Article

Managing Rather Than Avoiding “Difficulties” in Building Landscape Resilience

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Abstract: Building landscape resilience inspires the cultivation of the landscape’s capacity to recover from disruption and live with changes and uncertainties. However, integrating ecosystem and society within such a unified lens—that is, socio–ecological system (SES) resilience—clashes with many cornerstone concepts in social science, such as power, democracy, rights, and culture. In short, a landscape cannot provide the same values to everyone. However, can building landscape resilience be an effective and just environmental management strategy? Research on this question is limited. A scoping literature review was conducted first to synthesise and map landscape management change based on 111,653 records. Then, we used the Nuozhadu (NZD) catchment as a case study to validate our findings from the literature. We summarised current critiques and created a framework including seven normative categories, or common difficulties, namely resilience for “whom”, “what”, “when”, “where”, “why”, as well as “can” and “how” we apply resilience normatively. We found that these difficulties are overlooked and avoided despite their instructive roles to achieve just landscape management more transparently. Without clear targets and boundaries in building resilience, we found that some groups consume resources and services at the expense of others. The NZD case demonstrates that a strategy of building the NZD’s resilience has improved the conservation of the NZD’s forest ecosystems but overlooked trade-offs between sustaining people and the environment, and between sustainable development for people at different scales. Future researchers, managers, and decision-makers are thereby needed to think resilience more normatively and address the questions in the “seven difficulties” framework before intervening to build landscape resilience.

Keywords: critiques; framework; justice; landscape; resilience; socio–ecological systems

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1. Introduction

The relationship between ecological conservation and the livelihood of people who make a living on natural resources is of crucial concern to conserving biodiversity, reducing carbon emissions, reducing poverty, and promoting sustainable development [1,2]. Society’s demands on the environment are increasingly changing and diversifying, and this means that stakeholders now expect a landscape to concurrently fulfil more biophysical and sociocultural functions [3–5]. Landscapes reflect the relationship between human society and natural environment [6,7]. In facing a rapidly changing world, building resilience [8,9] has been proposed to guide environmental management to deal with risks, such as the effects of climate change [10–12]. Building resilience can enhance a landscape’s ability to meet the needs of people, plants, animals, and microorganisms among others [13–16]. Moreover, many scholars suggest managing landscapes for resilience to adapt, recover, or reorganise while facing disturbances [8,17,18]. “Although landscapes will persist in some form, it is unlikely that they will provide the same values to people or habitat for wildlife” (p. 1047) [19], or to every person [20]. Thus, here we ask: Is building landscape resilience

an effective and just management strategy for meeting and coordinating the competing needs of different actors who are dependent on the landscape? In addition, what are the common “difficulties” that should be dealt with by applying this notion in management?

To identify potential conflicts and instruct management, these two research questions need to be asked by researchers, managers and decision-makers before approaching the task of building landscape resilience. A landscape cannot provide the same values to all stakeholders and the prognosis of risks and challenges is also essential as identification or opportunities and benefits [21]. Considering the urgency and need to incorporate resilience into management normatively, we reviewed 111,653 publications on landscape management and summarised the research trends in this area. Building on this discourse, we defined a “seven difficulties framework” and proposed that this framework should be used as a checklist before applying the concept of resilience to the just and sustainable management of landscapes. Then, we exemplified these common difficulties based on our study of the management of the Nuozhadu (NZD) catchment, upper Mekong river. We conclude the paper by highlighting the need to justly and sustainably manage competing landscape needs, goals, and priorities of different actors while conserving the environment.

2. Literature Review

2.1. Review Approaches

A systematic review was initially developed in healthcare in the 1970s and has become a recognised standard for accessing, appraising and synthesising evidence, and has gradually been used in other disciplines [22–24]. Here, a literature review was undertaken, applying the methodological framework (Table 1) of Arksey and O’Malley [25] to understand trends in research for sustainable landscape management.

Table 1. Literature review methods adapted from Arksey and O’Malley [25].

Methodological Framework of Scoping Studies (Arksey and O’Malley, 2005)		Methods	Implementation
1.	Identifying the research question	Clearly articulate the research question based on research goals. Consider the population, intervention and outcomes of interest to establish an effective search strategy.	Goal: Understand the landscape of the underpinned scientific world of sustainable landscape management and the philosophy behind. Research question: What is known in the existing literature about sustainable (outcome) management (intervention) of landscape (population)? Web of Science (WoS) Core Collection (1900–present) including: <ul style="list-style-type: none"> • Science Citation Index Expanded (SCI-EXPANDED)—1900–present; • Social Sciences Citation Index (SSCI)—1900–present; • Arts & Humanities Citation Index (A&HCI)—1975–present; • Conference Proceedings Citation Index- Science (CPCI-S)—1990–present; • Conference Proceedings Citation Index—Social Science & Humanities (CPCI-SSH)—1990–present; • Emerging Sources Citation Index (ESCI)—2015–present; • Current Chemical Reactions (CCR-EXPANDED)—1985–present; • Index Chemicus (IC)—1993–present.
2.	Identifying relevant studies	Choose bibliographic databases, web-based search engines (e.g., Google Scholar) or grey literature source (e.g., organisation websites and thesis repositories).	

Table 1. Cont.

Methodological Framework of Scoping Studies (Arksey and O'Malley, 2005)		Methods	Implementation
3.	Study selection	Boolean operators (use OR, AND, NOT, quotation marks, wildcards and brackets.	(landscape OR ecosystem OR “natural resource” OR *land OR *forest OR reservoir OR marsh OR riparian OR “flood plain” OR meadow OR mountain* OR hill* OR “water bod*” OR vegetation OR “land use” OR wood* OR coast* OR desert OR agriculture* OR park*) AND (manag* OR restor* OR rehabilitat* OR conserv* OR govern* OR admin*) AND (sustain* OR resilien* OR viabil*)
4.	Charting the data	VOSviewer [26,27].	Export searching results (in total 111,653 full records) from WoS to VOSviewer.
5.	Collating, summarising, and reporting the results		Conduct bibliometric mapping (e.g., clustering and network visualation) in VOSviewer and manually reviewing classical and high-citation literature based on mapping results.

To assess the trends in research for sustainable landscape management, we used the VOSviewer developed by Van Eck and Waltman [26] to synthesise and map the change of keywords of 111,653 records (Figure 1) from the Web of Science (WoS) Core Collection from 1988 to 2018 (Figure 2).

Figure 1. Cumulative number of publications on sustainable landscape management accessed by the Web of Science from 1998 to 2021.

Figure 2. Literature mapping of key terms used in publications on sustainable landscape management accessed by the Web of Science from 1998 to 2018, via VOSview.

2.2. Landscape Approaches, Socio-Ecological Systems and Resilience

Landscape approaches that integrate social and ecological systems [28] as socio-ecological systems (SESSs) have attracted an increasing amount of research [29–31]. The strategies and knowledge of landscape management have been challenged by changing expectations for how the land and resources should be managed. This is exemplified by the change of keywords used in publications from conservation and biodiversity (in blue) to sustainability and sustainable development (in green), and resilience and climate change (in yellow) (Figure 2). From the nineteenth century, the approaches to landscape management were to identify ways of solving problems for the traditional utilisation including agricultural production and timber harvesting. The approach was to sustain the natural system's capability to provide the desired products and services [32]. Most prevailing studies at this stage talked about restoration, conservation-based management, and strategies such as the conservation of water and biological diversity [33]; maintenance of soil quality and fertility [34]; prevention of soil erosion [35]; sustainable crop production [36,37]; and forest management, habitat maintenance, and rehabilitation [38,39]. After the Rio Earth Summit in 1992 [40] and the release of the Millennium Ecosystem Assessment [41], an increasing number of studies began to challenge the traditional problem-solving approach. These studies proposed that the purpose of sustainable landscape management is to use ecosystems sustainably and in ways that contribute to human well-being [3,42]. Since the 2000s, more studies have recognised the challenges of living in an increasingly unstable and complex world undergoing global environmental change (e.g., climate, technological, and political change) [42]. These studies challenge the prevailing sustainable exploitation-based strategy which tries to identify and manage an “optimal” point between human needs and the conservation of the environment [43–46]. Integrative and holistic approaches, such as systems thinking, try to provide tools for managers to steer development and stewardship processes towards the desired states [47,48].

An SES is also called a human–nature or human–environment system, and it is a perpetually dynamic and complex system with the continuous interactions of many sub-systems, such as a resource system, resource units, governance system, and users [49–51]. Although the notion of SESs was coined in 1970 [52], it was first transformed into a framework by Berkes et al. [53] around 20 years later [54]. Moreover, its first application by Berkes et al. [53] emphasised the significance of building resilience in natural resource management. Resilience is the ability to adapt, change, and reorganise while coping with disturbance and meeting shocks [55], and building the resilience of SESs to all kinds of disturbance and threats has become a pursuit of many plans and practices of management schemes [56,57].

Thinking of the earth system as dynamic and complex [58], the SES concept has had wide influence, including in finance (e.g., attracting investment in natural capital), policy (e.g., policy design, implementation, and monitoring), governance systems (e.g., trade-offs between conservation and development) [50], and in other fields such as arts, humanities, medicine, and psychology [54]. Furthermore, several frameworks [50,59–61] and conceptual models [62,63] have been developed and applied to SESs to facilitate better policy design and practical management (e.g., urban planning and sustainable agriculture) [59,64–66]. Thus, we argue that sustainable landscape management should not favour either ecology or people under the SES concept. It should seek to avoid irrecoverable damage to an ecosystem's resilience or a human population's sustainable livelihoods, which is especially crucial when a population's livelihoods or well-being is closely connected to an ecosystem and natural resources [7,41,67,68]. Thus, building all parts of landscape resilience, that is the ability to adapt, change, and reorganise while coping with disturbance and meeting shocks, is increasingly important for a just and sustainable world [55,69–71].

The concept of building systems' resilience inspires the cultivation of the systems' capacity to recover from disruption and live with changes and uncertainties, and in doing so, challenges traditional or dominant management schemes [21]. However, many scholars find that integrating ecosystem and society within such a unified lens—that is, building resilience for the whole SES—clashes with a range of cornerstone concepts in social science for politics and governance in human society, such as power, democracy, rights, and culture (Klein et al., 2004, Davoudi et al., 2012, Fabinyi et al., 2014, Meerow and Newell, 2019). Building resilience in all parts of the SESs rather than to particular threats has been one of the main approaches proposed by resilience scholars (Olsson et al., 2014, Walker, 2020). However, this idealistic approach is very difficult to implement in practice, as building the resilience of some groups to certain threats will unavoidably detract from the interests of other groups [21,72–76]. For instance, in managing rivers, different stakeholders compete for conflicting ecosystem services such as fish versus hydroelectricity [77,78]. From a basin perspective, building dams could strengthen the resilience of the local community toward water security, flood mitigation, and affordable energy [78], but would reduce lower-reach communities' food security due to the loss of fish production [79]. From a multi-scale perspective, building dams could increase the global communities' resilience to climate change by reducing carbon emissions [78], but it may also reduce local communities' incomes and food supply [80,81]. Thus, if resilience is improved for all parts of the SESs, trade-offs need to be considered to meet the competing needs of different people at different scales. The kinds of perverse impacts that may be triggered in building resilience, defined as the seven difficulties, are now considered.

3. The Seven Difficulties Framework

The fields of science and social science are increasingly demanding the development of better practices for resilience thinking. Some interdisciplinary groups of researchers, such as the Santa Fe Institute and the Resilience Alliance, have developed frameworks and workbooks to translate this thinking into practice [82,83]. Moreover, some natural source management organisations, such as the Goulburn Broken Catchment Management Authority in Australia, have engaged local communities and developed their management

strategies based on resilience thinking [84], and thinkers have also proposed a range of different methods for assessing and measuring resilience and its changes [84,85]. A milestone is the resilience assessment workbook by Resilience Alliance [86] that uses an issue-based approach and provides worksheets to guide the assessment of resilience [85,86].

However, resilience thinking has also been criticised for the inadequate consideration of peoples' rights, governance, power, and cultural issues [73–91]. Critics argue that resilience thinking grows out of the complex systems theory of Holling [69], depoliticises changes (i.e., shock and disturbance), and overemphasises a unified and scientific approach of “imposed rationality” that is alien to the practices of human societies [74,92–95]. Table 3 summarises current critiques of resilience thinking into seven normative categories, or common difficulties, namely resilience for “whom”, “what”, “when”, “where”, “why”, as well as “can” and “how” we apply resilience normatively.

Table 2. Seven categories of common “difficulties” in building resilience. Source: Author.

Seven Categories of Typical Difficulties	Critiques	Representative Literature
Whom? <i>Setting subjects for resilience: Different actors value different resilience differently</i>	Who desires the current resilience system?	[21,72,73,89]
	Whose resilience is prioritised? For example, the resilience of some groups is achieved at the expense of certain other social groups and regions that bear the costs for resistance, adaptation, restructuring or transformation.	[16,73,74,89,96]
	Who determines what is desirable?	[16,19,21,73,74,89,91,93,97]
	Who is included, and who is excluded?	[16,21,74]
	Some regimes are undesirable by most people but super resilient, e.g., harsh dictatorships, salinized regions, and psychotic states in people.	[21,43,55,73,89,97,98]
	Who is responsible for building resilience?	[21,74,91,96,99]
What? <i>Setting objects for resilience: Resilience off/from what, to what</i>	Unclear meaning of resilience, e.g., three dimensions of resilience as conflicting with each other: resistance vs. adaptivity vs. transformability.	[73,74]
	Unclear meaning of equilibrium.	[72,92,100]
	An “umbrella concept” not being operational to support planning or management.	[72,74,92]
	To what extent of management.	[43,72]
	From what? What is the standing point: human society as part of nature OR social domain extending to nature.	[74,87,91]
	What is the main driver of change or collapses? Predictable or not?	[87–89]
	What is our greatest asset? Human agency, including knowledge and institutions, or nature?	[88,89,94]
	What mediates human–environment relations (or is there a need)?	[89,94]
When? <i>Setting time scale for resilience</i>	Is the focus on short-term, e.g., current generation and rapid onset or long term, e.g., future generation and cumulative resilience?	[16]
	Resilience from when, e.g., 1000 years ago or 10 years ago to when, e.g., now or future? The action taken now to build stability may reduce adaptive capacity to future changes.	[89]

Table 3. Seven categories of common “difficulties” in building resilience. Source: Author.

Seven Categories of Typical Difficulties	Critiques	Representative Literature
Where? <i>Setting boundaries for resilience</i>	The unclear boundary between nature and society.	[74,87,93]
	The unclear boundary of different scales, i.e., current–smaller–larger. For example, geographically, local, city-level, provincial, national or global scales?	[74]
	Blurring boundaries between crisis response and daily management.	[43,91]
Why? <i>Explicitly stating the motivations</i>	What is the goal of building resilience?	[16,21]
	Is resilience a good characteristic all the time? What are the underlying motivations for building resilience?	[16,21,73]
How? <i>A clear and transparent plan is needed</i>	Lacking clear guidance as to how resilience can be improved—are there any measurable goals?	[72,90]
Can? <i>Examining assumptions</i>	Can organisations and institutions learn as individuals do?	[73,87]
	Can social and ecological systems be unified under the same terms/principles, or common theorisation of dynamics? For example, “the ‘well-being’ of the social system is simply an impossible phrase” (Hornborg, 2009: 254).	[43,73,87,89]
	Can higher diversity and connectivity equal to higher resilient or buffering capacity?	[88]
	Can people’s interests and livelihoods be defined as primarily concerned with nature?	[101]
	Can the concept of resilience be used to include all responses to disturbance?	[73,74,88,97]
	Can knowledge be captured and stored as a “thing” or a “process”?	[89]
	Can resilience be used as a normative concept?	[102]

These critiques show that building resilience without clear targets and boundaries could have perverse outcomes. Resilience is “two-faced” and is neither good nor bad [55,73]. A system can be ecologically resilient but not socially desirable, and vice versa [21,103,104]. Resilience thinking fits with the complex systems theory within neoliberalism (or post-liberalism) [43,74,99,105], which evolves from critiques of libertarians, environmentalists and leftists to a homogenising philosophy of top-down natural resource management and a desire of holism since the Cold War [106,107]. Epistemological traditions of complex systems theory are based on a non-linear, dynamic, tipping-points and stochastic ontology [92,108,109]. These often depoliticise causal processes but emphasise self-reliant individuals and the harmonious functioning of natural systems through adaptation, wise management and appropriate technologies [43,88,101,110]. In addition, an idea of building resilience of SESs is cognate to pre-modern cosmologies that is somewhat in favour of the “savage thought” of Lévi-Strauss [53,87,110].

Building systems for an increasingly complex world with rising unpredictable changes has been proposed in strategies and plans under the resilience paradigm [55,111]. However, many on-the-ground practices mitigate against a sophisticated resilience response. These strategies and plans have often been reduced to emergency responses that emphasise short-term damage reduction [55,74]. Thus, our society could be misled into new dead ends, either to “rigidity traps” of harsh dictatorship like the totalitarian socialism of

the Soviet Union that is very internally resilient [106] or to the individual or community self-governance by diminishing the responsibility of the government [91]. With extreme self-governance, local landscape use may detract from the interests of the broader society and not address the normative questions we listed in the seven difficulties framework, such as resilience of what and for whom [90]. For example, the transitions towns movement established in the United Kingdom in 2005 initially aimed to build local communities' resilience to threats such as climate change, peak oil, and global financial crises by empowering people at the grassroots, restructuring social services, and reducing reliance on formal government [90]. This is done through the process of building community resilience by reinforcing autonomous activism or self-governance, that is, localising social, political, and economic interdependencies [91,97,112]. However, weakening formal governments will not always provide favourable outcomes because it could also reduce capacities to sustain public safety, such as reductions in police and fire services, and worsen inequalities between wealthier and poorer districts by reducing central coordination and cross-subsidies [113]. Thus, a paradoxical phenomenon will be triggered, that is, "decentralise power in the community, resulting in local residents taking action towards their own future post-disaster, while simultaneously seeking to hold government and other centralised power structures to account" (p.28) [97].

Based on this philosophical premise, by unifying nature and society under a single set of all-encompassing principles, resilience thinking has adopted a single epistemology of complex system theory [107]. Resilience thinking focusses on "unknown unknowns" (e.g., frequency, intensity, and timing of what disasters) and "unknown knows" (e.g., marginalised knowledge) but overlooks "known knows" (e.g., power and culture matter for human–environment relations) and "known unknowns" (e.g., where to look for a comprehensive and perfect dataset for decision making) of human society [101]. Resilience thinking emphasises managing uncertainties but current governance systems have also always operated under uncertainties and surprises, because policies are always made with a deficit of information and unpredictability [114]. Embedding resilience thinking into governance systems or embedding governance systems into resilience thinking to deal with complexity has been a topic of debate [92]. Critics of resilience thinking say that it overlooks opportunities to consider essential issues such as powers, rights, and conflicts, assumes that we are in a complex world where the only certainty is uncertainty [91], and thereby relies on self-management or self-governance solutions [110,115]. However, these critiques are not sufficient to deny the effectiveness of building a resilient system if adequate responses could be incorporated into management. We argue for a process of incorporating responses to the seven difficulties in planning to build resilient systems such as landscapes. In the following section, we use the Nuozhadu (NZD) catchment landscape as an example to show the importance of failing to consider these difficulties in building resilience.

4. An Example of Difficulties in Building Resilience: The Nuozhadu (NZD) Catchment Landscape

4.1. Background

Conflicts between the conservation of the environment and human well-being have long been discussed with respect to dams and reservoirs [41,116,117]. As a large source of renewable energy and flexible supply, hydropower has a major role in reducing global carbon dioxide emission. Nevertheless, hydropower also has severe negative impacts on ecology and society [118]. Sustainable catchment management is needed to mitigate its impacts on ecosystems (e.g., freshwater biodiversity) and the people affected by it, such as resettlers [119–123]. The sustainable management of landscapes affected by the construction of large reservoirs is important for biodiversity conservation and the livelihoods of resettlers [124–126]. Experiences with catchment management provide lessons for the integrated and sustainable management of other types of landscapes across the globe.

The Lancang-Mekong River is the ninth longest river in the world and the fifth longest in Asia. The river originates from the Jifu Mountain in the western part of the Qinghai-Tibet Plateau and flows southwards into the South China Sea [77]. As the largest hydropower

station (23.703TL; 5.85×10^6 kW; 261.5 m) on the Lancang River (i.e., upper Mekong River), the construction of the NZD Dam and its affiliated projects such as highways and bridges triggered significant resettlement. More than 46,000 people were relocated, 57% of the people resettled from all of the dams constructed on the Lancang River (Figure 3) [127]. More broadly, over 407,300 people were affected by the NZD. These people were resettled across nine counties, 110 townships, 1022 villages, and 15,051 village groups [128]. Around 95% of the people relocated by the NZD project were peasants with agricultural livelihoods. Among the 29,737 hectares of land inundated, more than 27,742 hectares (93.3%) were agricultural, in which 5816 hectares were cultivated, 2614 were vegetable gardens, 17,994 were forests, and 622 were meadows [128].

Figure 3. Map of the Nuozhadu (NZD) catchment landscape (inside the white line) and NZD Nature Reserve (inside the green line), and the reported appearing locations of wild elephants (black elephant icons) (Google Earth Image: December 2016). Note: A map of the NZD catchment landscape in December 2003 before constructing the NZD Dam is shown in the Supplementary Figure S3.2.

This case study discusses a landscape designated by the government as the NZD reservoir catchment landscape, the area enclosed by a white line in Figure 3, which comprises lower slopes of the catchment immediately adjoining the reservoir (henceforth called the landscape). The landscape encompasses a displaced population of 46,867, spanning across two municipalities, nine counties, 32 townships, 113 villages, and 597 village groups [128]. More than 10 indigenous ethnic minorities, including the Lahu People, Yi People, Hani People, Bulan People and Wa People, live in these catchment groups and their lifestyles

and livelihoods are closely connected with gathering and harvesting wild products in the NZD catchment area [128].

Because of the region's unique topography, geography, and variable regional climate, the NZD Nature Reserve (Figure 3) is an important global hot-spot of biodiversity (identified ecosystem services in the landscape are shown in Table S2 in Supplementary). Various types of vegetation communities grow in the reserve and are spread across the landscape, including tropical rain forests, tropical monsoon forests, evergreen broad-leaf forests, temperate deciduous forests, warm coniferous forests (e.g., *Pinus massoniana*, *Pinus yunnanensis*, and *Pinus khasya*), bamboo forests, and savanna shrub and grasslands [129]. The flora consists of 171 families, 652 genera, and 1077 species of vascular plants and the fauna includes 96 wild mammal species (e.g., *Macaca assamensis*, *Elephas maximus*, *Bos gaurus*, and *Pavo muticus*), 257 species of birds, 96 species of reptiles, and 48 species of fish [129,130]. The sustainable management of the landscape is a challenge because managers need to use limited capital to reconstruct the livelihoods of the resettlers as well as the broader population living in and around the landscape and conserve the region's abundant flora and fauna. The developer of NZD, the Huaneng Lancang River Hydropower Co. Ltd. (HRHC), claimed that the NZD is a "green and resilient" project that devotes resources to restoration and conservation, promotes local development and takes social responsibility for resettlers [131,132]. However, such assertions on its success in building resilience are questionable based on the following assessment.

4.2. Data and Methods

This assessment was carried out based on a mixed methods approach by following the guidelines of Small [133]. The data for this assessment were drawn from a combination of primary and secondary sources. Primary data were collected by the author in December 2017. A second revisit survey was finished in July 2018, and a third revisit was finished in January 2019. Secondary data were retrieved from the datasets of the Chaoxing Discover [134] and the China National Knowledge Infrastructure (CNKI) [135] by searching keywords "Nuozhadu" in Chinese. Details of the mixed-methods methodology applied is shown in Supplementary Table S1.

The Resilience Alliance [86] proposes an issue-based approach to better focus the resilience assessment of SESs on target issues. We propose that a mixed-methods approach serves as an effective theoretical framework to assess the issue-based resilience of complex SESs for three reasons. First, similar to an issue-based approach, a mixed-methods approach is grounded in pragmatism, aiming to solve emerging matters of dispute [136]. Second, the issue-based approach may help resilience assessment focus on the key issues of a complex and uncertain SES and thus avoid being submerged with information [86]. Moreover, a mixed-methods approach can be regarded as an expedient strategy when handling complex issues without clear guidance. Third, assessing a system's resilience is a dynamic process because system dynamics are changing, and our understanding of systems grows as time passes [86]. The issue-based approach is thus a dynamic one capable of addressing the specific conditions of different phases of a system [137]. Notably, the mixed methods approach as we define it above is more flexible and able to change into different forms to integrate qualitative and quantitative research that suits the local context and intended research questions [138]. Finally, it is important to effectively involve stakeholders in the identification of key issues—especially latent but critical system problems—with limited time and resources [139]. Using a mixed-methods approach thus meaningfully takes up crucial issues by absorbing different ranges of evidence and opinions [140].

4.3. Results

Our results show that the construction of the NZD significantly changed the resilience of the landscape. Regarding the ecological system, over 1447 hectares of land were flooded (see Figure 3) that were home to many nationally endangered plant species (e.g., *Cycas pectinate*, *Dalbergia fusca*, and *Toona ciliata*) [141,142]. Many local insects and animals

(e.g., *Ophiophagus Hannah*, *Loris tardigradus*, *Aonyx cinereal*, and *Bambusicola fytchii*) were affected by habitat loss and the cutting-off of their migration routes [130]. However, the reduced resilience of the ecological system was somewhat offset by the Chinese government's considerable efforts to restore the ecology and protect the environment as evident in its establishment of nature reserves and tributary fish reserves, the removal of planted rubber trees, the large-scale resettlement of residents, biodiversity offsets, fish breeding, and fisheries management [143,144]. Owing to these efforts for environmental protection and ecological restoration, interviewees ($n = 45$, but not all of them responded on every question) reported that the area of forest (45/45), water resources (28/45), wild resources (23/35, e.g., wild mushrooms, fern, fish), and fauna (38/40) and flora (31/32) species populations have increased in the landscape post-resettlement.

Although natural resources have increased post-resettlement, resettlers are unable to use these resources and this decreased the resilience of the social system. Most participants (37/45) said that they could not cultivate their remaining land because of the strict forestry protection regulations (Figure S1 in Supplementary), "super-efficient" monitoring, and high fines [145]. Moreover, resettlers cannot cut the trees (including commercial plantation such as rubber trees) on their land and redevelop the land again for any reason [145] if the trees are over three years old or the diameter of the trees on the ground was more than 10 cm (Figure S1). Most participatory resettlers (29/42) report that it took them more than three years to move and settle down (i.e., to remove useful materials from old houses and build new houses by themselves) in new locations, and in that time the seedlings on their remaining lands had grown into small trees. One interviewee, P(27), said:

We moved here but our land is very far from us. Our land (i.e., remaining land) is in very rural alpine areas. As we ultimately built our house here and settled down, we wanted to go back to redevelop our land left in our homeland. However, one staff from forestry public security stopped us and fined me lots of money while I had just cut three of my rubber trees I grew earlier. He told me that my land was left unused for more than three years, and the trees on it cannot be cut according to the forestry legislation.

Moreover, almost all of the resettlers (43/45) responded that their remaining land was expropriated by the local government as public forests. What they received is CNY 10 compensation (i.e., less than USD 2) annually for per mu (1 mu = 0.0667 hectares) of their land. Some participants (15) commented that such compensation is token. P(24) elaborated on this loss:

Few of my lands are flooded and thus, I just received a little bit of compensation, less than the money I put in building this house. A lot of land, more than 100 mu, is still left unused in my old home. The local government just told me that you could go back and continue using your land. Oh goodness, it is hundreds of kilometres away from here. Are you kidding? We do not even have the time and energy to manage the land here. You know that current forest management is so strict; we cannot go back for the trees that have grown so big and so high. We would be fined a lot if we choose to chop them down. Even if there is no fine, we are unable to manage the land here and the old home at the same time.

Another finding is that many communally owned properties like sandpits were expropriated by the local government to mitigate the adverse effects of the NZD Dam and the Jinghong Dam [77] but without any compensation. Eight participants from Village 4 reported that their income has reduced significantly post-resettlement because of losing the income from sand excavation. P(30) explained:

Formerly, our primary income was from sand excavation. Each member of my family can get at least 200 or 300 yuan per day, at that time . . . However, as you can see, the sandpit has been occupied by the local government without any negotiation with us.

Indirectly, increased biodiversity has also affected the livelihoods of relocated people. For example, 12 participants mentioned that the increasing biodiversity meant that more

wild pigs were disturbing the land around the water resources. The emergence of an increasing number of wild mammals like wild pigs and Asian elephants (Figures 3 and 4) not only affected the personal security of people (15 out of 45) but also had severe effects on water quality and availability (Figure S2 in Supplementary) for many resettlers (28 out of 45). For example, local villagers report that more than four groups of Asian elephants (groups including one, five, eight, and over ten elephants, respectively) frequently emerge at the lower landscape (Figure 3) from January 2019 to August 2019. According to their reports, over 30 people have died from elephant attack from 2017 to 2018, and around 15 killed in the first eight months of 2019 (the latest attack was on 6 August 2019). Elephants also affect the properties of local communities as they eat crops such as corn and bananas and demolish planted crops (e.g., coffee) and damage earthworks while moving (Figure 4).

Figure 4. Wild Asian elephants near a participant's land (© the author).

A further effect is that many relocated people (34/45) fear the risks that come with being in the forests. For example, 10 participants mentioned that they were afraid of the potential risks from the increasing number of bears and elephants. Before resettlement, two participants earned their primary income, 15 their secondary income, and 25 their extra income from excavation and gathering activities from the mountains, such as gathering herbs and picking wild mushrooms. However, after the increasing numbers of wild boars, snakes, and other dangerous animals, fewer relocated people choose to go to the mountains to gather these products, with the exception of four families who had no other choice because they have not been re-allocated any land post-resettlement to sustain their livelihood.

Local governments chose to prioritise building the ecological system's resilience over livelihoods. For example, we interviewed 10 villagers in Village 1 in December 2017 and found that the primary income of this village came from catching wild fish and aquaculture, as most of their land was either flooded or expropriated by the government as public forest. One interviewee P(4) stated:

We do not have any land now and we are becoming fishermen. If the government forbids us from catching fish, we will not have any income . . . What about the next generation? We have the compensation and can catch and breed fish, but they almost have nothing.

However, to protect the water quality, the local government initiated a policy in March 2018 to prohibit "illegal fisheries" in the landscape [144]. The pollution was not primarily caused by these small-scale "illegal" fishermen but rather by the "legal" commercial fishery

near the villages (according to all participants). We did not find most interviewees from 2017 when we returned in 2018 because most residents who could earn a reliable income chose to migrate for work to nearby towns or cities. What remains are their newly built houses and older adults, people with disabilities, and children, who are unable to work.

5. Discussion

The above findings illustrate that it is hard to assess whether the NZD landscape's resilience as a whole has been increased or decreased after relocating the resettlers (Figure 5 and Table 3). Although the available natural resource base significantly increased after resettlement due to local environmental governance, resettlers have been unable to use the resources, either because their use was unlawful or impractical. We built an influence model (Figure 5 and Table 3) to elaborate the outcomes and effects of the local governance of the landscape based on the guide of Proust and Newell [146] on constructing influence and casual loop diagrams, which are designed to express people's explanations of why things change over time. From the perspective of distributive environmental justice, the affected communities in the landscape have been disadvantaged [147]. Distributive justice captures the sharing of benefits (resources and services) and burdens (harm and risks) the populace endures [147–150]. Allen et al. [151] find that environmental justice is one of the prerequisites of achieving resilience of SESs. While affected communities in the landscape survived the burdens of displacement and resettlement, they also experienced the increasing risks from increased populations of wild animals, and their access to the natural resource base was decreased because of strict local environmental policies. Most resettlers (37/45) can only choose to work as migrant labourers and gain unstable income after losing access to land, fisheries and other natural resources. The burden falls upon local communities, but the benefits are enjoyed by people regionally, domestically and internationally.

Figure 5. Elaboration of an influence model for the outcomes and effects of local governance of the landscape (Note: “+” means a positive casual relation and “-” means a negative casual relation; definitions and elaborations of the 12 variables are shown in Table 4).

Table 4. Elaborations, definitions and examples of the 12 variables in the influence model for the outcomes and effects of local governance of the landscape.

#	Variable	Definition and Examples
A	Natural resource base	The total volume of natural resource that is available for local people [152].
B	Biodiversity	The diversity of species in the landscape. The flora consists of 171 families, 652 genera, and 1077 species of vascular plants and the fauna includes 96 wild mammal species (e.g., <i>Macaca assamensis</i> , <i>Elephas maximus</i> , <i>Bos gaurus</i> , and <i>Pavo muticus</i>), 257 species of birds, 96 species of reptiles, and 48 species of fish [129,130].
C	Resettlers' access to natural resource	Access by the local people to natural resources, such as land, forests, water, mushrooms, fisheries, nuts, sand pits among others [153].
D	Resettler's acquired natural resource	Acquired natural resource by the local people [153], such as wild products, water, fish and sand.
E	Risk of gathering wild products	Risks that local people need to manage while acquiring wild products [154]. Many resettlers (34/45) fear the risks that come with being in the forests. For example, ten participants mentioned that they were afraid of the potential risks from the increasing number of bears and elephants.
F	Conservation regulations and administration	Local environmental policies and governance. For example, resettlers cannot cut the trees (including commercial plantation such as rubber trees) on their land and redevelop the land again for any reason [145] if the trees are over three years old or the diameter of the trees on the ground was more than 10 cm.
G	Amount and stability of income	Resettlers' income and sustainability of their income throughout the year [152]. Most resettlers (37/45) work as part-time or casual migrant labourers gaining unstable income after losing access to land, fisheries and other natural resources. Eight participants from Village 4 reported that their income has reduced significantly post-resettlement because of losing the income from the sand excavation.
H	Resettlers' expenses on meeting basic needs	The money resettlers' spending on meeting their basic living needs [155]. Most resettlers (37/45) spent more post-resettlement.
I	Compensation	Compensation payments for resettlers' assets losses [156]. 32(/45) resettlers said that the received compensation was not enough to build a new house in new resettlement sites.
J	Local knowledge on gathering wild products	Local knowledge, social and cultural connections with the landscape accumulated by local communities through their history on gathering wild products [157]. For example, traditional local knowledge populations the living of some local species, especially fungus such as <i>Ramaria botrytoides</i> , <i>Lasiosphaera seu Calvatia</i> and <i>Russula virescens</i> .
K	Level of two-way communication between local governments and resettlers	The effectiveness of communications or quality of dialogues between local government and resettlers, normally under respectful, fair and open communicative environment [158,159]. Local governments chose to prioritise building the ecological system's resilience over livelihoods automatically without sufficient communications with resettlers because they believed that communities' livelihoods and well-being should improve as long as the ecological conditions have improved.
L	Resettlers' livelihood outcomes	Resettlers' livelihood outcomes are the achievements or outputs on increasing resettlers' income, well-being, food security and sustainable use of the natural resources base and reducing vulnerability [152]. The NZD case study demonstrates that livelihood reconstruction and improvement is one of the biggest challenges for resilient landscape management, involving trade-offs between sustaining people and the environment, and between sustainable development for people at different scales.

The Chinese case study is not unusual. Organisations like the World Bank have been recasting projects such as hydroelectric dams as building global resilience to climate change but at the cost of damaging local people's culture and livelihoods [106,160]. In addition,

Béné et al. (2014) found that building resilience cannot replace reducing poverty and increasing well-being. Thus, we argue that “resilience for whom” should be parallel to “resilience of what to what” if the concept of resilience in landscape management is to be just. Although “resilience for whom” has been included in some recent frameworks (like the one developed by Dewulf et al. [95]), prevailing frameworks of applying resilience such as the one by Sellberg et al. [161] and the Resilience Assessment Framework [86] do not include it. Including “resilience for whom” will not only help to identify justice issues but also aid our understanding of multi-scale dynamics; for example, building global resilience to climate change vs. diminishing local resilience by detracting from sustainable income and food security.

The when, where, and why of the difficulties of resilience have only been addressed by a few studies, such as by Meerow and Newell [16]. The how and can of difficulties have not been clearly addressed by a case study that we could locate. The how difficulty may need to be more directly and clearly addressed beyond simply emphasising self-governance, or social learning in a complex and contingent world. Otherwise, this self-governance solution to complexity and uncertainty may just generate more complexity and uncertainty, as pointed out by Duit et al. [92]. “If we understand self-governance as something like the ability of the governor to guide society along a preferred path—be it toward ideal justice, the maximisation of welfare, national community, or socialism—we have constructed a social world that is too complex for self-governance of any sort, democratic or not” (p. 968) [115]. Significantly, the last category, “can”, has been largely ignored by ecologists and managers [43,73,87,89]. The “can” question needs to be considered as it will help landscape managers to examine their assumptions underpinning their planning and management strategies. For example, the management of the landscape is also subject to a national strategy called “ecological civilisation” to conserve ecology, build resilience, and support China’s sustainability transition [162,163]. This builds on the “double-mountain” (两山理论) national conservation directive: “clear waters and green mountains are as valuable as gold and silver mountains” (绿水青山就是金山银山) formulated by Chinese Chairman Xi Jinping [164]. In other words, communities’ livelihoods and well-being should improve as long as the ecological conditions have improved because people’s livelihood is assumed to be primarily concerned with the ecological system (Figure 6) [101]. This assumption could be right when applied to some communities, especially the poor whose livelihoods are restricted by diminishing ecology [165].

Figure 6. Focal-scale system change and environmental justice claim-making in the NZD landscape (Source: author, adapted from the environmental justice claim-making framework developed by (p. 40) [147].

However, we found that the livelihoods of resettlers in the landscape have not improved with environmental restoration. Most resettlers (37/45) spent more post-resettlement on meeting their basic living needs after losing access to land, fisheries and other natural resources. The socio–ecological relationships in the landscape are more complex than the managers anticipated, such as with the emergence of wild mammals and their impact on water quality. As a result, this management strategy may not build resilience as the interactions of social and ecological systems are diminished (Figure 6). The profound local knowledge and social and cultural connections with the landscape accumulated by local communities over thousands of years are being lost [129,130]. For example, local knowledge such as the distribution and characteristics of some plants and fungi in the landscape (Figure 7) would be lost if local residents stopped gathering them in the mountains of the landscape. Moreover, traditional local knowledge is tied to the living and reproduction of some local species, especially fungi such as *Ramaria botrytoides*, *Lasiosphaera seu Calvatia*, and *Russula virescens*. Some of these species (Figure 7), such as *Litsea* and *Pyrus pashia* Buch.-Ham. ex D. Don, have co-evolved with the local communities of ethnic minorities [166,167] and thus some local activities (e.g., grazing livestock periodically) are necessary to sustain biodiversity [168]. Thus, current environmental governance to safeguard natural resources will isolate the local communities and ecological system in two “separate” systems with lower connectivity as the result of diminished interactions between social and ecological systems of the landscape (Figure 6). Connectivity in SESs facilitates the exchange of material and information functioning processes of the social and ecological systems [169]. After cutting off the daily and seasonal interactions between the local communities and the landscape, the resilience of the landscape may ultimately decline rather than increase as expected (Figure 6). In addition, a greater diversity of available actions in SESs is believed by scholars to be higher resilience when a system has to deal with shocks and stresses [104]. Limiting available actions of residents in the landscape as shown above also reduce its resilience.

Figure 7. Local knowledge of gathering wild products: *Pyrus pashia* Buch.-Ham. ex D. Don (left) and *Russula virescens* (right) (Photo: © the author).

A resilient system is supposed to learn from a disturbance and avoid or better cope with a similar disturbance in the future [55]. An assumption is that a system “can” draw on past experience and learn through individuals, but this assumption has been questioned by some social scientists as they find that institutions and organisation in the system may not have the same learning ability as individuals [74,87]. Here, we are not aiming to participate in this debate but instead emphasise the power issues underpinning normative resilience. In short, higher resilience, such as higher pathway diversity, is not necessarily desirable [104]. Thus, even if the institutions and organisations in a system “can” draw on

past disturbance and perform better in further disasters, the individuals in the institutions and organisations are generally struggling to maximise their power and affluence [87]. Thus, resilience was not improved as planned because measures were not adopted at the beginning to reconcile competing interests and develop solid implementation protocols [16]. For example, the loss of arable land is one of the main factors preventing resettlers from getting a sustainable income and achieving food security [80,170–173]. Allocating enough lands to resettled communities has been a goal (i.e., Goal 5) of the Chinese resettlement policy [174]. However, local governments are afraid of both the financial and environmental costs of cultivating new land [174–176] for resettlers and instead intentionally minimise the areas of re-allocated land (21/45) or prioritise non-land resettlement options, without involving stakeholders (especially resettlers and lower authorities) in these decisions [177].

As a case study with a mixture of primary and secondary sources of data, our findings cannot quantify the change in the resilience of the landscape and show all human–environment interactions. Our analysis is also constrained as research was limited to three visits to the landscape, as assessing resilience is time-sensitive [86]. More research and more regular visits are needed that positively engage local communities in discussing how to improve their livelihoods while protecting the landscape’s ecology to achieve resilient SESs. Nonetheless, the available evidence and our analysis highlight the need to consider the seven difficulties in resilience planning for just and sustainable landscape development.

6. Conclusions

Resilience represents an ability to live, learn from, and develop with changes, some of which are unpredictable [46,53,56,85]. It is unavoidable that our understandings of these complexities will be incomplete as these systems are dynamic and may have unpredictable characteristics. From this perspective, building landscape resilience could be an effective management strategy for coordinating the needs of different actors who are dependent on the landscape only as long as the approaches proposed or initiated by managers or researchers can enhance the landscape’s ability to coexist with changes and uncertainties justly [46,178].

However, building resilience without clear targets and boundaries has perverse impacts. Some groups consume resources and services at the expense of others. Seven categories of difficulties have been defined that should be addressed when using resilience concepts to instruct management, namely resilience for whom, what, when, where, why, as well as can and how we apply resilience. Using the seven difficulties to question management strategies and plans can identify assumptions behind building resilience to achieve more just and sustainable outcomes more transparently. We find these difficulties are generally overlooked and avoided despite their instructive roles to achieve just landscape management. The NZD case demonstrates that building the NZD’s resilience has reduced to conserve the NZD’s ecology and overlooks trade-offs between sustaining people and the environment, and between sustainable development for people at different scales. Similar conflicts between conservation and development have also been reported by scholars like Zhang [67] and Ding [177] in assessing the pastoral landscape. Researchers, managers, and other decision-makers need to think about resilience more normatively and address the questions we summarise in the framework before approaching building landscape resilience. In addition, undesirable resilience, as highlighted by Dornelles et al. [21], deserves more attention to avoid blurring claims, such as building the resilience of the whole system or country without identifying the trade-offs and causing undesirable harm to local people and ecosystems.

Supplementary Materials: The following are available online at <https://www.mdpi.com/2071-1050/13/5/2629/s1>, Figure S1: Conditions of some resettlers’ unflooded or allocated land post-resettlement, Figure S2: Unsanitary potable water supplied to a resettler’s home, Figure S3.1: Map of the NZD catchment after dam completion in December 2016 (inside the white line) and NZD Nature Reserve (inside the green line), and the reported appearing locations of wild elephants (black elephant icons), Figure S3.2: December 2003—map of the NZD catchment before dam completion

in December 2003 (inside the white line) and NZD Nature Reserve (inside the green line), and reported appearing locations of wild elephants (black elephant icons), Table S1. Application of the methodology of resilience assessment in the NZD reservoir landscape, Table S2. Identified ecosystem services of the NZD landscape, Interviewing outline.

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