The loss rate of coastal soil based on abnormal track detection and the development of agricultural tourism economy

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Abstract
With the rapid development of wireless sensor networks, digital communication technology, and positioning technology and the large-scale application of mobile terminal equipment, people’s geographical location information in daily life becomes easy to obtain. Therefore, it also provides strong support for trajectory data mining. Track anomaly detection is an important field in the field of track data mining, which can determine whether the moving object deviates from the normal track or whether a sudden action occurs. If we can detect the abnormal trajectory of moving objects and analyze the causes of the abnormal, we cannot only avoid similar problems through reasonable decision making in the future, but also contribute to the study of coastal soil loss. Soil erosion affects the ecological environment and people’s production and life. Serious soil erosion will destroy arable land, increase sediment deposition, and affect the water environment and water security. The spatial distribution and evolution of soil erosion are restricted by many factors. Using a soil erosion model to analyze soil erosion factors and soil erosion process can provide the theoretical basis for formulating soil and water conservation measures. In addition, the study of coastal soil loss is helpful to the development of ecological agriculture, and the development of ecological agriculture has a very important impact on the development of the agricultural economy. Ecological agriculture can promote the structural adjustment of agricultural industrialization, promote the development of China’s agriculture, increase the economic income of agricultural workers, and promote the development of ecological landscape agriculture and leisure tourism.

Keywords Abnormal trajectory detection · Coastal soil loss rate · Agricultural tourism · Development strategy

Introduction
With the rapid development of wireless sensor networks; digital communication technology; and positioning technology and the large-scale application of mobile terminal devices, such as smartphones, PC, electronic watches, and bracelets, these provide strong support for trajectory data mining (Miao et al. 2010). Trajectory data mining aims at moving objects such as human beings, cars, ships, and hurricanes; trajectory data is a record of the location information of moving objects, which is stored in the form of text, pictures, and so on; at the same time, it may also contain more valuable information such as direction, speed, acceleration, and distance from a specific target point (Ortiz and Roser 2006). Trajectory data is a kind of time series data stream, which is continuous in time and space and has a strong correlation, but it also has local specificity in a special region and hides more valuable information (Patyk-Kara et al. 2001). Trajectory data contains rich motion state information of moving objects. If we can analyze the behavior patterns of moving objects and obtain their daily behavior rules, we can predict the future behavior of moving objects (Van der Oever 2000). The application scenarios of trajectory data mining technology include hurricane path prediction, preference analysis of scenic spots, traffic warning, interest point, and discovery, which can provide a reference for people’s travel and decision making and management of relevant departments. Therefore, it is of great significance to apply abnormal trajectory monitoring technology to coastal soil loss (Ozturk and Arici 2020).

At present, China’s agriculture has entered the modern agricultural development mode. In the current agricultural development, in the process of crop planting, in order to reduce the
occurrence of crop diseases and insect pests, a variety of chemical reagents are used to inhibit the emergence of diseases and insect pests and improve the yield of agricultural products (Koycegiz and Buyukyildiz 2019). Although modern agriculture in the comprehensive use of a variety of advanced technical means, based on chemical drugs, makes the pace of agricultural development faster and higher crop yield (Tomlinson et al. 1980). But in this case, chemical reagents will pollute the soil and the surrounding ecological environment, resulting in adverse effects, which are not conducive to the sustainable development of agriculture. With the continuous development of agriculture, China has also noticed the environmental pollution caused by agricultural development (Kurt et al. 2003). Therefore, China advocates that in the process of agricultural development, ecological means should be actively used to replace the traditional crop planting methods, so as to minimize the impact of crop planting on the environment, realize the harmonious development of the environment and agricultural economy, promote more scientific agricultural development, and realize the sustainable development of agricultural economy (Srinivasa et al. 2010).

Materials and methods

Overview of the study area

First, the position of the research area: a river basin is located in the middle of Liaoning Province, and it is located at 122°25′ E~124°53′ E, 40°28′N~41°44′ N. It has a total length of more than 400 km and has many tributaries. The river basin has a population of about 7 million, and the secondary industry in the region is developed. The surrounding cities are large industrial cities, which are combined with other industrial cities in the province, which constitute the industrial intensive areas in the central part and are the industrial core of Northeast China. At the same time, Benxi Shuidong, tomb murals, and hot springs in Han and Wei dynasties are rich in tourism resources, and tourism has been developing continuously (Yalcin et al. 2016).

Research data

The types and sources of data required for this study are shown in the following table (Table 1). All kinds of processed data are resampled by ArcGIS and used after unified resolution (30 m).

| Table 1 Data and source of a river basin |
|----------------------------------------|
| Type of data | Input data | Precision | Data sources |
|--------------|------------|-----------|--------------|
| Spatial data | Digital elevation model (DEM) | 30 m | Geospatial Data Cloud |
| Meteorological data | 1985~2020 precipitation | Day by day | China Meteorological Data left |
| Soil attribute data | Soil texture, etc. | | World Soil Database |

Research methods

Abnormal trajectory detection

Mobile terminal positioning is mainly the positioning of mobile phones, PCs, and other devices. At present, the positioning function of a device often combines a variety of positioning technologies, including GPS (global positioning system) positioning and A-GPS (assisted GPS).

A-GPS is a kind of positioning technology for mobile terminal equipment, that is, auxiliary GPS technology. As shown in Fig. 1, the device first determines the current approximate position through the base station and feeds the position information back to the A-GPS server. The server determines the best satellite positioning parameters according to the position information and feeds it back to the mobile terminal device so that the mobile terminal device can quickly search for the GPS satellite, so as to accurately determine the current position. With the development of science and technology, mobile terminal devices at this stage tend to locate by default in a variety of ways. In most cases, they can accurately obtain positioning information. In this paper, the positioning information obtained in different ways is collectively referred to as trajectory data.

Analysis method of soil loss rate

In order to better describe the change rate of land use types and reveal the degree of human development of land use, the following methods are used in this paper:

The dynamic degree of single land use type reflects the quantity change of specific land use type in a certain period; the calculation is as follows:

\[ K = \frac{(U_b-U_a)}{U_a} \times T^{-1} \times 100\% \]  

where \( T \) is the research period.
The dynamic degree of comprehensive land use type reflects the regional difference of land use change; the calculation is as follows:

\[
S = \frac{\sum_{i=1}^{n} \Delta S_{i-j}}{2 \sum_{i=1}^{n} S_i} \times T^{-1} \times 100\%
\]  

(2)

Soil erosion will cause ecological damage, which is a major threat to global environmental problems. The causes of soil erosion are complex. In this paper, the modified soil loss equation (RUSLE) was used to study the characteristics and influencing factors of soil erosion; the formula is as follows:

\[
A = R \cdot K \cdot LS \cdot C \cdot P
\]  

(3)

**Rainfall erodibility factor**

According to Zhang Wenbo’s rainfall erosion rate formula, the rainfall erosion coefficient (R) is calculated as follows:

\[
R_i = \alpha \sum_{i=1}^{k} (R_i)^\beta, \quad \alpha = 21.586 \beta^{-7.1891}, \quad \beta = 0.8363 + \frac{18.144}{R_d} + \frac{24.455}{R_y}
\]  

(4)

**Soil erodibility factors**

In this paper, the soil erodibility factor (k) of a river basin is calculated according to Williams’ epic equation in 1984; the calculation formula is as follows:

\[
K = f_{\text{csand}} + f_{\text{cl-si}} + f_{\text{orgc}} + f_{\text{hisand}}
\]

(5)

\[
f_{\text{csand}} = 0.2 + 0.3\exp[-0.0256S_a(1-S_i/100)]
\]

(6)

\[
f_{\text{cl-si}} = [S_i/(C_i + S_i)]^{0.3}
\]

(7)

\[
f_{\text{orgc}} = 1 - \frac{0.25 \times C}{C + e^{(3.72 - 2.95C)}}
\]

(8)

\[
f_{\text{hisand}} = 1 - 0.7S_n/[S_n + \exp(-5.51 + 22.9S_n)]
\]

(9)

**Results**

**Land use change**

The land use data in 1985, 1996, 2007, and 2020 are classified and processed. The results are shown in Fig. 2. The main types of land use in the investigated area are forest and cultivated lands, which are mainly distributed in the mountainous and hilly areas in the southeast of the basin. The cultivated land is mainly distributed in the northwest plain and near the river canyon below 200 m above sea level.

The change of land use area reflects the change of land use structure. According to the statistics of land use in a river basin from 1985 to 2020, the results are shown in Table 2 and Fig. 3. According to the area ratio, the six land uses are arranged as follows: woodland (56%) > cultivated land (30%) > construction land (about 7%) > water body (about 2%) > grassland (1%) > unused land (0.3%). Among them, the area of woodland decreased from 7822.98 km² in 1985 to 7655.83 km² in 2020, a decrease of 2.18%. The area of woodland decreased mainly in the southeast of the basin and around the towns; the construction land has increased 554.36 km² in 34 years, with the growth rate reaching 42.49%. The main reason is the increase of construction land in low altitude areas in Northwest China, with the expansion of urban construction in cities A, B,
and L as the main; the area of unused land decreased as a whole, with a decline rate of 10.31%. However, the area increased rapidly from 1996 to 2007, with a change rate of 29.61%; taking 1996 as the turning point, the cultivated land area first increased and then decreased. The initial area was 4299.21 km² in 1985 and increased by 20.32 km² in 1996. The cultivated land area began to decline in 2007 and decreased to 4106.58 km² in 2020. It can be seen that the total area of cultivated land decreased, and the grassland area showed a slight decline trend. The area decreased by 67.52 km² in 34 years. However, the area increased slightly in 2007; the change trend of the water body was opposite to that of cultivated land, which decreased from 1985 to 1996 and increased after 1996. In general, the change of land use area in a river basin from 1985 to 2020 shows the decrease of unused land and grassland areas and the increase of construction land area.

In this part, the land use status of a river basin during 1985–2020 is analyzed by using the superposition analysis function of ArcGIS, and the land use transfer matrix (Table 3) is made, and the conversion relationship of land use types in the basin is further studied. The paper analyzes the professional situation of land use types in 1985–1996, 1996–2007, and 2007–2020. It can be seen that the cultivated land and forest land changes in a river basin are active from 1985 to 2020, which is the main transfer-out type of land use in the research area; the total area of land use transfer in the three periods decreased, indicating that the land use of a river basin was gradually stable from 1985 to 2020.

After analyzing the land use change in the study area from 1985 to 2020, the results are shown in Table 4. The dynamic degree of comprehensive land use in the study area is 0.35%. The dynamic degree of comprehensive land use in

![Fig. 2 Land use types of a river basin in 1985, 1996, 2007 and 2020](image)

Table 2 Land use area and change rate of a river basin in 1985, 1996, 2007, and 2020

| Types          | 1985    | Change rate (%) | 1996    | Change rate (%) | 2007    | Change rate (%) | 2020    | Change rate (%) |
|----------------|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
|                | Area (km²) |                 | Area (km²) |                 | Area (km²) |                 | Area (km²) |                 |
| Woodland       | 7822.98  \   | -0.88           | 7755.07  \   | -29.50          | 7723.41  \   | -0.41           | 7655.83  \   | -0.88           |
| Water body     | 267.92   \   |                  | 206.89   \   | -27.92          | 144.56   \   | -11.66          | 115.79   \   | 12.94           |
| Unused land    | 40.14    \   |                  | 31.38    \   | -27.92          | 44.58    \   | 29.61           | 41.06.58  \   | -22.51          |
| Grassland      | 183.31   \   |                  | 112.56   \   | -62.86          | 100.81   \   | -11.66          | 115.79   \   | 12.94           |
| Arable land    | 4299.21  \   | 0.47            | 4319.53  \   |                  | 4283.44  \   | -0.84           | 4106.58  \   | -4.31           |
| Construction land | 750.24 \    | 27.25           | 1031.27  \    | 3.52            | 1068.91  \    | 18.07           | 1304.60  \    | 18.07           |
1985–1996 and 2007–2020 changes greatly, and the dynamic degree in 1996–2007 is the smallest, which indicates that the land use change of a river basin tends to be stable in 1996–2007, and the land use change in other periods is relatively fast.

### Landscape pattern change

In this part, 14 indicators of patch type level and landscape level were selected to analyze the overall characteristics, fragmentation degree, patch shape, landscape diversity, and

#### Table 3  Land use transfer matrix of a river basin from 1985 to 2020

|                | 1985          | 1996          | 1996          | 2007          | 2007          | 2020          | 2020          |
|----------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Woodland       | 6802.48       | 7014.33       | 7104.33       | 6976.50       | 6797.34       | 7655.82       | 13,456.55     |
| Water body     | 42.35         | 5.41          | 5.41          | 42.35         | 42.35         | 42.35         | 42.35         |
| Unused land    | 1.86          | 3.46          | 3.46          | 1.86          | 1.86          | 1.86          | 1.86          |
| Grassland      | 84.16         | 61.48         | 61.48         | 61.48         | 61.48         | 61.48         | 61.48         |
| Arable land    | 697.92        | 697.92        | 697.92        | 697.92        | 697.92        | 697.92        | 697.92        |
| Construction land | 65.71       | 8.98          | 8.98          | 65.71         | 8.98          | 8.98          | 8.98          |
| Transfer-in area | 891.96      | 128.74        | 128.74        | 891.96        | 128.74        | 128.74        | 128.74        |
| Total          | 7694.45       | 205.56        | 205.56        | 7694.45       | 205.56        | 205.56        | 205.56        |
| Woodland       | 7014.33       | 7104.33       | 7104.33       | 7014.33       | 7014.33       | 7014.33       | 7014.33       |
| Water body     | 5.41          | 5.41          | 5.41          | 5.41          | 5.41          | 5.41          | 5.41          |
| Unused land    | 3.46          | 3.46          | 3.46          | 3.46          | 3.46          | 3.46          | 3.46          |
| Grassland      | 61.48         | 61.48         | 61.48         | 61.48         | 61.48         | 61.48         | 61.48         |
| Arable land    | 697.92        | 697.92        | 697.92        | 697.92        | 697.92        | 697.92        | 697.92        |
| Construction land | 65.71       | 8.98          | 8.98          | 65.71         | 8.98          | 8.98          | 8.98          |
| Transfer-in area | 891.96      | 128.74        | 128.74        | 891.96        | 128.74        | 128.74        | 128.74        |
| Total          | 7694.45       | 205.56        | 205.56        | 7694.45       | 205.56        | 205.56        | 205.56        |

**Fig. 3** Area change proportion of land use types in a river basin from 1985 to 2020.
evenness of land use landscape patches in a river basin from 1985 to 2020.

Landscape patch area (CA), the ratio of patch type to landscape area, and the number of patches (NP) can reflect the overall situation of land use landscape and the degree of landscape fragmentation in a river basin (Table 5).

In 1985, there were 1066 patches, and the number of forest landscape patches accounted for 6.66%; however, the number of construction land patches accounted for 37.34%, and the degree of fragmentation was the largest; secondly, the degree of landscape fragmentation is more serious in cultivated land, 37% and 10.23% respectively, and the degree of fragmentation was also serious. The most serious landscape fragmentation was in cultivated land, with an area of 4319.53 km² and 412 patches; secondly, construction land is seriously fragmented; the degree of fragmentation of other land use types is relatively light. In 2007, there were 1076 patches. In this period, the landscape fragmentation of cultivated land was the most serious, followed by construction land, and the fragmentation of unused land and water body was less. In 2020, there will be 1077 patches, and the largest number of landscape patches is arable land. The number of patches and the degree of fragmentation of each landscape had no significant change compared with 2007.

### Table 4: Dynamic degree of land use in a river basin from 1985 to 2020

| Time     | Single land use dynamic degree (%) | Comprehensive land use dynamics (%) |
|----------|-----------------------------------|------------------------------------|
|          | Woodland | Water body | Unused land | Grassland | Arable land | Construction land |          |
| 1985–1996 | 0.07     | -2.06     | -1.99       | -3.52     | 0.05        | 3.42              | 0.16     |
| 1996–2007 | -0.05    | 1.26      | 3.83        | -0.96     | -0.09       | 0.32              | 0.06     |
| 2007–2020 | -0.09    | 0.06      | -1.66       | 1.36      | -0.39       | 2.01              | 0.16     |
| 1985–2020 | -0.18    | -1.05     | -0.84       | -3.34     | -0.42       | 6.73              | 0.36     |

### Table 5: Landscape characteristics of a river basin from 1985 to 2020

| Types | Years | CA (km²) | Area ratio (%) | NP (a) | Types | Years | CA (km²) | Area ratio (%) | NP (a) |
|-------|-------|----------|---------------|--------|-------|-------|----------|---------------|--------|
| Woodland | 1985 | 7822.99 | 58.55 | 71 | Grassland | 1985 | 183.30 | 1.36 | 109 |
|        | 1996 | 7755.08 | 57.64 | 73 |       | 1996 | 112.57 | 0.85 | 111 |
|        | 2007 | 7723.42 | 57.41 | 71 |       | 2007 | 100.80 | 0.76 | 106 |
|        | 2020 | 7655.84 | 56.88 | 69 |       | 2020 | 115.78 | 0.87 | 106 |
| Water body | 1985 | 267.91 | 2.01 | 78 | Arable land | 1985 | 4299.22 | 32.16 | 392 |
|        | 1996 | 206.87 | 1.55 | 77 |       | 1996 | 4319.54 | 32.11 | 412 |
|        | 2007 | 235.38 | 1.76 | 79 |       | 2007 | 4283.45 | 31.84 | 404 |
|        | 2020 | 237.26 | 1.77 | 78 |       | 2020 | 4106.59 | 30.53 | 405 |
| Unused land | 1985 | 40.15 | 0.31 | 18 | Construction land | 1985 | 750.25 | 5.60 | 398 |
|        | 1996 | 31.37 | 0.24 | 19 |       | 1996 | 1031.26 | 7.67 | 397 |
|        | 2007 | 44.57 | 0.34 | 19 |       | 2007 | 1068.90 | 7.95 | 397 |
|        | 2020 | 36.38 | 0.28 | 22 |       | 2020 | 1304.60 | 9.68 | 397 |

### Soil erosion characteristics

The average annual rainfall map of a river basin is obtained by inverse distance weight interpolation method (Fig. 4, top), and the rainfall situation of each administrative region of a river basin is analyzed by using the administrative division map of a river basin (Fig. 4, bottom). It can be seen from Fig. 4 (top) that the rainfall in a river basin is concentrated between 682.48 and 977.77 mm, with a large spatial difference. Generally, it decreases from southeast to northwest, and the maximum value is located in the southeast of area B and area A. Most of area A and northwest of area L have less rainfall, which is consistent with the trend of more rainfall in the east and less rainfall in the west and more rainfall in the south and less rainfall in the north; the seasonal and spatial differences of precipitation in a river basin are formed. It can be seen from Fig. 4 (bottom) that the administrative regions of a river basin are arranged as follows: F region > B region > L region > A region > S region according to the size of rainfall. It can be seen that the highest value of rainfall appears in the A region; the average rainfall of the administrative region is 862.99 mm; and the lowest value appears in the S region and A region, with an average rainfall of about 719 mm.
The distribution map of annual average rainfall erodibility of a river basin is obtained by inverse distance weight interpolation method (Fig. 5, top), and the rainfall erodibility of each administrative region of a river basin is analyzed by using the administrative division map of a river basin (Fig. 5, bottom). Figure 5 (top) shows that the range of rainfall erodibility factor in the study area is 2874.2–5447.06 (MJ mm)/(hm$^2\cdot$h); the spatial distribution of rainfall erodibility factor is consistent with that of rainfall; and the factor value in the southeast is greater than that in the northwest, indicating that there is a significant correlation between rainfall erodibility factor and rainfall. It can be seen from Fig. 5 (bottom) that the administrative regions are arranged according to rainfall erodibility factors, and the highest value appears in area A within the basin. The annual average rainfall erodibility factor is 4409.91 (MJ mm)/(hm$^2\cdot$h), and the annual average rainfall erodibility factor in area S is 3122.24 (MJ mm)/(hm$^2\cdot$h), which is the lowest in the basin.

It can be seen from Fig. 6 that the distribution of land use is closely related to soil types: the main soil type in the study area is eluvial soil, accounting for 55.15% of the basin area, and most of the forest land in the study area is distributed in this soil type; most of the thin black soil, calcareous black soil, and shallow black soil are cultivated land, which is mainly due to the high nutrient content of black soil, which is conducive to the growth of crops and affects the layout of cultivated land; the formation of artificial soil is closely related to human activities; calcareous soil is mainly distributed along the upper reaches of a river; the saturated soil is mainly distributed in the woodland area on the south bank of the middle and lower reaches of a river.

In this part, the soil erodibility factors in the watershed are calculated by using the epic equation of Williams. The soil erodibility of each administrative region of a river basin is analyzed by using the administrative division map of a river basin (Fig. 7). The erosion factors of shallow black soil and lime soil are larger, but the two areas account for 0.28% and 4.19% of the total area, respectively, with less area and less risk; the erodibility factor of common leaching soil and calcareous coarse bone soil is 0.39, and the proportion of the two areas is 55.15%. The erodibility factor of calcareous black soil, thin black soil, and shallow black soil is 0.94, and the proportion of the two areas is 44.85%.
Fig. 5  Distribution of annual average rainfall erodibility in the watershed (upper) and administrative region (lower)

Fig. 6  Soil types of a river basin
soil areas is 56.14%, and the distribution area is high, so these two types of soil should be the key control area of soil erosion; in addition, it should be noted that the soil types of soil erosion are thin layer black soil, saturated soil, and artificial soil, and the K value of the three types of soil is above 0.36; soil erosion does not occur in the water area, so the K value of this type is 0. In addition, the areas with a large K value in the basin are mainly B and F areas and forest land areas in the south and south of zone A in the L area. These areas should pay attention to soil conservation.

Slope and slope length factors will affect the underlying surface and soil erosion and then affect soil erosion. Slope affects the redistribution of rainfall, determines the speed of water flow, and affects the rate of soil loss; the influence of slope length on soil erosion is different under different conditions. In this part, based on the DEM data of a river basin, the slope length is extracted. Using the modified formula of Liu Baoyuan and Wischmeier, the L and S factors of the study area are calculated based on ArcGIS, and the LS factor value distribution map of a river basin is obtained (Fig. 8, left). The slope length factor of each administrative region of a river basin is analyzed by using the administrative map of the river basin (Fig. 8, right). The results show that the values of L and S factors are larger in the southeast of a river basin, followed by the western part of the L area, and the northwest part of A area; according to the factor values of L and S, the order of administrative regions is D > F > B > L > A > S. It can be seen that the factor values of F and B are relatively large, so it is necessary to pay attention to the occurrence of soil erosion and do a good job in the prevention and control of soil and water conservation.

Vegetation coverage has an important impact on soil erosion. In the area with high vegetation coverage, the C value is small, and soil erosion is weak. Based on the land use data of 1985, 1996, 2007, and 2020, combined with the research results of Huang Jinliang and others, through ArcGIS spatial analysis technology, forest land, grassland, and cultivated land are assigned values according to the vegetation coverage, and the C value map of the study area is determined (Fig. 9).

Based on the data of land use in 1985, 1996, 2007, and 2020, combined with the research of Huang Jinliang and others, and through ArcGIS spatial analysis technology, this part evaluates the value according to land use types: unused land and natural vegetation (such as woodland and grassland) are considered not to have taken soil and water conservation measures and determine the p value distribution map of the study area from 1985 to 2020 (Fig. 10).

**Driving mechanism of soil loss**

A river basin belongs to the water erosion area. In this part, the weighted rainfall of the study area is calculated according to the formula, and the weighted rainfall map of the study area is drawn by using the inverse distance weight interpolation method (Fig. 11). A river basin is located in the monsoon climate zone, with the weighted rainfall ranging from 2512.3 to 3075.33 mm. It can be seen from the figure that the areas with larger weighted rainfall are concentrated in the upper reaches of the basin, while the northern area has the smallest weighted rainfall. According to the previous analysis, the seasonal distribution of rainfall in the watershed is uneven, and the characteristics of rainfall provide a potential possibility for soil erosion in the watershed.

Soil is the main body of soil erosion, and different soil types have different abilities to resist soil erosion. In this study, the soil in a river basin is divided into five types: calcareous soil, black soil, paddy soil, brown soil, and others. The results are shown in Fig. 12. It can be seen that the main soil type is brown soil; black soil and paddy soil are distributed in the plain area and gentle valley terrain in the northwest of
the basin; lime soil is mainly distributed along the middle and upper reaches of the river and in the south of L area; the area of other soil types is less and mainly some water bodies and unused land (a river basin, see Fig. 13).

**Discussion**

**Advantages of agricultural tourism economic development**

First of all, ecological agriculture can promote the structural adjustment of agricultural industrialization. There are great differences in China’s geographical environment, which leads to great differences in China’s regional agricultural development. Therefore, in order to promote the development of the agricultural economy, each region should take its own advantages as the basis, reasonably adjust its industrial structure according to social needs, and use ecological agriculture to drive the development of the agricultural economy (Abanuz 2019). The performance is commercial integration of agriculture, increasing the added value of agricultural products. For example, in some areas with advantages of aquatic products and poultries or areas where fishery and poultry industries are more developed due to the thorough transformation of aquatic products and poultry, we should create attractive and unique brands to enhance their market competitiveness. For example, there are some effective agricultural models, such as planting models, river processing plants, picking agriculture, and flower production base. This shows that ecological agriculture has
great potential advantages and good development prospects in agricultural development (Asan and Erturk 2013). The development of ecological agriculture can significantly improve agricultural production efficiency and unit land productivity, thus increasing farmers’ income and promoting the pace of ecological civilization construction.

Secondly, ecological agriculture can promote the development of China’s agriculture. Ecological agriculture is eco-friendly agriculture, which combines advanced agricultural management concepts with advanced agricultural science and technology (Barkett and Akın 2018). In the process of carrying out ecological agriculture, it is required to select reasonable agricultural production activities according to the local actual conditions, making full use of regional advantageous resources and agricultural characteristics (Cardona et al. 2005). This is mainly due to the different situations of

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**Fig. 9** Vegetation cover and management factors in a river basin: 1985, 1996, 2007, and 2020

![Vegetation cover and management factors](image1)

**Fig. 10** Soil and water conservation factors in a river basin: 1985, 1996, 2007, and 2020

![Soil and water conservation factors](image2)
agricultural development, environmental conditions, and regional resources in different regions (Cengiz et al. 2017). Therefore, in the process of carrying out ecological agriculture, only according to the local situation and choosing a reasonable mode of agricultural production can we adjust measures to local conditions and promote agricultural development to obtain maximum benefits on the basis of protecting the environment. It can be seen that the development of ecological agriculture cannot only improve the efficiency of the agricultural economy, but also promote the sustainable development of China’s agriculture.

**Challenges of agricultural tourism economic development**

China’s rural tourism is still in the initial stage of development, and there are some problems in its resource utilization and tourism activities. (1) Farmers have a low understanding of the wisdom of agricultural tourism and lack of understanding, which leads to the flooding of homogeneity and a large number of similar products. According to the results of the questionnaire, many farmers think that smart agricultural tourism is only agricultural sightseeing tourism or local characteristic tourism. They have a low understanding of the development of the Internet of Things of smart agricultural tourism, which greatly limits the development trend of smart agricultural tourism and reduces the richness of the development mode of smart agricultural tourism. As a result, many regions adopt the development mode of agricultural sightseeing gardens and picking gardens. Agricultural tourism products are single, and souvenir types are similar. Operators generally pursue short, flat, and fast and only rely on existing resources for simple packaging to develop low-end tourism (Dzhamalov et al. 2012), and at the same time, the pressure of
Homogeneous competition, high construction cost, and low rate of return limit and the diversity and breadth of smart agricultural tourism. (2) Rural infrastructure is backward, the service level is low, and the tourism development level is low. Most of the rural infrastructure services are relatively backward, road accessibility is low, and parking and other infrastructure are not perfect and at the same time, poor health conditions, catering, and accommodation effects and limitations; most of them cannot provide catering and accommodation services, most of them are operators to provide services in family units, and the quality of service personnel is uneven. (3) Strong commercial color, shallow local flavor, and single personality. Vernacular is an important selling point of rural tourism, but most of the operators are spontaneous operations, with a strong commercial atmosphere, low attention to local culture, excessive commercial packaging, and pursuit of online red scenic spots packaging, losing the unique charm of folk culture, leading to counterproductivity. (4) There is a lack of high-quality management personnel in rural areas, and farmers lack systematic education and management. Compared with traditional agriculture, smart agriculture tourism has higher requirements for the overall quality and literacy of farmers and needs more professional knowledge reserve and higher management ability (Eisler 2004). By 2020, there are more than 7 million returning entrepreneurs in China, and the overall quality of rural agricultural service personnel is on the rise. Driven by “innovation and entrepreneurship,” rural industrial integration has developed rapidly, but its development strength and extent have not greatly improved the overall education quality of farmers. Most farmers do not attach great importance to science, technology, and culture, and people’s traditional ideas are still “relying on natural harvest” and “relying on brute force” in agricultural development. China pays attention to reform and innovation, green development, talent work, and talent priority and has issued a lot of relevant incentive policies (Eren et al. 2004). However, due to the influence of traditional ideas, most college students are not willing to engage in the research of agricultural management development, and there is still a shortage of agricultural management talents.

Development countermeasures of the agricultural tourism economy

First of all, we should improve the development of human resources and establish a vocational education system for farmers. (1) In order to develop wisdom agriculture, we should train, introduce, and use reform-oriented talents and strive to put high-quality agricultural production and management talents into use faster. (2) We should carry out new vocational education for farmers. Relying on local government resources to establish professional farmers training college system and improve their comprehensive ability of production and management and cultural quality in order to better meet the needs of the development of modern agricultural production.

Secondly, strengthen the research and development of scientific research system and vigorously promote agricultural science and technology (Gao et al. 2011). In recent years, “sharing + economy” has become a hot spot, and agricultural extension can also take advantage of this opportunity. For example, due to the strong regional distribution of agriculture in China, the fragmentation of agricultural land in rural areas is inevitable, which also leads to serious waste if each scattered farmer purchases a large agricultural machinery. The use of shared agricultural machinery can solve this problem to a large extent (Horasan 2020). A rural cooperative purchase of agricultural machinery and the arrangement and coordination of farmers cannot only solve the technical
problems of agricultural cultivation, but also reduce the cost pressure of maintaining agricultural machinery.

Next, establish the latest infrastructure and improve it. In 2019, the CPC Central Committee and the State Council put forward opinions on establishing and improving the institutional mechanism and policy system for the development of urban–rural integration, comprehensively promoting and adjusting the overall strategic layout. Therefore, adhering to the new concept of development has strengthened the determination to improve the quality of agriculture. In order to narrow the gap between urban and rural development and residents’ life and to comprehensively promote the rural regeneration strategy and the new urbanization strategy as the starting point, we should improve the backward agriculture and rural infrastructure, solve the problem of property rights, and speed up the construction of property rights system. We will strive to improve the distribution of market-oriented factors, eliminate the shortcomings of institutional mechanisms as soon as possible, and promote the flow of urban and local resources (Horasan and Arıkk 2019). At the same time, we should speed up the formation of a new type of modern industrial peasant relationship that complements urban and rural areas and promotes mutual promotion, comprehensive integration, and common prosperity.

Finally, we should grasp the way out for small individual farmers. According to the data of agricultural census report, there are more than 200 million small farmers in China (Kadir and Karakas 2000). Nowadays, the construction and development of rural collective economic organizations in China are still advancing slowly. Small farmers lack organization guarantee and professional and technical personnel guidance, which makes small farmers in trouble. Therefore, (1) to further standardize agricultural production services, so that small farmers organized development, (2) we should speed up the improvement of the level of agricultural modernization and strive to innovate various ways of joint cooperation; (3) efforts should be made to improve the degree of small farmers’ organization and strengthen the construction of agricultural security system; and (4) we should strengthen the ability of small farmers to resist risks and establish a platform for the transfer of land management rights.

Conclusion

Taking a river basin as the research object, this study collected DEM data, precipitation data, land use data, and soil data; analyzed the change characteristics of land use and landscape patterns according to ArcGIS and FRAGSTATS, quantitatively analyzed the erosion factors in the investigated area using RUSLE model and ArcGIS; estimated the soil erosion modulus; and classified the erosion intensity. The spatial and temporal characteristics of soil erosion in a river basin during 34 years were analyzed; with the support of ArcGIS and SPSS, the driving mechanism of soil erosion was analyzed from five aspects of meteorology, soil texture, terrain slope, land use, and landscape pattern, and the influence of different soil erosion factors on soil erosion was further determined. At the same time, considering that the development of agricultural modernization is more and more dependent on informatization, the “Internet” is an important symbol to measure the degree of modernization. In the process of China’s agricultural development, the role of smart agricultural tourism is self-evident. Based on this, this paper analyzes the current situation of rural economic development in a town under the background of the integration of smart agriculture and tourism and puts forward some countermeasures for the development of smart agriculture and tourism.

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Declarations

Conflict of interest The authors declare that they have no competing interests.

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