GFOI Global Forest Observations Initiative | Plenary 9-11 May 2023

# Forest and Grassland Types Mapping in China Using GF-1/6 Chinese Satellite Data

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# Outline

1. Backgrounds

2. Forestry and Grassland Type Classification System

3. Methodology of Classification for Forestry and Grassland

4. Validation

5. Mapping

# 1. Backgrounds

## ➢ Composition of Gaofen (GF) satellite system

| Model | Payload | Launch Date |
|---|---|---|
| GF-1 | 2m/8m/PMS, 16m/WFV | April 26th, 2013 |
| GF-2 | 1m/4m PMS | August 19th, 2014 |
| GF-3 | 1m C-SAR | August 10th,2016 |
| GF-4 | Geostationary, 50m/PMS + 400m/MWIR | December 29th, 2015 |
| GF-5 | Hyperspectral, 30m AHSI (Land, Atmosphere, etc.) | May 9th, 2018 |
| GF-6 | 2m/8m/PMS, 16m/WFV | June 2nd, 2018 |
| GF-7 | Stereo Mapping, 0.65m/0.8m DLC, 3.2m MS | November 3rd, 2019 |

# 1. Backgrounds

■ **Duties of National Forestry and Grassland Administration**

**Supervision of forestry resources**

**Supervision of wetland resources**

**Supervision of grassland resources**

**Supervision of desert resources**

**Supervision of wild animals and plants resources**

**Remote sensing plays a key role for the management of the resources.**

# 1. Backgrounds

- **The objectives of this work are:**

- **Constructing the classification system for the distribution of forest and grassland types in China based on the separability of GF-1 and GF-6 WFV satellite imagery;**
- **Mapping forest and grassland types on national scale.**

# 1. Backgrounds

## ➢ Reference data for classification system

① 30-meter resolution land cover/land use taxonomy.

② Classification standards for the third national land survey.

③ Technical regulations for continuous forest inventory (GB/T 38590-2020).

④ Classification and codes for forestry resources - Forest types (GB/T 14721-2010).

⑤ Grassland classification (NY/T 2997-2016).

⑥ Technical specifications for desertified grassland treatment (DB15/T 1878—2020).

⑦ Wetland resource monitoring method based on TM remote sensing imagery (LY/T 2021-2012).

⑧ Technical regulations for wetland survey, 2010 edition.

⑨ Fourth national technical regulation on desertification and sandification monitoring.

# 2. Forestry and Grassland Type Classification System

**Primary level :** 7 types,

Including: forest land, grassland, wetland, desert/sandy land, cultivated land, construction land, and others

**Secondary level:** 38 classes

# 2. Forestry and Grassland Type Classification System

## Forest Land

## Secondary Level:

## 10 classes

| Primary Level | Secondary Level | | | Descriptions |
|---|---|---|---|---|
| Type Name | Class Code | | Class Name | |
| forest land | 1 | 101 | coniferous forest | A general term for all types of forests composed of coniferous species, including evergreen and deciduous coniferous pure forests and mixed forests, with conifers accounting for more than 65%. |
| | 2 | 102 | broad-leaved forest | Forests composed mainly of broad-leaved tree species, including evergreen and deciduous, as well as broad-leaved pure forests & mixed forests composed of broad-leaved tree species, where broad-leaved trees accounting for more than 65%. |
| | 3 | 103 | mixed broadleaf-conifer forest | Mixed broadleaf-conifer forest land is a transitional type between cold-temperate coniferous forests and summer-green broadleaved forests, consisting of a mixture of conifers and broad-leaved trees. The proportion of conifers and broad-leaved trees in the vertical projection area of the canopy ranged from 0.3 to 0.7, respectively. |
| | 4 | 104 | shrub forest | Forest land type with shrub as the main vegetation type; come with single-layer crown/forest layer generally about 5 meters in height, clustered and without a trunk; swamp thicket is excluded. |
| | 5 | 105 | bamboo forest | Forest land with a monodominant community composed of bamboo plants, where the breast diameters of banboo plants are larger than 2 cm, and canopy density ≥ 0.2. |
| | 6 | 106 | mangrove forest | Forest land where mangrove plants grow along the coast, referring to the woody biome of evergreen shrubs or trees in the tidal wetlands with mangrove plants as the main body, growing in the upper intertidal zone of tropical and subtropical low-energy coasts. |
| | 7 | 107 | swamp forest | Freshwater marshland with arbor forest plants as the dominant group, with canopy density ≥ 0.2. The soil is excessively moist, waterlogged or has shallow water layers, and the peat has developed |
| | 8 | 108 | swamp thicket | Freshwater marsh shrubland with shrub plants as the dominant community, with FVC≥30%. |
| | 9 | 109 | sparse forest | Forest land with canopy density between 0.1 and 0.2. |
| | 10 | 110 | other forest | Forest land such as nursery land, other unforested afforestation land and forest land without standing tree. |

# 2. Forestry and Grassland Type Classification System

## Grassland

## Secondary Level:

## 6 classes

| Primary Level | Secondary Level | | | Descriptions |
|---|---|---|---|---|
| Type Name | Class Code | | Class Name | |
| grassland | 11 | 201 | artificial grassland | The dominant species are formed by artificial cultivation. The biomass and coverage of natural plants account for less than 50. This land type includes improved grassland, cultivated grassland, green grassland, football field, golf course and other special purpose artificial grassland. |
| | 12 | 202 | swamp meadow | This type is dominated by natural herbaceous plants, swampy lowland meadows, alpine meadows; also, prolonged or frequent flooded, with vegetation cover ≥ 30. |
| | 13 | 203 | shrubland | Grassland dominated by natural shrubs and perennial grasses. The height of the shrub is generally less than 5 meters, and the degree of coverage for the shrub is between 30% to 40% in general. The ecological type is from xerocolous to humidogene, and the temperature ecological type is from low temperature to high temperature. |
| | 14 | 204 | natural grassland with high coverage | Natural grassland with degree of coverage above 50%. Such grasslands generally have good moisture conditions and densely-grown grass. |
| | 15 | 205 | natural grassland with medium coverage | Natural grassland with degree of coverage between 20% to 50%. Such grassland generally have inadequate moisture and relatively sparse vegetation. |
| | 16 | 206 | natural grassland with low coverage | Natural grassland with degree of coverage below 20%. Such grassland lack moisture, and have sparse vegetation. |

# 2. Forestry and Grassland Type Classification System

## Wetland

### Secondary Level:

### 5 classes

**Mangrove, swamp forests, and swamp shrublands with forests as elements are categorized into forest lands.**

**swamp meadow is categorized into grasslands.**

| Primary Level | Secondary Level | | | Descriptions |
|---|---|---|---|---|
| Type Name | Class Code | | Class Name | |
| wetland | 17 | 301 | offshore and coastal | In the coastal and coastal areas, shallow seas, coasts, estuaries and coastal lakes formed by natural coastal waterforms are collectively referred to as offshore and coastal wetlands, including shallow sea areas with a low tide depth of no more than 6 meters, and areas (except mangroves) where the high tide level (including the high tide line) can be directly infiltrated by seawater. |
| | 18 | 302 | river | River wetland is a collective term for riverbeds, river beaches, flood areas, deltas, sandbars and other natural bodies formed around natural river water bodies. These include permanent rivers, seasonal (rainy season) or intermittent rivers, and flooded river wetlands. |
| | 19 | 303 | lake | Wetlands consisting of natural depressions of various sizes and shapes on the ground, filled with water bodies, including freshwater lake wetlands and saltwater lake wetlands. |
| | 20 | 304 | marsh | A natural complex with the following basic characteristics: (1) the surface is often too wet or has a thin layer of water; (2) there is swampy, partially wet, aquatic or halophytic plants growing; (3) there is peat accumulation, or the soil layer has a clear latent layer. In this taxonomy, forest swamps, shrub swamps, and everglades are excluded from marsh. |
| | 21 | 305 | artificial waters | Artificial wetlands built for certain function or purpose, or wetlands formed by transforming natural wetlands. This type also includes constructed wetlands built for aquacultural purpose, ditches and canals built for irrigation, as well as sites for salt production by evaporation. |

# 2. Forestry and Grassland Type Classification System

## Desert/Sandy Land

## Secondary Level:

## 6 classes

| Primary Level | Secondary Level | | | Descriptions |
|---|---|---|---|---|
| Type Name | Class Code | | Class Name | |
| desert/sandy land | 22 | 401 | flowing sandy | The soil texture is sandy; the vegetation coverage is less than 10%; the surface is covered by sands in a flowing state. |
| | 23 | 402 | fixed sandy | The soil texture is sandy; the vegetation cover is ≥ 30% (when there is no other vegetation under the arbor canopy, and the canopy density is ≥0.50). The surface is stable or basically stable, including artificial fixed sand and natural fixed sand. |
| | 24 | 403 | semi-fixed sandy | The soil texture is sandy; vegetation coverage is between 10% to 30% (when there is no other vegetation under the arbor canopy, and the canopy density is ＜0.50). The wind and sand flow is blocked but the quicksand texture is still prevalent. This type includes artificial semi-fixed sand and natural semi-fixed sand. |
| | 25 | 404 | wind-eroded mounds/ wind-eroded badland | Wind erosion mound refers to the wind erosion land such as Yadan, Tulin, and Bai Gong Dun formed by wind erosion in arid areas. |
| | 26 | 405 | gobi desert | Vast flat land in arid areas. The surface is covered with gravel, gravelly sand and sparse vegetation. |
| | 27 | 406 | non-biological sand-control project site | Dunes and sandy areas that are immobilized or semi-fixed by non-biological means, such as mechanical sand barriers, and sand fixed by earth, rock or other materials. For lands where biological measures are used on top of non-biological sand control projects, they are classified as fixed or semi-fixed sandy land. |

# 2. Forestry and Grassland Type Classification System

## Cultivated land, construction land, and others

| Primary Level | Secondary Level | | | Descriptions |
|---|---|---|---|---|
| Type Name | Class Code | | Class Name | |
| cultivated land | 28 | 501 | paddy field | Cultivated land used for planting aquatic crops such as rice and lotus root, including cultivated land that implements the rotation of aquatic and dry crops. |
| | 29 | 502 | dry crop land | Cultivated land without irrigation facilities and mainly relies on natural precipitation to grow dry-growing crops, including cultivated land without irrigation facilities and relying only on flood diversion and siltation. |
| | 30 | 503 | irrigated land | Arable land that has guaranteed water sources and irrigation facilities, and can be irrigated normally in ordinary years to grow dry-growing crops (including vegetables). Including non-factory greenhouse land for growing vegetables. |
| construction land | 31 | 601 | urban construction | Artificially constructed impervious surface. |
| | 32 | 602 | rural settlement | Lands where rural populations are concentrated. |
| | 33 | 603 | road | This type mainly refers to the traffic road dominated by expressways, which can be recognized via imagery with spatial resolution of 16 meters. |
| | 34 | 604 | other construction land | This type includes industrial and mining land, mining land, etc. |
| others | 35 | 701 | glacier and permanent snowfields | Lands perennially covered by glaciers and permanent snow cover. |
| | 36 | 702 | alkaline land | Lands where the surface layer of salt and alkali accumulates, and only natural salt-tolerant plants grow. |
| | 37 | 703 | bare rock | Lands whose surface layer is rocky, and rocks covers more than 70% of the area. |
| | 38 | 704 | bare land | Lands where the surface layer is covered by soil, and FVC is below 5%. |

# 3. Methodology of Classification for Forestry and Grassland

## ➢ GF data

**① GF-1 satellite data for the year 2015; ② GF-1 and GF-6 satellite data for the year 2020.**

| parameters | GF-1 WFV | | GF-6 WFV | |
|---|---|---|---|---|
| spectral range | B1 | 0.45～0.52μm | B1 | 0.45～0.52μm |
| | B2 | 0.52～0.59μm | B2 | 0.52～0.59μm |
| | B3 | 0.63～0.69μm | B3 | 0.63～0.69μm |
| | B4 | 0.77～0.89μm | B4 | 0.77～0.89μm |
| | B5 | —— | B5 | 0.69～0.73μm |
| | B6 | —— | B6 | 0.73～0.77μm |
| | B7 | —— | B7 | 0.40～0.45μm |
| | B8 | —— | B8 | 0.59～0.63μm |
| spatial resolution | 16m | | ≤16m | |
| swath width | 800km | | ≥800km | |

Nearly 700 scenes of GF-1 imagery were screened for winter and summer in the year 2015 .

658 scnens of GF-1/6 imagery are screened for winter and summer in the year 2020.

# 3. Methodology of Classification for Forestry and Grassland

➢ **Supplementary data**

| Basic Data | Data Name | Timing | Resolution | Data Usage |
|---|---|---|---|---|
| **Administrative division data** | national provincial boundaries | 2012 | —— | Division of administrative areas |
| **DEM data** | national DEM data | —— | 30m | Support the interpretation of target land types |
| **Full coverage data** | national land use data of 10 types | 2010 | 30m | Revise the primary land type |
| | national land use data of 25 classes | 2015 | 30m | Revise the secondary land class |
| | Chinese vegetation distribution map (1: 1 million) | | | Trend consistency analysis |
| **Thematic data** | forest distribution map from the eighth Chinese national forest resources inventory | 2014 | 1000m | Verification and update of the secondary land type |
| | national gobi type distribution map, map of Chinese desert distribution in the year 1979 | 1979 | 1000m | |
| | national mangrove type distribution map | 2015 | 16m | |
| | national bamboo type distribution map | —— | 1000m | |
| **other business data** | national level-1 road vector map | 2015/2020 | —— | Revision and update |

# 3. Methodology of Classification for Forestry and Grassland

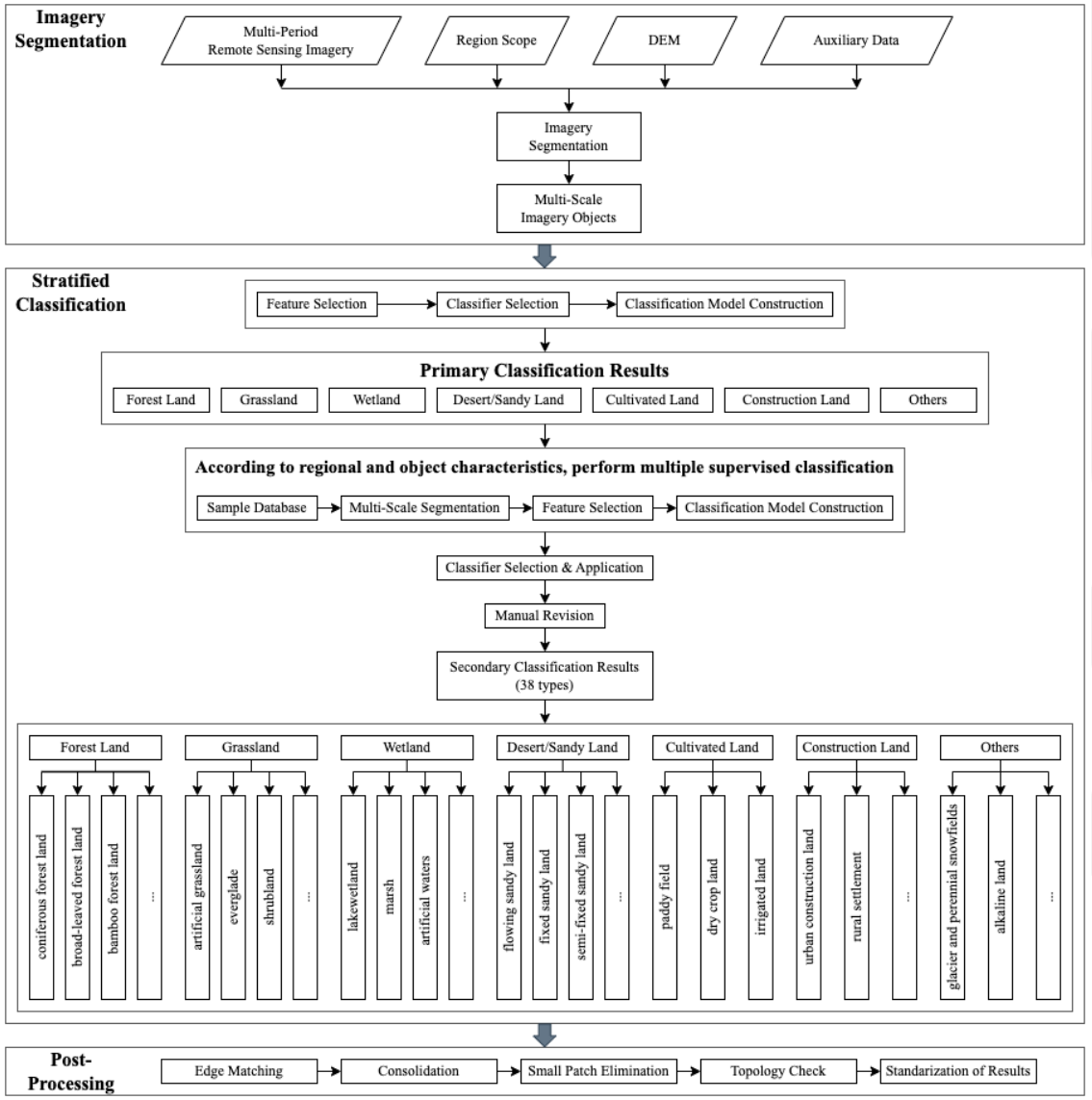
## ➢ Overall technical workflow

◆ **Method:** object-oriented automatic classification approach with manual collaboration to improve classification results.

◆ **Technical workflow:**

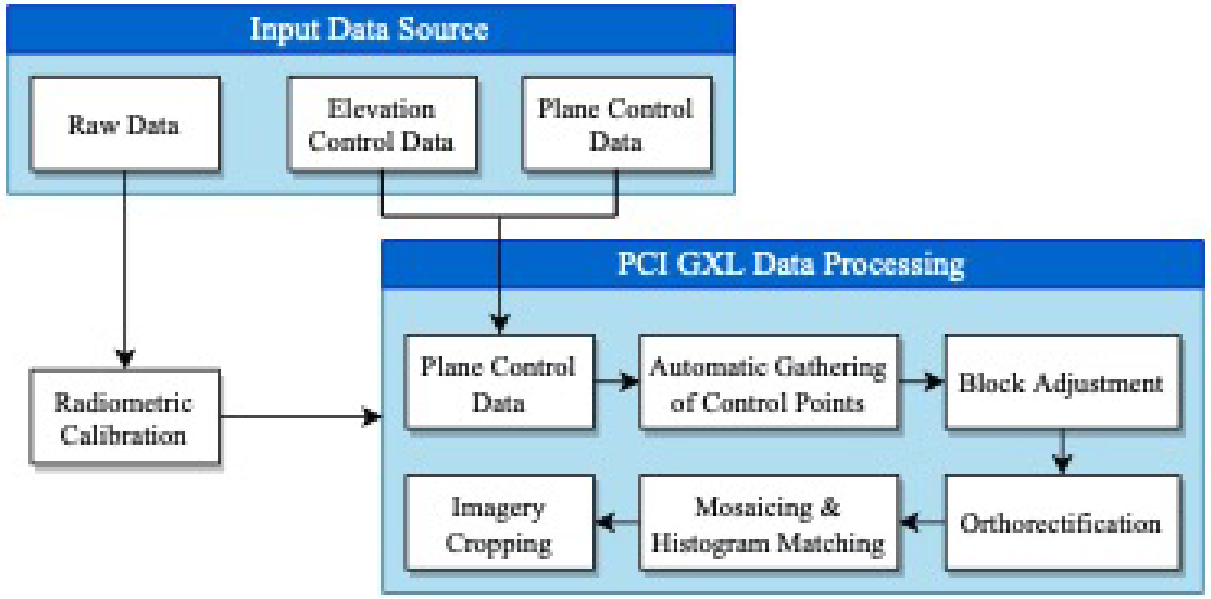
- ✓ data preprocessing
- ✓ imagery segmentation
- ✓ feature-optimizing hierarchical classification
- ✓ post-processing

Roadmap of automatic imagery interpretation

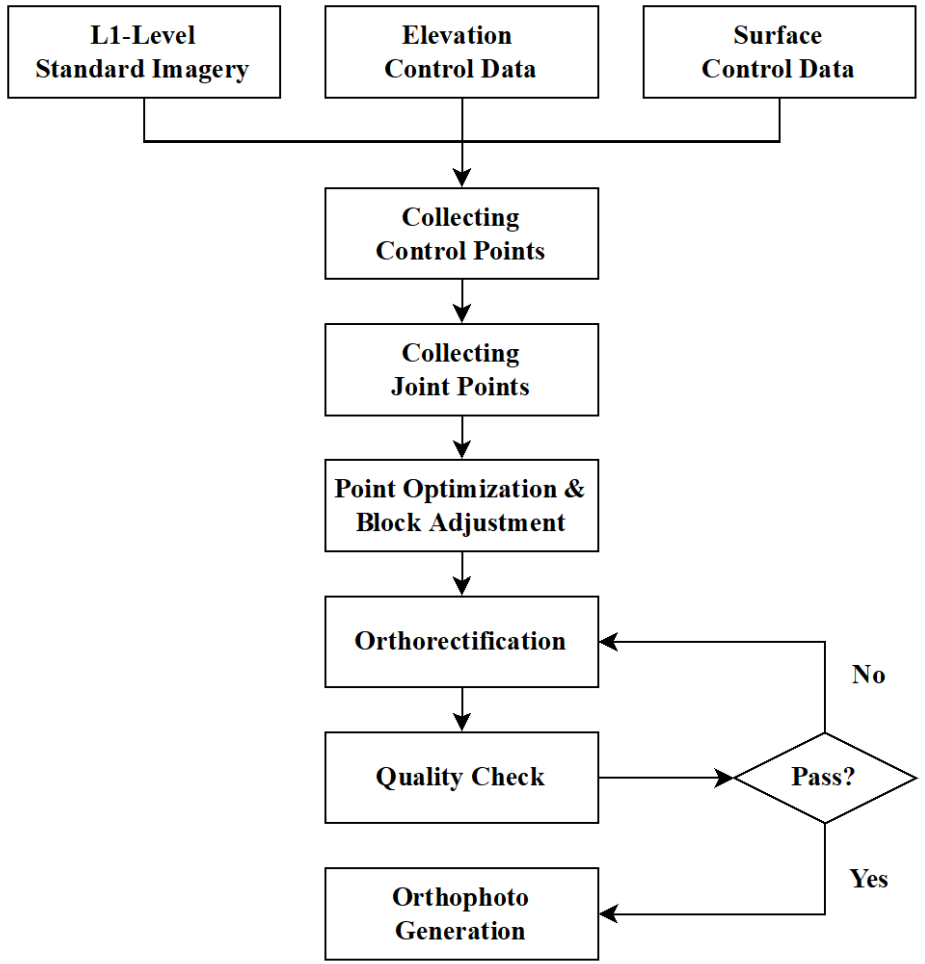


# 3. Methodology of Classification for Forestry and Grassland

## ➢ Data pre-processing




GF-1 data processing workflow



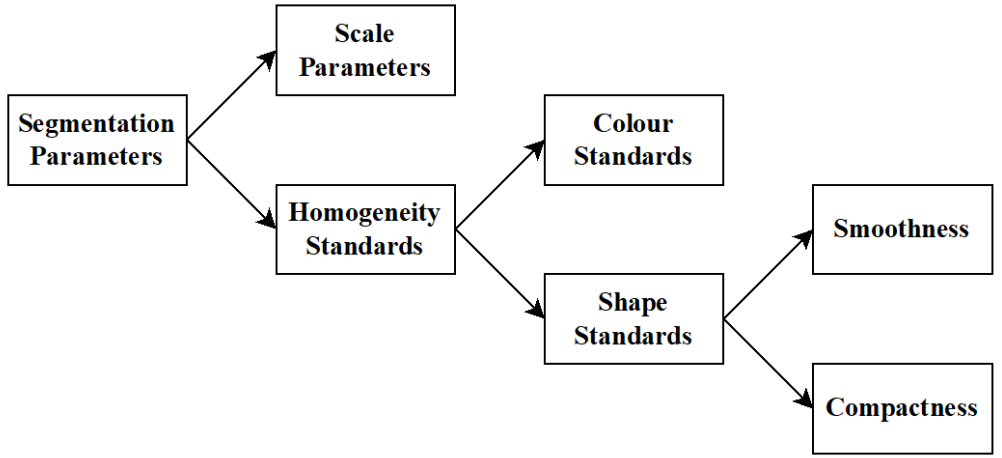

Imagery Orthorectification

# 3. Methodology of Classification for Forestry and Grassland

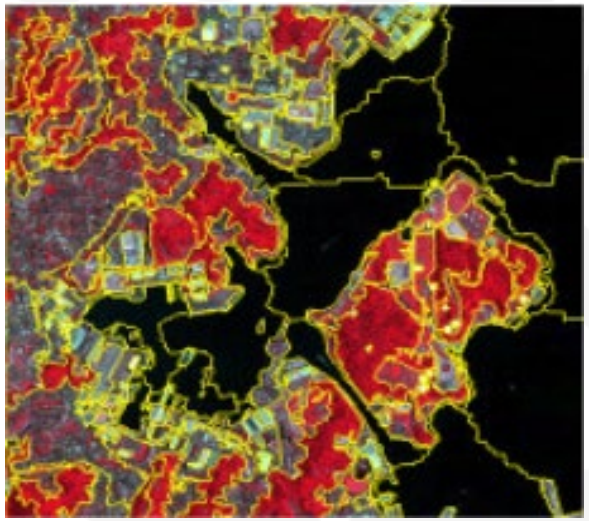
## ➢ Multi-scale segmentation

**The formula for regional heterogeneity of the merged objects is as follows:**

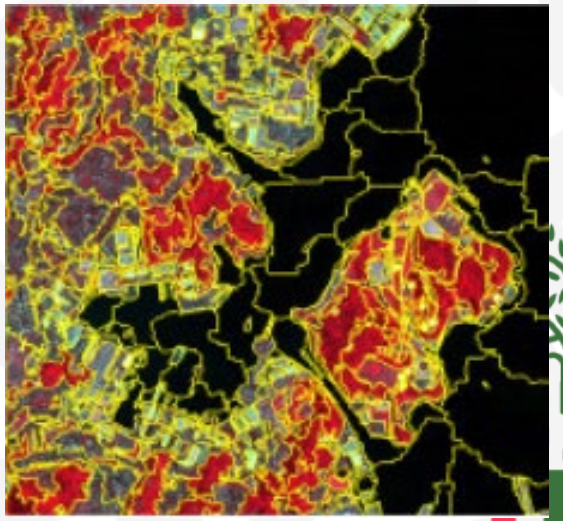
$$f = w_{color} h_{color} + (1 - w_{color}) \ h_{shape}$$




- ✓ **Multi-scale: to use different segmentation scales for the difference of land types;**
- ✓ **Object layer network establishing: when present segmentation scale cannot effectively separate different land types, adjust the scale parameter to form a finer object layer on top of previous one. In such way, the segmentation results at multiple scales can be obtained, and an object layer network is established.**



**large-scale object layer**



**small-scale object layer**

# 3. Methodology of Classification for Forestry and Grassland

## ➢ Feature selection

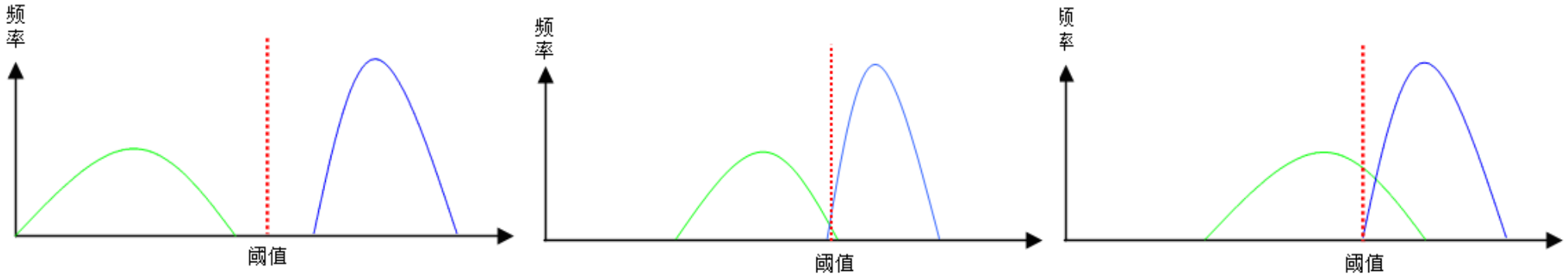
- ✓ **Separability and thresholds algorithm: to evaluate the degree of association between two categories on a certain feature;**
- ✓ **the Jeffries-Matudita distance (JM distance): to measure the separability between categories.**

**For two categories C1 and C2, the JM distance is:**

$$J = 2(1 - e^{-B})$$

$$B = \frac{1}{8}(m_1 - m_2)^2 \frac{2}{\sigma_1^2 + \sigma_2^2} + \frac{1}{2}\ln\left[\frac{\sigma_1^2 + \sigma_2^2}{2\sigma_1\sigma_2}\right]$$

**$m_i$ and $\sigma_i^2 (i = 1,2)$ represents the mean and variance of feature distribution of two types of sample objects, respectively.**

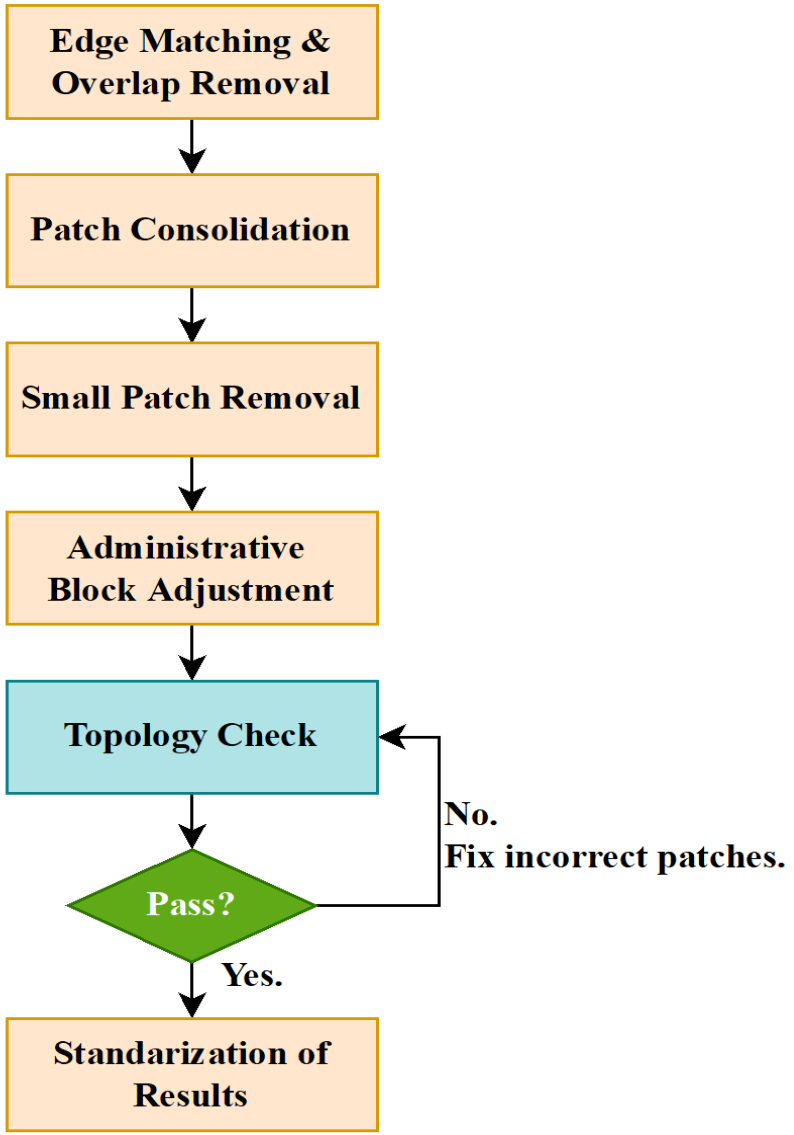



**（1）No spectral overlap** **（2）Partial spectral overlap** **（3）Severe spectral overlap**

# 3. Methodology of Classification for Forestry and Grassland

## ➢ Post-processing

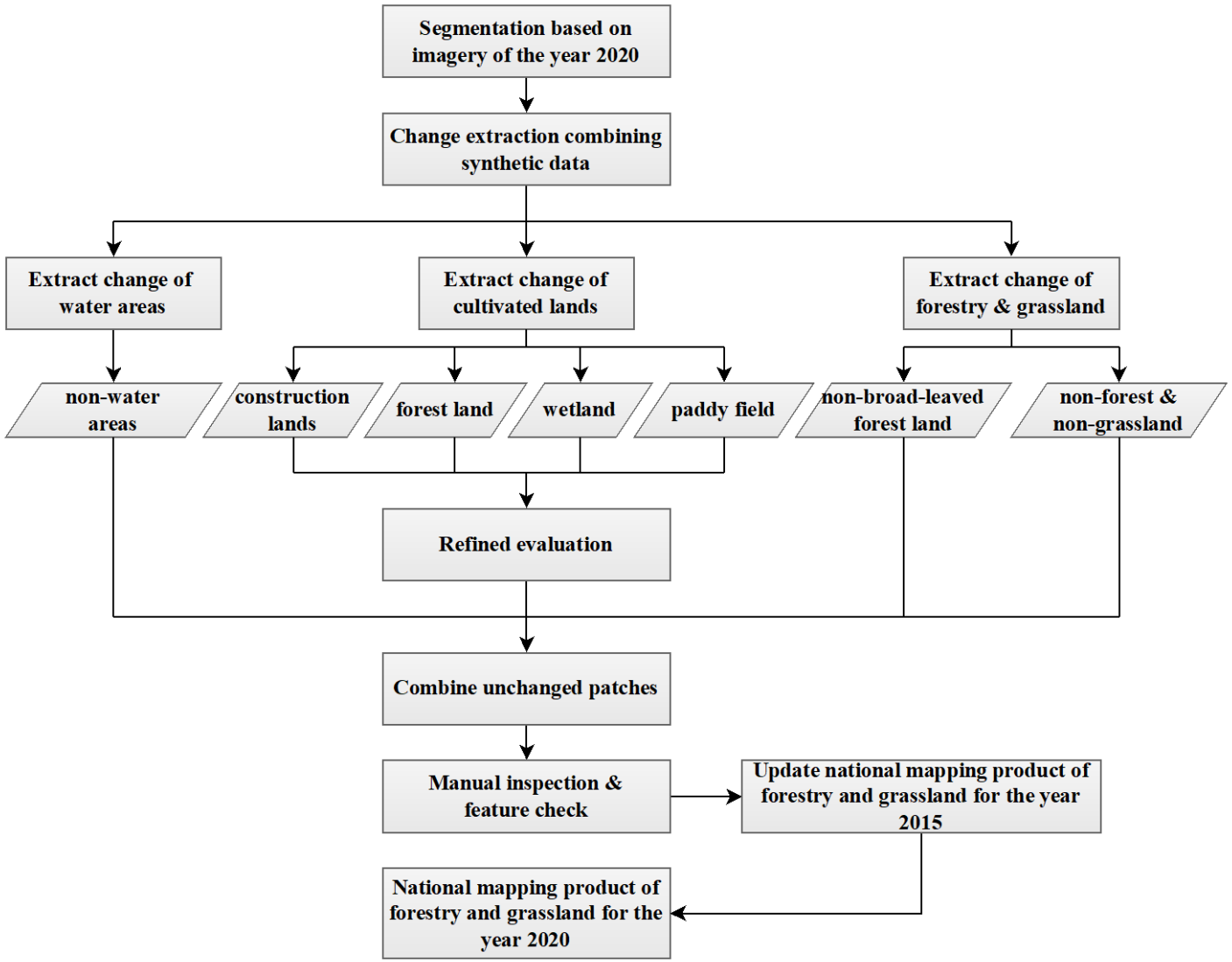
- ✓ overlapping edges of operation blocks
- ✓ merging plots
- ✓ removing small patches
- ✓ cutting administrative areas
- ✓ checking topology of patches, and standardizing results.



# 3. Methodology of Classification for Forestry and Grassland

## ➢ Thematic information extraction

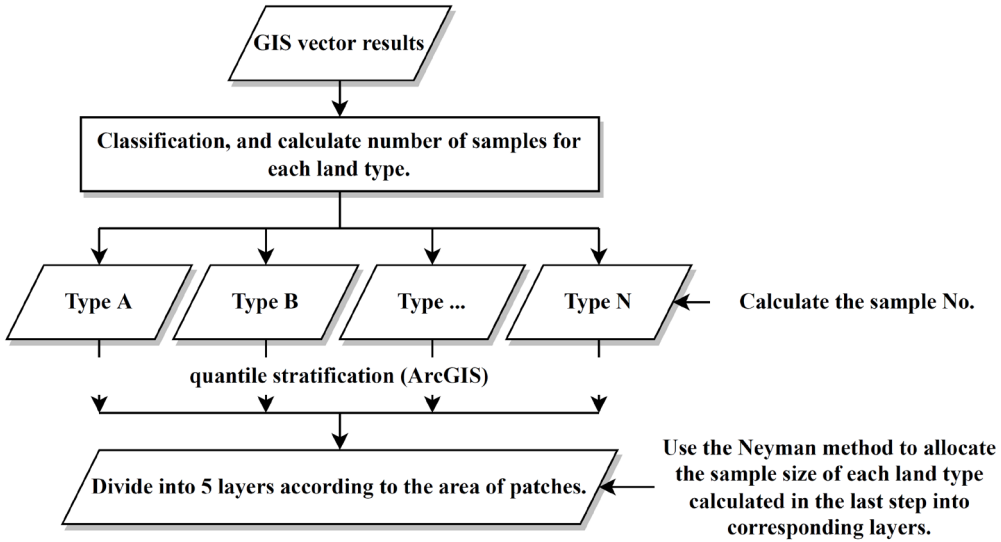
- ✓ multi-scale segmentation for the imagery of the year 2020;
- ✓ change detection based on the thematic vector product of national forest and grassland in the year 2015;
- ✓ Update the thematic vector map of the year 2015 to generate the map products for the year 2020.



# 4. Method of validation

**Random stratified sampling is used in the whole country, and sample patches are drawn from full-coverage vector patches on a provincial basis. The procedure is as follows:**

- ✓ **sampling is performed by province, and converted into random points.**
- ✓ **Based on random point, create circle buffer with areas of 100,000 square meters (diameter = 178 m).**
- ✓ **Check the consistency of the image properties within this circle with the information extraction patch properties: correct is consistent, otherwise incorrect.**
- ✓ **Count the number of correct and incorrect numbers by province. Precision = Correct / Total * 100%**

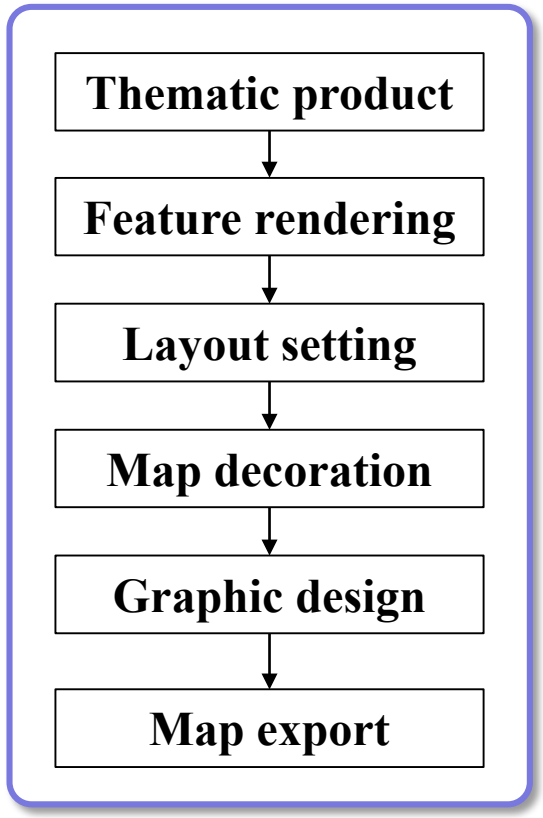


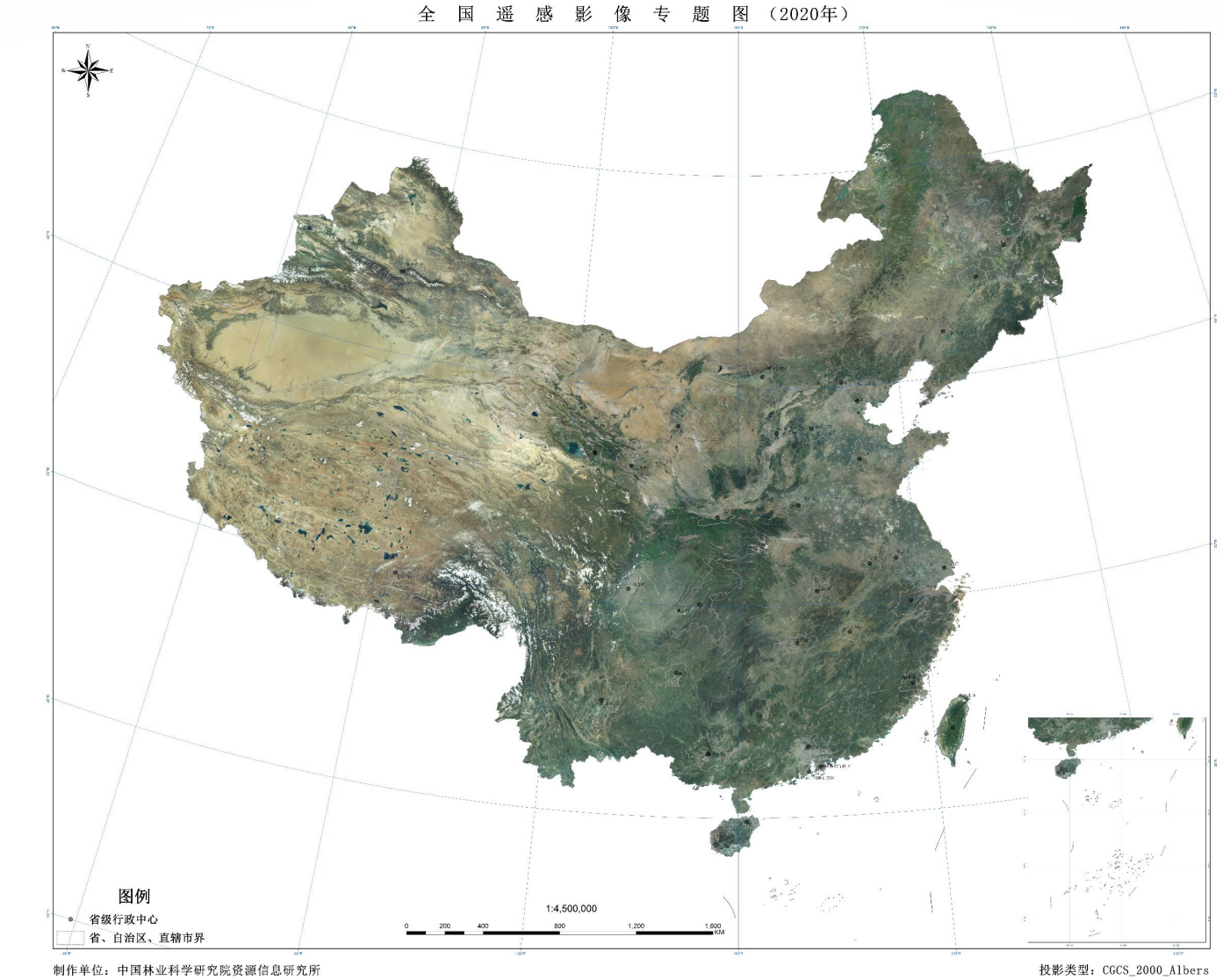

**Schematic diagram of the sampling process for precision evaluation**

**Schematic diagram of the original results (left) and sample (right)**

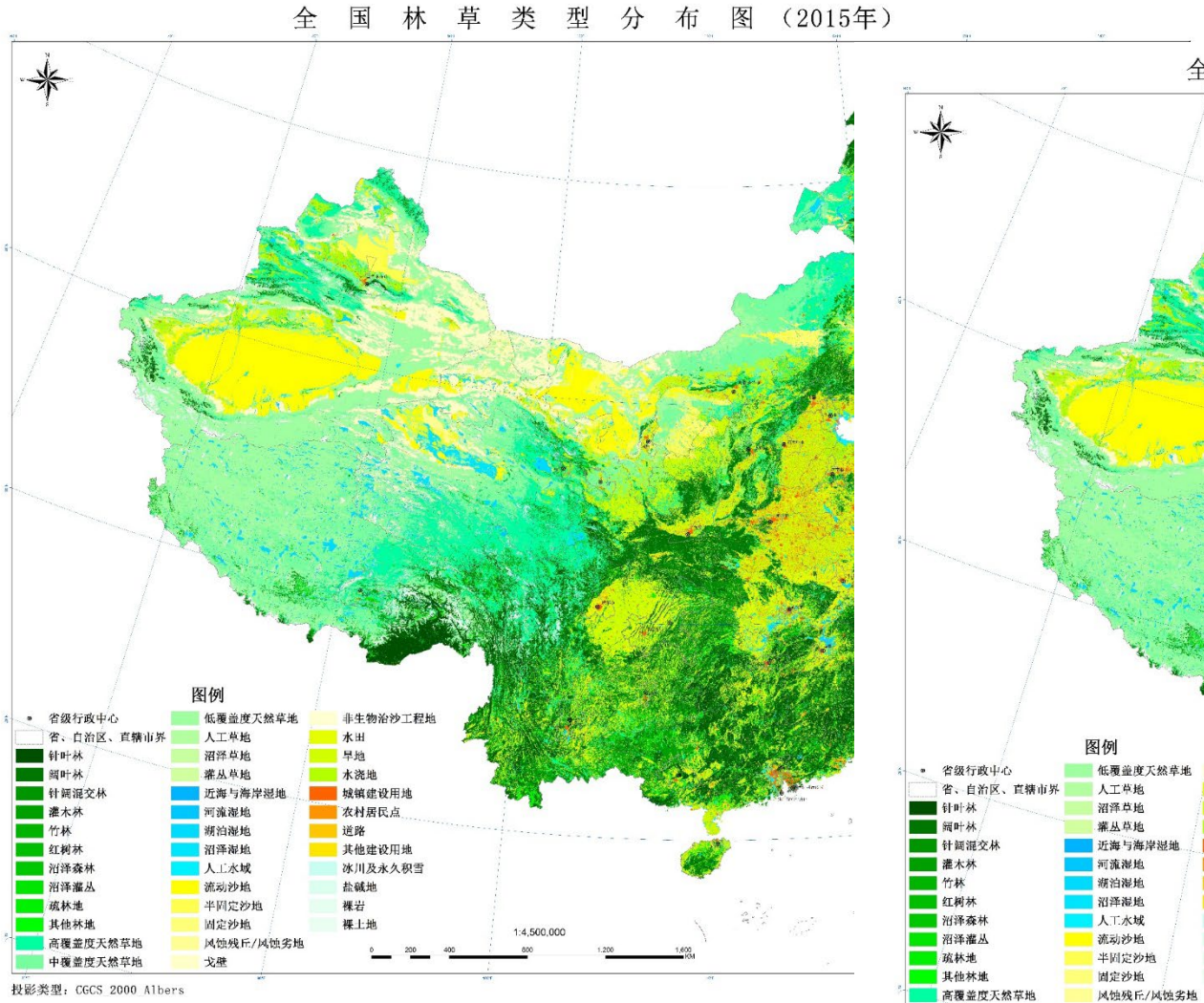
# 5. Mapping

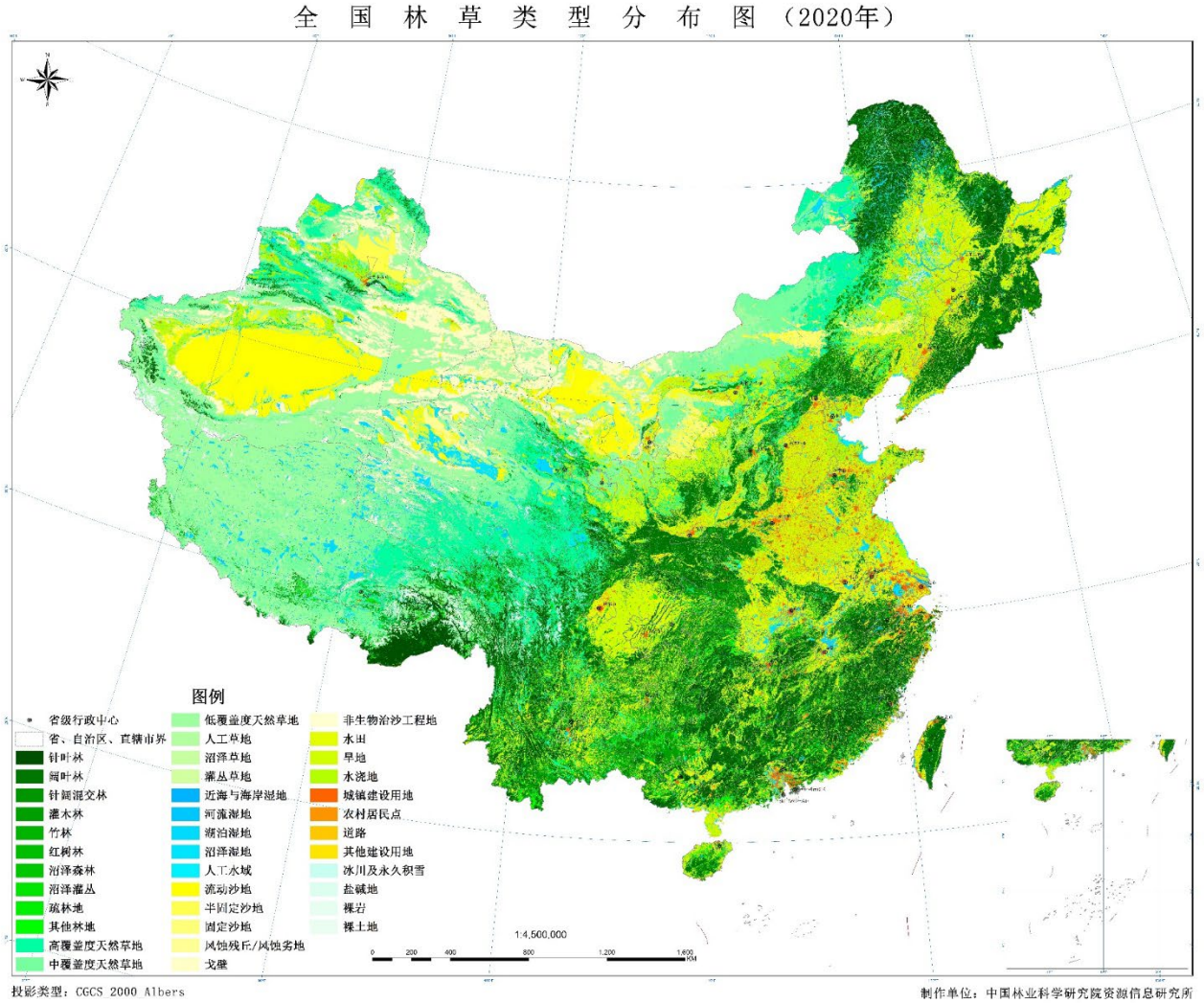
➢ **National Gaofen imagery mosaic**



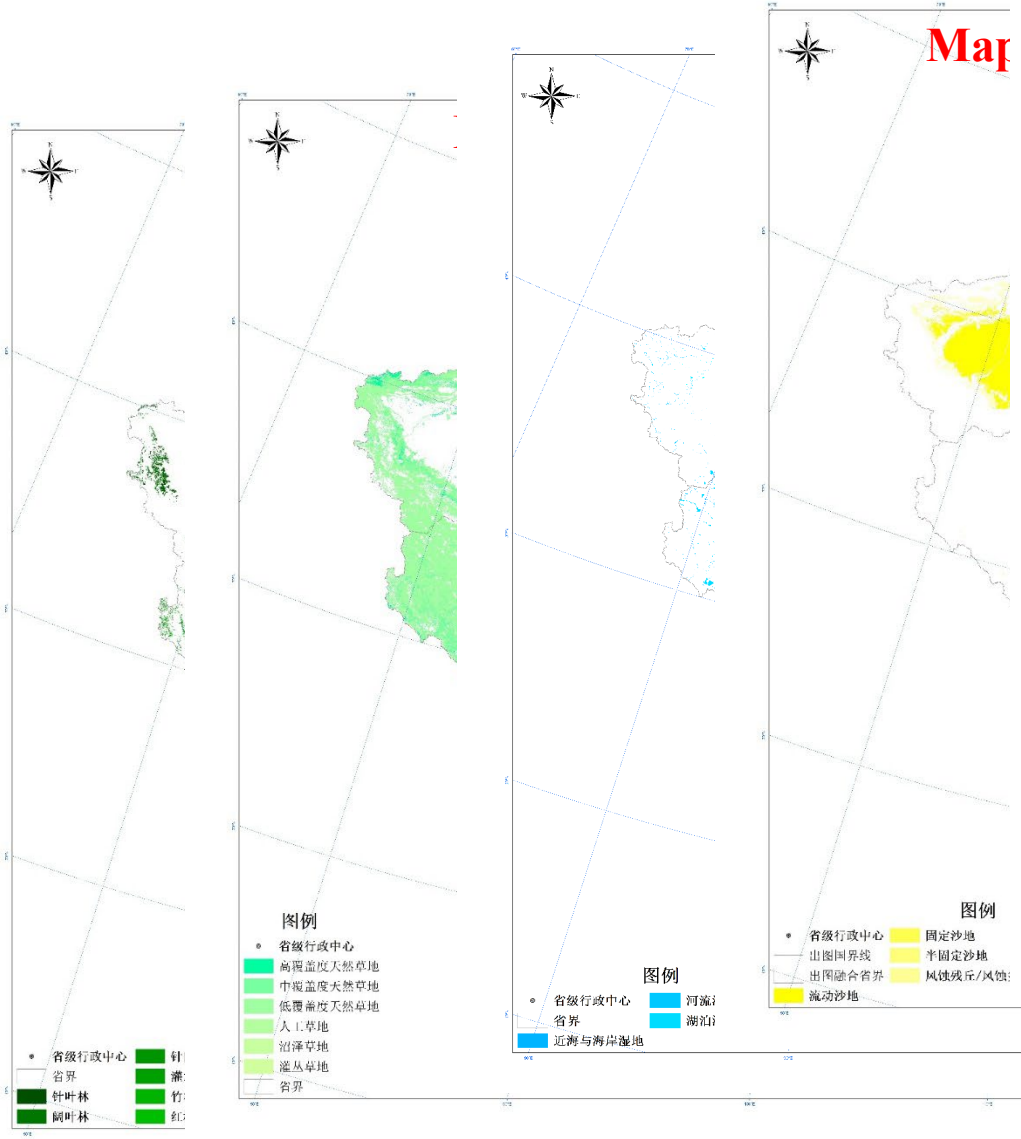
# 5. Mapping


全 国 林 草 类 型 分 布 图 （2015年）
图例
省级行政中心
省、自治区、直辖市界
针叶林
阔叶林
针阔混交林
灌木林
竹林
红树林
沼泽森林
沼泽灌丛
疏林地
其他林地
高覆盖度天然草地
中覆盖度天然草地
低覆盖度天然草地
人工草地
沼泽草地
灌丛草地
近海与海岸湿地
河流湖地
湖泊湖地
沼泽湖地
人工水域
流动沙地
半固定沙地
固定沙地
风蚀残丘/风蚀劣地
戈壁
非生物治沙工程地
水田
旱地
水浇地
城镇建设用地
农村居民点
道路
其他建设用地
冰川及永久积雪
盐碱地
裸岩
裸土地
1:4,500,000
投影类型：CGCS 2000 Albers

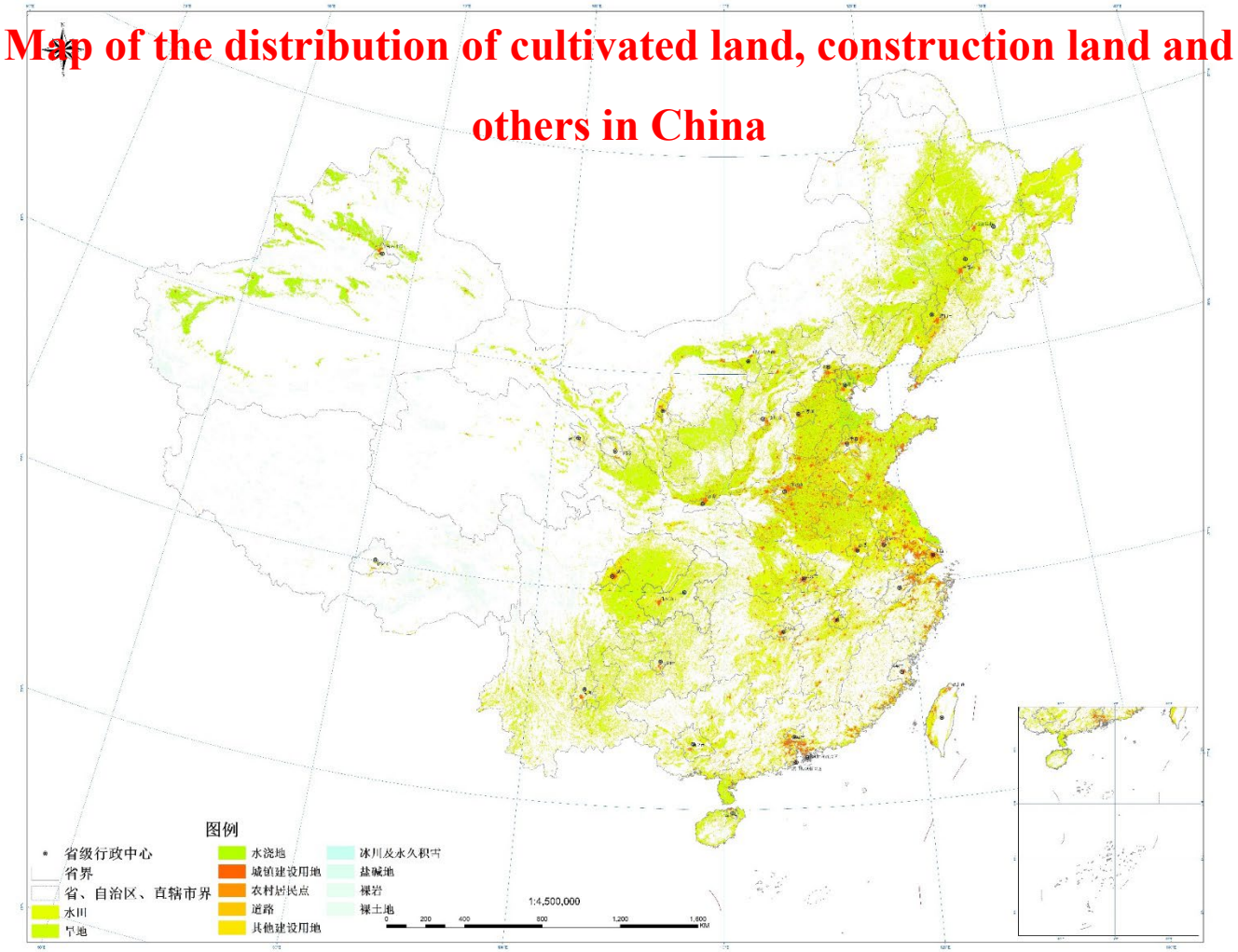

全 国 林 草 类 型 分 布 图 （2020年）
图例
省级行政中心
省、自治区、直辖市界
针叶林
阔叶林
针阔混交林
灌木林
竹林
红树林
沼泽森林
沼泽灌丛
疏林地
其他林地
高覆盖度天然草地
中覆盖度天然草地
低覆盖度天然草地
人工草地
沼泽草地
灌丛草地
近海与海岸湿地
河流湖地
湖泊湖地
沼泽湖地
人工水域
流动沙地
半固定沙地
固定沙地
风蚀残丘/风蚀劣地
戈壁
非生物治沙工程地
水田
旱地
水浇地
城镇建设用地
农村居民点
道路
其他建设用地
冰川及永久积雪
盐碱地
裸岩
裸土地
1:4,500,000
投影类型：CGCS 2000 Albers
制作单位：中国林业科学研究院资源信息研究所

# 5. Mapping

- **Map of forest and grassland types**




**Map of the distribution of cultivated land, construction land and others in China**



# 5. Mapping

- **Precision analysis**

| 2015 Special vector achievements | Total number of patches | Sample quantity | Sampling rate | Correct number of attributes | Attribute Precision |
|---|---|---|---|---|---|
| Henan Province | 231479 | 3299 | 1.43% | 2905 | 88.10% |
| Shanxi Province | 183156 | 2958 | 1.62% | 2691 | 91.00% |
| Shaanxi Province | 150526 | 1281 | 0.85% | 1101 | 85.90% |
| Beijing Tianjin Hebei | 425252 | 3192 | 0.75% | 2908 | 91.10% |
| Gansu Province | 335231 | 2564 | 0.76% | 2306 | 89.90% |
| Qinghai Province | 587931 | 3717 | 0.63% | 3303 | 88.90% |
| Shandong Province | 157394 | 6037 | 3.84% | 5672 | 94.00% |
| Liaoning Province | 171918 | 1547 | 0.90% | 1242 | 80.28% |
| Hunan Province | 157673 | 1392 | 0.88% | 1161 | 83.41% |
| Shanghai City | 18466 | 372 | 2.01% | 300 | 80.65% |
| Guizhou Province | 112893 | 1194 | 1.06% | 1012 | 84.76% |
| Zhejiang Province | 142236 | 1846 | 1.30% | 1488 | 80.61% |
| Fujian Province | 91210 | 910 | 1.00% | 748 | 82.20% |
| Guangdong Province | 130497 | | | | 81.74% |
| Jilin Province | 148121 | | | | 81.49% |
| Anhui Province | 229497 | | | | 82.59% |
| Chongqing City | 41717 | | | | 82.73% |
| Hubei province | 274902 | | | | 82.22% |
| Yunnan Province | 288771 | 1897 | 0.66% | 1537 | 81.02% |
| Sichuan Province | | | | | 68% |
| HainanProvince | | | | | 75% |
| Heilongjiang Province | | | | | 86% |
| Jiangsu Province | | | | | 00% |
| Jiangxi Province | | | | | 41% |
| Taiwan Province | | | | | 01% |
| Ningxia Hui Autonomo | | | | | 68% |
| Inner Mongolia Auton Region | | | | | 31% |
| Xinjiang Uygur Autono Region | | | | | 53% |
| Tibet Autonomous Re | | | | | 07% |
| Guangxi Zhuang Auto Region | | | | | 99% |
| Hong Kong Special Ad Region | | | | | 50% |
| Macau Special Admini Region | 40 | 40 | 100.00% | 38 | 95% |
| the Xisha Islands | 1 | 1 | 100.00% | 1 | 100.00% |
| Diaoyu Islands | 4 | 4 | 100.00% | 4 | 100.00% |

Precision of the year 2015

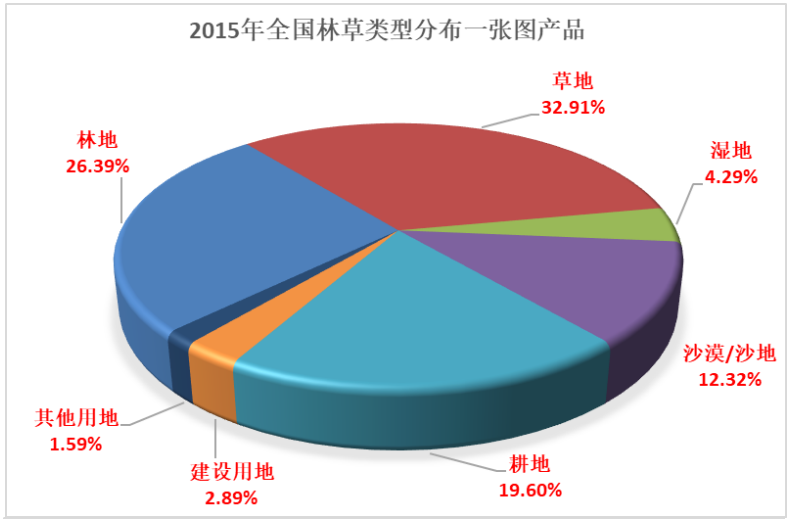
| 2015 Special vector achievements | Total number of patches | Sample quantity | Sampling rate | Correct number of attributes | Attribute Precision |
|---|---|---|---|---|---|
| Henan Province | 261819 | 2176 | 0.83% | 1755 | 80.65% |
| Shanxi Province | 214336 | 2760 | 1.29% | 2422 | 87.75% |
| Shaanxi Province | 227973 | 4708 | 2.07% | 3945 | 83.79% |
| Beijing Tianjin Hebei | 428156 | 4902 | 1.14% | 4207 | 85.82% |
| Gansu Province | 389327 | 5495 | 1.41% | 4404 | 80.15% |
| Qinghai Province | 642153 | 6604 | 1.03% | 6069 | 91.90% |
| Shandong Province | 203522 | 5360 | 2.63% | 4553 | 84.94% |
| Liaoning Province | 190227 | 2011 | 1.06% | 1830 | 91.00% |
| Hunan Province | 190388 | 2084 | 1.09% | 1858 | 89.16% |
| Shanghai City | 18331 | 556 | 3.03% | 510 | 91.73% |
| Guizhou Province | 186577 | 2730 | 1.46% | 2345 | 85.90% |
| Zhejiang Province | 151362 | 2326 | 1.54% | 2089 | 89.81% |
| Fujian Province | 116457 | 1312 | 1.13% | 1091 | 83.16% |
| Guangdong Province | 173454 | 2869 | 1.65% | 2303 | 80.27% |
| Jilin Province | 1 | | | 2240 | 85.53% |
| Anhui Province | 2 | | | 3326 | 91.05% |
| Chongqing City | | | | 754 | 82.77% |
| Hubei province | 2 | | | 3100 | 83.83% |
| Yunnan Province | 306206 | 2296 | 0.75% | 2162 | 94.16% |
| Region | 40 | 40 | 100.00% | 38 | |
| the Xisha Islands | 1 | 1 | 100.00% | 1 | 100% |
| Diaoyu Islands | 4 | 4 | 100.00% | 4 | 100% |

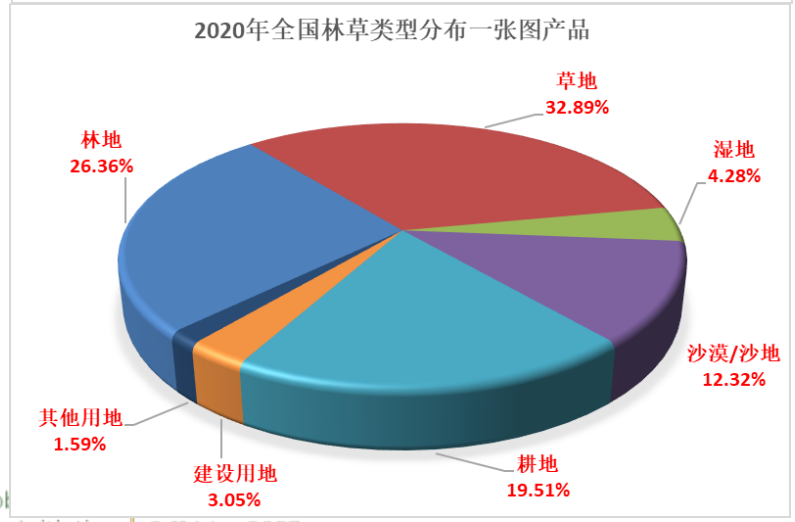
Precision of the year 2020

| Thematic vector results | Total number of pathces | number of samples | sampling rate (%) | number of correct samples | precision |
|---|---|---|---|---|---|
| year 2015 | 8083980 | 73495 | 0.9091 | 63838 | **86.86%** |
| year 2020 | 9204691 | 115101 | 1.2501 | 100427 | **87.25%** |

# 5. Mapping

## ➢ Statistics




| 2015全国林草一张图38类面积统计（单位：万公顷） | | 2020全国林草一张图38类面积统计（单位：万公顷） | |
|---|---|---|---|
| 类别 | 面积 | 类别 | 面积 |
| **林地** | **25079.367** | **林地** | **25048.724** |
| 针叶林 | 7635.560 | 针叶林 | 7633.743 |
| 阔叶林 | 8258.544 | 阔叶林 | 8241.990 |
| 针阔混交林 | 366.661 | 针阔混交林 | 365.789 |
| 灌木林 | 6330.799 | 灌木林 | 6325.149 |
| 竹林 | 500.809 | 竹林 | 500.519 |
| 其他林地 | 891.113 | 其他林地 | 887.363 |
| 疏林地 | 1095.881 | 疏林地 | 1094.171 |
| **草地** | **31275.668** | **草地** | **31250.062** |
| 人工草地 | 3.420 | 人工草地 | 3.617 |
| 沼泽草地 | 549.991 | 沼泽草地 | 541.279 |
| 灌丛草地 | 163.168 | 灌丛草地 | 163.168 |
| 高覆盖度天然草地 | 8796.497 | 高覆盖度天然草地 | 8785.715 |
| 中覆盖度天然草地 | 9025.429 | 中覆盖度天然草地 | 9020.426 |
| 低覆盖度天然草地 | 12737.162 | 低覆盖度天然草地 | 12735.858 |
| **湿地** | **4078.138** | **湿地** | **4070.470** |
| 近海与海岸湿地 | 40.585 | 近海与海岸湿地 | 35.411 |
| 河流湿地 | 1160.275 | 河流湿地 | 1171.791 |
| 湖泊湿地 | 927.354 | 湖泊湿地 | 926.060 |
| 沼泽湿地 | 988.326 | 沼泽湿地 | 988.485 |
| 红树林 | 2.292 | 红树林 | 2.137 |
| 沼泽森林 | 333.774 | 沼泽森林 | 333.203 |
| 沼泽灌丛 | 2.669 | 沼泽灌丛 | 2.675 |
| 人工水域 | 622.862 | 人工水域 | 610.708 |
| **沙漠/沙地** | **11705.572** | **沙漠/沙地** | **11705.483** |
| 流动沙地 | 4719.734 | 流动沙地 | 4719.734 |
| 固定沙地 | 795.994 | 固定沙地 | 795.987 |
| 半固定沙地 | 1277.416 | 半固定沙地 | 1277.416 |
| 风蚀残丘/风蚀劣地 | 142.677 | 风蚀残丘/风蚀劣地 | 142.593 |
| 戈壁 | 4769.590 | 戈壁 | 4769.590 |
| 非生物治沙工程地 | 0.162 | 非生物治沙工程地 | 0.162 |
| **耕地** | **18628.538** | **耕地** | **18536.295** |
| 水田 | 4459.397 | 水田 | 4424.361 |
| 旱地 | 12741.260 | 旱地 | 12689.061 |
| 水浇地 | 1427.882 | 水浇地 | 1422.873 |
| **建设用地** | **2748.759** | **建设用地** | **2898.854** |
| 城镇建设用地 | 918.064 | 城镇建设用地 | 958.211 |
| 农村居民点 | 1336.414 | 农村居民点 | 1356.091 |
| 道路 | 77.801 | 道路 | 101.279 |
| 其他建设用地 | 416.480 | 其他建设用地 | 483.273 |
| **其他用地** | **1514.731** | **其他用地** | **1513.900** |
| 冰川及永久积雪 | 389.894 | 冰川及永久积雪 | 389.446 |
| 盐碱地 | 274.588 | 盐碱地 | 273.698 |
| 裸岩 | 845.251 | 裸岩 | 845.782 |
| 裸土地 | 4.997 | 裸土地 | 4.975 |
| **总计** | **95030.773** | **总计** | **95023.789** |

# Thank you!