

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

| Refer ence | Study Area | District/ Province | Study Scale | Area (km ²) | Forest area (km ²) of District/ Province extracted from GFW/ GMW | Latitude | Longitude | Altitude (m) | Forest Type | RS Data/Imagery Used |
|------------------|--|--------------------------|----------------|----------------------------|--|----------|-----------|--------------------|---|--|
| Pre-2010 | | | | | | | | | | |
| [1] | Margala Hills, Islamab ad | Islamabad (Part of) | Local | 148 | 102 | 33.75 | 73.00 | 457.2 - 1584.96 | - | SPOT XS, Landsat TM and Landsat MSS |
| [2] | Margalla Hills, Islamab ad | 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 | - | mangrove s, mixed terrestrial vegetation (mainly Prosipus sp.) and marine algae | Landsat, ASTER (Terra) and SPOT |
| [5] | Riverine forests of Sindh | Kashmore (Part of) | Regiona l | 2410 | 1 | 28.09 | 69.18 | - | Riverine forests or Bela forests | Landsat MSS and TM |
| [6] | Ayubia National Park (ANP), NWFP | Abbottaba d (Part of) | Local | 34 | 765 | 34.06 | 73.42 | 1800 - 2980 | Moist Temperat e Himalayan Forest | Quickbird |
| Post-2010 | | | | | | | | | | |
| [7] | District Abbotta bad | Abbottaba d (Part of) | Local | 1967 | 765 | 34.12 | 73.28 | | Urban forest | Landsat TM, ETM, and ETM+ |
| [8] | Abbotta bad district, Khyber Pakhtun khwa | Abbottaba d | Local | 4600 | 765 | 34.11 | 73.29 | | Urban forest | SPOT-5 |
| [9] | Abbotta bad | Abbottaba d | 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 Pakhtun khwa (KP), and Azad Jammu Kashmir (AJK) | Gilgit- Baltistan, Khyber Pakhtun khwa, and Azad Jammu & Kashmir | Regiona l | 85435 | 15103 | 36.40 | 73.31 | - | | Subalpine scrub zones, alpine dry steppes and alpine meadows | Landsat 5 TM and Landsat 8 OLI |
| [26] | Rawal Watersh ed, Islamab ad | Islamabad (Part of) | Local | 274 | 102 | 33.70 | 73.12 | 1800 | | Forest, Conifer Forest, Dry Semi Evergreen Forest | Landsat 5 (TM) |
| [27] | Simly Watersh ed, Islamab ad | Islamabad (Part of) | Local | 164 | 102 | 33.70 | 73.12 | - | | Conifer Forest and Dry Semi Evergreen Forest | Landsat 5 (TM) and SPOT |
| [28] | Islamab ad | Islamabad | Local | 907 | 102 | 33.82 | 72.40 | 457-610 | | Margalla Hills | Landsat 5 TM imagery and SPOT 5 imagery |
| [29] | Margalla h Hills National Park (MHNP) , Islamab ad | Islamabad (Part of) | Local | 174 | 102 | 33.73 | 73.07 | 469- 1560 | | subtropica l broad- leaved evergreen , subtropica l chir pine forests | Landsat 5 TM, 7 ETM, 5 TM, 8 OLI |
| [30] | Margalla Hills National Park (MHNP) , Islamab ad | Islamabad (Part of) | Local | 571 | 102 | 33.75 | 73.01 | - | - | | Landsat 7 (ETM+), Landsat 8 (OLI) |
| [31] | Islamab ad | Islamabad | Local | 907 | 102 | 33.74 | 73.08 | - | - | | Landsat 5 and 8 |
| [32] | Islamab ad | Islamabad | Local | 906 | 102 | 33.47 | 72.81 | 400-650 | | Subtropica l broadleav es and pine forests | Landsat-5 TM TIRS and Landsat-8 OLI/TIRS |
| [33] | Islamab ad Capital | Islamabad | Local | 906 | 102 | 33.47 | 72.81 | 1175 | | Subtropica l 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 sub-tropical 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 Satellite 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 sub-tropical 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 Satellite 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 tropical thorn forests | |
| [67] | Jhelum River Basin (Mangla Dam Watersh ed), Punjab | Azad Jammu & Kashmir | Regiona l | 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] | Battagra m, Khyber- Pakhtun khwa | 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, Kohista n district, Khyber Pakhtun khwa (KP) | Kohistan (Part of) | Local | 7492 | 1304 | 35.38 | 73.33 | 3000- 4000 | Dense deodar and pine forest, Juniperus communis (juniper), Pinus wallichian a (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, Forests, 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/Shrubs, 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 assessme nt, 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 Photograp hs 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 |

11.943% -
14.77%.

| | | | | | | | | | | | |
|------|---|------------|--|------------------|--|---|---|--|---|----|----|
| [37] | Indus River Delta- Arabian Sea mangroves | Supervised | Dense Mangroves , Medium Mangroves , Sparse Mangroves , Saltbushes / Grasses, Algae, Mudflats and Water | Object- based | Nearest neighbour classificati on 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) Kalimat 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 assessme nt, study was done only for year 2009 | NA | NA |
|------|---|------------|--|------------------|--|---|---|--|---|----|----|

| | | | | | | | | | | | |
|------|---|--------|---|----|---|---|---|---|----------------|---|---|
| [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 |
|------|---|--------|---|----|---|---|---|---|----------------|---|---|

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 |
|------|---|------------|--|-------------|---|---|--|--|----------------|---|------------------------|

| | | | | | | | | | | | |
|------|------------------------------------|------------|---|-------------|---|---|--|--|-----------|--|----------------------------|
| | | | | | | | | 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) 2009 (Overall Accuracy: 86%, Kappa: 82%, Producer's accuracy: >87% for all classes except bare soil i.e. 79%, User's accuracy: >77%) | 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 |

| | | | | | | | | | | | |
|------|---|--|--|--------------|--|-----|--|---|-----------|---|--|
| [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 ² , 960.83km ² and 1010.11km ² , 1082.71km ² 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 ² remain forested after conversion of 24 km ² | The results show that there is a decrease of about 5 km ² of 'closed canopy Pinus wallichiana' forest from 2005 to 2011 in the state managed area, whereas, and a decrease of about 2 km ² in the community/private forest. Similarly, a reduction of closed canopy Pinus roxburghii forests of about 3 and 15 km ² 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 |

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
km2 were
transforme
d from
nonforeste
d land to
forest
while
about 31
km2
remained
unchanged
.
On the
other
hand, in
the
community
/private
forest,
about 31
km2 was
converted
from forest
to
nonforeste
d land
while
about 52
km2
remained
unchanged
.
An area
of about 49
km2 was
converted
from non-

| | | | | | | | | | | | |
|-----|-------------------------------------|------------|---|-------------|---|---|---|---|--|---|---|
| | | | | | | | | | 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 Grassland s, Tropical Moist Decidious, Irrigated Intensive Agriculture , Irrigated Agriculture , Slope Agriculture , Snow and Mixed Forests | - | Land cover classificati on (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] | Northwest ern 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 |
|------|---------------|------------|--|-------------|-------------------------------|---|---|---|----------------|--|----------------------------|

| | | | | | | | | | | | | |
|-----|--|------------|---|------------------|--|---|---|---|---|---|---|--|
| | | | | | | | 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 | - | - | |

>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 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 | Forest increased |
|------|--|------------|--|-----------------|------------------------------------|---|---|---|---|---|------------------|

| | | | | | | | | | | | |
|------|---|-------------|--|---------------------------------|------------------------------|-----|--|---|---|--|----------------------------|
| | | | | | | | | | | %) 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 | - | - |

| | | | |
|--|--|-------------------------------|---|
| 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 |
|--|--|-------------------------------|---|

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:

| | | | | | | | | | | | |
|------|-------------------------------------|------------|--|-------------|------------------------------|-----|------------------|--|---------------------|---|---|
| | | | | | | | | <p>>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%)</p> | | | |
| [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 | <p>1990 (Kappa: 0.90) 2000 (Kappa: 0.91) 2010 (Kappa: 0.87) 2017 (Kappa: 0.91)</p> | 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] | Northwest ern 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 ⁻¹) from 1994- 2016 | Forest decreased/ declined |
| [20] | Western Himalayan subalpine conifer forests | On-Screen Digitization | Forests, Agricultural land, Rangeland s and pastures, Barren land, and Settlement s | - | 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/vac ant land, Dry barren/vac ant 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 |

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

for all
classes)

| | | | | | | | | | | | |
|------|---|------------|--|-----------------|------------------------------------|---|---|---|--------------------|---|--|
| [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 |

| | | | | | | | | | | | |
|------|-----------------------------|------------|--|-------------|------------------------------|---|---|---|----------------|---|------------------------------------|
| | | | | | | | | | | degradation at the higher elevations in the 1993–2015 period. Reduced rate of 0.6% and 0.9% per year in the different valleys | |
| [21] | Baluchistan 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 vegetation 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 playground s), 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 |

| | | | | | | | | | | | |
|---------------------|--|------------|--|-----------------|------------------------------------|-----|---|---|--------------------|---|----------------------------|
| 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, Shrubland s, Savannas, Grassland s, Croplands, Urban, Non- vegetated lands. | - | MODIS land cover type product (MCD12Q 1) | - | - | - | 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 respectivel y. | Forest increased |
| [66] | Western Himalayan subalpine conifer forests | Supervised | - | Object- based | - | 373 | - | - | No change assessme nt, study was done only for year 2012 | - | - |
| [24] | Mixed forests | - | Landsat tree cover, Cropland, Shrub/gras s/wetland/ Sparse vegetation/ Built/ Bare areas, Water and Snow | Pixel- based | Rule- based classificati on | - | - | - | 2000-2018 | Did not mention | - |
| [32] | Western Himalayan subalpine conifer forests | Supervised | Forest land, Impervious surface, Grass/agri culture 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- 2000- 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 |

| | |
|---|--|
| 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 infrastructu re, commerca l and residential; road networks; and settlement s), 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 |
|------|--|------------|--|-----------------|------------------------------------|---|--|--|--------------------------------------|---|------------------|

| | | | | | | | | | | | |
|------|------------------------------------|------------|--|-------------|------------------------------|---|---|---|-----------|---|----------------------------|
| | | | 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:8 0.44%, 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 deforestati on rate of 2.51%, i.e. 1814.41 ha deforestati on per year | | | |
| [71] | Indus River Delta- Arabian Sea mangroves | Unsupervis ed | 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:9 6.9%, Kappa:0.8 91, 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∩SA VI (Overall Accuracy: | No change assessme nt, 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:0.8 92) 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 ²). | Forest increased |

References:

1. Siddiqui, M.N.; Jamil, Z. Forest change detection in Margala hills of Pakistan. *Adv. Sp. Res.* **1993**, *13*, 107–110, doi:10.1016/0273-1177(93)90210-3.
2. Malik, R.N.; Husain, S.Z. Evaluating deforestation using landsat TM and SPOT XS data in dry sub-tropical forest of Margalla Hills, northwest of Pakistan. *Geoinf. Eur. Integr.* **2003**, 429–434.
3. Lodhi, M.A.; Echavarria, F.R.; Keithley, C. Using remote sensing data to monitor land cover changes near afghan refugee camps in northern pakistan. *Geocarto Int.* **1998**, *13*, 33–39, doi:10.1080/10106049809354626.
4. Saeed, U.; Gilani, H.; Shahzad, N.; Gill, K. Remote sensing based forest change trend analysis – a case study of mangrove forest of Keti Bunder, Indus Delta. *Terra*

2001, 15, 12–24.

5. Siddiqui, M.N.; Jamil, Z.; Afsar, J. Monitoring changes in riverine forests of Sindh-Pakistan using remote sensing and GIS techniques. *Adv. Sp. Res.* **2004**, 33, 333–337, doi:10.1016/S0273-1177(03)00469-1.
6. Abbas, S.; Qamer, F.M.; Rana, A.D.; Hussain, N.; Saleem, R. Application of Object Based Image Analysis for Forest Cover Assessment of Moist Temperate Himalayan Forest in Pakistan. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2010**, XXXVIII-4/, 39–4.
7. Raza, A.; Raja, I.A.; Raza, S. LAND-USE CHANGE ANALYSIS OF DISTRICT ABBOTTABAD, PAKISTAN: TAKING ADVANTAGE OF GIS AND REMOTE SENSING ANALYSIS. *Sci. Vis.* **2012**, 18, 43–50.
8. Khan, U.; Minallah, N.; Junaid, A.; Gul, K.; Ahmad, N. Parallelepiped and Mahalanobis Distance based Classification for forestry identification in Pakistan. *2015 Int. Conf. Emerg. Technol.* **2015**, 1–6, doi:10.1109/ICET.2015.7389199.
9. Gul, K.; Minallah, N.; Junaid, A.; Aziz, N. Performance Analysis of Object Oriented Remote Sensing Techniques for Forest Detection in Pakistan. *Sindh Univ. Res. J. (Science Ser.* **2016**, 48, 511–515.
10. Nisa, Z. un; Mir, K.; Fatimah, H.; Batool, S.M.; Sanaullah; Atif, S.; Awan, M.A. Application of satellite remote sensing in forest change detection and its environmental impacts in district Abbottabad, Pakistan. *J. Pure Appl. Agric.* **2018**, 3, 49–62.
11. Ullah, S.; Ahmad, K.; Sajjad, R.U.; Abbasi, A.M.; Nazeer, A.; Tahir, A.A. Analysis and simulation of land cover changes and their impacts on land surface temperature in a lower Himalayan region. *J. Environ. Manage.* **2019**, 245, 348–357, doi:10.1016/j.jenvman.2019.05.063.
12. Shehzad, K.; Qamer, F.M.; Murthy, M.S.R.; Abbas, S.; Bhatta, L.D. Deforestation trends and spatial modelling of its drivers in the dry temperate forests of northern Pakistan — A case study of Chitral. *J. Mt. Sci.* **2014**, 11, 1192–1207, doi:10.1007/s11629-013-2932-x.
13. Zeb, A.; Armstrong, G.W.; Hamann, A. Forest conversion by the indigenous Kalasha of Pakistan: A household level analysis of socioeconomic drivers. *Glob. Environ. Chang.* **2019**, 59, doi:10.1016/j.gloenvcha.2019.102004.
14. Zeb, A.; Hamann, A.; Armstrong, G.W.; Acuna-Castellanos, D. Identifying local actors of deforestation and forest degradation in the Kalasha valleys of Pakistan. *For. Policy Econ.* **2019**, 104, 56–64, doi:10.1016/j.forpol.2019.04.005.
15. Zeb, A. Spatial and temporal trends of forest cover as a response to policy interventions in the district Chitral, Pakistan. *Appl. Geogr.* **2019**, 102, 39–46, doi:10.1016/j.apgeog.2018.12.002.
16. Sajjad, A.; Hussain, A.; Wahab, U.; Adnan, S.; Ali, S.; Ahmad, Z.; Ali, A. Application of Remote Sensing and GIS in Forest Cover Change in Tehsil Barawal, District Dir, Pakistan. *Am. J. Plant Sci.* **2015**, 06, 1501–1508, doi:10.4236/ajps.2015.69149.
17. Munawar, S.; Khokhar, M.F.; Atif, S. Reducing emissions from deforestation and forest degradation implementation in northern Pakistan. *Int. Biodeterior. Biodegrad.* **2015**, 102, 316–323, doi:10.1016/j.ibiod.2015.02.027.
18. Ullah, S.; Farooq, M.; Shafique, M.; Siyab, M.A.; Kareem, F.; Dees, M. Spatial assessment of forest cover and land-use changes in the Hindu-Kush mountain ranges of northern Pakistan. *J. Mt. Sci.* **2016**, 13, 1229–1237, doi:10.1007/s11629-015-3456-3.
19. Ullah, S.; Shafique, M.; Farooq, M.; Zeeshan, M.; Dees, M. Evaluating the impact of classification algorithms and spatial resolution on the accuracy of land cover

mapping in a mountain environment in Pakistan. *Arab. J. Geosci.* **2017**, *10*, doi:10.1007/s12517-017-2859-6.

20. Haq, F.; Rahman, F.; Tabassum, I.; Ullah, I.; Sher, A. Forest Dilemma in the Hindu Raj Mountains Northern Pakistan: Impact of Population Growth and Household Dynamics. *Small-scale For.* **2018**, *17*, 323–341, doi:10.1007/s11842-018-9390-9.
21. Khan, H.; Shafique, M.; Khan, M.A.; Bacha, M.A.; Shah, S.U.; Calligaris, C. Landslide susceptibility assessment using Frequency Ratio, a case study of northern Pakistan. *Egypt. J. Remote Sens. Sp. Sci.* **2019**, *22*, 11–24, doi:10.1016/j.ejrs.2018.03.004.
22. Imran, M.; Din, N. Geospatially mapping carbon stock for mountainous forest classes using InVEST model and Sentinel-2 data: a case of Bagrote valley in the Karakoram range. *Arab. J. Geosci.* **2021**, *14*, doi:10.1007/s12517-021-07023-4.
23. Qamer, F.M.; Shehzad, K.; Abbas, S.; Murthy, M.S.R.; Xi, C.; Gilani, H.; Bajracharya, B. Mapping deforestation and forest degradation patterns in Western Himalaya, Pakistan. *Remote Sens.* **2016**, *8*, 1–17, doi:10.3390/rs8050385.
24. Munawar, S.; Udelhoven, T. Land change syndromes identification in temperate forests of Hindukush Himalaya Karakorum (HHK) mountain ranges. *Int. J. Remote Sens.* **2020**, *41*, 7735–7756, doi:10.1080/01431161.2020.1763509.
25. Khan, T.U.; Mannan, A.; Hacker, C.E.; Ahmad, S.; Siddique, M.A.; Khan, B.U.; Din, E.U.; Chen, M.; Zhang, C.; Nizami, M.; et al. Use of GIS and Remote Sensing Data to Understand the Impacts of Land Use/Land Cover Changes (LULCC) on Snow Leopard (*Panthera Uncia*) Habitat in Pakistan. *Sustainability* **2021**, *13*, doi:10.3390/su13073590.
26. Butt, A.; Shabbir, R.; Ahmad, S.S.; Aziz, N.; Nawaz, M.; Tahir, M.S.A. Land cover classification and change detection analysis of rawal watershed using remote sensing data. *J. Biodivers. Environ. Sci.* **2015**, *6*, 236–248.
27. Butt, A.; Shabbir, R.; Ahmad, S.S.; Aziz, N. Land use change mapping and analysis using Remote Sensing and GIS: A case study of Simly watershed, Islamabad, Pakistan. *Egypt. J. Remote Sens. Sp. Sci.* **2015**, *18*, 251–259, doi:10.1016/j.ejrs.2015.07.003.
28. Hassan, Z.; Shabbir, R.; Ahmad, S.S.; Malik, A.H.; Aziz, N.; Butt, A.; Erum, S. Dynamics of land use and land cover change (LULCC) using geospatial techniques: a case study of Islamabad Pakistan. *Springerplus* **2016**, *5*, doi:10.1186/s40064-016-2414-z.
29. Mannan, A.; Feng, Z.; Ahmad, A.; Liu, J.; Saeed, S.; Mukete, B. Carbon dynamic shifts with land use change in margallah hills national park, Islamabad (Pakistan) from 1990 to 2017. *Appl. Ecol. Environ. Res.* **2018**, *16*, 3197–3214, doi:10.15666/aeer/1603_31973214.
30. Batool, R.; Javaid, K. Spatio-temporal assessment of Margalla hills forest by using LANDSAT imagery for year 2000 and 2018. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci. - ISPRS Arch.* **2018**, *42*, 69–72, doi:10.5194/isprs-archives-XLII-3-69-2018.
31. Waseem, S.; Khayyam, U. Loss of vegetative cover and increased land surface temperature: A case study of Islamabad, Pakistan. *J. Clean. Prod.* **2019**, *234*, 972–983, doi:10.1016/j.jclepro.2019.06.228.
32. Khan, M.S.; Ullah, S.; Sun, T.; Rehman, A.U.; Chen, L. Land-use/land-cover changes and its contribution to urban heat Island: A case study of Islamabad, Pakistan. *Sustain.* **2020**, *12*, doi:10.3390/su12093861.
33. Gilani, H.; Ahmad, S.; Qazi, W.A.; Abubakar, S.M.; Khalid, M. Monitoring of urban landscape ecology dynamics of Islamabad capital territory (ICT), Pakistan, over four decades (1976-2016). *Land* **2020**, *9*, doi:10.3390/land9040123.

34. Shah, A.; Ali, K.; Nizami, S.M. Four decadal urban land degradation in Pakistan a case study of capital city islamabad during 1979–2019. *Environ. Sustain. Indic.* **2021**, *10*, 100108, doi:10.1016/j.indic.2021.100108.
35. Shah, A.; Ali, K.; Nizami, S.M. Spatio-temporal analysis of urban sprawl in Islamabad, Pakistan during 1979–2019, using remote sensing. *GeoJournal* **2021**, *6*, doi:10.1007/s10708-021-10413-6.
36. Abbas, S.; Qamer, F.M.; Hussain, N.; Saleem, R.; Nitin, K.T. National Level Assessment of Mangrove Forest Cover in Pakistan. *ISPRS - Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2011**, XXXVIII-8/, 187–192, doi:10.5194/isprsarchives-xxxviii-8-w20-187-2011.
37. Abbas, S.; Qamer, F.M.; Ali, G.; Tripathi, N.K.; Shehzad, K.; Saleem, R.; Gilani, H. An assessment of status and distribution of mangrove forest cover in Pakistan. *J. Biodivers. Environ. Sci.* **2013**, *3*, 64–78.
38. Gilani, H.; Naz, H.I.; Arshad, M.; Nazim, K.; Akram, U.; Abrar, A.; Asif, M. Evaluating mangrove conservation and sustainability through spatiotemporal (1990–2020) mangrove cover change analysis in Pakistan. *Estuar. Coast. Shelf Sci.* **2021**, *249*, 107128, doi:10.1016/j.ecss.2020.107128.
39. Amjad, D.; Kausar, S.; Waqar, R.; Sarwar, F. Land cover change analysis and impacts of deforestation on the climate of District Mansehra, Pakistan. *J. Biodivers. Environ. Sci.* **2019**, *14*, 103–113.
40. Ullah, S.; Tahir, A.A.; Akbar, T.A.; Hassan, Q.K.; Dewan, A.; Khan, A.J.; Khan, M. Remote sensing-based quantification of the relationships between land use land cover changes and surface temperature over the lower Himalayan region. *Sustain.* **2019**, *11*, doi:10.3390/su11195492.
41. Shahzad, N.; Saeed, U.; Gilani, H.; Ahmad, S.R.; Ashraf, I.; Irteza, S.M. Evaluation of state and community/private forests in Punjab, Pakistan using geospatial data and related techniques. *For. Ecosyst.* **2015**, *2*, 1–13, doi:10.1186/s40663-015-0032-9.
42. Mannan, A.; Liu, J.; Zhongke, F.; Khan, T.U.; Saeed, S.; Mukete, B.; ChaoYong, S.; Yongxiang, F.; Ahmad, A.; Amir, M.; et al. Application of land-use/land cover changes in monitoring and projecting forest biomass carbon loss in Pakistan. *Glob. Ecol. Conserv.* **2019**, *17*, e00535, doi:10.1016/j.gecco.2019.e00535.
43. Siyal, A.A.; Siyal, A.G.; Mahar, R.B. Spatial and temporal dynamics of Pai forest vegetation in Pakistan assessed by RS and GIS. *J. For. Res.* **2016**, *28*, 593–603, doi:10.1007/s11676-016-0327-x.
44. Shafique, T.; Zuberi, M.H.; Shams, Z.I. Geospatial assessment of carbon stock inventory by vegetation indices in Pai Forest , Sindh , Pakistan. *Int. J. Environ. Qual.* **2021**, *43*, 47–64, doi:10.6092/issn.2281-4485/12203.
45. Qasim, M.; Hubacek, K.; Termansen, M.; Khan, A. Spatial and temporal dynamics of land use pattern in District Swat, Hindu Kush Himalayan region of Pakistan. *Appl. Geogr.* **2011**, *31*, 820–828, doi:10.1016/j.apgeog.2010.08.008.
46. Qamer, F.M.; Abbas, S.; Saleem, R.; Shehzad, K.; Ali, H.; Gilani, H. Forest cover change assessment in conflict-affected areas of northwest Pakistan: The case of Swat and Shangla districts. *J. Mt. Sci.* **2012**, *9*, 297–306, doi:10.1007/s11629-009-2319-1.
47. Qasim, M.; Hubacek, K.; Termansen, M.; Fleskens, L. Modelling land use change across elevation gradients in district Swat, Pakistan. *Reg. Environ. Chang.* **2013**, *13*, 567–581, doi:10.1007/s10113-012-0395-1.
48. Ali, S.; Ali, W.; Khan, S.; Khan, A.; Rahman, Z.U.; Iqbal, A. Forest cover change and carbon stock assessment in Swat valley using remote sensing and geographical information systems. *Pure Appl. Biol.* **2017**, *6*, 850–856, doi:10.19045/bspab.2017.60089.

49. Ahmad, A.; Liu, Q.J.; Nizami, S.M.; Mannan, A.; Saeed, S. Carbon emission from deforestation, forest degradation and wood harvest in the temperate region of Hindukush Himalaya, Pakistan between 1994 and 2016. *Land use policy* **2018**, *78*, 781–790, doi:10.1016/j.landusepol.2018.07.009.
50. Ahmad, A.; Liu, Q.J.; Marwat, K.B.; Shah, S.; Amir, M.; Mannan, A. Tree distribution pattern, growing stock characteristics and carbon mitigation potential of different forests ecosystems in kumrat, hindukush region of northern pakistan. *Pakistan J. Bot.* **2019**, *51*, 2185–2194, doi:10.30848/PJB2019-6(3).
51. Talib, B.; Arif, H.; Shahzad, M.; Mehmood, S.A.; Batool, Ha.; Naeem, K.; Batool, S.; Nasir, J.; Shafiq, M. Spatiotemporal Analysis of Land Use / Land Cover in Swat, Pakistan Using Supervised Classification in Remote Sensing: 2000 to 2015. *Int. J. Econ. Environ. Geol.* **2020**, *11*, 69–74, doi:10.46660/ijeeg.vol11.iss2.2020.450.
52. Masood, H.; Afsar, S.; Zamir, U. Bin; Kazmi, J.H. Application of comparative remote sensing techniques for monitoring mangroves in Indus Delta, Sindh, Pakistan. *Biol. Forum - An Int. J.* **2015**, *7*, 783–792.
53. Qasim, H.; Luqman, M.; Khan, S. A study of forest land cover changes using satellite remote sensing in thatta district Pakistan. *Sci. Int.* **2016**, *28*, 4069–4075.
54. Rehman, Z. ur; Kazmi, S.J.H. Land use/land cover changes through satellite remote sensing approach: A case study of Indus delta, Pakistan. *Pakistan J. Sci. Ind. Res. Ser. A Phys. Sci.* **2018**, *61*, 156–162, doi:10.52763/pjsir.phys.sci.61.3.2018.156.162.
55. Abbasi, H.U.; Chughtai, A.H.; Sultana, G.; Adhban; Farea, O.A.; Islam, H. Spatio-temporal Land use/cover assessment of Sub-Tropical Forests ofThatta Division. *Sindh Univ. Res. J. (Science Ser.* **2019**, *51*, 547–554.
56. Abbasi, H.; Baloch, M.A.; Memon, A.G. Deforestation Analysis of Riverine Forest of Sindh Using Remote Sensing Techniques. *Mehran Univ. Res. J. Eng. Technol.* **2011**, *30*, 477–482.
57. Iqbal, M.F.; Khan, I.A. Spatiotemporal Land Use Land Cover change analysis and erosion risk mapping of Azad Jammu and Kashmir, Pakistan. *Egypt. J. Remote Sens. Sp. Sci.* **2014**, *17*, 209–229, doi:10.1016/j.ejrs.2014.09.004.
58. Batool, S.; Khan, K.; Ghaffar, A.; Hussain, S.Z. Forest Cover Change Detection and Its Impact on Rainfall Patternin Thak Valley (Pakistan). *Pak. J. Sci.* **2015**, *67*, 1–9.
59. Baig, S.; Qazi, W.A.; Akhtar, A.M.; Waqar, M.M.; Ammar, A.; Gilani, H.; Mehmood, S.A. Above Ground Biomass Estimation of Dalbergia sissoo Forest Plantation from Dual-Polarized ALOS-2 PALSAR Data. *Can. J. Remote Sens.* **2017**, *43*, 297–308, doi:10.1080/07038992.2017.1330143.
60. Younis, S.M.Z.; Ammar, A. Quantification of impact of changes in land use-land cover on hydrology in the upper Indus Basin, Pakistan. *Egypt. J. Remote Sens. Sp. Sci.* **2018**, *21*, 255–263, doi:10.1016/j.ejrs.2017.11.001.
61. Rashid, B.; Iqbal, J. Spatiotemporal Change Detection in Forest Cover Dynamics along Landslide Susceptible Region of Karakoram Highway, Pakistan. *ISPRS Ann. Photogramm. Remote Sens. Spat. Inf. Sci.* **2018**, *4*, 177–184, doi:10.5194/isprs-annals-IV-3-177-2018.
62. Khan, I.; Javed, T.; Khan, A.; Lei, H.; Muhammad, I.; Ali, I.; Huo, X. Impact assessment of land use change on surface temperature and agricultural productivity in Peshawar-Pakistan. *Environ. Sci. Pollut. Res.* **2019**, *26*, 33076–33085, doi:10.1007/s11356-019-06448-5.
63. Urooj, R.; Ahmad, S.S. Spatio-temporal ecological changes around wetland using multispectral satellite imagery in AJK, Pakistan. *SN Appl. Sci.* **2019**, *1*, 1–8.
64. Khan, I.A.; Khan, M.R.; Baig, M.H.A.; Hussain, Z.; Hameed, N.; Khan, J.A. Assessment of forest cover and carbon stock changes in sub-tropical pine forest of Azad Jammu & Kashmir (AJK), Pakistan using multitemporal Landsat satellite data and field inventory. *PLoS One* **2020**, *15*, 1–19, doi:10.1371/journal.pone.0226341.

65. Mahmoudi, P.; Shirazi, S.A.; Firoozi, F.; Jahanshahi, S.M.A.; Mazhar, N. Detection of land cover changes in Baluchistan (shared between Iran, Pakistan, and Afghanistan) using the MODIS Land Cover Product. *Arab. J. Geosci.* **2020**, *13*, doi:10.1007/s12517-020-06284-9.
66. Ali, A.; Ashraf, M.I.; Gulzar, S.; Akmal, M.; Ahmad, B. Estimation of soil carbon pools in the forests of Khyber Pakhtunkhwa Province, Pakistan. *J. For. Res.* **2020**, *31*, 2313–2321, doi:10.1007/s11676-019-01059-9.
67. Saddique, N.; Mahmood, T.; Bernhofer, C. Quantifying the impacts of land use/land cover change on the water balance in the afforested River Basin, Pakistan. *Environ. Earth Sci.* **2020**, *79*, 1–13, doi:10.1007/s12665-020-09206-w.
68. Hussain, S.; Mubeen, M.; Akram, W.; Ahmad, A.; Habib-ur-Rahman, M.; Ghaffar, A.; Amin, A.; Awais, M.; Farid, H.U.; Farooq, A.; et al. Study of land cover/land use changes using RS and GIS: a case study of Multan district, Pakistan. *Environ. Monit. Assess.* **2020**, *192*, 2.
69. Hussain, S.; Mubeen, M.; Ahmad, A.; Akram, W.; Hammad, H.M.; Ali, M.; Masood, N.; Amin, A.; Farid, H.U.; Sultana, S.R.; et al. Using GIS tools to detect the land use/land cover changes during forty years in Lodhran District of Pakistan. *Environ. Sci. Pollut. Res.* **2020**, *27*, 39676–39692, doi:10.1007/s11356-019-06072-3.
70. Khan, K.; Iqbal, J.; Ali, A.; Khan, S.N. Assessment of sentinel-2-derived vegetation indices for the estimation of above-ground biomass/carbon stock, temporal deforestation and carbon emissions estimation in the moist temperate forests of pakistan. *Appl. Ecol. Environ. Res.* **2020**, *18*, 783–815, doi:10.15666/aeer/1801_783815.
71. Ali, A.; Nayyar, Z.A. Extraction of mangrove forest through Landsat 8 Mangrove Index (L8MI). *Arab. J. Geosci.* **2020**, *13*, doi:10.1007/s12517-020-06138-4.
72. Haq, N. ul; Rahman, F.; Tabassum, I.; Mehran Forest cover dynamics in Palas Valley Kohistan, Hindu Kush-Himalayan Mountains, Pakistan. *J. Mt. Sci.* **2021**, *18*, 416–426, doi:10.1007/s11629-020-6093-4.
73. Zafar, Z.; Mehmood, M.S.; Ahamad, M.I.; Chudhary, A.; Abbas, N.; Khan, A.R.; Zulqarnain, R.M.; Abdal, S. Trend analysis of the decadal variations of water bodies and land use/land cover through MODIS imagery: An in-depth study from Gilgit-Baltistan, Pakistan. *Water Sci. Technol. Water Supply* **2021**, *21*, 927–940, doi:10.2166/ws.2020.355.