

Supplementary Materials

Table S1. The study area and the covering countries around continents

| Continents | Dryland areas ($\times 10^4$ km ²) | Countries | Dryland areas ($\times 10^4$ km ²) (excluded countries with dryland area less than 0.02 million km ²) | Countries (excluded countries with dryland area less than 0.02 million km ²) |
|---------------|---|-----------|--|--|
| Asia | 1445.9 | 29 | 1441.4 | 20 |
| Africa | 1534.2 | 41 | 1528.6 | 29 |
| South America | 246.3 | 13 | 244.6 | 8 |
| North America | 339.5 | 8 | 338.4 | 3 |
| Europe | 23.8 | 4 | 22.4 | 1 |
| Oceania | 538.7 | 2 | 538.7 | 1 |
| Global | 4128.4 | 97 | 4114.1 | 62 |

Table S2. The 37 land cover categories in CCILI dataset and their re-groups

| Regrouped land covers | Ecological level | Land cover categories in LCCS system |
|--|------------------|--|
| Farmland | 5 | Cropland, rainfed |
| | | Cropland, rainfed-Herbaceous cover |
| | | Cropland, rainfed-Tree or shrub cover |
| | | Cropland, irrigated or post-flooding |
| | | Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%) |
| | | Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%) |
| Forest | 2 | Tree cover, broadleaved, evergreen, closed to open (>15%) |
| | | Tree cover, broadleaved, deciduous, closed to open (>15%) |
| | | Tree cover, broadleaved, deciduous, closed to open (>15%)-Tree cover, broadleaved, deciduous, closed |
| | | Tree cover, broadleaved, deciduous, closed to open (>15%)-Tree cover, broadleaved, deciduous, open |
| | | Tree cover, needleleaved, evergreen, closed to open (>15%) |
| Tree cover, needleleaved, evergreen, closed to open (>15%)-Tree cover, needleleaved, evergreen, closed | | |

| | | |
|------------|---|---|
| | | (>40%) Tree cover, needleleaved, evergreen, closed to open (>15%)-Tree cover, needleleaved, evergreen, open (15~40%) Tree cover, needleleaved, deciduous, closed to open (>15%) Tree cover, needleleaved, deciduous, closed to open (>15%)-Tree cover, needleleaved, deciduous, closed (>40%) Tree cover, needleleaved, deciduous, closed to open (>15%)-Tree cover, needleleaved, deciduous, open Tree cover, mixed leaf type (broadleaved and needleleaved) Mosaic tree and shrub (>50%) / herbaceous cover (<50%) Tree cover, flooded, fresh or brackish water Tree cover, flooded, saline water |
| Grassland | 4 | Mosaic herbaceous cover (>50%) / tree and shrub (<50%) Grassland |
| Shrub | 3 | Shrubland Shrubland-Evergreen shrubland Shrubland-Deciduous shrubland |
| Wetland | 1 | Shrub or herbaceous cover, flooded, fresh/saline/brackish water Water bodies |
| Urban area | 5 | Urban areas |
| Bare | 5 | Bare areas Bare areas-Consolidated bare areas Bare areas-Unconsolidated bare areas |
| Others | 5 | Lichens and mosses Sparse vegetation (tree, shrub, herbaceous cover) (<15%) Sparse vegetation (tree, shrub, herbaceous cover) (<15%)-Sparse tree (<15%) Sparse vegetation (tree, shrub, herbaceous cover) (<15%)-Sparse shrub (<15%) Sparse vegetation (tree, shrub, herbaceous cover) (<15%)-Sparse herbaceous cover (<15%) Permanent snow and ice |

Table S3. The transition matrix (%) of eight land cover categories (1992–2020)

| 1992\2020 | Farmland | Forest | Grassland | Shrub | Wetland | Urban area | Bare | Others |
|------------|----------|--------|-----------|-------|---------|------------|------|--------|
| Farmland | - | 1.98 | 2.14 | 0.59 | 0.10 | 1.84 | 0.45 | 0.54 |
| Forest | 1.68 | - | 1.38 | 3.71 | 0.20 | 0.07 | 0.10 | 0.44 |
| Grassland | 6.02 | 1.88 | - | 0.50 | 0.14 | 0.57 | 2.71 | 9.02 |
| Shrub | 2.95 | 4.38 | 1.14 | - | 0.05 | 0.51 | 0.22 | 0.42 |
| Wetland | 0.10 | 0.20 | 0.13 | 0.05 | - | 0.02 | 1.91 | 0.11 |
| Urban area | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 |
| Bare | 2.09 | 0.05 | 9.09 | 0.03 | 0.30 | 0.51 | - | 15.19 |
| Others | 3.36 | 0.51 | 15.28 | 0.17 | 0.05 | 0.14 | 5.00 | - |

Table S4. The CRs in 37 land cover categories (1992–2020)

| 37 original land cover categories in LCCS system | Percentage in 1992(%) | Percentage in 2020(%) | CR (%) |
|---|-----------------------|-----------------------|--------|
| Cropland, rainfed | 3.93 | 3.98 | 1.42 |
| Cropland, rainfed-Herbaceous cover | 2.83 | 3.04 | 7.65 |
| Cropland, rainfed-Tree or shrub cover | 0.08 | 0.08 | 2.82 |
| Cropland, irrigated or post-flooding | 1.92 | 2.01 | 4.94 |
| Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%) | 1.18 | 1.26 | 6.21 |
| Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%) | 1.34 | 1.33 | -0.49 |
| Tree cover, broadleaved, evergreen, closed to open (>15%) | 0.29 | 0.30 | 4.07 |
| Tree cover, broadleaved, deciduous, closed to open (>15%) | 0.76 | 0.73 | -3.19 |
| Tree cover, broadleaved, deciduous, closed to open (>15%)-Tree cover, broadleaved, deciduous, closed (>40%) | 0.18 | 0.17 | -4.75 |

| | | | |
|---|----------|----------|--------|
| Tree cover, broadleaved, deciduous, closed to open (>15%)-Tree cover, broadleaved, deciduous, open (15~40%) | 1.01 | 1.03 | 1.84 |
| Tree cover, needleleaved, evergreen, closed to open (>15%) | 0.72 | 0.70 | -1.67 |
| Tree cover, needleleaved, evergreen, closed to open (>15%)-Tree cover, needleleaved, evergreen, closed (>40%) | 0.04 | 0.04 | -4.82 |
| Tree cover, needleleaved, evergreen, closed to open (>15%)-Tree cover, needleleaved, evergreen, open (15~40%) | 0.00 | 0.00 | 0.00 |
| Tree cover, needleleaved, deciduous, closed to open (>15%) | 0.10 | 0.11 | 16.17 |
| Tree cover, needleleaved, deciduous, closed to open (>15%)-Tree cover, needleleaved, deciduous, closed (>40%) | 0.00 | 0.00 | 0.00 |
| Tree cover, needleleaved, deciduous, closed to open (>15%)-Tree cover, needleleaved, deciduous, open (15~40%) | 0.00 | 0.00 | 0.00 |
| Tree cover, mixed leaf type (broadleaved and needleleaved) | 0.15 | 0.15 | -1.31 |
| Mosaic tree and shrub (>50%) / herbaceous cover (<50%) | 1.17 | 1.24 | 6.08 |
| Mosaic herbaceous cover (>50%) / tree and shrub (<50%) | 0.73 | 0.69 | -4.76 |
| Shrubland | 13.37 | 13.15 | -1.63 |
| Shrubland-Evergreen shrubland | 0.00 | 0.00 | 4.42 |
| Shrubland-Deciduous shrubland | 1.76 | 1.74 | -0.94 |
| Grassland | 13.27 | 13.73 | 3.44 |
| Lichens and mosses | 0.001206 | 0.001201 | -0.38 |
| Sparse vegetation (tree, shrub, herbaceous cover) (<15%) | 11.96 | 12.13 | 1.39 |
| Sparse vegetation (tree, shrub, herbaceous cover) (<15%)-Sparse tree (<15%) | 0.00 | 0.00 | 1.56 |
| Sparse vegetation (tree, shrub, herbaceous cover) (<15%)-Sparse shrub (<15%) | 0.09 | 0.08 | -8.78 |
| Sparse vegetation (tree, shrub, herbaceous cover) (<15%)-Sparse herbaceous cover (<15%) | 0.67 | 0.57 | -14.46 |
| Tree cover, flooded, fresh or brackish water | 0.01 | 0.01 | 7.91 |
| Tree cover, flooded, saline water | 0.02 | 0.03 | 10.72 |
| Shrub or herbaceous cover, flooded, fresh/saline/brackish water | 0.53 | 0.53 | 0.42 |
| Urban areas | 0.08 | 0.27 | 228.18 |
| Bare areas | 40.65 | 39.79 | -2.11 |
| Bare areas-Consolidated bare areas | 0.17 | 0.17 | -1.16 |
| Bare areas-Unconsolidated bare areas | 0.21 | 0.22 | 2.50 |
| Water bodies | 0.61 | 0.53 | -14.20 |
| Permanent snow and ice | 0.17 | 0.17 | 0.00 |

Table S5. Top eight land cover transitions from 1992 to 2020(%)

| Land cover transitions | Percentage (%) |
|---|----------------|
| Bare areas -> Sparse vegetation (tree, shrub, herbaceous cover) (<15%) | 13.91 |
| Sparse vegetation (tree, shrub, herbaceous cover) (<15%) -> Grassland | 13.81 |
| Bare areas -> Grassland | 8.47 |
| Grassland -> Sparse vegetation (tree, shrub, herbaceous cover) (<15%) | 7.78 |
| Sparse vegetation (tree, shrub, herbaceous cover) (<15%) -> Bare areas | 4.67 |
| Grassland -> Bare areas | 2.29 |
| Sparse vegetation (tree, shrub, herbaceous cover) (<15%)-Sparse herbaceous cover (<15%) -> Sparse vegetation (tree, shrub, herbaceous cover) (<15%) | 2.26 |
| Water bodies -> Bare areas | 1.73 |

Table S6. Net change areas ($\times 10^4$ km²) of 8 land cover categories in continents

| Land covers | Asia | Africa | South America | North America | Europe | Oceania | Global |
|-------------|--------|--------|---------------|---------------|--------|---------|--------|
| Farmland | 8.74 | 8.07 | 1.40 | 1.98 | -0.13 | 2.22 | 22.29 |
| Forest | 0.66 | 3.84 | -3.30 | -0.07 | 0.19 | 2.35 | 3.66 |
| Grassland | 10.45 | -0.71 | 0.57 | -1.48 | -0.03 | 12.78 | 21.58 |
| Shrub | -0.57 | -5.26 | 1.39 | -2.45 | 0.00 | -5.13 | -12.01 |
| Wetland | -4.38 | 0.12 | -0.04 | 0.00 | 0.04 | -0.10 | -4.36 |
| Urban area | 5.54 | 1.33 | 0.39 | 1.89 | 0.28 | 0.05 | 9.49 |
| Bare | -22.66 | -14.39 | -2.30 | 0.08 | -0.03 | -4.50 | -43.79 |
| Others | 2.22 | 6.98 | 1.90 | 0.05 | -0.33 | -7.69 | 3.14 |

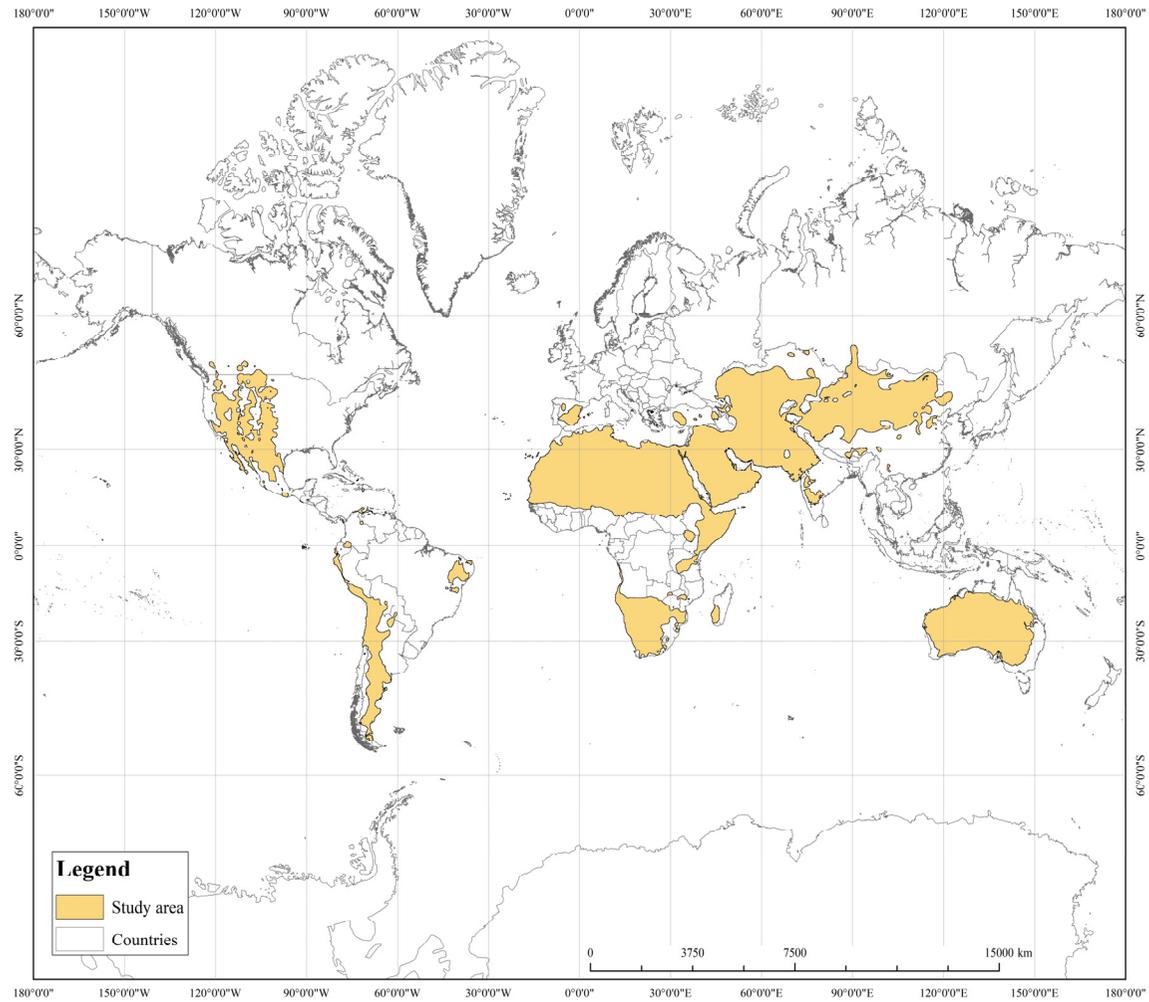


Figure S1. The study area