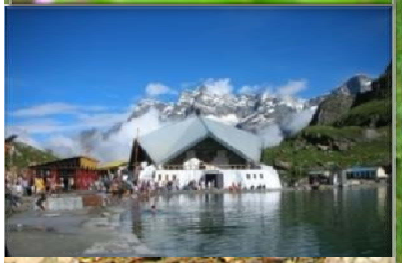
Are we creating a tower of Babel?

"Come let us go down there and confuse their language, that they may not understand one another's speech" so said the Lord upon visiting the tower of Babel created by the sons of men

Genesis II

Economics talks….and Votes count!!!






Thank You!