

**Table S1.** A catalog of seventy-three published studies between 1993 to 2021 (so far) on forest mapping using remotely sensed data in Pakistan

Reference	Study Area	District/ Province	Study Scale	Area (km <sup>2</sup> )	Forest area (km <sup>2</sup> ) of District/ Province extracted from GFW/ GMW	Latitude	Longitude	Altitude (m)	Forest Type	RS Data/Imagery Used
<b>Pre-2010</b>										
[1]	Margala Hills, Islamabad	Islamabad (Part of)	Local	148	102	33.75	73.00	457.2 - 1584.96	-	SPOT XS, Landsat TM and Landsat MSS
[2]	Margalla Hills, Islamabad	Islamabad (Part of)	Local	126	102	33.77	73.09	2200 (max)	Sub-Himalayan Tract Forest	SPOT XS and Landsat 5 TM
[3]	Siran Valley, NWFP	Mansehra (Part of)	Local	618	1385	34.52	73.12	900	Tropical Dry Deciduous forests	Landsat MSS and TM
[4]	Keti Bunder, Sindh	Thatta (Part of)	Local	82	34	24.41	67.43	-	mangroves, mixed terrestrial vegetation (mainly Prosipus sp.) and marine algae	Landsat, ASTER (Terra) and SPOT
[5]	Riverine forests of Sindh	Kashmore (Part of)	Regional	2410	1	28.09	69.18	-	Riverine forests or Bela forests	Landsat MSS and TM
[6]	Ayubia National Park (ANP), NWFP	Abbottabad (Part of)	Local	34	765	34.06	73.42	1800 - 2980	Moist Temperate Himalayan Forest	Quickbird
<b>Post-2010</b>										
[7]	District Abbottabad	Abbottabad (Part of)	Local	1967	765	34.12	73.28		Urban forest	Landsat TM, ETM, and ETM+
[8]	Abbottabad district, Khyber Pakhtunkhwa	Abbottabad	Local	4600	765	34.11	73.29		Urban forest	SPOT-5
[9]	Abbottabad	Abbottabad	Local	4999	765	34.10	73.28	-	Urban forest	SPOT-5

	district, KPK										
[10]	Abbotta bad district, KPK	Abbottaba d (Part of)	Local	1756	765	34.13	73.23	-	Urban forest	Landsat 5 TM	
[11]	Abbotta bad district, KPK	Abbottaba d (Part of)	Local	1967	765	34.13	73.25	-	Alpine forest	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI	
[12]	Chitral tehsil, NWFP	Chitral (Part of)	Local	5818	247	35.77	71.77	1063- 6628	Dry Temperat e Forests (dry temperate oak forest, dry temperate coniferous forest, and alpine meadow)	Landsat TM	
[13]	Kalasha valleys, Chitral District, KPK	Chitral (Part of)	Local	456	247	35.69	71.67	1070- 7700	Conifer species	Landsat	
[14]	Kalasha valleys, Chitral District, KPK	Chitral (Part of)	Local		247	35.71	71.69	-	Dry temperate coniferous forests	Landsat MSS, TM ETM+ and OLI	
[15]	Chitral district, KPK	Chitral	Local	14850	247	36.69	73.23	1070- 7700	Dry temperate coniferous , Deciduous forests and oak scrub forests	Landsat	
[16]	Tehsil Barawal , District Dir, KPK	Dir (Lower)	Local	391	257	34.98	71.93	-	Coniferou s Forests mixed with broadleav ed Forest	Landsat 5	
[17]	Dir district, Khyber Pakhtun khwa	Dir (Upper and Lower)	Local	4198	1276	35.20	71.88	-	Temperat e conifer forests	SPOT and MODIS	
[18]	Dir Kohista n forest division, Khyber Pakhtun khwa	Dir (Part of Upper Dir)	Local	927	1019	35.28	72.00	1165- 4847	subtropica l broadleav es Oak forest, temperate coniferous forest and	SPOT-5	

									alpine and subalpine regions	
[19]	Dir Kohistan Forest Division, Khyber Pakhtunkhwa	Dir (Part of Upper Dir)	Local	99	1019	35.29	72.01	1379-3035	Subtropical Oak Forest and Dry Temperate Coniferous Forest	Landsat 8 OLI, SPOT-5
[20]	Dir valley, KPK	Dir (Upper and Lower)	Local		1276	35.25	72.00	1400-5000	coniferous, alpine forests	Land-use survey maps
[21]	Central Karakoram National Park (CKNP), Gilgit-Baltistan	Gilgit (Part of)	Local	10000	148	35.92	74.83	1400-7788	-	SPOT-5
[22]	Bagrote valley, Gilgit Baltistan	Gilgit (Part of)	Local	4	148	35.83	74.47	1500-3700	Alpine, Sub-Alpine, Coniferous Forests	Sentinel-2
[23]	Khyber Pakhtunkhwa (KP) province, the administrative unit of Gilgit-Baltistan (GB) and the state of Azad Jammu and Kashmir (AJK)	Gilgit-Baltistan, Khyber Pakhtunkhwa, and Azad Jammu & Kashmir	Regional	182600	15103	34.25	73.25	350-4900	Alpine Scrub, Sub Alpine Forests, Dry Temperate Forests, Moist Temperate Forests, Sub-Tropical Coniferous Forests, Sub Tropical (broad leaved) Forests, and Tropical Dry Deciduous Forests	Landsat TM/ETM
[24]	Khyber Pakhtunkhwa (KP), Gilgit Baltistan (GB)	Gilgit-Baltistan, Khyber Pakhtunkhwa, and Azad	Regional	183000	15103	35.76	73.36	1500-3300	evergreen conifers, including some deciduous broad-leaved	MODIS

	and Kashmir	Jammu & Kashmir								and conifer species	
[25]	Gilgit-Baltistan (GB), Khyber Pakhtunkhwa (KP), and Azad Jammu Kashmir (AJK)	Gilgit-Baltistan, Khyber Pakhtunkhwa, and Azad Jammu & Kashmir	Regional	85435	15103	36.40	73.31	-		Subalpine scrub zones, alpine dry steppes and alpine meadows	Landsat 5 TM and Landsat 8 OLI
[26]	Rawal Watershed, Islamabad	Islamabad (Part of)	Local	274	102	33.70	73.12	1800		Forest, Conifer Forest, Dry Semi Evergreen Forest	Landsat 5 (TM)
[27]	Simly Watershed, Islamabad	Islamabad (Part of)	Local	164	102	33.70	73.12	-		Conifer Forest and Dry Semi Evergreen Forest	Landsat 5 (TM) and SPOT
[28]	Islamabad	Islamabad	Local	907	102	33.82	72.40	457-610		Margalla Hills	Landsat 5 TM imagery and SPOT 5 imagery
[29]	Margalla Hills National Park (MHNP), Islamabad	Islamabad (Part of)	Local	174	102	33.73	73.07	469-1560		subtropical broad-leaved evergreen, subtropical chir pine forests	Landsat 5 TM, 7 ETM, 5 TM, 8 OLI
[30]	Margalla Hills National Park (MHNP), Islamabad	Islamabad (Part of)	Local	571	102	33.75	73.01	-	-		Landsat 7 (ETM+), Landsat 8 (OLI)
[31]	Islamabad	Islamabad	Local	907	102	33.74	73.08	-	-		Landsat 5 and 8
[32]	Islamabad	Islamabad	Local	906	102	33.47	72.81	400-650		Subtropical broadleaves and pine forests	Landsat-5 TM TIRS and Landsat-8 OLI/TIRS
[33]	Islamabad Capital	Islamabad	Local	906	102	33.47	72.81	1175		Subtropical forest	Landsat 3 MSS, Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI

Territory (ICT)											
[34]	Islamabad	Islamabad	Local	906	102	33.72	73.08	457-610	Thick and mixed forest land	Landsat Multi-Spectral Scanner (MSS), Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETMp) and Operational Land Imager (OLI)	
[35]	Islamabad	Islamabad	Local	906	102	33.72	73.08	457-610	evergreen broadleaf forests and subtropical evergreen coniferous, deciduous broadleaf forest	Landsat 4/5 MSS/ TM, Landsat 7 ETM+ and Landsat 8 OLI	
[36]	Indus Delta and Sandspit, Sindh Miani Hor (Sonmiani bay), Kalamat Khor and Jiwani (Gwadar bay), Balochistan	Mangrove Sites of Pakistan	National	-	680	Indus Delta, 24.144 Sandspit, 24.836 Sonmiani, 25.2001 Kalamat Khor, 25.4035 Jiwani, 25.0234	Indus Delta, 67.6412 Sandspit, 66.933 Sonmiani, 66.74 Kalamat Khor, 64.039 Jiwani, 61.741	-	Mangroves Forest	ALOS - AVNIR-2	
[37]	Indus Delta and Sandspit, Sindh Sonmiani, Kalamat Khor and Jiwani, Balochistan	Mangrove Sites of Pakistan	National	1580	680	Indus Delta, 24.144 Sandspit, 24.836 Sonmiani, 25.2001 Kalamat Khor, 25.4035 Jiwani, 25.0234	Indus Delta, 67.6412 Sandspit, 66.933 Sonmiani, 66.74 Kalamat Khor, 64.039 Jiwani, 61.741	100	Mangroves Forest	ALOS - AVNIR-2	
[38]	Indus Delta, Sandspit, Sindh Sonmiani, Kalamat	Mangrove Sites of Pakistan	National	9538	680	Indus Delta: 23.957 Sandspit: 24.8399 Sonmiani: 25.5343	Indus Delta: 67.5015 Sandspit: 66.9478 Sonmiani: 66.3945 Kalamat	-	Mangrove forest	Landsat-5 TM, Landsat-7 ETM+ and Landsat-8 OLI	

	Khor and Jiwani, Balochistan					Kalamat Khor: 25.4105 Jiwani: 25.1678	Khor: 64.0827 Jiwani: 61.7558			
[39]	District Mansehra, KPK	Mansehra	Local	4296	1385	34.72	73.49	975	Tropical forest	Landsat 5 and 8
[40]	District Mansehra and District Battagram, KPK	Mansehra and Battagram (Part of)	Local	1802	1847	34.50	73.04	-	-	Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI
[41]	Murree Galliat area, Punjab	Rawalpindi (Part of)	Local	468	712	33.86	73.36	550-2600	Himalayan subtropical pine forests	SPOT-5
[42]	Foothills of the Himalayan Mountains, Punjab	Rawalpindi (Part of)	Local	622	712	33.82	73.36	513-2267	Sub-tropical and moist temperate forests	Landsat-5 TM and Landsat-8 OLI/TIRS
[43]	Shaheed Benazirabad district, Sindh	Shaheed Benazirabad (Part of)	Local	20	11	26.10	68.25	30	Pai forest	Landsat TM/ETM/OLI & TIRS
[44]	Pai forest, District Shaheed Benazirabad, Sindh	Shaheed Benazirabad (Part of)	Local	19	11	26.11	68.25	4m-33m	Pai forest	Landsat-8 OLI/TIRS
[45]	District Swat, NWFP	Swat	Local	5037	939	35.17	72.46	500-6500	Coniferous Forests	Aerial Photographs and Sattelite Imagery
[46]	Swat and Shangla districts, NWFP	Swat and Shangla	Regional	4109	1478	34.73	72.56	500-4000	Western Himalayan subalpine conifer forest and Himalayan subtropical pine forests	Landsat5 TM, Landsat7 ETM+, SPOT5 HRV
[47]	District Swat, NWFP	Swat	Local	5037	939	35.17	72.46	500-6500	Coniferous Forests	Aerial Photographs and Sattelite Imagery
[48]	Swat Valley, KPK	Swat	Local	5337	939	35.06	70.79	-	Tropical deciduous to Alpine	Landsat

[49]	Kumrat, KPK	Swat (Part of)	Local	346	939	35.56	72.43	2000-6000	coniferous forest	Landsat 5 TM, 8 OLI
[50]	Kumrat valley, KPK	Swat (Part of)	Local	346	939	35.65	72.30	2000-6000	Cedrus deodara forest (CD), Pinus wallichiana forest (PW), Abies pindrow (AP) and mixed coniferous forest	Landsat 8 OLI
[51]	Swat Valley, KPK	Swat	Local	5392	939	35.00	72.30	-	-	Landsat TM, ETM+ and OLI/ TIRS
[52]	Indus Delta, Sindh	Thatta (Part of)	Local	1010	34	24.25	67.71	-	Mangrove s Forest	Landsat TM and Landsat 8 OLI
[53]	Thatta district,, Sindh	Thatta (Part of)	Local	17361	34	24.58	67.92	-	Riverine forest/ Mangrove forest	Landsat
[54]	Indus Delta, Sindh	Thatta (Part of)	Local	11962	34	23.94	67.65	-	Mangrove s Forest	Landsat-7 ETM+ and Landsat-8 OLI/TIRS
[55]	Thatta River, Indus River Basin, Sindh	Thatta (Part of)	Local	942	34	24.66	67.97	-	Riverine Forest	Landsat 3 MSS, Landsat 5 TM
[56]	Sukkur and Shikarpur division' s forests, Sindh	Sukkur and Shikarpur (Part of)	Regional	1997	12	28.00	69.12	-	Riverine forests or Bela forests	Landsat MSS and TM
[57]	Muzaffarabad district, Azad Jammu and Kashmir (AJK)	Muzaffarabad	Local	740	724	34.28	73.64	-	Subtropical evergreen dry broad-leaved forests, subtropical chir pine forests and temperate broad leaved and coniferous forests	Landsat TM

[58]	Thak Valley, Khyber Pakhtunkhwa	Diamir (Part of)	Local	213	570	35.15	74.05	-	-	Landsat ETM
[59]	Chichawatni Irrigated Plantation, Sahiwal District, Punjab	Sahiwal (Part of)	Local	47	3	30.53	72.66		Dalbergia sissoo Forest Plantation	SAR (ALOS-2 PALSAR) dual-pol imagery and WorldView-3 satellite image
[60]	Besham Watershed, KPK	Buner (Part of)	Local	6812	464	34.50	72.50	-	-	Landsat 5 TM
[61]	Karakoram Highway (N-35), KPK and GB	Gilgit-Baltistan and Khyber Pakhtunkhwa (Part of)	Regional	4200	11042	34.91	72.87	4,693	Conifers and pine forests	Landsat 4-5 MSS, Landsat 7 ETM and Landsat 8 OLI
[62]	Peshawar, KPK	Peshawar	Local	1257	9	34.02	71.58	331	Urban forest	Landsat 5, 7 and 8
[63]	Mangla Dam, Mirpur District, Azad Jammu and Kashmir	Mirpur	Local	3053	63	33.12	73.39	630	Dry Subtropical Thistle and Scrub Forest	Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI
[64]	Sudhnuti district, AJK	Sudhnuti	Local	471	297	33.71	73.75	385-2121	Chir Pine (Pinus roxburghii) with a little mix of Blue Pine (Pinus wallichiana) when approaching temperate forest	Landsat TM, ETM+ and OLI
[65]	Balochistan and Eastern Iran	Balochistan	Regional	769824	18	28.85	66.41	600-1200	Mixed forests	MODIS
[66]	Khyber Pakhtunkhwa (KP)	Khyber Pakhtunkhwa	Regional	11336	10123	34.10	71.60	250-7708	Subalpine, dry temperate, moist temperate, oak, subtropical broad-leaved,	SPOT-5

									subtropical pine, and dry thorn forests	
[67]	Jhelum River Basin (Mangla Dam Watershed), Punjab	Azad Jammu & Kashmir	Regional	33397	4061	34.00	74.31	232-6285	Evergreen and deciduous forests	Landsat TM, ETM+ and OLI
[68]	Multan district, Punjab	Multan	Local	3650	59	29.90	71.35	-	Urban forest	Landsat TM and OLI
[69]	Lodhran district, Punjab	Lodhran	Local		1	29.90	71.35	-	Urban forest	Landsat 4, 5 Thematic Mapper (TM), Landsat 7 Enhanced TM Plus (ETM+), and Landsat 8 Operational Land Imager (OLI)
[70]	Battagram, Khyber-Pakhtunkhwa	Battagram	Local	1507	462	34.41	73.10	4000	Himalayan moist temperate forest and Sub-alpine temperate	Landsat-7 and Landsat-8
[71]	Coastal belt of Karachi Region, Sindh	Karachi (Part of)	Local	2030	34	24.77	67.18	-	Mangrove forest	Landsat 8 OLI
[72]	Palas Valley, Kohistan district, Khyber Pakhtunkhwa (KP)	Kohistan (Part of)	Local	7492	1304	35.38	73.33	3000-4000	Dense deodar and pine forest, Juniperus communis (juniper), Pinus wallichiana (blue pine), Abies webbiana (silver fir), Aesculus indica (bankhor), Pinus species, Cedrus deodara (deodar), Abies	Landsat 3 MSS, Landsat 7 ETM+ and Sentinel 2A

									pindrow (palunder), Pinus gerardiana (chalghoz a), and Juglans regia (walnut)	
[73]	Gilgit-Baltistan	Gilgit-Baltistan	Regional	68601	919	36.24	76.42	950-8538	Forest with needle leaf trees, broadleaf trees, and mixed	MODIS

**Table S2.** A database of methodology, accuracy, LULC classes, classification techniques, algorithms and forest change statistics published in seventy-three published articles (1993-2021) for forest mapping in Pakistan using remotely sensed data.

Reference	Forest Ecoregion	Classification Type	LULC Classes	Classification Technique	Algorithm used / Techniques	Ground Truthing/ Validation for Classification Accuracy	Classification accuracies used	Accuracy achieved	Change Assessment Years	Rate of Change of Forest (if calculated)	Forest Change
[1]	Himalayan subtropical pine forests	Unsupervised	Dense Forest, Sparse Forest, Bare Soil/ Very Sparse Vegetation	Principal Component Analysis	Maximum likelihood classification technique	-	-	-	1976-1987-1990	The rates of change in area between 1976 and 1987 in dense and sparse forests are about 64.27 and 31.55 ha/year, respectively, while the corresponding rates of change from 1976 to 1990 are about 32.42 and 35.36 ha/year, respectively.	Forest depleted from 1976-1987, Forest area increased from 1987-1990
[3]	Western Himalayan broadleaf forests	Unsupervised	Agriculture Riparian, Barren land/ fallow land and Water	Pixel-based	Nonhierarchical clustering procedure known as ISODATA (Interactive Self Organizing	-	-	-	1979-1993	20,270 ha in 1979 that reduced to 11,340 ha in 1993	Forest decreased/ declined

Data  
Analysis)

[4]	Indus River Delta-Arabian Sea mangroves	Manual	Dense Mangroves , Medium Mangroves , Sparse Mangroves , Very Sparse Mangroves , Saltbushes / Grasses, Marine Algae, Water	Pixel-based, visual interpretation and band combination	On-screen Digitization	-	-	-	1992-2001-2007	Decrease of 1938 ha of mangroves from 1992 to 2001. On the other hand a relatively positive trend of mangroves from 2001 to 2007 is analyzed.	Analysis reveals overall reduction of 1,938 ha (19.38 sq. km) of mangroves from 1992 to 2001 whereas, from 2001 to 2007 a positive trend in mangrove classes was observed in terms of sustainability.
[2]	Himalayan subtropical pine forests	Supervised	Agricultural Land, Dense Forest, Settlements/ Urban, Sparse Vegetation	Pixel-based	-	-	Overall accuracy, Overall Kappa Statistics	Did not mention	1990-1998	Forest cover decreased at an annual rate of 0.6%	Forest decreased
[5]	Aravalli west thorn scrub forests	Not mentioned	River, Riverine forest, Sandy and Barren Areas	Not mentioned	Not mentioned	-	-	-	1977-1990-1998	877.69 ha/year decrease from 1977-1990 897.5 ha/year decrease from 1990-1998	Forest decreased from 1977-1990 and from 1990-1998

[6]	Western Himalayan broadleaf forests	Supervised	Conifer Forest, Conifer forest (Shadowed), Mix Forest, Grasses/Scrubs, Bare soil/Rocks and Built-up area	Object-based	NN Fuzzy classifier	-	Overall accuracy	89.99%	NA	NA	NA
[56]	Aravalli west thorn scrub forests	Supervised	Forest, Water body, Grass/Agriculture land and Dry land/land use	Pixel-based	Maximum likelihood classification technique	-	Overall accuracy and Kappa Coefficient	1979 (Overall Accuracy: 99.96%, Kappa: 0.9995) 1992 (Overall Accuracy: 99.9%, Kappa: 0.9996) 1998 (Overall Accuracy: 99.53%, Kappa: 0.9935) 2000 (Overall Accuracy: 99.96%, Kappa: 0.9994) 2006 (Overall Accuracy: 99.93%, Kappa: 0.9985) 2009 (Overall	1979-1992-1998-2000-2006-2009	Forest cover in 1979 was 22.67%, in 1992 was 17.38%, in 1998 was 12.28%, in 2000 was 6.15%, in 2006 was 7.51% and in 2009 was 5.97%.	Result show that the deforestation from 1979-2009 was about 85%.

Accuracy:  
99.68%,  
Kappa:  
0.9945)

[36]	Indus River Delta-Arabian Sea mangroves	Supervised	Dense Mangroves , Medium Mangroves , Sparse Mangroves , Shrubs/ Grasses, Algae, Mudflats, Barren land, Saltpans, Built-up Area, and Water body	Object-based	NN Fuzzy classifier	250	Overall accuracy and Kappa Coefficient	Overall Accuracy: 83.2% Kappa value: 0.7301	No change assessment, study was done only for year 2008-09	NA	NA
[45]	Western Himalayan subalpine conifer forests	Manual	Forest cover, Agricultural land, Rangeland , Built up areas, and Water bodies	NA	Manual Digitization of Aerial Photographs and Satellite Imagery	-	-	-	1968-1990-2007	Forest change between 1968-2007 in Kalam (zone A) was - 30.5%, Malamjaba (zone B) was - 49.7% and Barikot (zone C) was - 70.9%.	A significant decrease in forests and increase in agriculture and built up areas

[46]	Mixed forests	Supervised	Dense forest, Open forest, Shrub/grass, Agriculture, Bare soil, and Water/snow	Pixel-based	Maximum likelihood classification technique	-	Overall accuracy, User's accuracy and Producer's accuracy	2001 (Overall Accuracy: 79.2%) 2009 (Overall Accuracy: 81.1%)	2001-2009	Annual gross deforestation rate, between 2001 and 2009, in swat was 0.96% in Shangla 0.64% and in other areas 0.91% with a total average of 0.82%.	Forest decreased/ declined
[7]	Western Himalayan broadleaf forests	Supervised	Settlement, Vegetation, Water, Forest and Bare land	Pixel-based	Maximum likelihood classification technique	-	-	-	1998-2005-2009	Forest change between 1998-2005 was positive i.e., 11.943% to 15.222% and between 2005-2009 was negative i.e., 15.222% to 14.77%. Overall forest change from 1998-2009 was positive i.e.,	Forest increased Overall

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11.943% -  
14.77%.

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[37]	Indus River Delta-Arabian Sea mangroves	Supervised	Dense Mangroves, Medium Mangroves, Sparse Mangroves, Saltbushes / Grasses, Algae, Mudflats and Water	Object-based	Nearest neighbour classification algorithm and rule-based methods	-	Overall accuracy and Kappa Coefficient	Indus Delta (Overall Accuracy: 80.2%, Kappa: 0.71) Sandspit (Overall Accuracy: 84.6%, Kappa: 0.74) Kalamat Khor (Overall Accuracy: 80.5%, Kappa: 0.76) Miani Hor (Overall Accuracy: 78.9%, Kappa: 0.69) Jiwini (Overall Accuracy: 83.8%, Kappa: 0.73)	No change assessment, study was done only for year 2009	NA	NA
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[47]	Western Himalayan subalpine conifer forests	Manual	forestland, agricultural land, rangeland, settlements and area covered by permanent or perennial water bodies	NA	Manual Digitization of Aerial Photographs and Satellite Imagery	-	-	-	1968-1990-2007	<p>In zone C, 75.1 % of the forest area was converted to rangeland in 40 years, whereas in zone A, 37.8 % of forest area was converted to rangeland, of which 2/3 took place in period 1</p> <p>The highest rate of reforestation was observed in zone A, where 27.7 % of rangeland and 16.0 % of agriculture land was reforested in period 1</p> <p>Reforestation in period 2 took place particularly on range</p>	Deforestation majorly while reforestation occurred but negligible
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land, with 0.3, 0.4 and 4.1 % in zones A, B and C, respectively, reforested. The extent of reforestation was, however, negligible compared to the rate of deforestation.

[12]	Northwestern Himalayan alpine shrub and meadows	Supervised	Forest, Grass/shrub, Agriculture, bare soil/rock, snow/glaciers and water body	Pixel-based	Maximum likelihood classification technique	-	Overall accuracy, Producer's accuracy, user's accuracy, Overall Kappa Statistics	The total accuracy rate (total number of accurate pixels compared to number of pixels taken as reference) was 87.6% and the kappa statistics value 85.0%. The producer's accuracy was over 80% in all classes except	1992-2000-2009	The deforestation rate increased from 0.14% per annum in 1992–2000 to 0.54% per annum in 2000–2009, with 3,759 ha forest lost over the 17 years	Deforestation occurred
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							agricultural fields (78.9%); the user's accuracy was over 80% in all classes except for grasses (75%).				
[57]	Himalayan subtropical pine forests	Supervised	Forest, Low vegetation, Built up, Bare soil and Water	Pixel-based	Maximum likelihood classification technique	-	Overall accuracy, Producer's accuracy, user's accuracy, Overall Kappa Statistics	1998 (Overall Accuracy: 89%, Kappa: 86%, Producer's accuracy: >90% for all classes except bare soil i.e. 85%, User's accuracy: >84% for all classes)	1998-2009	The classification results revealed that from 1998 to 2009, over a period of about 11 years, forest cover and low vegetation have decreased at the rate of 02.70% and 02.60% respectively.	Forest decreased/ declined
							2009 (Overall Accuracy: 86%, Kappa: 82%, Producer's accuracy: >87% for all classes except bare soil i.e. 79%, User's accuracy: >77%)				

[52]	Indus River Delta-Arabian Sea mangroves	Supervised Classification and On-Screen Digitization	Mangroves, Mudflats, Vegetation / Crop, Algae, Sand and Water	Pixel-based	Maximum likelihood classification technique and On-Screen Digitization	-	-	-	2009-2014	The supervised classification and onscreen digitization results showed that total area of mangrove cover was 946.52 km <sup>2</sup> , 960.83km <sup>2</sup> and 1010.11km <sup>2</sup> , 1082.71km <sup>2</sup> in 2009 and 2014 respectively	Forest increased
[16]	Western Himalayan subalpine conifer forests	Supervised	Agriculture, Snow, Barren, Forest and Water	Pixel-based	Maximum likelihood classification technique	-	-	-	2000-2012	From 2000 to 2012 the forest area is decreased by 12% and agriculture area is increased by 7%.	Forest decreased/ declined
[41]	Himalayan subtropical pine forests	Supervised	Close canopy Pinus roxburghii, Close canopy Pinus wallichiana, Open canopy (Pinus	Object-based	Standard nearest neighbor	117	Overall accuracy, Producer's accuracy, user's accuracy, Overall Kappa Statistics	2011 (Overall Accuracy: 94.01%, Kappa value: 0.93, Producer's accuracy: >91.67% for all	2005-2011	Based on a change matrix and cross-tabulation 122 km <sup>2</sup> remain forested after conversion of 24 km <sup>2</sup>	The results show that there is a decrease of about 5 km <sup>2</sup> of 'closed canopy Pinus wallichiana' forest from 2005 to 2011 in the state managed area, whereas, and a decrease of about 2 km <sup>2</sup> in the community/private forest. Similarly, a reduction of closed canopy Pinus roxburghii forests of about 3 and 15 km <sup>2</sup> is observed in state and community/private forests respectively. The decrease in the Pinus wallichiana and Pinus roxburghii forests in turn resulted in an increase in the open canopy covers of both the Pinus species

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roxburghii  
and Pinus  
wallichiana  
) , Open  
canopy  
(Quercus  
spp.  
and  
Aesculus  
spp.),  
Scrub  
forest,  
Grasses,  
Agriculture  
land,  
Barren  
area, Built-  
up area,  
and Water  
body

classes  
except  
scrub  
forest i.e.  
85.71%,  
User's  
accuracy:  
>80.95%  
for all  
classes)

to non-  
forested  
land within  
the state-  
owned  
forests,  
from 2005  
to 2011.  
Only 24  
km<sup>2</sup> were  
transforme  
d from  
nonforeste  
d land to  
forest  
while  
about 31  
km<sup>2</sup>  
remained  
unchanged  
.  
On the  
other  
hand, in  
the  
community  
/private  
forest,  
about 31  
km<sup>2</sup> was  
converted  
from forest  
to  
nonforeste  
d land  
while  
about 52  
km<sup>2</sup>  
remained  
unchanged  
.  
An area  
of about 49  
km<sup>2</sup> was  
converted  
from non-

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									forest classes to forest classes while 135 km2 remained unchanged within the non-forested land	
[8]	Western Himalayan broadleaf forests	Supervised	Unclassified, Shrubs & Bushes, Settlements, Forests, Sparse Vegetation, Water bodies and Barrend land	Pixel-based	Mahalanobis Distance Classification algorithm (MDC) and Parallelepiped classifier	-	Overall accuracy, Producer's accuracy, user's accuracy, Overall Kappa Coefficient	Parallelepiped Technique (Overall Accuracy: 95.4%, Kappa: 0.937, Producer's accuracy: >95.31% for all classes except Sparse Vegetation i.e. 76.31%, User's accuracy: >84.85% for all classes except Settlements i.e., 75.65%) MDC Technique (Overall Accuracy: 85.97%, Kappa:	No change assessment, study was done only for year 2014	-

0.8115,  
 Producer's  
 accuracy:  
 >70.28%  
 for all  
 classes,  
 User's  
 accuracy:  
 >61.55%  
 for all  
 classes  
 except  
 Sparse  
 Vegetation  
 i.e.,  
 46.84%)

[17]	Western Himalayan subalpine conifer forests	-	Temperate Conifer, Subtropical Conifer, Junipers, Alpine Meadows, Degraded Forests, Slope Grasslands, Tropical Moist Deciduous, Irrigated Intensive Agriculture, Irrigated Agriculture, Slope Agriculture, Snow and Mixed Forests	-	Land cover classification (LCC) obtained from Global Land Vegetation Monitoring (GVM) project and developed at NUST for year 2000	-	-	-	2000-2012	In 2001, forest area -36,200 ha (SPOT) and -5874 ha (MODIS)  In 2012, forest area 15,100 ha (SPOT) and 4160 ha (MODIS)	Forest increased
[58]	Northwestern Himalayan alpine	Supervised	Snow, Built up, Forest, Water, Vegetation	Pixel-based	-	-	-	-	1989, 1999, 2009	Forest in 1989 was 85.83 sq km, in 1999 was	Forest decreased/ declined

	shrub and meadows									41.34 sq km and in 2009 was 34.4 sq km	
[26]	Himalayan subtropical pine forests	Supervised	Agriculture , Settlements, Bare Soil/ Rock, Vegetation (Mixed forest), Water	Pixel-based	Maximum likelihood classification technique	100	Overall accuracy, Overall Kappa Statistics	Overall accuracy of 95.32% and 95.13% for 1992 and 2012 respectively Kappa statistics of 0.9237 and 0.9070 for 1992 and 2012 respectively	1992-2012	Vegetation (mixed forest) in 1992 was 13160 ha that decreased to 12292 ha in 2012 with a - 6.6% change.	Forest decreased/ declined
[27]	Himalayan subtropical pine forests	Supervised	Agriculture , Settlements, Bare Soil/ Rock, Vegetation (Mixed forest), Water	Pixel-based	Maximum likelihood classification technique	100	Overall accuracy, Overall Kappa Statistics	Overall accuracy of 95.32% and 95.13% for 1992 and 2012 respectively Kappa statistics of 0.9237 and 0.9070 for 1992 and 2012 respectively	1992-2012	Vegetation (mixed forest) in 1992 was 11,342 ha that decreased to 7008 ha in 2012 with a - 26% change.	Forest decreased/ declined

[53]	Aravalli west thorn scrub forests	Supervised	Dense Mangrove Forest, Sparse Mangrove Forest, Riverine Forest, Agriculture Land, Mesquite/Grasses/Bushes, Saccharum spp./Typha spp., Soil/Wet Soil/Mudflats/Rocks, Algal Mat, Sand/River Bed/Saline Area and Water	Pixel-based	Maximum likelihood classification technique	-	-	-	1990-2010-2014	All types of forests were 152,762 ha in 1990, 129,306 ha in 2010 and 102,223 ha in 2014	Forest decreased/ declined
[28]	Western Himalayan subalpine conifer forests	Supervised	Agricultural area, Built up area, Barren area, Forest area and Water body	Pixel-based	Maximum likelihood classification technique	100	Overall accuracy, Kappa statistics	Overall accuracy of 89% for both 1992 and 2012 Kappa statistics of 0.89 for both 1992 and 2012	1992-2012	Forest area in 1992 was 12,136 ha and in 2012 was 6138 ha with an annual rate of change of -2.47%	Forest decreased/ declined

[23]	Mixed forests	Supervised	Dense Coniferous Forest (DCF), Sparse Coniferous Forest (SCF), Dense Mix Forest (DMF), Sparse Mix Forest (SMF), Dense Broadleaved Forest (DBF), Sparse Broadleaved Forest (SBF), Grasses/Shrubs (GS), Alpine Grasses (AG), Peatlands (P), Agriculture (Cropped) (AC), Agriculture (Fallow) (AF), Bare Soil/Rocks (BSR), Snow/Glaciers/Ice (SGI) and Water bodies (W)	Pixel-based	Maximum Likelihood Classifier	-	Overall accuracy, producer's accuracy and user's accuracy	DCF (Overall Accuracy: 91%) SCF (Overall Accuracy: 80%) DMF (Overall Accuracy: 90%) SMF (Overall Accuracy: 84%) DBF (Overall Accuracy: 92%) SBF (Overall Accuracy: 92%) Dense Forest (PA: 80.95%, UA: 94.44%) Sparse Forest (PA: 71.43%, UA: 95.24%) Grass/Shrubs (PA: 49.35%, UA: 74.51%) Agriculture (PA: 65.31%, UA: )	1990-2000-2010	Overall, the annual forest cover rate of change is -0.38% for the entire area. Annual rate of change of forest in KP was -0.42%, in GB was -0.31% and in AJK was -0.13%.	Forest decreased/ declined
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60.38%)  
 Bare  
 soil/rocks  
 (PA:  
 81.25%,  
 UA:  
 59.09%)  
 Snow/Glac  
 iers (PA:  
 60.71%,  
 UA:  
 53.13%)  
 Water (PA:  
 112.50%,  
 UA:  
 64.29%)

[9]	Western Himalayan broadleaf forests	Supervised	Forest, Bare land, Shrubs & bushes, Sparse vegetation, Water and Settlement s	Object- based	Nearest neighbor classifier and Support Vector Machine classifier	-	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	Nearest Neighbor (Overall Accuracy: 96%, Kappa Coefficient: 0.96, Producer's accuracy: >92% for all classes, User's accuracy: >85% for all classes) Support Vector Machine (Overall Accuracy: 98.93%, Kappa Coefficient: 0.98, Producer's accuracy:	No change assessme nt, analysis year not mentioned in the paper	-	-
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>96% for all classes, User's accuracy: >93% for all classes)

[43]	Aravalli west thorn scrub forests	Supervised	Dense forest, Sparse forest, and Bare land	Pixel-based	Maximum Likelihood Algorithm	-	-	-	1987-1992-2000-2010-2013-2014	Forest area in 1987 was 1525 ha, in 1992 was 1057 ha, in 2000 was 1290 ha, in 2010 was 1540 ha, in 2013 was 1619 ha and in 2014 was 1637 ha.	Forest increased
										Forest increased on about 467 ha (24 %) over a period of 18 years (1992–2010) with an average annual increase in area of 26 ha. While from 2010 to 2014, vegetation increased on an area of about 113 ha (6	

										%) with an average annual increase of 28 ha.	
[18]	Western Himalayan subalpine conifer forests	Supervised	Forest land, Range land, Agriculture land, Barren land, Glacier/ snow cover, water bodies	Pixel-based	Maximum Likelihood Algorithm	297	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	2004 (Overall Accuracy: 62.22%, Kappa: 58%) 2007 (Overall Accuracy: 75%, Kappa: 65%) 2010 (Overall Accuracy: 78%, Kappa: 69%) 2013 (Overall Accuracy: 78%, Kappa: 69%)	2004-2007-2010-2013	Period 2004 to 2013 the area of forest land decreased by 6.4% with an annual declined rate of 0.6%	Forest decreased/ declined
[59]	Aravalli west thorn scrub forests	Calibration	Shisham (Dalbergia sissoo), Sufeda (Eucalyptus camaldulensis), Toot or Mulberry (Morus alba), and Simal (Bombax cieba) in pure and	L-band synthetic aperture radar	-	-	-	-	No change assessment, study was done only for year 2015	-	-

			mixed form with naturally grown Mesquite (Prosopis juliflora).								
[48]	Western Himalayan subalpine conifer forests	Supervised	Water, Dense forest, Mix class, Agriculture , Open forest, Pastures, and Snow	Pixel-based	-	30	Overall accuracy	72%	1992-2011	Dense forest shows decrease from 178933.5 ha to 108054.4 ha (13.42 % decrease) which amounts to about 3730.47 ha annually over the past nineteen years. Consequently, open forest is increased from 92633.6 ha to 116648.23 ha	Dense Forest decreased/ declined Open Forest increased
[19]	Western Himalayan subalpine conifer forests	Supervised	Forest land, Range land, Agriculture ,	Pixel-based	Non-parametric Image Classification Technique	280	Overall Accuracy, Producer's accuracy, user's accuracy	SPOT-5 SVM (Overall Accuracy: 89%, Kappa	No change assessment, study was done only for year 2013	-	-

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Settlement , Barren land, Water bodies	(k-nearest neighbor (k-NN), support vector machine (SVM), random forest (RF), and neural network (NN))	and Kappa Coefficient s	Coefficient: 0.86, Producer's accuracy: >71% for all classes, User's accuracy: >78%) k-NN (Overall Accuracy: 88%, Kappa Coefficient: 0.85, Producer's accuracy: >69% for all classes, User's accuracy: >71%) RF (Overall Accuracy: 88%, Kappa Coefficient: 0.84, Producer's accuracy: >69% for all classes, User's accuracy: >71%) NN (Overall Accuracy: 88%, Kappa Coefficient: 0.84, Producer's
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accuracy:  
>73% for  
all classes,  
User's  
accuracy:  
>64%)

Landsat-8  
SVM  
(Overall  
Accuracy:  
71%,  
Kappa  
Coefficient:  
0.59,  
Producer's  
accuracy:  
>26% for  
all classes,  
User's  
accuracy:  
>40%)

k-NN  
(Overall  
Accuracy:  
59%,  
Kappa  
Coefficient:  
0.54,  
Producer's  
accuracy:  
>11% for  
all classes,  
User's  
accuracy:  
>31%)

RF  
(Overall  
Accuracy:  
71%,  
Kappa  
Coefficient:  
0.59,  
Producer's  
accuracy:

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>17% for all classes, User's accuracy: >33%) NN (Overall Accuracy: 65%, Kappa Coefficient: 0.51, Producer's accuracy: >11% for all classes, User's accuracy: >4%)

[10]	Western Himalayan broadleaf forests	Supervised	Forest, Settlements, Bare land, Vegetation and Water	Pixel-based	Maximum Likelihood Algorithm	-	-	-	2000-2009	Forest area in 2000 was 21146.4 ha and in 2009 was 19592.73 ha	Forest decreased/ declined
[29]	Himalayan subtropical pine forests	Supervised	Settlements, Dense forest, Open forest, Water body and Agricultural land	Pixel-based	Maximum Likelihood Algorithm	200	Kappa statistics	1990 (Kappa: 0.90) 2000 (Kappa: 0.91) 2010 (Kappa: 0.87) 2017 (Kappa: 0.91)	1990-2000-2010-2017	Area under dense forest decreased by 11.14% (0.41% yr-1), while the area under open forests increased by 4.28% (0.15% yr-1)	Dense Forest decreased/ declined Open Forest increased

[49]	Northwestern Himalayan alpine shrub and meadows	Supervised	Agricultural land, Dense vegetation/ forest, Snow, Barren land, and Sparse vegetation/ forest and Range land	Pixel-based	Maximum Likelihood Algorithm	50	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	No accuracy values mentioned in the paper	1994-2016	Net loss of 629 ha forest (29 ha yr <sup>-1</sup> ) from 1994-2016	Forest decreased/ declined
[20]	Western Himalayan subalpine conifer forests	On-Screen Digitization	Forests, Agricultural land, Rangelands and pastures, Barren land, and Settlements	-	Scanned and Rectified	-	-	-	1970-2014	A total of a 17% decrease has been observed in forest cover areas from 1970 to 2014.	Forest decreased/ declined
[54]	Indus River Delta-Arabian Sea mangroves	Supervised	Dense mangrove, Normal mangrove, Cultivated land, Other vegetation, Wet mudflat, Dry mudflat, Wet barren/vacant land, Dry barren/vacant land, Turbid water and Deep water	Pixel-based	-	-	-	-	2000-2014	Dense mangroves decreased from 5682 ha in 2000 and 4382 ha at a rate of - 0.93 sq km/ year  Normal mangroves increased from 58446 ha in 2000 and 90939 ha at a rate of 23.21 sq km/ year	Dense mangroves decreased and normal mangroves increased

[60]	Western Himalayan subalpine conifer forests	Supervised	Water, Soil, Forest, Grass, Built-up	Pixel-based	Maximum Likelihood Algorithm	98	Overall Accuracy, Kappa Coefficient	Overall accuracy: 71.4%, Kappa Coefficient (2010) 0.623	2000-2010	Forest in 2000 was 2280.31 sq km and in 2010 was 1892.56, a change of -17% (2000-2010)	Forest decreased/ declined
[30]	Himalayan subtropical pine forests	Supervised	Forest, Open Land, Water bodies, Build up, Shadow	Pixel-based	Maximum Likelihood Algorithm	-	-	-	2000-2018	Forest in 2000 was 4964.897 sq km and in 2018 was 4313.416 sq km, a change of -13% (2000-2018)	Forest decreased/ declined
[61]	Western Himalayan subalpine conifer forests	Supervised	Open land, Urban, Water, Vegetation, Forest and Snow	Pixel-based	Maximum Likelihood Algorithm	500	Overall Accuracy, Kappa Coefficient	1990 (Overall Accuracy: 88%, Kappa: 0.83) 2000 (Overall Accuracy: 85%, Kappa: 0.78) 2010 (Overall Accuracy: 83%, Kappa: 0.77) 2016 (Overall Accuracy: 89%,	1990-2000-2010-2016	There has been 26% decrease in forest cover from 1990 to 2016	Forest decreased/ declined

Kappa:  
0.85)

[11]	Western Himalayan broadleaf forests	Supervised	Built-up, Agriculture, Vegetation (forest), Bare Soil, Water	Pixel-based	Non-parametric Image Classification Technique (Support Vector Machine (SVM))	-	Overall Accuracy, Kappa Coefficient	1987 (Overall accuracy 82.44%, Kappa Coefficient 0.76) 2002 (Overall accuracy 88.80%, Kappa Coefficient 0.86) 2017 (Overall accuracy 94.68%, Kappa Coefficient 0.92)	1987-2002-2017	Vegetation in 1987 was 68200 ha, in 2002 was 68900 ha and in 2017 was 73000 ha with a net change of +2.90%	Forest increased
[42]	Himalayan subtropical pine forests	Supervised	Forest land, Barren mountains, Agricultural land, Built-up area, and Water body	Pixel-based	Maximum Likelihood Algorithm	300	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	1998 (Overall Accuracy: 96%, Kappa Coefficient: 0.832, Producer's accuracy: >72.73% for all classes, User's accuracy: >91.18% for all classes except	1998-2008-2018	Forest land shows decline from 40,936.77 ha in 1998 to 40,545.63 ha in 2008 to 39,231.90 ha in 2018. Forest land annual rate of change was -0.09%	Forest decreased/ declined

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Barren mountains i.e. 70%) 2008 (Overall Accuracy: 96%, Kappa Coefficient: 0.823, Producer's accuracy: >83.33% for all classes except Agricultural i.e. 72.73, User's accuracy: >83.78% for all classes except Barren mountains i.e., 69.23) 2018 (Overall Accuracy: 96%, Kappa Coefficient: 0.841, Producer's accuracy: >83.87% for all classes except Agricultural i.e. 72.73, User's accuracy: >80.00%	from 1998- 2008 and - 0.32% from 2008- 2018
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for all  
classes)

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[13]	Northwest ern Himalayan alpine shrub and meadows	Supervised	Forest, Cropland and Other Classes	Pixel- based	Maximum Likelihood Algorithm	-	-	-	2003-2015	Not reported	Forest decreased/ declined
[14]	Northwest ern Himalayan alpine shrub and meadows	Supervised	Dense forest, Sparse forest, Crops, and Other	Pixel- based	Maximum Likelihood Algorithm	-	-	-	1973- 1993-2015	In the 1973–1993 period, most deforestati on occurred at higher elevations in valuable confer forests, and that deforestati on has shifted to the lower elevation oak forests in the 1993–2015 period. There also appears to be an increase in forest	Overall forest cover decline between 1993 and 2015

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										degradatio n at the higher elevations in the 1993–2015 period. Reduced rate of 0.6% and 0.9% per year in the different valleys	
[21]	Baluchista n xeric woodlands	Supervised	Urban area, Water bodies, Barren land and Vegetation (cropland, forest, and grassland)	Pixel- based	Maximum Likelihood Algorithm	-	-	-	1996- 2003-2016	Vegetation shows increase from 398.96 sq km in 1996 to 594.97 sq km in 2003 and then decrease 464.68 sq km in 2016	Overall veegtation cover increased
										Vegetation shows an overall positive change from 1996- 2016 of 65.72 sq km	
										Vegetation decreased by 21.90% from 2003 to 2016.	

[39]	Western Himalayan broadleaf forests	Supervised	Barren land, Builtup area, Forest area, Grass land, Ice area and Water area	Pixel-based	-	-	-	-	1998-2008-2017	Forests shows increase from 601 sq km in 1998 to 668 sq km in 2008 and then huge decrease 194 sq km in 2017	Forest decreased/ declined
[62]	Karakoram-West Tibetan Plateau alpine steppe	Supervised	Water body, Forest and Shrub land, Barren land, Alpine Pasture, Spare Grass, Irrigated Agricultural Land, Permanent Snow and Glacier	Pixel-based	Visual Image Classification	-	-	-	No change assessment, study was done only for year 2013	-	-
[31]	Western Himalayan subalpine conifer forests	Supervised	Forestland, Grassland, Settlements, Wetlands, Croplands, and Other lands (bare land, shadow region)	Pixel-based	Maximum Likelihood Algorithm	-	-	-	1992-2000-2008-2017	It is found that study area faced 22% reduction in the vegetative cover over the time period 1992-2000  the results confirmed 51%	Forest decreased/ declined

reduction  
in the  
vegetative  
cover  
between  
the time  
period  
2008-2017

[40]	Mixed forests	Supervised	Built-up, Vegetation (parks, trees, grasslands , and playgrounds), Bare Soil, Water	Pixel-based	Non-parametric Image Classification Technique (Support Vector Machine (SVM)) using Anderson classification scheme (Level 1)	160	Overall accuracy, Producer accuracy, User accuracy, Kappa Coefficient	1990 (Overall Accuracy 94.96%, Kappa Coefficient 0.92, User Accuracy 96.34%, Producer Accuracy 93.15%) 2002 (Overall Accuracy 92.26%, Kappa Coefficient 0.88, User Accuracy 96.34%, Producer Accuracy 86.24%) 2017 (Overall Accuracy 91.35%, Kappa Coefficient 0.87, User Accuracy 93.67%, Producer	1990-2002-2017	Vegetation in 1990 was 1017.66 sq km, in 2002 was 933.25 sq km and in 2017 was 841.89 sq km with net change of -9.88% (1990-2017)	Vegetation (forest) decreased/ declined
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Accuracy  
92.84%)

[15]	Karakoram -West Tibetan Plateau alpine steppe	Supervised	Dense forest, Sparse forest, Cropland, and Other classes	Pixel- based	Maximum Likelihood Algorithm	-	Overall accuracy, User's accuracy and Producer's accuracy	Overall accuracy: 89% and 93% with 90% and 92% producer accuracies for dense and sparse forest respectivel y	1973- 1993-2015	Forest in 1973 was 89938 ha that reduced to 82540 ha in 1993 and 68904 ha in 2015.  Annual rate of change 1973–1993 was - 0.43%, 1993-2015 was - 0.82% and 1973-2015 was - 0.63%	Forest decreased/ declined
[63]	Western Himalayan subalpine conifer forests	Supervised	Water body, Vegetation (forest), Built-up area, Barren area	Pixel- based	Maximum Likelihood Algorithm	120	Overall accuracy, Kappa statistics	1992 (Overall accuracy: 95.83% and Kappa Statistics: 0.93) 2002 (Overall accuracy: 96.67% and Kappa Statistics:	1992- 2002-2013	Vegetation in 1992 was 738.1 sq mi, in 2002 was 732.7 sq mi and in 2013 was 526.73 sq mi with net change of - 211.37 sq	Forest decreased/ declined

							0.95) 2013 (Overall accuracy: 99.17% and Kappa Statistics: 0.99)		mi (1992- 2013)		
[55]	Indus River Delta- Arabian Sea mangroves	Supervised	Forest cover, Water body, Grass/ Agriculture land, Dry/ Barren land	Pixel- based	Maximum Likelihood Algorithm	28	Overall accuracy, Kappa Coefficient	1979 (Overall accuracy: 93.46% and Kappa Coefficient: 0.9094) 1992 (Overall accuracy: 98.10% and Kappa Coefficient: 0.9886) 1998 (Overall accuracy: 99.01% and Kappa Coefficient: 0.9986) 2000 (Overall accuracy: 99.79% and Kappa Coefficient: 0.9966) 2006 (Overall accuracy: 100% and Kappa Coefficient: 1.0) 2009 (Overall	1979- 1992- 1998- 2000- 2006- 2009-2010	Forest cover was 35.11%, 29.14%, 8.10%, 5.56%, 2.57%, 3.025%, 2.237% in years 1979, 1992, 1998, 2000, 2006, 2009 and 2010 respectivel y. -89.07% net change was observed	Forest decreased/ declined

								accuracy: 100% and Kappa Coefficient: 1.0) 2010 (Overall accuracy: 99.00% and Kappa Coefficient: 0.9825)			
[50]	Northwest ern Himalayan alpine shrub and meadows	Supervised	Dense Forest, Open forest, Agriculture land, Range land, Barren land, Water bodies and Snow and Glaciers	Pixel- based	Maximum Likelihood Algorithm	50	Overall Accuracy, Kappa Coefficient	Did not mention	No change assessme nt, study was done only for year 2016	-	-
[64]	Himalayan subtropical pine forests	Supervised	Forest, Non-forest	Pixel- based	Thresholdi ng approach (linear mixture model (LMM) approach)	140	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Statistics	Overall Accuracy: 96% Kappa Statistics: 0.92 Producer's accuracy: 97% for forest and 95% for non-forest classes User's accuracy: 96% for forest and 97% for	1989- 1993- 1999- 2005- 2010- 2015-2018	Forest area declined from 19701 ha in 1989 to 18523 ha in 1993, 17574 ha in 1999 and then increased from 17792 ha in 2005 to 18447 ha in 2010 to 19015 ha in 2015	Forest increased

								non-forest classes		and 20262 ha in 2018	
[65]	Baluchistan xeric woodlands	Supervised	Water, Forest, Shrublands, Savannas, Grasslands, Croplands, Urban, Non-vegetated lands.	-	MODIS land cover type product (MCD12Q1)	-	-	-	2001-2002-2003-2004-2005-2006-2007-2008-2009-2010-2011-2012-2013	Forest cover was -12.7, -13, 48.7, -22.2, 10, -25.5, -2.2, -4.7, -3.7, 6.2, 27, 40.2 sq km from 2001-2013 respectively.	Forest increased
[66]	Western Himalayan subalpine conifer forests	Supervised	-	Object-based	-	373	-	-	No change assessment, study was done only for year 2012	-	-
[24]	Mixed forests	-	Landsat tree cover, Cropland, Shrub/grass/wetland/ Sparse vegetation/ Built/ Bare areas, Water and Snow	Pixel-based	Rule-based classification	-	-	-	2000-2018	Did not mention	-
[32]	Western Himalayan subalpine conifer forests	Supervised	Forest land, Impervious surface, Grass/agriculture land, Barren land and	Pixel-based	Machine Learning (Random Forests) algorithm	460	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	1998 (Overall Accuracy: 84%, Kappa: 0.79) 2018 (Overall Accuracy:	1993-2018	Forest land in 1993 was 27,999 ha that decreased to 26,675 ha in 2018 with an -	Forest decreased/ declined

			Water bodies				91%, Kappa: 0.85)			1.4% change from 1993- 2018	
[33]	Western Himalayan subalpine conifer forests	Supervised	Tree cover >40% canopy, Tree cover <40% canopy, Settlement, Soil, and Water	Pixel-based	Maximum Likelihood Algorithm	125	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	1976 (Overall Accuracy: 0.83, Kappa: 0.79, Producer's accuracy > 72%, User's accuracy > 75%) 1990 (Overall Accuracy: 0.85, Kappa: 0.81, Producer's accuracy > 80%, User's accuracy > 77%) 2000 (Overall Accuracy: 0.86, Kappa: 0.82, Producer's accuracy > 80%, User's accuracy > 80%) 2010 (Overall Accuracy: 0.88, Kappa:	1976-1990-2010-2016	Annual rate of change of Tree cover >40% canopy was - 0.81% per year from 1976-2016	Forest decreased/ declined

							0.84, Producer's accuracy > 80%, User's accuracy > 79%) 2016 (Overall Accuracy: 0.90, Kappa: 0.85, Producer's accuracy > 84%, User's accuracy > 84%)				
[67]	Western Himalayan subalpine conifer forests	Supervised	Agriculture , Forest, Grass, Settlement and Water	Pixel- based	Machine Learning (Random Forests) algorithm	-	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	2001 (Overall Accuracy: 90%, Kappa: 89%, Producer's accuracy > 83%, User's accuracy > 83%) 2009 (Overall Accuracy: 92%, Kappa: 90%, Producer's accuracy > 88%, User's accuracy > 82%) 2018 (Overall	2001- 2009-2018	Forest in 2001 was 9311 sq km, in 2009 was 10,745 sq km, and in 2018 12,118 sq km with positive difference of 2806.87 sq km from 2001-2018	Forest increased

									Accuracy: 95%, Kappa: 94%, Producer's accuracy > 93%, User's accuracy > 94%)		
[51]	Western Himalayan subalpine conifer forests	Supervised	Forest, Settlement , Snow, Water body and Others	Pixel- based	-	-	-	-	2000- 2005- 2010-2015	Forest in 2000 was 1473.07 sq km, in 2005 was 1235.40 sq km, in 2010 was 1167.93 sq km and was 1086.05 sq km.	Forest decreased/ declined
[68]	Aravalli west thorn scrub forests	Supervised	Forest, Wheat, Sugarcane , Other crops, Building, Water and Bare soil	Pixel- based	-	-	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	Rabi Season 1988 (Overall Accuracy: 87.6%, Kappa: 0.75, Producer's accuracy > 85.2%, User's accuracy > 85.5%) 2002 (Overall Accuracy: 84.5%, Kappa: 0.77, Producer's accuracy >	1988- 2002-2017	Forest in 1988 was 9400 ha, in 2002 was 7285 ha, and in 2017 was 5297 ha with change of -4103 ha from 1988- 2017 during Rabi Season  Forest in 1988 was 9793 ha, in 2002 was 7139 ha,	Forest decreased/ declined

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80.4%,  
User's  
accuracy >  
82.1%)  
2017  
(Overall  
Accuracy:  
85.1%,  
Kappa:  
0.82,  
Producer's  
accuracy  
>84.2%,  
User's  
accuracy >  
79.2%)

and in  
2017 was  
4937 ha  
with  
change of  
-4856 ha  
from 1988-  
2017  
during  
Kharif  
Season

Kharif  
Season  
1988  
(Overall  
Accuracy:8  
6%,  
Kappa:  
0.81,  
Producer's  
accuracy >  
84.4%,  
User's  
accuracy >  
82.7%)  
2002  
(Overall  
Accuracy:  
89.3%,  
Kappa:  
0.84,  
Producer's  
accuracy  
>83.5%,  
User's  
accuracy  
>81.9%)  
2017  
(Overall

Accuracy:  
87.7%,  
Kappa:  
0.78,  
Producer's  
accuracy  
>83.2%,  
User's  
accuracy >  
83.1%)

[69]	Aravalli west thorn scrub forests	Supervised	vegetation (natural vegetation, forest, crop fields, agricultural lands, parks, and vegetated lands), built-up area (all infrastructure, commercial and residential; road networks; and settlements), bare soil (unused lands,	Pixel-based	Maximum Likelihood Algorithm	-	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	1977 (Overall Accuracy: 0.86, Kappa: 0.77, Producer's accuracy > 82.9%, User's accuracy > 89.1%) 1987 (Overall Accuracy: 0.85, Kappa: 0.74, Producer's accuracy > 83.9%, User's accuracy > 84.3%) 1997	1977-1987-1997-2007-2017	Vegetation (forest) in 1977 was 87.9%, in 1987 was 89.8%, in 1997 was 91.5%, in 2007 was 90.8% and in 2017 was 89.5%.	Forest increased
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			empty lands, open space, fallow lands, earth/sand fillings, bare soil, and others), and water bodies (river, lakes, ponds, canals, low-lying areas, marshy lands and swamps, etc.)				(Overall Accuracy: 0.86, Kappa: 0.77, Producer's accuracy > 85.5%, User's accuracy > 87%) 2007 (Overall Accuracy: 0.88, Kappa: 0.79, Producer's accuracy > 87.7%, User's accuracy > 89.8%) 2017 (Overall Accuracy: 0.95, Kappa: 0.84, Producer's accuracy > 87.5%, User's accuracy > 95%)				
[70]	Himalayan subtropical pine forests	Supervised	Forest, Agriculture , Shrub and Grassland, Settlement , Barren land, Water and	Pixel-based	Maximum Likelihood Algorithm	-	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Statistics	2000 (Overall Accuracy: 80.44%, Kappa: 0.7621, Producer's accuracy > 65.31%, User's	2000-2015	Forest in 2000 was 72287.26 ha and in 2015 was 45077.62 ha. decreased to 45077.62	Forest decreased/ declined

			Glacier and Snow				accuracy > 69.14% 2015 (Overall Accuracy: 86.24%, Kappa: 0.8422, Producer's accuracy >67.59%, User's accuracy >77.59%)		ha (27.98% of the study area) in 2015. It indicates a 27209.64 ha (-16.88%) loss with an annual deforestation rate of 2.51%, i.e. 1814.41 ha deforestation per year		
[71]	Indus River Delta-Arabian Sea mangroves	Unsupervised	Mangroves , Non-mangroves	Pixel-based	Spectral Indices (ASST_1, ASST_2, NDMI, NDVI, RVI, EVI, CMRI, and SAVI)	2000	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	L8MI_1 (Overall Accuracy:96.9%, Kappa:0.891, Producer's accuracy = 96.2%, User's accuracy = 86.2%) L8MI_2 (Overall Accuracy: 97.0%, Kappa: 0.894, Producer's accuracy = 96.8%, User's accuracy = 86.2%) NDMI∩SAVI (Overall Accuracy:	No change assessment, study was done only for year 2017	-	-

							95.8%, Kappa: 0.851, Producer's accuracy = 96.9%, User's accuracy = 79.8%)				
[72]	Western Himalayan subalpine conifer forests	Supervised	Forest cover, Agriculture land, Shrubs/Bu shes, Bare soil/rocks, Snow cover/Glaci ers and Water bodies	Pixel- based	Maximum Likelihood Algorithm	-	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	1980 (Overall Accuracy: 94.60%, Kappa: 93.41%, User's accuracy > 90%) 2000 (Overall Accuracy: 95.50%, Kappa: 94.39%, User's accuracy > 90%) 2010 (Overall Accuracy: 94.40%, Kappa: 93.20%, User's accuracy > 90%) 2017 (Overall Accuracy: 93.00%, Kappa: 91.40 %, User's accuracy > 90%)	1980- 2000- 2010-2017	Forest cover was 36,942.00 ha in 1980, was 34631.35 ha in 2000, was 26374.93 ha in 2010 and was 19863.17 ha in 2017 with a change of - 12.23% from 1980- 2017	Forest decreased/ declined

[35]	Western Himalayan subalpine conifer forests	Supervised	Built-up area, Agriculture, Forest, Water bodies, Bare soil	Pixel-based	Maximum Likelihood Algorithm	50	Overall accuracy, Kappa Statistics	1979 (Overall Accuracy: 90.5%, Kappa Stat: 0.90) 1989 (Overall Accuracy: 91.13%, Kappa Stat: 0.92) 1999 (Overall Accuracy: 95.32%, Kappa Stat: 0.94) 2009 (Overall Accuracy: 94.44%, Kappa Stat: 0.92) 2019 (Overall Accuracy: 95.1%, Kappa Stat: 0.93)	1979-1989-1999-2009-2019	Forest land in 1979 was 174.7 sq km, in 1989 was 139.2 sq km, in 1999 was 134.8 sq km, in 2009 was 122.7 sq km and in 2019 was 93.4 sq km. -81.3 sq km overall change in forest land (1979-2019)	Forest decreased/ declined
[44]	Aravalli west thorn scrub forests	Unsupervised	Forest (Vegetation)	Pixel-based	Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI)	-	-	-	2018-2020	-	Forest carbon stock declining

[22]	Karakoram -West Tibetan Plateau alpine steppe	Supervised	Rocks/barr en land, Snow/glaci er, Alpine/sum mer pastures, Winter pastures, Dense conifer, Sparse conifer, Agricultural land, Linear/bloc k plantations , Sparse broadleave d, Sparse mix, Dense mix, Dense broadleave d, Settlement s, Rivers/Lak es	Object- based	Standard nearest neighbor	179	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	Overall accuracy: 92.180%, Kappa Coefficient: 0.914, User's accuracy: 91.17%, Producer's accuracy: 92.70%	2016	-	-
[34]	Western Himalayan subalpine conifer forests	Supervised	Built-up area, Agriculture , Forest, Water bodies, Bare soil	Object- based	Not mentioned	-	Overall accuracy, Kappa statistics	Overall classificati on accuracy for all images was above 90% and the Kappa statistic was also 0.90	1979- 1989- 1999- 2009-2019	Forest land in 1979 was 174.7 sq km, in 1989 was 139.2 sq km, in 1999 was 134.8 sq km, in 2009 was 122.7 sq km and in 2019 was 93.4 sq km. -81.3	Forest decreased/ declined

										sq km overall change in forest land (1979-2019)	
[25]	Mixed forests	Supervised	Forest Land, Built-up Area, Agricultural Land, Water Bodies, Barren Mountains, Snow Cover	Pixel-based	Maximum Likelihood Algorithm	-	Overall accuracy, User's accuracy and Producer's accuracy, Kappa Coefficient	Did not mention	2000-2010-2020	Forest land in 2000 was 5470.32 sq km, in 2010 was 6845.54 sq km and in 2020 was 3693.12 sq km. - 1777.20 sq km (-32%) change was observed.	Forest decreased/ declined
[38]	Indus River Delta-Arabian Sea mangroves	Supervised	Mangroves , Non-mangroves	Pixel-based	Machine Learning (Random Forests) algorithm	-	Overall accuracy, Kappa Coefficient value	1990 (Overall Accuracy: 91.8%, Kappa: 0.892) 1995 (Overall Accuracy: 94%, Kappa: 0.906) 2000 (Overall Accuracy: 93%, Kappa:0.892) 2005 (Overall Accuracy: 94.2%, Kappa:	1990-1995-2000-2005-2010-2015-2020	An estimated 477.22 km2 mangrove area in 1990 increased to 1463.59 km2 in 2020 a 3.74% annual rate of change.	Forest increased

								0.908) 2010 (Overall Accuracy: 93.6%, Kappa: 0.892) 2015 (Overall Accuracy: 93.6%, Kappa: 0.904) 2020 (Overall Accuracy: 95.4%, Kappa: 0.926)			
[73]	Karakoram -West Tibetan Plateau alpine steppe	Supervised	Barren, Forest, Snow, Urban, Water, Wetlands, and Other LULC	Pixel- based	Maximum Likelihood Algorithm	30	Overall accuracy	Overall Accuracy: 92.3%	2008- 2009- 2010- 2011- 2012- 2013- 2014- 2015- 2016-2017	During 2008– 2017, there was a constant substantial increase in total forest area observed (51.34– 55.83 km <sup>2</sup> ).	Forest increased

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