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Yearly/250-m Raster Dataset Development of Ecosystem Quality Index (EQI) of China (2007–2024)

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Abstract: The Ecosystem Quality Index (EQI) serves as a critical indicator for characterizing the structural integrity and functional status of ecosystems, holding significant application value in ecological monitoring and territorial spatial optimization. However, existing EQI datasets are often limited by either insufficient temporal coverage or coarse spatial resolution. To address these limitations, this study developed an annual 250-m resolution EQI dataset for China spanning 2007–2024, following the Technical specification for investigation and assessment of national ecological status—ecosystem quality assessment (HJ 1172—2021). Multi-source remote sensing products, including Fractional Vegetation Cover (FVC), Leaf Area Index (LAI), and Gross Primary Productivity (GPP), were integrated to construct the dataset. The dataset is archived in .tif format. It comprises 54 data files with a total volume of 31.3 GB (compressed into 9 files, 6.55 GB). The results indicate that China's EQI exhibited a significant overall increasing trend from 2007 to 2024. Spatially, relatively high EQI values were primarily observed in southern and southwestern China, whereas lower values were concentrated in northwestern China and certain alpine regions. This dataset supported the completion of the author's Master degree of Engineering thesis.

Keywords: Ecosystem Quality Index (EQI); Fractional Vegetation Cover (FVC); Leaf Area Index (LAI); Gross Primary Productivity (GPP); Master degree of Engineering thesis

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Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodb.2026.03.02.V1.

1 Introduction

Ecosystem quality is an important measure of the structural integrity and functional status of regional ecosystems, and its variation is directly related to ecological security and sustainable development capacity. With China's ongoing efforts to achieve its "dual-carbon" goals and promote territorial spatial optimization, high-resolution and long-term assessments

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[2] Qing, A. Yearly/250-m raster dataset of Ecosystem Quality Index (EQI) of China (2007–2024) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2026. https://doi.org/10.3974/geodb.2026.03.02.V1.

of ecosystem quality have become increasingly important for ecological management and environmental decision-making. Existing studies have frequently relied on single indicators, such as Normalized Difference Vegetation Index (NDVI) or Gross Primary Productivity (GPP), to evaluate ecosystem conditions. However, these indicators often fail to comprehensively capture both the structural and functional characteristics of ecosystems[1–4]. In addition, existing ecosystem quality datasets are generally constrained by limited temporal continuity or insufficient spatial resolution, restricting their applicability in long-term ecological monitoring and large-scale environmental assessments[5,6].

To address these limitations, the Ministry of Ecology and Environment of P. R. China issued the Technical specification for investigation and assessment of national ecological status—ecosystem quality assessment (HJ 1172—2021)[7], which proposes the Ecosystem Quality Index (EQI) based on Fractional Vegetation Cover (FVC), Leaf Area Index (LAI), and Gross Primary Productivity (GPP). Through the integration of multiple indicators, this approach provides a more comprehensive representation of ecosystem structural characteristics and ecological functioning. In this context, utilizing multi-source remote sensing data, this study developed a 250-m resolution EQI dataset for China covering the period from 2007 to 2024, aiming to provide a unified and standardized data foundation for investigating long-term spatiotemporal dynamics of ecosystem quality.

2 Metadata of the Dataset

The metadata of Yearly/250-m raster dataset of Ecosystem Quality Index (EQI) of China (2007–2024)[8] is summarized in Table 1. It includes the dataset full name, short name, authors, year of the dataset, temporal resolution, spatial resolution, data format, data size, data files, data publisher, and data sharing policy, etc.

Table 1 Metadata summary of the Yearly/250-m raster dataset of Ecosystem Quality Index (EQI) of China (2007–2024)

Items	Description
Dataset full name	Yearly/250-m raster dataset of Ecosystem Quality Index (EQI) of China (2007–2024)
Dataset short name	eqi_2007_2024
Author	Qing, A., Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, qingao23@mails.ucas.ac.cn
Geographical region	China
Year	2007–2024
Temporal resolution	Year
Spatial resolution	250 m
Data format	.tif
Data size	6.55 GB (compressed)
Data files	Annual EQI raster data from 2007 to 2024
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	(1) *Data* are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use *Data* subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute *Data* subject to written permission from the GCdataPR Editorial Office and the issuance of a *Data* redistribution license; and (4) If *Data* are used to compile new datasets, the "ten percent principle" should be followed such that *Data* records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[9]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS, GEOSS, PubScholar, CKRSC, OARL

3 Methods

3.1 Algorithm

The Ecosystem Quality Index (EQI) is used to comprehensively characterize the structural and functional status of regional ecosystems and serves as an important indicator of overall ecosystem quality. According to the HJ 1172—2021, ecosystem quality assessment is based on 3 key remote sensing indicators, namely FVC, LAI, and GPP, and achieves a quantitative characterization of ecosystem quality through a multi-indicator integrated approach. In this study, raster grids with a spatial resolution of 250 m were adopted as the fundamental assessment units. An automated processing workflow was developed using Python to enable batch calculations of EQI, resulting in the generation of an annual 250-m resolution EQI dataset for China covering the period from 2007 to 2024.

(1) Data acquisition and indicator system construction

Multi-source remote sensing datasets of FVC, LAI, and GPP were collected to establish the indicator system for ecosystem quality assessment. FVC represents the proportion of the vertically projected area of components, including leaves, stems, and branches, relative to the total area of a statistical unit, primarily reflecting the horizontal structural characteristics of vegetation. LAI is defined as the ratio of total leaf area to unit ground area and is widely used to characterize the complexity of vegetation vertical structure. GPP refers to the total amount of organic carbon fixed through photosynthesis by green plants per unit area and unit time and mainly reflects vegetation photosynthetic activity and ecosystem productivity. Regarding data sources, the FVC dataset with a spatial resolution of 250 m was obtained from the National Tibetan Plateau Data Center[1]. The LAI dataset (250 m) and GPP dataset (500 m) were derived from the Global Land Surface Satellite (GLASS) products[2].

(2) Data preprocessing

Systematic preprocessing procedures were conducted for all multi-source remote sensing datasets prior to EQI calculation. First, data completeness checks were conducted to identify missing values, which were then supplemented. At the same time, abnormal values were removed and scale conversions were performed to minimize uncertainties associated with remote sensing retrieval errors. Second, annual maximum composite values were generated at the pixel scale based on the original time-series data. Subsequently, raster tiles were mosaicked and clipped using the national boundary of China to produce spatially continuous datasets covering the entire study area.

(3) Spatial consistency processing

Because the FVC, LAI, and GPP datasets differed in spatial resolution and projection system, spatial consistency processing was required prior to index calculation. Using the FVC dataset as the reference, the LAI and GPP datasets were reprojected and resampled to ensure consistency in coordinate reference system, spatial resolution (250 m), and spatial extent among all datasets.

To eliminate differences in measurement units and value ranges among indicators, the Min-Max normalization method recommended in HJ 1172—2021 was applied:

$$X' = \frac{X - X_{\min}}{X_{\max} - X_{\min}} \tag{1}$$

where X is the original indicator value, $X_{\min}$ and X_{max} are the minimum and maximum values of the indicator within the study area, and X' is the normalized value. Following normalization, all indicators were transformed to a standardized range of 0–1, thereby

[1] National Tibetan Plateau Data Center. https://data.tpdc.ac.cn/home.

[2] Global Land Surface Satellite. https://glass.hku.hk/.

improving comparability among variables and facilitating subsequent integration into the EQI framework.

(4) Calculation of the Ecosystem Quality Index

Following data preprocessing and indicator standardization, the Ecosystem Quality Index was constructed in accordance with the methodology specified in HJ 1172—2021. EQI was calculated at the pixel scale as follows:

$$EQI_i = \frac{FVC_i + LAI_i + GPP_i}{3} \times 100 \tag{2}$$

where EQI_i is the EQI of pixel i, FVC_i is the normalized Fractional Vegetation Cover of pixel i, LAI_i and GPP_i are the normalized Leaf Area Index and Gross Primary Productivity of pixel i, respectively.

3.2 Technical Route

Figure 1 outlines the dataset workflow. LAI, GPP, and FVC are acquired, checked for completeness and outliers. Annual maximum composites and spatial mosaicking/cropping generate baseline data. Multi-source data are then unified in projection, resolution, and extent, and normalized. Finally, EQI is calculated per HJ 1172—2021 to produce the 250-m annual China EQI dataset (2007–2024).

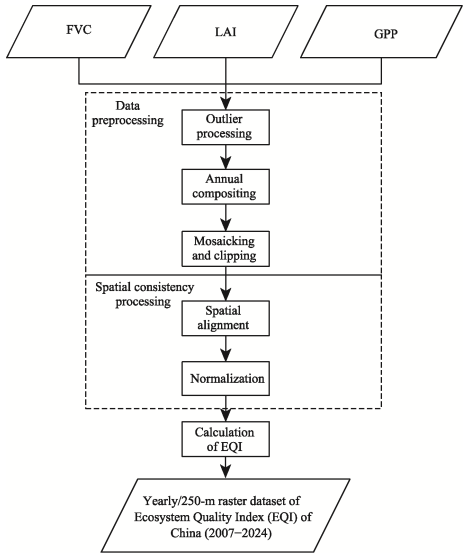


Figure 1 Flowchart of the dataset development

4 Data Results

4.1 Dataset Composition

The Yearly/250-m raster dataset of Ecosystem Quality Index (EQI) of China (2007–2024) covers the entire territory of China and is archived in .tif format. Pixel values range from 0 to 100, with higher values indicating better ecosystem quality. The dataset has an annual temporal resolution and includes annual EQI raster products from 2007 to 2024. In total, the dataset comprises 54 data files, which are compressed into 9 archive files to facilitate data storage.

4.2 Data Products

4.2.1 Temporal Characteristics of the EQI of China

From 2007 to 2024, the EQI of China exhibited a stable and significant increasing trend over time (Figure 2a). Linear regression analysis yielded a slope of 0.193 per year, indicating a steady increase in ecosystem quality throughout the study period. The coefficient of determination (R^2) was 0.739, suggesting that the temporal variable explained approximately 73.9% of the interannual variation in EQI, and the trend showed strong consistency. Furthermore, the trend was highly significant ($p = 4.87\times10^{-6}$), confirming a statistically robust increase in ecosystem quality over time. To further characterize temporal variations in the distribution of EQI, annual boxplots were constructed using raster data from 2007 to 2024 (Figure 2b). The results show a gradual increase in the median EQI throughout the study period, consistent with the trend observed for the mean value. This finding indicates that ecosystem quality improved not only at the average level but also across the overall distribution.

Regarding distributional variability, the interquartile range (P25–P75) exhibited only minor fluctuations over time, and its width remained generally stable throughout the study period. This suggests that interannual changes in EQI were primarily manifested as an overall upward shift in ecosystem quality rather than substantial changes in distributional dispersion. Overall, the EQI dataset showed a significant, stable, and low-volatility increasing trend from 2007 to 2024. The strong temporal consistency observed in the dataset highlights its suitability for long-term ecological monitoring, trend detection, and ecosystem change assessment.

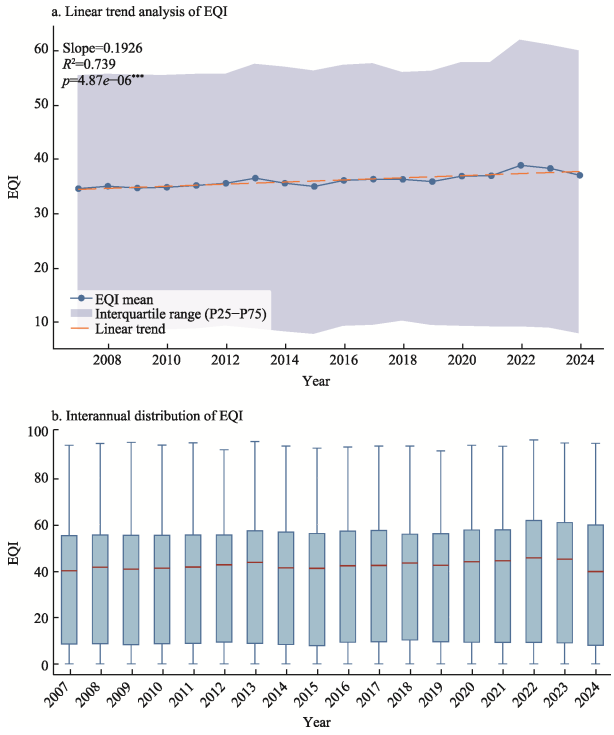


Figure 2 Temporal characteristics of the EQI of China (2007–2024)

4.2.2 Spatial Characteristics of the EQI of China

From the perspective of spatial distribution, the EQI in China in 2024 exhibited pronounced

regional heterogeneity (Figure 3). Overall, higher EQI values were concentrated in southern and southwestern China, whereas lower values were predominantly observed in northwestern and certain high-altitude regions. Central and eastern China showed evident transitional characteristics, while parts of northeastern China formed localized high-value clusters. To further characterize the interprovincial spatial pattern of EQI in 2024, the mean EQI values were calculated and ranked for each province (Figure 4). Across 34 provinces of China, the mean EQI was 50.22, with a standard deviation of 16.28, a coefficient of variation of 32.42%, and a range of 59.75, indicating substantial spatial heterogeneity at the provincial scale.

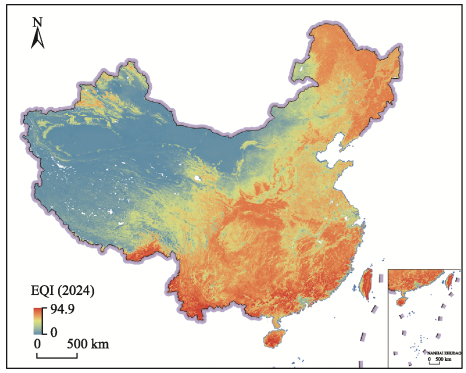


Figure 3 Spatial distribution map of the EQI of China (2024)

At the provincial level, high-value regions were primarily concentrated in southern and southwestern China, where ecological background conditions are relatively favorable. The top-ranked provinces in terms of mean EQI were Hainan (70.49), Taiwan (70.24), Fujian (68.41), Guangxi (68.38), and Yunnan (66.36). In Hainan, pixels in the 60–80 and 80–100 classes accounted for 48.33% and 30.54%, respectively, indicating a clear dominance of high-value areas. In Taiwan, pixels in the 80–100 interval accounted for 45.78%, showing a marked concentration of high-value areas. In Fujian and Guangxi, the proportions of pixels in the 60–80 interval reached 71.10% and 66.92%, respectively, further indicating a pronounced clustering of high EQI values. Overall, southern and southwestern China formed a spatially continuous belt of high EQI values, indicating relatively high ecosystem quality in these regions.

In contrast, low-value areas were mainly distributed in northwestern China and certain high-altitude regions. Provinces with relatively low mean EQI included Xinjiang (10.74), Xizang (18.04), Qinghai (20.66), Gansu (23.57), and Ningxia (25.97). Among them, pixels in the 0–20 class accounted for 82.60% in Xinjiang and 69.41% in Xizang, while corresponding proportions were 55.28% in Qinghai and 54.81% in Gansu, indicating a clear dominance of low-value pixels and generally poor ecosystem quality. In Ningxia, the proportion of pixels in the 0–20 class reached 45.18%. Inner Mongolia had a mean EQI of 31.83, with 35.79% of pixels falling within the 0–20 class, further indicating that arid, semi-arid, and alpine regions in Northern China are predominantly characterized by low to moderately low EQI levels.

Notably, central and eastern China exhibited clear transitional characteristics. For example, the mean EQI values of Hubei, Anhui, Liaoning, and Henan were 57.84, 55.68, 56.22, and 54.26, respectively, placing them at a moderately high level nationwide. Their pixel distributions were mainly distributed in the 40–60 and 60–80 classes. In addition, within northeastern China, Heilongjiang (61.39) and Jilin (59.34) showed relatively high

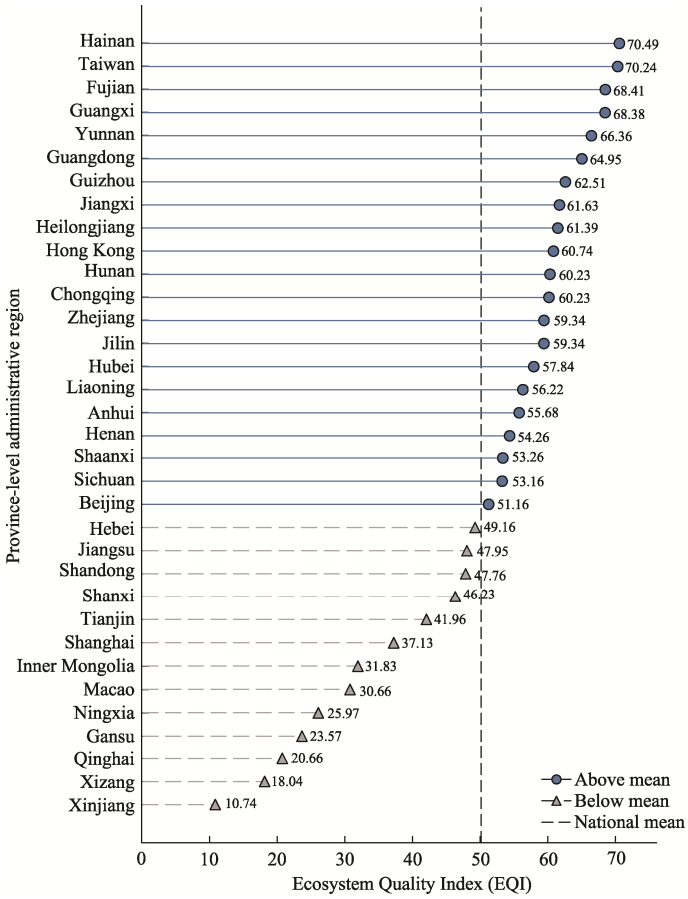


Figure 4 Interprovincial differences in the EQI of China (2024)

EQI levels, indicating that parts of northeastern China constitute another distinct high-value region, differentiated from the low-value zones in northwestern China.

4.2.3 Distribution Structure Analysis of China's EQI

To characterize the overall distribution structure of the EQI in China in 2024, this study constructed the probability density function (PDF) and cumulative distribution function (CDF) based on raster pixel values (Figure 5). The results show that EQI values in 2024 ranged from 0.00 to 94.90, with a mean of 36.95, a median of approximately 39.93, a standard deviation of 25.78, and first and third quartiles (P25 and P75) of 7.89 and 59.87, respectively. Overall, the EQI distribution spanned a wide range, indicating pronounced spatial heterogeneity in ecosystem quality across China.

From the perspective of the probability density distribution, EQI did not follow a simple unimodal normal distribution. Instead, it exhibited a pattern characterized by a pronounced concentration in the low-value range alongside a broad spread across medium-to-high values. Binned statistics show that approximately 27.55% of pixels fell within the 0–10 interval, indicating that low-value pixels accounted for a considerable proportion nationwide. Meanwhile, about 48.15% of pixels were distributed within the 40–80 interval, among which the 40–60 and 60–80 intervals accounted for 25.14% and 23.01%, respectively. This suggests that the EQI distribution in China is primarily concentrated in the medium to moderately high range, despite the presence of a substantial low-value component.

From the cumulative distribution function, the CDF curve rose rapidly in the low-value range, continued to increase steadily in the medium-value range, and gradually flattened in the high-value range. Quantitatively, approximately 75.21% of pixels had EQI values not exceeding 60, about 90.16% did not exceed 70, and about 98.21% did not exceed 80, whereas only 1.79% of pixels fell within the 80–100 interval. This indicates that although high-EQI areas exist in localized regions, their spatial extent is limited, and high values primarily constitute the upper tail of the overall distribution.

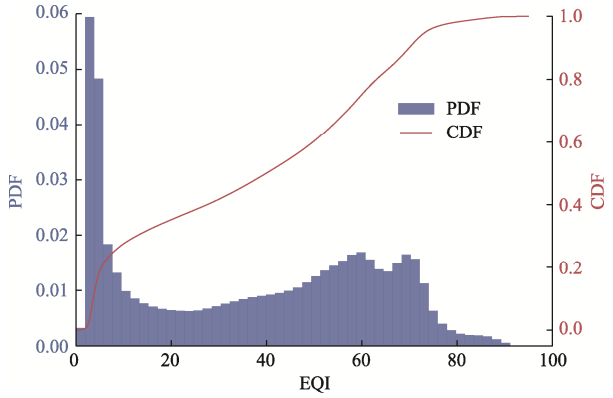


Figure 5 Probability density function and cumulative distribution function of the EQI of China (2024)

5 Discussion and Conclusion

Based on the HJ 1172—2021, this study developed a 250 m resolution dataset of the EQI for China (2007–2024) by integrating multi-source remote sensing data, including FVC, LAI, and GPP. This dataset covers the period from 2007 to 2024 and spatially encompasses the entire territory of China, enabling continuous characterization of spatiotemporal dynamics in ecosystem quality at a national scale. In the temporal dimension, the national mean EQI exhibited a stable upward trend during 2007–2024. The interannual median showed a consistent increase, while the interquartile range remained relatively stable, indicating overall temporal consistency and robustness of the dataset. In the spatial dimension, EQI exhibited a persistent pattern characterized by relatively high values in southern and southwestern China, lower values in northwestern China and certain high-altitude regions, and transitional zones across central and eastern China. Pronounced interprovincial heterogeneity was also evident. In terms of distribution structure, EQI demonstrated a combined pattern of strong concentration in low-value regions and wide dispersion across medium-to-high value ranges, reflecting substantial spatial heterogeneity in ecosystem quality across China. Overall, this dataset provides a standardized, long-term, and high-resolution representation of ecosystem quality dynamics in China. It can serve as a fundamental basis for continuous monitoring of ecosystem conditions, identification of regional disparities, assessment of ecological conservation and restoration outcomes, and support for territorial spatial planning and environmental decision-making.

Despite these strengths, several limitations remain. First, the construction of EQI relies on remote sensing inputs such as FVC, LAI, and GPP, and its accuracy is influenced by uncertainties in the original datasets, as well as preprocessing steps including gap filling, resampling, and cross-scale harmonization. Error propagation across multi-source data integration may therefore introduce uncertainty into the final results. Second, the dataset is

currently constructed at an annual scale, which is suitable for long-term trend analysis and large-scale spatial pattern characterization, but is less capable of capturing seasonal dynamics and short-term variability. Third, due to the limited availability of comparable national-scale EQI products, external validation and inter-product benchmarking remain constrained. Future research could further improve the dataset in 2 respects. First, extending the dataset to seasonal or sub-annual scales would enable a more detailed characterization of ecosystem dynamics. Second, integrating additional independent observations would support more comprehensive validation and regional applicability assessments. This dataset supported the completion of the author's Master degree of Engineering thesis, under the guidance of Associate Professor HAN Mengyao.

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Conflicts of Interest
The authors declare no conflicts of interest.

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