Journal of Landscape Research 2026, 18(5): 31-34, 40

From "Single-Point Restoration" to "Systemic Regeneration": Innovative Pathways for Ecological Restoration under System of Comprehensive Land Consolidation

CHEN Yaxuan[1], YOU Jie[2*]

(1. Pengzhou Institute of Planning, Surveying and Design, Pengzhou, Sichuan 611900, China; 2. Sichuan Xingji Cloud Spatial Planning Co., Ltd., Chengdu, Sichuan 610107, China)

Abstract Comprehensive land consolidation has shifted from pilot exploration to nationwide implementation, and has become an important instrument for territorial spatial governance and rural development. In practice, however, ecological restoration has largely fallen into the predicament of "fragmented governance": consolidation and restoration are carried out in isolation from each other, and engineering design tends to follow an engineering logic while neglecting ecological logic. In response, this paper proposes "systemic regeneration" as a new paradigm of ecological restoration, arguing that "ecological function reorganization" should supersede "form restoration", and that "value activation" should replace "passive protection". Conceptually, the paper develops an analytical framework along four dimensions—concept, space, technology and institution: at the conceptual level it promotes the shift from "form restoration" to "function reorganization"; at the spatial level it stresses the superimposition of ecological functions with production and living functions; at the technical level it focuses on close-to-nature restoration and the application of new technologies; and at the institutional level it concentrates on the value realization of ecological products. Practices in Sichuan, Guangdong and Hubei are used to illustrate the argument. The study concludes that only by moving ecological restoration from a "technical project" to a "value-creation project" can a genuine win–win outcome be achieved across the ecological, economic and social dimensions.

Keywords Comprehensive land consolidation, Ecological restoration, Systemic regeneration, Value realization of ecological products, Close-to-nature restoration

DOI 10.16785/j.issn 1943-989x.2026.5.007

Comprehensive land consolidation has moved from the stage of pilot exploration to that of full-scale implementation, and has become an important policy instrument for territorial spatial governance and rural development. Evidence from local practice shows that Sichuan Province has advanced comprehensive land consolidation from pilot status to full implementation, with 183 projects implemented province-wide involving a consolidated area of about 231,300 hm^2; Guangdong Province has approved 189 consolidation plans, of which 146,000 hm^2 are designated for ecological restoration[1]. These figures indicate that comprehensive land consolidation is becoming a basic instrument for coordinating the governance of agricultural land, construction land and ecological space, and that its scale and coverage continue to expand.

In both existing practice and the relevant literature, the positioning of ecological restoration within comprehensive land consolidation remains insufficiently clear. In most localities ecological restoration is treated as an "add-on" to consolidation projects: agricultural land consolidation takes the acquisition of cultivated land quotas as its main objective, construction land consolidation is oriented toward freeing up development space, and ecological restoration is reduced to individual tasks such as "tree planting and greening" or "mine re-greening", failing to form an organic connection with the overall layout of comprehensive land consolidation[2-3]. This "single-point restoration" approach has long confined ecological restoration to an isolated state in which ecology is discussed only in terms of ecology; production and living elements are not incorporated into the overall arrangement, and no dedicated method of benefit analysis exists. As a result, ecological restoration plays the role of a "side dish" rather than the "main course" in the consolidation system[4].

The root of the above predicament lies in the fact that, although comprehensive land consolidation bears the name "comprehensive", in actual operation the consolidation of agricultural land, construction land and ecological restoration largely proceeds along three separate "tracks"[5]. Ecological restoration forms no functional superimposition with production space or living space, nor is it incorporated into the whole-process design of consolidation projects, so that the comprehensive benefits of consolidation cannot be fully released. A paradigm shift in thinking on ecological restoration is therefore urgently needed, namely the shift from "single-point restoration" to "systemic regeneration". "Systemic regeneration" does not regard ecological restoration as a "patching up" of damage already done; rather, it uses spatial restructuring, technological application and value development as instruments to promote the overall enhancement of ecological functions within a region[6].

This paper proposes "systemic regeneration" as a new paradigm for ecological restoration, and its significance is reflected at two levels. At the theoretical level, the paper attempts to construct an analytical framework for ecological restoration under the comprehensive land consolidation system along the four dimensions of concept, space, technology and institution, and to move research on ecological restoration from "form restoration" toward "function reorganization", and from "passive protection" toward "value activation". At the practical level, drawing on cases from Sichuan, Guangdong and Hubei, the paper discusses how ecological restoration can be transformed from a "cost item" into an "investment item", and from a "technical project" into a "value-creation project", in order to provide operable pathways for ecological restoration practice in comprehensive land consolidation

Received: October 16, 2026 Accepted: October 26, 2026
* Corresponding author.

and ultimately to serve the goal of a win–win outcome across the ecological, economic and social dimensions[3,7].

1 Conceptual renewal: from "form restoration" to "function reorganization"

Conventional ecological restoration mostly follows the idea of "imitating nature" and relies on engineering measures such as filling in mine pits, straightening river bends and simple re-greening. Such practices emphasize the restoration of surface landforms while paying little attention to the structure and processes of ecosystems. After re-greening, some mines have failed to take into account the integrity of ecological elements such as hydrology and soil, and have degraded again after a few years[3]. This shows that taking "form restoration" as the sole objective makes it difficult to form a stable, self-sustaining ecosystem, and difficult to achieve functional synergy with production and living spaces.

The "systemic regeneration" paradigm argues that "function reorganization" should replace "form restoration". By "function reorganization" is meant that ecosystem services such as water conservation, the reproduction of flora and fauna, and carbon sequestration are considered as a whole, so that ecological restoration is organically integrated with production and living rather than restoring some natural form in isolation[2].

The Chengdu Ring City Ecological Zone provides a relatively complete demonstration. In this area land consolidation has been combined with ecological restoration; 806.67 hm² of ecological restoration has actually been completed, and gross ecosystem product (GEP) has risen from 13.087 billion yuan before consolidation to 16.419 billion yuan[4]. "Function reorganization" turns ecological restoration from a "cost item" into an "investment item": it no longer depends solely on fiscal support, but can raise gross ecosystem product through wetland-based water treatment, temperature regulation by green space and agricultural landscape creation. This shift shows that the conceptual renewal of ecological restoration is not merely a matter of technical choice, but a matter of value positioning: only by moving from "form restoration" to "function reorganization" can ecological restoration become an organic component of comprehensive land consolidation[3].

2 Spatial strategy: creating value through "superimposition"

The core advantage of comprehensive land consolidation lies in "spatial coordination", that is, breaking through the governance boundaries of a single land category or a single function so as to achieve the integrated arrangement of agricultural land, construction land and ecological space. If ecological restoration is confined in isolation to the category of "ecological space", this core advantage cannot be brought into play[5].

2.1 How the functional zoning approach separates ecological space from production and living spaces

Conventional spatial planning is mostly arranged according to "functional zoning": farmland is production space, forest land is ecological space, and the two do not mix. If this "either-or" classification is applied mechanically in hilly areas, cultivated land may become fragmented and ecological corridors may be interrupted. As a result, it is difficult for ecological functions to work in synergy with production and living functions, and ecological restoration is easily excluded from the main design of consolidation projects[5].

2.2 Strategy: pursuing the "superimposition" of ecological, production and living functions

An innovative spatial strategy should pursue the "superimposition" of ecological, production and living functions. Such superimposition is not a simple spatial patching-together; rather, it realizes functional compounding within the consolidation unit, making ecological restoration an intrinsic functional component of each stage of consolidation rather than an additional project[5].

2.2.1 "Ecology+production": functional compounding within consolidation units. With respect to the superimposition of ecology and production, local practice has already provided some replicable approaches. In Hubei Province, guided by the idea of "forest–farmland exchange", scattered forest land on gentle slopes below 6° has been consolidated and converted into larger contiguous parcels of cultivated land, while steep slopes have been returned to forest, thereby taking both ecological protection and agricultural land use into account. In Luojiang, Sichuan, biochar-based organic fertilizers and ecological irrigation canals have been applied simultaneously in agricultural land consolidation, bringing both cultivated land quality and soil carbon sink capacity into consideration. In Daying County, Suining, the method of "merging small fields into large ones" has reduced the number of cultivated land parcels by 40.8%, which facilitates intensive farming and reduces the redundancy of "marginal" elements such as field ridges and ditches. These practices indicate that deeper thinking on "superimposition" should be placed at the level of the micro-design of consolidation projects: ecological restoration must not be merely an "add-on project" to agricultural land consolidation, but should be an intrinsic functional component of every stage of consolidation[5].

2.2.2 "Ecology+living": ecological reconstruction of rural human settlements. With respect to the superimposition of ecology and living, the ecological transformation of living space is an aspect whose potential in comprehensive consolidation is still underestimated. In Niufo Town, Sichuan, the elements of "micro-farmland" and "micro-courtyard" have been applied in more than 200 settings in the design of resettlement sites, bringing ecological functions into ordinary living situations so that courtyards simultaneously serve the functions of carbon storage, food production and social interaction[6]. In the rural housing project in Luojiang, "small vegetable gardens, small flower gardens and small orchards" are allocated to each household as a means of ecological service, preserving natural value while rural housing is renewed. This mode of ecological reconstruction of rural human settlements—"ecology+living"—has won broad support from local residents, and has shifted ecological restoration from "landscape creation" to "lifestyle design".

The core of the spatial strategy lies in "superimposition". Only by realizing the compounding of ecological, production and living functions within the consolidation unit can ecological restoration move from passive "space occupation" to active "value creation", and can the "spatial coordination" advantage of comprehensive land consolidation be truly brought to bear.

3 Technical strategies: "human intervention" and "self-organization"

At the technical level, ecological restoration within comprehensive land consolidation faces one core proposition: how to handle the relationship between "human intervention" and "self-organization". Over-reliance on engineering intervention tends to produce high restoration costs and short maintenance cycles, whereas leaving nature entirely to its own succession makes it difficult to restore ecological functions within the consolidation cycle. The key to the technical strategy therefore lies in initiating natural processes through moderate human intervention, so that the ecosystem gradually acquires the capacity for self-renewal and self-maintenance[1].

Conventional ecological restoration is mostly carried out along the lines of "imitating natural forms", relying on engineering measures such as covering with soil, planting trees and re-greening. Such practices emphasize the restoration of surface landforms while paying little attention to the integrity of ecological processes such as hydrology, soil and microorganisms, so that restoration effects are often difficult to sustain. The re-degradation of some mines a few years after re-greening is related to this.

3.1 Close–to–nature restoration: using engineering to initiate natural processes

The essence of "close-to-nature restoration" lies not in "imitating natural forms" but in "activating natural processes". With regard to mine ecological restoration, the approach of "development and reclamation+soil improvement+vegetation reconstruction" adopted in Guang'an City centers on soil improvement and uses microbial communities as a means of restoration, combining soil, microorganisms and plants rather than simply covering soil and planting trees, thereby promoting the self-renewal and maintenance of the ecosystem[7]. A more frontier example is "in-situ mineral conversion technology": harmful metals in tailings are stabilized and part of the nutrients are converted into slow-release fertilizers, turning mine ecological restoration areas from an "ecological burden" into a "resource reservoir". This technology drives changes in material flows through a single, critical intervention, shifting from "pollutant release" to "nutrient supply", and thereby initiating a benign ecological succession.

3.2 Empowering precise restoration with intelligent technologies

3.2.1 Limitations of the conventional inspection model. Comprehensive land consolidation often faces practical challenges such as diverse restoration types, scattered spatial distribution and long governance cycles. The conventional "human-wave tactic" relies on manual visual inspection and paper-based records; it is not only inefficient, but also prone to missed and erroneous judgments owing to differences in subjective assessment, and it is difficult for it to form unified, quantifiable evaluation criteria for key indicators such as slope stability and the morphology of earthwork accumulation.

3.2.2 A practical case. The "UAV+AI+quality and safety" inspection model explored in Luojiang District, Deyang City, Sichuan Province, provides a technical way out of this predicament. The scheme uses unmanned aerial vehicles equipped with high-precision optical lenses and LiDAR to carry out high-frequency, full-coverage low-altitude aerial photography of the consolidation area, and then applies deep learning algorithms to automatically identify abnormal features such as slope cracks, soil layer slippage and excessive stacking height, and to classify risk levels and spatially locate hidden danger points. Practical data show that this model has raised the overall efficiency of inspection by more than 40%, while keeping the accuracy of image interpretation at a high and stable level, effectively compressing the time cost of manual re-checking.

The deeper value of intelligent technology goes far beyond "speeding up". More importantly, it endows ecological restoration with the capacity for "adaptive management", that is, a closed-loop governance mindset oriented toward dynamic processes. Conventional supervision is usually limited to node-by-node acceptance, and can hardly capture landform changes in the intermediate states of restoration; by contrast, an AI-empowered inspection system can compare time-series images of the same area and track in real time the evolution curves of indicators such as vegetation recovery, soil and water conservation and slope deformation. Once a trend deviating from the preset threshold appears, the system automatically issues an early warning and generates disposal suggestions. This capacity for real-time tracking and dynamic analysis enables management departments to flexibly adjust construction schemes or replanting measures on the basis of on-site feedback, preventing problems from accumulating into disasters. In this way, intelligent technology transforms ecological restoration from a "one-off project" into "continuous maintenance", which both improves the precision of resource allocation and reduces the risk of secondary ecological disturbance caused by later rework, and thus realizes an upgrading of governance from "treating manifested problems" to "preventing latent problems".

The key to the technical strategy lies in initiating natural processes through moderate human intervention and in using intelligent technology to achieve dynamic monitoring and adaptive management. Close-to-nature restoration addresses the question of "how to initiate natural processes", while intelligent technology addresses the question of "how to track continuously and adjust dynamically". The combination of the two can move ecological restoration from short-term projects to long-term maintenance, and provide a replicable methodological demonstration for similar consolidation projects.

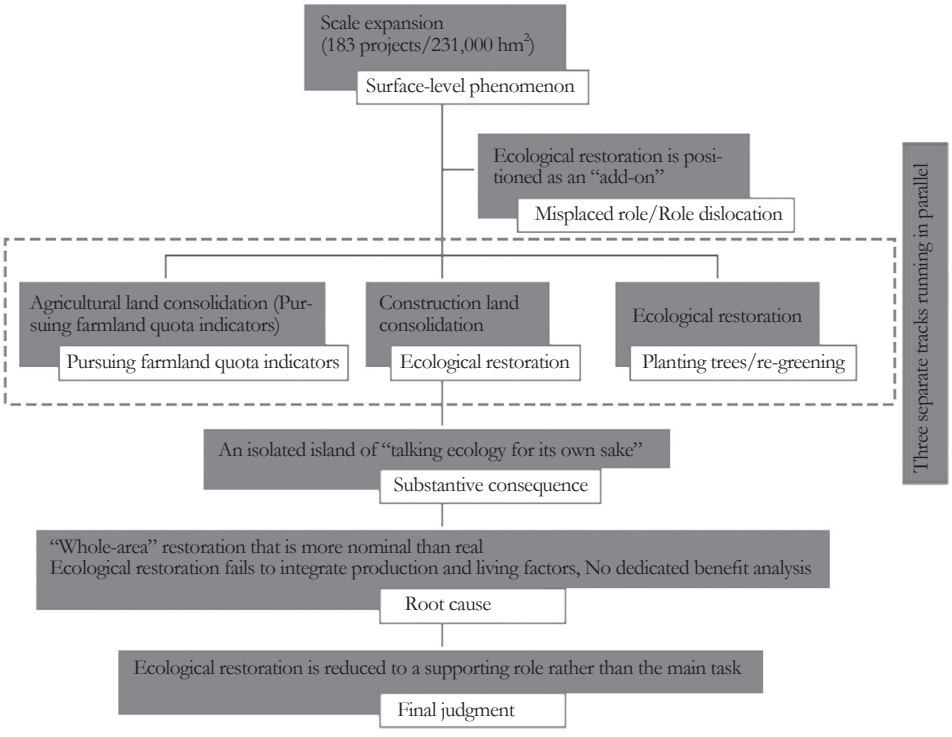

Fig.1 Transition from "single–point restoration" to "systemic regeneration"

4 Institutional strategies: making ecological restoration "profitable"

For ecological restoration to be sustainable, a positive cycle must ultimately be established

on the basis of an "input–output" standard. At present, funding for comprehensive consolidation has largely shifted from "blood transfusion" as the main mode to "blood transfusion and blood formation in parallel", yet investment in ecological restoration still depends heavily on public finance. How to break out of this predicament is the core question that the value mechanism for ecological products must resolve.

4.1 Commercialization of ecological indicators

Part of the ecological benefit obtained through comprehensive consolidation can be converted into value through indicator trading. At present, the trading system for newly added cultivated land indicators is relatively mature, having formed a complete chain from indicator generation, acceptance and warehousing to cross-regional adjustment and trading, with relatively clear price signals and regulatory frameworks. By contrast, new types of ecological benefit indicators—such as carbon sink increments and ecological land increments—still lack market-oriented and standardized trading methods. Baseline determination, additionality demonstration, and monitoring and verification for carbon sinks are still being explored on a pilot basis, and the definition of property rights and the value assessment of ecological land also lack unified norms, so that a large amount of potential ecological revenue cannot enter the trading market.

Under these constraints, some localities have begun to explore diversified operation paths. In Nanshui Town, Guangdong, starting from wetland restoration, the Tamarix resources within the restoration area have been used to develop a series of health-preserving tea products, forming a closed-loop model of "ecological restoration—product development—revenue feedback" that allows ecological benefits to spill over into value through physical products. Meanwhile, ecological compensation remains an important supporting instrument. In its territorial spatial ecological restoration plan, Dayi County has used mechanisms such as central and provincial transfer payments and horizontal ecological compensation within the river basin to make restoration areas benefit directly; at an estimated trading price of 50–100 yuan per ton of carbon dioxide for forestry carbon sinks, potential carbon sink revenue can become a supplementary source of finance, and, together with green financial instruments such as green bonds and ecological banks, forms a diversified pattern of funding sources. These explorations show that only when indicator trading, product operation, fiscal compensation and green finance work in coordination can a sustainable channel for value realization be provided for the ecological benefits of comprehensive consolidation.

4.2 Ecological premium of "consolidation+industry"

The deep transformation of ecological value into economic and social benefits cannot stop at the acceptance of restoration projects or the trading of indicators; it must follow the integrated path of "consolidation+industry", that is, reshaping the regional industrial structure simultaneously with ecological restoration, so that the "scenic beauty" of lucid waters and lush mountains is transformed into the "output value" of invaluable assets.

In Zengcheng District, Guangdong, an abandoned mine pit—an ecological scar left over from history—was used to complete systematically 14 ecological restoration projects covering water body treatment, mountain re-greening, soil improvement, shoreline reorganization, forest form transformation and farmland recovery, building a composite landscape system in which "river, lake, shoreline, forest and farmland" coexist organically. This reshaping of the ecological base has not only eliminated hidden geological hazards and improved the regional microclimate, but has also given rise to new business formats centered on ecological sightseeing, rural homestays, nature education and farming experience. At present, Zengcheng District attracts more than 3 million visitor trips each year and directly or indirectly secures the livelihood of more than 1,500 people[7]; the collective economic income of surrounding villages has nearly tripled compared with that before restoration. This "ecological premium" does not rely on a ticket economy or one-off land transfer; rather, by raising ecological quality it drives up land value, the brand premium of agricultural products and the willingness of external investors in tandem.

The exploration of Dayi County, Sichuan, is equally exemplary. In its territorial spatial plan the county treats ecological restoration as a prerequisite constraint and guiding instrument, and coordinates the construction of the Giant Panda National Park and 13 biodiversity conservation projects, covering the connectivity of rare species habitats, the restoration of water conservation forests and the reconstruction of native plant communities. Although these restoration projects have not generated direct cash flow in the short term, they have significantly raised the region's ecological recognizability and environmental carrying capacity, making Dayi one of the most "ecologically attractive" counties on the periphery of the Chengdu metropolitan area. According to local statistics, after the implementation of the restoration plan, green investment in eco-tourism, nature study and wellness vacations has followed, and has cumulatively provided local employment for about 50,000 people, many of them laborers returning from traditional agriculture or migrant work.

From Zengcheng to Dayi, a common experience is emerging: the "premium" of ecological restoration does not occur automatically; it requires "consolidation" and "industry" to be superimposed in space, coordinated in time and interlocked in mechanism. Policy design in the next stage should pay more attention to the "industrial compatibility" of ecological restoration plans, introducing market demand assessment in the fields of culture and tourism, agriculture and wellness at the project approval stage, and incorporating composite indicators such as employment generation and investment leverage into restoration performance appraisal. Only in this way can ecological value move from "numbers on the books" to "dividends in daily life", and can a sustainable development loop be realized in which the ecological, social and economic dimensions benefit simultaneously.

5 Conclusion

What is lacking in ecological restoration within comprehensive land consolidation is not technology, but a paradigm. "Single-point restoration" treats ecology as an object of protection, whereas "systemic regeneration" treats ecological restoration as a source of value. If ecological restoration is moved from a "cost item" to an "investment item", and from "passive protection" to "active operation", it will no longer be an "add-on" to consolidation pro-jects, but a fundamental driving force of comprehensive land consolidation. Therefore, the four dimensions of concept, space, technology and institution must work in coordination. More fundamentally, this is a cognitive shift: ecological restoration should not take the land's "return to its original state" as the standard, but should aim at "becoming more valuable". This is both a respect for nature and a proper attitude toward ecological development.

References

[1] Qin, Z., Sun, L.X. (2026). Research on technologies for ecological environment protection and restoration in comprehensive land consolidation. *Urban Construction Theory*

(To be continued in P40)

structure. The "technology display + cultural and creative experience" reuse model balances historical context, industrial technology display, and regional economic development. It can serve as a reference for the reuse of other industrial heritage architectural remains.

References

[1] Douet, J. (Ed.). (2016). *Industrial heritage re-tooled*: *The TICCIH guide to industrial heritage conservation* (*1st ed.*). New York: Routledge.

[2] Chen, B. W., Zhang, H. F., Wei, X. Y., et al. (2025). Industrial heritage in China: Spatial patterns, driving mechanisms, and implications for sustainable reuse. *ISPRS International Journal of Geo-Information*, *15*(1).

[3] Chen, J. (2020). Visualising data for industrial heritage reuse studies: A case in Chongqing, China. *Proceedings of the 24th International Conference Information Visualisation* (*IV*). Electr Network.

[4] Liu, F., Zhao, Q., Yang, Y. (2018). An approach to assess the value of industrial heritage based on Dempster–Shafer theory. *Journal of Cultural Heritage*, *32*, 210-220.

[5] Sun, Q. C. (2015). On the protection and utilization of China's cultural heritage in the digital age: An exemplification of Shaanxi Province. *Journal of Ankang College*, *27*, 87-92.

[6] Liu, Y., Li, H., Li, W., Li, Q., Hu, X. (2021). Value assessment for the restoration of industrial relics based on analytic hierarchy process: A case study of Shaanxi Steel Factory in Xi'an, China. *Environmental Science and Pollution Research International*, *28*, 69129-69148.

[7] Mushtaha, E., Shamsuzzaman, M., Abdouli, S. A., Hamdan, S., Soares, T. G. (2020). Application of the analytic hierarchy process to developing sustainability criteria and assessing heritage and modern buildings in the UAE. *Architectural Engineering and Design Management*, *16*, 329-355.

[8] Dalkey, N., Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management Science*, *9*, 458-467.

[9] Khan, M. R., Alam, M. J., Tabassum, N., Khan, N. A. (2022). A systematic review of the Delphi–AHP method in analyzing challenges to public-sector project procurement and the supply chain: A developing country's perspective. *Sustainability*, *14*, 14215.

[10] Qiao, Y. L., Wang, J. P., Wang, Y. G. (2024). Sustainability evaluation of green building construction based on a combination method of weighting and improved matter-element extension. *AIMS Mathematics*, *9*(9), 24418-24442.

[11] Wuxi proposal—Focusing on industrial heritage conservation in a period of high economic development. (2006). Wuxi: Archicreation.

[12] Zhao, W. K., Zhou, B. (2022). Out of the dilemma: Industrial heritage value evaluation and renewal suitability research in Chengdu, China. *Journal of Urban Planning and Development*, *148*(2).

[13] Taipei Declaration for Asian Industrial Heritage—TICCIH. (n.d.). Retrieved January 28, 2025, from https://ticcih.org/about/charter/taipei-declaration-for-asian-industrial-heritage/

[14] Wind, Y., Saaty, T. L. (1980). Marketing applications of the analytic hierarchy process. *Management Science*, *26*, 641-658.

[15] Saaty, T. L. (1982). The analytic hierarchy process: A new approach to deal with fuzziness in architecture. *Architectural Science Review*, *25*, 64-69.

****

(Continued from P34)

Research (*Electronic Edition*), (7).

[2] Pang, H.X. (2026). Theoretical construction and measures of comprehensive land consolidation and ecological restoration. *Practical Rural Technology*, (6), 114-116.

[3] Xu, H.Z. (2021). Mechanism and implementation path of comprehensive land consolidation in promoting rural revitalization. *Guizhou Social Sciences*, (5), 144-152.

[4] Wang, C., Hu, Q. & Yuan, D.P., et al. (2025). Exploration of the construction of a city-level green ring with multi-dimensional growth: practice of the Chengdu Ring City Ecological Park. *Dwelling*, (8), 145-148.

[5] Zhu, Y., Wang, Y.M. & Liu, M. (2025). Countermeasures for comprehensive land consolidation and ecological restoration in territorial spatial planning. *Rural Scientific Experiment*, (18), 33-35.

[6] Sun, G.Y., Wu, C.Y. & Li, X.R. (2026). Path of comprehensive land consolidation for the coordination of cultivated land protection and ecological restoration. *Ecological Environment Protection and Restoration*, *39*(6), 80-82.

[7] Wan, Y.J., Wu, D.F. (2026). Integration logic and realization path of comprehensive land consolidation and the combined supply of natural resource assets under the modernization of territorial spatial governance. *China Resources Comprehensive Utilization*, *44*(6), 125-128, 233.