agriculture

MDPI

Article

Implementation Framework for Transformation of Peat Ecosystems to Support Food Security

Dian Charity Hidayat [1,2], Kosuke Mizuno [1], Chairil Abdini Abidin Said [1] and Herdis Herdiansyah [1,*]

[1] School of Environment Science, Universitas Indonesia, Salemba Raya Street, Central Jakarta 10430, Indonesia
[2] Research Center of Cooperation, Corporation, and People Economy, National Research and Innovation Agency, Gatot Subroto Street, Jakarta 12710, Indonesia
* Correspondence: herdis@ui.ac.id

Abstract: The development of food estates, including peatland ecosystems, is expected to support food security in all regions equally. Technically, the widespread clearing of peatlands for cultivating a specific food crop has multiple environmental effects. The need for more attention to non-technical aspects related to the socioeconomic life of the surrounding community is also an obstacle to the sustainability of the food estate program. In support of food security and sovereignty, this study aimed to develop an implementation framework for sustainably utilizing peat ecosystems as arable land-producing food commodities. A systematic literature review in accordance with the PRISMA guidelines and field observations were used to develop ecosystem concepts by focusing on maintaining an ecosystem's social, economic, and ecological aspects. This paper describes the history of peat ecosystem utilization, evaluates previous errors in peatland clearing for food, and analyzes the data using the perspective of peat hydrological unit to better understand the livelihood preferences of existing communities. The previous literature's key findings served as the guidelines for constructing the implementation framework. First, this method identifies people's natural resource-based livelihoods and describes peatland ecosystems. Second, it evaluates the long-term viability of livelihoods and identifies improvement levers. Finally, it facilitates increasing the scale of food commodities produced from sustainable livelihoods to meet market demand while maintaining ecosystem resilience.

Keywords: food estate; food security; peat hydrological unit; sustainable livelihood; up-scalability

Citation: Hidayat, D.C.; Mizuno, K.; Said, C.A.A.; Herdiansyah, H. Implementation Framework for Transformation of Peat Ecosystems to Support Food Security. *Agriculture* **2023**, *13*, 459. https://doi.org/10.3390/agriculture13020459

Academic Editor: Christos Karelakis

Received: 29 December 2022
Revised: 8 February 2023
Accepted: 8 February 2023
Published: 15 February 2023

1. Introduction

One positive impact of the COVID-19 pandemic is the awareness it has fostered of the need to increase food security throughout the entire region of Indonesia. The warning concerning the threat of imminent famine due to supply chain bottlenecks was publicized by the Food and Agriculture Organization (FAO) of the United Nations [1]. This led to the Indonesian government's decision to build food estates, including food estates on peatland ecosystems. However, the aim is to ensure the realization of food security. Food security is a condition where all human beings have physical, social, and economic access to food [2]. One of the issues during the pandemic has been the importance of achieving food security that can be initiated by identifying lands suited for food commodity production, determining their potential, and developing reasonable and sustainable plans [3]. Reduced food mobility and production due to the pandemic have heightened the significance of using natural resources sustainably [4].

In theory, food security is intended to reduce the presence of dependencies. Epistemologically, dependency theory is described as an attachment between the central and local governments [5]. In Indonesia, the implementation of the food estate program has been carried out with disregard for the socio-cultural, economic, and ecological aspects of the peat ecosystems, resulting in enormous losses. The transformation of subsistence agriculture into valuable commodities that boost farmers' incomes [6] cannot be realized,

either. Finally, the development of food estates creates reliance on the socio-cultural and economic sectors, including human resources, markets, and the environment. Given these factors, a better and more comprehensive approach is needed to improve peatland food commodities that are socially acceptable, economically beneficial, and ecologically harmless to the environment.

According to the food estate program on peatland ecosystems, several discoveries were made and recorded for future development. However, social conflicts; constraints on land, agribusiness infrastructure and facilities; politics; and the application of technology that could be more environmentally friendly led to the cessation of this initiative in the provinces of Central, North, and West Kalimantan [7]. The application of ecologically unfriendly food production technology [8] and the lack of attention to water governance's technical and non-technical aspects, including the social, cultural, economic, and environmental sectors [9], also triggered the failure of peatland clearing. The construction of drainage systems in peat domes disrupts the stability of carbon storage [10]. Even the selection of edible commodities, such as rice and corn, cultivated on a large scale does not consider existing local food sources [7]. There are concerns that the food estate program is bound to shift from family and village to company-based agricultural production [11].

The construction of food estates, canals and drainage systems, and other land interventions, such as liming and fertilization, cause more significant damage. Unfortunately, the clearing of peatlands also degrades water quality [12]. The construction of canals and drainage systems reduces the groundwater level, affecting the high carbon dioxide flux [13]. Annually, 55 metric tons of carbon dioxide are released from one hectare of drained peatland [14]. Drainage systems, changes in vegetation, and continuous fire outbreaks contribute to flooding [15]. Changes in peatland ecosystem function caused by land drainage might increase CO_2, NO_2, and CH_4 emissions, ultimately impacting climate change [16–19]. In the past three decades, approximately 25 million hectares of peatland have been deforested, drained, and converted, leading to reduced productivity, flooding, and greenhouse gas (GHG) emissions [20].

The high costs required for sustainable peat management impact efforts to prevent environmental damage. Rice field planting initiatives, which are part of the food estate program, are highly dependent on fertilizers and pesticides [21]. For farmers to work on paddy fields, the high costs of land preparation, fertilizers, and pesticides have presented a need for approx. IDR 7–8 million in capital [22]. However, this has led to the reluctant use of peatlands and abandoned areas. The neglect of lands for rice field planting has led to fire-prone and dormant areas [23]. The high demand for capital also encourages land burning because it is easier and cheaper. Short- and medium-term land-use benefits take precedence over sustainable management [24]. The repeated burning of detritus during peatland preparation reduces the land's ability to retain water and accelerates nutrient loss [25]. Peatland interventions to produce food commodities in food estate development cause a detrimental multiplier effect from social, economic, and ecological aspects.

The concept of food estate development within a neoliberalist paradigm approach, namely wide-scale land clearing for the cultivation of certain crops, infrastructure development, and market access, will result in biodiversity loss. During the establishment of the Merauke Integrated Food and Energy Estate (MIFEE) in Papua, the commodification of natural resources and land resulted in indigenous peoples losing not only land but also their communal and cultural identity [26]. So, adopting an approach based on a social-ecological system is necessary. Based on Plehwe (2009), neoliberalism is a policy that leads to market mechanisms and free competition [27]. The implementation of neoliberal approaches to food security and food sovereignty programs has proven to have failed to alleviate poverty and hunger [28]. The development of food security through infrastructure, market access, and capital tends to lead to the loss of biodiversity; for this reason, a social-ecological system is needed to synergize food security and biodiversity conservation [29]. Availability, distribution, use, vulnerability, sustainability, and regulation are all key challenges for food security [30].

The resilience of a social-ecological system to the use of natural resources is determined by the livelihoods of a community and its social networks [31]. People's livelihoods are key to achieving sustainable development [32]. In the context of food estate development, research questions arise regarding how to achieve sustainable community livelihoods and food security through land-clearing approaches for large-scale cultivation of food crops. Based on this background, this paper sought to develop an implementation framework for sustainable community livelihood approaches that are aligned with developing peatland ecosystem food estates for improved food security. This research aimed to offer an alternative to peatland clearing and intervention for establishing food estates in peat ecosystems by increasing the quantity of food commodity supplied by sustainable community livelihoods.

2. Materials and Methods

The implementation framework provides direction on implementing knowledge management and facilitating theory transformation into practice [33]. One approach to framework development is to draw on existing determinant frameworks and relevant theories from various disciplines [34]. This paper identifies relevant theories and conceptual models using bibliometrics as a metadata source. After that, a literature review is carried out under the stages to compile the implementation framework. This literature review will likely produce one of the added values, which can be relevant and applied in the real world through synthesizing literature in case studies [35].

The case study in this study is a peat ecosystem with various typologies, called peat hydrological units (PHU), and has never been carried out by a food estate program before. The study was conducted at the PHU Sungai Belayan, the largest PHU in Kutai Kartanegara Regency, East Kalimantan Province. The Kutai Kartanegara Regency-level government is preparing its area as a food buffer area for the New Capital of Indonesia to be built in the East Kalimantan Province.

To build an implementation framework for food estate development approaches in peatland ecosystems, this paper uses a systematic literature review combined with field observations. The metadata are taken from Dimension because many of these sources index the results of research related to peatlands in Indonesia in the form of scientific articles, books, book sections, and proceedings. Several stages are used to retrieve the metadata according to the research questions to achieve the research objectives. The open-source reference manager, the Publish or Perish application, retrieves the metadata, which are then collected into Mendeley for further analysis with the VOS Viewer [36]. In this study, the VOS Viewer is only used to perform metadata extraction and display the state of the art of the research.

Furthermore, the extracted metadata are analyzed using a systematic literature review in accordance with the PRISMA 2020 guidelines [37]. The metadata extraction technique utilizes several keywords that are adjusted to the stages of compiling the implementation framework. The selection of articles is based on the suitability of the topic and the language used, namely Indonesian and English. Field observations and interviews with respondents around the PHU are also carried out to validate the data from the literature review.

The first stage is the history of peatland use. Knowing the history of peatland use at the case study site and its surroundings generates knowledge about peat utilization before the food estate program is carried out, the development of community livelihoods, and the relationship between community livelihoods and peatland conservation. The results of the literature review are validated with the field observation data. Second, a literature review of the purpose, objectives, and framework of the food estate program is conducted. Third, an approach that can be used in the development of food estates, based on the results of the first and second steps, is further analyzed using a sustainability theory focusing on the social, economic, and ecological dimensions. Fourth, a plan to transform how peat ecosystems are used for food estate development to ensure food sovereignty is proposed.

3. Results

3.1. Literature Review of the History of Peatland Use before the Food Estate Program

For decades, the traditional cultivation of crops on peatlands was carried out by the Bugis, Dayak, Banjar, and Malay tribes. Before 1950, Dayak and Banjar communities managed thin peatlands behind rivers [38]. Observations in the field indicate that community-managed peatlands are neither deep peatlands nor peat domes but rather pictorial lands along rivers. People tend to use rivers as a mode of interregional transport since scenic locations typically have many rivers. A small motorless ship called *ketinting* serves as a means of transportation. People tend to fish daily and cultivate rice on the outskirts of rivers. Community settlements are also developed by the riversides. In other words, its members tend to manage alluvial lands and thin peatlands.

These communities rarely manage deep peatlands because they are acidic, and more effort is needed for land preparation. However, people sometimes utilize timber and other forest products, so it is feared that this will threaten conservation. Deep peatlands tend to have highly acidic soils [39]. Generally, they are overgrown with vegetation, mostly woody trees that make up peat forests. Community members usually utilize non-timber and wood products to build houses and *ketinting*. The use of non-timber products poses relatively no threat to peat forest conservation. On the contrary, using timber products tends to threaten forests and peatlands. Due to the length of time required for these trees to mature, it is impossible for the cultivation of native peat plants to catch up with the rate of utilization. Currently, the increasing population and the fulfillment of their needs result in excessive or uncontrollable exploitation of peat forests [40], and the massive use of timber products is perceived as a threat to the conservation process.

Deep peatlands and forests are the keys to its ecosystem conservation procedure. These peatlands are more than three meters deep and are used for carbon storage and water absorption [41]. Deep peatland interventions for farming and plantation business activities can cause several problems, including the dry nature of continuous fire outbreaks, the pyrite content that damages crops, and the inability of plant roots to absorb water from drainages that are too deep [42]. On the other hand, cultivating native peat plants takes quite a long time on average, thereby making it uneconomically feasible. Therefore, the government stipulates that deep peatlands are protected from being cultivated [43].

One way to ensure the protected peatlands are properly managed is by ascertaining that the economic activities of the surrounding communities must be able to provide income that guarantees sustainable welfare. The livelihoods of those outside the inner peatland need to be improved by minimizing existing constraints. Based on research [44], the restraints before and after the food estate program have increased. Therefore, this initiative needs to be carried out on peat ecosystems to boost the livelihoods of existing communities by minimizing its constraints.

The knowledge possessed by community members influences a peatland's managerial methods and techniques. In some regions, this is hereditary, and leaders initiate procedures related to customary norms and customs. For example, the Dayak communities cultivate peatlands behind river embankments (back swamps) or *lawau* plots, while the indigenous people of Banjar do the same through the manufacture of handles [38]. These are irrigation procedures developed by tidal movements [45]. However, local wisdom in the form of arable land preparation involving fire to burn detritus is an aspect of traditional rituals that must be properly supervised [46]. In line with the conservation process, techniques employed to boost livelihood must also be supervised to prevent them from damaging the environment.

Over time, the developed income sources in a community consist of basic and alternative livelihoods, which depend on natural and non-natural resources. This study's scope of discussion is on the types of basic livelihoods and alternatives based on natural resources, especially those that produce food needs. The hereditary livelihoods in the Central Mahakam Region (CMR) include fishing with *ketinting* and nets, planting tidal rice, tapping palms, and raising swamp buffaloes. Currently, these livelihoods are developing and are

still being cultivated by the community with a little touch of knowledge and technology. Most fishermen have used motorized boats and cultivated fish in cages, which depicts an improved and sustainable livelihood.

Based on the explanation above, it is concluded that when building a food estate, there is a need to maintain deep peatlands because these are perceived as the key to ecosystem conservation and can increase eco-livelihood activities that prosper the region. Communities that rely on sustainable livelihoods to meet their requirements are averse to using deep peatlands because doing so would increase their costs and efforts. The reciprocal dynamic relationship between cultural and biological diversities is defined as biocultural diversity [47]. The importance of livelihoods in nature conservation has caused [48] to propose a more specific definition. Biocultural diversity is further defined as a dynamic, place-based multiplicity of human and nonhuman beings alongside their means of livelihood and constituting relations. The adoption of this definition leads to the focus on the main and alternative livelihoods as a nature conservation approach.

3.2. Literature Review of Food Estate Development

Food estate is a national nutritional barn realized through the integration of agriculture, plantations, and animal husbandry in an area [49]. This program is an investment project for cultivating food commodities on a broad scale of relatively 25 hectares [50]. It is presumed that this initiative is economically feasible and profitable and tends to meet food needs sustainably. Therefore, it is determined that this program, as a food commodity business realized from agriculture, plantations, and animal husbandry, is integrated on a large scale and is economically feasible.

Food security is hoped to be realized by fulfilling the nation's needs. In the present study, this is expected to result in food sovereignty. The research carried out by [51] stated that a relationship exists between food security and food sovereignty in Indonesia. According to [51], food security is understood as the availability of imported and locally manufactured edibles in warehouses and markets. In contrast, its sovereignty is the ability of a State to achieve self-sufficient strategic commodities on a national scale without external interference. In this study, the development of food estates in peat ecosystems mainly focuses on the ability of humans to manage their natural resources to meet the nation's needs. Therefore, it is more appropriate to employ the principle of food sovereignty.

The essence of transforming peat ecosystems for food estate development is to open up large land areas for cultivation activities to meet market demand. Technically, the land-clearing process adopted a spatial approach. However, during its implementation, the determination of the area of interest became wider than the land suitability mapping issued by the Ministry of Agriculture [52]. On the other hand, the food estate program carried out in Central Kalimantan caused 241 and 279 land conflicts in 2020 and 2019, respectively, including the loss of local livelihoods, places of origin, and the identity of indigenous peoples [53]. The need for massive land is the main problem in developing food estates. Therefore, the strategy relating to transforming peat ecosystems needs to be changed by minimizing land use.

The transformation of peat ecosystems into food estates can also be realized through a typological approach. In such an ecosystem, there are various typologies. Therefore, food estate planning needs to be understood from a peat hydrological unit (PHU) perspective. Peatland ecosystems found in a PHU consist of protected or conservation areas, and cultivated regions [43,54]. Food commodities cultivated in each of these typologies certainly vary. On the other hand, its development into superior commodities requires a stable, sustainable level of productivity that meets the market demand. Therefore, a particular strategy that needs to be pursued is the development of similar food commodities from several regions under conducive peatland typological conditions.

In general, threats associated with the realization of food security include increased population, prices, reduced varieties of crops, limited land, drought, and wastage [55]. The community engaged in a series of protests to defend their lands and to protest against the loss of cultural identity due to the development of food estates by implementing neoliberalism policies [26]. According to Plehwe (2009), these policies are intended to market certain mechanisms and freely engage in competition [27]. Food production in landscapes with infrastructure, market access, and capital usually leads to biodiversity loss [29,56]. There is a need for a social-ecological system to ensure that food security and biodiversity conservation can synergize. [29]. For this reason, pro-societal policies must be implemented to build a food estate.

3.3. Sustainable Community Livelihood-Based Approach

Sustainable livelihoods can withstand pressures and shocks while maintaining and increasing their assets without damaging their natural resource base [57]. Increasing resource-use intensity, the diversity and complexity of small-farming livelihood systems, and small-scale economic synergy makes it possible to multiply livelihoods [58]. The evaluation of farm households' level of sustainable livelihood in ecological resettlement zones must take into account both society and the environment [59]. It is further argued that the relationship between human and nonhuman aspects defines ecological livelihood [60]. This study assumes that a sustainable livelihood meets three interconnected criteria: the social aspect is acceptable; the ecological aspect does not harm the environment; and the economic aspect sustainably generates income.

An integrated development involves adopting a sustainable livelihood approach [59,61]. Several sustainability schemes are related to the relationship between ecological, social, and economic dimensions. Theoretically, there is no solid conception regarding the sustainability scheme of these three dimensions, so the operational concept of sustainability is still ontologically open [62]. The first scheme is the Triple Bottom Line Model, which also presumes a relationship between these dimensions [63]. The second is the pillar model, which assumes that the economic, ecological, and social dimensions are independent. The third one, the Nested Model, criticizes the previous two schemes. It assumes that the economic dimension is part of the social dimension, which is an aspect of ecology [62,64]. Livelihoods are considered sustainable when they focus more on the environment or the ecological dimension because the main aim of food estate development realized through community livelihoods tends to be sustainable without damaging the environment.

Sustainable community livelihoods are the sources of income that can withstand pressures and shocks, as well as maintain and increase their assets, without destroying the natural resource base [57]. Increased assets are generated from sustainable income. Therefore, its realization is due to the sustainability of the environmental and social aspects [58]. Furthermore, the relationship between the human and nonhuman aspects defines ecological livelihood [60]. The present research states that sustainable livelihood is viewed from three interconnected aspects, namely from the social, ecological, and environmental sectors. From the social, ecological, and environmental perspectives, it is acceptable not to damage the environment and continue to generate income on an ongoing basis.

Within the framework of sustainable livelihoods designed by the DFID (Department for International Development, United Kingdom), a society's source of income is generated from the transformation of social, human, financial, natural, and physical capital [65]. Human, physical, and financial capital are directly needed in the production process of a currency. Meanwhile, social and natural capital affect its sustainability. The relationship between the concepts of sustainable development and sustainable livelihoods is that of livelihood, which is socially measured from the elements of social capital and acceptable human capital; economically measured by the elements of human capital, physical capital, and financial capital that can be profitable; and ecologically measured from natural capital that does not damage the environment so that it can be sustainable.

The elements of social capital can be used to assess sustainable livelihoods based on social aspects or dimensions. According to Putnam, social capital focuses on norms, values, beliefs, and networks. Meanwhile, Bourdieu stated that this concept conflicts with the roles or functions of actors. [66]. Norms are guidelines to check community behaviors, and there are sanctions for violations [67]. The social values in a society are contained in local wisdom developed from one generation to another. According to Haba (2007) and Abdullah (2008), it is defined as some form of cultural wealth developed as an important element that can increase cohesion in society [68]. Local wisdom is believed to shape thoughts and behavioral patterns [69]. The concept of social networks concerning social capital is based on existing relationships among individuals of specific groups, both inside and outside a community, to enable the effective and efficient running of activities [70]. It is hoped that firm local wisdom can resolve social conflicts [71].

The elements of human capital are used to assess sustainable livelihoods from the social aspects. Human capital is one of the factors of social development and economic growth, which consists of skills, knowledge, attitudes, and socio-culture, including individual capacity to innovate and discover [72]. Information literacy is a competency that needs to be developed as an individual capital for people to be highly productive [73]. Even investment in education and training is also included in social capital [74]. A community's traditional ecological knowledge gained from the experience of adapting to changes in the socio-cultural and spatial patterns of the environment can be used to resolve related problems [75]. This tool is used for maintaining socio-ecological resilience, and climate adaptation plays a relevant role in social empowerment and sustainable natural resource management [76]. Haverkort and Reijntjes stated that the relationship between humans and nature is described based on the worldview or the perspective of a particular society toward its environment [77]. Women play a relevant role in changing the initial subsistence livelihoods into flexible activities to earn money [78]. Ethnicity also affects perceptions of the resilience of a livelihood [79]. In the present research, indicators of knowledge, perspective, expertise, formal education, training, gender, ethnicity, and counseling are used to explain the community's social conditions in discharging their daily tasks.

On the other hand, human capital, in the form of availability and labor cost, is used to assess sustainable livelihoods related to the economic aspect. Based on the framework of the socio-ecological system, economic variables, such as productivity, market incentives, and land value, are more important in determining the use of peatlands [80]. The growth of financial capital, such as greater access to loans and improved connectivity between a village and the market, facilitates the transition from subsistence to flexible activity [78]. Therefore, certain human, financial, and physical elements are also employed to assess sustainable livelihoods from the economic perspective or dimension.

3.4. Commodity Scaling Framework of the Framework for Sustainable Development and Environmental Resilience

Conceptual tools are employed to realize sustainable development by connecting the concepts of a viable framework and ecological resilience (water–energy–food nexus), which are adopted to ensure environmental livelihood security by striking a balance between natural supply and human demand [81]. In a more detailed analysis, [32] explained an environmental livelihood security framework by considering water, energy, and food needs to measure and monitor people's sources of income at various spatial scales and institutional levels. Furthermore, the challenge in this study is how this environmental livelihood security framework can be implemented in the food estate program.

Related to the development of food estates in peat ecosystems, edible commodities produced from livelihoods must meet market demand while consistently balancing with natural supply. One of the obstacles encountered in the Central Mahakam Region is that businesses are still small-scale and subsistent. Moreover, most of the marketing activities are carried out in the scope of sub-districts and districts. Related tasks, such as export activities, are executed outside the province in a monopolized manner, and this causes prices to fall

at the time of harvest. Constraints that have a multiplier impact need to be minimized to ensure the produced food commodities can consistently meet the market needs. By reducing these obstacles, a community's livelihood business scale will be increased.

In addition, food commodities must be produced by the communities around sustainable peat ecosystems to ensure consistent supply. For this reason, this research proposes scaling up to transform food commodities that can meet market needs. Massive peatland interventions do not perform scaling to cultivate certain food commodities, rather it focuses on sustainable livelihoods. Therefore, the present research adopts an environmental livelihood security framework [81], modified with the scaling-up concept to become more implementable (Figure 1).

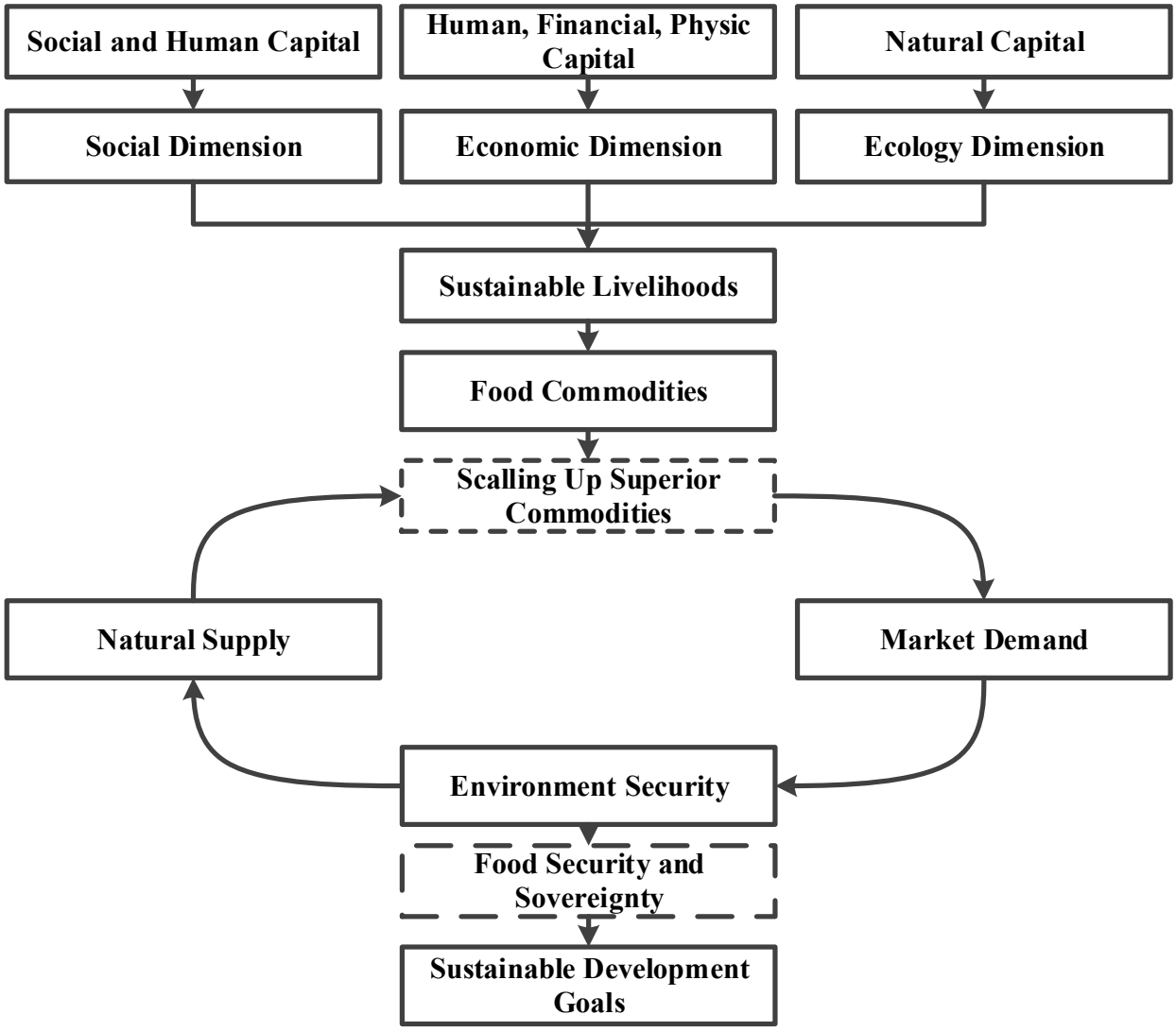

Figure 1. Peat Food Commodity Scalability Framework.

The concept of scaling up that is being developed to be implemented in the development of food estates includes research with the latest updates. From the metadata related to scaling up and up-scalability, the mapping shown in Figure 2 is obtained. The data collected from Dimension totaled 520 records. The data were extracted in the period 2010–2022, and they took the form of articles, chapters, book sections, and proceedings. Most of the scaling studies are in the fields of chemistry and industry. The map shows that the novelty of this research is increasing the scale of food commodities.

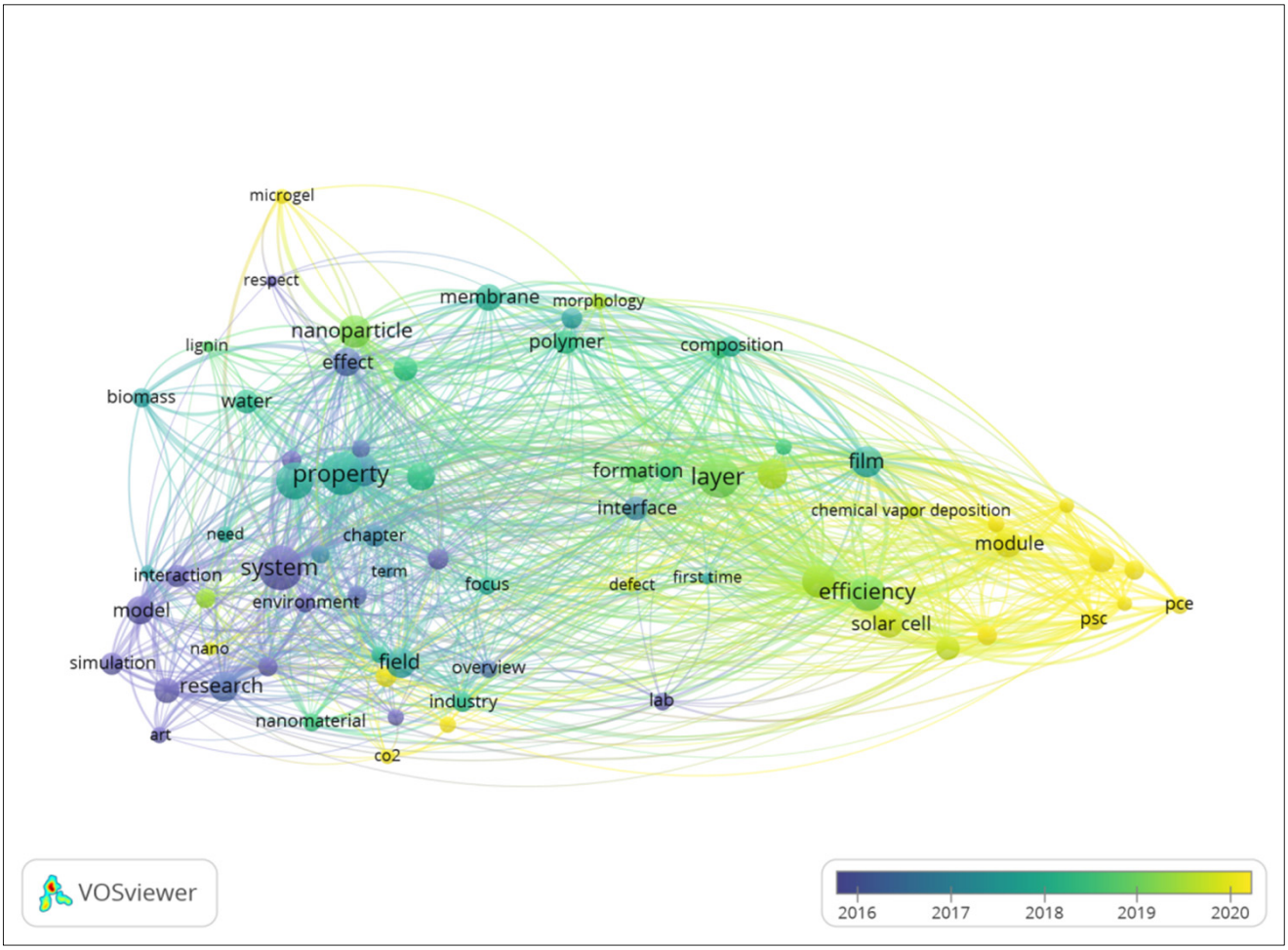

Figure 2. Overlay Visualization of Up Scale and Scalability Keywords.

Figure 2 illustrates that the development of food estates for food security has generally not yet been discussed in the context of up-scalability. Recent research, denoted by the yellow sphere on the right, has centered on the efficiency of power conversion (PCE) in renewable energy when discussing up-scalability. In the meantime, previous research on scalability concentrated on chemical systems and models.

3.5. The Concept of Scaling Food Commodities

The hierarchy theory initially explains the scaling issue in environmental science. Nowadays, it is illustrated by the paradigm of socio-ecological systems associated with vulnerability [82]. Scale-up or scaling-up is related to the adopted processes, actors, incentives, institutional arrangements, and policies [83]. However, three approaches can be used to realize this procedure: value chain procedures and private sector engagement; information and communication technology; and policy engagement [84]. The concept of scaling is different from scalability, which is described as the potential for certain innovations or change interventions to be adapted, expanded, and replicated [83]. Political and economic analysis of global value chains is needed to describe sustainable production and consumption systems [85]. In this research, scaling is defined as a process of improvement related to the role of institutions and stakeholders in a value chain, including technological innovation and policies.

Some works in the literature are related to increasing the scale of management in commodity development. Therefore, three key aspects are adopted to develop local food commodities: using several types of labor; operating according to the season; and managing expected quantity and quality [86]. The research carried out by [87] focuses on how far the

scale of governance has increased in several sectors influenced by the environment, markets, and social geography. The methods used are stakeholders' interview sessions, farmer-level surveys, and literature reviews. Differences in governance levels are influenced by the quality of environmental resources, players, markets, knowledge, and networks [87].

Of course, a scale increase that differs from some of the earlier mentioned studies is needed for the ecosystem-based approach adopted in this study. Meanwhile, in a peat hydrological unit, there are several scattered typologies. It is necessary to combine these diverse types, and this requires a cluster system to increase the scale of the commodity from livelihood to a certain typology.

4. Discussion

4.1. Technical and Non-Technical Aspects of Food Estate Development

Based on the background and the literature review as mentioned above, it is concluded that several problems are encountered in developing food estates in peatland ecosystems. Therefore, technical and non-technical issues must be considered when planning future food estate development, as shown in Table 1.

Table 1. Considerations in the Development of Peat Ecosystem Food Estates.

No	Evaluation of Peat Ecosystem Food Estate Development Has Been Conducted	Transformation of Peat Ecosystem Food Estate Development in the Future
	Technical aspect	
1	The need for a large land triggers changes in its usage.	Minimize land-use change.
2	The rice field printing program requires high costs and a relatively huge farmer business capital because it needs a lot of lime, fertilizers, and medicines.	Agricultural efforts are carried out on the right typology of a hydrological unit, namely on alluvial areas along rivers and thin peatlands.
3	Construction of canals, irrigation systems on deep peatlands, and peat domes.	Irrigation canals are not allowed to be built on deep peatlands and peat domes.
4	Cultivation of agriculture and plantations on deep peatlands.	Peatlands have a protected function; therefore, they need to be conserved and not used for agricultural or plantation purposes.
	Non-technical aspect	
1	Social conflicts arise during land acquisition.	Invite the community to participate in the construction of food estates.
2	Communities lose their place of living, cultural identity, and livelihoods.	An approach focuses on people's livelihoods and how to make them sustainable.
3	Food estate development by implementing neoliberalism policies.	Food estate development with the implementation of people's economic policies.

From the literature review, problems arising from technical and non-technical aspects turn out to cause multiplier effects that damage the environment and are economically unfavorable and socially unacceptable. Technical aspects have an operational impact on the production process when it comes to generating food for people's livelihoods. Technically, several principles must be firmly adhered to in the food estate establishment in peatland ecosystems. First, minimize peatland clearing by cultivating appropriately on shallow peat and alluvial lands along rivers instead of deep peatlands. Continuously safeguard and conserve deep peatlands by not constructing irrigation on them, particularly on peat

domes, and by growing native peat vegetation, honey trees, and other sorts of plants that can survive on deep peatlands without land intervention.

Non-technical aspects indirectly affect the production process of food commodities in people's livelihoods. Individuals have a preference for the type of natural resource-based livelihood they pursue. Preferences are influenced by knowledge, number of human resources, financial capital, availability of resources, and enforceable customary laws. The food estate development program's involvement must consider the community's preferences and participation. Thus, it is expected that no social conflicts will arise.

4.2. Implementation Stages of Food Estate Development through Community Livelihoods

From the history of the development of people's livelihoods, it can be understood that the arable land of the community's livelihood is the waters of rivers and lakes, alluvial land, and thin peatlands around these waters. Deep peatlands, as the key to the conservation of peat ecosystems, are not used for cultivation because they are too sour and require more cost and effort for their processing. However, the use of timber from peat forests is a threat as the population increases. For this reason, people's livelihoods need to be scaled up to ensure sustainable community welfare. Thus, indirectly increasing the scale of people's livelihoods is expected to conserve peatlands.

To develop food estates by increasing the scale of sustainable peatland commodity livelihoods, it is necessary to transform the technical aspects in Table 1. The type of community livelihood based on natural resources is in accordance with the typology of arable land. Based on the literature of sustainable concepts, food estate development planning needs to focus more on ecological than social and economic aspects. Ecological aspects need to be prioritized by understanding diverse ecological typologies and having a mindset from the perspective of a peat hydrological unit (PHU). The PHU is a peatland ecosystem bounded by two rivers. In this study, the PHU Belayan includes the Belayan River and Kelinjau River sub-PHU and the Belayan Melintang River sub-PHU. From the map overlay results, the PHU Belayan can be seen in Figure 3. From the picture, it can be seen that there are several typologies of community arable land in the PHU. The dominant arable land of the community in each village varies, such as peatland dominant, river dominant, lake dominant, and has a combination of typologies.

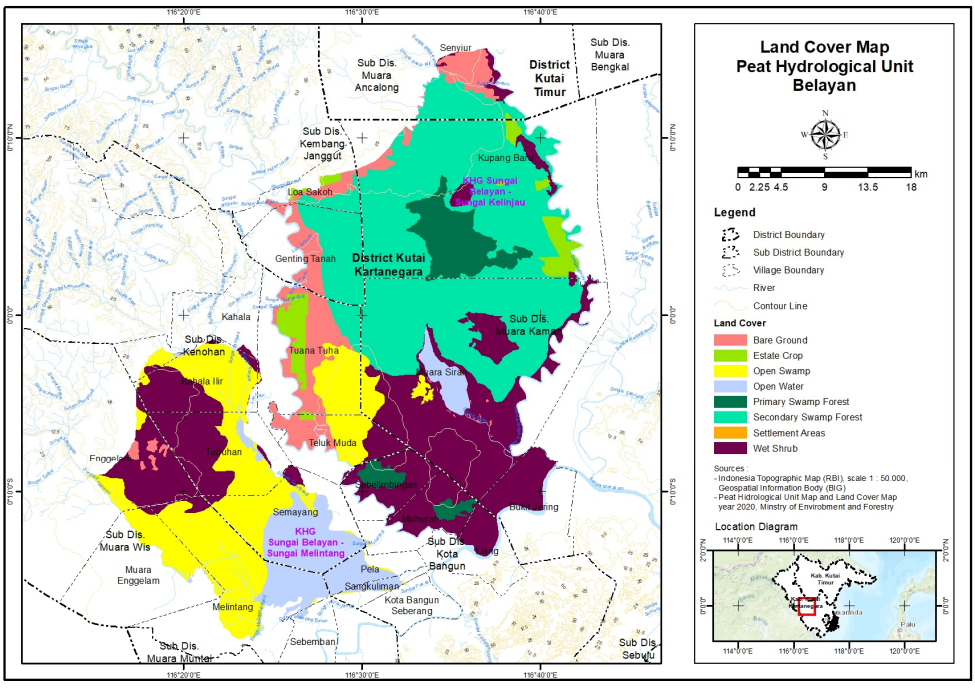

Figure 3. Land Cover Map of Belayan.

The first stage of the implementation method for understanding the ecological aspects is to identify and analyze natural resource-based livelihoods and land typologies in a PHU. Land typology can be obtained by overlaying the PHU with its functions, peatland thickness or pyrite, vegetation type, and plantation concessions. In terms of food estate development, the results of the arable land typology are then analyzed for their suitability with the livelihoods of people who produce food commodities, production potential, and alternative livelihood potential. Alternative livelihoods need to be considered because this is included in the factors that affect the sustainability of livelihoods. The results are then analyzed with the suitability of existing community livelihoods, potential production, and interventions due to the suitability of the land and ecosystem. Incidentally, the outcome of the analysis is an eco-livelihood.

The results of the overlay of the study location map obtain several dominant typologies. Overall, the arable land in a peat hydrological unit consists of shallow peatlands, alluvial lands, white rivers (freshwater), and black water lakes (peat water). The stream between a black water lake and a white river is often called *bangar* (turbid water). The first typology is villages with dominant ecosystems of shallow peatlands and white rivers as arable land. Based on the field observations, natural resource-based livelihoods in these villages include fishermen, swallow nests, and palm plantations. The second typology is villages with dominant ecosystems of shallow peatlands and black water lakes as arable land. Natural resource-based livelihoods in these villages include fishermen, bird's nests, and swamp buffalo. The third typology is a village with a dominant ecosystem of alluvial land and white rivers as arable land. Livelihoods in the village include fishermen, bird's nests, and agriculture. The fourth typology is a village with an alluvial land ecosystem and a black water lake as arable land. From the overall typology, natural resource-based livelihoods in the village are fishermen and swallow's nests.

The second step is to analyze the sustainability of livelihoods that have the potential to be eco-livelihood. It is assessed from the social, economic, and ecological aspects. When these three aspects are weighed, it is discovered that ecology has a heavier weight. The criteria for the social aspect are social norms, networks, conflicts, and local wisdom. For the economic aspect, the criteria are financial, physical, and human capital elements, including the availability and cost of labor; access to capital, equipment, and supplies; profits; and marketing. Furthermore, the criteria for the ecological aspect are elements of natural capital, namely the impact of livelihoods on drought and forest and land fires; suitability of arable land; and the effects of climate change.

Multi-dimensional scaling (MDS) analysis can be used to determine the sustainability of multidimensionality. The evaluation of sustainable livelihoods concerning the three aspects involves adopting descriptive analysis and multi-dimensional scaling (MDS). Meanwhile, MDS, in a broad sense, is defined as various forms of cluster and linear multivariate analyses. At the same time, from a narrow perspective, it represents data inequality in a low-dimensional space [88]. It is calculated in three stages: obtaining a comparative distance scale for each variable; estimating the addition of constants and using them to change the absolute distance scale; and projecting them into a dimensional drawing [89]. This analysis makes it possible to assess sustainability from several different dimensions. As an application of the concept of sustainability from studies in the literature, weighting can be used where the weight of the ecological dimension is greater than the social and economic dimensions. Furthermore, the evaluation procedure also ranks several factors perceived as leverages from the social, economic, and ecological dimensions. These levers can be used as interventions through programs and policies so that livelihoods can be sustainable.

Livelihoods that are analyzed qualitatively and quantitatively in the second period are assessed as sustainable or not and mapped according to the results of the first step. Although those that are considered sustainable are based on the results of the MDS analysis, livelihoods that are not yet sustainable, but which status tends to be improved through the leveraging factors are mapped based on the identification outcomes of potential livelihoods and the typology of the overlay mapping on a peat hydrological unit.

The third step is increasing the scale of the leading commodities produced by people's livelihoods. From the literature review, scaling up can be performed using the marketing chain approach, institutions, technological innovation, and policies. Meanwhile, the marketing chain approach is carried out by analyzing the role of stakeholders in the market. The analytical results have proven how to make the market chain more effective, thereby ensuring that smallholders' margin or added value is greater. The institutional approach is carried out by analyzing economic and social institutions that affect people's livelihoods. Understanding these institutions' strategic role will improve the scale of commodities. The technological innovation approach is to transfer knowledge of technology applied to increase the scale of commodities without threatening environmental resilience. The policy approach is carried out by implementing laws that align people's livelihoods to guarantee sustainability. This is made possible by replacing neoliberalism policies with populist economic regulations.

By enhancing the levers of people's livelihoods as a consequence of sustainable analysis, the scale of people's livelihoods will rise in terms of market chains, institutions, technological adoption, and associated government policies. The condition of increasing the scale can be met by achieving the economies of the scale. The results of the scale-up analysis and the typological analysis of a peat hydrological unit can be analyzed using geographically weighted regression to produce an appropriate food estate development policy recommendation (see Figure 4).

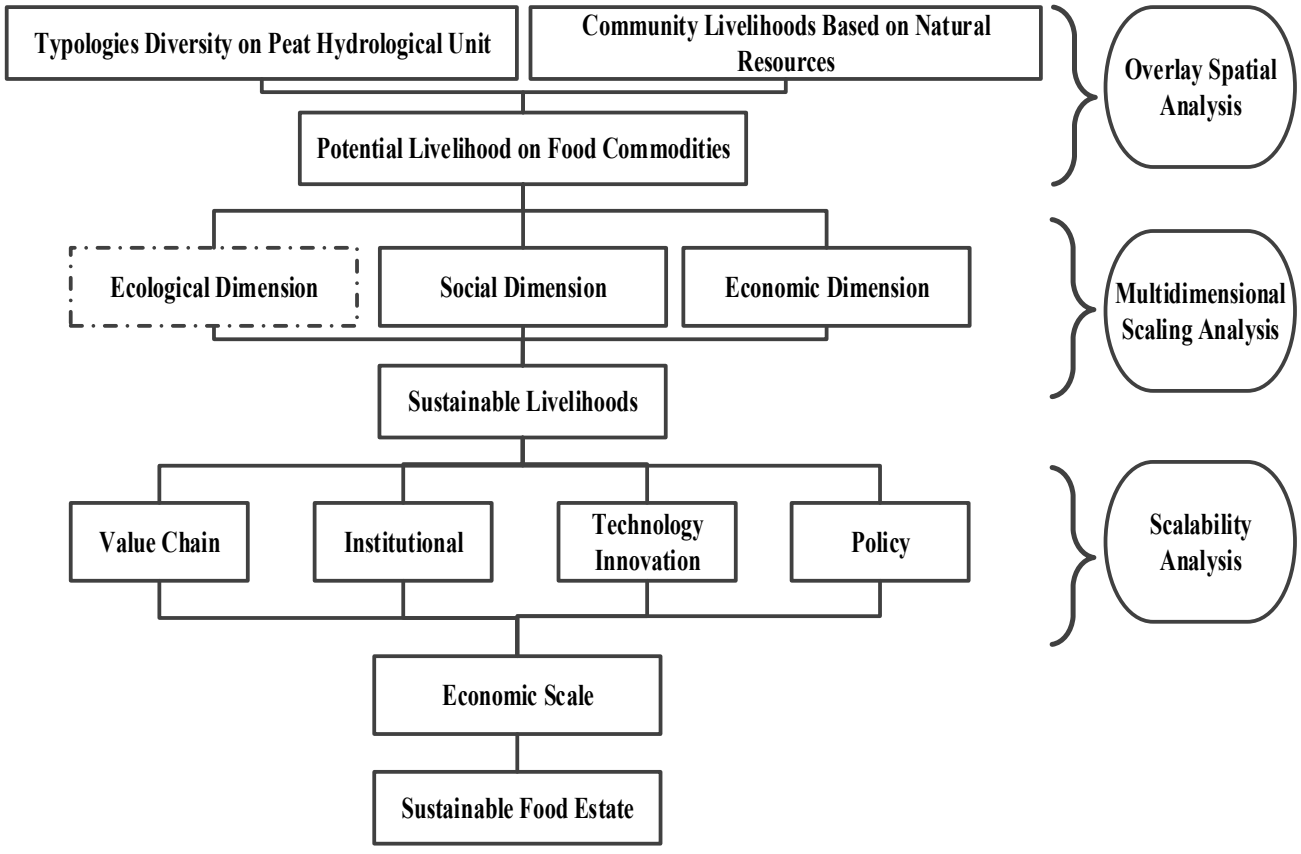

Figure 4. Implementation Framework of Sustainable Food Estates.

5. Conclusions

The development of food estates on peatland ecosystems needs to be carried out with an ecosystem-based approach and sustainable livelihoods. Its implementation enables the transformation of food estate development that minimizes changes in land use and peatland clearing, considers the typology within a peat hydrological unit, and protects the functions of deep peatlands.

Before increasing the scale of food commodities, it is necessary to ensure that these items are produced from sustainable livelihoods. This can be realized by identifying and characterizing the typology of land, production potential, and types of livelihoods. Then the community's livelihood is analyzed by multi-dimensional scaling in which the ecological dimension is highly emphasized. Leverage factors resulting from the analysis can be used for interventions to ensure people's livelihoods are sustainable. Ultimately, scale-up is carried out through market chain, institutional, technological innovation, and policy approaches. Therefore, food estate development through sustainable community livelihoods can create food security and sovereignty.

The transformation of food estate development can be accomplished through technical and non-technical aspects. From a technical standpoint, this can be achieved by minimizing peatland clearing, cultivating shallow peatlands and alluvial lands along waters, and conserving deep peatlands. Non-technically, it is implemented by involving the community in the food estate development and taking their socioeconomic preferences into account. According to the field observations, all types of villages' arable land are inhabited by bird nests farmers and fishermen. These livelihoods of food commodity producers follow the criteria for the transformation of food estate development, so it is worth further evaluating using the implementation framework in this study.

Author Contributions: Conceptualization, methodology, software, and writing–original draft preparation, D.C.H.; supervision and writing–review and editing, K.M., C.A.A.S. and H.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Ministry of Research and Technology/National Research and Innovation Agency (RP IPSH/ RP2_ 003/2.3_2022).

Institutional Review Board Statement: This study was conducted in accordance with the Ethics Committee of the National Research and Innovation Agency (decree number: 002/KE.01/SK/3/2022, date approval 29 March 2022).

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available from the corresponding author upon request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. FAO. *Addressing the Impacts of COVID-19 in Food Crises*; FAO: Rome, Italy, 2021.
2. FAO. *The Water-Energy-Food Nexus: A New Approach in Support of Food Security and Sustainable Agriculture*; Food and Agriculture Organization (FAO): Rome, Italy, 2014.
3. Everest, T.; Sungur, A.; Özcan, H. Determination of Agricultural Land Suitability with a Multiple-Criteria Decision-Making Method in Northwestern Turkey. *Int. J. Environ. Sci. Technol.* **2021**, *18*, 1073–1088. [CrossRef] [PubMed]
4. Everest, T.; Savaşkan, G.S.; Or, A.; Özcan, H. Suitable Site Selection by Using Full Consistency Method (Fucom): A Case Study for Maize Cultivation in Northwest Turkey. *Env. Dev. Sustain.* **2022**, 1–20. [CrossRef]
5. Ghosh, B.N. *Dependency Theory Revisited*; Routledge: Abingdon, UK, 2019.
6. Natawidjaja, R.S. Pengembangan Komoditas Bernilai Tinggi (High Value Commodity) Untuk Meningkatkan Pendapatan Petani. In Proceedings of the Prosiding Seminar Nasional Dinamika Pembangunan Pertanian dan Pedesaan: Mencari Alternatif Arah Pengembangan Ekonomi Rakyat, Bogor, Indonesia; 2007; pp. 17–29. Available online: https://pustaka.unpad.ac.id/archives/146027# (accessed on 28 December 2022).
7. Sutawi. Food Estate: Mewujudkan Ketahanan Pangan Masa Pandemi Dan Pasca Pandemi Covid-19. In *New Normal, Kajian Multidisiplin*; In'am, A., Latipun, Eds.; Psychology Forum: Malang, Indonesia, 2020; p. 583. ISBN 978-623-94285-2-5.

8. Kamin, A.B.M.; Altamaha, R. Modernisasi Tanpa Pembangunan Dalam Proyek Food Estate Di Bulungan Dan Merauke. *BHUMI J. Agrar. Pertanah.* **2019**, *5*, 163–179. [CrossRef]
9. Suriadikarta, D.A. Pembelajaran Dari Kegagalan Penanganan Kawasan PLG Sejuta Hektar Menuju Pengelolaan Lahan Gambut Berkelanjutan. *Pengemb. Inov. Pertan.* **2009**, *2*, 229–242.
10. Baird, A.J.; Low, R.; Young, D.; Swindles, G.T.; Lopez, O.R.; Page, S. High Permeability Explains the Vulnerability of the Carbon Store in Drained Tropical Peatlands. *Geophys. Res. Lett.* **2017**, *44*, 1333–1339. [CrossRef]
11. Dwiguna, A.R.; Munandar, A.I. Analisis Naratif Kebijakan Pangan Nasional Melalui Program Food Estate Narrative. *J. Adm. Pembang. Kebijak. Publik* **2020**, *11*, 273–284.
12. Shah, N.W.; Nisbet, T.R. The Effects of Forest Clearance for Peatland Restoration on Water Quality. *Sci. Total Environ.* **2019**, *693*, 133617. [CrossRef]
13. Adji, F.F.; Damanik, Z.; Yulianti, N.; Birawa, C.; Handayani, F.; Sinaga, A.N.; Teguh, R.; Dohong, S. Dampak Alih Fungsi Lahan Terhadap Sifat Fisik Tanah Dan Emisi Karbon Gambut Transisi Di Desa Kanamit Barat Kalimantan Tengah. *J. Pedon Trop.* **2017**, *3*, 79–88.
14. Harris, N.; Sargent, S. Destruction of Tropical Peatland Is an Overlooked Source of Emissions. World Resources Institute Insights. 2016. Available online: https://wri-indonesia.org/id/blog/kerusakan-lahan-gambut-tropis-merupakan-sumber-emisi-co2-yang-terabaikan (accessed on 28 December 2022).
15. Page, S.; Hosciło, A.; Wösten, H.; Jauhiainen, J.; Silvius, M.; Rieley, J.; Ritzema, H.; Tansey, K.; Graham, L.; Vasander, H.; et al. Restoration Ecology of Lowland Tropical Peatlands in Southeast Asia: Current Knowledge and Future Research Directions. *Ecosystems* **2009**, *12*, 888–905. [CrossRef]
16. Langeveld, C.A.; Segers, R.; Dirks, B.O.M.; Van Den Pol-van Dasselaar, A.; Velthof, G.L.; Hensen, A. Emissions of CO_2, CH_4 and N_2O from Pasture on Drained Peat Soils in the Netherlands. *Eur. J. Agron.* **1997**, *7*, 35–42. [CrossRef]
17. Hooijer, A.; Page, S.; Canadell, J.G.; Silvius, M.; Kwadijk, J.; Wösten, H.; Jauhiainen, J. Current and Future CO_2 Emissions from Drained Peatlands in Southeast Asia. *Biogeosciences* **2010**, *7*, 1505–1514. [CrossRef]
18. Hatala, J.A.; Detto, M.; Sonnentag, O.; Deverel, S.J.; Verfaillie, J.; Baldocchi, D.D. Greenhouse Gas (CO_2, CH_4, H_2O) Fluxes from Drained and Flooded Agricultural Peatlands in the Sacramento-San Joaquin Delta. *Agric. Ecosyst. Environ.* **2012**, *150*, 1–18. [CrossRef]
19. Prananto, J.A.; Minasny, B.; Comeau, L.P.; Rudiyanto, R.; Grace, P. Drainage Increases CO_2 and N_2O Emissions from Tropical Peat Soils. *Glob. Chang. Biol.* **2020**, *26*, 4583–4600. [CrossRef] [PubMed]
20. Hoyt, A.M.; Chaussard, E.; Seppalainen, S.S.; Harvey, C.F. Widespread Subsidence and Carbon Emissions across Southeast Asian Peatlands. *Nat. Geosci.* **2020**, *13*, 435–440. [CrossRef]
21. Fachlevi, R.; Ismayani, A. Optimalisasi Dan Strategi Peningkatan Produksi Padi Lahan Sawah Baru Di Kabupaten Aceh Timur. *J. Bisnis Tani* **2018**, *4*, 109–121.
22. Hidayat, D.C. *Laporan Analisis Manfaat Dan Biaya Komoditas Paludikultur Provinsi Kalimantan Utara*; Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ): North Kalimantan, Indonesia, 2020.
23. Nurhayati, A.D.; Saharjo, B.H.; Sundawati, L.; Vetrita, Y. Perilaku Dan Persepsi Masyarakat Terhadap Terjadinya Kebakaran Gambut Di Kabupaten Ogan Komeriling Ilir Provinsi Sumatera Selatan. *J. Nat. Resour. Environ. Manag.* **2020**, *10*, 568–583. [CrossRef]
24. Ferré, M.; Muller, A.; Leifeld, J.; Bader, C.; Müller, M.; Engel, S.; Wichmann, S. Sustainable Management of Cultivated Peatlands in Switzerland: Insights, Challenges, and Opportunities. *Land Use Policy* **2019**, *87*, 104019. [CrossRef]
25. Gunawan, H.; Afriyanti, D.; Humam, I.A.; Nugraha, F.C.; Wetadewi, R.I.; Surayah, L.; Nugroho, A.; Antonius, S. Pengelolaan Lahan Gambut Tanpa Bakar: Upaya Alternatif Restorasi Pada Lahan Gambut Basah. *J. Nat. Resour. Environ. Manag.* **2020**, *10*, 668–678. [CrossRef]
26. Lamonge, M. *Neo-Liberalism, Social Conflict and Identity of Papuan Indigenous People Case Study of Merauke Integrated Food & Energy Estate (MIFEE) in Papua*; International Institute of Social Studies: Hague, The Netherlands, 2012.
27. Ganti, T. Neoliberalism. *Annu. Rev. Anthropol.* **2014**, *43*, 89–104. [CrossRef]
28. Friesen, L.D. The Failures of Neoliberal Food Security and the Food Sovereignty Alternative. *USURJ Univ. Saskatchewan Undergrad. Res. J.* **2017**, 4. [CrossRef]
29. Hanspach, J.; Abson, D.J.; French Collier, N.; Dorresteijn, I.; Schultner, J.; Fischer, J. From Trade-Offs to Synergies in Food Security and Biodiversity Conservation. *Front. Ecol. Environ.* **2017**, *15*, 489–494. [CrossRef]
30. Zhang, Y.; Lu, X. A Comprehensive Evaluation of Food Security in China and Its Obstacle Factors. *Int. J. Environ. Res. Public Health* **2022**, *20*, 451. [CrossRef] [PubMed]
31. Goulden, M.C.; Adger, W.N.; Allison, E.H.; Conway, D. Limits to Resilience from Livelihood Diversification and Social Capital in Lake Social-Ecological Systems. *Ann. Assoc. Am. Geogr.* **2013**, *103*, 906–924. [CrossRef]
32. Biggs, E.M.; Bruce, E.; Boruff, B.; Duncan, J.M.A.; Horsley, J.; Pauli, N.; McNeill, K.; Neef, A.; Van Ogtrop, F.; Curnow, J.; et al. Sustainable Development and the Water-Energy-Food Nexus: A Perspective on Livelihoods. *Environ. Sci. Policy* **2015**, *54*, 389–397. [CrossRef]
33. Wong, K.Y.; Aspinwall, E. Knowledge Management Implementation Frameworks: A Review. *Knowl. Process Manag.* **2004**, *11*, 93–104. [CrossRef]
34. Nilsen, P. Making Sense of Implementation Theories, Models and Frameworks. *Implement. Sci.* **2015**, *10*, 53. [CrossRef] [PubMed]

35. Van Wee, B.; Banister, D. How to Write a Literature Review Paper? *Transp. Rev.* **2016**, *36*, 278–288. [CrossRef]
36. Al Husaeni, D.F.; Nandiyanto, A.B.D. Bibliometric Using Vosviewer with Publish or Perish (Using Google Scholar Data): From Step-by-Step Processing for Users to the Practical Examples in the Analysis of Digital Learning Articles in Pre and Post Covid-19 Pandemic. *ASEAN J. Sci. Eng.* **2021**, *2*, 19–46. [CrossRef]
37. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *Syst. Rev.* **2021**, *10*, 89. [CrossRef]
38. Mulyanto, B.; Sumawinata, B.; Sandrawati, A. Sejarah Pengelolaan Lahan Gambut Di Indonesia. *Gakuryoku* **2005**, *11*, 120–126.
39. Ariyanto, D.P.; Yunus, A.; Pudjiasmanto, B.; Widijanto, H. Suntoro the Productivity Increasing of Peatlands on Community Land by Multi-Cropping Model in Riau Indonesia. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *393*, 12103. [CrossRef]
40. Najiyati, S.; Muslihat, L.; Suryadiputra, I.N.N. Panduan pengelolaan lahan gambut untuk pertanian berkelanjutan. In *Proyek Climate Change, Forests and Peatlands in Indonesia*; Wetlands International—Indonesia Programme dan Wildlife Habitat Canada: Bogor, Indonesia, 2005.
41. Suriadikarta, D.A. Utilization and Development Strategy of PLG Peat Land in Central Kalimantan. *J. Sumberd. Lahan* **2008**, *2*, 31–44.
42. Pandjaitan, N.H.; Hardjoamidjojoi, S. Kajian Sifat Fisik Lahan Gambut Dalam Hubungan Dengan Drainase Untuk Lahan Pertanian. *Bul. Keteknikan Pertan.* **1999**, *13*, 87–96.
43. Gunawan, H.; Afriyanti, D. Potensi Perhutanan Sosial Dalam Meningkatkan Partisipasi Masyarakat Dalam Restorasi Gambut. *J. Ilmu Kehutan.* **2019**, *13*, 227–236. [CrossRef]
44. Suyanto, S.; Khususiyah, N.; Sardi, I.; Buana, Y.; Van Noordwijk, M.; Centre, W.A. *Analysis of Local Livelihoods from Past to Present in the Central Kalimantan Ex-Mega Rice Project Area*; World Agroforestry Centre: Nairobi, Kenya, 2009.
45. Prayoga, K. Pengelolaan Lahan Gambut Berbasis Kearifan Lokal Di Pulau Kalimantan. In Proceedings of the Prosiding Seminar Nasional Lahan Basah, Banjarmasin, Indonesia, 5 November 2016; pp. 1016–1022.
46. Hadiwijoyo, E.; Saharjo, B.H.; Putra, E.I. Local Wisdom of Dayak Ngaju in Central Kalimantan on Land Preparation by Using Fire. *J. Trop. Silvic.* **2017**, *8*, 1–8. [CrossRef]
47. Bridgewater, P.; Rotherham, I.D. A Critical Perspective on the Concept of Biocultural Diversity and Its Emerging Role in Nature and Heritage Conservation. *People Nat.* **2019**, *1*, 291–304. [CrossRef]
48. Thornton, S.A.; Setiana, E.; Yoyo, K.; Harrison, M.E.; Page, S.E.; Upton, C. Towards Biocultural Approaches to Peatland Conservation: The Case for Fish and Livelihoods in Indonesia. *Environ. Sci. Policy* **2020**, *114*, 341–351. [CrossRef]
49. Wulandani, B.R.D.; Anggraini, W. Food Estate Sebagai Ketahanan Pangan Di Tengah Pandemi Covid-19 Di Desa Wanasaba. *SELAPARANG J. Pengabdi. Masy. Berkemajuan* **2020**, *4*, 386. [CrossRef]
50. Asti, A.; Priyarsono, D.S.; Sahara, S. Analisis Biaya Manfaat Program Pembangunan Food Estate Dalam Perspektif Perencanaan Wilayah: Studi Kasus Provinsi Kalimantan Barat. *J. Agribisnis Indones.* **2017**, *4*, 79. [CrossRef]
51. Neilson, J.; Wright, J.; Aklimawati, L. Geographical Indications and Value Capture in the Indonesia Co Ff Ee Sector. *J. Rural Stud.* **2018**, *59*, 35–48. [CrossRef]
52. Husnain, H.; Mulyani, A. Dukungan Data Sumberdaya Lahan Dalam Pengembangan Kawasan Sentra Produksi Pangan (Food Estate) Di Provinsi Kalimantan Tengah. *J. Sumberd. Lahan* **2021**, *15*, 23. [CrossRef]
53. Wisnu, D. Food Estate Program Law Politics: Toward Fulfillment of the Rights of Central Kalimantan Dayak Indigenous Peoples. *J. Contemp. Sociol. Issues* **2022**, *2*, 76–91. [CrossRef]
54. Suwarno, Y.; Purwono, N.; Suriadi, A.B.; Nahib, I. Kajian kesatuan hidrologis gambut wilayah kalimantan tengah. In Proceedings of the Seminar Nasional Badan Informasi Geospasial, Jakarta, Indonesia, 24 November 2016; pp. 233–242.
55. Kwasek, M. Threatsto Food Security and Common Agricultural Policy. *Econ. Agric.* **2012**, *59*, 701–713.
56. Benton, T.; Bieg, C.; Harwatt, H.; Pudassaini, R.; Wellesley, L. *Food System Impacts on Biodiversity Loss Three Levers for Food System Transformation in Support of Nature*; Chatham House: London, UK, 2021; ISBN 9781784134334.
57. Scoones, I. *Sustainable Rural Livelihoods A Framework for Analysis*; Institute of Development Studies: Brighton, UK, 1998.
58. Chambers, R.; Conway, G.R. *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*; Institute of Development Studies: Brighton, UK, 1992; Volume 296.
59. Wang, Z.; Li, W.; Qi, J. Evaluation and Strategic Response of Sustainable Livelihood Level of Farmers in Ecological Resettlement Area of the Upper Yellow River—A Case Study of Liujiaxia Reservoir Area, Gansu Province. *Int. J. Environ. Res. Public Health* **2022**, *19*, 16718. [CrossRef] [PubMed]
60. Miller, E. *Reimagining Livelihoods Life Beyond Economy, Society and Environment*; University of Minnesota Press: London, UK, 2019; ISBN 9788578110796.
61. Knutsson, P. The Sustainable Livelihoods Approach: A Framework for Knowledge Integration Assessment. *Hum. Ecol. Forum* **2006**, *13*, 90–99.
62. Purvis, B.; Mao, Y.; Robinson, D. Three Pillars of Sustainability: In Search of Conceptual Origins. *Sustain. Sci.* **2019**, *14*, 681–695. [CrossRef]
63. Barbier, E.B. The Concept of Sustainable Economic Development. *Econ. Sustain.* **1987**, *14*, 87–96. [CrossRef]
64. Barbier, E.B. Cash Crops, Food Crops, and Sustainability: The Case of Indonesia. *World Dev.* **1989**, *17*, 879–895. [CrossRef]

65. Saragih, S.; Lassa, J.; Ramli, A. *Kerangka Penghidupan Berkelanjutan (Sustainable Livelihood Framework)*; Hivos Southeast Asia Office: Jakarta, Indonesia, 2007.
66. Siisiäinen, M. Two concepts of social capital: Bourdieu vs. Putnam. In Proceedings of the the Third Sector: For What and for Whom? Dublin, Ireland, 5–8 July 2000; p. 26.
67. Fitriana, E. Marni Transmigran Sebagai Modal Sosial Dalam Pengembangan Food Estate Di Kabupaten Pulang Pisau. *Sosiohumaniora J. Ilm. Ilmu Sos. Hum.* **2021**, *7*, 1–14. [CrossRef]
68. Banda, M. Upaya Kearifan Lokal Dalam Menghadapi Tantangan Perubahan Kebudayaan. In Proceedings of the Makalah Konferensi Internasional; Fakultas Pascasarjana USU: Medan, Indonesia, 2016; pp. 21–22.
69. Affandy, S. Penanaman Nilai-Nilai Kearifan Lokal Dalam Meningkatkan Perilaku Keberagamaan Peserta Didik. *Atthulab Islam. Relig. Teach. Learn. J.* **2019**, *2*, 69–93. [CrossRef]
70. Amiruddin, S. Jaringan Sosial Pemasaran Pada Komunitas Nelayan Tradisional Banten. *KOMUNITAS Int. J. Indones. Soc. Cult.* **2014**, *6*, 106–115. [CrossRef]
71. Astri, H. Penyelesaian Konflik Sosial Melalui Penguatan Kearifan Lokal. *J. Aspir.* **2011**, *2*, 151–162.
72. Šlaus, I.; Jacobs, G. Human Capital and Sustainability. *Sustainability* **2011**, *3*, 97. [CrossRef]
73. Setyowati, L. Literasi Informasi Dilihat Dari Perspektif Modal Manusia. *Libr. J. Perpust.* **2015**, *3*, 232.
74. Morse, S.; McNamara, N. Sustainable Livelihood Approach: A Critique of Theory and Practice. In *Sustainable Livelihood Approach: A Critique of Theory and Practice*; Springer: Berlin/Heidelberg, Germany, 2013; pp. 1–190. ISBN 9789400762688.
75. Gamachchige, R.N.; Thennakoon, T.M.S.P. Application of Traditional Ecological Knowledge for Sustainable Ecological Restoration. In *Environmental Management and Sustainable Development*; UTHM: Parit Raja, Malaysia, 2019; Volume 33, pp. 6–13. ISBN 9789672216766.
76. Hosen, N.; Nakamura, H.; Hamzah, A. Adaptation to Climate Change: Does Traditional Ecological Knowledge Hold the Key? *Sustainability* **2020**, *12*, 676. [CrossRef]
77. Van Opstal, M.; Hugé, J. Knowledge for Sustainable Development: A Worldviews Perspective. *Environ. Dev. Sustain.* **2013**, *15*, 687–709. [CrossRef]
78. Khatiwada, S.P.; Deng, W.; Paudel, B.; Khatiwada, J.R.; Zhang, J.; Wan, J. A Gender Analysis of Changing Livelihood Activities in the Rural Areas of Central Nepal. *Sustainability* **2018**, *10*, 4034. [CrossRef]
79. Quandt, A. Variability in Perceptions of Household Livelihood Resilience and Drought at the Intersection of Gender and Ethnicity. *Clim. Chang.* **2019**, *152*, 1–15. [CrossRef]
80. Buschmann, C.; Röder, N.; Berglund, K.; Berglund, Ö.; Lærke, P.E.; Maddison, M.; Mander, Ü.; Myllys, M.; Osterburg, B.; van den Akker, J.J.H. Perspectives on Agriculturally Used Drained Peat Soils: Comparison of the Socioeconomic and Ecological Business Environments of Six European Regions. *Land Use Policy* **2020**, *90*, 104181. [CrossRef]
81. Biggs, E.; Boruff, B.; Bruce, E.; Duncan, J.M.A.; Haworth, B.J.; Duce, S.; Horsley, J.; Curnow, J.; Neef, A.; McNeill, K.; et al. *Environmental Livelihood Security in Southeast Asia and Oceania: A Water-Energy-Food-Livelihoods Nexus Approach for Spatially Assessing Change*; International Water Management Institute: Battaramulla, Sri Lanka, 2014; ISBN 9789290908074.
82. Buizer, M.; Arts, B.; Kok, K. Governance, Scale and the Environment: The Importance of Recognizing Knowledge Claims in Transdisciplinary Arenas. *Ecol. Soc.* **2011**, *16*, 21. [CrossRef]
83. Anandajayasekeram, P. *Scaling Up and Scalability: Concepts, Frameworks and Assessment*; VUNA: Pretoria, South Africa, 2016.
84. Westermann, O.; Thornton, P.; Forch, W. *Reaching More Farmers Innovative Approaches to Scaling Up Climate-Smart Agriculture*; CGIAR: Montpellier, France, 2015.
85. Taherzadeh, O.; Bithell, M.; Richards, K. Water, Energy and Land Insecurity in Global Supply Chains. *Glob. Environ. Chang.* **2020**, *67*, 102158. [CrossRef]
86. Nost, E. Scaling-up Local Foods: Commodity Practice in Community Supported Agriculture (CSA). *J. Rural Stud.* **2014**, *34*, 152–160. [CrossRef]
87. Hajjar, R.; Newton, P.; Adshead, D.; Bogaerts, M.; Maguire-Rajpaul, V.A.; Pinto, L.F.G.; McDermott, C.L.; Milder, J.C.; Wollenberg, E.; Agrawal, A. Scaling up Sustainability in Commodity Agriculture: Transferability of Governance Mechanisms across the Coffee and Cattle Sectors in Brazil. *J. Clean. Prod.* **2019**, *206*, 124–132. [CrossRef]
88. De Leeuw, J.; Heiser, W. Theory of Multidimensional Scaling. In *Handbook of Statistics*; Nord Holland: Amsterdam, The Netherlands, 1982; Volume 2, pp. 285–316. ISBN 9780444862174.
89. Torgerson, W.S. Multidimensional Scaling: I. *Theory and Method. Psychometrika* **1952**, *17*, 401–419. [CrossRef]