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Assessing the Ecological Carrying Capacity of Countries along the Belt and Road

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Abstract: The Belt and Road Initiative (B&R Initiative) is a crucial strategy to promote regional sustainable development in the new era. However, the realization of the B&R Initiative faces huge challenges because of the dual characteristics of a fragile eco-environment and strong dependence on ecological resources for economic development in the Belt and Road (B&R) countries. The ecological carrying capacity (*ECC*) is a crucial indicator for evaluating regional sustainable development. From the perspective of the relationship between the supply and consumption of ecological resources, this study uses net primary productivity data to measure the supply capacity of ecological resources, and it uses the agricultural production and trade data provided by the United Nations Food and Agriculture Organization to measure the level of ecological resource consumption. These supply and consumption data are then used to assess the *ECC* and ecological carrying status (*ECS*) of the B&R countries in 2017. The results show that: (1) The *ECC* of the B&R is 11.097 billion people; the ecosystem can also support 6.433 billion people, and the *ECC* is in a state of rich and surplus. (2) The *ECS* is polarized among the regions and countries along the B&R. Of the 65 countries, the *ECC* of 40 countries is in a rich and surplus state, mainly in Mid-East Europe and Southeast Asia, while the *ECC* of 19 countries is in severe overload, mainly in West Asia/Middle East. (3) Although the ecosystems still have ample carrying space in countries along the B&R, ecological protection is still facing enormous challenges during the implementation of the B&R Initiative combined with the internationally recognized ecological protection standards as well as the forecasts of the population and economic development. As the core content of building a new international trade network, the B&R Initiative will help to solve the spatial mismatch between the supply and consumption of ecological resources, which provides a new opportunity to coordinate the contradiction between the ecological protection and social demands of the B&R countries.

Key words: ecological carrying capacity; ecological carrying status; supply-consumption relationship; Net Primary Production (*NPP*); the Belt and Road (B&R)

1 Introduction

In 2015, China published *Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road*, in which the Belt and Road Initiative (B&R Initiative) was proposed. The B&R Initiative is a crucial strategy for China to promote multi-field cooperation among countries in the new era, with the aim of promoting the realization of the Sustainable Development Goals (SDGs) (Chin and He, 2016; Guterres, 2017; Zhang et al., 2017). The Belt and Road (B&R) countries are generally located in a sensitive zone of global climate change and a fragile eco-environment, and their ecosystems are easily destroyed and difficult to restore (Liu et al., 2018; Wu et al., 2019). Meanwhile, the B&R countries are mostly develop-

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ing countries. Some countries mainly rely on agriculture and primary processing industries to develop their economy and maintain the residents' livelihoods, which are highly dependent on ecological resources (Chen et al., 2018; Guo, 2018). Therefore, there are some concerns that the B&R Initiative might increase the threats to ecosystem sustainability when promoting socio-economic development in the B&R countries (Ascensao et al., 2018).

Ecological carrying capacity (ECC) takes the complex system of nature-economy-society as the research object, which is raised in discussing the coupling relationship between the ecosystem and the social system (Feng et al., 2017; Du et al., 2018). The ecosystem is the foundation for human survival and development, and the dynamic relationship between ecological resource supply and human consumption is the basic man-land relationship. Human beings consume the critical elements of the ecosystem to meet their demands. When the speed of consumption exceeds the speed of regeneration, the natural capital would gradually decrease and the safety and sustainability of regional ecosystems would be threatened (Rosamond et al., 2005; Yu et al., 2017). With the continuous development of sustainable development theory, scientists have cautioned that maintaining the integrity of the ecosystem and controlling human activities within the ECC are the primary conditions for achieving sustainable development (Scoones, 1993). Therefore, studying the ECC to clarify the carrying threshold of the local ecosystems is an essential task in promoting the sustainable development of the B&R countries.

Net Primary Productivity (NPP), the amount of biomass energy that vegetation converts from solar energy through photosynthesis in terrestrial ecosystems, is considered an essential indicator for measuring the ecosystem structure characteristics and carrying capacity (Zhao et al., 2018). In 1997, Haberl first clearly put forward the concept of Human Appropriation of Net Primary Production (HANPP) (Haberl, 1997). The HANPP evaluation method uses NPP to measure the supply capacity of the ecosystem on the supply side and calculates the NPP consumption to measure the consumption and occupation by human activities on the consumption side. Therefore, the HANPP evaluation method reveals the supply-consumption relationship between human activity, social-economic development, and ecological resource endowment. With the development of HANPP, it has gradually become a key method for evaluating the ECC based on the supply-demand relationship of ecosystem services (Haberl et al., 2007; Yan et al., 2012).

This study takes the 65 countries involved in the initial phase of the B&R Initiative as the research object. The ECC of these B&R countries in 2017 is studied based on the supply-consumption relationship of ecological resources. The NPP is used to calculate the supply capacity of ecological resources by the ecosystem, and converting the production and trade volume of agricultural products to NPP represents the consumption level of ecological resources by the social system. The ECC and ECS of the B&R countries are then evaluated based on the supply capacity and the level of ecological resources consumed. This study hopes to provide the foundation and basis for ecological protection during the implementation of the B&R Initiative.

2 Methods

2.1 Study area

The B&R countries in this study include 65 countries (see Fig. 1), mainly located in the Eurasian continent and occupying nearly 50 million square kilometers. In 2017, the population of the B&R countries was approximately 4.665 billion people, accounting for 62% of the global population. The B&R countries were mainly developing countries, with

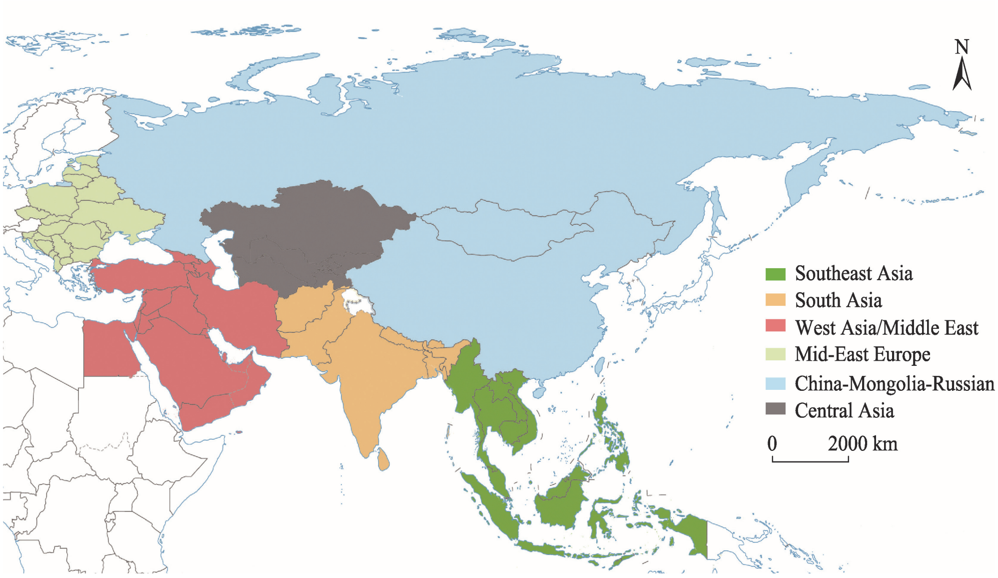

Fig. 1 The B&R countries and their zoning standards

2.2 Data sources

The data used in this study included six factors related to either resource endowment or utilization, as shown in Table 1.

2.3 Methods

2.3.1 Estimation of ecological resource supply (*SNPP*)

(1) Based on Gross Primary Production (*GPP*), *NPP* was calculated using the autotrophic respiratory ratio (Albrizio and Steduto, 2003).

$$NPP=GPP\times(1-Ra) \quad (1)$$

where, *NPP* represents the Net Primary Productivity (unit: gC m^{-2}), *GPP* represents the Gross Primary Productivity (unit: gC m^{-2}), and *Ra* represents the autotrophic respiratory ratio.

(2) Based on LUCC data, the above-ground biomass proportion coefficient (α) was calculated using the ratio of above-ground and underground biomass of different vegetation types (Jackson et al., 1996; Mokany et al., 2006).

Table 1 The types and sources of data used in this study

Name	Resolution	Time-period	Source
Land use/cover change	300 m	2000–2017	European Space Agency, CCI-LC
Gross Primary Production	500 m	2000–2017	Vegetation Photosynthesis Model (Zhang et al., 2017)
Agriculture, forestry and animal husbandry production	Country	2017	Faostat Database
Agricultural, forestry and animal husbandry product trade	Country	2017	Faostat Database
Population	Country	2017	Word Bank Data
Land area	Country	2017	Word Bank Data

(3) The above-ground *NPP* was calculated by multiplying *NPP* and α, and then the total ecological supply was obtained through spatial statistics. To eliminate annual fluctuations in the ecological supply caused by natural factors (Imhoff and Bounoua, 2006), the multi-year average of total ecological supply was taken as the total ecological supply (*SNPP*) in this study:

$$SNPP=\frac{\gamma^2\sum_{i=1}^{n}\alpha_i\times NPP_i}{n} \quad (2)$$

where, *SNPP* represents the total ecological supply (unit: gC), γ represents the spatial resolution (500 m), α represents the above-ground biomass proportion coefficient, *NPP* represents the Net Primary Productivity (unit: gC m^{-2}), and *i* represents the year.

2.3.2 Estimation of ecological resource consumption (*CNPP*)

(1) The amount of ecological resources ultimately consumed by the regional social system is the sum of the amounts of ecological resources consumed by agricultural, forestry, and animal husbandry production activities and the net amount of ecological resources in trade.

$$CNPP = CNPP_P + CNPP_I - CNPP_E \quad (3)$$

where, *CNPP* represents the consumption of ecological resources (unit: gC), and $CNPP_P$, $CNPP_I$ and $CNPP_E$ represent the consumption of ecological resources in production activities, import trade and export trade, respectively.

(2) Production consumption ($CNPP_P$) refers to the amount of ecological resources consumed in agricultural, forestry and animal husbandry activities.

$$CNPP_P = CNPP_{PA} + CNPP_{PF} + CNPP_{PS} \quad (4)$$

$$CNPP_{PA}=YIE\times(1-Mc)\times(1+HF)\times Fc \quad (5)$$

$$CNPP_{PF}=\frac{TIM\times T\times\rho\times Fc\times 10^6}{Ur\times(1-Ba)} \quad (6)$$

$$CNPP_{PS}=\left(LIV\times GW\times GD\times Fc\times 1000\right) \quad (7)$$

where, $CNPP_{PA}$, $CNPP_{PF}$, and $CNPP_{PS}$ represent the consumption of ecological resources in agriculture, forestry and animal husbandry, respectively (unit: gC). In Equation (5), *YIE* represents the crop produced yield (unit: g), *Mc* represents the moisture content (Lobell et al., 2002; Zhou et al., 2018), and *HF* represents the harvest index (Haberl et al., 2007; Peters et al., 2014). In Equation (6), *TIM* represents timber harvesting (unit: m^3), ρ represents the wood density (unit: t m^{-3}) (Winjum et al., 1998), *T* represents the conversion coefficients to Roundwood (Picos et al., 2010), *Ur* represents the effective utilization rate of forest resources, and *Ba* represents bark coefficient (Haberl et al., 2007). In Equation (7), *LIV* represents the stockpiled livestock quantity or column livestock quantity[①] (unit: Head), *GW* represents the hay eaten by livestock every day (unit: kg DM $head^{-1}$ day^{-1}) (Haberl et al., 2007; Herrero et al., 2013), and *GD* represents the number of feeding days per year (unit: day $head^{-1}$) (Haberl et al., 2007; Herrero et al., 2013). *Fc* represents the conversion coefficient between biomass and carbon content based on an international standard of 0.45 gC g^{-1} for agriculture and animal husbandry, and an international standard of 0.50 gC g^{-1} for forestry (Dixon et al., 1994; Fan et al., 2008).

① Due to the lack of data in the column for livestock quantity, the column livestock quantity is calculated based on slaughter livestock quantity, import livestock quantity and export livestock quantity as: final value=slaughter+export-import.

(3) Trade consumption ($CNPP_I$, $CNPP_E$) refers to the flow of ecological resources in agricultural, forestry and animal husbandry products driven by trade, including four parts: agricultural product trade consumption, livestock product trade consumption, live animal trade consumption, and forest product trade consumption.

$$CNPP_I = CNPP_{IA} + CNPP_{IF} + CNPP_{IS} + CNPP_{IL} \quad (8)$$

$$CNPP_E = CNPP_{EA} + CNPP_{EF} + CNPP_{ES} + CNPP_{EL} \quad (9)$$

where, $CNPP_{IA}$, $CNPP_{IF}$, $CNPP_{IS}$ and $CNPP_{IL}$ represent the ecological resource consumption by agricultural products, live animals, livestock products and forest products in import trade, respectively (unit: gC). $CNPP_{EA}$, $CNPP_{EF}$, $CNPP_{ES}$ and $CNPP_{EL}$ represent the ecological resource consumption by agricultural products, live animals, livestock products and forest products in export trade, respectively (unit: gC).

$$CNPP_{IA} = \frac{YIE_I \times 1 - Mc \times (1 + HF) \times Fc}{1 - WAS}$$

$$CNPP_{EA} = \frac{YIE_E \times 1 - Mc \times (1 + HF) \times Fc}{1 - WAS} \quad (10)$$

$$CNPP_{IF} = \frac{TIM_I \times T \times \rho \times Fc \times 10^6}{Ur \times (1 - Ba) \times (1 - WAS)}$$

$$CNPP_{EF} = \frac{TIM_E \times T \times \rho \times Fc \times 10^6}{Ur \times (1 - Ba) \times (1 - WAS)} \quad (11)$$

$$CNPP_{IS} = LIV_I \times GW \times GD \times Fc \times 1000$$

$$CNPP_{ES} = LIV_E \times GW \times GD \times Fc \times 1000 \quad (12)$$

$$CNPP_{IL} = \frac{MEM_I \times FCR \times Fc}{1 - WAS}$$

$$CNPP_{EL} = \frac{MEM_E \times FCR \times Fc}{1 - WAS} \quad (13)$$

where, YIE_I and YIE_E represent the amounts of imported agricultural products and exported agricultural products, respectively (unit: g), and *WAS* represents the loss rates of agricultural products in processing, packaging, and transportation (Gustavsson et al., 2011). In Eq. (11), TIM_I and TIM_E represent the amounts of imported forest product and exported forest product, respectively (unit: m^3), *WAS* represents the loss rate of forest product in production (Rosillo-Calle et al., 2015). In Eq. (12), LIV_I and LIV_E represent the amounts of imported live animals and exported live animals, respectively (unit: Head). In Eq. (13), MEM_I and MEM_E represent the amounts of imported livestock product and exported livestock product, respectively (unit: g), *FCR* is the feed conversion ratio (unit: g DM g^{-1}) (Imhoff et al., 2004; Quan et al., 2018; Zhou et al., 2018; Clark et al., 2019), *WAS* represents the loss rates of livestock products in processing, packaging, and transportation (Gustavsson et al., 2011), and *Fc* represents the conversion coefficient between biomass and carbon content based on an international standard of 0.45 gC g^{-1} for livestock products (Fan et al., 2008).

2.3.3 Estimation of the consumption level of ecological resources (*CNPP-LEV*)

$$CNPP\text{-}LEV = \frac{CNPP}{POP} \quad (14)$$

where, *CNPP-LEV* represents the consumption level of ecological resources (unit: gC capita^{-1}), *CNPP* represents the consumption of ecological resources (unit: gC), and *POP* represents the permanent population (unit: capita).

2.3.4 Estimation of ecological carrying capacity (*ECC*) and ecological carrying index (*ECI*)

The estimation of ecological carrying capacity is divided into two aspects: the total population that can be carried by the regional ecosystem and the population that can be carried by regional unit area.

$$ECC = \frac{SNPP}{CNPP\text{-}LEV} \quad (15)$$

$$ECC\text{-}UA = \frac{ECC}{Area} \quad (16)$$

where, *ECC* represents the ecological carrying capacity (unit: capita), *ECC-UA* represents ecological carrying capacity per unit area (unit: capita km^{-2}), *SNPP* represents the total ecological supply (unit: gC), *CNPP-LEV* represents the consumption level of ecological resources (unit: gC capita^{-1}), and *Area* represents the land area (unit: km^2).

$$ECI = \frac{POP}{ECC} \quad (17)$$

where, *ECI* represents the ecological carrying index, *ECC* represents the ecological carrying capacity (unit: capita), and *POP* represents the permanent population (unit: capita).

2.3.5 The classification of ecological carrying status (*ECS*)

In order to qualitatively evaluate the relationship between *ECC* and population in the region, the ecological carrying index is divided into six intervals corresponding to six levels of ecological carrying status (Table 2), referring to the classification scheme adopted in Chinese land carrying capacity research (Feng et al., 2008).

Table 2 Classification standard table for ecological carrying status

Ecological Carrying Index (*ECI*)	<0.6	0.6–0.8	0.8–1.0	1.0–1.2	1.2–1.4	>1.4
Ecological Carrying Status (*ECS*)	Rich and surplus	Surplus	Balance	Critical overload	Overload	Severe overload

3 Results

3.1 Ecological carrying capacity (*ECC*)

In 2017, the *ECC* of the B&R was 11.097 billion people, and the permanent population was about 4.664 billion. Thus, the ecosystem could still support 6.433 billion additional people by comparing the *ECC* and the permanent population (Table 3). In terms of subregions, the *ECC* of the six subregions of the B&R showed polarization. The *ECC* had exceeded 2.00 billion people in three of the regions: China-Mongolia-Russia, Southeast Asia and South Asia. The total *ECC* of the above three regions is 9.652 billion people, accounting for 86.97% of the *ECC* of the B&R countries. However, the *ECC* had not exceeded 1 billion people in the other three regions: West Asia/Middle East, Mid-East Europe and Central Asia, accounting for less than 10% of the *ECC* of the B&R countries (Table 3).

Affected by the country area and land productivity, the *ECC* among the B&R countries was considerably variable. For example, the *ECC* of Russia was 2.581 billion people (maximum), while the *ECC* of Bahrain was 2200 people in 2017 (minimum). The countries with an *ECC* of between 5 million and 100 million people accounted for more than 60% of the B&R countries. The *ECC* of Russia, China, India and Indonesia exceeded 1 billion people. The total land area of Russia and China accounts for more than 50% of the B&R area, which is the main reason for their high *ECC*. India and Indonesia have high land production capacity because they are located in tropical regions and are dominated by farmland and forests; meanwhile, the consumption levels of ecological resources are low in India and Indonesia. Therefore, the *ECC* of India and Indonesia exceed 1 billion people, below only Russia and China. There were seven countries with an *ECC* of less than 1 million people. Among them, five countries are located in the West Asia/Middle East region with a desert/semi-desert ecosystem, and the low land production capacity is the primary cause for the low *ECC*. The lack of land area is the primary cause for the low *ECC* of Singapore and Maldives (Fig. 2).

3.2 The ecological carrying capacity per unit area (*ECC-UA*)

In 2017, the *ECC-UA* of the B&R was approximately 222.43 capita km^{-2} (Table 3). In terms of subregions, the *ECC-UA* values of the six subregions of the B&R were considerably different. The *ECC-UA* of West Asia/Middle East with desert/semi-desert conditions and Central Asia dominated by desert steppe were 41.20 capita km^{-2} and 48.64 capita km^{-2}, or less than one-fourth of the average level of the B&R. Southeast Asia, dominated by tropical rainforest and subtropical monsoon forest ecosystems, had the highest *ECC-UA* among the six subregions (approximately 720.86 capita km^{-2}), which was more than three times the average level of the B&R (Table 3).

Table 3 The *ECC* and *ECC-UA* of the B&R regions and their subregions in 2017

Regions	*ECC* (×10^8 capita)	Population (×10^8 person)*	The proportion of *ECC* (%)	*ECC-UA* (capita km^{-2})
Southeast Asia	31.29	6.48	28.20	720.86
South Asia	21.16	17.93	19.07	443.55
West Asia/Middle East	3.60	4.42	3.25	48.64
Mid-East Europe	9.23	1.76	8.32	434.54
China-Mongolia-Russian	44.06	15.34	39.71	161.29
Central Asia	1.62	0.71	1.46	41.20
Total	110.97	46.65	100.00	222.43

Note: * The data comes from the World Bank, 2017.

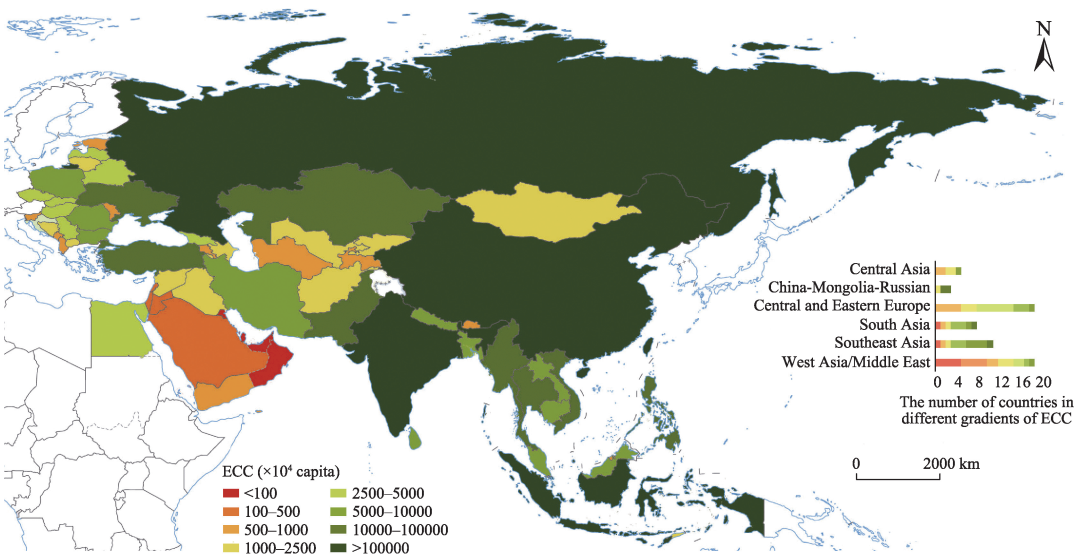

Fig. 2 The spatial distribution of the *ECC* of the B&R countries in 2017

On the national scale, the *ECC-UA* of countries along the B&R varied between 0.93 and 1295.98 person km^{-2}, and the gap of the *ECC-UA* between countries was more than 1000-fold. Among the B&R countries with high values, the *ECC-UA* of Philippines, Thailand, Timor-Leste and Brunei were more than 1000 capita km^{-2}, and all of them are located in Southeast Asia; and the 14 countries with the *ECC-UA* more than 500 capita km^{-2} were located in Mid-East Europe, South Asia and Southeast Asia. Among the B&R countries with low values, the *ECC-UA* of Qatar, UAE, Oman, Saudi Arabia, Kuwait, Bahrain, and Mongolia were less than 10 capita km^{-2}, and all are located in West Asia/Middle East except for Mongolia; and the 21 countries with the *ECC-UA* less than 100 capita km^{-2} were mainly located in West Asia/Middle East (Fig. 3).

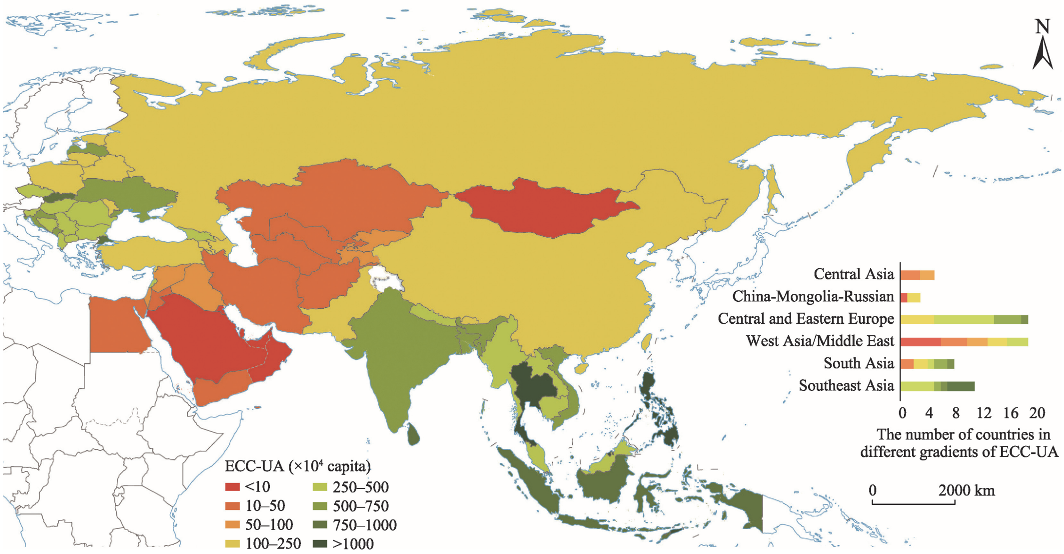

Fig. 3 The spatial distribution of the *ECC-UA* of the B&R countries in 2017

3.3 Ecological carrying status (*ECS*)

In 2017, the *ECI* of the B&R was 0.42 and the *ECC* had the status of rich and surplus combined with the *ECI* grading standard. In terms of subregions, the *ECI* values of Mid-East Europe, Southeast Asia, China-Mongolia-Russia and Central Asia were 0.19, 0.21, 0.35 and 0.44 (each less than 0.60), and the *ECC* had the status of rich and surplus in the above four regions. The *ECI* was 0.84 and the *ECC* was in balance in South Asia; while the *ECI* was 1.23 and the *ECC* was in overload in West Asia/Middle East (Table 4).

Table 4 The *ECI* and *ECS* of B&R regions and their subregions in 2017

Regions	*ECI*	*ECS*
Southeast Asia	0.21	Rich and surplus
South Asia	0.85	Balance
West Asia/Middle East	1.23	Overload
Mid-East Europe	0.19	Rich and surplus
China-Mongolia-Russia	0.35	Rich and surplus
Central Asia	0.44	Rich and surplus
Total	0.42	Rich and surplus

At the country scale, the *ECS* of the B&R countries showed polarization. The *ECC* of 40 countries was in a rich and surplus state, mainly in the Mid-East Europe and Southeast Asia subregions, including all countries of Mid-East Europe. However, the *ECC* of 19 countries was in severe overload, mainly in West Asia/Middle East. Only six countries were in a state other than these two: the *ECC* of Tajikistan, Syria, and Iran was in critical overload, the *ECC* of Turkmenistan was in balance, the *ECC* of China and India was in a surplus state (Fig. 4).

4 Discussion

In this study, the results show that the ecosystems of the B&R could still support 6.433 billion additional people in 2017, which is the maximum number of people that the ecosystems can still support. In the ecological footprint study, at least 12% of productive land should be reserved for biodiversity conservation (Feng, 2004). Moreover, it would have a negative impact on biodiversity when the *HANPP* exceeds 50% based on the species energy hypothesis (Haberl et al., 2004).

According to *Half of Earth*, there are international calls to achieve 50% marine and land protection by 2050 (Baillie and Zhang 2018; Pimm et al., 2018). If this study sets a 50% threshold for the supply of ecological resources, the *ECC* of the B&R is about 5.543 billion people, and the ecosystem can still support only 0.879 billion people. Relevant prediction research shows that by 2060, the population will increase by anywhere from 330 million to 1.83 billion, and GDP will increase by 3.0- fold to 6.4-fold in the B&R countries compared to 2016 (Jiang et al., 2018). The economic growth of the B&R dominated by developing countries will drive an increase in the consumption level, making it a hot spot for ecological resource demand growth. Therefore, coordinating the relationship between ecological protection and economic development in implementing the B&R Initiative is still facing enormous challenges.

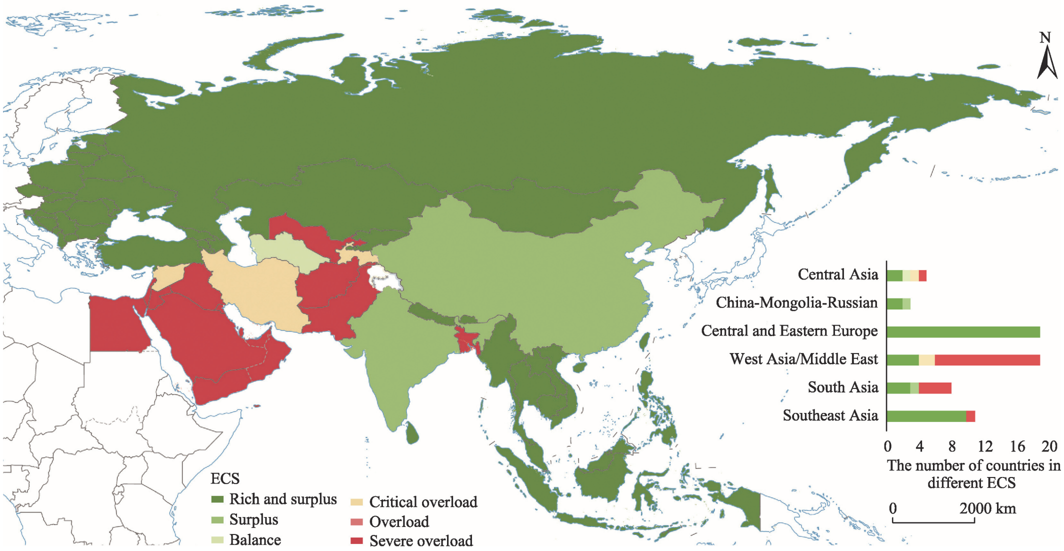

Fig. 4 The spatial distribution of the *ECS* of the B&R countries in 2017

In this study, the results show the *ECC* of 19 countries is in severe overload. However, there are no studies showing that the ecosystems of the above-mentioned countries have systematically collapsed thus far. Furthermore, the Maldives has become a global tourist attraction with its good eco-environment, and Singapore is a Garden City. According to Singapore statistical information, the ecological resources demanded by the residents lives are mainly obtained through the import trade of agricultural products (Singapore Food Agency, 2020), which enables the country to meet the high standards of the residents' living demands without sacrificing the local eco-environment. The geographical space between production and consumption of ecological resources is increasingly separated by international trade (Wiedmann and Lenzen, 2018), which provides an opportunity for countries that lack ecological resources to coordinate the contradictory relationship between ecological protection and social demands. Building a new international trade network is the core content of the B&R Initiative (Liu et al., 2017), which can balance this two-level differentiation of the ecological carrying status of the B&R countries through trade. The countries with ecological overload can achieve ecologically sustainable development by importing ecological resources from the counties with ecological surplus; meanwhile, the counties with ecological surplus can improve social and economic sustainability by transforming their resource advantages into economic advantages.

5 Conclusions

From the perspective of the supply-consumption of ecological resources, this research evaluated the ecological carrying capacity (*ECC*) and ecological carrying status (*ECS*) of the B&R countries and subregions. The results showed three main features of the B&R.

(1) The *ECC* and *ECC-UA* of the B&R regions were 11.097 billion people and 222.43 capita km^{-2} in 2017. The ecosystem could still support 6.433 billion additional people by comparing the *ECC* and the permanent population, and was in in a state of rich and surplus.

(2) The *ECC* of the six subregions of the B&R showed polarization. The *ECC* had exceeded 2.00 billion people in China-Mongolia-Russia, Southeast Asia and South Asia, but had not exceeded 1 billion people in Central Asia, West Asia/Middle East or Mid-East Europe. The *ECC-UA* of the six subregions of the B&R were considerably different. The *ECC-UA* of West Asia/Middle East and Central Asia was less than 40 capita km^{-2}, but the *ECC-UA* was approximately 720.86 capita km^{-2}. The *ECC* was in a state of rich and surplus in Mid-East Europe, Southeast Asia, China-Mongolia-Russia and Central Asia; balanced in South Asia; and overloaded in West Asia/Middle East.

(3) The *ECC* and *ECC-UA* of the B&R countries varied considerably. The *ECC* of Russia and China with large land areas, and India and Indonesia with high land productivity were each more than 1 billion people, while the countries with *ECC* of less than 1 million people were mainly located in West Asia and tend to lack land resources and have low productivity. The countries with the *ECC-UA* of more than 500 capita km^{-2} were mainly located in Mid-East Europe, South Asia and Southeast Asia, but the countries with the *ECC-UA* of less than 100 capita km^{-2} were mainly located in West Asia/Middle East and Central Asia. The *ECS* of the

B&R countries also showed polarization. The *ECC* of 40 countries was in a state of rich and surplus, mainly in Mid-East Europe and Southeast Asia; while the *ECC* of 19 countries was in severe overload, mainly in West Asia/Middle East.

Although the ecosystems still have ample carrying space in the countries along the B&R, ecological protection is still facing enormous challenges during the implementation of the B&R Initiative, combined with the internationally recognized ecological protection standards and the forecasts of future population and economic development. The B&R Initiative, as the core content of building a new international trade network, will help in solving the spatial mismatch between the supply and consumption of ecological resources, which provides a new opportunity to coordinate the contradiction between the ecological protection and social demands of the B&R countries.

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“一带一路”沿线国家生态承载力评估

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摘　要：“一带一路”倡议是中国在新时期推动区域可持续发展的关键倡议。由于“一带一路”沿线国家具有生态环境脆弱与经济发展对生态资源依赖性强的双重特征，“一带一路”倡议目标的实现面临着巨大的挑战。生态承载力作为区域可持续发展能力评价的重要指标，本研究从生态资源供给与消耗关系角度出发，通过植被净初级生产力数据测算生态资源供给能力，利用联合国粮农组织提供的农业生产与贸易数据测算生态资源消耗水平，进而开展 2017 年“一带一路”沿线国家生态承载力与生态承载状态评估，结果表明:（1）“一带一路”沿线国家生态承载力总量为 110.97 亿人，与常住人口相比，生态系统尚有 64.33 亿人的承载空间，生态承载力处于富富有余状态。（2）“一带一路”沿线区域间和国家间生态承载状态呈两极分化现象：在 65 个国家中，有 40 个国家生态承载力处于富富有余状态，主要分布在东南亚和中东欧地区，有 19 个国家生态承载力处于严重超载状态，主要分布在西亚/中东地区。（3）尽管沿线国家生态系统尚有较大的承载空间，但结合国际呼吁的生态保护标准与未来沿线国家人口与经济发展预测结果来看，“一带一路”倡议实施过程中生态保护问题依然严峻；但以构建新的国际贸易网络为核心内容的“一带一路”倡议，有助于解决沿线国家由于生态资源供给与消耗空间不匹配的问题，为沿线国家协调生态保护与社会需求的矛盾提供新的契机。

关键词：生态承载力；生态承载状态；供需平衡关系；植被净初级生产力；一带一路