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Perspective

Agroforestry-Based Ecosystem Services: Reconciling Values of Humans and Nature in Sustainable Development

Meine van Noordwijk [1,2,3]

1 World Agroforestry (ICRAF), Bogor 16155, Indonesia; M.vannoordwijk@cgiar.org
2 Plant Production Systems, Wageningen University & Research, 6700 AK Wageningen, The Netherlands
3 Study Group Agroforestry, Faculty of Agriculture, Brawijaya University, Jl Veteran, Malang 65145, Indonesia

Abstract: Agroforestry as active area of multi-, inter-, and transdisciplinary research aims to bridge several artificial divides that have respectable historical roots but hinder progress toward sustainable development goals. These include: (1) The segregation of "forestry trees" and "agricultural crops", ignoring the continuity in functional properties and functions; the farm-scale "Agroforestry-1" concept seeks to reconnect perennial and annual, woody and nonwoody plants across the forest–agriculture divide to markets for inputs and outputs. (2) The identification of agriculture with provisioning services and the assumed monopoly of forests on other ecosystem services (including hydrology, carbon storage, biodiversity conservation) in the landscape, challenged by the opportunity of "integrated" solutions at landscape scale as the "Agroforestry-2" concept explores. (3) The gaps among local knowledge of farmers/agroforesters as landscape managers, the contributions of social and ecological sciences, the path-dependency of forestry, environmental or agricultural institutions, and emerging policy responses to "issue attention cycles" in the public debate, as is the focus of the "Agroforestry-3" concept. Progress in understanding social–ecological–economic systems at the practitioners–science–policy interface requires that both instrumental and relational values of nature are appreciated, as they complement critical steps in progressing issue cycles at the three scales. A set of hypotheses can guide further research.

Keywords: coinvestment; instrumental values; landscape; relational values; restoration; social–ecological systems; stewardship; sustainable development goals (SDGs); trees; water

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1. Introduction

Agroforestry-based ecosystem services, the title of the special issue this perspective is part of, refers to an active arena of international agricultural research connected with global sustainability science at the science–policy interface [1]. This research deals with "theories of place" (how and why do social–ecological contexts differ from each other as part of multiscale spatial patterns?), theories of change (how, when, and why does the process of change happen?), and theories of induced change (how can change processes in their existing context be nudged into a direction that is deemed to be desirable?) [2]. It also deals with value plurality as depending on context and stakeholders' expressions of value that express "instrumentality" complement those that emphasize "relations" [3]. "Ecosystem services" (ES), "agroforestry" (AF), and "value plurality" all refer to connections. Their combination may thus need to clarify the components of all three terms as well as their interfaces. Ecosystem services is commonly defined as the benefits people derive in various ways from functioning ecosystems (including agro-ecosystems and forest ecosystems) and that can be at risk due to human activities from local to global scales. It connects "service providers" (nature and its guardians) and "service beneficiaries" (e.g., people, companies, cities, nations). While terminologies and metaphors have been proposed other than that of a servant, the alternative terms referring to "nature" and "contributions" (voluntary? appropriated?) may have similar semantic challenges [4]. Ecosystem services as ongoing benefit flows have been promoted as reason to appreciate the underlying "natural capital", but it may have become (too) strongly associated with economic valuations of these services. Economic estimates of costs to society of loss of natural ecosystems [5,6] are astronomical and call for a realignment of economic priorities in achieving progress in human well-being under the umbrella of sustainable development. Quantitative economic language, however, has been interpreted as underrating qualitative social dimensions [4]. Current interest in "relational values" can be understood as emphasizing social ("in-group") aspects over economic (costs, benefits) ones [7].

Agroforestry, the word constructed by combining agro- and forestry, has from its start been concerned with bridging between concepts that appeared to contradict each other [2]. It is currently understood to refer to three nested scales: as "AF1" to the scale of trees, management practices, plot-level technology, and farm level decisions; as "AF2" to landscapes with trees and forest (patches) in which productivity ("provisioning services") interacts with other ES ("regulating" and "cultural" services); and as "AF3" to the reconciliation of agriculture and forestry as separate policy domains that interact at "land use" and natural resource management levels, connecting local knowledge, sciences and policy framing in "issue cycles" [8]. As partial tree cover in what is classified as agricultural lands is common (more than a third of such lands has at least 10% tree cover) and appears to be increasing [9], agroforestry is part of mainstream land use.

As a dominant theory of inducible change, the Sustainable Development Goals have tried to define a "safe space for humanity" that links local to global concerns and vice versa. Following the Doughnut model of Raworth [10], these goals can be summarized as centrifugal expansion in an inner circle of reducing development deficits (essentially the Millennium Development Goals that have not yet been achieved), with simultaneous centripetal movement avoiding overshoot of planetary boundaries and restoring functions that were lost from "degraded" parts of the planet (Figure 1). The Earth is too small to achieve all SDGs in silos, with separate land allocations for each goal. Provision of water (of acceptable quality and regularity of flow), food, fiber, and energy may have to be achieved on the same units of land that also provide jobs and contribute to public health. Multifunctional landscapes that simultaneously contribute to multiple goals are in demand, that combine fairness (ensuring that nobody is left behind in reducing development deficits that contribute to poverty) and efficiency of avoiding planetary overshoot [11]. Rather than the "productivity gaps" that still are a major focus of agronomy [12], the broader concept of "multifunctionality gaps" has been the focus of agroforestry in its first four decades [13,14]. To avoid further land degradation and promote land restoration, multifunctional use of land is needed within the boundaries of the soil–water system; new business models in robust economic systems are needed based on environmental systems thinking integrating environmental, social, and economic interests [15].

This leads to the three questions that frame this perspective as a review of relevant literature: 1. how are value concepts of agroforestry evolving in relation to ES discourse and sustainability concerns at the multifunctional landscape scale?; 2. how can the interaction among the three agroforestry scales and concepts (AF1, AF2, and AF3) be understood?; and 3. what roles can research play in connecting theories of place and change to policies that aim for applicable theories of induced change, in support of SDGs? The rest of this paper will review these three questions and then formulate some hypotheses for follow-up research.

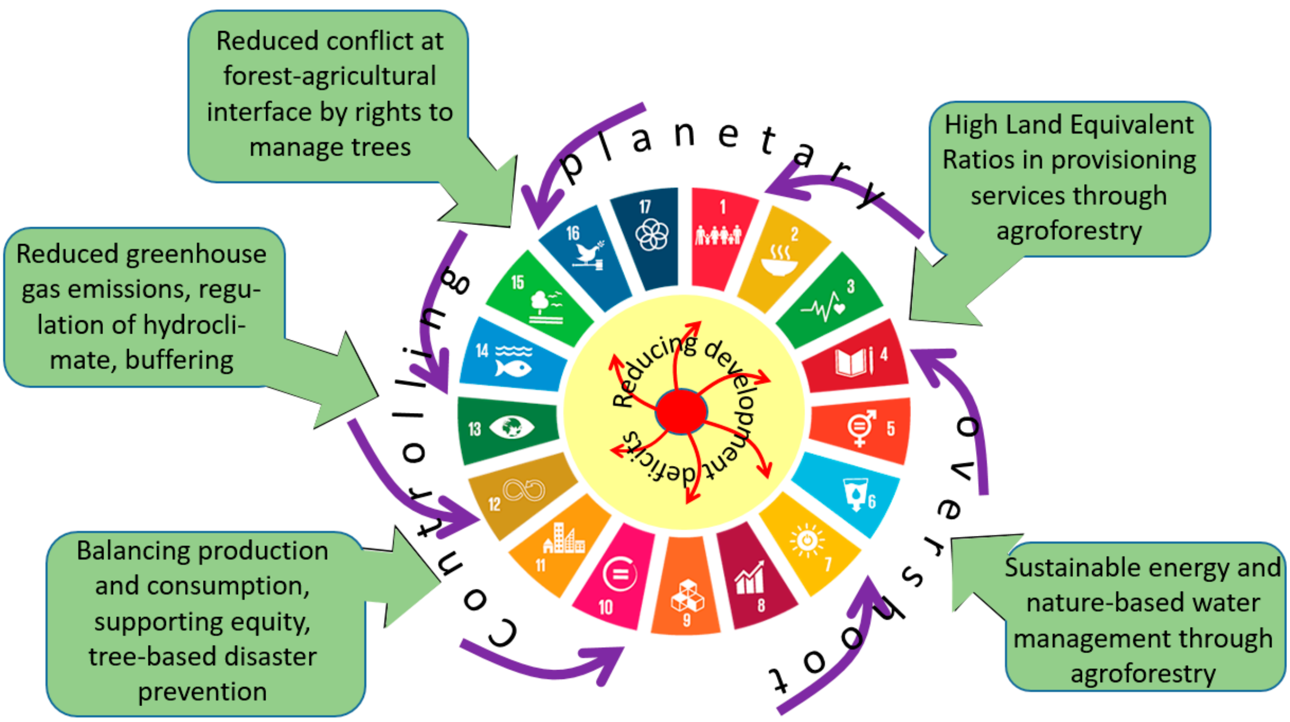

Figure 1. Agroforestry contributes to the various Sustainable Development Goals as safe space for humanity, between "development deficits" and "planetary boundary overshoot".

2. Roots of Sustainability Concepts Relevant to Agroforestry

2.1. Three Changes of Theory Foundational to Sustainable Development

Changes in the way human society effectively relates to and values nature, and nature-derived land uses such as agroforestry, require changes in theory, and thus a theory of change of theory [16]. IPBES reports record the ongoing loss of biodiversity and identify market-based production responding to ever-growing demand as major drivers of destruction and a principal theory of change [17]. Three "changes of theory" that originated in the 18th, 19th, and 20th century, respectively "the blind watchmaker" (a later metaphor for the ideas of Charles Darwin), "the invisible hand" (Adam Smith), and "the not-so-tragic commons" (Elinor Ostrom), have shaped how sustainability scientists perceive humanity (Figure 2). All three theories connected basic mechanisms at the level of the individual to impacts at scales (time, space, systems) many orders of magnitude beyond the location and lifespan of the individual. Previous theories lacked mechanisms for change in organisms after their creation, which lived in autocratically governed static economies where neither individuals nor local communities counted. Although all three changes of theory are now mainstream, the radical break with preceding theories of change can hardly be overstated.

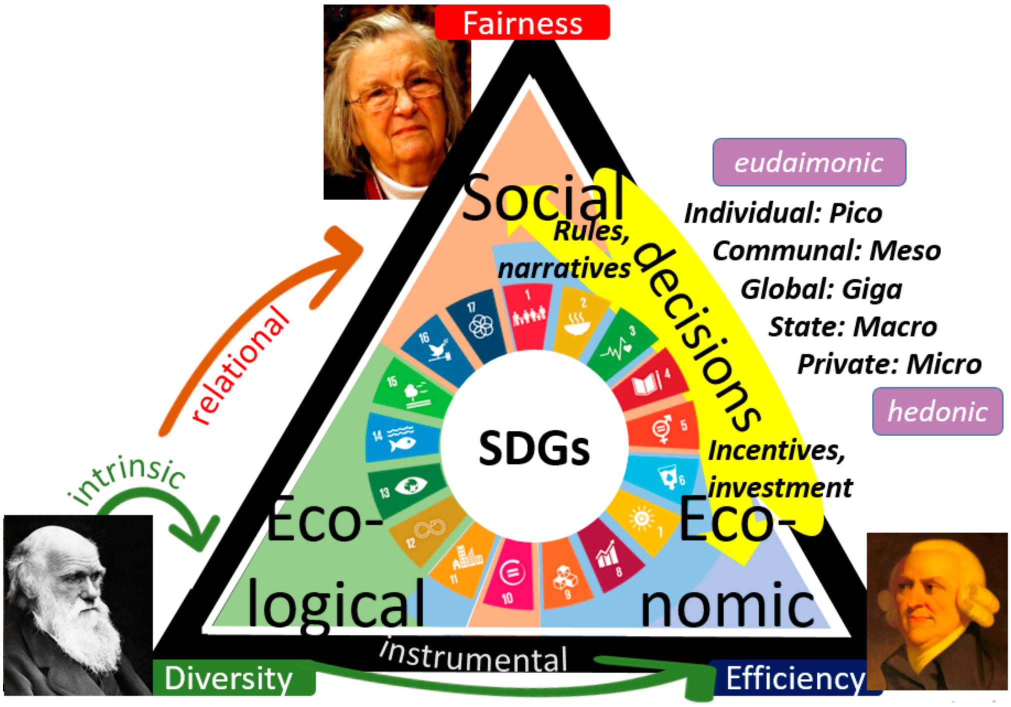

Figure 2. The triple bottom line of People–Profit–Planet or social, economic, and ecological aspects of value (importance, exchangeability, and long-term survival) for sustainability is reflected in the current set of 17 Sustainable Development Goals (SDGs) and connects the intellectual breakthroughs of the invisible hand, blind watchmakers, and not-so-tragic commons, attributed to Adam Smith [18]., Charles Darwin [19], and Elinor Ostrom [20], respectively; human decision making across the social–economic spectrum depends on the scale (see Figure 3 for the pico–giga terminology) and reflects different types of values: the intrinsic, instrumental, and relational values of nature and its diversity, the efficiency of using scarce resources, and the hedonic and eudaimonic improvements of human quality of life (see below for a further discussion).

A first powerful cross-scale mechanism was found in the invisible hand that efficiently links supply and demand in markets through the self-interest of individuals [21]. Adam Smith also explored [22] how moral sentiments in a society constrain (or should constrain) this self-interest, but this part of his heritage received less attention than his ode to market forces. The second mechanism revolutionized biology and its application in medical agricultural and biotechnological sciences, with the current rate of evolution of a specific virus remaining headline news. Moderate rates of errors in replication of genetic code, in combination with sexual reproduction involving recombination, and selective phenotype survival with feedback to gene frequencies were understood to be the blind watchmaker's [23] recipe for the overwhelming biodiversity of our planet. The diversification mechanism interacts with factors such as climate, water, carbon and nutrient cycles and geomorphology. It also implies coevolution in plant–herbivore, predator–prey, disease–host, symbionts, pollinator–flower, and seed dispersal–dispersant relations providing positive feedback loops to ever-increasing diversity levels. These relations between organisms translate to differential survival, but also lead to interconnected sensitivity to collapse. Plate tectonics as the source of continental drift supported (was a driver of) further speciation, but also set up the current sensitivity to "invasive" species overcoming geographic isolation. Any seed-dispersing animal modifies vegetation in a direction of fruits it likes to eat, but our species has learned over the past 10,000 years to coevolve and further work with, rather than against nature, in domesticating the major sources of food, gradually adding visioning, design, planning, and rationality to the blind watchmaker. Agriculture, with the option of storing, hoarding, and transporting food, is widely seen as the start of social stratification and power structures [24,25]. The popular Jenga game, where a fair number of blocks of wood can be extracted from a stack before an inevitable collapse follows, provides a visualization of this risk [26] when the invisible hand is not constrained in its resource extraction.

Once governments learned to work with, rather than against, market forces, economies blossomed. They did so well that the invisible hand gradually, and initially imperceptibly to the blind watchmaker, started to destroy its work. This is the theory of change the IPBES reports indicate as a major driver behind ongoing trends: market-driven expansion of the human sphere of influence, destroying habitat. However, the emergence of SARS-Cov-2 at the end of 2019 showed that the opposite, results of the blind watchmakers' activity destroying those of the invisible hand, can happen as well [27]. A modified theory of change has negative outcomes on both sides of the interaction and urges a coevolutionary path of humans and the rest of the planet's life forms. The mutual dependence of nature (N) and humans (H) has gradually dawned on mainstream political systems with current financial understanding of "nature risk" [28]. The main religions of the world have assigned H a special, privileged position that, however, comes with obligations for stewardship and adaptive social–ecological governance [29]. Prioritizing N has also been discussed (and objected to) as a "dark-green religion" [30].

The third intellectual breakthrough, the revision of what is tragic about the commons, is the most recent of the three foundations of sustainability science, and it is still in the process of mainstreaming. To some extent it fills the place left by the failure of a third theory of change rooted in social concerns over inequity and in the expectation that political power will (or at least can) shift to (what used to be) the proletariat. In practice new autocracies emerged where the ideas of Karl Marx were applied [31]. Yet, at the smaller scale of "commons", bottom-up institutions have historically and to this day been able to manage resources, avoiding the free-for-all degradation expected. Where the lack of private property rights (especially the right of exclusion) had been portrayed as a tragedy of the commons and as the primary bottleneck to environmental management benefitting the well-being of local communities, a counter-narrative emerged of the comedy of the commons [32], to be better understood and heard. Two thousand years ago, Roman society, the legal thinking of which greatly influenced later European law, was sufficiently interested in public property (ius publicum) to distinguish various categories within the concept, as applied, for example, to issues of water at various scales. Debate on the relative merits of "common law" revolved about a bundle of rights and the roles of community-based institutions at a scale intermediate between the state and the individual. The "institutional economics" analyses by Elinor Ostrom [33] brought back respect for the ability of local communities to develop their own rules, incentives, and narratives to manage resources, including land, forest, and inland and coastal fisheries. With the concept of commons broadening from grazing land to various types of land and water use, and more recently the atmosphere and global climate system, the scale at which resources can be managed needs to be reflected in the institutions managing it. Private, communal, national, and global scales all have a role to play. The triple bottom line of these ideas is that working with, rather than against, nature, markets, and communities is essential to transcend conflicts and move towards diverse, efficient, and fair societies. The challenge is where to start.

Research on human well-being or qualities of lives has explored two general perspectives [34] that date back to Greek philosophers more than 2000 years ago: the hedonic (pleasure-oriented) approach, which focuses on happiness and defines well-being in terms of pleasure attainment and pain avoidance; and the eudaimonic approach, which focuses on meaning and self-realization and defines well-being in terms of the degree to which a person is fully functioning [35]. It refers to a perception of social harmony, reflected in societal concepts as adat in Indonesian cultures [36], satoyama landscapes in Japan [37], yin-yang in Chinese philosophy [38], or religious concepts such as kosher or halal [39]. Eudaimonic well-being may well be an acquired taste during an individual's development, achieved when aspirations, rationalizations, and actions match [40,41]. Self-actualization, personal expressiveness, and perceived vitality are indicators at the interface of individuals and the social groups in which they function. In Bahasa Indonesia, there are two words for "we": an "in-group" we (kami) and a "we" (kita) that includes those spoken to, regardless of the relationship. Adat applies to the first, with a dotted line that is fluid and negotiable; internalization may strive for widening the kami concept. Grossly simplifying matters: the heritage of Adam Smith is mostly invoked in market-based efficiency, pursuit of hedonic values, and defending individual freedom versus "the state", the ideas of Elinor Ostrom in balancing rights and responsibilities, eudaimonic values of well-functioning community-based resource management, and appreciating the institutional dynamics multilayered governance where fairness concepts are not to be ignored in the search for efficiency.

2.2. Theories of Induced Change

In connection with an analysis of drivers, pressure, system state, impacts, and responses (DPSIR) change processes can be classified as (1) responsive—connecting (undesirable) impacts to a (corrective) response, (2) adaptive—optimizing impacts given a changed system state, (3) mitigative—given existing pressures reducing (spatially explicit) negative changes in the state of the system, (4) transformative—given the drivers, reduce (generic) pressures, or (5) reimaginative—challenge the drivers in view of the overarching goals of safe human well-being on the only planet we have [42].

Sustainable development that connects local to global scales and vice versa requires cross-scale analysis. Theories of induced change with mechanisms at pico (brain synapses, genes), micro (self-interest), and meso (rules) levels can have impacts at macro (national) and (giga) planetary scales [43] (Figure 3).

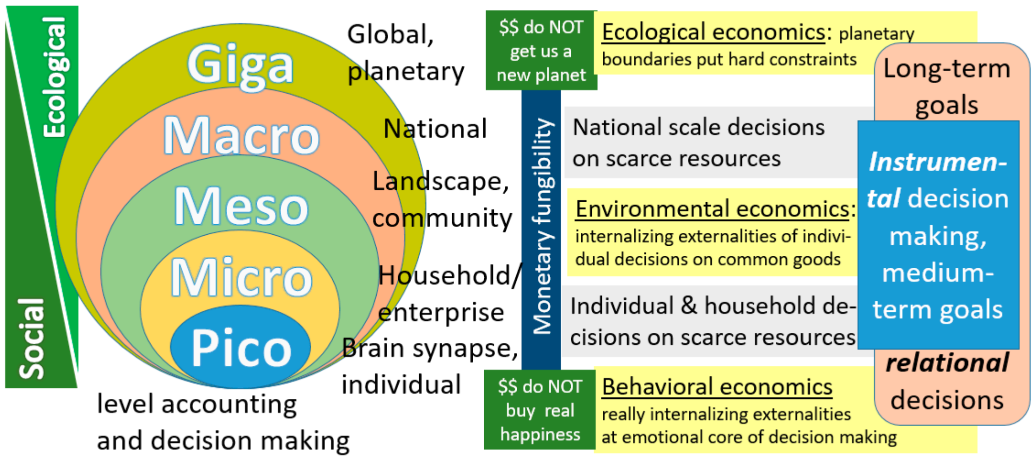

Figure 3. Linking five scales of economic analysis of social–ecological systems to two ways of decision making instrumental (medium-term goal oriented) and relational [44].

Economic analysis of decision making has long been differentiated by scale. Beyond the micro (household, enterprise) and macro (state) accounting stance of economics as a discipline that aims to understand human decisions facing scarcity, three further scales have been explored in recent decades: meso, giga, and pico [44] (Figure 3). The contrast between the meso and giga scales has been discussed in the debate of "environmental" versus "ecological" economics. The first aims for a meso-scale perspective where "market failures" that are the consequence of explicit valuation of commons (including ecosystem services) can be addressed ("internalizing externalities") by facilitating the emergence of new (regulated) markets that try to get "prices" more aligned with "values at stake", influencing household-level decisions and choices both in the consumptive and investment spheres.

Ecological economics (giga), in contrast, is not content with fitting environmental issues into a mainstream economics perspective but starts from planetary boundary perspectives on the types of changes needed to fit humans into what a living planet can deal with, aiming to stop short of a number of precipices, of which global climate change is now probably the best understood for its risks of self-propelling changes. The fifth scale, pico, refers to synapses in human brains where actual decisions are made, as explored in behavioral economics, interfacing psychology, neurology, game theory, and choice experiments. The relevance of branding, influencing perceptions, and priming human decisions had been long understood in marketing research. More formal understanding and academic recognition within economics only arose in the past three decades. Its application of "nudging" [45] as a way of less visibly (obnoxiously?) influencing individual- and household-level decisions aligned with public governance values has been practiced for less than two decades.

Thus, modification of prices is only one of several ways to internalize externalities (Figure 4), as human decision-making responds to both rational and emotional clues [46], and human sociality [47] analyzes decisions in terms that are understood by "influencers" and social media but have not yet been integrated in standard economic theory.

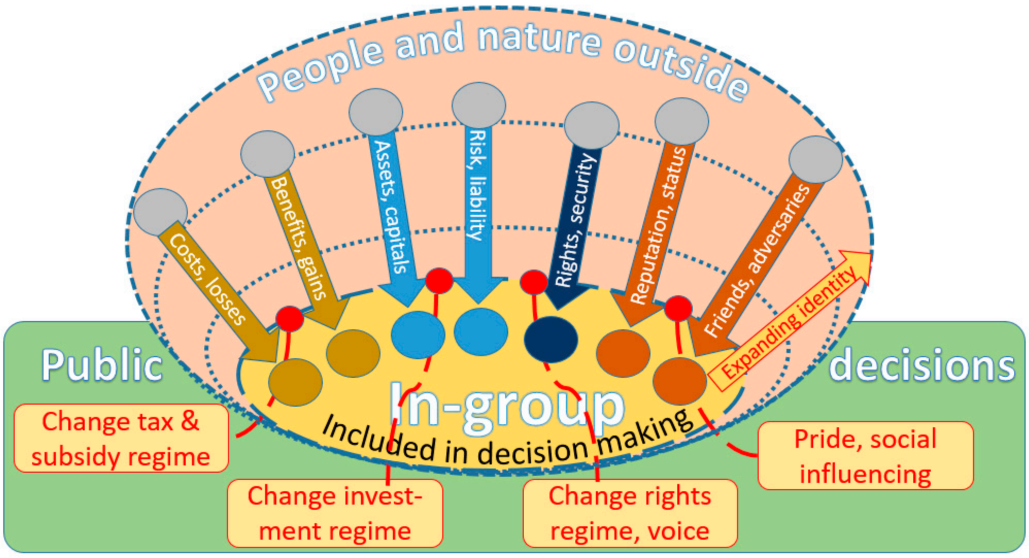

Figure 4. Visualization of the various approaches to internalize externalities in human decision making, which tends to consider consequences (costs and benefits) for an in-group but not for people and nature beyond this emotional inner circle unless efforts to expand the inner circle are effective.

2.3. Teleconnections and Distractors

Thirty years ago, the world was, at a conference in Noordwijk, as close as it has ever been to binding international agreement on combatting climate change [48], but the fossil fuel lobby successfully obstructed agreements at government level in 1989 [49,50] and ever since through disinformation and fear campaigns that suggested citizen self-interest would be better off ignoring the signals of planetary overshoot. Small-scale effects with global consequences became known as the butterfly effect as part of chaos theory, which term refers to the positive feedback loops, metaphorically, of a butterfly clapping its wings triggering hurricanes far away [51].

A stronger, more current story of teleconnections, although other theories are around as well, is that caged wild animals (illegally traded) in the Wuhan market were in close enough contact with people to allow a virus to jump the species barrier. The rest is rewriting history books as we speak, demonstrating that cross-scale theories of change are rightly known as "going viral", in the world of memes as well as genes. A single schoolgirl who decided one day to skip school and sit in front of her parliament with a "Skolstrejk för klimatet" poster, started a movement now known as the Extinction Rebellion, and, once she got noticed, was strengthened by her rebuttal of denial and conspiracy theories and became a role model not only for her own generation but for the world [52]. Her urge to action focused on the climate change issue the world had been talking about since she was born (and before). Planetary anxiety may trigger what technical, solution-oriented talks to rein in market forces failed to achieve: consumer restraint to reduce footprints to what is affordable within planetary boundaries. Consumer power may achieve what governments, subject to its interaction with industry, cannot.

The metaphors used here, the invisible hand that drives global environmental destruction in the name of human welfare and that ignores its ticking wristwatch, made by a blind watchmaker, while understanding the commons, can now be appreciated as a social–ecological system in need of reimaginative as well as transformative changes beyond the tinkering of adaptive and mitigative responses. The typology of "leverage points" that was formulated on the basis of early whole-Earth system models [53] still applies; the most effective leverage points relate to rules and incentives (#5) and goals (#3) on the instrumental side and self-organization (#4) and mindsets (#2) on the relational value side. However, the most powerful leverage point of all, the power to transcend the existing system (#1), may refer to ways to go beyond the limits of the current valuation debate and the way it has been framed.

2.4. Value Types

Two main categories of "values" of nature to humans are currently distinguished: instrumental (goal-oriented, potentially substitutable means to achieve goals) and relational (based on a two-way interaction that establishes affinity and is not easily substitutable) [7,54] (Figure 5).

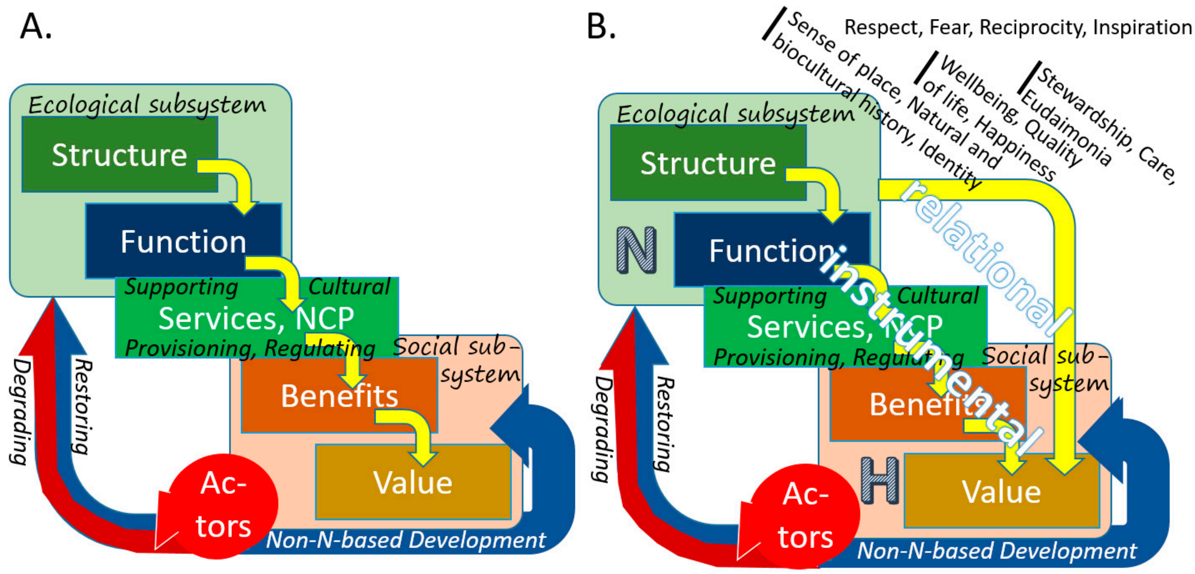

Figure 5. (**A**) The ecosystem cascade concept of ecological–social systems, with ecosystem services (alternatively described as nature's contributions to people or NCPs) at the interface of the two subsystems and feedback by human actors using, degrading, and/or restoring the ecological subsystem; (**B**) Distinction between instrumental (goal-oriented) values of nature and relational values that are not dependent on material benefits.

When positioned in a feedback loop between human and nature (Figure 6), relational and instrumental values may have complementary roles with respect to decisions to improve qualities of human lives. In this interpretation, the degree of substitutability may not be most important distinction between instrumental and relational values: the first is counted in terms of benefits and contribution by nature, the second by the investment in effort. The latter matches the long-term experience that getting school children to care for plants or animals shapes their values on environmental issues [55]. Stewardship as a central concept of relational value has emerged in many human societies [56]. This view on relational values as based on direct engagement may also help to further analyze the noted gender differences in appreciating landscape elements and land use decisions [57].

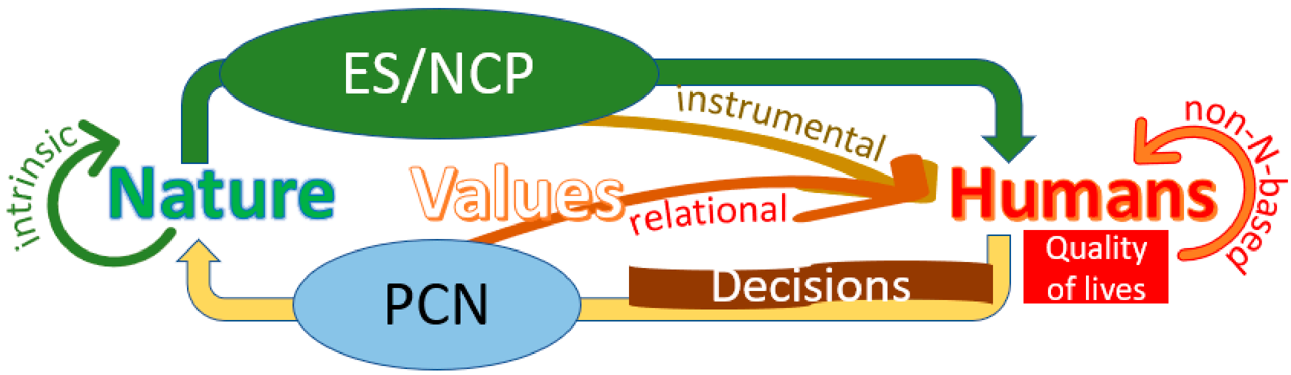

Figure 6. Interpretation of the complementarity of goal-oriented, instrumental and engagement-based, relational values of nature to humans, with respect to ecosystem services (ES) (or nature's contributions to people, NCP) and people's contributions to nature (PCN).

A substantial share of the words and metaphors that can be used to describe relational values of nature to humans, are derived from the way relations between humans are understood, within and outside an in-group or family concept. Tigers may be described as "uncles" living in Asian forest, not to be disturbed but fair in their retaliatory actions against human trespassers [58]; nature may be described as a "mother". The relations themselves grade from fear and respect, competition, enemies, friends, reciprocity, love and care, or stewardship. Elaborating on a diagrammatic representation in [42], instrumental values can be interpreted as part of an overarching relational value concept (with servant or contributor as a one-direction oriented relation) (Figure 7).

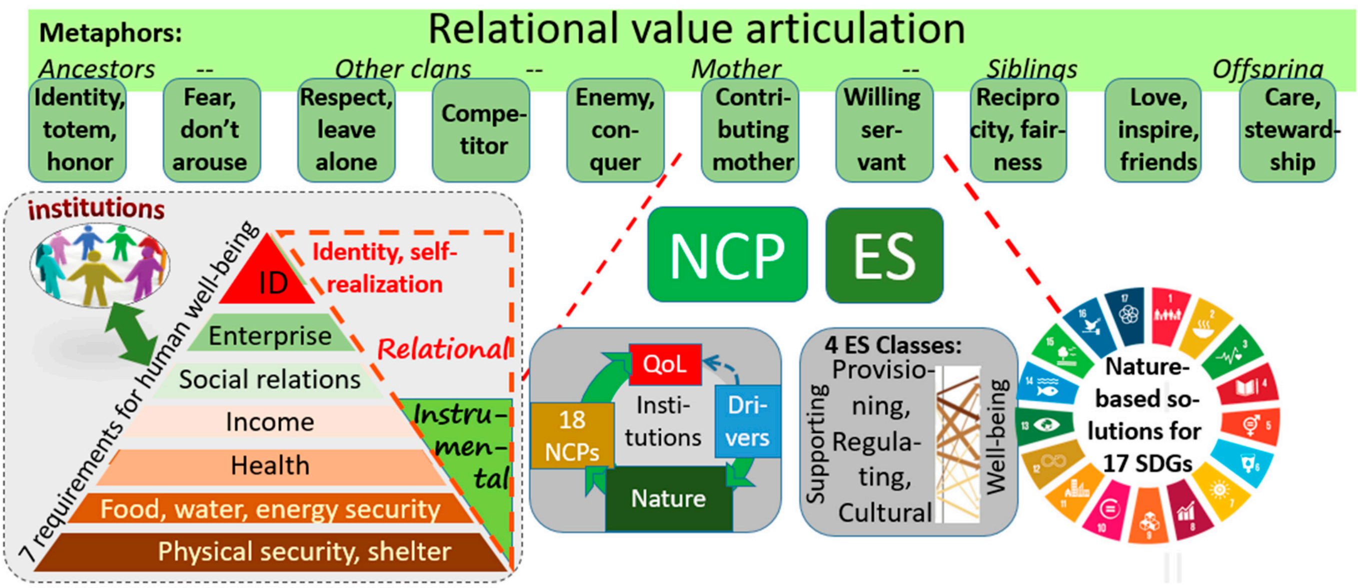

Figure 7. Portrayal of instrumental as a specific subset of relational values [7], including the material values involved in a modified Maslow pyramid of human wellbeing [59] and nature-based solutions [60] to the various SDGs.

In agroforestry the primary relational targets are the tree, the forest and the farmer. Trees play many symbolic roles, ranging from the "tree of life" to the peace-making rituals of tree planting as joint relational effort to (symbolically) transcend conflicts [61]. The popularity of tree planting as activity that responds to global climate change and is expected to protect people from harm has had various instrumental rationalizations but has relational roots [62,63]. Seeing both trees and forests at the same time is a recognized challenge. The derivation of the term forest is on the exclusion of local communities of resources claimed by the central state power, and despite the interest in community-based forest management or social forestry, it is still hard to bridge the differences in relational value expressed by the term forest [64]. Agroforests, as farmer-managed forests, often with complex bundles of rights for individuals and local in-group customary community members, have both instrumental and relational values that need to be appreciated.

3. Nested-Scale Agroforestry Concepts in Relation to Ecosystem Services

3.1. Three Agroforestry Concepts

The three agroforestry concepts that relate patch to landscape- and policy-level analysis (Table 1) relate to both instrumental and relational values—but to different degrees. Instrumental values of nature to humans have been the basis of (meso- to micro-)economic analysis that connect the ideas of Adam Smith to those of Charles Darwin; they are relevant at all three AF concept scales. Relational values may be primarily located at the picoeconomic scale of behavioral economics, bringing in aspects of collective action and commons and thus the ideas of Elinor Ostrom.

Table 1. Agroforestry (AF) concepts with their social and ecological aspects across scales, in relation to ecosystem services issues and underlying science.

AF Concept—Scale	Social Aspects	Ecological Aspects	ES Aspects	Underlying Science
AF1—patch/farm	Farmer resources, knowledge, targets, management choices (~ gender, ~ age, ~ context); input and output markets; value chain relations	Tree cover, tree diversity; tree–soil–crop interactions in spatial and climatic contexts; response to farmer management; land equivalent ratio (LER) for productivity	Generate, Influence, Manage	Knowledge types; tree growth (architecture and functioning); water, nutrient, light, and carbon capture and cycles; options in context evaluation; farm economics
AF2—landscape	Ecosystem (dis)service perceptions across stakeholders at local to global scales; instrumental and relational value of nature as concepts	Lateral flows (water, organisms, fire, nutrients, soil, etc.), buffers and filters; biodiversity change; land equivalent ratio for multifunctionality (land shparing index) [1]	Express, Interact, Manage	Quantifying scale relations; instrumental and relational values influencing decision making in issue cycles; self-regulation of industry, ~ certification
AF3—policy	Sustainable Development Goals (SDGs); reconciling rights and incentives in agricultural and forestry institutional traditions	Planetary boundaries linked to land and water use: climate change, biodiversity loss, pollution, land degradation	Recognize, Regulate, Reward	Issue cycles; subsidiarity (devolution of governance); transparency; environmental and intergenerational justice

[1] The term shparing indicates that the land sparing versus land sharing debate may have been a false dichotomy, where land sparing can be achieved through land sharing with land equivalent ratios above 1.0 (as discussed below).

Early analysis of the interactions between trees and crops in agroforestry has built on the land equivalent ratio concept that emerged from the intercropping literature [65]. Rather than expecting benefits for each component as such, when compared to dedicated specialized ways of producing any single component, LER provides a metric for how much land can be spared by combining multiple elements on a single piece of land (Figure 8). If all relations with tree cover are linear, the LER may be 1.0, but values below 1.0 are possible when convex relations prevail, and values above 1.0 if concave relations dominate. The LER index obviously depends on the functions that are included—in the original concept, the key function was production per unit area, while more recent interpretations include many aspects of multifunctionality [66].

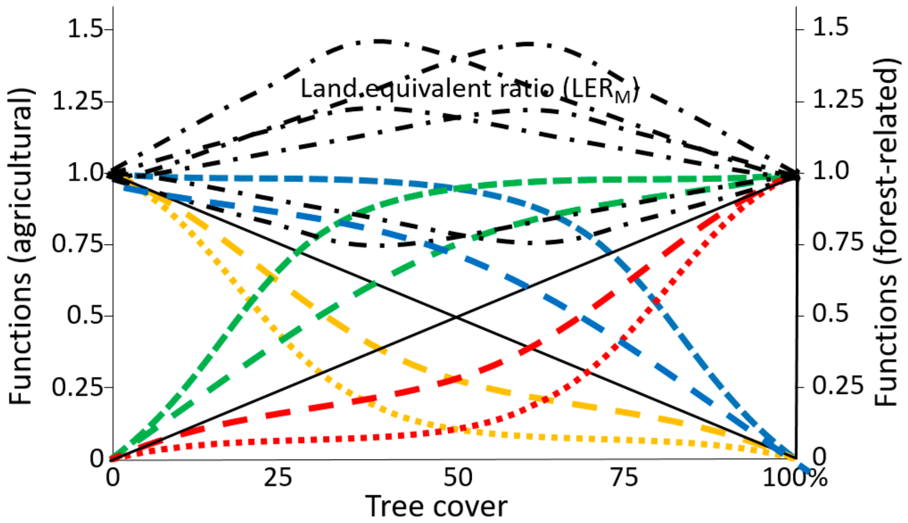

Figure 8. Schematic relationships of various land functions, either agricultural or forest-related, in relation to the percentage tree cover on a unit of land [67]; depending on the weights assigned to the various functions, the LER sum across functions can be convex, with an intermediate tree-density optimum, or concave, with an advantage for segregating.

3.2. Agroforestry as Part of a Landscape Mosaic

At the AF2 and AF3 scales, ecosystem services of agroforestry are not standalone entities that can be expressed per unit area and multiplied with the area under agroforestry for a total contribution to human well-being. Rather, agroforestry at these scales needs to be understood and appreciated in a spatial context: it may be the recipient of ecosystem services from "upstream", providing benefits to people in the agroforestry systems themselves, as well as passing on (modified) services to those further "downstream" (Figure 9). Landscape mosaics can be characterized by the relative proportions of the components and the spatial pattern or grain size of the mosaic, with edge length per unit area and types of neighbors as distinguishing features. The components are here presented as four categories: forest, agroforestry (here understood as half-open vegetation with trees, intermediate between open-field agriculture and closed-canopy forest), agricultural, and urban environments. Finer-grained mosaics have been associated with land sharing views on multifunctionality, coarse-grained mosaics with economic specialization and trade globalization.

In this view there are ten types ecosystem services: 1, 2, 3, and 4 provided by the local environment to people living in forest, agroforestry, agricultural, and urban environments, respectively; 5, 6, and 8 provided by forests (and the people living there) to human beneficiaries in agroforestry, agricultural, and urban environments, respectively; 7 and 9 derived from agroforestry and provided to agricultural and urban parts of the landscape; and 10 derived from agricultural parts of the landscape and provided to urban people. Agroforestry thus plays a role in the provisioning services of (domesticated) forest products [68–70] and the regulating services on water flows [71] or carbon storage [71–73]. Part of these agroforestry services are supported by the presence of forests in the landscape (arrow 5) and contribute (arrow 7) to the services agriculture in turn provides (arrow 10).

Similar to a value added tax concept that applies to economic value chains, each landscape component could be held accountable for the net balance of incoming and outgoing services. There are some building blocks for such analysis, that include the local forest typology of Karen in Thailand with a specific word for "forests protecting rice-fields" [74] and the recent analysis of watersheds where agricultural over-use of ground- or surface water competes with urban beneficiaries [75]. However, a full analysis along such lines does not yet exist. Few studies, if any, have effectively dissected these interactions and clarified the degrees of substitutability between them. Partial compensation of forest-based ES by agroforestry (including provisioning of medicinal plants and animals, forest fauna and flora, supporting human food security) has been documented in several landscapes [76–78]. If landscape management is based on local knowledge and experience, such explicit dissection may not be needed, but where national policies and international incentive systems and policy support continue to make distinctions between forest and agriculture without space for intermediate agroforestry that can match both definitions [79], evidence from well-quantified case studies can contribute to policy change, potentially rediscovering, reinventing, or reimagining agroforestry [42]. An example where the mosaic concept has been applied is in the flow persistence metric that translates the plot-level pathways of peak rainfall events, to the temporal dynamic of rivers and floods [80]. Similar analyses of the net balance of erosion and sedimentation in landscapes with the existing spatial filter and buffer elements [74,81,82] defy the simplicity of expressing ES values as entities per unit area, with a total derived by multiplying area fractions with value per unit area. What needs to be valued is the mosaic with its structure and functions.

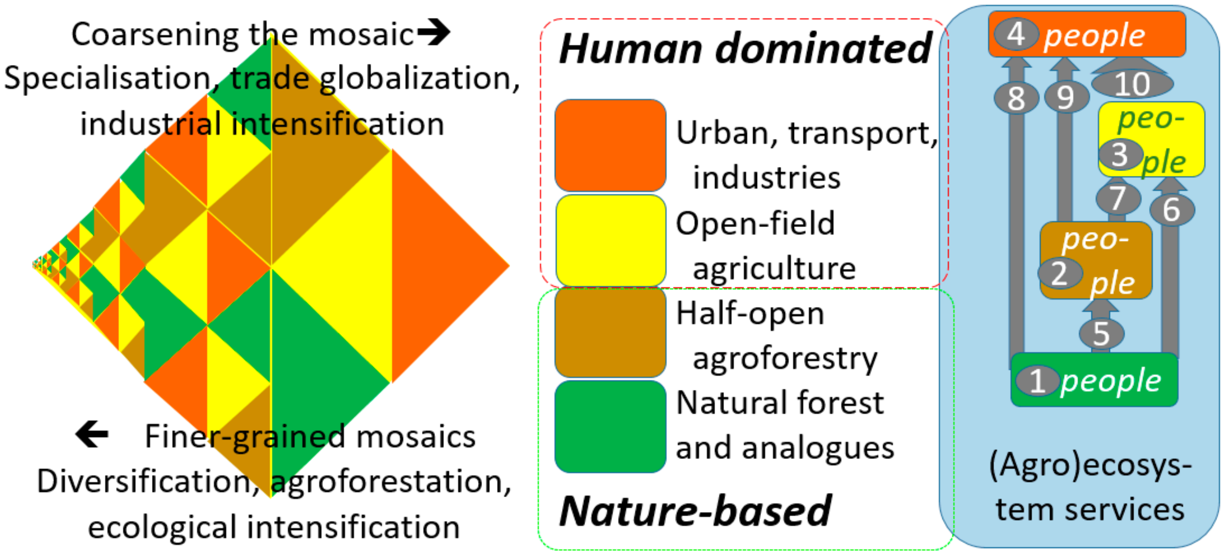

Figure 9. Relative composition (fractions of various colors) and spatial pattern (grain size of the mosaic) as two aspects of land cover at the forestry–agricultural–urban interfaces that jointly determine a set of six (agro-)ecosystem services via direct and indirect benefits people obtain (Source: [27]).

3.3. *Agroforestry and Metrics for Multifunctionality*

A central metric for progress towards multifunctionality across all relevant goals and efficient use of the land available could be that the land equivalent ratio for multifunctionality, LER_M, exceeds 1.0 [66]. LER_M is the sum of the areas of land managed specifically to achieve any of the various functions that match what multifunctional land use provides jointly. Examples include the provisioning of food, building materials, firewood, groundwater recharge, C storage, and belowground biodiversity conservation [66]. A subset of this index, the land equivalent ratio for productivity (LER_P), is commonly found to be in the range 1.1–1.3 for legume and cereal systems, for example; this may indicate negative yield gaps when current practice monocultures are taken as point of reference for the productivity of each component of a mixture. Forms of agricultural/agroforestry land use that do not maximize productivity as such may achieve high LER_M values through a range of ecosystem services and thus have land sparing properties through their land sharing [83]. Such land uses contradict the usually inferred contrast between sparing (by minimizing yield gaps) and sharing as two ways to reconcile production and other ecosystem services [84]. As the land sparing argument refers to the proportions of land required for agriculture and land sharing to the mosaic pattern (Figure 9), the sparing versus sharing debate may be based on a false dichotomy. Sparing through sharing (or "shparing") is feasible when LER_M exceeds 1.0.

A recent contribution to the debate on whether or not the promotion of agroforestry in tropical landscapes is a sensible policy stated [85], "Agroforestry is widely promoted as a potential solution to address multiple UN Sustainable Development Goals, including Zero Hunger, Responsible Consumption and Production, Climate Action, and Life on Land. Nonetheless, agroforests in the tropics often result from direct forest conversions, displacing rapidly vanishing and highly biodiverse forests with large carbon stocks, causing undesirable trade-offs." These authors concluded that forest-derived agroforestry supports higher biodiversity than open-land-derived agroforestry but essentially represents a degradation of forest, whereas open-land-derived agroforestry rehabilitates formerly forested open land. Ironically, expansion of the first type (forest derived), although associated with higher biodiversity indicators than the second (restoration based), might be rated as less biodiversity friendly than the second. Policies that promote the second might need to be combined with conserving remaining natural forest and maintaining tree diversity in forest-derived agroforests [86].

3.4. Agroforestry and the Half Earth Debate

Beyond the relational biophilia argument [87], current proposals to formulate targets for the post-2020 global biodiversity agenda that reserve half of the Earth for Nature blend a strong intrinsic (moral, ethical) values with reference to the planetary boundaries as existential risk for all life on the planet. The proposal builds on the relative success in achieving the Aichi target for increasing protected areas relative to the lower degrees of progress on other targets [88]. As the initial formulation and support came mainly from the "fortress conservation" lobbies, groups concerned with the rights, perspectives, and livelihoods of the people currently living in the areas that would get a primarily "conservation" designation responded with alarm [89,90]. Some follow-up proposals referred to 30% of the earth as conservation area, plus 20% under indigenous people's management, but the discussion continues. An aspect that is relatively absent from the debate so far is the spatial consequences and the alternative ways of achieving such targets, e.g., through spatial segregation of "production" and conservation areas (Figure 10A) or in a spatially integrated mosaic (Figure 10B) that may have a (fractal) scale distribution.

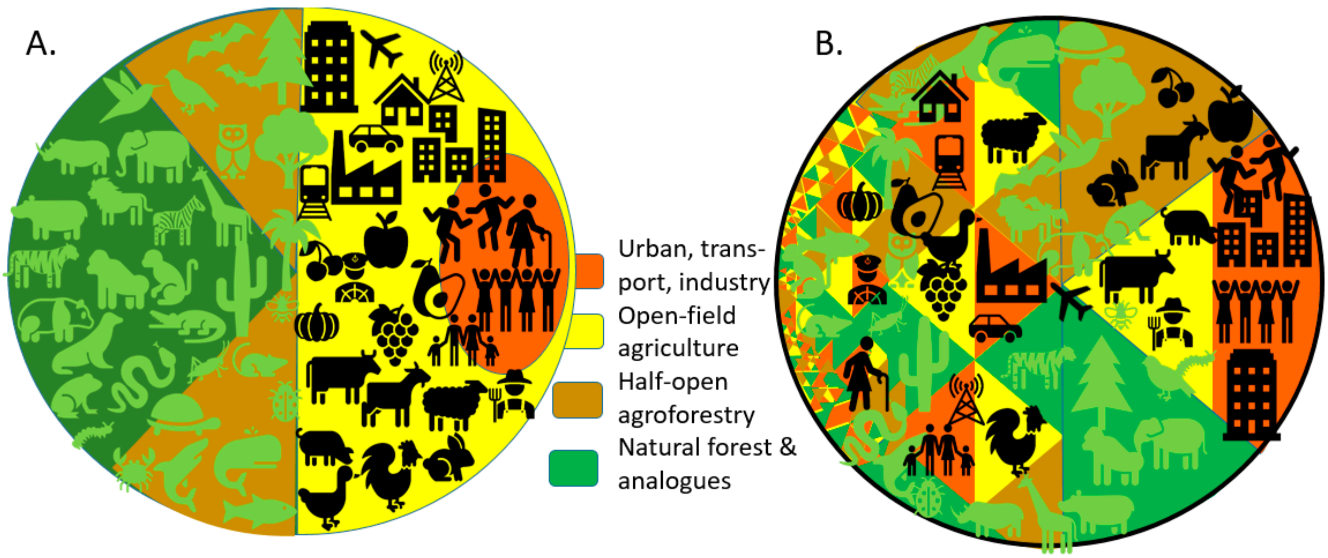

Figure 10. Visualization of the half earth debate and two contrasting spatial ways of achieving it: (**A**). through spatial segregation minimizing the nature–human interface and maximizing space for species with low compatibility with humans, or (**B**). through spatial integration with more intensive nature–human contact and proximity.

The segregated option, with large, protected areas segregated from intensive agriculture and urban domains, may achieve the best outcomes for conservation of threatened wilderness and associated species (especially those with large home ranges and low tolerance of human presence); in the spatially integrated option, more people would experience nature, or at least natural landscape elements, in their neighborhoods and potentially benefit from them in various ways. In terms of instrumental and relational values, the segregated and integrated options [91] thus have different consequences for change relative to the current mosaic of urban, open-field agriculture (including monoculture tree crops and short-rotation plantation forestry), half-open agroforestry (including trees outside forest), and natural vegetation (with levels of management that match sustainable use criteria). Many landscapes still are coarsening the grain size of the mosaic [92,93], influencing the environmental and social interactions between nature and people. The land sparing versus land sharing debate of the past decades [94,95] has focused on either closing mono-cultural yield gaps (through conventional intensification) or exploiting land equivalent ratios (through "ecological intensification"; [52]) as approaches to reconciling production and conservation needs of society.

A recent economic analysis [96] suggested that half Earth scenarios could be economically viable if technological progress towards land sparing continues and if the recreational needs of an increasingly urban and affluent population provide incentives and employment outside the urban and primary production areas. The authors may not have realized (and the debate has not picked up) that these arguments refer to a Figure 10B rather than Figure 10A scenarios. Value arguments have suggested that people move towards nature if nature does not move towards people [97]. In follow-up to the COVID pandemic, however, the spatial integration of people and nature will have to be reconciled with relational/instrumental concerns about public health [27]; a main objection to the half Earth concept is that the half of the planet where people dominate still needs elements of nature to function [98]. In this debate, the relational and instrumental value categories are fluid and part of a continuum.

The scope for a more connective agroforestry landscape concept has never been larger than now, as a key challenge for implementing the landscape approach is that political processes and conservation initiatives still operate in "silos", largely disconnected from farmers and local key agents responsible for tree governance [99]. The recent "making peace with nature" report [100] urges for a coherent approach to climate change, loss of biodiversity, and pollution as part of reimagining and transforming the ways in which the values of humans and nature are reconciled. An ambitious vision of the way agroforestry can be part of the solution needs to connect local to global scales and vice versa.

4. Roles for and Contributions by Agroforestry Research

4.1. Issue Cycle Stages

The recent "The Future is Now" UN sustainability science report [101] identified four levers that are essential in opening transformative pathways toward sustainable development: (1) governance (public decision making, rules); (2) economy and finance (incentives and investment); (3) individual and collective action (motivation and social feedback); and (4) science and technology (knowledge and understanding). The boundary work research tradition has long analyzed how the latter can be more effectively linked to the first three [1,102]. These levers match, but in different order, the various knowledge-to-action chains identified along an issue cycle [8]: (a) agenda setting; (b) better and more widely shared understanding of what is at stake and how it can be monitored; (c) commitment to common principles and moving on from denial and conspiracy theories; (d) differentiated responsibility in practice through means of implementation devolved to (newly created or existing) formal institutions; and (e) efforts to monitor and evaluate effects, which can be the start of a new issue cycle while allowing for genuine innovation. Progress markers along these five chains are available [8] (Table 2); bottlenecks in any of the chains can slow progress in others, including in the way knowledge of values and decision making progress.

Table 2. Progress markers (from 1 to 10) for four interrelated knowledge-to-action chains in the issue (decisions) cycle [8] classified by instrumental [ ], relational [ ] or mixed [ ] value articulations.

Chains A: Agenda Setting and B: Science-Based Understanding of Ongoing Change and Emerging Issues	Chain C: Societal Willingness to Act—From Denial to Responsiveness, Common Goals, and Responsibility	Chain D: Governability Pathways to Change from Blame Games to Taking Responsibility and Means of Implementation	Chain E: Technological, Institutional Innovation: Real-Life Solutions and Learning
ab1. Initial guesstimates of seriousness of impacts of "emerging issues" based on current understanding of "systems"	c1. Steps from "ignoring" to "denial", based on conflicting evidence from "best" and "worst" cases in public discourse	d1. Identification of current rules, incentives, and motivational instruments as contributors/aggravators of the issue at stake, and options to reform them	e1. Adequate grounding of potential innovators in existing knowledge and theories to explore new applications, and in lists of "unresolved questions" for society at large
b2. Operational definitions of the entities and processes associated with the "issue" (potentially reframing, splitting and lumping of issues based on increased understanding of causation and/or effects)	c2. Steps from denial to accepting issues as part of the concurrent "agenda", requiring debate in a multiple stakeholder context with multiple knowledge claims	d2. Reflection on an "at least do no harm" precautionary principle in the face of remaining uncertainty and existing communication pathways with the wider stakeholder community	e2. Safe spaces for innovators, in terms of resources (finances, facilities) needed and protection from micromanagers
b3. Cause–effect mechanisms, feedback loops and system dynamics associated with the issue	c3. Steps from "blaming others" and "victim roles" to facing complex reality and taking shared responsibility	d3. Path dependency of the issue and opportunities to deal with the established context and its spatial variation	e3. Support for functional diversity of pathways explored and delayed, stepwise selection of increased support for "likely winners", within clear societal goals and criteria
b4. Agreed methods with known biases to allow replicable research and mapping	c4. Initial estimates of differential (by geographic and social strata) vulnerability	d4. Relevance of and steps towards legal change in rights and responsibilities in the existing constitutional framing	e4. Risk awareness and compliance with agreed safeguards by all innovators, but especially publicly supported ones
b5. Studies of spatial extent and temporal change of key aspects of the issue, its drivers, and its consequences	c5. Initial estimates of differential contribution to "causes" and likely need to change behavior and/or pay for damage done	d5. Economic (efficiency) dimensions of proposed pathways for dealing with the issue (at cause and/or consequence level)	e5. Early awareness of scale relations (in applicability, undesired/unexpected consequences) of emerging innovations
b6. Articulation of the planetary boundaries associated with the issue	c6. Initial estimates of differential opportunities to adapt to consequences and reduce contributions to "causation"	d6. Motivational and social (fairness) dimensions of proposed pathways for dealing with the issue (at driver and/or consequence level)	e6. Effective two-way feedback where existing theory ("first principles") appears to contrast with emerging practices (Pasteur quadrant)
b7. Using understanding of nonlinearity and feedback loops, proposition of thresholds for "safe operating space"	c7. Articulation of culture- and religion-based motivation to act in solidarity or direct self-interest	d7. Intersectoral integration across all relevant aspects of current agendas (i.e., beyond the focal issue)	e7. Early feedback from potential users and stakeholders of potential consequences that are to be avoided
b8. Agreed monitoring, reporting, and verification tools for collective action at relevant scales (local to global)	c8. Dynamic coalitions for change in the face of tradeoffs and synergy with other issues in various stages of their own "cycle"	d8. Polycentric governance dimensions of rights and responsibilities across institutional scales	e8. Opportunities to evaluate likely wider consequences in scenario tools that are sufficiently robust to extrapolate beyond known empirics

Table 2. *Cont.*

Chains A: Agenda Setting and B: Science-Based Understanding of Ongoing Change and Emerging Issues	Chain C: Societal Willingness to Act—From Denial to Responsiveness, Common Goals, and Responsibility	Chain D: Governability Pathways to Change from Blame Games to Taking Responsibility and Means of Implementation	Chain E: Technological, Institutional Innovation: Real-Life Solutions and Learning
b9. Scenario-evaluation tools to judge likely effectiveness of proposed and emerging innovations in their multidimensional characteristics (incl. tradeoffs and synergy)	c9. Prioritization among concurrent issues and negotiated trade-offs between agendas of multiple negotiating parties	d9. Opportunities for new public–private partnerships (covenants, phased change, clarity on long-term goals and standards)	e9. Stepwise empirical tests at relevant scales for "promising candidates", with clarity on standards to be applied for societal risk management
b10. Regular reassessment and recalibration of simplified proxies used for monitoring compliance and progress in dealing with the issue	c10. Sufficiently ambitious goals and adequate governance instruments (incl. monitoring compliance and effectiveness, sanctions) at all relevant scales in agreements and plans of action, with "common but differentiated responsibility"	d10. Where necessary, adjusting governance instruments based on litigation by specific stakeholder groups	e10. Adequate recognition (remuneration, influence) for past success (recognizing its limited predictive skill for future successes)

Taking the values of others, beyond one's in-group, into account is an important dimension of "governability" [103]. This process can be based on moral or ethical values and (relational) choices, but it can also derive from pragmatic (instrumental) considerations and experience that the "others" may have the power to disrupt and that they need incentives to not do so. In the analysis of social systems and their decision making, (reference) groups, rituals, affiliation, status, and power have been identified as aspects that need to be understood in their interaction [104,105]. Typically, public decisions consist of a declaration of principles followed by the creation of (or "outsourcing" to existing) institutions mandated to implement agreed goals, within delineated powers to enforce [106,107]. Communication and nudging [108] are likely to be central to such a theory of change of theory at the scale of human societies.

4.2. Methods and Interdisciplinarity of Agroforestry Research

The methods sections of the papers in the special issue on agroforestry-based ecosystem services demonstrate that agroforestry research has derived and embraced methods from many research traditions, ranging from agronomic trials, ecological, soil science, economics, social sciences and policy analysis. This reflects the trends in a recent overview of agroforestry research methods [109]. Further progress on the appreciation of agroforestry-based ecosystem services will require, for example,

1. Enhanced quantification of trees-outside-forests [9,110,111] in relation for "forest function" thresholds such as those for rainfall [112] and infiltration [113];
2. Distinctions between forest-derived and restoration-based agroforestry practices [15,85,86] and the expected societal costs and benefits [114];
3. Reconciling local, science-based, and policy-oriented ecological knowledge [115,116];
4. Process-level understanding of tree–soil–crop interactions used in bio-economic models [117] and the dependence on tree cover (Figure 8) of specific ecosystem services in each context [118–120];
5. Market-oriented domestication of local fruit trees [121], regularization of smallholder cash-crop production within the supposedly permanent forest estate [122];
6. Further landscape-scale studies of biodiversity impacts beyond plot-level effects on average farms [123–125];

7. Location specificity of trade-off management in the food–energy–water nexus [42,66,126] and in biodiversity [85,127–129], with increased interest in disease risks outside and within agroforestry [130,131];
8. Balancing the two sides of the doughnut in challenging any siloed interpretation of SDGs ([8,10,66,132]; Figure 1);
9. Realistic and critical impact assessments of agroforestry-enhancing projects in local contexts [133–135], in view of livelihood strategies and tactics that include migration [136] and grasping new economic opportunities [137];
10. Use of participatory methods in scenario development and reimagining desirable futures a local scale [42,138], reconciled with understanding agent behavior through "sociality" research [139].

4.3. Research Roles in Theories of Induced Change

In line with the stronger impact orientation of most of the funding sources for applied or use-oriented research, it is important that "theories of induced change" are explicit in how research can contribute to the progress of policy issue cycles (Table 3).

Table 3. Achievable goals for researchers interacting with policy issue cycles stages [109].

Policy Cycle Stage	Researcher Goals	Impact Looks Like ...
Problem alert	Spotting new social and environmental problems or phenomena that (someone believes) limit progress to development goals such as SDGs	Raised interest and concern among researchers (and others? Activists?)
Problem scope and basis	Understanding: (A) extent of the problem (areas, people affected), (B) drivers and mechanisms, (C) connections to current or new theory	Either increasing numbers of people aware of and understanding nature of the problem and why it matters, or (if it turns out to be an unimportant problem) efforts redirected to areas with more potential effect
Potential solutions and interventions	Showing that there are actions that will alleviate the problem and policies that will promote those actions	Pilot projects that excite people, increase demands, generate more nuanced research
Political agenda setting	Getting relevant policy makers interested and pushing towards policy change	Convincing demonstrations that the problem impacts things policy makers care about and that policies proposed will help
Policy formulation	Systematic investigation of a problem and thoughtful assessment of options and alternatives	Convincing policy options formulated
Selection Process	Prioritization (decision-making) of available options given costs/benefits and compromises across diverse stakeholder interests	New policies adopted and followed
Implementing	Introduce actions based on policy aimed at changing the problem	Change in state of problem
Evaluation and monitoring	Confirm that the problem is under control (or tracking in the right direction) and remains so	Problem is solved—extent of "fix" and role of the policy.

4.4. Hypotheses for Further Research

In each of the three questions, several hypotheses emerged from our exploration of concepts:

i. The way plural value concepts of agroforestry evolve in relation to ES discourse and sustainability concerns at the multifunctional landscape scale.

Hypothesis 1. *The broader landscape context influences the roles trees and agroforestry play in value addition in forest-to-urban land use gradients, with the suggested ten-point classification of beneficiaries and service providers (Figure 9) largely untested.*

Hypothesis 2. *Critical tree cover thresholds for ecohydroclimatic functions in the agroforestry–forest continuum (Figure 8), including rainfall triggering and infiltration, depend on terrain properties and position relative to global atmospheric circulation patterns.*

ii. The interaction between the three agroforestry scales (AF1, AF2, and AF3) and value-of-nature concepts.

Hypothesis 3. *Instrumental, goal-oriented values of agroforestry land uses can be more effectively expressed in national policy debates in relation to nature-based solutions to a suite of SDGs (such as those linked to food, health, water, energy, jobs, sustainable cities, and climate change), rather than purely in economic value (SDG1 only),*

Hypothesis 4. *Relational values of nature to humans play an under-appreciated role in the communication of agroforestry options and the concerns in producer–consumer teleconnections of tropical commodity supply and value chains.*

iii. The roles research can play in connecting theories of place and change to policies that aim for applicable theories of induced change, in support of SDGs.

Hypothesis 5. *The complementarity of relational and instrumental value concepts in overcoming the successive hurdles that hinder progress of public policy issue cycles calls for boundary work teams with broad sets of analytical and communicative skills.*

Hypothesis 6. *A healthy research portfolio requires intellectual and financial space to invest in "high-risk, high potential impact" early stages of emerging issues in which agroforestry plays a role as cause and/or solution, beyond the more easily plannable later stages of issue cycles.*

5. Conclusions and Outlook

This review of a wide-ranging literature suggested that value concepts of agroforestry are evolving as part of the wider ES discourse and sustainability concerns at and beyond the multifunctional landscape scale. Basic understanding of the existing and evolving diversity of living organisms, the strengths and limitations of profit-oriented individual actions that drive markets, and the relevance and history of local community-scale institutions are essential now that it is the global commons of reconciling planetary boundaries with remaining development deficits that drives the agenda at the highest level. Both instrumental (goal-orientation, rationality) and relational (social in-group orientation) values are used in communication and broadening the political platforms for theories of induced change at landscape and regional scales.

The three agroforestry scales and concepts (farm, landscape, and policy integration) interact with the way these values can be articulated and, where relevant, quantified. In terms of the efficient use of land argument, land sparing can be achieved by land sharing if the latter meets the quantitative requirement that the land equivalent ratio, across relevant functions, is above 1.0. To evaluate this metric in practice, it is important to understand how intermediate (partial) tree cover affects a wide range of ecological functions that can contribute to services from a human perspective.

Current research on agroforestry and the ecosystem services it provides at local, national and global scales commonly embraces a social–ecological system framing. Two-way feedbacks between social and ecological subsystems across scales are at the center of research interest. Most research has, however, been framed in an instrumental ecosystem services perspective, where the ecological subsystem serves the social system, rather than as a two-way relational one, where stewardship enhances and broadens relational values.

Many contemporary studies are both multi- and interdisciplinary in nature, and they can become transdisciplinary if they explicitly compare farmers' ecological knowledge with science-based perspectives, farmers' choices with regard to what economic analysis suggests as ways to reconcile multiple goals, and/or policy ambitions with the social–ecological reality of landscapes connected to global trade. Relevant, use-oriented agroforestry research can play active roles in connecting theories of place and change to policies that aim for applicable theories of induced change in support of SDGs. The substantial number of hurdles that need to be taken to link knowledge with action in environmental issue cycles require both instrumental and relational value arguments to play out, without suggestions that they are anything but complementary perspectives rather than separate "values" that would need to be added up to attain a "total value". The potential emotional appeal of trees (and especially tree planting) will continue to be both an opportunity and a challenge for promoting agroforestry unless the relational and instrumental values of agroforestry are more widely understood as complementary articulations of a rich and complex reality in plural societies.

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References

1. Clark, W.C.; Tomich, T.P.; Van Noordwijk, M.; Guston, D.; Catacutan, D.; Dickson, N.M.; McNie, E. Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proc. Natl. Acad. Sci. USA* **2016**, *113*, 4615–4622. [CrossRef] [PubMed]
2. Van Noordwijk, M.; Coe, R.; Sinclair, F.L. Agroforestry paradigms. In *Sustainable Development through Trees on Farms: Agroforestry in Its Fifth Decade*; World Agroforestry (ICRAF): Bogor, Indonesia, 2019; pp. 1–12. Available online: https://worldagroforestry.org/trees-on-farms (accessed on 2 July 2021).
3. Zafra-Calvo, N.; Balvanera, P.; Pascual, U.; Merçon, J.; Martín-López, B.; van Noordwijk, M.; Mwampamba, T.H.; Lele, S.; Speranza, C.I.; Arias-Arévalo, P.; et al. Plural valuation of nature for equity and sustainability: Insights from the Global South. *Glob. Environ. Chang.* **2020**, *63*, 102115. [CrossRef]
4. Kadykalo, A.N.; López-Rodriguez, M.D.; Ainscough, J.; Droste, N.; Ryu, H.; Ávila-Flores, G.; Le Clec'h, S.; Muñoz, M.C.; Nilsson, L.; Rana, S.; et al. Disentangling 'ecosystem services' and 'nature's contributions to people'. *Ecosyst. People* **2019**, *15*, 269–287. [CrossRef]
5. Costanza, R.; D'Arge, R.; de Groot, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O'neill, R.V.; Paruelo, J.; et al. The value of the world's ecosystem services and natural capital. *Nature* **1997**, *387*, 253–260. [CrossRef]
6. Costanza, R.; de Groot, R.; Braat, L.; Kubiszewski, I.; Fioramonti, L.; Sutton, P.; Farber, S.; Grasso, M. Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosyst. Serv.* **2017**, *28*, 1–16. [CrossRef]
7. Himes, A.; Muraca, B. Relational values: The key to pluralistic valuation of ecosystem services. *Curr. Opin. Environ. Sustain.* **2018**, *35*, 1–7. [CrossRef]
8. Van Noordwijk, M. Integrated natural resource management as pathway to poverty reduction: Innovating practices, institutions and policies. *Agric. Syst.* **2019**, *172*, 60–71. [CrossRef]

9. Zomer, R.J.; Neufeldt, H.; Xu, J.; Ahrends, A.; Bossio, D.; Trabucco, A.; Van Noordwijk, M.; Wang, M. Global Tree Cover and Biomass Carbon on Agricultural Land: The contribution of agroforestry to global and national carbon budgets. *Sci. Rep.* **2016**, *6*, 1–12. [CrossRef]
10. Raworth, K. A safe and just space for humanity: Can we live within the doughnut. *Oxfam Policy Pract. Clim. Chang. Resil.* **2012**, *8*, 1–26.
11. Van Noordwijk, M.; Leimona, B. Principles for fairness and efficiency in enhancing environmental services in Asia: Payments, compensation, or co-investment? *Ecol. Soc.* **2010**, *15*, 17. Available online: http://www.ecologyandsociety.org/vol15/iss4/art17/ (accessed on 2 July 2021). [CrossRef]
12. Woittiez, L.S.; van Wijk, M.T.; Slingerland, M.; van Noordwijk, M.; Giller, K.E. Yield gaps in oil palm: A quantitative review of contributing factors. *Eur. J. Agron.* **2017**, *83*, 57–77. [CrossRef]
13. Van Noordwijk, M.; Brussaard, L. Minimizing the ecological footprint of food: Closing yield and efficiency gaps simultaneously? *Curr. Opin. Environ. Sustain.* **2014**, *8*, 62–70. [CrossRef]
14. Minang, P.A.; van Noordwijk, M.; Duguma, L. Policies for ecosystem services enhancement. In *Sustainable Development through Trees on Farms: Agroforestry in Its Fifth Decade*; World Agroforestry (ICRAF): Bogor, Indonesia, 2019; pp. 361–375. Available online: https://worldagroforestry.org/trees-on-farms (accessed on 2 July 2021).
15. Keesstra, S.; Mol, G.; De Leeuw, J.; Okx, J.; Molenaar, C.; De Cleen, M.; Visser, S. Soil-Related Sustainable Development Goals: Four Concepts to Make Land Degradation Neutrality and Restoration Work. *Land* **2018**, *7*, 133. [CrossRef]
16. Van Noordwijk, M. *Theories of Place, Change and Induced Change for Tree-Crop-Based Agroforestry*; World Agroforestry (ICRAF): Bogor, Indonesia, 2021.
17. Díaz, S.; Settele, J.; Brondízio, E.S.; Ngo, H.T.; Guèze, M.; Agard, J.; Arneth, A.; Balvanera, P.; Brauman, K.; Butchart, S.H.; et al. *Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; IPBES: Bonn, Germany, 2019.
18. Available online: https://commons.wikimedia.org/wiki/File:Charles_Darwin_01.jpg (accessed on 25 June 2021).
19. Available online: https://commons.wikimedia.org/wiki/File:Adam_Smith,_1723_-_1790._Political_economist_-_Google_Art_Project.jpg (accessed on 25 June 2021).
20. Available online: https://creativecommons.org/2012/06/13/honoring-elinor-ostrom/ (accessed on 25 June 2021).
21. Smith, A. *An Inquiry into the Nature and Causes of the Wealth of Nations*; W. Strahan and T. Cadell: London, UK, 1776.
22. Smith, A. *The Theory of Moral Sentiments*, 2nd ed.; A. Millar; A. Kincaid and J. Bell: Strand: Edinburgh, UK, 1761; Available online: https://books.google.co.id/books?id=bZhZAAAAcAAJ&q=editions:u_L0P5LRqXkC&pg=PP3&redir_esc=y#v=onepage&q=editions%3Au_L0P5LRqXkC&f=false (accessed on 2 July 2021).
23. Dawkins, R. *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design*; WW Norton & Company: New York, NY, USA, 1996.
24. Mazoyer, M.; Roudart, L. *A History of World Agriculture: From the Neolithic Age to the Current Crisis*; Monthly Review Press: New York, NY, USA, 2006.
25. Diamond, J. *Collapse: How Societies Choose to Fail or Survive*; Lane: London, UK, 2005.
26. De Ruiter, P.C.; Wolters, V.; Moore, J.C.; Winemiller, K.O. Food web ecology: Playing Jenga and beyond. *Science* **2005**, *309*, 68–71. [CrossRef] [PubMed]
27. Duguma, L.A.; van Noordwijk, M.; Minang, P.A.; Muthee, K. COVID-19 pandemic and agroecosystem resilience: Early insights for building better futures. *Sustainability* **2021**, *13*, 1278. [CrossRef]
28. Nature-Risk-Rising. Available online: https://www.weforum.org/reports/nature-risk-rising-why-the-crisis-engulfing-nature-matters-for-business-and-the-economy (accessed on 30 March 2021).
29. Folke, C.; Hahn, T.; Olsson, P.; Norberg, J. Adaptive governance of social-ecological systems. *Annu. Rev. Environ. Resour.* **2005**, *30*, 441–473. [CrossRef]
30. Taylor, B.R. *Dark Green Religion: Nature Spirituality and the Planetary Future*; University of California Press: Berkeley, CA, USA, 2010.
31. Rosenau, J.N. *Turbulence in World Politics: A Theory of Change and Continuity*; Princeton University Press: Princeton, NJ, USA, 2018.
32. Rose, C. The comedy of the commons: Custom, commerce, and inherently public property. *Univ. Chic. Law Rev.* **1986**, *53*, 711–781. Available online: https://digitalcommons.law.yale.edu/fss_papers/1828/ (accessed on 25 March 2021). [CrossRef]
33. Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action*; Cambridge University Press: Cambridge, UK, 1990.
34. Ryan, R.M.; Deci, E.L. On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annu. Rev. Psychol.* **2001**, *52*, 141–166. [CrossRef]
35. Bauer, J.J.; McAdams, D.P.; Pals, J.L. Narrative identity and eudaimonic well-being. *J. Happiness Stud.* **2008**, *9*, 81–104. [CrossRef]
36. Davidson, J.; Henley, D. (Eds.) *The Revival of Tradition in Indonesian Politics: The Deployment of Adat from Colonialism to Indigenism*; Routledge: London, UK; New York, NY, USA, 2007.
37. Takeuchi, K. Rebuilding the relationship between people and nature: The Satoyama Initiative. *Ecol. Res.* **2010**, *25*, 891–897. [CrossRef]
38. Fang, T. Yin Yang: A new perspective on culture. *Manag. Organ. Rev.* **2012**, *8*, 25–50. [CrossRef]
39. Ahmad, J.; Kadir, A.; Bahari, M.A. Disequilibrium and divinity salience as invariant structures in the halal executives' experience of eudaimonia. *Adv. Bus. Res. Int. J.* **2019**, *5*, 1–15. [CrossRef]

40. Steger, M.F.; Kashdan, T.B.; Oishi, S. Being good by doing good: Daily eudaimonic activity and well-being. *J. Res. Personal.* **2008**, *42*, 22–42. [CrossRef]
41. Ryff, C.D.; Singer, B.H. Know thyself and become what you are: A eudaimonic approach to psychological well-being. *J. Happiness Stud.* **2008**, *9*, 13–39. [CrossRef]
42. Van Noordwijk, M.; Speelman, E.; Hofstede, G.J.; Farida, A.; Abdurrahim, A.Y.; Miccolis, A.; Hakim, A.L.; Wamucii, C.N.; Lagneaux, E.; Andreotti, F.; et al. Sustainable Agroforestry Landscape Management: Changing the Game. *Land* **2020**, *9*, 243. [CrossRef]
43. Minang, P.A.; Duguma, L.A.; Alemagi, D.; van Noordwijk, M. Scale considerations in landscape approaches. In *Climate-Smart Landscapes: Multifunctionality in Practice*; Minang, P.A., van Noordwijk, M., Freeman, O.E., Mbow, C., de Leeuw, J., Catacutan, D., Eds.; World Agroforestry Centre (ICRAF): Nairobi, Kenya, 2015; pp. 121–133.
44. Van Noordwijk, M.; Leimona, B.; Jindal, R.; Villamor, G.B.; Vardhan, M.; Namirembe, S.; Catacutan, D.; Kerr, J.; Minang, P.A.; Tomich, T.P. Payments for environmental services: Evolution toward efficient and fair incentives for multifunctional landscapes. *Annu. Rev. Environ. Resour.* **2012**, *37*, 389–420. [CrossRef]
45. Thaler, R.H.; Ganser, L.J. *Misbehaving: The Making of Behavioral Economics*; WW Norton: New York, NY, USA, 2015.
46. Kahneman, D. *Thinking, Fast and Slow*; Macmillan: London, UK, 2011.
47. Fiske, A.P. The four elementary forms of sociality: Framework for a unified theory of social relations. *Psychol. Rev.* **1992**, *99*, 689. [CrossRef]
48. Gupta, J.; Matthews, R.; Minang, P.; van Noordwijk, M.; Kuik, O.; van der Grijp, N. Climate change and forests: From the Noordwijk Declaration to REDD. In *Climate Change, Forests and REDD. Lessons for Institutional Design*; Routledge: London, UK, 2013; pp. 1–24.
49. The Noordwijk Ministerial Declaration on Climate Change. Available online: https://unfccc.int/resource/ccsites/senegal/fact/fs218.htm (accessed on 15 February 2021).
50. Hoe Het Redden van de Aarde Strandde in Noordwijk aan Zee. Available online: https://www.youtube.com/watch?v=LqjZStt9quE (accessed on 15 February 2021).
51. Lorenz, E. The butterfly effect. *World Sci. Ser. Nonlinear Sci. Ser. A* **2000**, *39*, 91–94.
52. Thunberg, G. *No One Is Too Small to Make a Difference: Illustrated Edition*; Allen Lane, Penguin: London, UK, 2019; ISBN 9780241453445.
53. Meadows, D. Leverage points: Places to intervene in a system. *Solut. A Sustain. Desirable Future* **1999**, *1*, 41–49.
54. Stålhammar, S.; Thorén, H. Three perspectives on relational values of nature. *Sustain. Sci.* **2019**, *14*, 1201–1212. [CrossRef]
55. Van Noordwijk-Van Veen, J.C. *Biologieonderwijs en Milieueducatie op de Basisschool [Biology Education and Environmental Education at Primary Schools]*; Van Gorcum: Assen, The Netherlands, 1973.
56. Ross, A.; Sherman, R.; Snodgrass, J.G.; Delcore, H.D. *Indigenous Peoples and the Collaborative Stewardship of Nature: Knowledge Binds and Institutional Conflicts*; Left Coast Press: Walnut Creek, CA, USA, 2011.
57. Villamor, G.B.; Chiong-Javier, E.; Djanibekov, U.; Catacutan, D.C.; van Noordwijk, M. Gender differences in land-use decisions: Shaping multifunctional landscapes? *Curr. Opin. Environ. Sustain.* **2014**, *6*, 128–133. [CrossRef]
58. Nyhus, P.; Tilson, R. Agroforestry, elephants, and tigers: Balancing conservation theory and practice in human-dominated landscapes of Southeast Asia. *Agric. Ecosyst. Environ.* **2004**, *104*, 87–97. [CrossRef]
59. Namirembe, S.; Leimona, B.; van Noordwijk, M.; Minang, P.A. (Eds.) *Co-Investment in Ecosystem Services: Global Lessons from Payment and Incentive Schemes*; World Agroforestry Centre (ICRAF): Nairobi, Kenya, 2018.
60. Cohen-Shacham, E.; Walters, G.; Janzen, C.; Maginnis, S. (Eds.) *Nature-Based Solutions to Address Global Societal Challenges*; IUCN: Gland, Switzerland, 2016.
61. Rival, L. (Ed.) *The Social Life of Trees: Anthropological Perspectives on Tree Symbolism*; Routledge: London, UK, 2021.
62. Van Noordwijk, M.; Hoang, M.H.; Neufeldt, H.; Öborn, I.; Yatich, T. *How Trees and People Can Co-Adapt to Climate Change: Reducing Vulnerability in Multifunctional Landscapes*; World Agroforestry Centre: Nairobi, Kenya, 2011.
63. Van Noordwijk, M.; Coe, R.; Sinclair, F.L.; Luedeling, E.; Bayala, J.; Muthuri, C.W.; Cooper, P.; Kindt, R.; Duguma, L.; Lamanna, C.; et al. Climate change adaptation in and through agroforestry: Four decades of research initiated by Peter Huxley. *Mitig. Adapt. Strateg. Glob. Chang.* **2021**, *26*, 1–33. [CrossRef]
64. Van Noordwijk, M. Prophets, profits, prove it: Social forestry under pressure. *One Earth* **2020**, *2*, 394–397. [CrossRef]
65. Mead, R.; Willey, R. The concept of a 'land equivalent ratio' and advantages in yields from intercropping. *Exp. Agric.* **1980**, *16*, 217–228. [CrossRef]
66. Van Noordwijk, M.; Duguma, L.A.; Dewi, S.; Leimona, B.; Catacutan, D.C.; Lusiana, B.; Öborn, I.; Hairiah, K.; Minang, P.A. SDG synergy between agriculture and forestry in the food, energy, water and income nexus: Reinventing agroforestry? *Curr. Opin. Environ. Sustain.* **2018**, *34*, 33–42. [CrossRef]
67. Van Noordwijk, M.; Chandler, F.; Tomich, T.P. *An Introduction to the Conceptual Basis of RUPES: Rewarding Upland Poor for the Environmental Services They Provide*; ICRAF-Southeast Asia: Bogor, Indonesia, 2004; p. 41.
68. Michon, G.; De Foresta, H. Agroforests: Pre-domestication of forest trees or true domestication of forest ecosystems? *NJAS Wagening. J. Life Sci.* **1997**, *45*, 451–462. [CrossRef]
69. Wiersum, K.F. Forest gardens as an 'intermediate' land-use system in the nature-culture continuum: Characteristics and future potential. In *New Vistas in Agroforestry*; Springer: Dordrecht, The Netherlands, 2004; pp. 123–134.

70. Van Noordwijk, M.; Rahayu, S.; Gebrekirstos, A.; Kindt, R.; Tata, H.L.; Muchugi, A.; Ordonez, J.C.; Xu, J. Tree diversity as basis of agroforestry. In *Sustainable Development through Trees on Farms: Agroforestry in Its Fifth Decade*; Van Noordwijk, M., Ed.; World Agroforestry (ICRAF): Bogor, Indonesia, 2019; pp. 17–44. Available online: https://worldagroforestry.org/trees-on-farms (accessed on 2 July 2021).
71. Van Noordwijk, M.; Bargues-Tobella, A.; Muthuri, C.W.; Gebrekirstos, A.; Maimbo, M.; Leimona, B.; Bayala, J.; Ma, X.; Lasco, R.; Xu, J.; et al. Agroforestry as part of nature-based water management. In *Sustainable Development through Trees on Farms: Agroforestry in Its Fifth Decade*; Van Noordwijk, M., Ed.; World Agroforestry (ICRAF): Bogor, Indonesia, 2019; pp. 305–334. Available online: https://worldagroforestry.org/trees-on-farms (accessed on 2 July 2021).
72. Rosenstock, T.S.; Wilkes, A.; Jallo, C.; Namoi, N.; Bulusu, M.; Suber, M.; Mboi, D.; Mulia, R.; Simelton, E.; Richards, M.; et al. Making trees count: Measurement and reporting of agroforestry in UNFCCC national communications of non-Annex I countries. *Agric. Ecosyst. Environ.* **2019**, *284*, 106569. [CrossRef]
73. Hairiah, K.; van Noordwijk, M.; Sari, R.R.; Saputra, D.D.; Suprayogo, D.; Kurniawan, S.; Prayogo, C.; Gusli, S. Soil carbon stocks in Indonesian (agro) forest transitions: Compaction conceals lower carbon concentrations in standard accounting. *Agric. Ecosyst. Environ.* **2020**, *294*, 106879. [CrossRef]
74. Van Noordwijk, M.; Poulsen, J.; Ericksen, P. Quantifying off-site effects of land use change: Filters, flows and fallacies. *Agric. Ecosyst. Environ.* **2004**, *104*, 19–34. [CrossRef]
75. Khasanah, N.; Tanika, L.; Pratama, L.D.Y.; Leimona, B.; Prasetiyo, E.; Marulani, F.; Hendriatna, A.; Zulkarnain, M.T.; Toulier, A.; van Noordwijk, M. Groundwater-extracting rice production in the Rejoso watershed (Indonesia) reducing urban water availability: Characterization and intervention priorities. *Land* **2021**, *9*, in press.
76. Pfund, J.L.; Watts, J.D.; Boissiere, M.; Boucard, A.; Bullock, R.M.; Ekadinata, A.; Dewi, S.; Feintrenie, L.; Levang, P.; Rantala, S.; et al. Understanding and integrating local perceptions of trees and forests into incentives for sustainable landscape management. *Environ. Manag.* **2011**, *48*, 334–349. [CrossRef] [PubMed]
77. Vira, B.; Agarwal, B.; Jamnadas, R.; Kleinschmit, D.; McMullin, S.; Mansourian, S.; Neufeldt, H.; Parrotta, J.A.; Sunderland, T.; Wildburger, C. *Introduction: Forests, Trees and Landscapes for Food Security and Nutrition*; IUFRO World Series 33; IUFRO: Vienna, Austria, 2015; pp. 14–23.
78. Van Noordwijk, M.; Bizard, V.; Wangpakapattanawong, P.; Tata, H.L.; Villamor, G.B.; Leimona, B. Tree cover transitions and food security in Southeast Asia. *Glob. Food Secur.* **2014**, *3*, 200–208. [CrossRef]
79. Van Noordwijk, M.; Suyamto, D.; Lusiana, B.; Ekadinata, A.; Hairiah, K. Facilitating agroforestation of landscapes for sustainable benefits: Tradeoffs between carbon stocks and local development benefits in Indonesia according to the FALLOW model. *Agric. Ecosyst. Environ.* **2008**, *126*, 98–112. [CrossRef]
80. Van Noordwijk, M.; Tanika, L.; Lusiana, B. Flood risk reduction and flow buffering as ecosystem services. Part 1: Theory on flow persistence, flashiness and base flow. *Hydrol. Earth Syst. Sci.* **2017**, *21*, 2321–2340. [CrossRef]
81. Van Noordwijk, M.; van Roode, M.; McCallie, E.L.; Cadisch, G. Erosion and sedimentation as multiscale, fractal processes: Implications for models, experiments and the real world. In *Soil Erosion at Multiple Scales, Principles and Methods for Assessing Causes and Impacts*; Penning de Vries, F., Agus, F., Kerr, J., Eds.; CAB International: Wallingford, UK, 1998; pp. 223–253.
82. Verbist, B.; Poesen, J.; van Noordwijk, M.; Widianto, W.; Suprayogo, D.; Agus, F.; Deckers, S. Factors affecting soil loss at plot scale and sediment yield at catchment scale in a tropical volcanic agroforestry landscape. *Catena* **2010**, *80*, 34–46. [CrossRef]
83. Khasanah, N.; van Noordwijk, M.; Slingerland, M.; Sofiyudin, M.; Stomph, D.; Migeon, A.F.; Hairiah, K. Oil Palm Agroforestry Can Achieve Economic and Environmental Gains as Indicated by Multifunctional Land Equivalent Ratios. *Front. Sustain. Food Syst.* **2020**, *3*, 122. [CrossRef]
84. Phalan, B.T. What have we learned from the land sparing-sharing model? *Sustainability* **2018**, *10*, 1760. [CrossRef]
85. Martin, D.A.; Osen, K.; Grass, I.; Hölscher, D.; Tscharntke, T.; Wurz, A.; Kreft, H. Land-use history determines ecosystem services and conservation value in tropical agroforestry. *Conserv. Lett.* **2020**, *13*, e12740. [CrossRef]
86. Van Noordwijk, M.; Gitz, V.; Minang, P.A.; Dewi, S.; Leimona, B.; Duguma, L.; Pingault, N.; Meybeck, A. People-Centric Nature-Based Land Restoration through Agroforestry: A Typology. *Land* **2020**, *9*, 251. [CrossRef]
87. Wilson, E.O. Biophilia and the Conservation Ethic. In *Evolutionary Perspectives on Environmental Problems*; Routledge: London, UK, 2007; pp. 249–257.
88. Secretariat of the Convention on Biological Diversity. *Global Biodiversity Outlook 5*; Secretariat of the Convention on Biological Diversity: Montreal, QC, Canada, 2020; Available online: https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf (accessed on 5 March 2021).
89. Domínguez, L.; Luoma, L. Decolonising conservation policy: How colonial land and conservation ideologies persist and perpetuate indigenous injustices at the expense of the environment. *Land* **2020**, *9*, 65. [CrossRef]
90. Büscher, B.; Fletcher, R.; Brockington, D.; Sandbrook, C.; Adams, W.M.; Campbell, L.; Corson, C.; Dressler, W.; Duffy, R.; Gray, N.; et al. Half-Earth or Whole Earth? Radical ideas for conservation, and their implications. *Oryx* **2017**, *51*, 407–410. [CrossRef]
91. Van Noordwijk, M.; Tomich, T.P.; de Foresta, H.; Michon, G. To segregate-or to integrate? The question of balance between production and biodiversity conservation in complex agroforestry systems. *Agrofor. Today* **1997**, *9*, 6–9.
92. Van Noordwijk, M.; Tata, H.L.; Xu, J.; Dewi, S.; Minang, P.A. Segregate or integrate for multifunctionality and sustained change through rubber-based agroforestry in Indonesia and China. In *Agroforestry-the Future of Global Land Use*; Nair, P.K., Garrity, D.P., Eds.; Springer: Dordrecht, The Netherlands, 2012; pp. 69–104.

93. Asubonteng, K.O.; Pfeffer, K.; Ros-Tonen, M.A.; Baud, I.; Benefoh, D.T. Integration versus segregation: Structural dynamics of a smallholder-dominated mosaic landscape under tree-crop expansion in Ghana. *Appl. Geogr.* **2020**, *108*, 102201. [CrossRef]
94. Phalan, B.; Onial, M.; Balmford, A.; Green, R.E. Reconciling food production and biodiversity conservation: Land sharing and land sparing compared. *Science* **2011**, *333*, 1289–1291. [CrossRef]
95. Ellis, E.C.; Pascual, U.; Mertz, O. Ecosystem services and nature's contribution to people: Negotiating diverse values and trade-offs in land systems. *Curr. Opin. Environ. Sustain.* **2019**, *38*, 86–94. [CrossRef]
96. Dinerstein, E.; Vynne, C.; Sala, E.; Joshi, A.R.; Fernando, S.; Lovejoy, T.E.; Mayorga, J.; Olson, D.; Asner, G.P.; Baillie, J.E.; et al. A global deal for nature: Guiding principles, milestones, and targets. *Sci. Adv.* **2019**, *5*, eaaw2869. [CrossRef]
97. Dolan, R.; Bullock, J.M.; Jones, J.P.G.; Athanasiadis, I.N.; Martinez-Lopez, J.; Willcock, S. The flows of nature to people, and of people to nature: Applying movement concepts to ecosystem services. *Land* **2021**, *10*, 576. [CrossRef]
98. Rolo, V.; Roces-Diaz, J.V.; Torralba, M.; Kay, S.; Fagerholm, N.; Aviron, S.; Burgess, P.; Crous-Duran, J.; Ferreiro-Dominguez, N.; Graves, A.; et al. Mixtures of forest and agroforestry alleviate trade-offs between ecosystem services in European rural landscapes. *Ecosyst. Serv.* **2021**, *50*, 101318. [CrossRef]
99. Zinngrebe, Y.; Borasino, E.; Chiputwa, B.; Dobie, P.; Garcia, E.; Gassner, A.; Kihumuro, P.; Komarudin, H.; Liswanti, N.; Makui, P.; et al. Agroforestry governance for operationalising the landscape approach: Connecting conservation and farming actors. *Sustain. Sci.* **2020**, *15*, 1417–1434. [CrossRef]
100. United Nations Environment Programme. Making Peace with Nature: A Scientific Blueprint to Tackle the Climate, Biodiversity and Pollution Emergencies. Nairobi. 2021. Available online: https://www.unep.org/resources/making-peace-nature (accessed on 1 July 2021).
101. IGS-UN [Independent Group of Scientists appointed by the Secretary-General]. *Global Sustainable Development Report 2019: The Future Is Now—Science for Achieving Sustainable Development*; United Nations: New York, NY, USA, 2019; Available online: https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf (accessed on 5 March 2021).
102. Cash, D.; Clark, W.C.; Alcock, F.; Dickson, N.M.; Eckley, N.; Jäger, J. *Salience, Credibility, Legitimacy and Boundaries: Linking Research, Assessment and Decision Making*; KSG Working Papers Series, RWP02-046; Kennedy School of Governance, Harvard University: Boston, MA, USA, 2003. [CrossRef]
103. Kooiman, J. Exploring the concept of governability. *J. Comp. Policy Anal. Res. Pract.* **2008**, *10*, 171–190. [CrossRef]
104. Hofstede, G.J. GRASP agents: Social first, intelligent later. *Ai Soc.* **2019**, *34*, 535–543. [CrossRef]
105. Kemper, T.D. *Status, Power and Ritual Interaction: A Relational Reading of Durkheim, Goffman and Collins*; Ashgate: Farnham, UK, 2011.
106. Vatn, A. *Institutions and the Environment*; Edward Elgar Publishing: Cheltenham, UK, 2007.
107. Vatn, A. Rationality, institutions and environmental policy. *Ecol. Econ.* **2005**, *55*, 203–217. [CrossRef]
108. Thaler, R.H.; Sunstein, C.R. *Nudge: Improving Decisions about Health, Wealth, and Happiness*; Yale University Press: New Haven, CT, USA, 2008.
109. Van Noordwijk, M.; Coe, R. Methods in agroforestry research across its three paradigms. In *Sustainable Development through Trees on Farms: Agroforestry in Its Fifth Decade*; van Noordwijk, M., Ed.; World Agroforestry (ICRAF): Bogor, Indonesia, 2019; pp. 324–346. Available online: https://worldagroforestry.org/trees-on-farms (accessed on 2 July 2021).
110. Brandt, J.; Stolle, F. A global method to identify trees outside of closed-canopy forests with medium-resolution satellite imagery. *Int. J. Remote Sens.* **2020**, *42*, 1713–1737. [CrossRef]
111. Oloo, F.; Murithi, G.; Jepkoshei, A. Quantifying tree cover loss in urban forests within Nairobi city metropolitan area from Earth observation data. *Environ. Sci. Proc.* **2021**, *3*, 78. [CrossRef]
112. Duku, C.; Hein, L. The impact of deforestation on rainfall in Africa: A data-driven assessment. *Environ. Res. Lett.* **2021**, *16*, 064044. [CrossRef]
113. Suprayogo, D.; van Noordwijk, M.; Hairiah, K.; Meilasari, N.; Rabbani, A.L.; Ishaq, R.M.; Widianto, W. Infiltration-Friendly Agroforestry Land Uses on Volcanic Slopes in the Rejoso Watershed, East Java, Indonesia. *Land* **2020**, *9*, 240. [CrossRef]
114. Wainaina, P.; Minang, P.A.; Gituku, E.; Duguma, L. Cost-Benefit Analysis of Landscape Restoration: A Stocktake. *Land* **2020**, *9*, 465. [CrossRef]
115. Nguyen, M.P.; Vaast, P.; Pagella, T.; Sinclair, F. Local Knowledge about Ecosystem Services Provided by Trees in Coffee Agroforestry Practices in Northwest Vietnam. *Land* **2020**, *9*, 486. [CrossRef]
116. Cahyono, E.D.; Fairuzzana, S.; Willianto, D.; Pradesti, E.; McNamara, N.P.; Rowe, R.L.; van Noordwijk, M. Agroforestry Innovation through Planned Farmer Behavior: Trimming in Pine–Coffee Systems. *Land* **2020**, *9*, 363. [CrossRef]
117. Burgess, P.J.; Graves, A.R.; García de Jalón, S.; Palma, J.H.N.; Dupraz, C.; van Noordwijk, M. Modelling agroforestry systems. In *Agroforestry for Sustainable Agriculture*; Mosquera-Losada, M.R., Prabhu, R., Eds.; Burleigh Dodds Science Publishing Limited: Cambridge, UK, 2019; pp. 209–238.
118. Hairiah, K.; Widianto, W.; Suprayogo, D.; Van Noordwijk, M. Tree Roots Anchoring and Binding Soil: Reducing Landslide Risk in Indonesian Agroforestry. *Land* **2020**, *9*, 256. [CrossRef]
119. Nyberg, Y.; Musee, C.; Wachiye, E.; Jonsson, M.; Wetterlind, J.; Öborn, I. Effects of Agroforestry and Other Sustainable Practices in the Kenya Agricultural Carbon Project (KACP). *Land* **2020**, *9*, 389. [CrossRef]
120. Aynekulu, E.; Suber, M.; van Noordwijk, M.; Arango, J.; Roshetko, J.M.; Rosenstock, T.S. Carbon Storage Potential of Silvopastoral Systems of Colombia. *Land* **2020**, *9*, 309. [CrossRef]

121. Do, V.H.; La, N.; Mulia, R.; Bergkvist, G.; Dahlin, A.S.; Nguyen, V.T.; Pham, H.T.; Öborn, I. Fruit Tree-Based Agroforestry Systems for Smallholder Farmers in Northwest Vietnam—A Quantitative and Qualitative Assessment. *Land* **2020**, *9*, 451. [CrossRef]
122. Purwanto, E.; Santoso, H.; Jelsma, I.; Widayati, A.; Nugroho, H.Y.S.H.; van Noordwijk, M. Agroforestry as policy option for forest-zone oil palm production in Indonesia. *Land* **2020**, *9*, 531. [CrossRef]
123. Cabral, J.P.; Faria, D.; Morante-Filho, J.C. Landscape composition is more important than local vegetation structure for understory birds in cocoa agroforestry systems. *For. Ecol. Manag.* **2020**, *481*, 118704. [CrossRef]
124. Niether, W.; Jacobi, J.; Blaser, W.J.; Andres, C.; Armengot, L. Cocoa agroforestry systems versus monocultures: A multi-dimensional meta-analysis. *Environ. Res. Lett.* **2020**, *15*, 104085. [CrossRef]
125. Kay, S.; Kühn, E.; Albrecht, M.; Sutter, L.; Szerencsits, E.; Herzog, F. Agroforestry can enhance foraging and nesting resources for pollinators with focus on solitary bees at the landscape scale. *Agrofor. Syst.* **2020**, *94*, 379–387. [CrossRef]
126. Elagib, N.A.; Al-Saidi, M. Balancing the benefits from the water–energy–land–food nexus through agroforestry in the Sahel. *Sci. Total Environ.* **2020**, *742*, 140509. [CrossRef]
127. Marconi, L.; Armengot, L. Complex agroforestry systems against biotic homogenization: The case of plants in the herbaceous stratum of cocoa production systems. *Agric. Ecosyst. Environ.* **2020**, *287*, 106664. [CrossRef]
128. Mupepele, A.C.; Keller, M.; Dormann, C.F. European agroforestry is no universal remedy for biodiversity: A time-cumulative meta-analysis. *bioRxiv* **2020**. Available online: https://www.biorxiv.org/content/biorxiv/early/2020/08/28/2020.08.27.269589.full.pdf (accessed on 2 July 2021). [CrossRef]
129. Sari, R.R.; Saputra, D.D.; Hairiah, K.; Rozendaal, D.M.A.; Roshetko, J.M.; van Noordwijk, M. Gendered Species Preferences Link Tree Diversity and Carbon Stocks in Cacao Agroforest in Southeast Sulawesi, Indonesia. *Land* **2020**, *9*, 108. [CrossRef]
130. Cerda, R.; Avelino, J.; Harvey, C.A.; Gary, C.; Tixier, P.; Allinne, C. Coffee agroforestry systems capable of reducing disease-induced yield and economic losses while providing multiple ecosystem services. *Crop Prot.* **2020**, *134*, 105149. [CrossRef]
131. Durand-Bessart, C.; Tixier, P.; Quinteros, A.; Andreotti, F.; Rapidel, B.; Tauvel, C.; Allinne, C. Analysis of interactions amongst shade trees, coffee foliar diseases and coffee yield in multistrata agroforestry systems. *Crop Prot.* **2020**, *133*, 105137. [CrossRef]
132. Mulia, R.; Nguyen, D.D.; Nguyen, M.P.; Steward, P.; Pham, V.T.; Le, H.A.; Rosenstock, T.; Simelton, E. Enhancing Vietnam's Nationally Determined Contribution with Mitigation Targets for Agroforestry: A Technical and Economic Estimate. *Land* **2020**, *9*, 528. [CrossRef]
133. Magaju, C.; Ann Winowiecki, L.; Crossland, M.; Frija, A.; Ouerghemmi, H.; Hagazi, N.; Sola, P.; Ochenje, I.; Kiura, E.; Kuria, A.; et al. Assessing Context-Specific Factors to Increase Tree Survival for Scaling Ecosystem Restoration Efforts in East Africa. *Land* **2020**, *9*, 494. [CrossRef]
134. Hughes, K.; Morgan, S.; Baylis, K.; Oduol, J.; Smith-Dumont, E.; Vågen, T.G.; Kegode, H. Assessing the downstream socioeconomic impacts of agroforestry in Kenya. *World Dev.* **2020**, *128*, 104835. [CrossRef]
135. Sollen-Norrlin, M.; Ghaley, B.B.; Rintoul, N.L.J. Agroforestry benefits and challenges for adoption in Europe and beyond. *Sustainability* **2020**, *12*, 7001. [CrossRef]
136. Mulyoutami, E.; Lusiana, B.; van Noordwijk, M. Gendered migration and agroforestry in Indonesia: Livelihoods, labor, know-how, networks. *Land* **2020**, *9*, 529. [CrossRef]
137. Chizmar, S.; Castillo, M.; Pizarro, D.; Vasquez, H.; Bernal, W.; Rivera, R.; Sills, E.; Abt, R.; Parajuli, R.; Cubbage, F. A Discounted Cash Flow and Capital Budgeting Analysis of Silvopastoral Systems in the Amazonas Region of Peru. *Land* **2020**, *9*, 353. [CrossRef]
138. Andreotti, F.; Speelman, E.N.; Van den Meersche, K.; Allinne, C. Combining participatory games and backcasting to support collective scenario evaluation: An action research approach for sustainable agroforestry landscape management. *Sustain. Sci.* **2020**, *15*, 1383–1399. [CrossRef]
139. Hofstede, G.J.; Frantz, C.; Hoey, J.; Scholz, G.; Schröder, T. Artificial Sociality Manifesto. Review of Artificial Societies and Social Simulation, 8th April 2021. Available online: https://rofasss.org/2021/04/08/artsocmanif/ (accessed on 15 May 2021).