

# Natural Capital Accounting and Valuation of Ecosystem Services- Karnataka State, India NCAVES – INDIA [SSFA/2019/1502]

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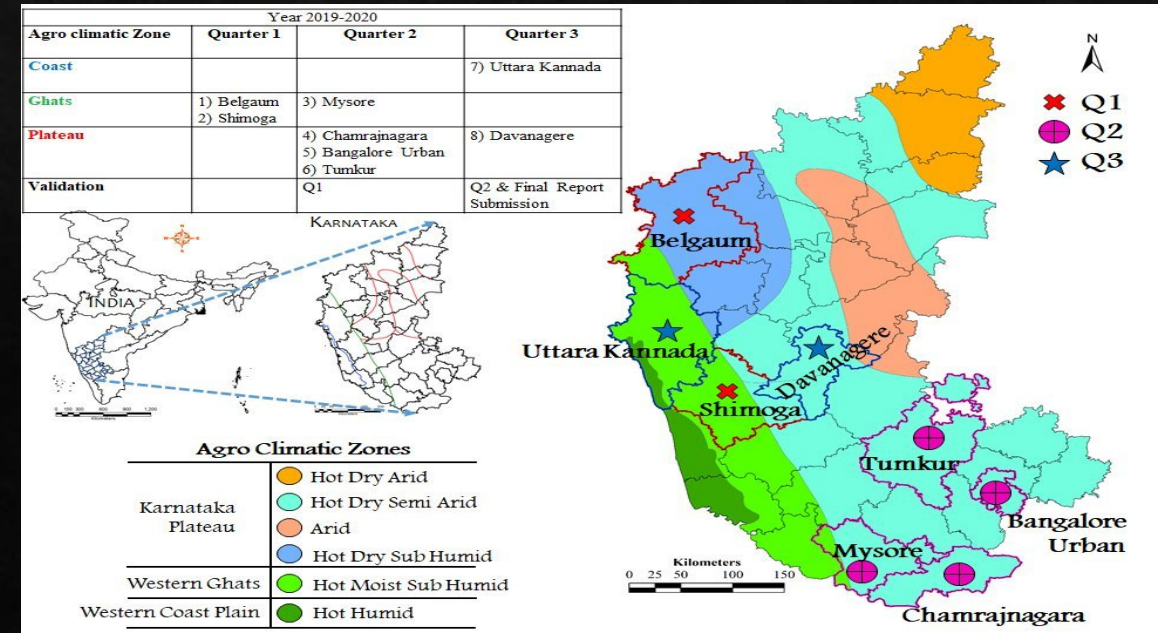
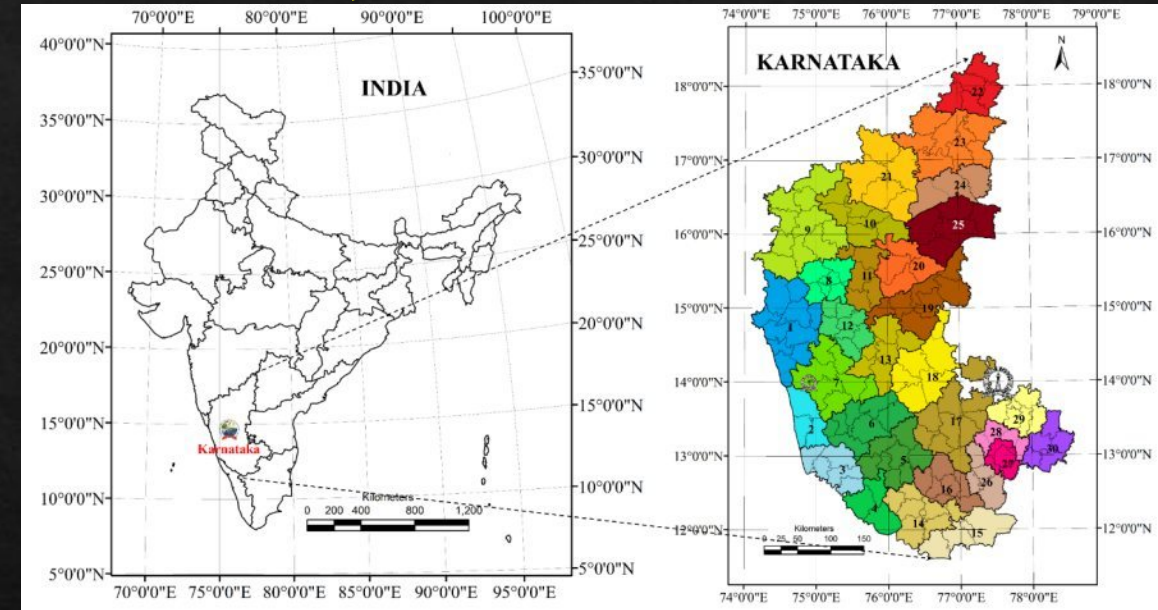


# NCAVES – Karnataka, India

## Objectives:

- ◆ Compile ecosystem extent and condition accounts for the state of Karnataka
- ◆ Compile pilot ecosystem services supply accounts (in physical units)
- ◆ Valuation of the ecosystem services
- ◆ Scenario-based assessment of policy interventions

Study Period: December 2019 – May 2021  
[Covid 19 Period: March – June 2020, May-June 2021]





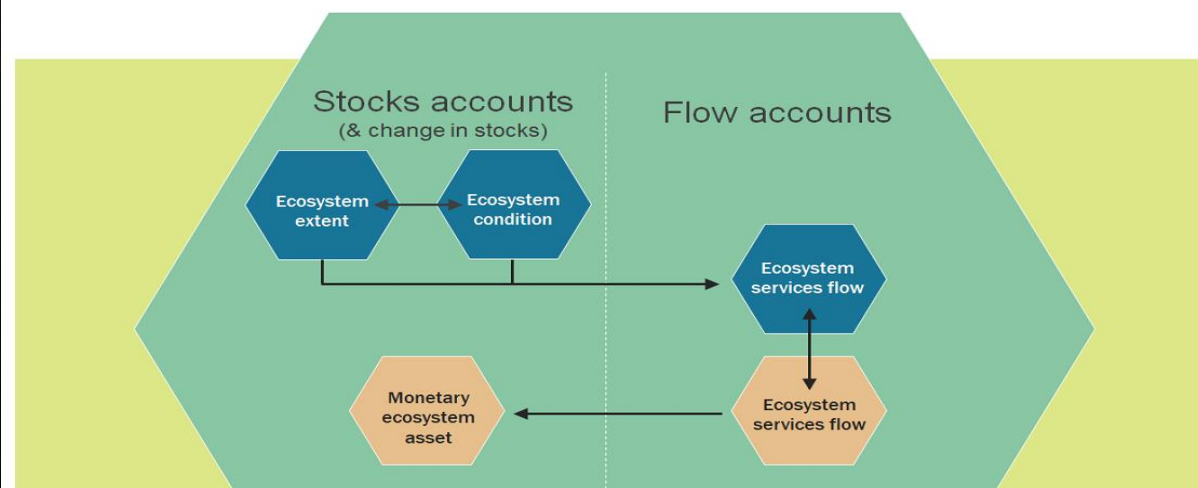
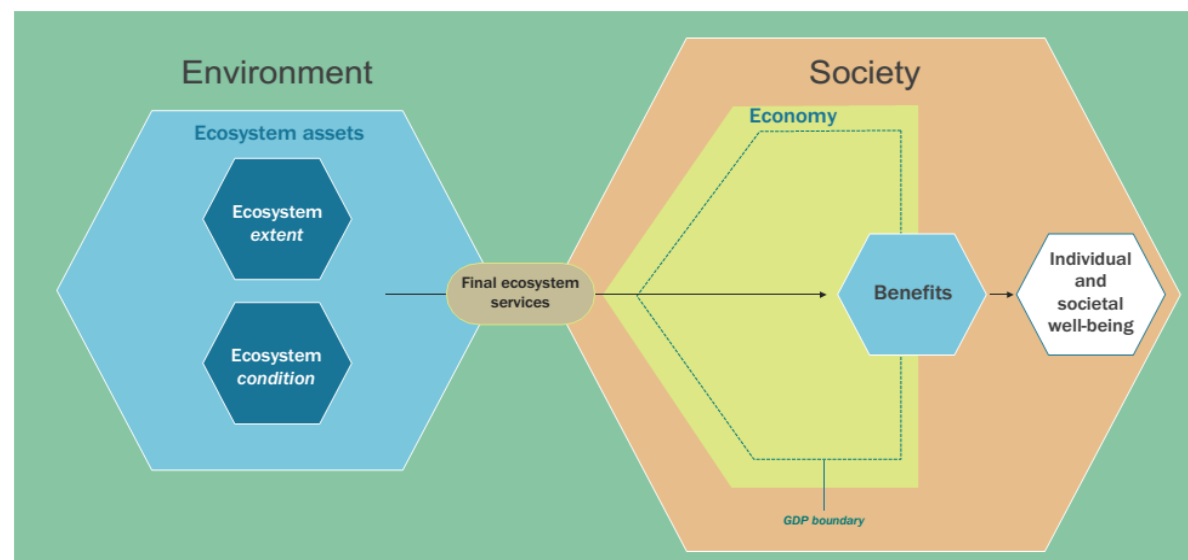
# SEEA Experimental Ecosystem Accounting (SEEA EEA)

**Ecosystem extent** accounts: record the total area of each ecosystem which is classified by type within an ecosystem accounting area and, over time in a specified area (e.g. State, District)

**Ecosystem condition** accounts: record the condition of ecosystem assets in terms of selected characteristics at specific points in time and, over time, record the changes to their condition.

**Ecosystem goods and services** accounts: record the supply of ecosystem services by ecosystem assets and the use of those services by economic units, including households. Ecosystem services accounts are presented both in physical and monetary units, using techniques for valuation of ecosystem services.

**Ecosystem monetary asset** accounts: record information on stocks and changes in stocks (additions and reductions) of ecosystem assets. This includes accounting for ecosystem degradation and enhancement.





# Ecosystem dynamics: Land use Dynamics – 10 districts, Temporal Remote Sensing Data (available cloud free data), Field data collection (ground truthing), Supervised Classification (GMLC) and Validation



Figure 2.1: FCC and Training data collection

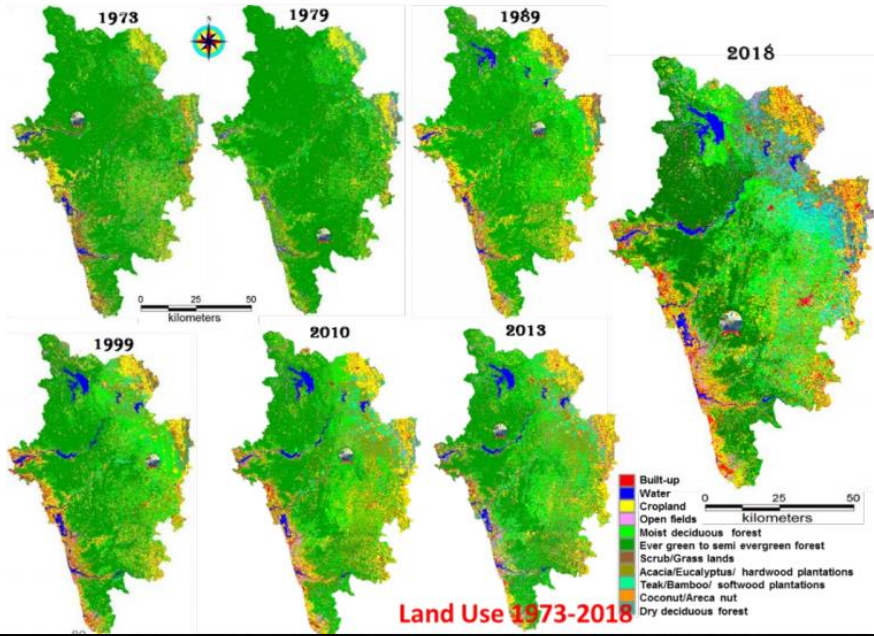


Table 4.1.2.1: Ecosystem Extent – Uttara Kannada **district** (units in hectares and percentages) – based on temporal remote sensing data analyses

Year	Category Land use												
	Units	Built-up	Crop land	Horticulture	Fallow land	Evergreen to semi evergreen	Moist deciduous forest	Dry deciduous forest	Scrub/grass	Acacia/Eucalyptus/ Hardwood	Teak/ Bamboo/ Softwood plantations	Water	Total
1973	Ha	3886	71990	20702	14071	696978	95357	25410	38109	40905	13997	7681	1029086
	%	0.4	7.0	2.0	1.4	67.7	9.3	2.5	3.7	4.0	1.4	0.7	
1979	Ha	9738	103163	29675	15988	589762	102967	29113	58936	50321	20896	18527	1029086
	%	0.9	10.0	2.9	1.6	57.3	10.0	2.8	5.7	4.9	2.0	1.8	
1989	Ha	12982	121167	32227	34783	531872	143849	13848	44123	55694	21937	16604	1029086
	%	1.3	11.8	3.1	3.4	51.7	14.0	1.3	4.3	5.4	2.1	1.6	
1999	Ha	21635	138458	43623	21945	423062	179075	8374	47366	73977	38588	32983	1029086
	%	2.1	13.5	4.2	2.1	41.1	17.4	0.8	4.6	7.2	3.7	3.2	
2010	Ha	28491	148187	53646	30813	367064	166266	9008	35158	119717	44794	25942	1029086
	%	2.8	14.4	5.2	3.0	35.7	16.2	0.9	3.4	11.6	4.4	2.5	
2013	Ha	31589	145395	53993	37660	330204	161996	9873	40402	122927	67111	27936	1029086
	%	3.1	14.1	5.2	3.7	32.1	15.7	1.0	3.9	11.9	6.5	2.7	
2018	Ha	54023	149151	52232	41941	298015	163734	13701	41331	109705	76847	28406	1029086
	%	5.2	14.5	5.1	4.1	29.0	15.9	1.3	4.0	10.7	7.5	2.8	
Changes during 1973 to 2018													
1973	Ha	3886	71990	20702	14071	696978	95357	25410	38109	40905	13997	7681	1029086
2018	Ha	54023	149151	52232	41941	298015	163734	13701	41331	109705	76847	28406	1029086
Net Change of extent (during 1973 to 2018)													
Extent	Ha	50137	77161	31530	27870	-398963	68377	-11709	3222	68800	62850	20725	
	%	1290.2	107.2	152.3	198.1	-57.2	71.7	-46.1	8.5	168.2	449.0	269.8	

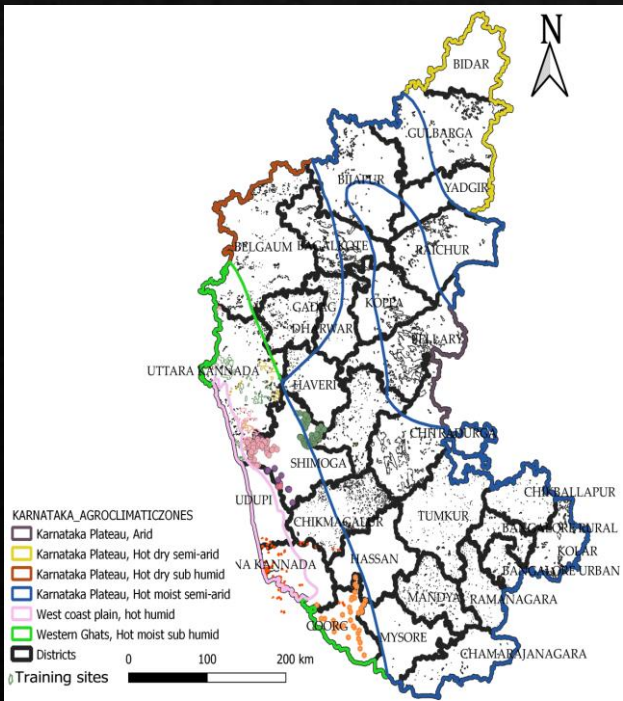
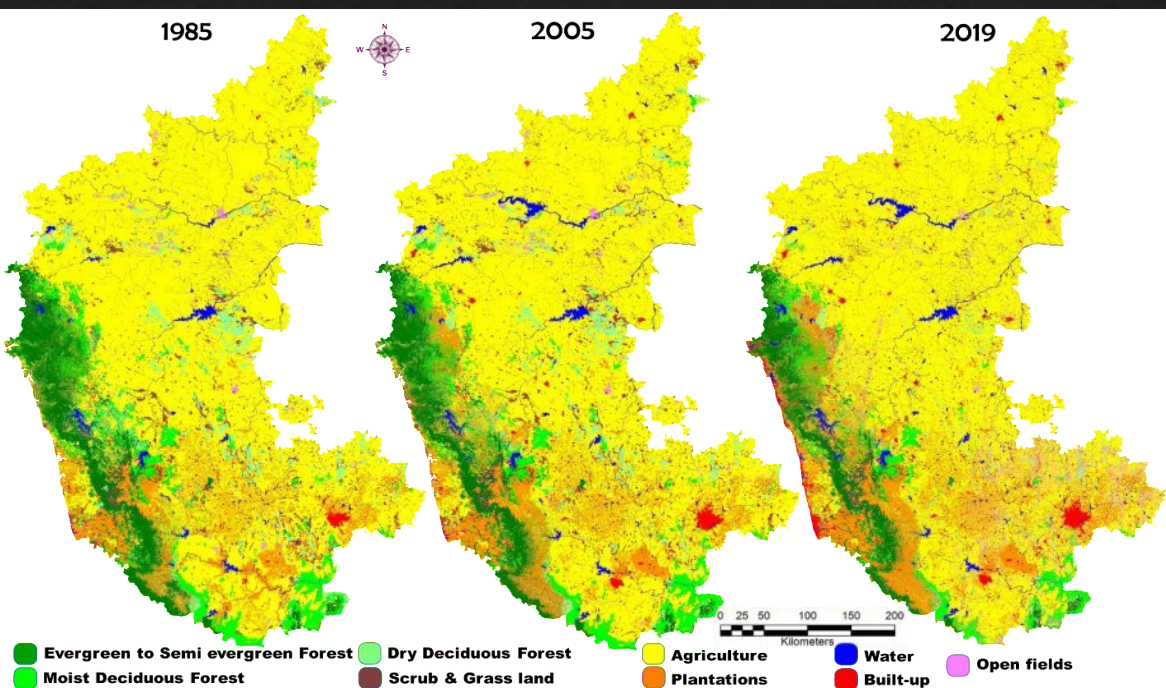
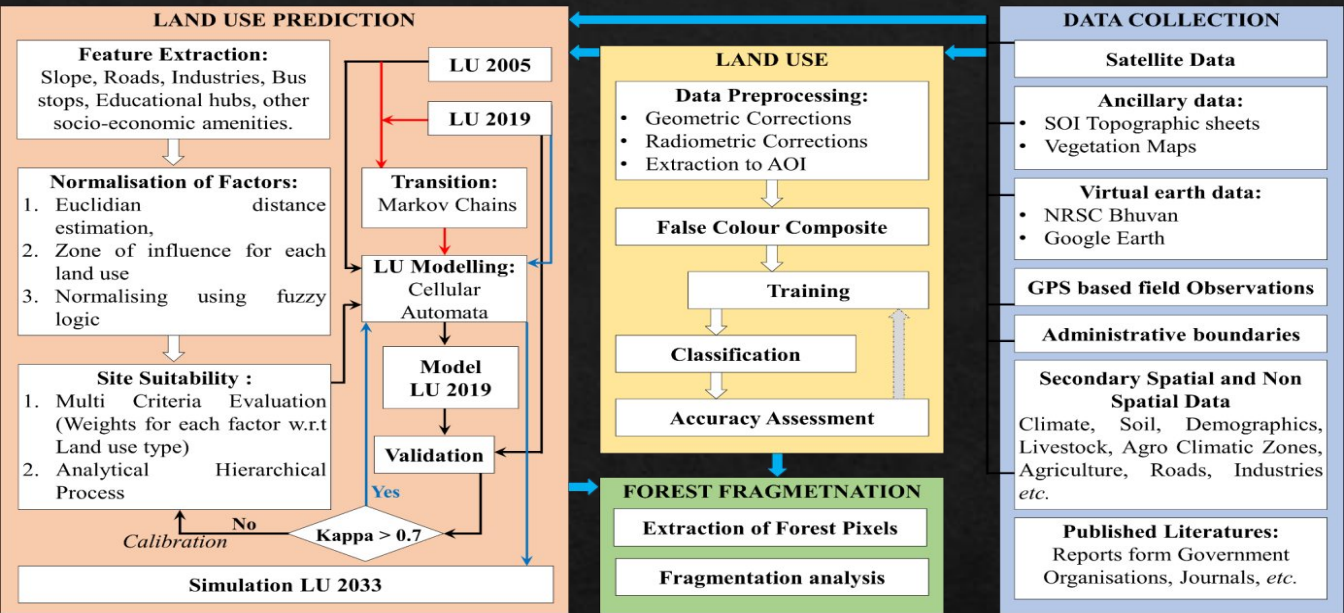
# Transitions across LU categories during 2010 to 2018 – Uttara Kannada district (Extent in Hectares and %)

2018 Land use categories	Units											
	2010	Built-up	Crop land	Horticulture	Fallow Land	Evergreen to semi evergreen	Moist deciduous forest	Dry deciduous forest	Scrub/grass	Plantation	Water	Total -Ha (opening) 2010
<b>Built-up</b>	Ha	18587	362	1281	1669	1741	1549	407	642	2032	219	28491
	%	65.2	1.3	4.5	5.9	6.1	5.4	1.4	2.3	7.1	0.8	
<b>Crop land</b>	Ha	16319	77663	8470	5538	13305	10398	766	3382	12083	263	148187
	%	11.0	52.4	5.7	3.7	9.0	7.0	0.5	2.3	8.2	0.2	
<b>Horticulture</b>	Ha	2240	4065	20320	948	11804	8261	502	1139	4298	70	53646
	%	4.2	7.6	37.9	1.8	22.0	15.4	0.9	2.1	8.0	0.1	
<b>Fallow Land</b>	Ha	4143	222	957	8931	2576	3430	1327	2037	6224	965	30813
	%	13.4	0.7	3.1	29.0	8.4	11.1	4.3	6.6	20.2	3.1	
<b>Evergreen to semi evergreen</b>	Ha	2176	3007	9508	1995	275824	50047	43	8774	15267	423	367064
	%	0.6	0.8	2.6	0.5	75.1	13.6	0.0	2.4	4.2	0.1	
<b>Moist deciduous forest</b>	Ha	2761	5711	6228	1865	3450	111784	171	7679	26486	131	166266
	%	1.7	3.4	3.7	1.1	2.1	67.2	0.1	4.6	15.9	0.1	
<b>Dry deciduous forest</b>	Ha	215	319	29	690	127	105	3010	366	4138	9	9008
	%	2.4	3.5	0.3	7.7	1.4	1.2	33.4	4.1	45.9	0.1	
<b>Scrub/grass</b>	Ha	759	4569	428	2064	3106	4152	1764	10838	7298	179	35158
	%	2.2	13.0	1.2	5.9	8.8	11.8	5.0	30.8	20.8	0.5	
<b>Forest Plantation</b>	Ha	4926	22061	3546	2158	19536	31255	3070	6195	71516	249	164511
	%	3.0	13.4	2.2	1.3	11.9	19.0	1.9	3.8	43.5	0.2	
<b>Water</b>	Ha	693	706	240	932	533	432	4	517	531	21531	26119
	%	2.7	2.7	0.9	3.6	2.0	1.7	0.0	2.0	2.0	82.4	
<b>Closing Stock (2018)</b>	Ha	52819	118685	51009	26792	332003	221412	11066	41568	149873	24036	1029263
	%	5.1	11.5	5.0	2.6	32.3	21.5	1.1	4.0	14.6	2.3	

Note: Diagonal elements indicate persistent (to be the same)



# ECOSYSTEM EXTENT AND DYNAMICS



Category	1985		2005		2019	
	Asset Extent	%	Asset Extent	%	Asset Extent	%
	Sq. Km		Sq. Km		Sq. Km	
Evergreen Forest	14292.73	7.45	12444.70	6.49	10887.78	5.68
Moist deciduous Forest	10960.11	5.71	9900.18	5.16	7892.28	4.12
Dry Deciduous Forest	7621.69	3.97	7409.52	3.86	4280.94	2.23
Scrub_Grass lands	6732.90	3.51	5603.86	2.92	4906.70	2.56
Plantations	16789.65	8.75	20209.09	10.54	21325.23	11.1
Agriculture	128467.66	66.98	127196.30	66.32	127962.17	66.7
Water	4343.79	2.26	5176.70	2.70	5933.93	3.09
Built-up	904.17	0.47	2666.15	1.39	5748.34	3.00
Openland	1678.30	0.88	1184.50	0.62	2853.63	1.49
Total Area	191791					

1985	Transition - Land uses during 1985 to 2019									
	Evergreen Forest	Moist deciduous Forest	Dry Deciduous Forest	Scrub_Grass lands	Plantations	Agriculture	Water	Built-up	Openland	Opening Stock 1985
Evergreen Forest	9097.08	1401.59	210.59	286.13	2372.34	416.42	182.38	174.97	151.23	14292.72
	63.6	9.8	1.5	2.0	16.6	2.9	1.3	1.2	1.1	
Moist deciduous Forest	387.83	5580.61	469.95	164.07	1647.94	1972.61	61.23	190.48	485.38	10960.11
	0.4	54.1	4.3	1.5	15.0	18.0	0.6	1.7	4.4	
Dry Deciduous Forest	68.24	419.41	2306.13	86.64	778.53	3373.70	46.54	84.96	457.55	7621.70
	0.9	5.5	30.3	1.1	10.2	44.3	0.6	1.1	6.0	
Scrub_Grass lands	135.92	113.07	71.93	1787.16	700.67	3056.49	102.57	327.04	438.06	6732.90
	2.0	1.7	1.1	26.5	10.4	45.4	1.5	4.9	6.5	
Plantations	242.81	258.46	93.23	107.87	11660.53	3343.89	122.26	775.41	185.16	16789.63
	1.4	1.5	0.6	0.6	69.5	19.9	0.7	4.6	1.1	
Agriculture	69.37	119.47	116.65	254.37	4050.33	114150.32	2008.46	3169.43	4529.38	128467.79
	0.1	0.1	0.1	0.2	3.2	88.9	1.6	2.5	3.5	
Water	14.17	15.67	6.98	8.66	114.46	734.35	3321.21	93.15	35.15	4343.79
	0.3	0.4	0.2	0.2	2.6	16.9	76.5	2.1	0.8	
Built-up	1.41	3.29	0.51	1.58	14.98	19.54	2.41	858.69	1.75	904.17
	0.2	0.4	0.1	0.2	1.7	2.2	0.3	95.0	0.2	
Openland	1.04	2.05	11.59	13.03	31.72	842.52	15.42	50.43	710.49	1678.30
	0.1	0.1	0.7	0.8	1.9	50.2	0.9	3.0	42.3	
Closing Stock, 2019	10017.87	7913.63	3287.57	2709.51	21371.50	127909.85	5862.48	5724.56	6994.14	191791.11
Note: Diagonal elements indicate persistenet to be in the same category										

Level-1	Level-2	KARNATAKA				
		Opening Stock 1985	Additions to Stock	Reduction in Stock	Closing Stock 2019	Net change (in%) during 1985 to 2019
Built-up land	Built-up	904.17	4865.87	45.48	5724.56	533.13
	Urban					
	Rural					
	Mining					
	Sub-Total 1					
Agricultural Land	Plantations	16789.63	9710.97	5129.10	21371.50	27.29
	Cropland	128467.79	13759.53	14317.46	127909.85	-0.43
	Fallow Land	1678.30	6283.65	967.82	6994.14	316.74
	Sub-Total 2	146935.72	29754.14	20414.38	156275.49	6.36
Forests	Evergreen/Semi-Evergreen	14292.72	920.79	5195.64	10017.87	-29.91
	Moist Deciduous	10960.11	2333.01	5379.50	7913.63	-27.80
	Dry Deciduous	7621.70	981.44	5315.56	3287.57	-56.87
	Scrub Forest	6732.90	922.35	4945.74	2709.51	-59.76
	Forest Plantation					
	Swamp/Mangroves					
	Sub-Total 4	39607.42	5157.59	20836.44	23928.58	-39.59
Grass / Grazing	Grass / Grazing					
	Sub-Total 5					
Snow and Glacier	Snow and Glacier					
	Sub-Total 6					
Wetlands / water bodies	Inland Wetland					
	Coastal Wetland					
	River/stream/canals					
	Waterbodies	4343.79	2541.28	1022.58	5862.48	34.96
	Sub-Total 7	4343.79	2541.28	1022.58	5862.48	34.96
Grand Total		191791.1	42318.88	42318.88	191791.11	0.00





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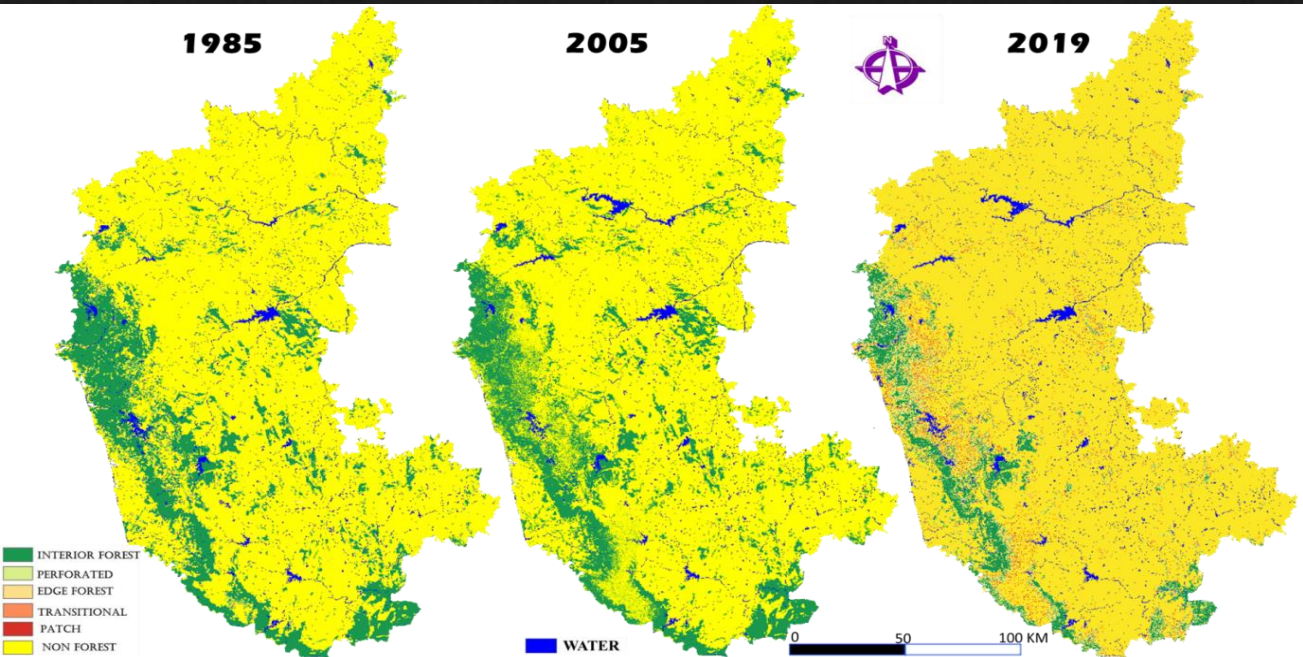
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Ecosystem Condition	ECT groups	ECT classes
	Abiotic ecosystem characteristics	1.Physical state characteristics (soil structure, water availability)
		2. Chemical state characteristics (soil nutrient levels, water quality, air pollutant concentrations)
	Biotic ecosystem characteristics	3. Compositional state characteristics (including species-based indicators)
		4. Structural state characteristics (including vegetation, biomass, food chains)
		5. Functional state characteristics (including ecosystem processes, disturbance regimes)
	Landscape level characteristics	6. Landscape and seascape characteristics (including landscape diversity, connectivity, fragmentation, embedded semi-natural elements in farmland), Land Surface Temperature (LST)

# Ecosystem condition Accounts:

## Forest Fragmentation,



Fragmentation Metrics		Interior	Patch	Transitional	Edge	Perforated	Non forests	Water	Total
Year	Units								
1985	sq.km	31224	1247	211	3184	1189	150057	4680	191791
	%	16.3	0.7	0.1	1.7	0.6	78.2	2.4	
2005	sq.km	24607	1170	2359	6655	1151	150671	5178	
	%	12.8	0.6	1.2	3.5	0.6	78.6	2.7	
2019	sq.km	11335	2839	2071	7365	595	161661	5926	
	%	5.9	1.5	1.1	3.8	0.3	84.3	3.1	
Changes during 1985 to 2019									
1989	sq.km	31224	1247	211	3184	1189	150057	4680	191791
2019	sq.km	11335	2839	2071	7365	595	161661	5926	191791
Net changes during 1985 to 2019									
	sq.km	-19889	1592	1860	4181	-595	11603	1247	
	%	-63.7	127.3	881.0	131.3	-50.9	14.7	26.6	

## Land Surface Temperature,

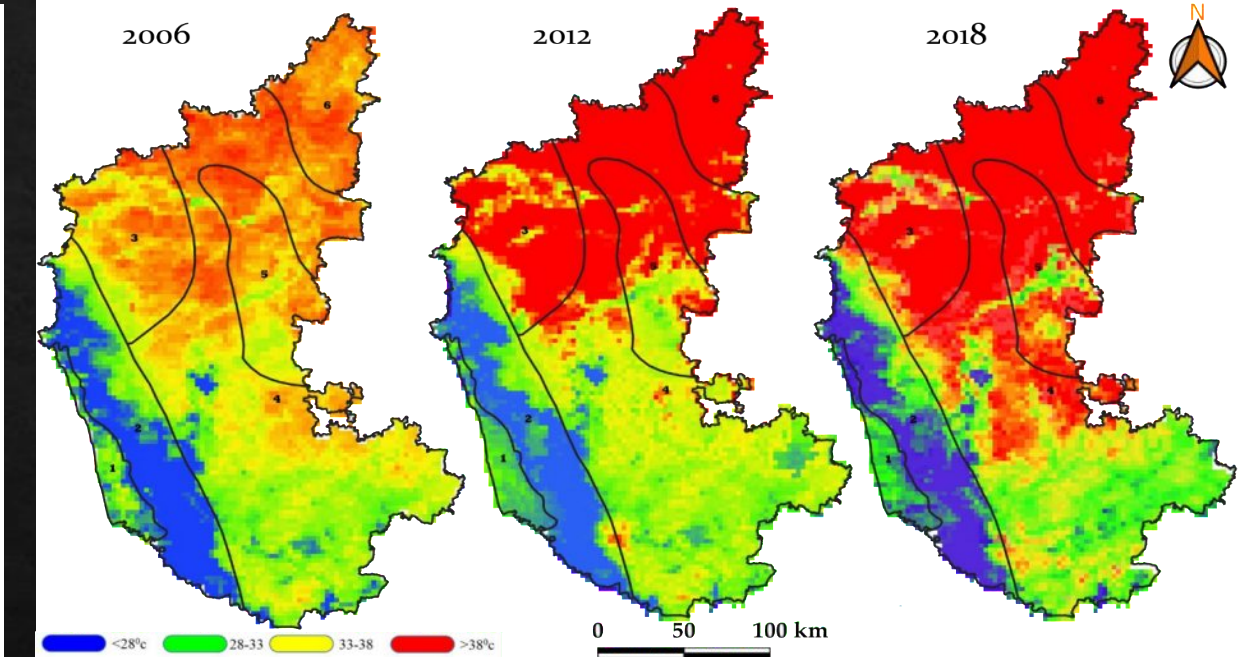


Table 3.2.12: Ecosystem Condition Indicators based on Landscape level Characteristics considering land Surface Temperature in Karnataka State (district wise)

Karnataka State (district wise)						Scope : Landscape level			
Districts		Opening Stock 2005				Closing Stock 2019			
	units	Total	High (<30 °C)	Medium (30 -35 °C)	Low (>35 °C)	Total	High (<30 °C)	Medium (30 -35 °C)	Low (>35 °C)
Bagalkot	Ha	688140	747	8870	678523	688140	0	11498	676642
	%		0.11	1.29	98.60		0.00	1.67	98.33
Bangalore-Rural	Ha	251101	0	3780	247321	251100	0	6596	244504
	%		0.00	1.51	98.49		0.00	2.63	97.37
Bangalore-Urban	Ha	226800	0	8771	218029	226800	0	25953	200847
	%		0.00	3.87	96.13		0.00	11.44	88.56
Belgaum	Ha	1547100	11643	68806	1466651	1547100	567	117563	1428970
	%		0.75	4.45	94.80		0.04	7.60	92.36



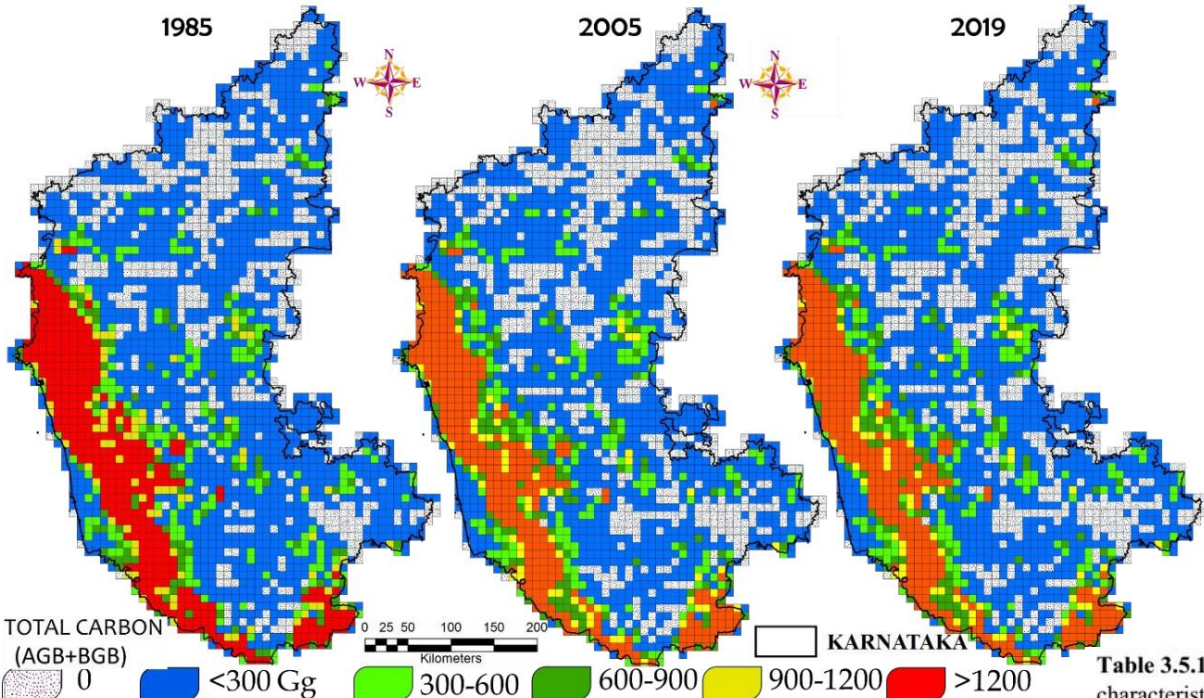


Figure 3.3.5. Total AGB & BGB of Karnataka from 1985-2019

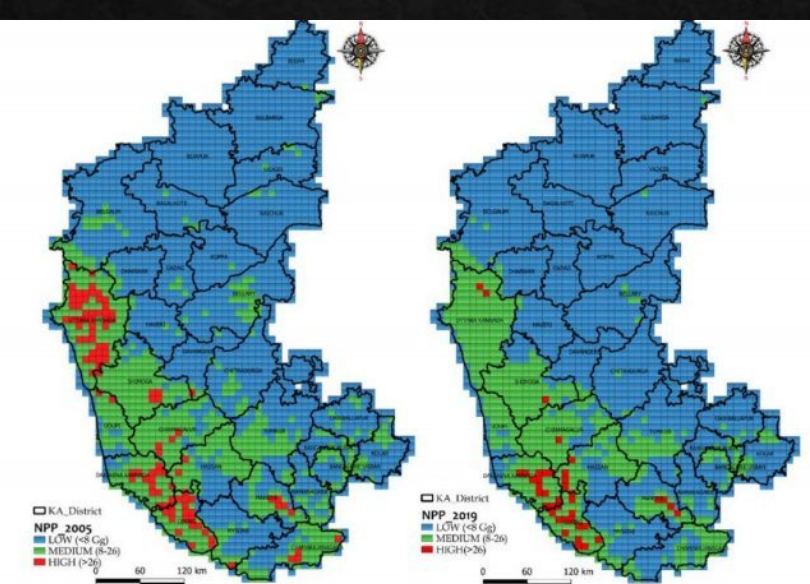


Figure 3.3.6. NPP in forest ecosystems in Karnataka

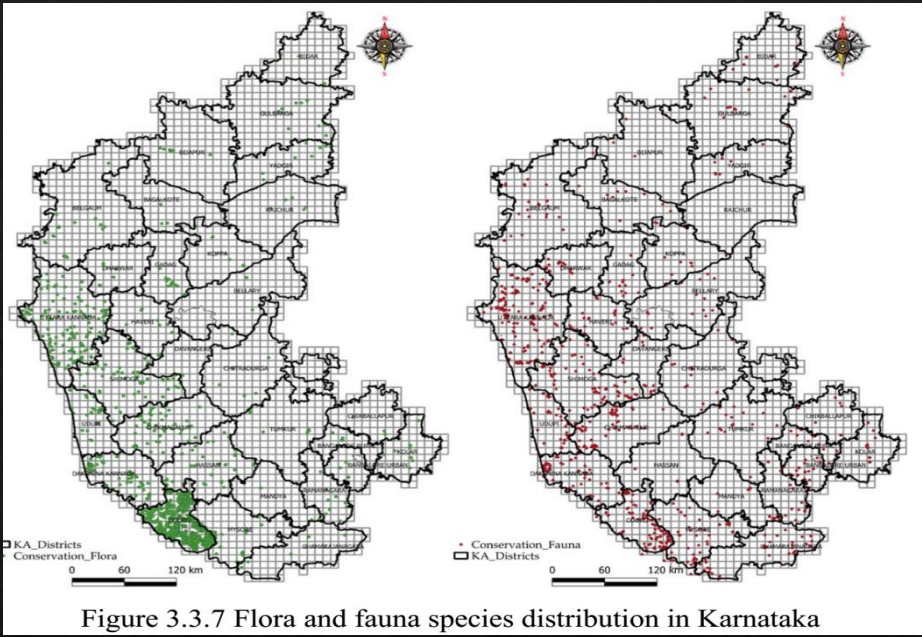


Figure 3.3.7 Flora and fauna species distribution in Karnataka

Table 3.5.1: Ecosystem conditions based on abiotic characteristics considering Soil in Karnataka State (district wise), India - physical state characteristics (EC and pH) and Chemical state characteristics (soil nutrient levels)

Soil condition based on Physical and Chemical parameters					Ecosystem: Agricultural Lands						
District	ECT	Parameter	Unts	Total	Opening 2005			Total	Closing 2020		
					High	Medium	Low		High	Medium	Low
Bagalkot	Soil - Chemical (macro nutrients)	K	sq.km	6885	4698	2187	0	6885	3888	2997	0
		%			68.2	31.8	0.0		56.5	43.5	0.0
		N	sq.km	6885	405	3969	2511	6885	0	2673	4212
		%			5.9	57.6	36.5		0.0	38.8	61.2
		P	sq.km	6885	0	324	6561	6885	567	6237	81
		%			0.0	4.7	95.3		8.2	90.6	1.2
		Zn	sq.km	6885	0	0	6885	6885	0	4536	2349
		%			0.0	0.0	100.0		0.0	65.9	34.1
	Soil – chemical (micro nutrients)	Fe	sq.km	6885	0	3078	3807	6885	0	5346	1539
		%			0.0	44.7	55.3		0.0	77.6	22.4
		OC	sq.km	6885	0	6156	729	6885	0	5913	972
		%			0.0	89.4	10.6		0.0	85.9	14.1
		B	sq.km	6885	0	6075	810	6885	0	6075	810
		%			0.0	88.2	11.8		0.0	88.2	11.8
		Cu	sq.km	6885	0	162	6723	6885	0	162	6723
	Soil Physical	%			0.0	2.4	97.6		0.0	2.4	97.6
		Mn	sq.km	6885	0	6885	0	6885	0	6885	0
		%			0.0	100.0	0.0		0.0	100.0	0.0
		S	sq.km	6885	6885	0	0	6885	6885	0	0
		%			100.0	0.0	0.0		100.0	0.0	0.0
		EC	sq.km	6885	5994	810	81	6885	5994	810	81
		pH	sq.km	6885	87.1	11.8	1.2	6885	87.1	11.8	1.2



Table 3.6.1: Ecosystem Condition Index Account – Karnataka state (district wise)

Districts	SEEA -EA Conditions	Indicato r	Paramete r	Opening -2005 (%)				Closing - 2020 (%)			
				weight	High	Medium	Low	High	Medium	Low	
Uttara Kannada	Abiotic ecosystem	Soil	K	0.017	0.0	84.4	15.6	0.0	99.3	0.7	
		Soil	N	0.017	100.0	0.0	0.0	0.0	0.0	100.0	
			P	0.017	0.0	0.0	100.0	37.6	62.4	0.0	
			OC	0.017	0.0	72.4	27.6	0.0	100.0	0.0	
			S	0.017	45.4	54.6	0.0	45.4	54.6	0.0	
			Zn	0.017	0.0	85.8	14.2	0.0	100.0	0.0	
			Fe	0.017	0.0	100.0	0.0	0.0	100.0	0.0	
			B	0.017	0.0	0.0	100.0	0.0	0.0	100.0	
			Cu	0.017	0.0	99.3	0.7	0.0	99.3	0.7	
			Mn	0.017	0.0	100.0	0.0	0.0	100.0	0.0	
			EC	0.017	100.0	0.0	0.0	100.0	0.0	0.0	
			pH	0.017	94.4	5.6	0.0	100.0	0.0	0.0	
	Biotic - Compositional State	Flora		0.05	87.8	5.5	6.7	73.1	5.5	21.4	
		Fauna		0.05	56.3	11.0	32.7	46.9	11.0	42.1	
	Biotic - Structural State	AGB		0.05	46.2	35.2	18.6	33.1	42.1	24.8	
		BGB		0.05	46.2	35.2	18.6	33.1	42.1	24.8	
	Biotic - Functional State	NPP		0.10	32.4	55.2	12.4	1.4	84.8	13.8	
	Landscape Level	Fragmentation			0.25	55.0	10.8	34.2	45.8	13.5	40.8
		LST			0.25	20.6	53.2	26.2	0.6	69.9	29.6
Ecosystem condition Account			Index	1.00	39.6	35.9	24.5	25.8	46.3	28.0	

Note: N: Nitrogen, P: Phosphorous, K: Potash, OC: Organic Carbon, Zn: Zinc, Fe: Iron, B: Boron, Cu: Copper, Mn: Manganese, S: Sulphur, EC: Electrical conductivity, AGB: Above ground biomass, BGB: Below ground Biomass, NPP: Net Primary Productivity, LST: Land Surface Temperature

# Ecosystem services supply accounts (physical units) & Valuation of the ecosystem services



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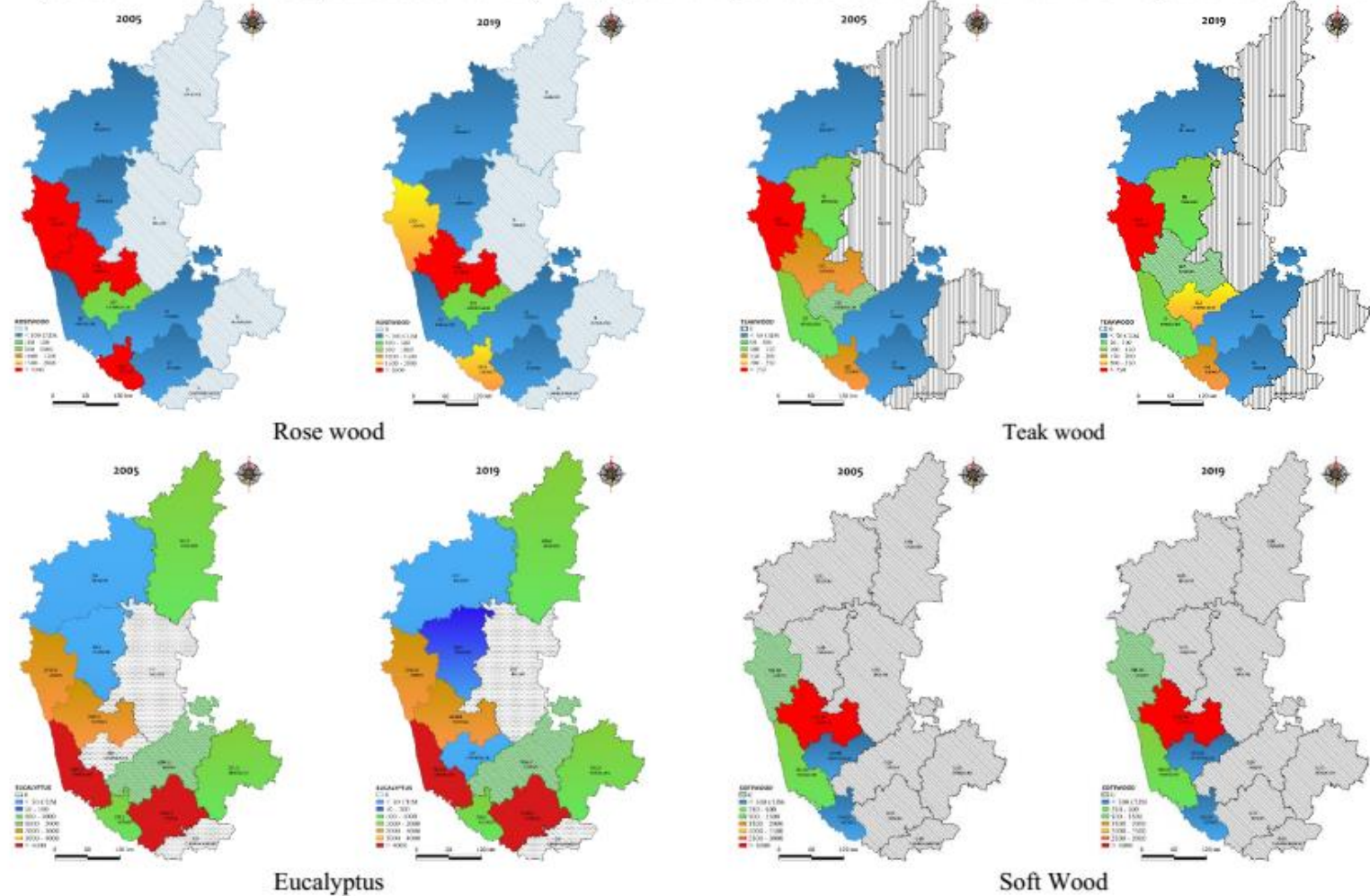
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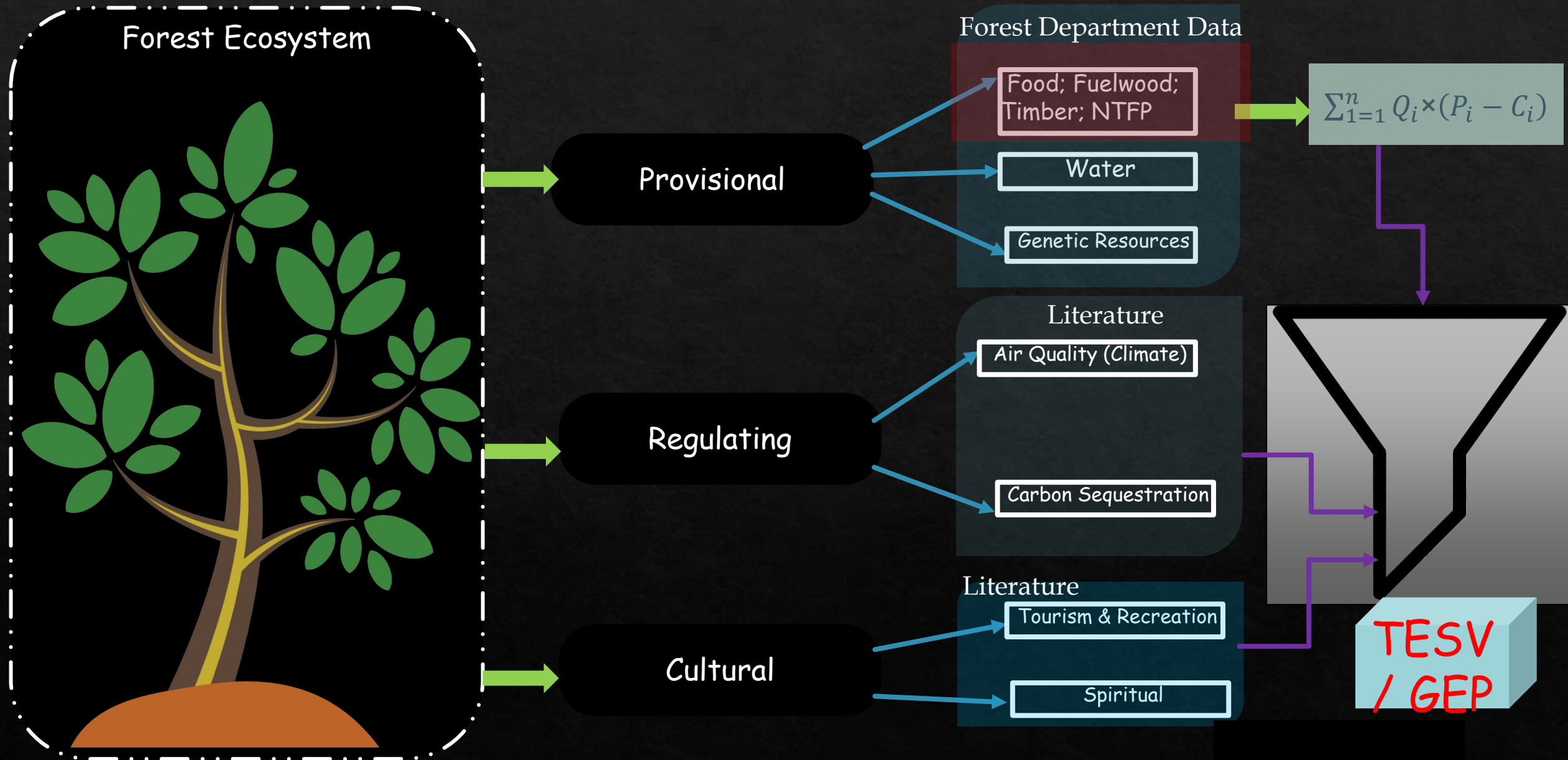


Figure 5.3.1 Timber, Bamboo, and canes extracted (in the physical units) across forest circles in Karnataka for the years 2005 and 2019





# Forest Ecosystems



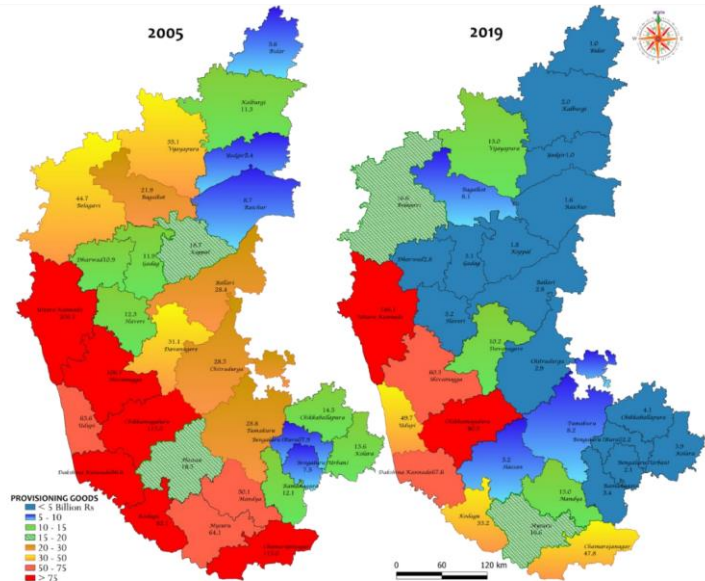


# Provisioning Services

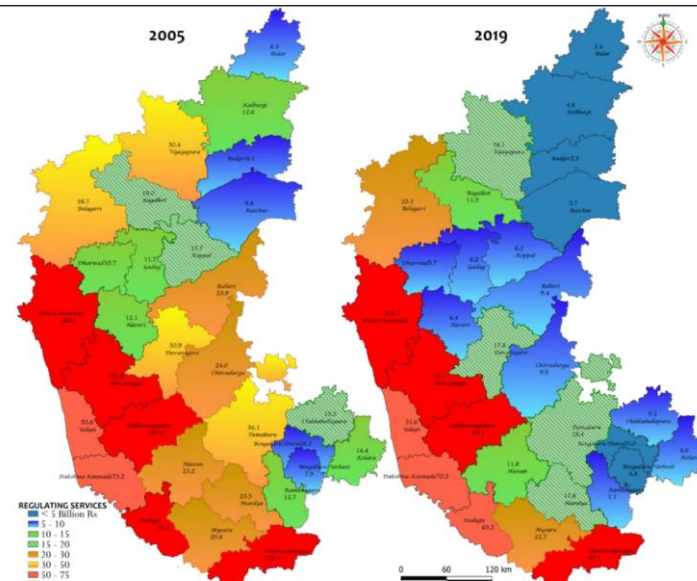
# Regulating Services

# Cultural Services

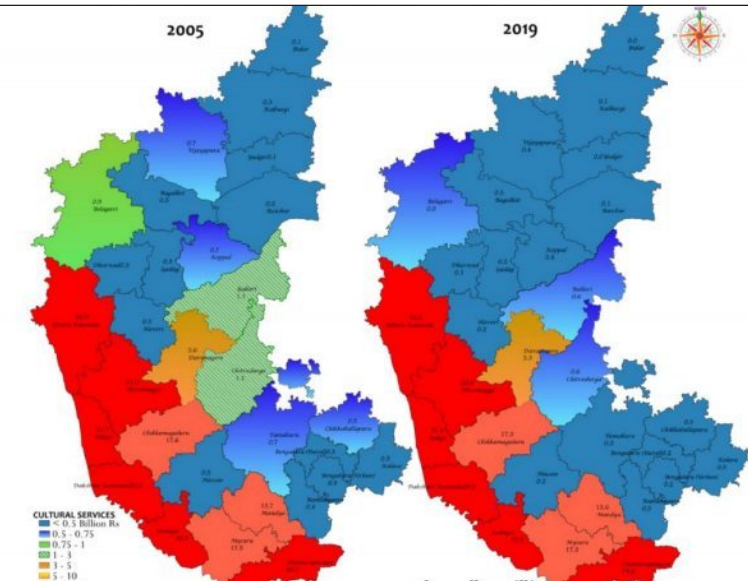
Provisioning Services



Regulating Services



Cultural Services



## TESV - GEP

## Total Ecosystem Supply Value (TESV) of forest ecosystems in Karnataka

2894 billion INR/year (2005) and 1835 billion rupees/year (2019).

TESV

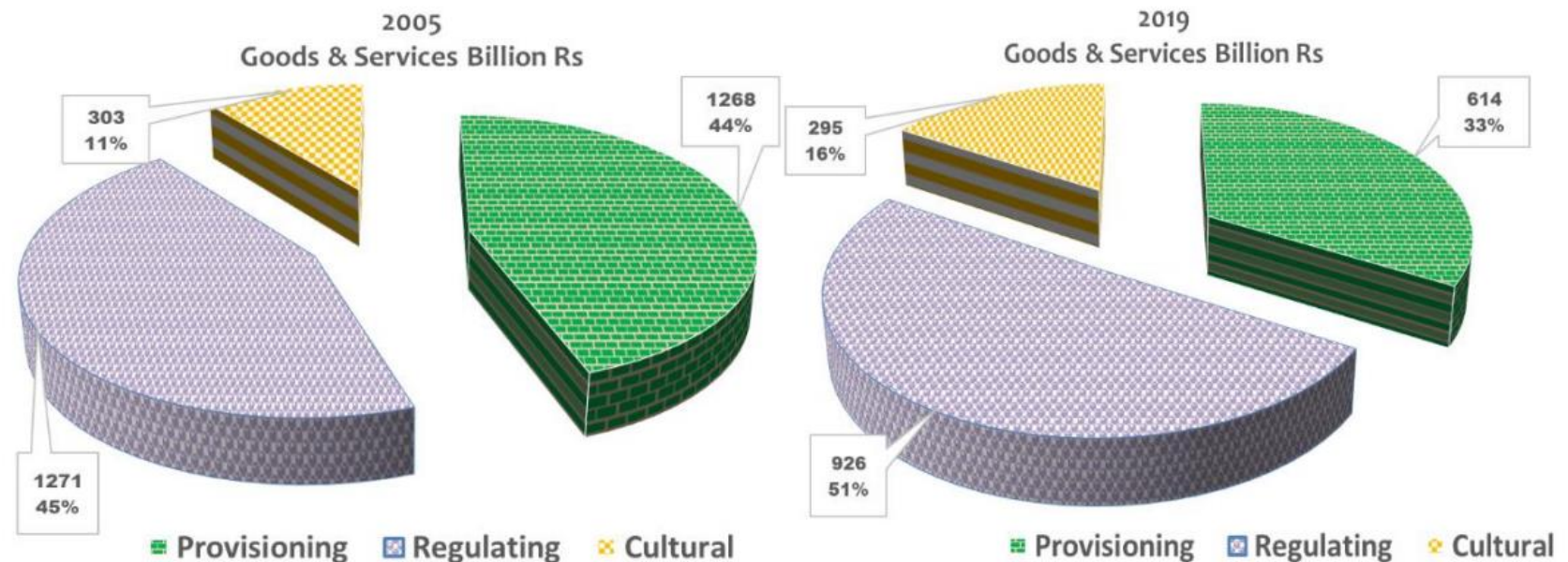
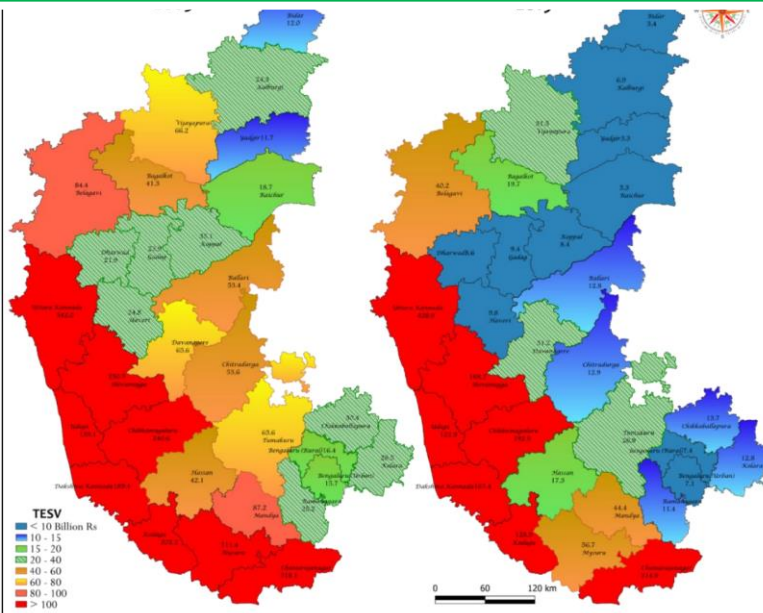


Figure 5.3.32. District-wise TESV (Total Ecosystem Supply Value) of forest ecosystem in Karnataka.



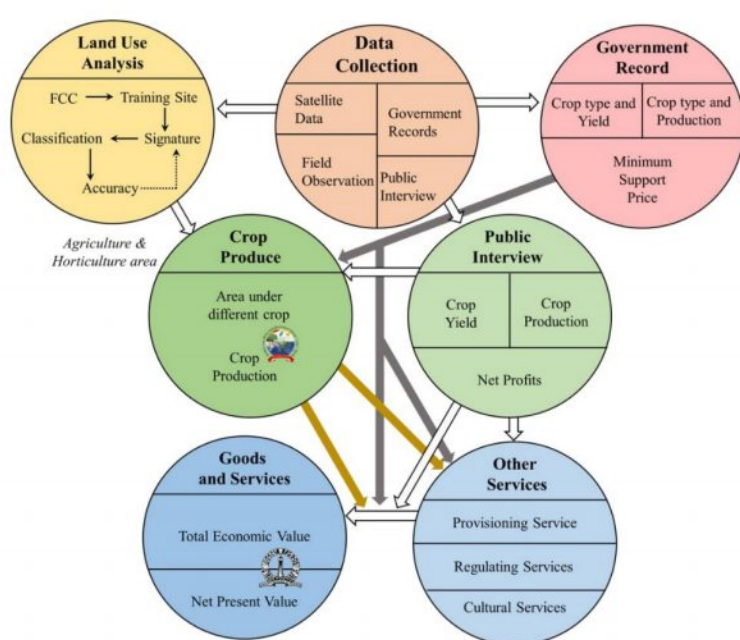


Figure 4.2.1. Method for accounting services in the agriculture ecosystem

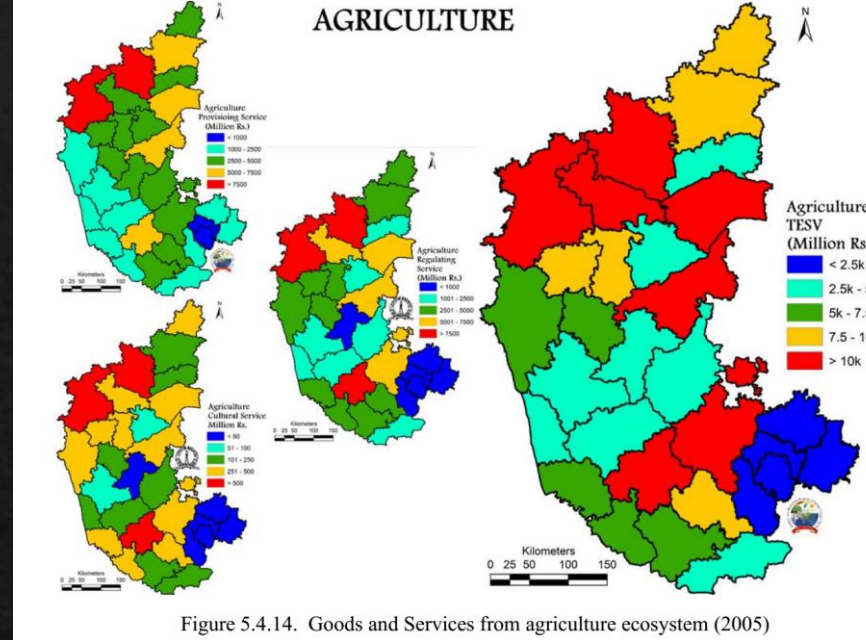


Figure 5.4.14. Goods and Services from agriculture ecosystem (2005)

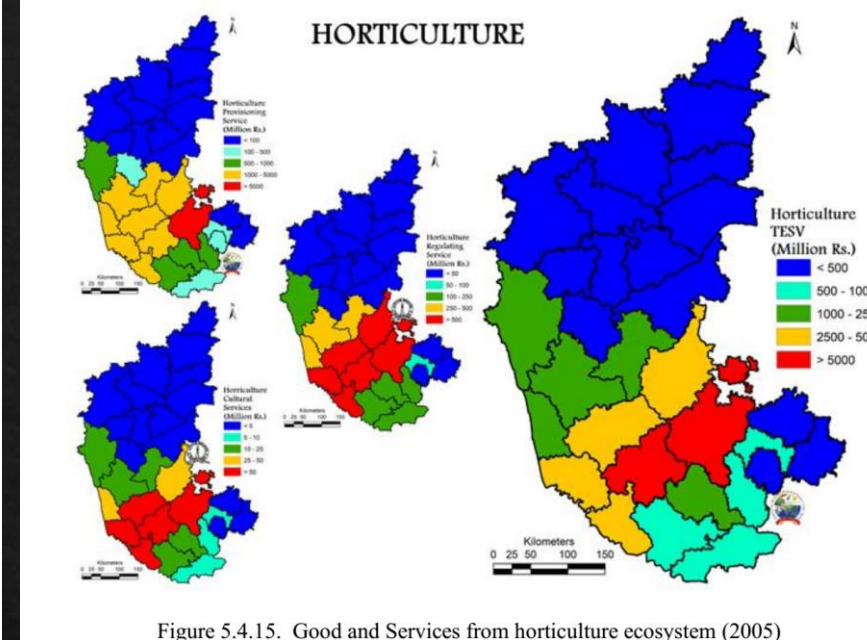


Figure 5.4.15. Good and Services from horticulture ecosystem (2005)

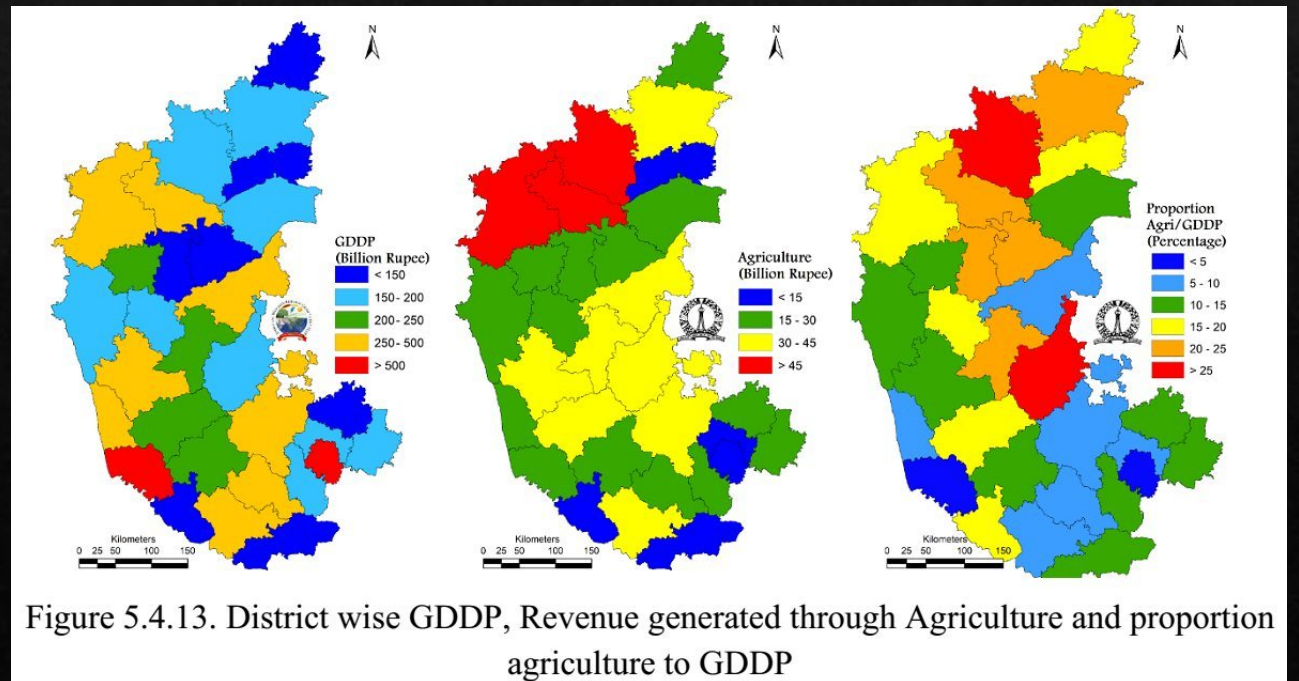
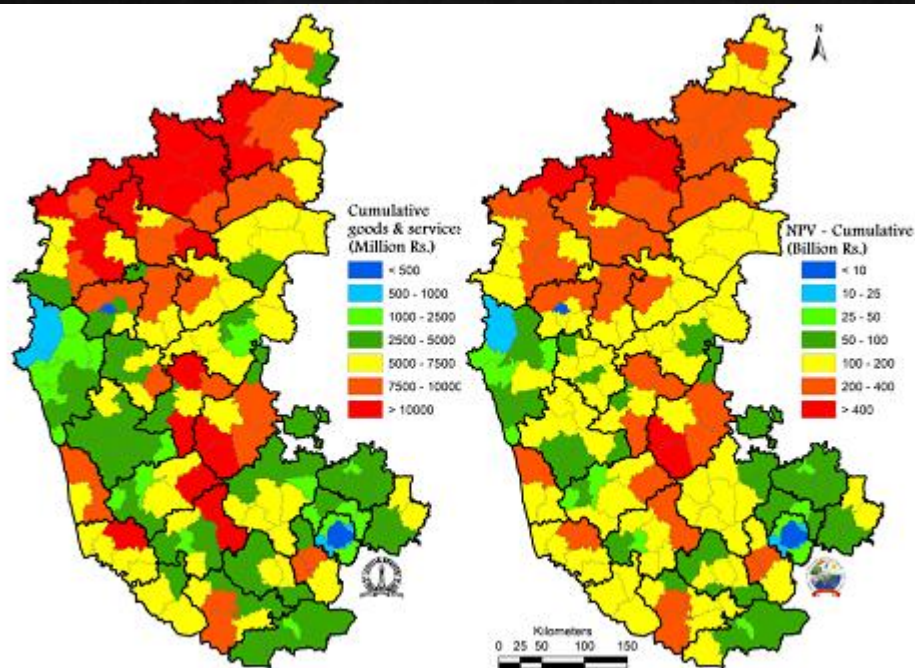


Figure 5.4.13. District wise GDDP, Revenue generated through Agriculture and proportion agriculture to GDDP

**TESV: Total Ecosystem Supply Value; GDDP: Gross District Domestic Product**



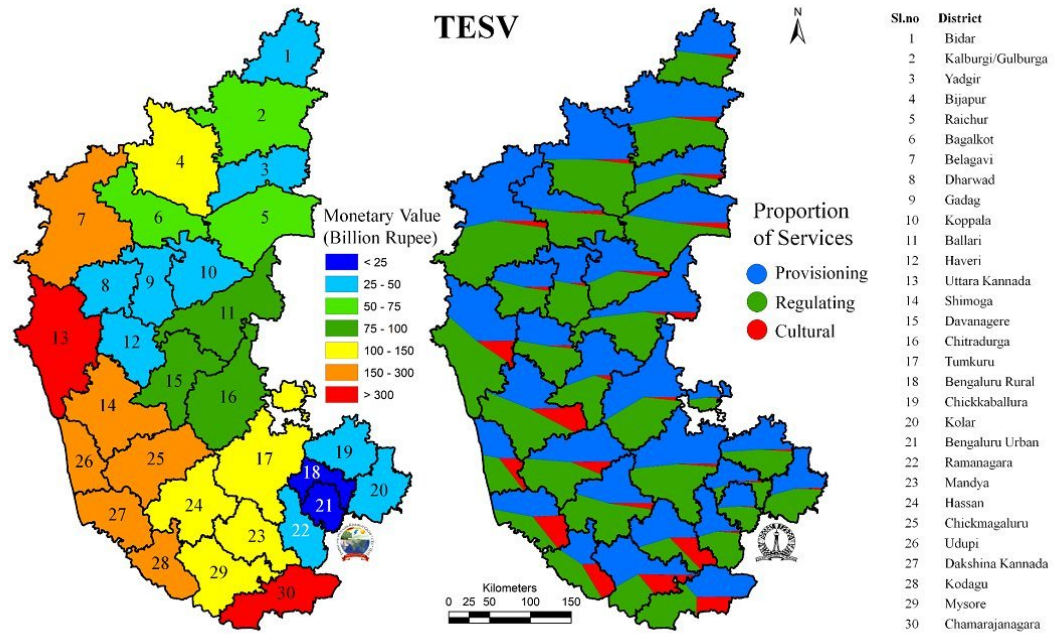


Figure 5.5.1: TESSV – Total Ecosystem Supply Value with the proportion of services (provisioning, regulating and cultural), 2005

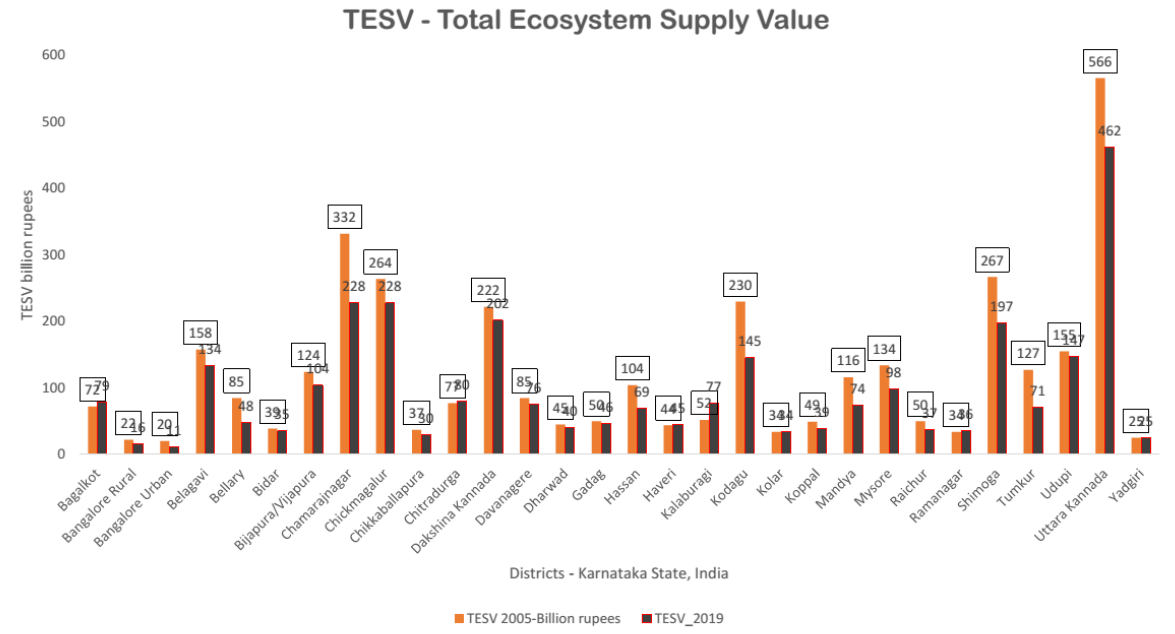


Figure 5.5.4. Comparison of TSEV of 2005 (@2019 monetary value) and 2019

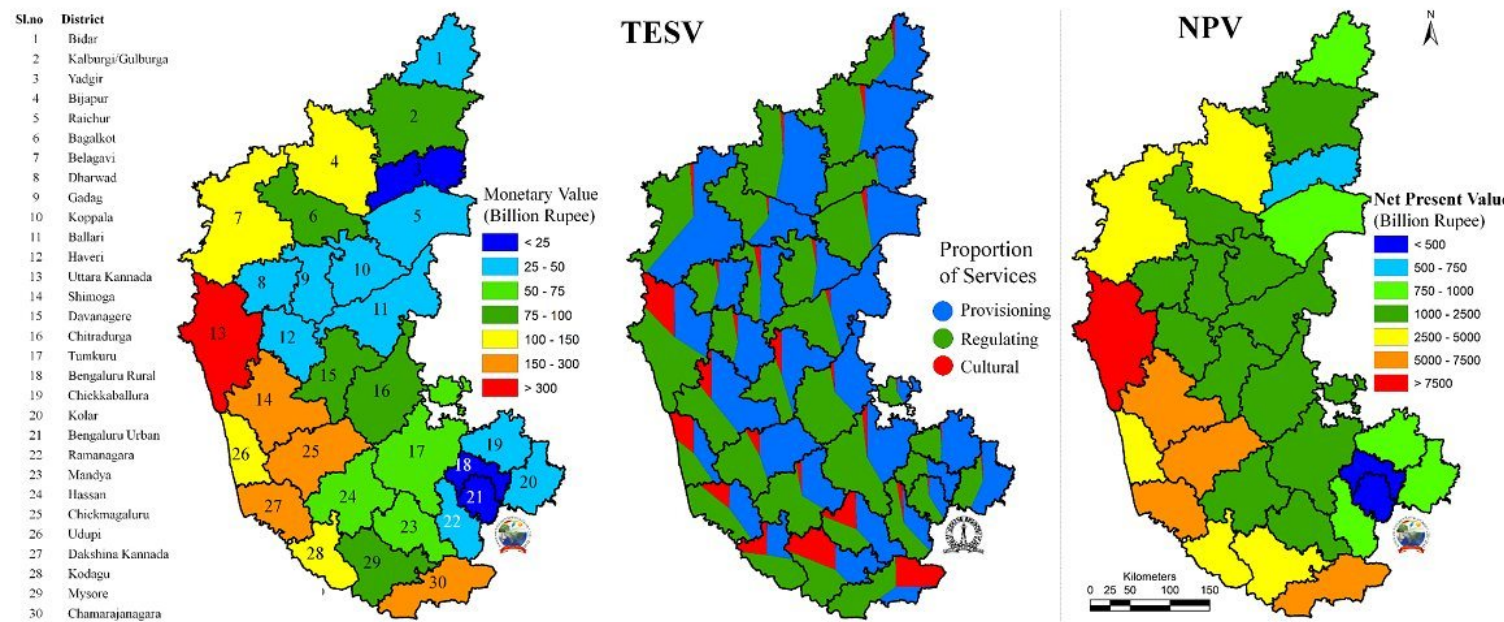


Figure 5.5.2: TESSV with the proportion of services (provisioning, regulating and cultural), and NPV 2019-20



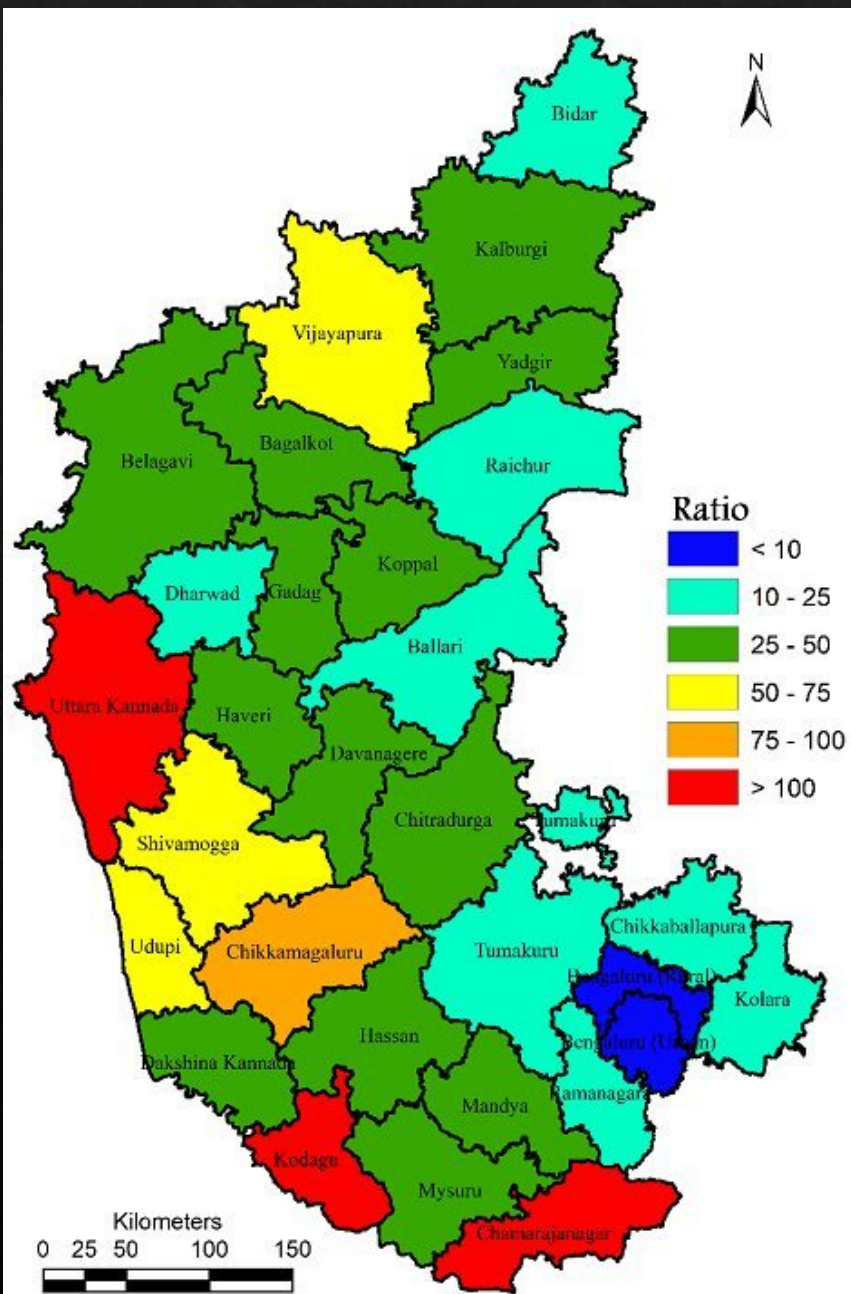


Figure 5.5.6: TESS to GDDP ratio

Table 5.5.4: TESS and Share of TESS in GDDP

District	Revenue Billion Rupee				Ratio		
	TESS Forest	TESS Agriculture	TESS Total	GDDP	Forest	Agriculture	Total
Bagalkot	19.7	59.7	79.4	265.5	7.4	22.5	29.9
Bangalore Rural	7.4	8.5	15.9	162.5	4.6	5.2	9.8
Bangalore Urban	7.1	4.3	11.4	3635.6	0.2	0.1	0.3
Belagavi	40.2	93.7	133.9	454.6	8.8	20.6	29.5
Bellary	12.8	35.2	48.0	334.8	3.8	10.5	14.3
Bidar	3.4	31.6	35.0	144.9	2.4	21.8	24.2
Bijapura/Vijapura	31.5	72.5	104.0	188.1	16.8	38.5	55.3
Chamarajnagar	214.9	12.8	227.7	117.0	183.7	10.9	194.6
Chikmagalur	192.9	35.4	228.3	230.2	83.8	15.4	99.2
Chikkaballapura	13.7	16.4	30.1	144.4	9.5	11.4	20.9
Chitradurga	12.9	66.6	79.6	169.6	7.6	39.3	46.9
Dakshina Kannada	167.4	34.9	202.3	587.2	28.5	5.9	34.4
Davanagere	31.2	45.3	76.5	202.1	15.4	22.4	37.8
Dharwad	8.6	31.0	39.6	244.7	3.5	12.7	16.2
Gadag	9.4	36.7	46.1	109.1	8.6	33.6	42.3
Hassan	17.3	51.5	68.7	236.4	7.3	21.8	29.1
Haveri	9.8	35.2	44.9	155.3	6.3	22.7	28.9
Kalaburagi	6.9	69.7	76.6	195.1	3.5	35.7	39.3
Kodagu	128.9	15.7	144.6	61.6	209.3	25.5	234.8
Kolar	12.8	20.7	33.5	176.6	7.3	11.7	19.0
Koppal	8.4	31.0	39.4	118.9	7.1	26.0	33.1
Mandya	44.4	29.6	73.9	267.3	16.6	11.1	27.7
Mysore	56.7	41.5	98.2	352.1	16.1	11.8	27.9
Raichur	5.3	31.3	36.6	173.5	3.1	18.0	21.1
Ramanagar	11.4	25.0	36.3	159.6	7.1	15.6	22.8
Shimoga	168.2	28.5	196.7	300.5	56.0	9.5	65.5
Tumkur	26.9	44.5	71.4	385.3	7.0	11.6	18.5
Udupi	122.9	24.3	147.2	276.3	44.5	8.8	53.3
Uttara Kannada	438.9	23.0	461.9	186.2	235.7	12.3	248.1
Yadgiri	3.3	21.6	25.0	93.4	3.6	23.2	26.7
KARNATAKA	1835.2	1077.6	2912.8	10128.4	18.12	10.64	28.76

# SCENARIO-BASED ASSESSMENT OF POLICY INTERVENTIONS IN KARNATAKA STATE, INDIA



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(i) Business as usual scenario (BAU)

BAU assumes the current development will continue and evaluates the various agents responsible for the change and forecast what would be the future landscape status

## Policy Context

(ii) Agent based land use transition scenario (ALT)

Various driver's (agents) such as proposed (new) developments by the government, existing and proposed (i) industries, (ii) liner projects, (iii) urbanization, (iv) slope, (v) core built-up areas, (vi) special economic zones (SEZ) etc., responsible for the land use changes in the neighborhood.

(iii) Reserve Forest Protection (RFP) and stringent conservation of national parks and sanctuaries scenario

Spatial extent of reserve forests, national parks, sanctuaries are maintained with strict regulations. Absence of abrupt land use change.

(iv) Afforestation (High conservation) scenario (AF)

Considering afforestation initiatives, agents are -same as (ii);  
Spatial extent of afforestation data (during the past decade) and proposed afforestation

(v) SDP-Sustainable Development Policy Scenario

Sustainable development policy scenario ensures (i) the protection of reserve forests and (ii) afforestation and hence includes the constraints same as scenario 3 & 4 and allows the growth in regions other than forest area.



# Modeling Landscape Dynamics: Scenario based Analysis

Modeling of landscape dynamics  
Hybrid Fuzzy  
Analytical Hierarchy  
Process (AHP) based  
Spatial  
Markov chains (MC)  
Cellular automata  
(CA)  
(Fuzzy AHP-MCA)  
technique  
using temporal data.

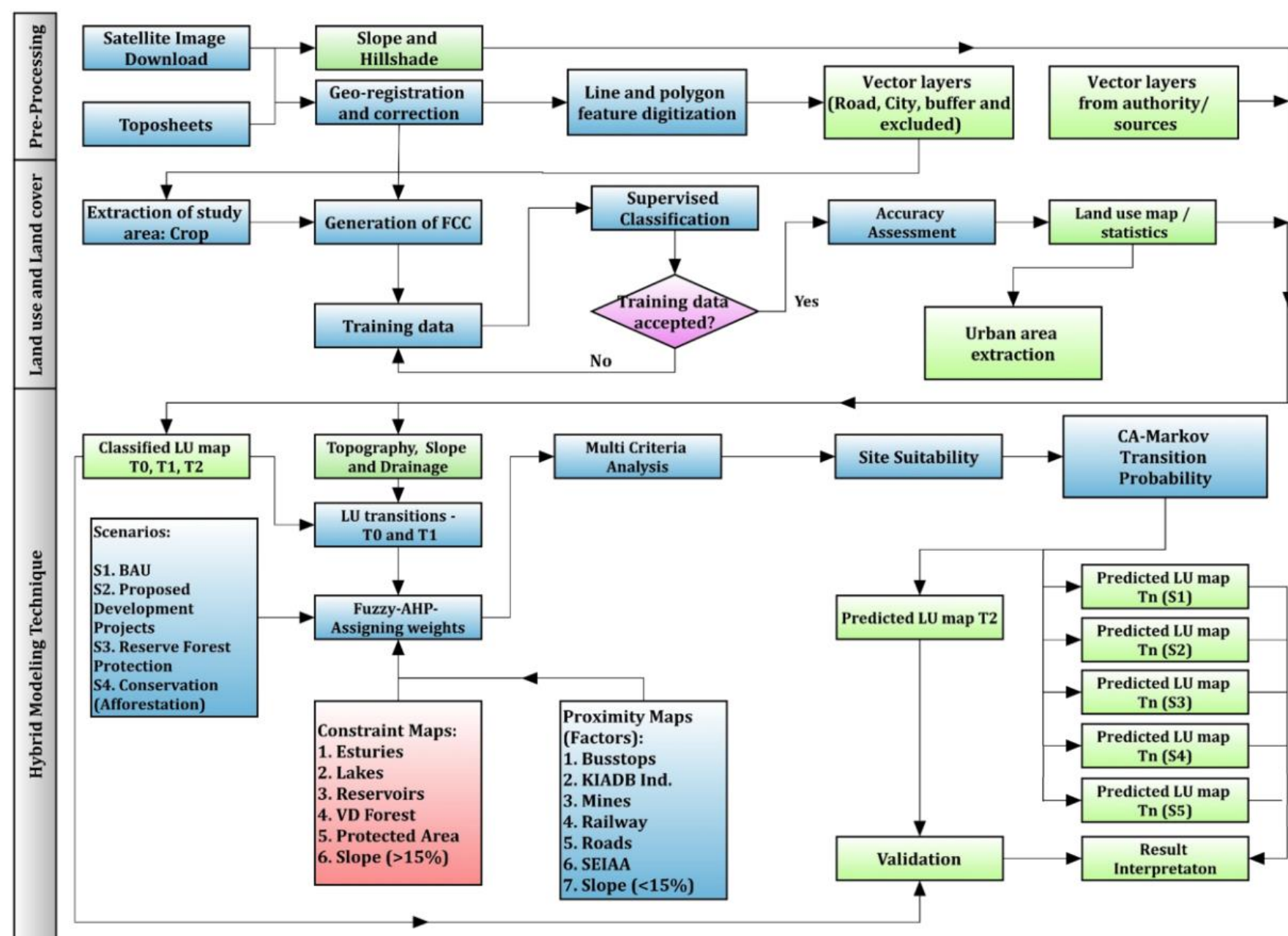
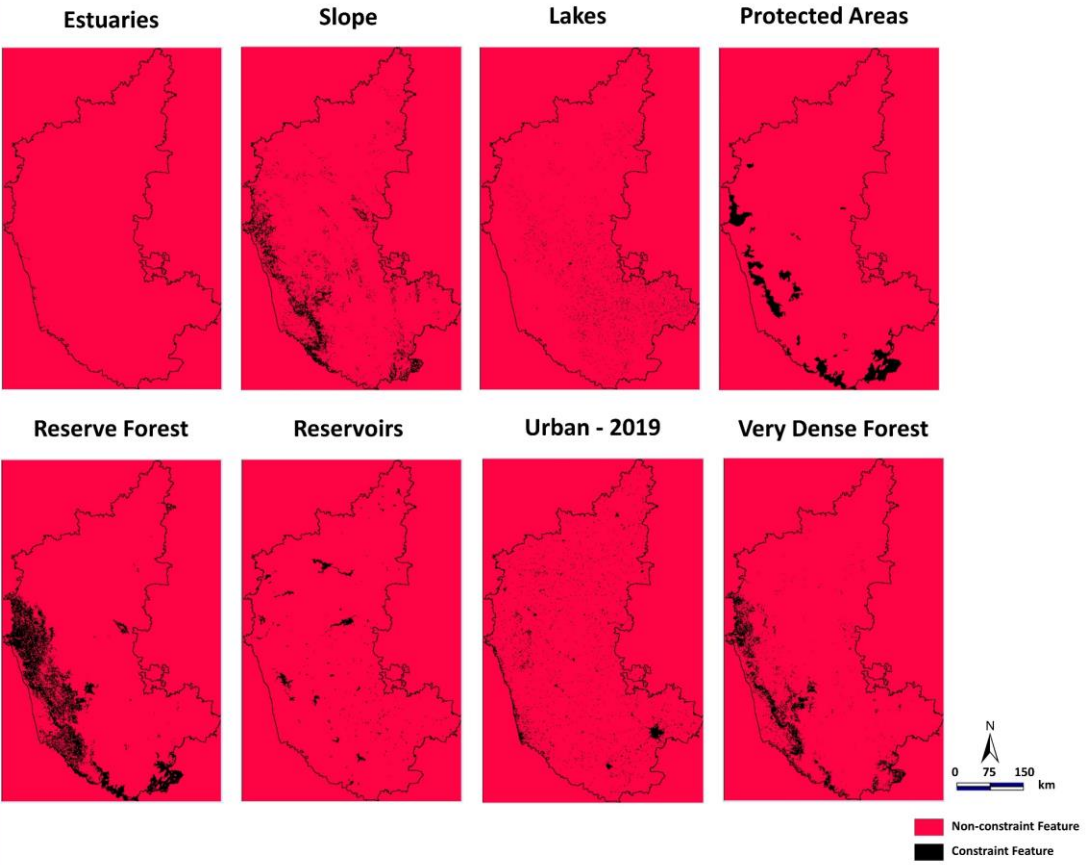


Figure 4.5: Method adopted to analyze land use transitions in the Karnataka region



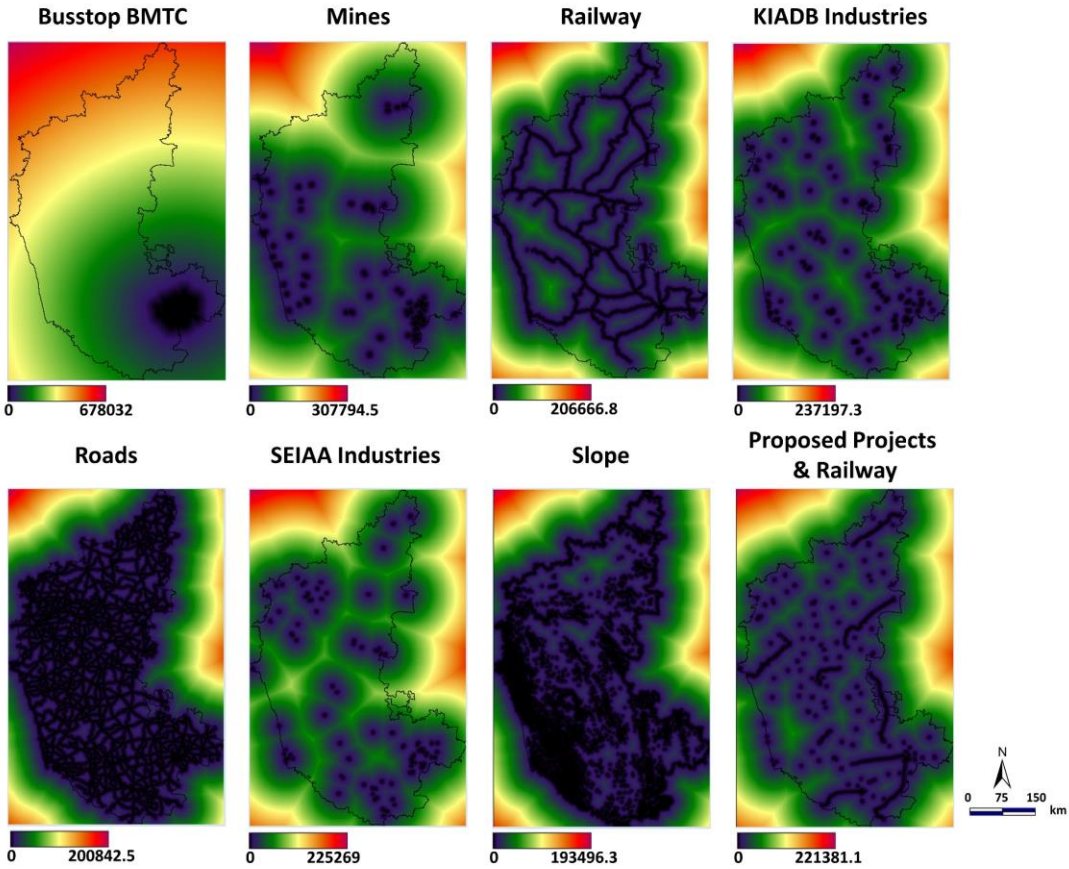
# Model Constraints:

## CONSTRAINT MAPS



# Agents

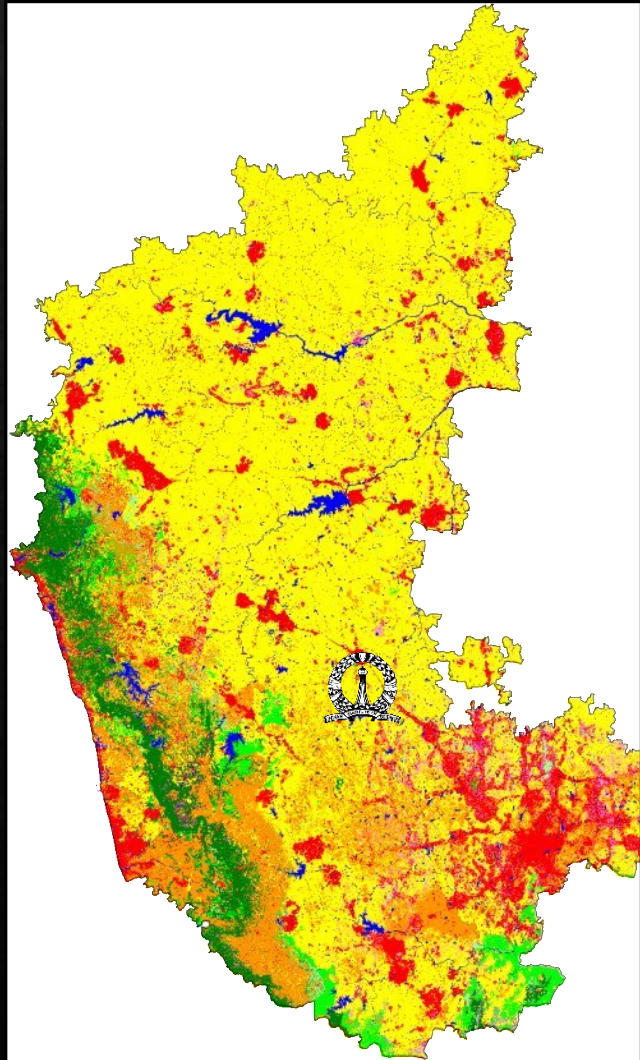
## DISTANCE MAPS



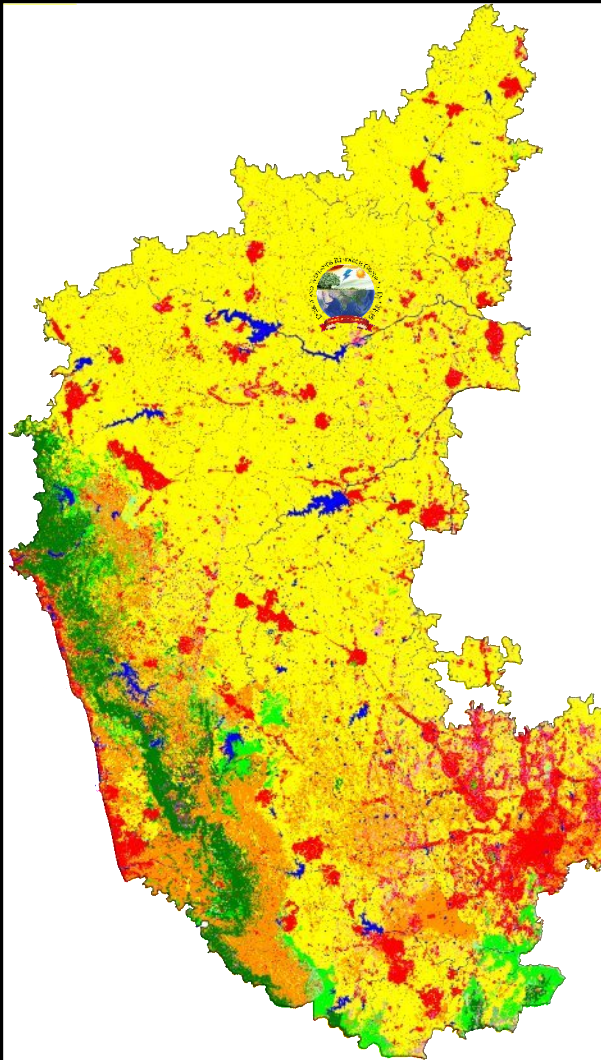


# Scenarios: BAU, ALT, RFP, AF

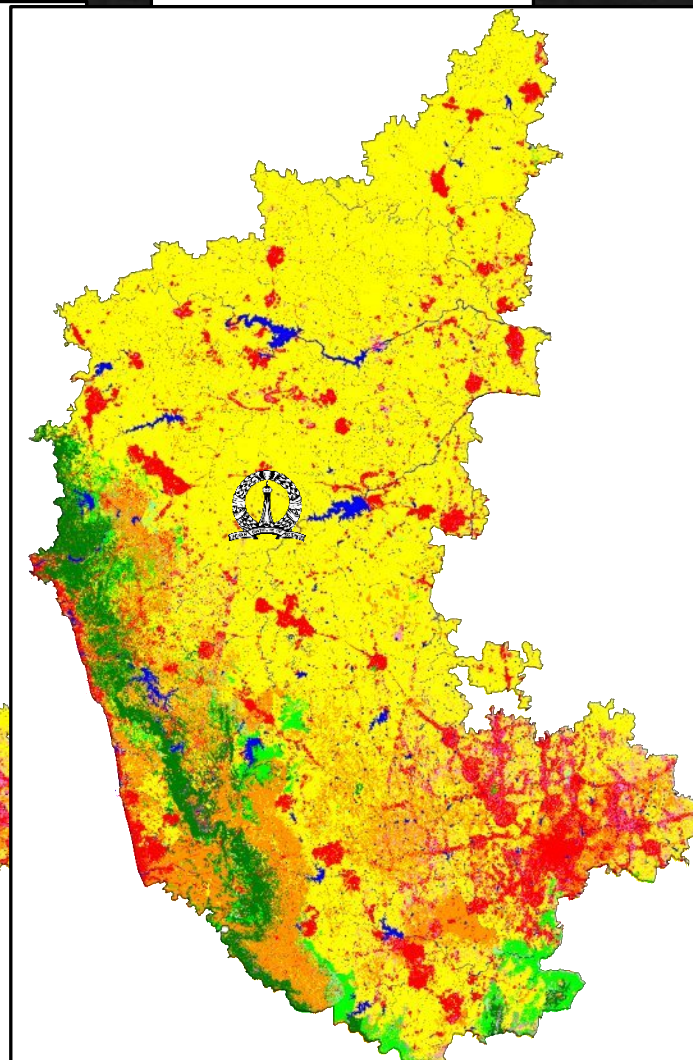
BAU: 2033



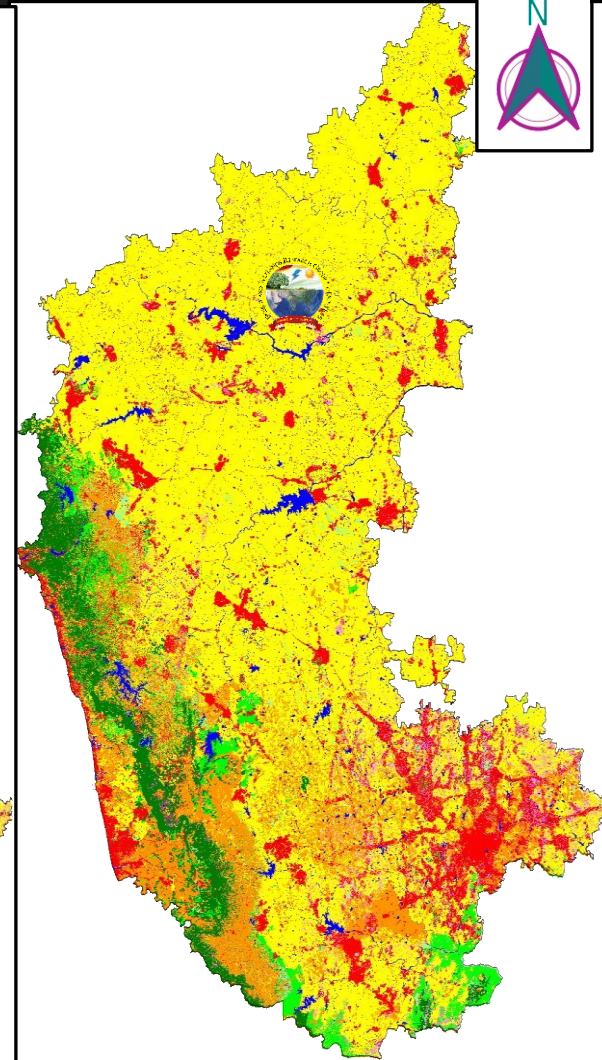
ALT: 2033



RFP: 2033



AF: 2033





Land use categories	Land use distribution in 2033 (ha and %)									
	BAU_2033		ALT_2033		RFP_2033		AF_2033		SDP_2033	
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	22,01,515	11.48	28,10,015	14.65	21,70,349	11.32	21,46,203	11.19	20,71,994	10.76
Agriculture	1,17,64,649	61.34	113,30,926	59.08	1,18,94,624	62.02	1,18,58,568	61.83	1,16,67,178	60.88
Plantation	21,77,670	11.35	20,66,713	10.78	21,98,428	11.46	21,69,239	11.31	21,52,053	11.23
Open fields	6,68,824	3.49	6,68,824	3.49	6,85,063	3.57	6,68,824	3.49	6,85,063	3.57
Evergreen Forest	9,20,948	4.80	9,15,179	4.77	9,32,811	4.86	9,59,097	5.00	9,72,489	5.07
Moist Deciduous Forest	5,77,449	3.01	5,72,085	2.98	5,41,381	2.82	5,75,213	3.00	6,66,957	3.48
Dry Deciduous	1,52,389	0.79	1,51,217	0.79	1,24,597	0.65	1,56,922	0.82	2,36,863	1.24
Scrub_Grass	1,15,952	0.60	1,14,432	0.60	91,496	0.48	97,938	0.51	1,96,677	1.01
Water	5,99,704	3.13	5,49,709	2.87	5,40,351	2.82	5,47,096	2.85	5,29,826	2.76
Total	1,91,79,100									

Ecosystem: Forests (in Billion Rupees)						
Policy Scenarios						
Services Type	2019	BAU	ALT	RFP	AF	SDP
Provisioning Goods	613.90	524.23	521.67	533.69	530.82	540.33
Regulating Services	926.36	724.85	716.94	720.78	725.33	824.59
Cultural Services	294.97	291.69	291.62	291.67	291.68	293.23
Total	1835.23	1540.77	1530.23	1546.14	1547.83	1658.15

Figure 5.14: Relative share of ecosystem services (forest ecosystems), 2019

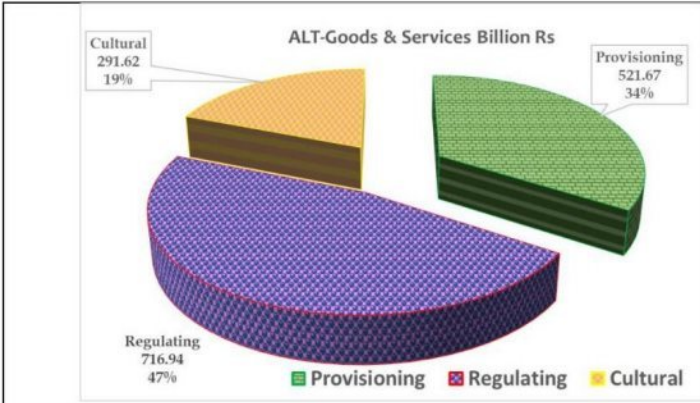
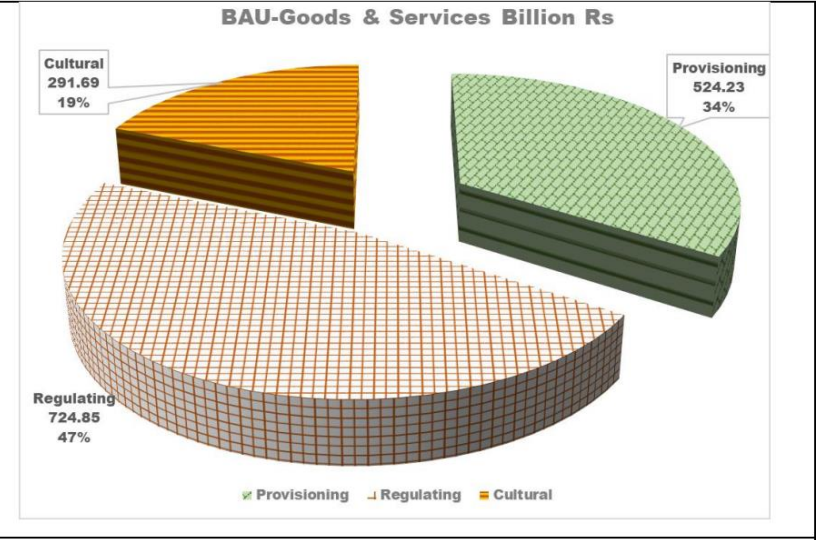
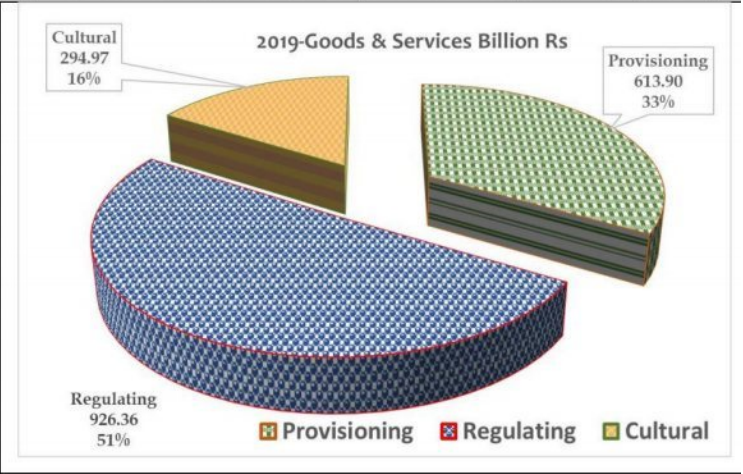


Figure 5.13b: Relative Share of Forest Ecosystem Services, 2033 (ALT Scenario)

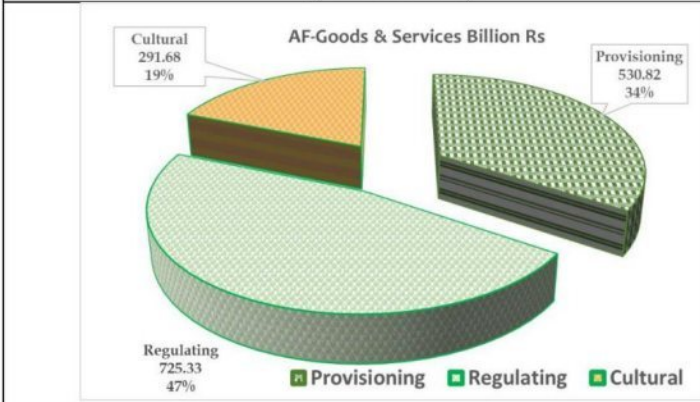


Figure 5.13d: Relative Share of Forest Ecosystem Services, 2033 (BAU Scenario)

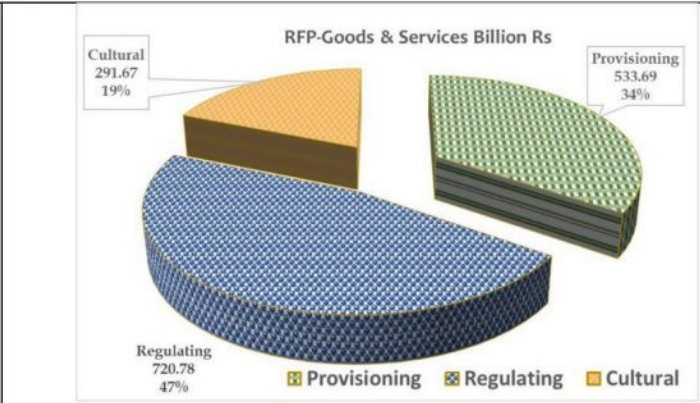


Figure 5.13c: Relative Share of Forest Ecosystem Services, 2033 (RFP Scenario)

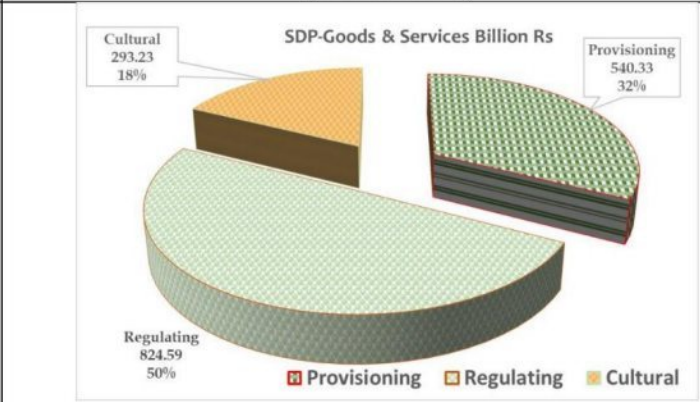


Figure 5.13f: Relative Share of Forest Ecosystem Services, 2033 (BAU Scenario)

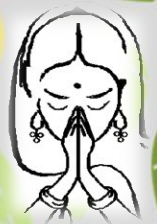


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- ◇ **Dr. Bhanumati of The Ministry of Statistics and programme Implementation, Gol.**

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- ❖ **The NCAVES project is being carried out as a collaboration between United Nations environment programme (UNEP), United Nations Statistics Division (UNSD), the Ministry of Statistics and Programme Implementation (MoSP), Government of India and The ENVIS division, The Ministry of Environment Forests and Climate Change (MoEFCC), Government of India.**





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