

Land consolidation boosting poverty alleviation in China: Theory and practice

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ABSTRACT

Regional impoverishment is an external manifestation of unbalanced human-land relationship in specific areas. The important role of the full utilization of land resources in alleviating the man-land contradiction has been gradually recognized. As one of the most prominent poverty-stricken countries in the world, China has been innovating the way of land use to alleviate poverty. Under the background of land system innovation, land consolidation is an instrument to alleviate poverty. This study first analyzed the mechanism and path behind land consolidation boosting poverty alleviation, then systematically reviewed the evolution of China's land policies related to poverty alleviation since 1978, and finally explained the successful practice of land consolidation boosting poverty alleviation through a typical case study. Results show that land consolidation has multi-functional characteristics. Land consolidation has played an active role in increasing cultivated land area, promoting agricultural production scale, improving rural production conditions and living environment, alleviating ecological risk and supporting for rural development. It also helps to create employment opportunities, promote the capitalization of land resources, widen the way for farmers to increase their income, solve the predicament of lack of land, technology and funds faced by the development of poor areas and revitalize rural economy, thus contributing to rural development and poverty alleviation. Nevertheless, third-party assessment of the whole process of socio-economic and ecological impacts of land consolidation is still needed. Decision-making of land consolidation needs to take full account of different stakeholders' interests and bottom-up participation is also necessary. These findings will provide beneficial reference for making-decision for sustainable land use and effective poverty alleviation in other developing countries.

1. Introduction

Land is a fundamental resource for human survival and development (Wang, 1997; Liu et al., 2014). With populations growth, the demand for arable land has gradually increased. Since 1960s, intense anthropogenic activities, such as infrastructure construction and rapid urban sprawl, have led to huge losses of cultivated land worldwide (Chen, 2007; Su et al., 2014; Liu et al., 2014) and caused concerns about food security (Godfray et al., 2010; Jin et al., 2017). Urban sprawl leads to land fragmentation (Irwin and Bockstael, 2007), which increases the transaction cost of investments and affects sustainable land management (Sklenicka et al., 2014; Teshome et al., 2016). Land

consolidation is an important tool to reduce land fragmentation (Niroula and Thapa, 2005; Tan et al., 2006; Pašakarnis and Maliene, 2010; Zhang et al., 2014). Land consolidation refers to the activities of comprehensive management of unused, inefficient¹ and idle land, damaged and degraded land to meet the functional needs of human production, life and ecology. It is a general term for land development, arrangement, reclamation and restoration (MRL, 2018). Land consolidation has its multifunction. It has been acknowledged as an effective instrument to add new farmland, improve land productivity, promote sustainable land use and alleviate the man-land contradiction (Sklenicka, 2006; Pašakarnis & Maliene, 2010; Lisec et al., 2014; Hartvigsen, 2014; Jin et al., 2017; Li et al., 2018; Du et al., 2018). Land

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¹ The inefficient use land refers to the construction land with scattered layout, extensive utilization and unreasonable use in cities and towns.

consolidation policies have gradually changed from the original agricultural production goals to an instrument to support rural development (Crecente et al., 2002). Furthermore, there are inconsistent conclusions on the impact of land consolidation on ecological environment. Some studies showed that land consolidation has a negative impact on the ecosystem services value and landscape diversity of the project area (Zhang et al., 2014; Wang et al., 2015). However, land consolidation has not per se a negative ecological effect. In Central and Western Europe countries, even nature conservation organisations have acknowledged the contributions of land consolidation to solve land use conflicts and to support nature protection (Crecente et al., 2002; Sklenicka, 2006; Pašakarnis and Maliene, 2010; Hartvigsen, 2014). In central China, land consolidation helps to mitigate the ecological risk of the project area (Yu et al., 2010). Obviously, land consolidation has exerted far-reaching impacts on improving farmland quality, promoting agricultural production scale and increasing the competitiveness of agricultural products, adjusting land use structure, developing modern agriculture, alleviating ecological risk, ensuring national food security and supporting for rural development (Crecente et al., 2002; Niroula and Thapa, 2007; Van Dijk, 2007; Long, 2014; Yan et al., 2015; Liu et al., 2014; Wang et al., 2014; Jin et al., 2016; Jiang et al., 2017; Aslama et al., 2017; Allahyari et al., 2018; Colombo and Perujo-Villanueva, 2019).

China is the most populous developing country in the world with the fundamental realities of little land for more population. Since reform and opening up in 1978, rapid socioeconomic development and urbanization has inevitably occupied large-scale arable land (Zhou et al., 2018a). Inefficient use of construction land, scattered and fragmented farmland, serious soil pollution and land degradation in China all have aggravated the already tense human-land relationship. Statistics show that about 40% of the country's construction land was inefficiently used and 10–15% of rural residential land was idled² (Yun, 2014). The urban industrial and mining construction land in inefficient utilization is about 5000 ha, accounting for 11% of the built-up area of the country (Yun, 2014). Every year, about 0.27 million ha of arable land are lost due to natural disasters and human production and construction activities (MLR & NDRC, 2017). Part of China's rural homestead is in idle, scattered and empty state for a long time. The per capita residential area of the rural population reaches 317 square meters and is 2.68 times of the per capita construction land area of urban residents. Farmland fragmentation causes land degradation (Sklenicka, 2016). Over 40% of the Chinese cultivated land has been degraded, and 19.4% of the arable land has been contaminated (MOA, 2014; Zhao et al., 2014). It is estimated that the potentials of land consolidation of hollowed villages in China will reach 6.9–8.1 million ha by 2020 (Liu et al., 2013). Furthermore, China's high-quality farmland and urban gathering areas are highly overlapped in space, further intensifying the intense man-land relationship and land use conflict (Yun et al., 2009; Si et al., 2010; Liu et al., 2017). To ensure national food security and stabilize farmland patterns, China has been implementing land consolidation projects since the mid-1990s (Huang et al., 2011; Yan et al., 2012). Land consolidation has been an effective instrument for China's rural space reconstruction (Long, 2014), hollowed villages renovation (Li et al., 2014) and rural development (Pašakarnis and Maliene, 2010; Lisec et al., 2014). Land consolidation had contributed to the increase of 13.58% of China's cultivated land between 2000 and 2008 (Wang et al., 2012). Between 2011 and 2015, 27.67 million ha of high-quality farmland have been added through land consolidation (Yan, 2017).

Land is the primary means for generating a livelihood and a main

vehicle for investing in developing countries (Deininger, 2003). There are rich and exploitable reserve land resources in the poor areas, and land consolidation can help to promote the capitalization of land resources (Zhou et al., 2018a). Providing poor people with access to land and improving their ability to make effective use of the land they occupy is critical to reducing poverty and empowering poor people (Deininger, 2003; Galiani and Ernesto, 2010). Previous studies mainly focused on the role of land consolidation in increasing cultivated land, improving the quality of cultivated land and rural environment, few studies have explored the mechanism of land consolidation to boost poverty alleviation. This study systematically reviewed the evolution process of China's land policies related to antipoverty, analyzed the mechanism of land consolidation to promote poverty and studied the practice of land consolidation boosting poverty alleviation and development through a typical case. These findings would provide vital decision support for land policy innovation and poverty alleviation in developing countries.

2. Theoretical framework

Poverty usually includes regional (place) poverty and individual (people) poverty, which interact with each other (Zhou et al., 2019). Regional poverty is an external manifestation of unbalanced human-land relationship in specific areas (Zhou et al., 2018a, 2018b). Influencing factors of regional poverty include insufficient endowment of natural resources, backward infrastructure and public services, adverse traffic conditions, fragile ecological environment and frequent natural disasters (Dasgupta et al., 2005; Barbier, 2010; Bui et al., 2014; Watmough et al., 2016; Kelly et al., 2015; Watts, 2017; Liu et al., 2017; Zhou et al., 2018b) (Fig. 1). There is a vicious spiral between regional impoverishment and environmental degradation in most poor areas (Scherr, 2000; Dasgupta et al., 2005; Watmough et al., 2016; Pasanen et al., 2017). Individual poverty is affected by poor living conditions, unhealthy status, low educational level, unemployment, insufficient self-development ability and lack of developing funds, and the aging and hollowing of rural population (Liu et al., 2010; Liu et al., 2017, 2018a). The rural poor are often concentrated in fragile environmental areas, and their livelihoods depend on natural resource endowments and ecosystem services (Barbier, 2010). More importantly, most poverty-stricken areas often face a realistic dilemma of lack of land, funds and technology (Swinton et al., 2003; Zhou et al., 2018a). Lack of assets and access to key markets may also constrain the ability of poor households to adopt technologies to improve their farming systems and livelihoods (Pattanayak et al., 2003; Barbier, 2010; Rodríguez-Pose and Hardy, 2015).

Land consolidation can provide funds, technology and land for the development of poor areas. Land resources have three basic attributes: resources, assets and capital. Poor areas often have rich and scattered, fragmented and sleepy reserve land resources. Under the existing technology level and market demand, the asset and capital attributes of land resources have not yet been fully developed. Under the background of land system innovation, land consolidation can inject new vitality for promoting poverty alleviation and crack the bottleneck of poverty alleviation and development, such as shortage of land and funds as well as labor force output (Zhou et al., 2018a; Liu et al., 2018a). Land consolidation includes unused land development, low-efficient use land arrangement, damaged land and wasteland reclamation, and polluted and degraded land restoration, which aims at turning them into available farmland or construction land through land engineering measures (Ministry of Land and Resources of China (MLR, 2018). The unused land involves in bare land, saline alkali land, marsh land, sandy land and low-hilly and slow-sloping land. Land arrangement includes the conversion of unused village land to construction land and high-standard farmland construction. The inefficient use land in this study refers to the construction land with scattered layout, extensive utilization and unreasonable use in villages and towns, such as

² Rural residential land is the collective land occupied and used by farmers as residential land. According to China's land management law, residential land belongs to the collective ownership of farmers. Villagers have only the right to use and no ownership. Rural residential land represents one of the most important land use types in China.

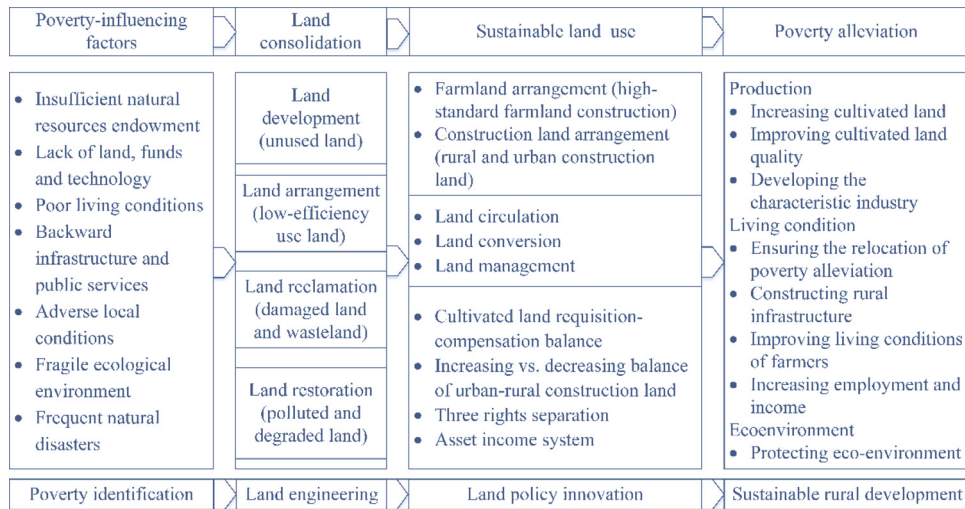


Fig. 1. Mechanism behind land consolidation promoting poverty alleviation.

old and abandoned residential land. The damaged land refers to the land damaged by excavation, collapse, occupation and natural disasters. The degraded land refers to the land with low or no productivity caused by human unreasonable development and utilization. The production, living and ecological land in a certain poor area can be increased through the development, arrangement, reclamation and restoration of unused, inefficient use, damaged and degraded polluted land (Fig. 1). For example, relocated measures can be taken for some poor villages in place unsuitable for living (Liu and Li, 2017). The concentrated residence of villages helps to make intensive use of land resources. The old and abandoned homestead in the relocation area can be reclaimed to construction land or cultivated land, and the living environment of the villagers can be improved, thus improving human health and strengthening the endogenous dynamics of rural development (Lo et al., 2016; Zhou et al., 2018a). New land added through land consolidation can be used to develop characteristic industries.

Land consolidation promoting poverty alleviation involves four different stakeholders, i.e., governments, enterprises, cooperatives and farmers (Fig. 2). The role of local government is to innovate land policy, draw up land consolidation plan, attract investment and establish risk sharing mechanism. Enterprises, usually land comprehensive

development and utilization companies, provide funds and technology to carry out land consolidation and use the consolidated land to develop modern agriculture or tourism. Village-level cooperatives coordinate mass work, deal with the relationship between enterprises and farmers and implement the dividend promised by enterprises to farmers. Local governments can sell quotas to other counties or provinces where cultivated land was occupied by construction and can get land financial fund from this trade and use this fund to develop county economy, infrastructure and public services. Peasant households voluntarily invest in enterprises with their own land (unused land in barren hills), and they can cultivate their own land after consolidation, or circulate land for the enterprises for developing modern agriculture. Meanwhile, farmers with labor force can work in the land consolidation projects. Farmers can get asset income and share dividends from land circulation as well as wage income. Therefore, land consolidation can promote the capitalization of land resources in poverty-stricken areas. Labor input earnings in land consolidation projects accounts for about 20% of the total investment (Huang and Xia, 2017). This typical model of land consolidation promoting poverty alleviation involves farmers' bottom-up participation. Obviously, land consolidation can help to improve agricultural productive conditions, increases crop production, boosts

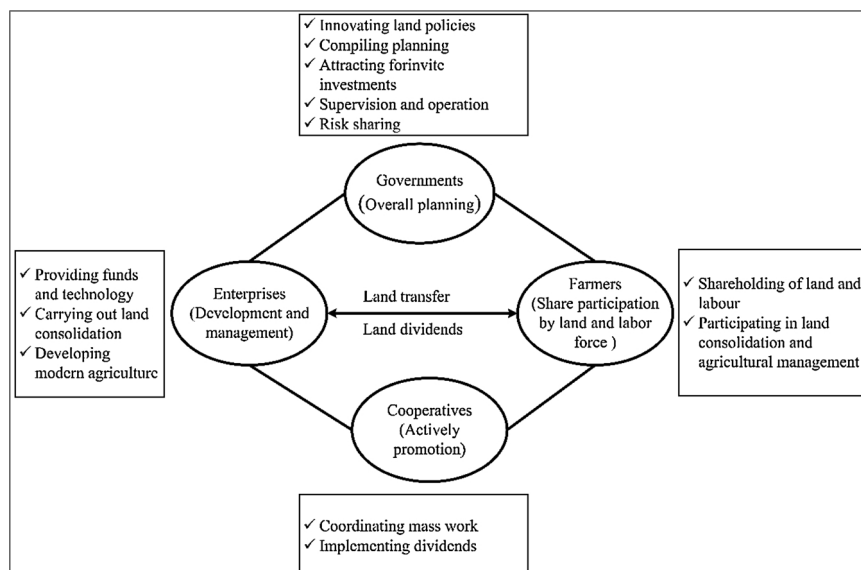


Fig. 2. The role of different stakeholders in land consolidation.

farmer's income, beautifies rural living environment, and lifts rural poor population out of poverty and revitalizes the declining countryside (Liu and Li, 2017; Liu et al., 2018a; Zhou et al., 2018a).

3. Land policies, land consolidation and poverty alleviation in China

3.1. The evolution of land poverty alleviation policy

Land policy, land rights and land reform play a vital role in economic development and poverty reduction (Besley and Burgess, 2000). As one of the most poverty-stricken countries in the world, China has formulated and implemented a series of unconventional land use policies or measures to support its anti-poverty plan and practice over the past three decades. First, since 1987, the Ministry of Land and Resources of China (MLR), now renamed as the Ministry of Natural Resources, has carried out the fixed-points help the poor (i.e., choosing one or more specific places to help the poor, 定点扶贫) in Ganzhou city (Central China). Second, preferential land use policy has been promulgated to guarantee the landing of anti-poverty projects. For example, China has proposed to prioritize arranging annual construction land quota of 40 ha for every state-designated impoverished county (in all 592 counties) to develop production and help the poor out of poverty since 2016. Third, the increasing vs. decreasing balance of urban-rural construction land policy (IDBUCLP) was used to promote the *ex situ* poverty alleviation relocation (ESPAR). From 2016 to 2020, the country will relocate 10 million rural poor people living in unsuitable areas (Zhou et al., 2018a). In 2016, more than 0.19 million ha of construction land quota have been arranged to support the ESPAR of 4.2 million rural poverty-stricken population and help them moving away from unsuitable living areas. Furthermore, to meet the needs of poverty alleviation and development for land use, the MLR has allowed to circulate the surplus quota from IDBUCLP within the provincial domain since 2016 that cannot be transferred across the county before this. In 2017, the scope of the circulation further expanded from 832 counties to 1250 counties. Later, the surplus quota from the IDBUCLP in deep poverty-stricken counties can be circulated across trans-regions and trans-provinces. Fourth, land consolidation has paved a new way for poverty-stricken areas to get rid of poverty. Since 2011, the country has arranged more than 5200 land consolidation projects in poor areas with a construction scale of 0.41 million ha (Zhou, 2016). Finally, rural land system reform endows farmers with more land value-added benefits. The implementation of the separation of three rights (i.e., ownership right, management right and contract right) of land and asset income support system have been used to wake up the unused reserve land resources in the poverty-stricken areas, realizing the capitalization of land resources (Zhou et al., 2018a). In addition, the Chinese government has supported the construction of rural primary, secondary schools and higher vocational schools for the poor areas to improve the education of the poor and block the intergenerational transmission of poverty. Construction land quota have been allocated to increase the home security rate to maximize the dependence of those who are unable to work (Wang and Zheng, 2016).

Especially, the country has also innovated land use policies to support poverty alleviation and development in deep poverty-stricken areas in recent years (Liu et al., 2018b). The deep-poverty areas can take the lead in starting a new round of land use planning revision. Land use quotas have been given priority to meet the land use needs of infrastructure construction, immigrant relocation and livelihood development (MRL, 2017; Jiao, 2018; General Office of the State Council of China (GOSC, 2018). The scale of the quota from the IDBUCLP is no longer restricted in the deep-poverty areas and the surplus quota can be circulated across trans-provinces or regions (General Office of the State Council of China (GOSC, 2018). Furthermore, it is required that land consolidation projects and funds should be prioritized in the deep-poverty areas, with emphasis on supporting major projects for poverty

alleviation (MRL, 2017). These innovative policies aim to increase farmers' income and improve the production and living environment in rural areas (Yuan et al., 2017; Zhou et al., 2018a; Liu et al., 2018a).

3.2. Land consolidation and poverty alleviation

China's land consolidation practices have a long history and can be traced back 1066 b.c., but modern land consolidation projects started in the 1950s, which involves in land rearrangement, drainage systems renovation and field road construction (Wang, 1997; Jin et al., 2016, 2017). In 1999, the revised PRC Land Management Law stipulated clearly that the country encourages land consolidation. In the late 1990s, the MLR launched the 1st Ten-Year (2000–2010) National Land Development and Consolidation Planning, which aims to consolidate fragmented and underused land, reclaim wasteland or land damaged by mining or natural disasters, and develop unused land resources with the prerequisite of guarding against desertification and soil erosion. As a result, during the period 2001–2010, 2.76 million ha of cultivated land were added through land consolidation, exceeding the area occupied by construction and damaged by natural disasters by the same period (Jin et al., 2017).

To further promote poverty alleviation and ensure national food supply security, the country has implemented the second-round National Land Consolidation Planning (2011–2015). This plan has set the binding targets of building up 26.7 million ha of high-standard farmland and supplementing 1.6 million ha of farmland through land consolidation program by 2015. During the period 2011–2015, China has achieved its land consolidation goals, and built 28.6 million ha of high standard farmland and supplemented 1.84 million ha of cultivated land (Yan et al., 2015; MLR & NDRC, 2017). The area of newly-added farmland exceeded the area occupied by non-agricultural construction and destroyed by disasters during the same period, which safeguards the national food security. After land consolidation, the quality of the newly-added cultivated land has been improved by an average of one grade,³ its average yield has been increased by 10–20% and the arable land productivity has been elevated with a new food production capacity of 3.74 billion kilograms (MLR & NDRC, 2017).

Meanwhile, land consolidation also helps to promote rural investment, farmers' employment and farmers' income increase. Between 2011–2015, China has invested more than \$802 billion in land consolidation projects, benefiting more than 100 million farmers. Every year, farmer's income in the land consolidation project area increases by an additional \$131 (MLR & NDRC, 2017). By the IDBUCLP, the country has invested \$87 billion in its rural areas to consolidate the scattered, idle and inefficient construction land, which helps to improve the living environment in rural areas. At the same time, the country also supports land consolidation in the poor areas through preferential land policies and allows 100 counties to establish high-standard farmland, which effectively guide the land consolidation projects and funds incline to the poor areas and reduce poverty. Obviously, land consolidation has greatly increased China's cultivated land, optimized the structure of land use and promoted rural investment and farmers' income increase.

More recently, to further reduce poverty and ease the human-land relationship contradiction, the country has formulated the new-round National Land Consolidation Planning (2016–2020). According to the plan, between 2016 and 2020, China plans to invest \$247 billion in land

³ According to the National Standard of Cultivated Land Quality Grade in China, from the perspective of agricultural production, the quality of cultivated land in China is classified into ten grades in terms of cultivated land productivity, soil health status and the ability of field infrastructure to meet the sustained output and quality safety of agricultural products. The quality of cultivated land in the first class is the highest, and that in the tenth class is the lowest (AQSIQ and SAC, 2016).

Table 1

The scales of high-standard farmland construction and newly-added cultivated by land consolidation in China from 2016 to 2020.

Sources: The data are available from MLR & NDRC, 2017.

Province	High-standard farmland construction (10 ⁴ mu)	Newly-added cultivated by land consolidation (10 ⁴ mu)
Total	4000	2000
Beijing	23	12.25
Tianjin	112	21.9
Hebei	2258	89.36
Shanxi	1081	81.44
Inner Mongolia	2577	41.01
Liaoning	1166	58.91
Jilin	1513	41.99
Heilongjiang	3431	60.3
Shanghai	23	13.95
Jiangsu	1910	104.19
Zhejiang	961	74.15
Anhui	2039	89.53
Fujian	851	50.65
Jiangxi	1448	68.82
Shandong	2478	104.79
Henan	2869	118.13
Hubei	1357	97.17
Hunan	1821	76.5
Guangdong	1046	57
Guangxi	1389	58.41
Hainan	248	16.08
Chongqing	563	54.42
Sichuan	1934	92.72
Guizhou	1035	64.14
Yunnan	1113	97.76
Tibet	30	5.71
Shaanxi	1025	76.61
Gansu	932	45.95
Qinghai	270	13.69
Ningxia	478	21.97
Xinjiang	2019	190.5

consolidation to improve the quality of cultivated land and build high-standard farmland (MLR & NDRC, 2017). China's 31 provinces,

municipalities and autonomous regions are undertaking the task of high-standard farmland construction. The provinces with the largest scale of high-standard farmland construction include Heilongjiang, Henan, Inner Mongolia, Shandong, Hebei, Xinjiang and Anhui province, most of which concentrate in China's commodity grain production bases (Table 1). During the period 2016–2020, about 0.13 million ha of farmland will be supplemented by land consolidation around the country, which mainly are obtained from Xinjiang, Henan, Shandong, Jiangsu, Yunnan, Hubei and Sichuan provinces. Fig. 3 shows the key areas of agricultural land arrangement, land reclamation, and suitable farmland development in China during the period 2016–2020. The key areas of agricultural land arrangement involve the country's 1548 counties, concentrated in the North China Plain, the middle-lower reaches of the Yangtze River, the Northeast Plain, the Yunnan-Guizhou Plateau, the Loess Plateau, the Sichuan basin and the Inner Mongolia plateau. The key areas of land reclamation and suitable farmland development involve 543 counties and 214 counties of the country, respectively (MLR & NDRC, 2017).

4. Case study

This study adopts a case study method combining quantitative and qualitative methods. Case study is a scientific method and its advantage lies in that it is suitable for real life and provides detailed in-depth investigation data (Krusenvik, 2016). A case study is systematic inquiry into an event or a set of related events for a specific research area which aims to describe and explain its mechanism (Bromley, 1991; Crowe et al., 2011). Land consolidation is a complex system engineering, involving different stages and stakeholders. Case studies can well reveal the mechanism of socio-economic impacts of land consolidation (Coelho et al., 1996; Yu et al., 2010; Zhang et al., 2014; Wang et al., 2015; Janus and Markuszewska, 2017; Demetriou, 2018). In view of this, this study also adopts case study method to explore socio-economic impact of land consolidation. The data used in the study were obtained through face-to-face interviews with local governments, village cadres and land consolidation project leaders. Data on villagers' income increase are provided by land consolidation enterprises, which

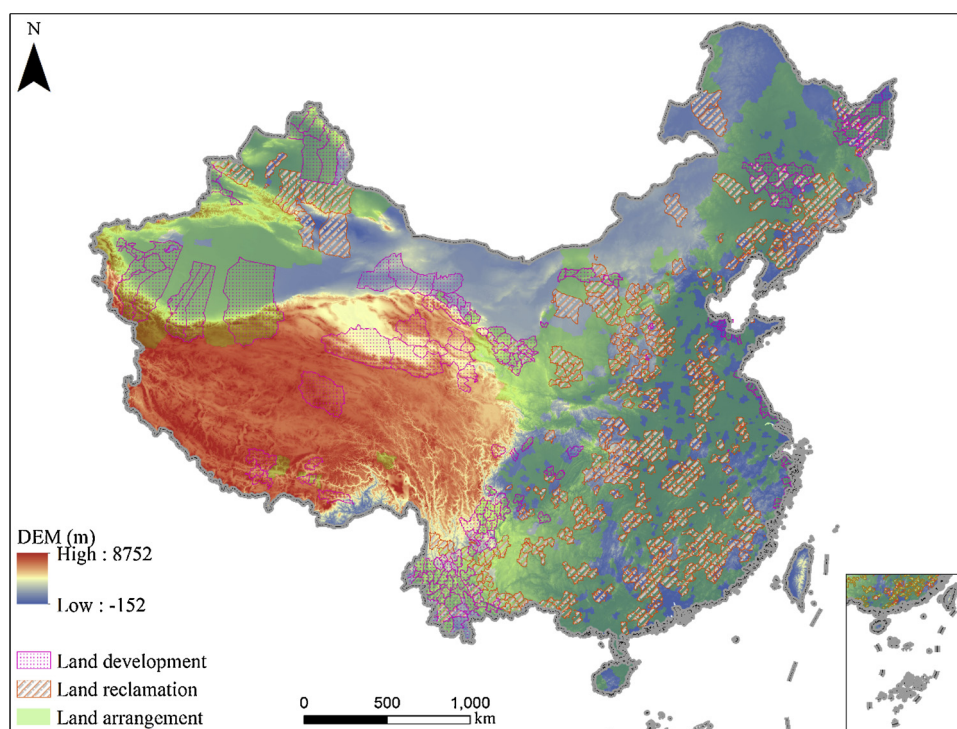


Fig. 3. Areas involve in land consolidation during the period 2016–2020.

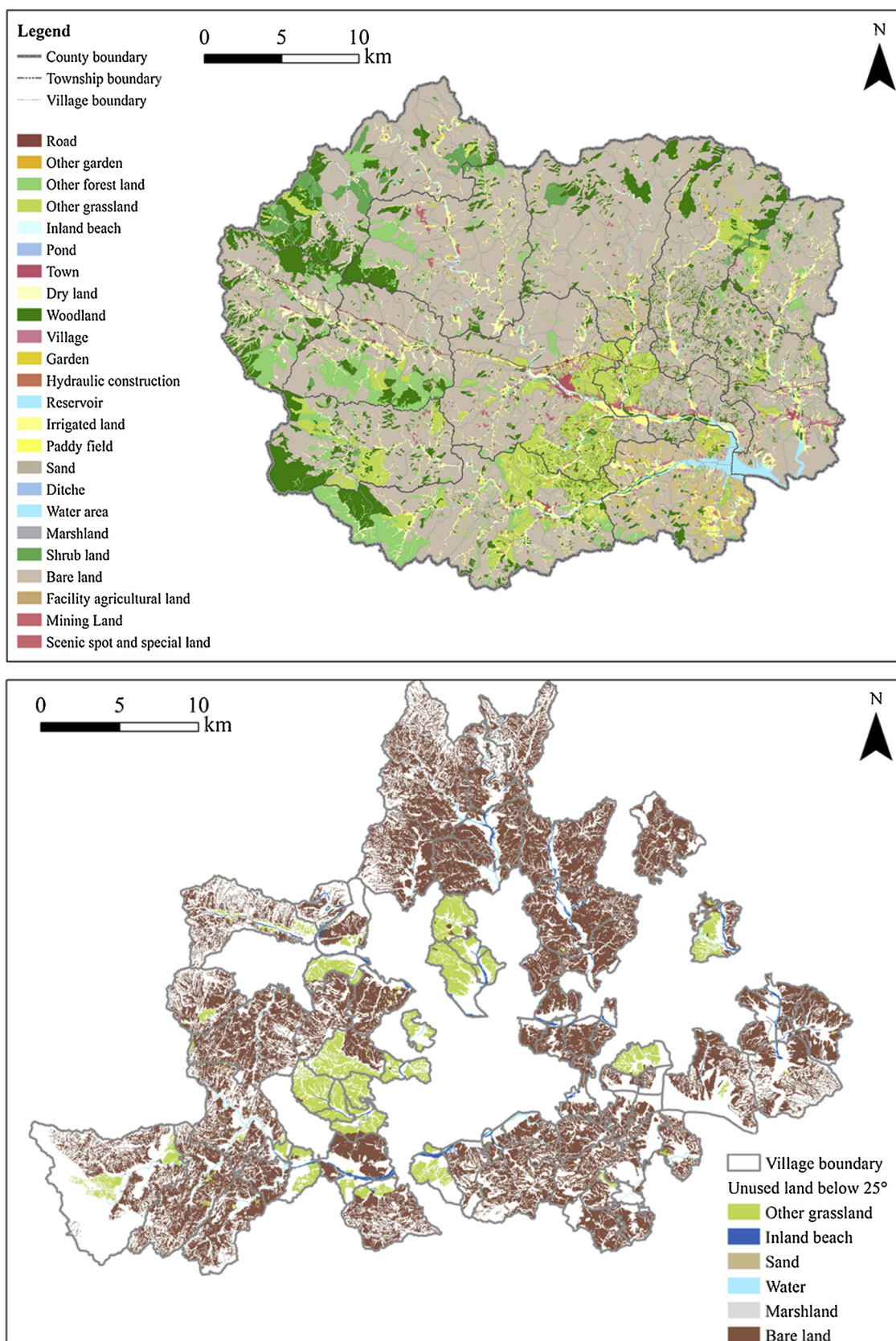


Fig. 4. Land use types (above) and unused land below 25° (below) in Fuping County, Hebei Province.

make detailed statistics on land transfer fees of farmers and wages of migrant workers in the project area. We also verified with the head of the village committee and some farmers in land consolidation project area on the amount of land transfer and daily wage income.

Fuping County is a pilot county of land consolidation projects in China and a microcosm of unused land development and utilization in mountainous areas. Land consolidation in Fuping County can better reveal the mechanism of socio-economic impact of land consolidation. Fuping County (N38°9′~39°7′, E113°45′~114°31′) is in the Taihang Mountain hinterland of western Hebei province, China. It is a typical mountainous county and state-designated impoverished county. Fuping's land area is about 250,580 ha with more than 170,000 ha of unused land. Among them, 34,667 ha of used land with slope below 25° can be exploited (Fig. 4). By the end of 2014, there were 108,100 rural people living below the national poverty line (RMB 2300/USD 370 per year) in the county. Like other poor counties in China, Fuping's development is also facing the realistic predicament of lack of land, technology and funds (Zhou et al., 2018a). In 2015, the MLR supported Fuping County to carry out a pilot of poverty alleviation promoted by land consolidation of the unused land. In the same year, Fuping County takes land consolidation as a strategic breakthrough for its poverty alleviation and plans to increase cultivated land by 13,333 ha in five years through land consolidation.

Fuping's land consolidation adopts the mode of government-led, farmer land equity and enterprise development and management. Its land consolidation projects involve 70,000 people of 98 villages of the county. Though land consolidation, the per capita cultivated land in the project area will increase by 0.2 ha. Villagers in the project area of land consolidation increase their income through three ways, i.e., land transfer funds, wage income and dividends from shares. The county fiscal revenue can be significantly increased through the transfer of the surplus quota from the increasing vs. decreasing balance of urban-rural construction land and the cultivated land requisition-compensation balance. By the end of 2017, the county has completed the project approval of 88 land consolidation projects in 46 villages, and the fiscal revenues from the surplus quota circulation in Fuping reached \$0.88 billion. Obviously, Fuping's land consolidation has greatly increase cultivated land and improve its quality, which helps to develop modern agriculture, promote economic development and the increase of farmers' income, thus alleviating poverty.

Baiya Village, located in the east of Fuping County, is the earliest village to carry out land consolidation in the county. It includes nine unincorporated villages and 2389 people. The village has 1,367 ha of barren mountain areas. Increasing farmers' income through land

consolidation is one of the main ways to get rid of poverty. The land consolidation project of Baiya village was set up in July 2015 and completed in October 2016 (Fig. 5). The total development scale of the project was 288.4 ha and total investment is \$12 million. In the village, 164.4 ha of arable land have been added through land consolidation and agricultural infrastructure such as water conservancy, electric power and roads have been improved. The newly-added cultivated land prioritized developing apple, cherry and other fruit industries. Land consolidation project in the village involves 520 villagers, of whom 200 households are poor. The land transfer fee paid by enterprises to farmers is about \$137,216 per year. A total of 168 poor people participated in land consolidation and post operation management. The wage income is about \$12 for every female worker and \$18 for every male worker a day, and their income per worker is \$1459 per person per year. Five years later (since 2020), the profits of the project area will be semi-dividend for the farmers and enterprises. In addition, the ecological benefits of land consolidation are obvious. The county's forest coverage will be increased by 5.3% after the additional 1333 ha of cultivated land through land consolidation being used to develop the forest and fruit industry (Bian, 2018). Obviously, land consolidation has obvious economic, ecological and social benefits.

5. Discussion

Land consolidation does help to optimize land use structure, increase quality of cultivated land, improve agricultural production capacity, decrease agriculture production cost, develop modern agriculture and alleviate poverty but has negative effects on ecosystem services value and landscape diversity (Crecente et al., 2002; Cay et al., 2010; Huang et al., 2011; Zhang et al., 2014). Land consolidation has different eco-environmental and socio-economic impact in different engineering phases, which depends on the scale of the project (Crecente et al., 2002; Yu et al., 2010; Wang et al., 2015; Teshome et al., 2016). Some traditional models such as system-dynamic model, input-output model, ecosystem service evaluation and cost-benefit analyses have been used to assess the resource-environment-ecological impacts of land consolidation (Papousek, 2011; Guan et al., 2013; Zhang et al., 2014; Wang et al., 2015). The existing studies showed that the amplification effect of land consolidation project investment on the national economy of a region or country is 2.8 times (Guan et al., 2013). Simulated results indicated that land consolidation will lead to the loss of ecosystem service of the wetland and grassland, and the total ecosystem service value will decrease by nearly 30% in the late stage of land consolidation (Wang et al., 2015). Implementing land consolidation

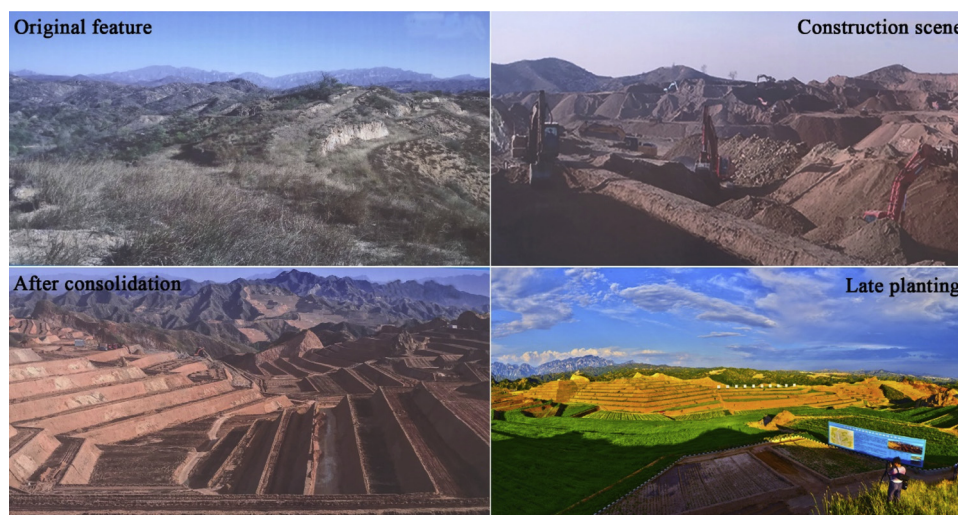


Fig. 5. Land consolidation in Baiya village of Fuping County, Hebei Province.

projects will reduce the ecological service value of the project area by 0.3% (Gu, 2012). A recent study showed that the impact of land consolidation on the ecological environment of the project area experienced a process from negative to positive impacts (Wu et al., 2018). Our research results show that land consolidation not only has positive social and economic benefits, but also has obvious ecological benefits. Therefore, the socio-economic and ecological benefits of land consolidation need to be further scientifically assessed.

Land consolidation needs to deal with the relationship different stakeholders, e.g., farmers, government and entrepreneurs, which need an integrated planning and decision-support system (Demetriou et al., 2012; Jiang et al., 2015). Land allocation has a prominent effect on the success of land consolidation (Cay et al., 2010). The active participation of land owners in the land consolidation is the basis for developing good practices (Lisec et al., 2014). Policymakers should consider local socio-economic conditions and ensure grassroots participation, flexible implementation and adequate compensation for villagers as well as late eco-environmental effect (Wang et al., 2014). Top-down land consolidation policies has priority to administrative efficiency instead of farming efficiency, but it should be combined with bottom-up participatory measures to avoid the new conflicts caused by land consolidation (Jin et al., 2017). Our case study further demonstrates the importance of bottom-up participation in successful land consolidation. Furthermore, confronting with global countryside decline, land consolidation needs to be set within the broader framework of rural revitalization strategies (Wang et al., 2014; Liu and Li, 2017).

Land consolidation should take full consideration of the willingness of farmers. Land is the root of farmers' survival and development. The success of any land consolidation program, therefore, depends on how well farmers' needs, capabilities and

aspirations are reconciled and integrated into it (Niroula and Thapa, 2005). Only when the rights and interests of farmers are not impaired, can farmers maximize their enthusiasm and participate in land consolidation. A recent survey on the satisfaction of land consolidation in Dadao village of Fuping County showed that the villagers' recognition for land consolidation is still not high and 30% of farmers are not satisfied with current land consolidation projects (Wu et al., 2018). On the one hand, farmers worried about that the follow-up management of enterprises can't keep up and cause the consolidated land to be abandoned again. On the other hand, the homogeneity utilization of the consolidated land is serious. Most of the existing consolidated land in Fuping County are used to develop apple, pear, peach and other forest and fruit industries and there is lack of diversified utilization of newly-added cultivated land (Wu et al., 2018).

Third-party assessment of the whole process of socio-economic and ecological impacts of land consolidation is needed. It is urgent to establish the third-party evaluation index system for the whole process of land consolidation, including survey, planning and designing, and its social, economic and eco-environmental influences at construction stage as well as the quality of arable land, agricultural productivity, ecological risk and people's livelihood improvement in the later stage. Accordingly, the accountability system for land consolidation projects should be also be established.

6. Conclusions

Land is the material basis for human survival and development. As a populous country dominated by agriculture, China's land resource has been increasingly intensively used over the past three decades with the rapid urbanization, which has led to a tense human-land relationship. Over the past ten years, increasing land fragmentation, land pollution, land degradation and inefficient land use have threatened China's food security and public health. The insufficiency of land resources per capita is also an important factor in rural poverty in China. Rural impoverishment is an external manifestation of imbalance between man and land in rural regional system. In addition, the transformation and

development of rural poverty-stricken areas in China are generally faced with the realistic predicament of lack of funds and technology. Under the background of land system innovation, land consolidation can inject new vitality into the development of poverty-stricken areas and help to alleviate the man-land relationship contradiction and reshape the new pattern of urban-rural relations.

Land policy innovation and land consolidation are closely related to poverty alleviation and development. The Chinese government has attached great importance to the role of land policy innovation in boosting poverty alleviation and development since 1978. As one of the most prominent poverty-stricken countries in the world, China has formulated and implemented a series of land priority policies to support its poverty alleviation and development. The prominent initiatives include the inclination of land use quotas, land consolidation projects and funds to poor areas, and the priority of construction land quota to poor areas to meet the needs of poverty alleviation and development. More importantly, the restriction on trans-circulation for the surplus quota from the IDBUCPL has been relaxed and the scope of the transfer in the province has been expanded from 592 state-designated counties to 1250 counties (including provincial-designated counties), and the cross-regional/provincial transfer in the deep-poverty areas has been allowed. In addition, the country has given priority to supporting the poor areas to carry out the high-standard farmland construction and major land consolidation projects. It is no exaggeration to say that China is doing its best to alleviate poverty through land policy innovation, land system reform and land consolidation.

Land consolidation is an important way to promote poverty alleviation and development. Land consolidation is conducive to increasing arable land, improving the quality of arable land, promoting the adjustment of agricultural structure, improving agricultural production potential, providing employment opportunities, promoting farmers' income and improving rural environment, and promoting rural economic revitalization and rural development. Furthermore, land consolidation can help to promote the capitalization of land resources in rural poverty-stricken areas and solve the predicament of lacking land, funds and technology faced by its development. Overall, land consolidation not only has a positive impact on the social and economic development of poor areas, but also provides opportunities for improving the ecological environment.

For all that, the social, economic and ecological impact of land consolidation on regional development need be assessed by third-parties. Post-effect assessment of land consolidation should be strengthened. The system-dynamic model, input-output model, cost-benefit analyses and life cycle assessment can be used to evaluate the socio-economic benefits and eco-environmental impact of land consolidation. Remote sensing technology can be used for dynamic monitoring of vegetation before and after land consolidation project area. Big-data analysis can be used to investigate which reserve land resources are suitable for a region to develop and the intensity and scale of its maximum utilization. Long-term fixed-point observation of public health in land consolidation project areas is also necessary. In all, no "one-size-fits-all" model exists for all areas, land consolidation should be adapted to local conditions and the best consolidation plan should be adopted.

Conflict of interest statement

No conflict of interest exists in the submission of this manuscript, and manuscript is approved by all authors for publication. The work described was original research that has not been published previously, and not under consideration for publication elsewhere, in whole or in part. All the authors listed have approved the manuscript that is enclosed.

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