Monitoring and analysis of green sustainable development in impoverished counties based on nighttime light and RSEI

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Abstract. Sustainable assessment of the quality of green sustainable development in poor counties is essential for urban environmental management, planning as well as achieving sustainable development goals. Currently, there are shortage of related researches on poverty alleviation and ecological environment monitoring in poverty-stricken counties, this study which is based on the nighttime light images and Landsat8 OLI images, constructing a light index, remote sensing ecological index (RSEI) and coupling coordination model of the two. Analyze the situation from 2013 to 2019 poverty alleviation in poor counties in Fujian Province and the ecological environment and explore its coupling and coordination relationship. The results show that from 2013 to 2019, the economy of poor counties has doubled and the most obvious accomplishments of poverty alleviation were in the year 2015 to 2017; the RSEI value of poor counties has all increased, the overall ecological level is at a high-quality level, and the coverage rate is high. The coupling degree C and coordination degree D of the light index and RSEI show a fluctuating upward trend, and both of them are at a good coupling and coordination level, achieving a win-win situation for economic and ecological benefits.

1. Introduction

Eliminating poverty is the dream of humanity, and the history of human development is also the history of constant struggle against poverty. 17 Sustainable Development Goals (SDGs) have been put forward in the agenda of the UN 2030 Sustainable Development Goals, which aims to solve the development problems of the three dimensions of society, economy and environment in an integrated manner from 2015 to 2030 and shift to the path of Sustainable Development [1]. Monitoring and evaluating the achievements of poverty alleviation and changes in the ecological environment is of great significance for the poverty-stricken counties from getting rid of poverty to realizing rural revitalization [2].

Nighttime Light (NTL) is the use of remote sensing technology to capture the Earth’s night light from outer space, which can quickly, accurately and objectively obtain information on the surface and human activities [3,4]. Using NTL data, researchers from various countries have explored changes in the external urban spatial structure and changes in internal social and economic development [5,6], especially in the analysis of human activity characteristics [7,8], urbanization process [9,10], war damage assessment [11] and other related research applications. Pan et al. took the districts and counties of Chongqing as the research area and introduced the night light data to construct a poverty measurement index system[12]; Yu et al. used NPP-VIIRS data to verify that there is a greater
The above studies mainly focus on the monitoring of urban urbanization which is based on luminous light or the monitoring of ecological environment which is based on RSEI. No studies have evaluated the economic development and ecological environment quality of poverty-stricken counties in the process of poverty alleviation by combining light index and RSEI. Therefore, this paper adopts NPP-VIIRS DNB night-light remote sensing image and Landsat8 OLI image as the basic data source to study economic development and ecological changes in the process of poverty alleviation in the poverty-poor counties of Fujian Province. This also monitors and evaluates the quality of green and sustainable development in the region so as to provide auxiliary reference and decision support for the evaluation of rural revitalization and sustainable green development goals.

2. Data and methods

2.1. Overview of the study area and data sources

Fujian Province is located in southeastern China on the coast of the East China Sea. The land area is between 23°33′ N to 28°20′ N and 115°50′ E to 120°40′ E. There are towering peaks and ridges, continuous hills, river valleys and basins interspersed between them. Mountains and hills account for more than 80% of the total area of the province. The climate conditions are superior, and it is popularly known as "eight mountains, one river and one field". In 2012, Fujian Province for the first time identified 23 counties in the 6 urban districts as key counties for poverty alleviation and development at the provincial level, strengthened the improvement of conditions in poverty-stricken areas, accelerated support for economic development, and eliminated all poverty-stricken counties by 2019. This paper takes 23 poverty-stricken counties in Fujian Province as the research area, and selects one county in each of the six urban districts as the object: Yongtai, Shouning, Guangze, Qingliu, Pinghe and Changting, to analyze the sustainability of ecological and economic development among them.

As shown in Table 1, the luminous remote sensing year data used in this study were synthesized by the Suomi-NPP satellite using its Visible Infrared Imaging Radiometer (VIIRS), from the Penn Institute of Public Research, USA; Landsat8 OLI remote sensing images were downloaded from China's geospatial data cloud website; Social and economic data such as GDP come from Fujian Statistical Yearbook and monthly statistical data from 2012 to 2020; The vector map of the administrative boundary of the study area comes from the 1:4 million county-level administrative boundary data released by the National Basic Geographic Information Center in 2019.
Table 1. Data sources and information.

| Data source            | Description                                                                 | Time       | Source                                                                 |
|------------------------|-----------------------------------------------------------------------------|------------|------------------------------------------------------------------------|
| Night light data       | Luminous year data is synthesized from the monthly average of cloudless radiation | 2012-2020  | https://eogdata.mines.edu/nighttime_light/annual/v20/                   |
| Landsat8 OLI image     | Spatial resolution 30m, cycle 16 days                                        | 2013-2020  | http://www.gscloud.cn/home                                               |
| Socioeconomic data     | Population and GDP data                                                     | 2012-2020  | Fujian Statistical Yearbook, Fujian Municipal Statistical Yearbook       |
| Administrative boundary| Fujian county-level vector data                                             | 2019       | National Basic Geographic Information Center                            |

2.2. Research route

In this study, data preprocessing was carried out to eliminate image noise for the annual data images of luminous and Landsat8 OLI remote sensing images; Secondly, the nocturnal index model and the RSEI model obtained from the principal component analysis of greenness, humidity, dryness and heat were constructed, and the RSEI equally-spacing classification and difference value were tested and analyzed. Meanwhile, the coupling coordination model of the two was constructed; Finally, the three models are used to monitor and analyze the poverty alleviation and ecological environment of the poverty-stricken counties and evaluate their green and sustainable development. As shown in Figure 1.
2.3. Data preprocessing

2.3.1. Luminous image preprocessing. Firstly, Fujian county administrative zoning map is used to cut out the corresponding NPP/VIIRS night light annual data. To make the data more accurate, avoid the influence of image grid deformation and facilitate the calculation of the pixel area of the bright value in the image, the projection coordinate system of the light raster image data is usually converted into an Albers equal-area cut conic projection. The sampling method adopts the NEAREST proximity method suitable for discrete data processing, and the spatial resolution is 700m [22,23]. The luminous data has negative and extreme values due to the influence of stray light, lightning, moon illumination and clouds. The threshold is selected as the image radiation value equal to 0, that is, the luminous pixel is the luminous pixel if the radiation value is greater than 0, and the rest is assigned as 0 as the background value. The extremely bright value is removed by removing the 0.1% pixels with the highest luminous intensity [24].

2.3.2. Landsat8 OLI image preprocessing. The original image was preprocessed by ENVI software, such as atmospheric correction and radiation calibration [25]. Since there is a large area of water in the research area, the humidity index will have errors, so it is necessary to use the MNDWI index to identify and mask the water part in the research area before extracting the RSEI, and then cropping the corresponding research administrative area with ArcGIS software [26].

2.4. Model construction

2.4.1. Construction of light index. The construction of the luminous index should make full use of the GDP distribution and human activity information carried by image pixels. The sum of the radiance values of the night light pixels in each area is the total nighttime light intensity value (TNL), and the ratio of the total night light intensity to the area is the average nighttime light intensity (ANL), and the two attributes can reflect GDP and population spatial information, the calculation formula is as (1) (2). Development Intensity (DI) refers to the difference in the total light Intensity in poverty alleviation. The greater the difference, the faster the Development speed of the city. In this paper, DI values are divided into 7 levels as shown in Table 2:

\[
TNL = \sum_{i=1}^{n} DN_i \tag{1}
\]

\[
DI = TNL_{past} - TNL_{pre} \tag{2}
\]

\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
Level & DI & -20 & -5 & -2 & -0.5 & 0.5 & 2 & 5 & 20 \\
\hline
Severe lag & Moderate lag & Mild lag & Unchanged & Moderate development & Development & Heavy development & \\
\hline
\end{tabular}

Table 2. DI classification.

2.4.2. Construction of remote sensing ecological index. Remote Sensing Ecological Index is an ecological index that can integrate multiple ecological factors to monitor and evaluate the regional ecological environment based on remote sensing information. It is composed of the vegetation index (NDVI), humidity index (Wet) and dryness index (IBI), Heat Index (LST). The calculation formula for each index is as (3~7).

\[
RSEI = f\{NDVI, Wet, NDSI, LST\} \tag{3}
\]

\[
NDVI = (\rho_5 - \rho_4)/(\rho_5 + \rho_4) \tag{4}
\]
\begin{align*}
W_{et} &= 0.1511 \rho_2 + 0.1973 \rho_3 + 0.3283 \rho_4 \\
&+ 0.3407 \rho_5 - 0.7117 \rho_6 - 0.4559 \rho_7 \\
I_{BI} &= \frac{2\rho_5/(\rho_5 + \rho_4) - \rho_4/(\rho_4 + \rho_3) + \rho_2/(\rho_2 + \rho_5)}{2\rho_5/(\rho_5 + \rho_4) + \rho_4/(\rho_4 + \rho_3) + \rho_2/(\rho_2 + \rho_5)} \\
LST &= \frac{\tau_p}{1 + (\Delta T_p / \rho) \theta} - 273.5
\end{align*}

Principal component analysis (PCA) can use less calculation to select the quantity and obtain the effect of selecting the best subset of variables. The PCA of the four indexes corresponding to the RSEI index is carried out, and the first component is the initial remote sensing ecological index RSEI\textsubscript{PFIRST}, as shown in formula (8). Use equation (9) to normalize RSEI\textsubscript{PFIRST} to get RSEI, and its value is between 0 and 1. The closer to 1, the better the ecological environment quality, and vice versa, the worse the ecological quality. The RSEI change value is divided into 7 levels as shown in Table 3.

\begin{equation}
RSEI = \frac{(RSEI_{PFIRST} - RSEI_{PFIRST \_min})}{(RSEI_{PFIRST \_max} - RSEI_{PFIRST \_min})}
\end{equation}

### Table 3. RSEI classification.

| RSEI   | Level            | Value | Level | Value  |
|--------|------------------|-------|-------|--------|
| -1 - -0.5 | Severely degraded | -0.5 - -0.2 | -0.05 - 0.05 | 0.05 - 0.2 | 0.2 - 0.5 | 0.5 - 1 |

2.4.3. **Construction of coupling coordination model.** The coupling coordination degree model is used to analyze the coordinated development level of things[27,28]. In this paper, the coupling coordination degree function of the interaction between ecological remote sensing index and luminous index can be obtained by quoting the coupling model of economics, as shown in formula (10,11):

\begin{align*}
C(U_1, U_2) &= 2 \left[ 1 \left( \frac{U_1U_2}{(U_1 + U_2)^2} \right) \right]^{\frac{1}{2}} \\
D &= \sqrt{C \ast T}
\end{align*}

In the formula, C represents the interaction coupling degree of each function, reflects the strength of the interaction coupling of each system, and \( U_1, U_2 \) is the evaluation function of each index. The closer the value of C is to 1, the better the coupling degree. D represents the degree of coordination, \( T = mU_1 + nU_2 \), \( m=n=1/2, m+n=1, T \in [0,1] \). Discuss the coupling degree C and the coordination degree D, as shown in Table 4.

### Table 4. Coupling and coordination level.

| Coupling Value | Level       | Coordination Value | Level         |
|----------------|-------------|--------------------|---------------|
| [0,0.3]        | Low         | [0,0.4]            | Maladjustment |
| (0.3,0.5]      | Antagonistic| (0.4,0.5]          | Mild coordination |
| (0.5,0.8]      | Running-in  | (0.5,0.8]          | Well coordination |
| (0.8,1]        | High        | (0.8,1]            | Quality coordination |

3. **Results and analysis**

3.1. **Analysis of economic development of impoverished counties**

As shown in Figure 2, the total luminous intensity TNL of the 23 poor counties in Fujian Province and the GDP statistics of the corresponding counties in the four years are logarithmically fitted, and it is found that they have a strong correlation from 2013 to 2019, and the R2 value is above 0.75. The
higher the TNL of a poor county, the higher its corresponding GDP and the better the level of economic development. Therefore, luminous data can better reflect the economic development level of poor counties.

Figure 2. 2013-2019 GDP and TNL fitting.

In order to facilitate the coupling and coordination, the total luminous intensity is normalized to obtain TNL_NORM as shown in Table 5. It is found that the total value of noctilucent light in all the six poverty-stricken counties has more than doubled from 2013 to 2019, and the lower the original total value of the light, the greater the increase. Among them, the biggest increase occurred from 2015 to 2017, indicating the fastest economic development during this period. This is mainly because the 13th Five-Year Plan in 2015 emphasized targeted poverty alleviation and implemented poverty alleviation projects. It also held a poverty alleviation and development work conference to study the poverty alleviation of the poor, develop the urban economy, help urban areas to get rid of poverty, and achieve poverty alleviation in poverty-stricken counties. At the same time, it can be found that there are regional differences in poverty alleviation, and the development of poor counties is unbalanced. In other words, the overall economic development of Shouning, Guangze and Qingliu is lower than that of Yongtai, Pinghe and Changting, but after poverty alleviation, the gap shows a trend of narrowing. This is closely related to the implementation of the mountain-sea cooperation and linkage development model initiated by President Xi Jinping. That is, the coastal economic development counties will provide one-to-one assistance to the 23 key counties of provincial-level poverty alleviation and development work, and promote the mountain-sea cooperation in industrial docking, labor assistance, talent exchange and technical assistance.

Table 5. Normalized total light intensity.

| TNL_NORM | 2013 | 2015 | 2017 | 2019 |
|----------|------|------|------|------|
| Yongtai county | 0.22 | 0.27 | 0.49 | 0.57 |
| Shouning county | 0.04 | 0.07 | 0.25 | 0.23 |
| Guangze county | 0.04 | 0.05 | 0.35 | 0.30 |
| Qingliu county | 0.09 | 0.03 | 0.21 | 0.22 |
| Pinghe county | 0.54 | 0.37 | 0.63 | 0.76 |
| Changting county | 0.25 | 0.25 | 0.64 | 0.62 |

The development intensity DI from 2013 to 2019 is shown in Figure 3. In addition to the mountainous areas, the overall light intensity and range of residential areas in the six poverty-stricken counties are in an increasing trend, and the increase is most obvious in Yongtai and Changting, especially in the light range and brightness of the county center. Comparing with the national highway network map, it is found that the areas with increased lights mainly revolve around highways and town
centers, indicating that urbanization has a significant impact on poverty alleviation. At the same time, there has been a lagging development in some areas, especially the Pinghe County area, showing a trend of lagging development in some areas, which is related to the relocation of urban centers.

3.2. Analysis of ecological conditions in typical poor counties

The statistical results of the RSEI value, the mean value of each index and the contribution to the first principal component of the 6 poverty-stricken counties are shown in Table 6.

From an overall point of view, the RSEI of the 6 poor counties was at a relatively high level in 2013-2019, and the RSEI value was all higher than 0.6, and all had a slight increase. From 2013 to 2015, Yongtai, Shouning and Guangze focused on ecological environment construction and increased the average RSEI to above 0.7, while the ecological environment of Pingping, Qingliu and Changting was damaged to varying degrees. From 2015 to 2017, except for Qingliu County, the RSEI value of other counties decreased to varying degrees, while TNL increased to a large extent, indicating that economic development had a significant impact on the ecological environment.

Judging from the average values of the ecological indicators in the 6 poor counties, the average values of NDVI and WET from 2013 to 2019 are basically above 0.7 with little fluctuation, indicating that the vegetation coverage of poverty-stricken counties is stable and at a high level after poverty alleviation and cap removal. However, the mean value of LST and IBI is about 0.4, without significant increase, indicating that human development activities and urban expansion do not have obvious damage to the ecological environment of the poor counties on the whole.

From the perspective of the first principal component of the ecological indicators in the six poverty-stricken counties, both NDVI and WET indicators are positive, indicating that vegetation coverage and humidity have a promoting effect on the ecological environment. Among them, NDVI has a higher contribution rate, indicating that vegetation had the most obvious promoting effect on the ecological environment. The LST and IBI indicators are both negative, indicating that dryness and heat inhibit the ecological environment. These two indicators are mainly due to the effects of impervious surfaces such as urban buildings, while urban expansion and land development have a destructive effect on the ecological environment.

As shown in Figure 4, the ecological environment of the six impoverished counties is generally good, and there is no situation that the entire area is ecologically poor. From 2013 to 2019, the remote sensing ecological index RSEI has all increased after the poverty-stricken counties were lifted out of poverty. This is because Fujian Province adheres to the new development concept and continues to take a high-quality development path with ecology as the priority and green development as the orientation. Among the six poverty-stricken counties, the RSEI in Shouning County improved most
obviously, and the ecological environment in most areas of the county improved obviously, and the RSEI increased significantly. The overall ecological environment of Yongtai, Guangze and Changting has been improved, and there is no obvious decline in any area. Although the overall RSEI of Pinghe County in Qingliu County is good, the ecological environment has not improved. Among them, the environment in the southwest of Pinghe County has been significantly improved, but the ecological environment in the southeast has declined significantly.

Table 6. Statistics of RSEI indicators.

| Impoverished counties | INDEX | 2013 Mean | PFIRST Mean | 2015 Mean | PFIRST Mean | 2017 Mean | PFIRST Mean | 2019 Mean | PFIRST Mean |
|-----------------------|-------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|
| Yongtai county        | NDVI  | 0.899     | 0.495       | 0.874     | 0.554       | 0.828     | 0.477       | 0.869     | 0.402       |
|                       | WET   | 0.825     | 0.315       | 0.811     | 0.383       | 0.788     | 0.303       | 0.864     | 0.333       |
|                       | LST   | -0.382    | -0.463      | 0.376     | -0.428      | 0.408     | -0.545      | 0.342     | -0.566      |
|                       | IBI   | -0.029    | -0.664      | 0.394     | -0.602      | 0.448     | -0.619      | 0.299     | -0.637      |
|                       | RSEI  | 0.69      | 0.72        | 0.64      | 0.72        |           |             |           |             |
| Shouning county       | NDVI  | 0.855     | 0.346       | 0.877     | 0.812       | 0.901     | 0.366       | 0.867     | 0.412       |
|                       | WET   | 0.889     | 0.267       | 0.559     | 0.146       | 0.826     | 0.418       | 0.784     | 0.353       |
|                       | LST   | -0.414    | -0.702      | 0.329     | -0.432      | 0.417     | -0.647      | 0.327     | -0.476      |
|                       | IBI   | -0.387    | -0.562      | 0.453     | -0.364      | 0.273     | -0.521      | 0.057     | -0.691      |
|                       | RSEI  | 0.61      | 0.74        | 0.68      | 0.72        |           |             |           |             |
| Guangze county        | NDVI  | 0.823     | 0.724       | 0.835     | 0.655       | 0.835     | 0.435       | 0.808     | 0.557       |
|                       | WET   | 0.727     | 0.128       | 0.838     | 0.115       | 0.849     | 0.312       | 0.854     | 0.198       |
|                       | LST   | -0.399    | -0.427      | 0.368     | -0.506      | 0.423     | -0.552      | 0.342     | -0.388      |
|                       | IBI   | -0.334    | -0.526      | 0.394     | -0.549      | 0.427     | -0.637      | 0.423     | -0.705      |
|                       | RSEI  | 0.69      | 0.71        | 0.67      | 0.72        |           |             |           |             |
| Qingliu county        | NDVI  | 0.854     | 0.545       | 0.805     | 0.684       | 0.816     | 0.563       | 0.822     | 0.504       |
|                       | WET   | 0.804     | 0.320       | 0.543     | 0.085       | 0.823     | 0.277       | 0.708     | 0.338       |
|                       | LST   | -0.435    | -0.426      | 0.371     | -0.513      | 0.361     | -0.389      | 0.399     | -0.425      |
|                       | IBI   | -0.402    | -0.647      | 0.452     | -0.509      | 0.409     | -0.673      | 0.389     | -0.671      |
|                       | RSEI  | 0.68      | 0.60        | 0.71      | 0.69        |           |             |           |             |
| Pinghe county         | NDVI  | 0.811     | 0.725       | 0.846     | 0.591       | 0.825     | 0.616       | 0.881     | 0.599       |
|                       | WET   | 0.723     | 0.111       | 0.667     | 0.152       | 0.821     | 0.234       | 0.773     | 0.175       |
|                       | LST   | -0.394    | -0.409      | 0.408     | -0.559      | 0.382     | -0.448      | 0.387     | -0.576      |
|                       | IBI   | -0.409    | -0.542      | 0.298     | -0.561      | 0.476     | -0.603      | 0.323     | -0.527      |
|                       | RSEI  | 0.67      | 0.64        | 0.64      | 0.67        |           |             |           |             |
| Changting county      | NDVI  | 0.882     | 0.597       | 0.771     | 0.633       | 0.849     | 0.487       | 0.900     | 0.527       |
|                       | WET   | 0.863     | 0.206       | 0.817     | 0.218       | 0.817     | 0.298       | 0.861     | 0.210       |
|                       | LST   | -0.363    | -0.445      | 0.374     | -0.521      | 0.401     | -0.553      | 0.359     | -0.478      |
|                       | IBI   | -0.341    | -0.635      | 0.469     | -0.529      | 0.402     | -0.606      | 0.308     | -0.669      |
|                       | RSEI  | 0.76      | 0.64        | 0.64      | 0.77        |           |             |           |             |
3.3. Analysis of Green Sustainable Development

After 2013, Fujian Province gradually integrated the concept of ecological civilization into the development process of new-type urbanization. According to the carrying capacity of resources and environment, Fujian Province established the concept of ecological civilization and green and low-carbon development, focused on promoting green development, and built resource-saving and environment-friendly new towns. As can be seen from Figure 5, TNL_NORM of the six impoverished
counties increased greatly during 2013-2019, while RSEI remained unchanged at 0.6-0.8. In Table 7, the coupling degree C and coordination degree D of the study area has increased by more than 30% from the average value. From the specific values of each county, the coupling degree C increased from 2013 to 2019, among which the coupling degree increased fastest from 2015 to 2017 and approached 1 in 2019, indicating that the two were in the high coupling stage, signifying a close correlation between them. The coordination level D increased by 10%-20% from 2013 to 2019, showed a fluctuating upward trend, indicating that the coupling coordination level between poverty alleviation and ecological environment has been continuously improving, and reached above the good coordination level in all cases in 2019. This is because we have adhered to the concept that clear waters and green mountains are gold and silver mountains in the course of development. We have explored the establishment of a diversified compensation mechanism for ecological protection, adopted measures such as closing mountains for forest cultivation, developing green industries, and implementing ecological resettlement and relocation. We have promoted soil erosion control and achieved win-win ecological and economic benefits.

![Figure 5. TNL_NORM and RSEI trend.](image)

| Table 7. Coupling degree. |
|--------------------------|
| Coupling Coordination   | 2013 | 2015 | 2017 | 2019 | 2013 | 2015 | 2017 | 2019 |
| Yongtai county          | 0.85 | 0.89 | 0.99 | 0.99 | 0.62 | 0.66 | 0.75 | 0.80 |
| Shouning county         | 0.49 | 0.56 | 0.88 | 0.85 | 0.40 | 0.48 | 0.64 | 0.63 |
| Guangze county          | 0.44 | 0.49 | 0.95 | 0.91 | 0.40 | 0.43 | 0.70 | 0.68 |
| Qingliu county          | 0.64 | 0.43 | 0.84 | 0.85 | 0.49 | 0.37 | 0.62 | 0.62 |
| Pinghe county           | 0.99 | 0.96 | 1    | 1    | 0.78 | 0.70 | 0.80 | 0.84 |
| Changting county        | 0.86 | 0.90 | 1    | 0.99 | 0.66 | 0.63 | 0.79 | 0.83 |
| MEAN                    | 0.71 | 0.71 | 0.94 | 0.93 | 0.56 | 0.55 | 0.72 | 0.73 |

4. Conclusion and discussion

4.1. Conclusion

In this paper, nighttime light data and Landsat 8 OLI remote sensing images were used as data sources. The light index and RSEI method were used to analyze the ecological environment in the study area,
and the two methods were coupled and coordinated to realize the monitoring and evaluation of poverty alleviation and sustainability in poverty-stricken counties. Studies have shown that:

1) The luminous index can be used to monitor the economic development of poor counties on a county-level scale, and the correlation R2 value of its logarithmic fitting effect is about 0.8. DI chart can be used to better monitor the economic development degree of poverty-stricken counties. It can be found that poverty-stricken counties doubled their economic growth from 2013 to 2019, their infrastructure was greatly improved, and rural areas were successfully lifted out of poverty, with the most obvious achievements from 2015 to 2017.

2) Monitoring the ecological environment of impoverished counties based on the RSEI shows that the RSEI value of impoverished counties in Fujian Province has stabilized and increased slightly, the overall ecological level is at a high-quality level, and the vegetation coverage rate is high.

3) The coupling and coordination study of the lighting index and RSEI found that the coupling degree C and the coordination degree D present a fluctuating upward trend, and the two are at a good coupling and coordination level, indicating that adhering to the concept of green water and green mountains is a golden mountain and silver mountain can achieve ecological benefits and economics Benefit and win-win.

4.2. Discussion
The image data selected in this article can basically represent the situation in poor counties, but the low resolution of the sensor to obtain luminous data makes it impossible to effectively extract the lights in some rural areas; Although most of the aurora and fire noises are filtered out from the synthesized nocturnal annual data, there is still some noise inevitably. At the same time, there will also be thick clouds in the Landsat8 OLI remote sensing images, resulting in noise in the data; In future work, we can improve the denoising model algorithm and increase the sensor resolution, to provide more accurate data for the assessment of economic development and ecological assessment of poor counties.

Secondly, in terms of model construction. This article uses the total radiation value normalization method to normalize the lighting index normalization, which can further dig into the new poor county lighting index evaluation method to better monitor the economic development of the region. The RSEI model can be combined with multi-source data to improve the representativeness of the ecological index to the ecological environment. In the construction of the coupling model, a new model of the coupling and coordination relationship between the two systems can be explored.

Last but not least, this article selects one poverty-stricken county in each of the six urban areas in Fujian Province. Although it can basically represent the economic and ecological environment development of the 23 poverty-stricken counties in Fujian Province, the specific conditions of the 23 counties are not the same, so they cannot fully reflect the situation of all counties. Therefore, it is possible to research the economic and ecological monitoring of all poor counties to compare the differences in the development of different counties.

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