Research Paper

Uneven Green

Exploring the Spatial Linkages between Ecological Restoration and Socio-Economic Recovery in Post-Industrial Landscapes

Chenyang PAN, The University of Edinburgh, United Kingdom

Abstract

As globalisation accelerates, how traditional industrial bases can achieve a coordinated transformation of both economy and ecology has become a key issue in global industrial transition. Existing research mainly focuses on economic and social policies, but lacks exploration of the spatial coupling mechanisms between ecological restoration and economic revitalisation in the context of resilience and ecological renaissance. In the process of ecological restoration, heavy industrial regions often face intertwined socio-economic and ecological spatial challenges, including exacerbated inequalities, ecosystem degradation, and spatial fragmentation, which in turn hinder coordinated regional development. This study aims to explore the spatial coupling relationship between ecological restoration and economic revitalisation in abandoned heavy industrial areas within the context of ecological-economic transition, as well as their spatial distribution characteristics and underlying mechanisms.

Taking the ecological restoration of the River Leven catchment in the UK as a case study, this research integrates GIS spatial analysis and multiple regression methods to investigate the spatial coupling mechanisms between land re-greening and socio-economic revitalisation. Firstly, remote sensing data and urban statistical data are used to obtain the Normalised Difference Vegetation Index (NDVI) for each spatial unit within the catchment, reflecting the status of ecological restoration. In addition, data on regional Gross Domestic Product (GDP), employment rate, and the Index of Multiple Deprivation (IMD) are collected to comprehensively assess regional economic revitalisation and social vulnerability. Using GIS platforms for spatial registration and overlay analysis, the study reveals the spatial distribution characteristics, clustering patterns, and spatial heterogeneity of land re-greening and socio-economic revitalisation at the catchment scale. Furthermore, multiple regression and geographically weighted regression (GWR) are employed to analyse the spatial correlations.

The results show that the degree of land re-greening and the level of socio-economic revitalisation in the River Leven catchment are significantly positively correlated in spatial terms. High-value clusters are mainly concentrated in the mid-upper reaches of the catchment and surrounding western settlements, such as Kinross, where ecological restoration has been particularly effective and economic and social conditions are generally favourable. In contrast, the lower reaches of the catchment, including Levenmouth and its surrounding areas, appear as high-deprivation zones on the Index of Multiple Deprivation (IMD) map, indicating relatively weaker economic and social conditions. The results of multiple regression and geographically weighted regression (GWR) further reveal that for every 0.1 increase in NDVI, GDP rises by approximately 2.7% and employment rate by 1.9%, while the Index of Multiple Deprivation (IMD) decreases, indicating that ecological restoration has significantly improved the economic and social conditions in disadvantaged areas. It is noteworthy that the distribution of ecological restoration investment within the catchment is uneven. For example, the cumulative area of ecological restoration land in the mid-upper reaches and western regions (such as around Kinross) accounts for 41.3% of

the total catchment, while the ecological restoration coverage rate in high-deprivation areas is less than 15%. This disparity in distribution has also exacerbated local economic and social inequalities.

This study confirms the spatial coupling mechanisms between ecological restoration and economic revitalisation in the transformation of heavy industrial regions. The spatial disparities in land ecological restoration directly affect both the equity and pace of socio-economic revitalisation. Future socio-economic policies should focus on the coordination of land ecological restoration, promoting the allocation of ecological restoration resources towards disadvantaged and high-deprivation areas. This will deepen the understanding of synergistic mechanisms within the ecological-economic-social system and enhance the overall social inclusiveness and resilience of the region.

Keywords

Ecological Restoration, Economic Revitalisation, Spatial Inequality

1. Introduction

As factories and heavy industries shut down around the world, many regions that once depended on them are now facing major changes. These places are dealing with social, environmental, and economic problems all at once. Old industrial areas, especially those built around coal and steel, are being reshaped by the global move toward cleaner energy. Governments and individuals want safer energy, cleaner air and a more stable climate, which is the reason for this shift. This shows that the desire to reduce pollution is increasing. Therefore, in order to achieve more environmentally friendly and sustainable growth, the economic manifestation of dependence on fossil fuels in the past is trying to transform (Ioj et al., 2014; Macaulay, 2018; Svopova et al., 2021). On the other hand, regions that have long relied on coal and heavy industry face major problems. Job losses, slowing economic growth, and land destruction are problems faced by many places (Svobodova, 2020). Their challenge isn't just clean-energy transformation. In addition, they need to restore the local economy and natural environment (Johnston & Cushing, 2020; Anokye & Darko, 2025).

Over time, these changes can bring new opportunities for green development and stronger communities. Due to deforestation, land loss and rapid urban development, it has become more difficult for many developing countries to rebuild their natural and local economies. Kanger et al. (2023) believed that the traditional industrial development mode consumes too many natural resources. Therefore, low-carbon systems are needed. These areas must rebuild their economies and cities in a fairer and more balanced way in order to achieve real progress.

The decline of post-industrial areas is not the only sign. They are places where humans and nature are constantly changing. In these areas, the restoration of the environment is closely linked to the creation of new jobs and the reconstruction of community life. However, these areas still face major problems. Recovery requires significant industry and environmental change (Meenar et al., 2025).

Many historic industrial cities have seen factory closures and land destruction. These cities are full of hope because of the environmental restoration. However, this work does not only involve fixed land. This means reintegrating scattered communities and repairing outdated infrastructure. Throughout the process, the connection between nature and people is crucial. Parks, forests and wetlands support the local economy by providing basic resources. Building community ties helps rebuild social life. (Fan et al., 2017 ; Dogan et al., 2023). Nature-based approaches, such as establishing green parks and improving urban ecosystems can

make cities cleaner and healthier. In addition, these projects can improve people's quality of life, create employment opportunities, and promote the recovery of the local economy (Li et al., 2025). Some cities, such as Shanghai and Barcelona, have transformed old factories into green public spaces to attract tourists and businessmen (Fan et al., 2017).

These projects may not produce the same benefits for each community. It is often difficult to balance the fairness and inclusiveness of a fixed environment where resources are scarce (Rahman et al., 2024). Equal access to green space is common in many old industrial areas. In the industrial age, these communities suffered from pollution and poor health. Now, as they work to recover, they also yearn for fairness and justice (Foster and Sandberg, 2014).

In many cases, the funds and projects used for repairs have not been shared fairly. Wealthier areas tend to be greener faster, while poorer neighbourhoods lag behind. This makes the social gap bigger and bigger. Environmental justice is very important here. Many local groups are committed to ensuring that everyone, including low-income and minority residents, has access to parks and green projects (De Sousa Silva et al, 2018; 2022, Das). Nevertheless, there are still many problems. In places that relied on heavy industry in the past, old problems often limited the effectiveness of repair work. Fixing the environment is helpful, but it can't undo the damage of the past or address deep social inequalities (Zografoss & Robbins, 2020).

'Green gentrification ' is another problem. When new green projects improve a region, house prices usually rise. Low-income families may be excluded. This has led to further deterioration of inequality. This applies particularly to communities struggling to survive (Jennings et al., 2012; Angelofski, 2016). Many studies have examined the relationship between economic recovery and environmental recovery. However, few people have studied their mutual influence in different fields. Most studies focus on either environmental or economic aspects, rather than both. In addition, few people pay attention to how resource inequality exacerbates social inequality. In many post-industrial areas, wealthy communities usually get more help and recover faster. Poorer communities need more time to recover. This is why the gap between them is growing. New green projects may crowd out long-term residents in some cities. Therefore, their retention becomes more difficult. Although this issue has been discussed, few studies have focused on how neighbourhood cohesion and residents' emotional ties in these areas.

This study focuses on how environmental repair and economic recovery work together in old heavy-industry zones. It looks at how these two processes are spread out across space and how they affect each other. The aim is to find out how cities can restore nature and rebuild the economy at the same time without making inequality worse. Meanwhile, this study reveals ways to make both environmental and social progress possible, even when resources are not shared equally.

This study addresses three core questions.

1. What is the link between environmental restoration and economic recovery across space? Specifically, do these two mechanisms influence each other in different areas? Furthermore, how does this relationship show up in the speed and quality of recovery from place to place?
2. How does uneven development of environmental restoration resources affect justice in economic recovery? In old industrial regions, does the way these resources are spread make it harder for poorer or less-connected groups to benefit? How does this imbalance influence the distributive justice of neighbourhoods during the revitalisation phase?
3. In what ways do spatial analytics support uncovering inequality in regional recovery? Can empirical spatial techniques map the geographic distribution of environmental restoration advantages?

Moreover, to what extent do these methodologies elucidate the impact on local economies and equitable development?

2. Methodology

2.1. Case Study Area: River Leven Catchment, United Kingdom

This study aims to explore the River Leven catchment in central Scotland, which is a typical post-industrial area (see Figure 1). The river starts from Loch Leven near Kinross and flows southeast through towns like Glenrothes and Cardenden. It forms a long and narrow drainage area (see Figure 2). In the past, the River Leven catchment was full of life and industry. There were hundreds of mills, factories, and even a busy port and many miners, mill workers, and factory labourers made a living from this. But now, most factories have closed down, leaving behind empty land and abandoned buildings as these industries have declined. So that unemployment remains high, the majority of the residents face low well-being. In some parts of the catchment, up to 45% of people live in areas ranked among the most deprived in Scotland (Vale of Leven, n.d.).

The river currently isolates adjacent neighbourhoods and exhibits severe ecological damage. It has been transformed from a community connector into a spatial divider, notably pollution and habitat degradation, resulting from years of industrial activity. To address these issues, the region has started several ecological restoration and sustainable projects that include cleaning up the river and creating new wetlands (see Figure 3). The goal is to improve the local environment and support social and economic recovery.

This catchment is chosen for the study for three main reasons. First, its clear history of industrial decline makes it a good example of how environmental recovery and economic revival work together. Second, it combines both active restoration projects and existing social problems, which provides real-world evidence for exploring how unbalanced resource distribution affects recovery. Third, the area has a complete data reserve that provides reliable information on the environment, land use, and social and economic factors, which are useful for mapping and statistical analysis.

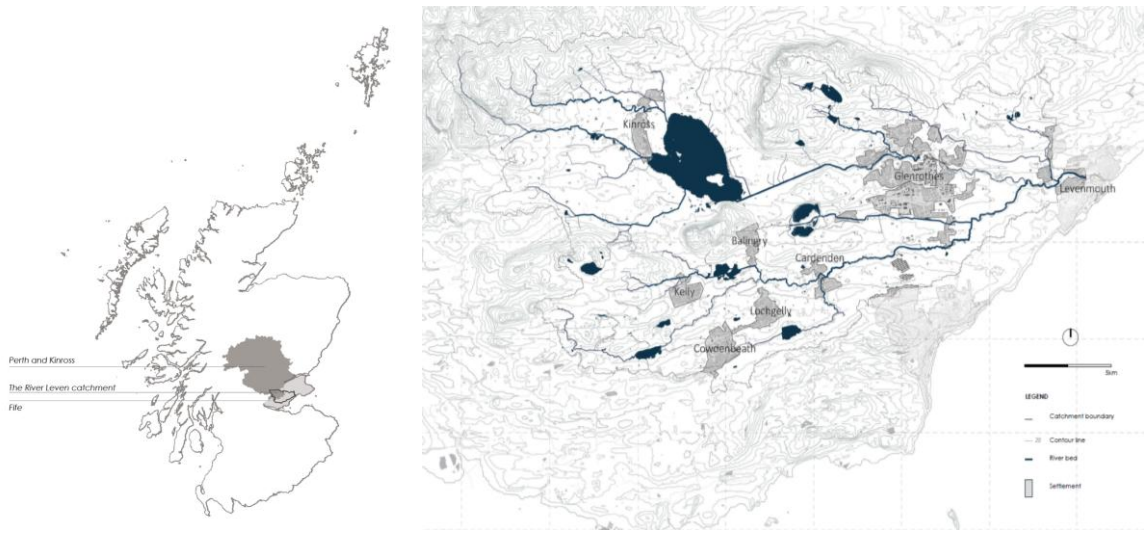

Figure 1 (left). Location of the Case Study Area. Source: Scotland Councils. Drawn by the author
Figure 2 (right). River Leven Catchment. Source: Digi map. Drawn by the author



Figure 3. Current Situation. Source: photography by the author

2.2. Data Sources and Variable Definitions

This study uses data from satellite images and social and economic statistics. Existing research has been able to prove that the Normalised Difference Vegetation Index (NDVI) is an effective method to measure the ecological restoration status of this area (Valtonen et al., 2021). Moreover, the Index of Multiple Deprivation (IMD) provides information about poverty and social disadvantage across regions (MHCLG, 2019). On this basis, this study uses NDVI to describe environmental recovery, and social and economic recovery are measured through observing different indicators. The study also adds some control factors to make the results more reliable.

2.3. Regression Analysis and Spatial Heterogeneity Testing

At first, this study sets up a multiple linear regression model to examine how environmental recovery, shown by NDVI, connects with social and economic recovery, shown by GDP growth, higher employment rates, and IMD. The model is written:

$$Y_i = \beta_0 + \beta_1 \text{NDVI}_i + \beta_2 X_{i2} + \cdots + \epsilon_i$$

NDVI_i is the vegetation index for that unit, X_{i2}, …are the control variables where Y_i represents the socio-economic revival indicator for the i-th spatial unit, and ϵ_i is the error term. This model helps identify the overall relationship between ecological restoration and socio-economic revival. Previous studies have shown that vegetation cover is positively correlated with wealth and economic conditions.

The study also takes into account that spatial relationships may not stay the same across all areas. To find these differences, the study uses a Geographically Weighted Regression (GWR) model. This model helps show how the relationships vary across different regions. The GWR model is written like this:

$$Y_i = \beta_0(u_i, v_i) + \beta_1(u_i, v_i)\,\text{NDVI}_i + \beta_2(u_i, v_i)\,X_{i2} + \cdots + \epsilon_i$$

Where (u_i, v_i)represents the coordinates of the i-th spatial units, helping to understand how ecological restoration effects vary across different locations.

This study explores the interaction between environmental recovery and economic growth changes across different places. The analysis shows the strength of this connection and helps explain why these differences happen, promoting useful ideas for making better policies and practical plans.

3. Results & Discussion

The research results show a clear positive link between land greening and social and economic recovery in the River Leven catchment (see Figures 4 and 5). The upper and middle parts of the catchment, such as the western areas like Kinross, have higher NDVI values and stronger signs of environmental recovery. In these places, greening projects have made real progress. Biodiversity has grown, and the quality of residents' living conditions has improved with more green spaces, and these achievements in restoring nature have also helped local economies. Therefore, areas with better environmental conditions often have more jobs, higher incomes, and stronger infrastructure in the Leven catchment.

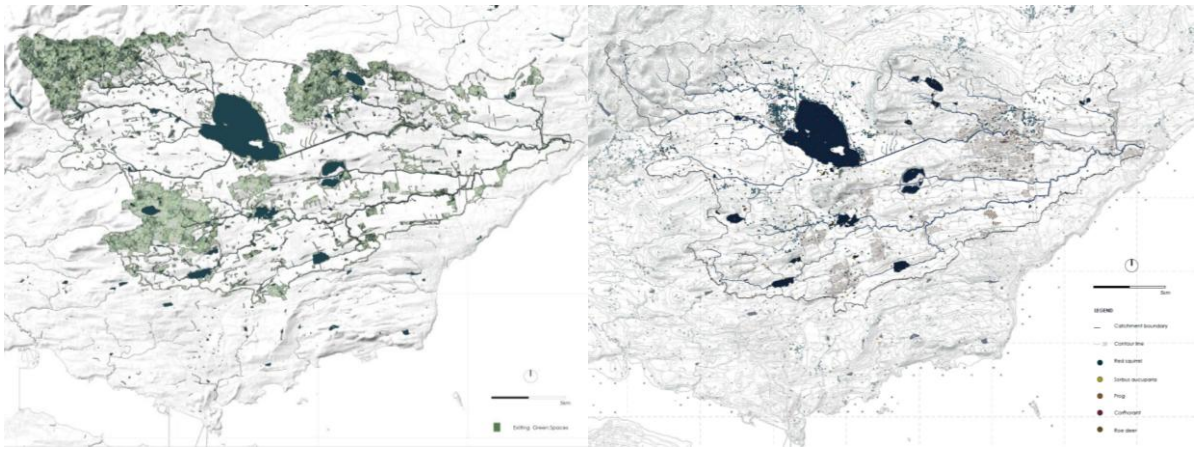

Figure 4 (left). River Leven Catchment NDVI. Source: Scottish Forestry. Drawn by the author
Figure 5 (right). Representative Biodiversity Distribution. Source: Digi Map. Drawn by the author

However, the situation is more complex in the downstream areas of the catchment, particularly in Levenmouth and its surrounding regions, where higher levels of deprivation are shown and the economic revival process has significantly lagged (see Figure 6). The prolonged industrial decline and ecological degradation have resulted in insufficient investment in ecological restoration. The low levels of land revegetation in these high-deprivation areas have directly impacted local intensifying inequality between regions. Many factors contribute to the low levels of revegetation in these areas when these regions face insufficient funding and low public investment. Furthermore, historical social segregation and economic vulnerability have led to a lack of motivation among local governments and communities to promote ecological restoration, thereby deepening the vicious cycle between poverty and ecological degradation. Therefore, ecological restoration is not only an environmental issue but a crucial factor in achieving social equity and economic opportunity. Especially, ecological restoration often becomes an important component for achieving socio-economic revival in resource-limited areas.

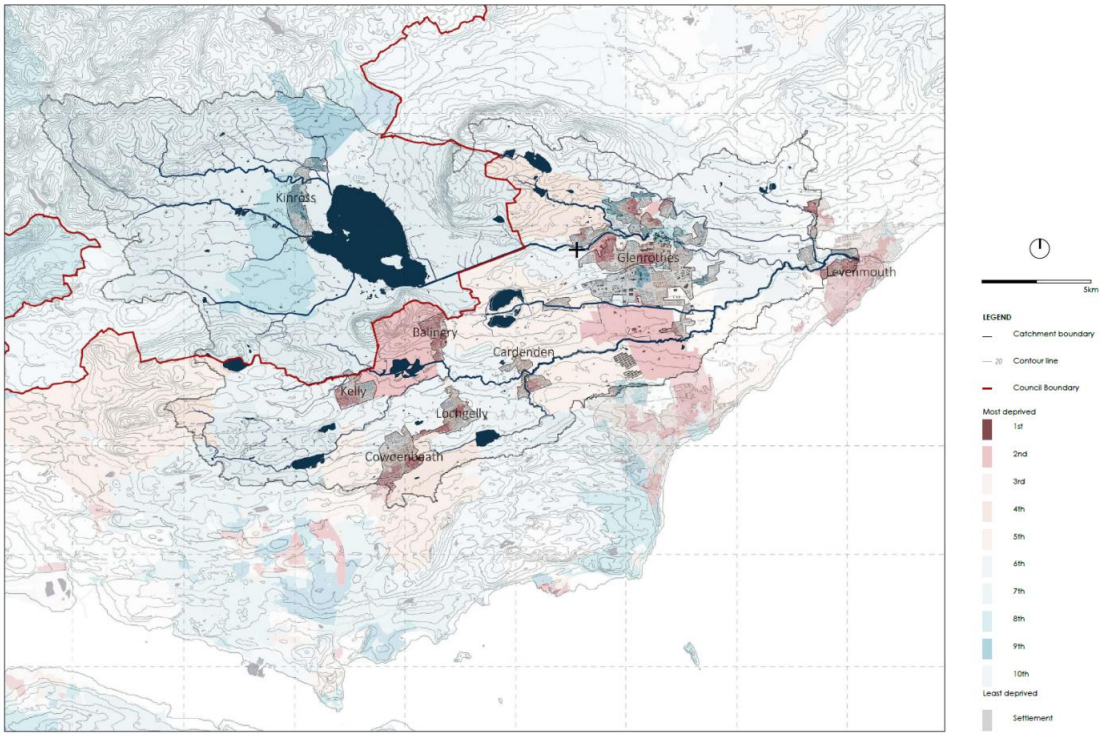

Figure 6.The difference in deprivation indices of the catchment. Source: Digi Map. Drawn by the author

The spatial coupling mechanism between land vegetation restoration and socio-economic revival to explore further through multiple regression analysis (OLS) and geographically weighted regression (GWR) models. The results show a significant positive correlation between the degree of land vegetation restoration and the GDP growth rate. Specifically, for each 0.1 increase in NDVI, GDP will rise by about 2.7 %. This finding indicates that ecological restoration can effectively promote regional economic development. At the same time, the results of the GWR model display that the relationship has spatial variability in different geographical locations. The impact of land vegetation restoration on economic growth is particularly obvious in the upstream and western regions of the basin; this effect is relatively weak in the downstream and high deprivation areas, which also highlights the obvious spatial differences.

The underlying causes of this spatial heterogeneity are diverse. On the one hand, rich areas usually receive more government support and private investment, which helps to obtain more funds and resources for ecological restoration, thus accelerating the process of vegetation restoration (World Bank, 2023). On the other hand, ecological restoration in poor and highly deprived areas is slow due to factors that limit financial resources and insufficient government support. In addition, these areas usually face higher land use pressure and environmental degradation, which increases the difficulty and cost of restoration work. Therefore, the success of ecological restoration depends not only on environmental improvement, but also on social capital, community participation and policy support.

It is worth noting that the basin reflects a significant imbalance in the allocation of ecological restoration resources. According to the study, the ecological restoration area in the upper and western parts of the catchment accounts for 41.3 % of the total area of the catchment. For example, the area close to Kinross includes more ecologically protected areas and important Special Scientific Interest Points (SSSIs) (see Figure 7). In contrast, ecological restoration coverage was less than 15 % in the southeast and some high-deprivation areas. The uneven distribution of resources has exacerbated the economic and social gap,

especially in areas where the ecological restoration process is lagging, failing to alleviate economic vulnerability and social inequality.

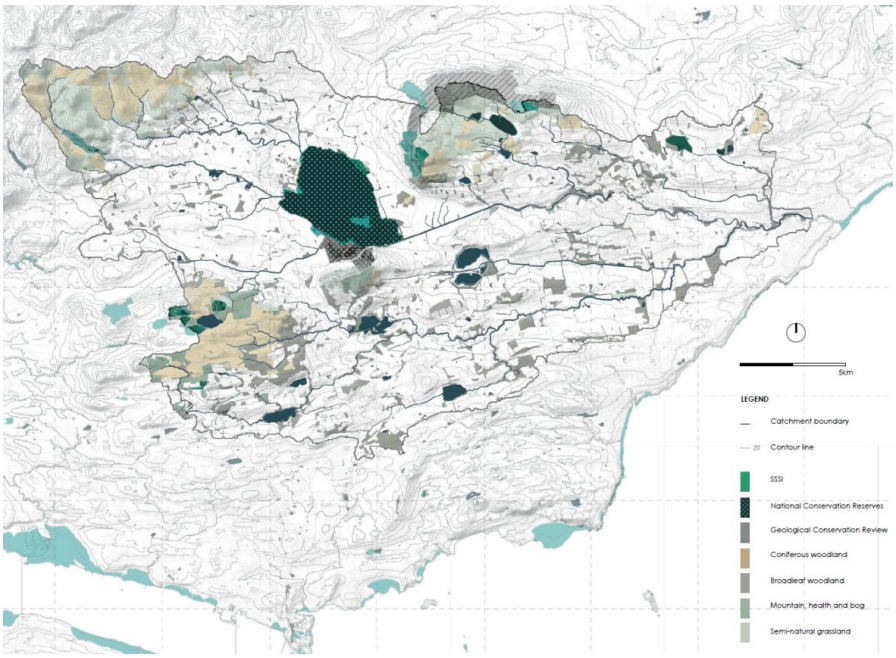

Figure 7. Distribution of Nature Reserves. Source: Digi Map. Drawn by the author

From the perspective of natural and social relations, restoration work is more effective in wealthy areas such as Kinross. One reason is that these areas have stronger community ties. Studies have shown that repair depends not only on funding, but also on active community participation and good local governance (Durant et al., 2023; Dai et al., 2024). These factors not only promote local social connections but also help the project go smoothly. Poor areas such as Levenmouth lack community participation and government support. Because of this, social ties are still weak, and environmental projects cannot reach their full potential. This shows that in old industrial areas where social recovery is needed, building strong community links is crucial.

This study shows that environmental restoration is not just a natural improvement. This is an important way to promote social and economic recovery. In old industrial areas, especially in poor areas, the focus of restoration should be on repairing the environment and building a stronger community network. At the same time, ensuring the fair distribution of resources is crucial. Local policies must be clear and inclusive. Governments should ensure that poor and low-income areas can participate in and benefit from environmental projects. Only in this way can a more equitable and balanced recovery of society and the economy be achieved.

4. Conclusion

This study focuses on the River Rive basin in the UK to understand the social and economic impacts of natural restoration. The results show that there is a significant positive correlation, especially in the upper and western parts of the basin. In these areas, the repair work has achieved good results. The environment is more beneficial. People get better jobs, income and quality of life. The problem is greater in the lower catchments, such as Levenmouth, and in the poorer surrounding areas. These places received less repair funds. This makes the existing inequality more serious.

The results show that even in resource-poor places, repairing the environment is good for the local economy and community life. However, if resources are shared unfairly, progress will slow down. In poor areas, the project is small in scale, limited in funds, and low in public participation. Because of this, these regions recover more slowly and have less fairness. In addition, the study found that the links between environmental work and strong communities vary in different regions. Wealthy areas perform better because they have more policy support and active community groups. In poorer areas, fewer participants and supporters usually lag behind others.

This research helps us understand how to fix nature and how communities can work together. It shows the impact of these efforts on many different areas. In addition, it shows that if repair resources cannot be allocated fairly, social inequality will be further aggravated. According to research, environmental work should not only focus on nature. In addition, it should help rebuild communities and make things fairer for everyone. This study gives clear policy recommendations in practice. It says funds should be allocated more fairly when projects are resumed. In addition, it shows that more people should participate, especially in low-income areas, so that everyone can benefit.

In addition, the study shows that cooperation from different fields is crucial, such as environmental science, economics and social studies. Using maps and simple models helps to show how these systems interact with each other and how they change in different regions. In addition, research shows that community participation and government support are critical to successful recovery, especially in poor and unequal areas. However, collecting reliable data in these places is still a challenge.

This research method can be used in other cities or old industrial areas. Simple models and maps can help researchers and policymakers understand the impact of fixed environments on local economies and communities. Using this method can promote fair and balanced development in more places, especially in places with few resources and large social gaps. In this case, this study provides practical tools and useful guidance to achieve a fair and sustained recovery.

5. References

Agyeman, J. (2005) *Sustainable communities and the challenge of environmental justice*. New York, NY, USA: New York University Press.

Alrayyan, K.M. (2026) 'Decision-making processes for parkification: Developing an evaluation framework through the transformation of post-industrial sites into urban parks', *Cities (London, England)*, 169(106601), p. 106601. Available at: https://doi.org/10.1016/j.cities.2025.106601.

Anguelovski, I. (2016) 'From toxic sites to parks as (green) LULUs? New challenges of inequity, privilege, gentrification, and exclusion for urban environmental justice', *Journal of planning literature*, 31(1), pp. 23–36. Available at: https://doi.org/10.1177/0885412215610491.

Anokye, K. and Darko, L.O. (2025) 'Ecological responses to anthropogenic stress: Restoring degraded landscapes from galamsey activities in Ghana – A review', *Cleaner Waste Systems*, 12(100423), p. 100423. Available at: https://doi.org/10.1016/j.clwas.2025.100423.

Benra, F. *et al.* (2024) 'National ecosystem restoration pledges are mismatched with social-ecological enabling conditions', *Communications earth & environment*, 5(1). Available at: https://doi.org/10.1038/s43247-024-01909-3.

Cohen, D.A. *et al.* (2019) 'Park use and park-based physical activity in low-income neighborhoods', *Journal of aging and physical activity*, 27(3), pp. 334–342. Available at: https://doi.org/10.1123/japa.2018-0032.

Dai, H. *et al.* (2024) 'Communities in ecosystem restoration: The role of inclusive community engagement', *People and Nature*, 6(5), pp. 1352–1365.

Das, D.K. (2022) *Factors and strategies for environmental justice in organized green spaces*. Urban Planning.

De Sousa Silva, C. *et al.* (2018) 'Environmental justice in accessibility to green infrastructure in two European cities', *Land*, 7(4), p. 134. Available at: https://doi.org/10.3390/land7040134.

Dogan, E., Cuomo, F. and Battisti, L. (2023) 'Reviving urban greening in post-industrial landscapes: The case of Turin', *Sustainability*, 15(17), p. 12760. Available at: https://doi.org/10.3390/su151712760.

Durrant, E. *et al.* (2023) 'Existing evidence on the use of participatory scenarios in ecological restoration: a systematic map', *Environmental evidence*, 12(1), p. 27. Available at: https://doi.org/10.1186/s13750-023-00314-1.

Fan, P. *et al.* (2017) 'Nature-based solutions for urban landscapes under post-industrialization and globalization: Barcelona versus Shanghai', *Environmental research*, 156, pp. 272–283. Available at: https://doi.org/10.1016/j.envres.2017.03.043.

Foster, J. and Sandberg, L.A. (2014) 'Post-industrial urban greenspace: justice, quality of life and environmental aesthetics in rapidly changing urban environments', *Local environment*, 19(10), pp. 1043–1048. Available at: https://doi.org/10.1080/13549839.2014.966557.

Galatowitsch, S. (2023) 'Organizational capacity and ecological restoration', *Restoration ecology*, 31(1). Available at: https://doi.org/10.1111/rec.13757.

Iojă, C.I. *et al.* (2014) 'The potential of school green areas to improve urban green connectivity and multifunctionality', *Urban forestry & urban greening*, 13(4), pp. 704–713. Available at: https://doi.org/10.1016/j.ufug.2014.07.002.

Jennings, V., Johnson Gaither, C. and Gragg, R.S. (2012) 'Promoting environmental justice through urban green space access: A synopsis', *Environmental justice*, 5(1), pp. 1–7. Available at: https://doi.org/10.1089/env.2011.0007.

Johnston, J. and Cushing, L. (2020) 'Chemical exposures, health, and environmental justice in communities living on the fenceline of industry', *Current environmental health reports*, 7(1), pp. 48–57. Available at: https://doi.org/10.1007/s40572-020-00263-8.

Kanger, L. *et al.* (2023) 'Long-term country-level evidence of major but uneven ruptures in the landscape of industrial modernity', *Environmental innovation and societal transitions*, 48(100765), p. 100765. Available at: https://doi.org/10.1016/j.eist.2023.100765.

Li, Y. *et al.* (2025) 'A systematic review of nature-based solutions to urban hazards through the lens of environmental justice', *Human Settlements and Sustainability*, 1(1), pp. 1–14. Available at: https://doi.org/10.1016/j.hssust.2024.12.002.

Mccauley, D. (2018) 'Just transition: integrating climate, energy and environmental justice Energy Policy', *energy and environmental justice Energy Policy* [Preprint].

Meenar, M. *et al.* (2025) 'Mapping the emotional landscapes of parks in post-industrial communities enduring environmental injustices: Potential implications for biophilic city planning', *Cities (London, England)*, 158(105692), p. 105692. Available at: https://doi.org/10.1016/j.cities.2024.105692.

MHCLG (Ministry of Housing, Communities & Local Government) (2019) *English indices of deprivation 2019: research report*.

Otto, I.M. *et al.* (2020) 'Social tipping dynamics for stabilizing Earth's climate by 2050', *Proceedings of the National Academy of Sciences of the United States of America*, 117(5), pp. 2354–2365. Available at: https://doi.org/10.1073/pnas.1900577117.

Rahman, M.S. *et al.* (2024) 'Unveiling environmental justice in two US cities through greenspace accessibility and visible greenness exposure', *Urban forestry & urban greening*, 101(128493), p. 128493. Available at: https://doi.org/10.1016/j.ufug.2024.128493.

Rockström, J. *et al.* (2017) 'A roadmap for rapid decarbonization', *Science (New York, N.Y.)*, 355(6331), pp. 1269–1271. Available at: https://doi.org/10.1126/science.aah3443.

Svobodova, K. (2020) 'Complexities and contradictions in the global energy transition: a re-evaluation of country-level factors and dependencies Appl', *Energy* [Preprint].

Svobodova, K., Owen, J.R. and Harris, J. (2021) 'The global energy transition and place attachment in coal mining communities: Implications for heavily industrialized landscapes', *Energy research & social science*, 71(101831), p. 101831. Available at: https://doi.org/10.1016/j.erss.2020.101831.

Valtonen, A. *et al.* (2021) 'Remotely sensed vegetation greening along a restoration gradient of a tropical forest, Kibale National Park, Uganda', *Land Degradation and Development*, 32(18), pp. 5166–5177. Available at: https://doi.org/10.1002/ldr.4096.

World Bank (2023) *Blueprints for Private Investment in Ecosystem Restoration: Executive Summary* (no date). Washington DC: World Bank.

Zografos, C. and Robbins, P. (2020) 'Green sacrifice zones, or why a green New Deal cannot ignore the cost shifts of just transitions', *One Earth (Cambridge, Mass.)*, 3(5), pp. 543–546. Available at: https://doi.org/10.1016/j.oneear.2020.10.012.