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Enacting Responsibilities in Landscape Design: The Case of Advanced Biofuels

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Abstract: In this article, we explore the opportunities and challenges of landscape approaches through the lens of responsible research and innovation (RRI). We use the case of transport biofuels to reflect on the capacity of landscape approaches to support the governance of emerging technologies. The case study, developed in the region of Sardinia, Italy, consists of a landscape design process for the implementation of biofuel technologies that rely on the use of non-food dedicated crops and agricultural residues. By using non-food feedstocks, the biofuel project aims to avoid competition with food production and achieve sustainability goals. Through the discussion of key dimensions of RRI in relation to this case, the article puts forward a set of critical aspects of landscape design processes that require further attention from theorists and practitioners in the field of landscape-based planning. These include the power imbalance that exists between the diverse actors involved in project activities, a need for improving the flexibility of the configuration of socio-technical systems, revising assumptions on 'valid' knowledge, and improving the deliberative component of planning processes.

Keywords: landscape approaches; landscape design; responsible research and innovation; biofuels

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1. Introduction

Biofuels have been in the spotlight of academic and policy debates for almost a decade. The debate has largely focused on the sustainability and legitimation of these alternatives to fossil fuels [1]. The 'politics of biofuels' have been extensively studied, with scholars addressing questions of power, distribution of benefits and burdens, and critically analysing the fabrication of imaginaries and forms of biofuel governance around the world [2,3]. Many scholars have also focused on case studies to examine the concerns and values of different stakeholders and community actors surrounding specific biofuel projects [4,5]. However, despite the dynamics of dialogues and co-production mechanisms being instrumental in shaping the outcomes of decision-making [6], few studies have offered more detailed accounts of planning processes in biofuel developments [7].

In this paper, we examine the application of landscape approaches in the planning of emerging biofuel projects. Landscape approaches have been promoted as an alternative to conventional, sectorial land-use planning, policy, governance, and management of natural resources [8]. Landscape scholars contend that the landscape represents a suitable scale for integrating the environmental, economic, and social dimensions of sustainability research [9], making landscape science an essential part of sustainability science [10]. We are particularly interested in exploring the role played by the concerns, interests, knowledge, and values held by local stakeholders in shaping 'desirable' outcomes within landscape approaches. We do so by mobilising the framework of responsible research and innovation

(RRI) as a lens through which we may consider these aspects. RRI emerged in past decade as a response to the call for ensuring that technological development is in line with societal needs [11]. One of the main objectives of RRI is to open-up decision-making processes in science, technology, and innovation, to include the perspectives of a range of actors, so as to anticipate and increase reflexivity to the ethical and societal aspects of emerging technologies, such as nanotechnology, geoengineering and synthetic biology [12]. Seen through the lens of RRI, landscape planning processes for biofuel technologies require critical examination of value-based matters and what can be, at times, competing concerns amongst the different actors [13]. In this sense, biofuel developments are situated not only within specific environmental, political, and social contexts, but also within particular forms of dialogue and mobilisations of knowledge. As we discuss later in the paper, although holding similarities and sharing goals, we argue that the RRI and landscape planning communities have not yet initiated a dialogue between each other – a missed opportunity that this paper aims to address.

We explore synergies and differences between RRI and landscape approaches focusing on 'advanced' technologies to produce biofuels. Specifically, we use the case illustrated in Di Lucia, et al. [14], in which a landscape approach was applied for the planning of a biofuel project in the region of Sardinia, Italy. Deployment of these technologies is progressing at a slow pace, with only a handful of commercial scale projects globally [15]. The Sardinian case confirms that the success and failure of bioenergy projects depend on a series of factors, many of which are context-dependent [16].

Biofuels make an interesting case for the analysis of the ethical, environmental, and societal issues that might arise from transitions in sociotechnical systems. As emerging technologies for advanced biofuels make their way via demonstration plans for production at commercial scale, it is possible to grasp how responsibility over their implications is enacted, and how different actors understand the benefits and drawbacks of new projects. Mediated by landscape design approaches, the analysis of imminent biofuel projects sheds light on how anticipation, deliberation, reflection, and responsiveness, which are fundamental dimensions of RRI, are mobilised in landscape planning processes.

2. Background

2.1. Emerging Technologies for Transport Biofuels

Governments around the world have supported biofuels as strategic technologies to reduce carbon emissions in transport while contributing to economic development in rural areas and reducing dependence on imported fossil fuels. Conventional biofuel technologies, also known as 'first-generation' biofuels, have relied on the use of sugar, starch, and oil-based feedstock to produce ethanol and biodiesel worldwide, particularly in Brazil and the United States [17]. However, conventional biofuels have shown limited capacity to advance these objectives and to significantly reduce climate changing emissions. Studies report positive but limited energy balance combined with limited savings of greenhouse gases (GHG) emissions over their lifecycle, particularly when indirect emissions are accounted for [18]. More worryingly, there is a risk that competition for fertile land can, either directly or indirectly, result in the conversion of natural areas and the release of stored carbon, contributing to climate change and food insecurity [19].

The controversy over the sustainability of conventional biofuels has been a driver of the development of advanced technologies aimed to tackle GHG emissions and concerns around food security [20]. These technologies, also known as 'second-generation' or 'advanced' biofuels, focus on the use of agricultural and forest residues, waste, and dedicated energy crops not included in the food or feed supply chain [21]. They promise savings of GHG emissions up to 95% compared to the life cycle emissions of fossil fuels, reduced competition with food and feed production for natural resources, and higher material and chemical efficiencies [22]. Further technological development in biofuel production has therefore been driven by the limitations of conventional technologies and their potential environmental and social impacts. Scientific evidence supporting these impacts led to diminished political support for conventional biofuels and increased funding for advanced biofuels [23]. It can be argued that conventional biofuels experienced a legitimacy crisis fueled by negative public perception and controversy [24]. This controversy can be seen as a response to a lack of alignment between societal needs (i.e., environmental and social sustainability) and the promises made by technologies being pushed by the industry and governments. The challenge for new biofuel technologies is, therefore, to achieve a level of 'societal alignment' [25] which is able to support their legitimacy.

2.2. Landscape Approaches

Since the 1980s, landscape approaches have become increasingly popular as integrated strategies to bring together multiple stakeholders to provide solutions on multiple scales [26]. A common feature of these approaches has been the focus on a particular place—the landscape [8]. A landscape consists of multiple ecosystems over a watershed or a geopolitically-defined area. The term has become a key concept in a number of fields, including sustainability science, where the landscape represents a basic spatial unit of society–nature interactions and a pivotal scale domain for the research and application of sustainability [9,27].

Landscape approaches share a focus on long-term collaborative processes to achieve a balance between multiple and sometimes conflicting objectives [28]. The philosophy of land-use and natural resource management proposed by these approaches is increasingly promoted to address the inevitable trade-offs among various competing claims on natural resources [8,29]. Conventional, sectorial planning and management have proved poorly-suited for that. Integrated landscape approaches attempt to minimise trade-offs and maximise synergies [30] by bringing together the diverse range of stakeholders operating within the landscape [26]. The assumption is that this participatory process will eventually lead to consensus on desired outcomes [31].

Among landscape approaches, landscape design has been defined as the "intentional change of landscape patterns, for the purpose of sustainably providing ecosystem services while recognizably meeting societal needs and respecting societal values" [32] (p. 635). Here landscape science is combined with the design component of the approach for its ability to create 'possibility spaces' within which desirable futures can be shaped [33,34]. The effectiveness of the landscape design, and landscape approaches in general, can be determined by achieving agreement among decision makers, i.e., process outcomes, or by the ability to deliver social and environmental benefits, i.e., management outcomes. Nevertheless, the evaluation of management outcomes is considered a challenging task due to the need for long-term monitoring [28].

2.3. Responsible Research and Innovation

As an emerging framework in political and academic circles, RRI is a continuation of longstanding debates about the governance of technological change. It responds to concerns on how to anticipate the potential impacts of emerging technologies, how to reflect on their wider social and ethical implications, and how to include diverse actors in the decision-making process. While not a fully consolidated framework, RRI draws on the key assumption that technological change should be better aligned to societal needs [12]. In parallel to efforts in participatory appraisals of technological change [35,36], RRI aims to address societal needs by expanding the boundaries and scope of technocratic, expert-driven processes. By 'opening up' these processes, the goal is to allow for different narratives and visions to be considered, something which could ultimately lead to the construction of multiple scenarios for technological change. In this context, there are some key elements that a RRI lens makes particularly visible and worthy of analysis when applied to the case of sustainability appraisals. These are anticipation, inclusion, reflexivity, and responsiveness [37].

Anticipation is connected to the notion of capacity building, i.e., as a sort of continuous, preparatory exercise to confront unknown challenges if/when they arrive [38]. Anticipation is an umbrella-concept that entails subsidiary approaches and methodologies, including constructive models of technology assessment [37]; public deliberation on the potential benefits, negative impacts, risks, and alternatives to technological development [39]; and scenario building, including the creation of physical prototypes and simulations [40,41]. In the field of sustainability assessments, anticipation emerges in the context of a need to improve interventions by prioritising careful design of criteria which are "explicitly drawn from social and environmental values", before the implementation of projects [42] (p. 201). To 'anticipate' is therefore to support arrangements and deploy instruments that increase our individual or institutional ability to govern technological change.

The second dimension is related to the notion of 'inclusion', and to the contentious issue of expertise. It entails debates around the type of actors and knowledge considered to be certified and legitimate, and, therefore, worthy of being invited. Expertise may work as a device that excludes certain actors, keeping them from influencing the directions and outcomes of formal decision-making processes [43]. For example, scientific knowledge tends to hold a higher status than 'lay knowledge'. This is, in part, because scientific institutions have been historically at the heart of decision-making processes, and have been regarded as agents of neutrality, reason, and impartiality [44]. In this context, the scientific expert will not only answer questions in scientific terms, but will have framed questions as scientific in the first place. By doing so, experts may impose their understanding of what are deemed as relevant concerns in relation to an issue. Subsequently, they may indirectly determine what constitutes relevant knowledge to address this issue [45]. Because the way problems are framed shapes the responses to these very problems, the less inclusive a process is, the less likely it is that we will find multiple perspectives on a given problem.

'Reflexivity' is related to inclusion, but is more closely focused on the entanglement between knowledge, values, and concerns. Wesselink, et al. [46], for example, discuss how discourses around sustainable development and ecological modernisation are fabricated by specific interpretations of reality, mobilising at the same time scientific facts, values, and concerns. Central to the notion of reflexivity is taking responsibility for considering our own beliefs and assumptions [47], particularly considering our aims and reasons in view of others when deliberating on a given issue [48]. As an exercise of self-critique, actors should be as transparent as possible in regards to the drivers behind ones own preferences and choices, examining the values and worldviews guiding ones position.

Finally, interconnected to the previous dimensions, 'responsiveness' refers to an institutional capacity to respond "to new knowledge as this emerges and to emerging perspectives, views and norms" [37] (p. 1572). Simply put, it refers to the change that could be produced as a result of greater inclusion and reflection in the governance of science, technology, and innovation. Stilgoe et al.'s understanding of responsiveness draws largely on the conceptualisation put forward by Pellizzoni [49], who connects it to notions of care, liability, and accountability—all important ingredients of responsibility. For him, responsiveness entails a capacity to share agendas and plans of action before deciding and acting as collectives or as individuals. Here, the possibility of changing the initial plan—or of developing a shared plan from scratch—can be taken as a first-order impact of governance systems which are, in principle, more open and reflexive.

3. The Case of Advanced Transport Biofuels in Sardinia

3.1. Background—Study Area and the Biofuel Project

As in the rest of Europe, interest in advanced biofuels in Italy has been on the rise for a number of years. In 2013, a technology developer (Biochemtex, a world leader in advanced technology for transport biofuels with investments in Europe, USA, Latin America and China (www.biochemtex.com)) selected the Sardinian island for its first-of-a-kind commercial scale production unit of cellulosic ethanol from a dedicated non-food energy crop, giant reed (*Arundo donax*). The crop was selected for its attractive yields and capacity to withstand periods of drought which characterise the region [50]. Field trials conducted in Sardinia showed that, when not constrained by water limitations, giant reed yields range between 25 and 35 t DM/ha [51]. In spite of the potential improvements in terms of environmental and material efficiencies offered by cellulosic ethanol compared to conventional ethanol, the biofuel investor expected "some level of criticism from some groups of local stakeholders" [50].

This was in line with the negative debate surrounding biofuels both in Italy and the EU. Partly in reaction to this debate, the investor planned to limit the cultivation of giant reed to abandoned or underutilized agricultural land in an area, the South-West of Sardinia, characterised by high levels of unemployment and environmental pollution [50,52]. The project received the endorsement of the national and regional governments on the condition that the area become a major supplier of the biomass feedstock. However, as early as 2014, an intense debate around the project had erupted in Sardinia, with a few groups in favour and a wealth of positions very critical towards the project.

3.2. Application of the Landscape Design Approach

In 2015, a landscape design exercise was conducted to explore the potential to contribute to landscape multifunctionality and sustainable outcomes in the case of advanced ethanol in Sardinia [14]. In this section, we focus our attention on how concerns, knowledge, and value claims held by local stakeholders were elicited, and how they shaped decision-making in the landscape exercise.

3.2.1. Local Stakeholders

Stakeholder engagement is an essential component of landscape design. In the exercise, stakeholders were defined as either groups or individuals in local communities who rely on the ecosystem services affected by the biofuel project, or decision-makers and land managers able to affect the provision of these services. The exercise sought to engage a representative sample of key stakeholders, i.e., those that should be at the table for decisions to be considered implementable. Stakeholder categories were identified through six scoping interviews with local informants and a review of documents including the local media coverage. From these data, ten categories emerged: biofuel producers, farmers and farmer associations, regional governments, municipal governments, irrigation agencies, water agencies, agricultural development agencies, environmental NGOs, and workers' unions. For each category, a sample of individuals able to commit to a few meetings and to represent the position of their constituency was engaged in the landscape design process.

3.2.2. Local Concerns and Values

The concerns and values of local stakeholders shape landscape design given that these processes are mostly led by deliberations about goals and values [34]. In the exercise, values were interpreted as 'assigned values' or "the relative importance or worth of an object to an individual or group in a given context" [53] (p. 233). Aware that the values people attach to places are complex judgments based on knowledge as well as emotional reactions [54] (p. 13), in the exercise, they were elicited by exploring stakeholder views on the biofuel project and its potential impacts on environmental and socio-economic conditions. The data were collected through a review of documentary sources and twenty-two face-to-face, semi-structured interviews with representatives of each of the stakeholder categories above.

The data collected showed that, due to a lack of publicly available information about the biofuel project, stakeholders had only a superficial understanding of its features. Participants stressed a lack of systemic knowledge about the project and its potential impacts, and suggested that this lack was a critical limit to the development of an informed opinion about the project. This was in line with the communication strategy of the biofuel investor which disclosed (limited) information only to individuals with a role in the public authorisation process, or in the future biomass supply chain [50]. As a result, stakeholders shared a wide range of views on the project. The most common concerns referred to the limited availability of water for irrigation, the risk of competition with local food production, and the loss of biodiversity in the area. These results largely matched evidence from the review of documentary sources. Moreover, stakeholders considered the generation of employment and income, and the reduction of GHG emissions as key opportunities of the biofuel project.

3.2.3. Knowledge of Landscape Functions and Services

Mobilising local and expert knowledge of landscape functions and services is another critical component of landscape approaches. In response to the demands of stakeholders, the exercise focused on the development of systemic knowledge of the biofuel project and potential alternatives in line with stakeholders' concerns and values. This process relied on integrative and participatory computer modelling [55]. Both the landscape design team and local experts participated in the modelling activities. Firstly, the team developed a set of scoping models relying on the results of the assessment of local concerns and values and the data provided by stakeholders via interviews. Then, the models, their input data, and the preliminary results were reviewed in four focus groups involving local experts familiar with agricultural systems, water resources, natural habitats, and land resources. This process of integration of scientific and local knowledge sought to improve the credibility, saliency, and legitimacy of the knowledge used in the approach [56], by ensuring that the models were in line with stakeholders' concerns and values, and that input data and results were validated against local experience.

As part of the knowledge co-production process, the team developed a set of alternative scenarios for the biofuel project. In landscape design, stakeholders are encouraged to consider new alternatives that inspire decision making [57]. The team developed four alternative scenarios for the biofuel project, each representing a desirable future characterised by a 'what if' change of some system conditions. In the 'base' scenario, the biofuel project is implemented following the original plan of the company, in which c. 6000 ha of arable land, not used for food crop production, are converted to giant reed and irrigated with water supplied by the irrigation systems. In the 'Recycled Water' scenario, c. 6000 ha of giant reed are cultivated and irrigated with recycled water from residential water treatment plants to mitigate the impacts on water availability. The 'Polluted Land' scenario seeks to limit competition with food and animal feed production by cultivating giant reed on land officially classified as polluted. Finally, a 'Food and Fuel' scenario was developed to mitigate the impacts on food production by assuming a three-fold increase in the acreage of durum wheat to provide both feedstock for biofuel (straw) and local food production (grain).

Stakeholders played a central role in the identification of the themes and key features of scenarios. The 'Recycled Water' scenario was championed, in particular, by the regional water agencies who had piloted a number of projects to test the feasibility of utilising residential waste water for agricultural purposes [58]. The 'Polluted Land' scenario was proposed by many stakeholders in line with the regional plan for the treatment and reutilisation of polluted areas [59]. Finally, the 'Food and Fuel' scenario was designed following diffused opinion among stakeholders, who stressed the need to revert the declining food production in the area. Few elements in each scenario were selected by the landscape design team without direct input from stakeholders, e.g., the selection of durum wheat as feedstock in the 'Food and Fuel' scenario. The models developed by the team and validated during the focus groups were employed to analyse each scenario. The results provided the knowledge-base for the decision-making part of the exercise.

3.2.4. Decision-Making

The landscape design approach is underpinned by the assumption that by accounting for trade-offs among objectives and exploiting synergies, it will eventually lead to consensus among parties on desired outcomes [31]. Consensus about desirable outcomes and collaboration among parties are foundations of the governance system promoted by landscape approaches. To promote these goals, the landscape design team organized a one-day event involving sixteen representatives of all stakeholder categories. The event sought to develop a dialogue among participants employing the results of the model simulations to evaluate the acceptability of scenarios.

The results of the modelling exercise were presented by the research team and used to structure the discussions among participants. The results provided a shared knowledge base for the group to discuss the biofuel project and alternative scenarios. Overall, the group did not question the credibility or legitimacy of the data presented, which might be a result of local experts having been previously engaged in the focus groups. During the discussions, participants referred extensively to the modelling results showing the simulated effects of each scenario on issues considered of key importance by stakeholders. This provided a practical means for participants to compare scenarios and articulate their positions. Overall, participants focused on impacts on water resources, employment, and income generation, while other issues such as climate change and biodiversity, which often dominate debates on transport biofuels, were less polarised among participants.

A tangible result of the event was the design of a shared pathway to guide the planning of the biofuel project that no participant openly opposed. This pathway emerged from the evaluation of all alternative scenarios, and contained some features of each scenario, except the 'Food and Fuel' scenario; this was due to the economic limitations of the scenario linked to the cultivation of durum wheat in the area which is not profitable without substantial EU Common Agricultural Policy subsidies. Agreement among parties was achieved through meeting the interest, i.e., the underlying reasons, needs, and values that explain the positions of all participants through dialogue, taking into account their views, knowledge, and understandings of what is being proposed; see e.g., [60]. This process was led by a facilitator and articulated by asking participants to illustrate their views on the pros and cons of each scenario. In this process, the facilitator played an important role, ensuring that participants had equal opportunities to contribute, and that discussions did not diverge from the object of the meeting. In the final part of the event, attention was dedicated to the implementation of the shared pathway and the definition of a set of practical actions. These consisted of (i) an evaluation of the agronomic suitability of local land resources for energy crop production, (ii) an assessment of the potentials of small-scale waste water treatment plants, and (iii) an expansion of giant reed field trials to evaluate rain-fed management opportunities. For each action, participants identified an organization responsible for executing and monitoring activities.

4. Landscape Design Seen through the Lens of Responsible Research and Innovation

RRI is a framework that suggests certain flexibility in terms of its translation and operationalisation across different disciplines and sociotechnical systems [12]. The version put forward by Stilgoe, et al. [37], presented in Section 2, has become prominent within academic and policy circles, precisely because its dimensions (i.e., anticipation, inclusion, reflexivity and responsiveness) are open enough to allow for their interpretation in different contexts. By reflecting on these four key dimensions of RRI, in this section, we explore the opportunities and challenges of landscape approaches, and discuss them *vis-à-vis* the landscape design case presented above.

4.1. Anticipating Scenarios

The conceptualisation of anticipation in RRI follows a change in focus amongst the technology assessment community, from one of 'forecasting' to one of 'foresight'. As put by Cuhls [61], the background of foresight is to prepare for the future or try to actively shape it; as such, it is a potentially useful tool to support planning processes. In early developments of the field of forecasting, planners and decision-makers would seek for a pool of 'appropriately qualified' experts who would provide input to quantitative probability assessments; see Fischhoff et al. [62], for an example. Compared with the paradigm of early forecasting, foresight processes aim at broadening the participation to diverse actors in the process of building and selecting multiple future options. More recently, these ideas became encapsulated in the concept of anticipatory governance, defined as "the cultivation of a societal capacity for foresight", as formal and informal, forward-looking, and engagement-oriented practices [63]. By collectively anticipating scenarios as early as possible in planning processes, it is expected that not only the design and the goals of sociotechnical systems will be better aligned to those of diverse stakeholders, but also that a great deal of unintended, potentially detrimental consequences could be avoided.

The ambition of a landscape approach is to take precautionary steps before making decisions on the development and implementation of projects, and to design landscape configurations in ways that reflect the knowledge and values of stakeholders [26]. Limitations of the approach emerge where the role of the approach is solely on the mitigation and remediation of the negative impacts of pre-planned projects, i.e., projects for which most of the decisions have already been made. When landscape approaches are applied as an ex-post tool, typically in the context of disagreement and controversy, they develop under the assumption that change is irreversible. This limits the scope of landscape approaches, which may work as tools for adaptation to change, instead of facilitators of collective, integrated shaping of desired futures [64]. Key proponents of what could be called more constructive and anticipatory models of landscape approaches, e.g., [28], highlight their focus on long-term engagements to ensure the delivery of lasting societal benefits through adaptive management. However, the reality is that landscape exercises tend to be situated within a short timeframe and adopt a focus on achieving short-term goals—which are typically easier to demonstrate and measure; see e.g., [30]. Furthermore, ex-post assessment of impacts in complex contexts is already a difficult task in itself [28], suggesting that the anticipation of future complex scenarios and their uncertain potential impacts are even more challenging.

In the case of advanced biofuels in the region of Sardinia, landscape design was employed with the aim of opening up opportunities for designing alternative future scenarios that would reflect the interests and concerns of a diverse group of stakeholders. The approach sought to support arrangements and deploy instruments that increase the ability to direct change towards societal benefits while dealing with unintended consequences. A key feature was the timing of the exercise in relation to the lifetime of the biofuel project. Activities were conducted at the point when the biofuel company had a project plan that was sufficiently developed to allow for constructive discussions, but were held early enough for their results to be meaningful, that is, to allow for alternatives to be considered by decision makers. Each alternative scenario was analysed by applying the integrated model developed with stakeholders, while scenario plausibility, an important factor in their success [11,65], was discussed with stakeholders in focus groups. In this way, the exercise sought to provide knowledge of alternative futures with attention to issues that were framed and considered to be of critical importance by the stakeholders themselves. A critical remaining challenge, however, is the time and labour required for the modelling of complex systems where local baseline data are limited.

4.2. Engaging Stakeholders

A critical point to consider in relation to inclusiveness is that of which actors (alongside their knowledge, interests, and concerns) tend to be included, and which are left out, from decision-making processes, and how this may affect problem-framing. From the framing of problems through to the prescription of solutions and implementation of projects, public and stakeholder engagement approaches could represent merely consultative or more participatory exercises. On one end of the spectrum, these activities tend to be advisory, prescriptive, and linear (i.e., one-way communication, such as public hearings and expert panels), whereas on the other end, they could be more empowering, representative of public and stakeholder diversity and dialogical [66]. Felt and Fochler [67] put forward a broad and relatively open categorisation which might be helpful for the purposes of a critical examination of public and stakeholder engagement in planning processes. The table below adapts and summarises their proposal (Table 1).

Landscape approaches support a call for stakeholder engagement from the outset of design processes [31]. Besides engagement, empowerment of local communities, capacity building and transparency are central ideas within mainstream conceptualisations of landscape approaches, including landscape design. Dialogue, learning, resilience, and adaptation are fundamental processes in these approaches [26]. Recent interpretations of landscape approaches stress the importance of stakeholder diversity, and put forward methods to ensure transparency and the social legitimation of these processes, for example, through the formation of 'coalitions' for the collective development of 'theories of change' [28]. Proponents of these approaches also have an interest in critically investigating the processes through which citizens engage in knowledge co-production, the most meaningful form of engagement envisaged by Felt and Fochler [67], and how their knowledge emerges and is applied in landscape processes [28]. However, these approaches may fall short of a theory of expertise that renders visible their assumptions on knowledge legitimacy. Answers to questions such as who is a legitimate stakeholder and what types of knowledge, including non-scientific knowledge, should be included in these processes are not evident.

Table 1. General categorisation of engagement models adapted from Felt and Fochler [67].

Engagement Model	Description
Public and stakeholder education	The development and implementation of emerging technologies should be protected from societal intervention; it is the role of experts to instruct and educate publics and stakeholders to tackle mistrust.
Public and stakeholder dialogue/participation	The development and implementation of emerging technologies should be open to societal debate and consultation but publics and stakeholders are not responsible for creating knowledge.
Public and stakeholder co-production of knowledge	Science, technology and innovation are intertwined with society. Publics and stakeholders should be actively engaged in the process of knowledge production of direct use for them and are able to shape the framing of problems and to contribute to the design of solutions.

In the case study, engagement activities were deployed building on the results of the assessment of local values and concerns, and considering the socio-cultural and biophysical contexts. These activities sought the engagement of representatives of all key categories of local stakeholders identified in the first stage of the landscape design process. The involvement of local stakeholders played a crucial role in the co-production of transdisciplinary knowledge through the integration of local and scientific perspectives. Participatory modelling was the approach employed to integrate these two forms of knowledge. In participatory modelling, stakeholders contribute to data collection, model selection and development, scenario building, and/or results interpretation [68]. Although there is no optimal level of engagement or predetermined components of participation in modelling, several approaches to participation have been suggested; see e.g., [55]. As discussed by Voinov, et al. [55], some components or parts of the modelling process are more likely to involve stakeholders than others. In the case study, the design process sought to ensure an open dialogue and the inclusion of a range of positions representative of various categories of stakeholders. However, engagement remained limited, particularly in the selection of the biophysical models used in the analysis which, due to time and resource constraints, was based mainly on data availability and the research team's familiarity with the models.

4.3. Reflecting on Values, Knowledge and Power Asymmetries

Central to the notion of reflexivity in RRI is taking responsibility for considering our own beliefs and assumptions. In the field of climate adaptation planning, Haverkamp [6] puts forward a value-based approach to show how adaptation strategies are anything but politically neutral and value-free constructs. For example, a tendency to rely on expert knowledge at the expense of knowledge from local communities can lead to an overly biased framing of problems (e.g., in terms of biophysical impacts instead of social impacts), and the suggestion of related solutions (e.g., engineered and technical remedies), which are often disconnected from 'real' local concerns and needs [6:49]. Of importance here is, first, the issue of a power imbalance between the actors responsible for implementing a planning process and those identified as interested or affected groups; and, second, of a widespread misconception that values and knowledge operate separately when actors are making decisions, especially in fields informed or intersected by science and technology, which claim to be fully objective, in other words, value-free [69].

With a few exceptions, the issue of reflexivity is overlooked in the landscape science literature. In the field of landscape planning, Bardsley, et al. [70] stress the need for increased reflexivity when deliberative approaches to planning are faced with multiple interpretations of risk and value. In the analysis of a case study on land use in peri-urban areas prone to wildfires, the authors build on social theory to explore how historically-situated 'cultures of value and risk' intersect with institutional decision-making and people's decisions to inhabit these areas. Similarly, Dalglish, et al. [71] suggest that in landscape governance, the deployment of renewable energy technologies requires attention to historically-rooted social and cultural conditions. The authors also consider questions of justice and disparities in power. For Sayer, et al. [30], these are issues which landscape approaches appear poorly suited to address, alongside the problem of entrenched interests. Because landscape design inherently involves hierarchical structures and dispute between different agendas, there is a concern that more powerful stakeholders might dominate the process and control the outcomes. This has motivated recent calls in spatial planning for looking at social justice issues and the problem of 'hegemonic' discourses [72].

In the case study, the values and views of local stakeholders shaped the development of landscape knowledge and the framing of problems. The scope of the integrative model employed to co-produce knowledge covered all the broad issues identified by stakeholders based on their prioritisation of concerns. However, the modelling techniques utilised represented a compromise between the need to ensure the credibility and legitimacy of the knowledge produced, and the time and resources available for the exercise. Furthermore, throughout the process, equal treatment of stakeholders was a challenge. Vested interests and power imbalances between stakeholders risked invalidating the exercise, especially if, at the end, some participants would oppose the conclusions. The landscape exercise sought to promote the legitimacy of the process by ensuring a comprehensive coverage of issues addressed in the interviews and effective participation in focus groups and in decision-making, where power issues around the table were mitigated, ensuring that all participants had space to contribute while having access to the same data and information. Moreover, although the decision-making process relied on consensus-making and on facilitating collaboration among participants, any power imbalances occurring outside the scope of the exercise would have been left untouched, potentially hindering the implementation of the decisions reached.

4.4. Responsiveness

Responsiveness alludes to the possibility of change that could be produced as a result of anticipation, greater stakeholder participation, and reflexivity. Here, the possibility of changing the initial plan, or of developing a shared plan from scratch, can be taken as a first-order impact of dialogues which are, in principle, more open and reflexive. Responsiveness thus refers to the capacity to change shape or direction in response to changing circumstances or stakeholder values, while recognising the insufficiency of knowledge and control [73]. This should be an iterative, inclusive, and open process of adaptive learning, with dynamic capability processes through effective mechanisms of participatory and anticipatory governance [37].

A key feature which characterises landscape approaches is the iterative process of negotiation, trial, and adaptation [26]. Landscape scholars stress the need for adaptive feedback mechanisms and monitoring to ensure that interventions are adapted to changing priorities or circumstances [30,74]. Since landscapes are constantly changing under the influence of multiple drivers, to realise the full potential of landscape design there is a need to deploy effective processes to monitor the management process and its outcomes over long time periods [28]. However, effective monitoring requires that baselines are developed and desired outcomes are agreed in ways that enable measurement [30]. From monitoring activities, new evidence should emerge and feed back to the decision-making process to inform future decisions. This is a critical component of any adaptive management process and a basis of landscape design [30,74].

In the case study, the goal of the landscape exercise was to achieve an agreement on how the biofuel project could represent a shared view supported by different stakeholders. Here, evidence of responsiveness can be found comparing the initial plan, i.e., the 'Base' scenario, with the shared pathway. At the beginning of the exercise, most stakeholder groups contested the biofuel project for various reasons including a lack of knowledge on the project details. This misinformation allowed the emergence of poorly-founded expectations among stakeholders. The landscape exercise provided participants with the opportunity to acquire knowledge, to debate, and to reach a shared position and develop practical actions and monitoring activities. These actions and tasks were considered necessary to move from a broad agreement among parties to a detailed, practically-implementable plan for the biofuel project. However, they were never executed due to a sudden change in the industrial strategy by the biofuel company. In any case, had the project gone ahead, the human and financial resources required for long-term monitoring of the exercise's outcomes would be considerable. Long-term monitoring is already a challenging aspect of planning recognised by the landscape science community [28], without considering the need for broader analyses of responsiveness and adjustment of pathways based on participatory processes.

5. Lessons Learned and Conclusions

Landscape design has been suggested as an approach to effectively guide the deployment of biofuel systems within existing socio-economic and environmental systems [74]. As we have discussed above, recent approaches to landscape design have accommodated more constructivist and participatory perspectives. These overlap, to some extent, with those put forward by the RRI agenda. Observed through the lenses of RRI, landscape design as a planning and decision-making approach provides opportunities, but also entails important challenges. Some of these can only be identified when reflecting on a real-world case of implementing novel technologies, such as the case study of advanced biofuels in Sardinia. These opportunities and challenges resonate, in part, with the literature and practice of landscape approaches, and are certainly not exclusive to the case of biofuels or energy technologies.

Landscape design has the capacity to time landscape activities and project planning. As one of its core features, it also seeks to develop plausible shared scenarios of alternative futures through participatory approaches to planning. On the other hand, there are key critical aspects of landscape design processes that require further attention from theorists and practitioners in the field of landscape design. We briefly outline these below with a focus on the enactment of different types of responsibility:

(a) There is a risk that potential power imbalances will emerge between those regarded as being 'in charge' of decisions and those considered as 'affected by' decisions. Project managers and more powerful stakeholders with an interest in the implementation of a project (e.g., industry, policy-makers) are typically regarded as those holding responsibility for the consequences of technological development. While this assumption is already problematic, this responsibility tends to get extended to that of controlling the decisions being made, which then tend to be defined—or sometimes even 'pre-agreed'—by these same actors. Ideally, power relations in decision-making processes related to planning should be as horizontal as possible, and conducive to cooperation and fairness. Importantly, the initial framing of problems should reflect diverse concerns and interests with any prioritisation of issues depending on collective agreement.

(b) An ability to reflect on the interactions between values and knowledge and the motivations, concerns, and interests behind the positions of the different stakeholders should be nurtured in planning processes. The commonly-held view of expert knowledge as 'value-free' knowledge, compared with local, non-expert knowledge as 'value-laden' must be challenged from the construction of problems through to the development of solutions. Indeed, the ways in which problems are framed define, to a great extent, the approaches chosen to address these, as well as the solutions prescribed. All actors involved in planning processes hold specific values, and these values shape the kinds of information they produce or select. In other words, in the same way that every actor is responsible for filtering knowledge that they deem as useful, they are also responsible for critically reflecting on their own motivations for knowledge production or selection of information.

(c) Those designing and implementing new technologies in the present are also responsible for their configurations and consequences in the future. There is a need for developing capacity to ensure adaptive management, and long-term monitoring strategies that allow for the adjustment of sociotechnical systems in every project proposed. By the same token, these systems should be designed in ways that increase their flexibility and the possibility of change in direction in terms of their development, including the possibility of revisiting their objectives. Whereas technological development involves a great deal of uncertainty, and although potential technological lock-ins are unavoidable, designers and planners should strive to ensure that the economic, social and environmental commitments that come with projects are achieved, as well as to consider the potential reversibility of specific socio-technical systems.

(d) As a principle of shared responsibilities, meaningful and effective public and stakeholder engagement should be sought in the different phases of the planning process, and particularly in those in which participation is known to be overlooked. This includes the early and more critical phases of landscape design, such as the identification and definition of variables for assessment. Echoing earlier points, public and stakeholder engagement is only meaningful when different actors take responsibility for the definition of problems, and when the concerns emerging from engagement are effectively incorporated into decisions.

Together, these different forms of responsibilities speak to the question of how landscape approaches, and landscape design in particular, could support the alignment of novel technologies with broader societal needs while improving fairness and transparency of the process. Despite some challenges, the aims of landscape design should be compatible with those of RRI. By deploying RRI as a lens through which may be viewed the analysis of a real case of implementation of novel technologies, we have put forward some critical aspects that we argue the landscape science community can benefit from further developing in both theoretical and empirical terms. Landscape approaches can be a powerful broker between new technologies and their embeddedness in society. They have the role of facilitating negotiations between different values and concerns in a comprehensive manner, cutting across different dimensions of sustainability. Ultimately, they shape processes of societal alignment between technological development and society. If planning processes are not conducted with a view to improve deliberation, fairness, and transparency, the objective of aligning these developments with societal needs might fail. As seen in the case of conventional biofuel technologies, this failure may bring with it the risk of losing social and political legitimacy in the long run.

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References

1. Palmer, J.R. Biofuels and the Politics of Land-Use Change: Tracing the Interactions of Discourse and Place in European Policy Making. *Environ. Plan. A* **2014**, *46*, 337–352. [CrossRef]

2. Borras, S.M., Jr.; McMichael, P.; Scoones, I. The Politics of Biofuels, Land and Agrarian Change: Editors' Introduction. *J. Peasant Stud.* **2010**, *37*, 575–592. [CrossRef] [PubMed]
3. Ponte, S.; Birch, K. The Imaginaries and Governance of Âbiofueled Futuresâ. *Environ. Plan. A* **2014**, *46*, 271–279. [CrossRef]
4. Tomei, J.; Upham, P. Argentinean Soy-Based Biodiesel: An Introduction to Production and Impacts. *Energy Policy* **2009**, *37*, 3890–3898. [CrossRef]
5. Selfa, T.; Kulcsar, L.; Bain, C.; Goe, R.; Middendorf, G. Biofuels Bonanza?: Exploring Community Perceptions of the Promises and Perils of Biofuels Production. *Biomass Bioenergy* **2011**, *35*, 1379–1389. [CrossRef]
6. Haverkamp, J.A.R. Politics, Values, and Reflexivity: The Case of Adaptation to Climate Change in Hampton Roads, Virginia. *Environ. Plan. A* **2017**, *49*, 2673–2692. [CrossRef]
7. Goldstein, J.E. Knowing the Subterranean: Land Grabbing, Oil Palm, and Divergent Expertise in Indonesia's Peat Soil. *Environ. Plan. A* **2016**, *48*, 754–770. [CrossRef]
8. Arts, B.; Buizer, M.; Horlings, L.; Ingram, V.; van Oosten, C.; Opdam, P. Landscape Approaches: A State-of-the-Art Review. *Annu. Rev. Environ. Resour.* **2017**, *42*, 439–463. [CrossRef]
9. Wu, J.J. A Landscape Approach for Sustainability Science. In *Sustainability Science*; Springer: Berlin, Germany, 2012; pp. 59–77.
10. Wu, J. Landscape Sustainability Science: Ecosystem Services and Human Well-Being in Changing Landscapes. *Landsc. Ecol.* **2013**, *28*, 999–1023. [CrossRef]
11. Von Schomberg, R. Prospects for Technology Assessment in a Framework of Responsible Research and Innovation. In *Technikfolgen Abschätzen Lehren*; Springer: Berlin, Germany, 2012; pp. 39–61.
12. Ribeiro, B.E.; Smith, R.D.J.; Millar, K. A Mobilising Concept? Unpacking Academic Representations of Responsible Research and Innovation. *Sci. Eng. Ethics* **2017**, *23*, 81–103. [CrossRef] [PubMed]
13. Raman, S.; Mohr, A.; Helliwell, R.; Ribeiro, B.; Shortall, O.; Smith, R.; Millar, K. Integrating Social and Value Dimensions into Sustainability Assessment of Lignocellulosic Biofuels. *Biomass Bioenergy* **2015**, *82*, 49–62. [CrossRef] [PubMed]
14. Lucia, D.L.; Usai, D.; Woods, J. Designing Landscapes for Sustainable Outcomes – the Case of Advanced Biofuels. *Land Use Policy* **2018**, *73*, 434–446. [CrossRef]
15. International Renewable Energy Agency (IRENA). *Innovation Outlook Advanced Liquid Biofuels*; International Renewable Energy Agency: Abu Dhabi, UAE, 2016.
16. Ribeiro, B.E.; Quintanilla, M.A. Transitions in Biofuel Technologies: An Appraisal of the Social Impacts of Cellulosic Ethanol Using the Delphi Method. *Technol. Forecast. Soc. Chang.* **2015**, *92*, 53–68. [CrossRef]
17. Fagundes, P.D.; Padula, A.D.; Padilha, A.C.M. Interdependent International Relations and the Expansion of Ethanol Production and Consumption: The Brazilian Perspective. *J. Clean. Prod.* **2016**, *133*, 616–630. [CrossRef]
18. Alkimim, A.; Clarke, K.C. Land Use Change and the Carbon Debt for Sugarcane Ethanol Production in Brazil. *Land Use Policy* **2018**, *72*, 65–73. [CrossRef]
19. Pimentel, D.; Marklein, A.; Toth, M.A.; Karpoff, M.N.; Paul, G.S.; McCormack, R.; Kyriazis, J.; Krueger, T. Food Versus Biofuels: Environmental and Economic Costs. *Hum. Ecol.* **2009**, *37*, 1. [CrossRef]
20. Daioglou, V.; Doelman, J.C.; Stehfest, E.; Müller, C.; Wicke, B.; Faaij, A.; van Vuuren, D.P. Greenhouse Gas Emission Curves for Advanced Biofuel Supply Chains. *Nat. Clim. Chang.* **2017**, *7*, 920–924. [CrossRef]
21. Naik, S.N.; Goud, V.V.; Rout, P.K.; Dalai, A.K. Production of First and Second Generation Biofuels: A Comprehensive Review. *Renew. Sustain. Energy Rev.* **2010**, *14*, 578–597. [CrossRef]
22. International Energy Agency (IEA). Sustainable Production of Second-Generation Biofuels: Potential and Perspectives in Major Economies and Developing Countries. In *Information Paper*; Eisentraut, A., Ed.; International Energy Agency: Paris, France, 2010.
23. European Commission (EC). *Proposal for Amending Directive 98/70/Ec Relating to the Quality of Petrol and Diesel Fuels and Amending Directive 2009/28/Ec on the Promotion of the Use of Energy from Renewable Sources*; EC: Brussels, Belgium, 2012.
24. Mohr, A.; Raman, S. Lessons from First Generation Biofuels and Implications for the Sustainability Appraisal of Second Generation Biofuels. *Energy Policy* **2013**, *63*, 114–122. [CrossRef] [PubMed]
25. Ribeiro, B.; Bengtsson, L.; Benneworth, P.; Bührer, S.; Castro-Martínez, E.; Hansen, M.; Jarmai, K.; Lindner, R.; Olmos-Peñuela, J.; Ott, C.; et al. Introducing the Dilemma of Societal Alignment for Inclusive and Responsible Research and Innovation. *J. Responsb. Innov.* **2018**, *5*. [CrossRef]

26. Reed, J.; van Vianen, J.; Deakin, E.L.; Barlow, J.; Sunderland, T. Integrated Landscape Approaches to Managing Social and Environmental Issues in the Tropics: Learning from the Past to Guide the Future. *Glob. Chang. Biol.* **2016**, *22*, 2540–2554. [CrossRef] [PubMed]
27. Opdam, P. Exploring the Role of Science in Sustainable Landscape Management. An Introduction to the Special Issue. *Sustainability* **2018**, *10*, 331. [CrossRef]
28. Sayer, J.A.; Margules, C.; Boedhihartono, A.K.; Sunderland, T.; Langston, J.D.; Reed, J.; Riggs, R.; Buck, L.E.; Campbell, B.M.; Kusters, K. Measuring the Effectiveness of Landscape Approaches to Conservation and Development. *Sustain. Sci.* **2017**, *12*, 465–476. [CrossRef]
29. Shames, S.; Clarvis, M.H.; Kissinger, G. *Financing Strategies for Integrated Landscape Investment: Synthesis Report*; EcoAgriculture Partners: Washington, DC, USA, 2014.
30. Sayer, J.; Margules, C.; Boedhihartono, A.K.; Dale, A.; Sunderland, T.; Supriatna, J.; Saryanthi, R. Landscape Approaches; What Are the Pre-Conditions for Success? *Sustain. Sci.* **2015**, *10*, 345–355. [CrossRef]
31. Sayer, J.; Sunderland, T.; Ghazoul, J.; Pfund, Je.; Sheil, D.; Meijaard, E.; Venter, M.; Boedhihartono, A.K.; Day, M.; Garcia, C. Ten Principles for a Landscape Approach to Reconciling Agriculture, Conservation, and Other Competing Land Uses. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 8349–8356. [CrossRef] [PubMed]
32. Nassauer, J.I.; Opdam, P. Design in Science: Extending the Landscape Ecology Paradigm. *Landsc. Ecol.* **2008**, *23*, 633–644. [CrossRef]
33. De Landa, M.; Ellingsen, E. Possibility Spaces. In *Models*; Emily, A., Eric, E., Jonathan, S., Eds.; Princeton Architectural Press: New York, NY, USA, 2008; pp. 214–217.
34. Swaffield, S. Empowering Landscape Ecology-Connecting Science to Governance through Design Values. *Landsc. Ecol.* **2013**, *28*, 1193–1201. [CrossRef]
35. Andersen, I.-E.; Jæger, B. Scenario Workshops and Consensus Conferences: Towards More Democratic Decision-Making. *Sci. Public Policy* **1999**, *26*, 331–340. [CrossRef]
36. Stirling, A. *Direction, Distribution and Diversity! Pluralising Progress in Innovation. Sustainability and Development*; STEPS Centre: Brighton, UK, 2009.
37. Stilgoe, J.; Owen, R.; Macnaghten, P. Developing a Framework for Responsible Innovation. *Res. Policy* **2013**, *42*, 1568–1580. [CrossRef]
38. Guston, D.H. Understanding 'Anticipatory Governance'. *Soc. Stud. Sci.* **2014**, *44*, 218–242. [CrossRef] [PubMed]
39. Wiek, A.; Foley, R.W.; Guston, D.H.; Bernstein, M.J. Broken Promises and Breaking Ground for Responsible Innovation–Intervention Research to Transform Business-as-Usual in Nanotechnology Innovation. *Technol. Anal. Strateg. Manag.* **2016**, *28*, 639–650. [CrossRef]
40. Hoogma, R.; Kemp, R.; Schot, J.; Truffer, B. *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*; Taylor & Francis: Abingdon, UK, 2005.
41. Davies, S.R.; Glerup, C.; Horst, M. On Being Responsible: Multiplicity in Responsible Development. In *Responsibility in Nanotechnology Development*; Arnaldi, S., Ferrari, A., Magaudda, P., Marin, F., Eds.; Springer: Dordrecht, The Netherlands, 2014; pp. 143–159.
42. Wender, B.A.; Foley, R.W.; Hottle, T.A.; Sadowski, J.; Prado-Lopez, V.; Eisenberg, D.A.; Laurin, L.; Seager, T.P. Anticipatory Life-Cycle Assessment for Responsible Research and Innovation. *J. Responsib. Innov.* **2014**, *1*, 200–207. [CrossRef]
43. Nowotny, H. Transgressive Competence: The Narrative of Expertise. *Eur. J. Soc. Theory* **2000**, *3*, 5–21. [CrossRef]
44. Stengers, I. Another Look: Relearning to Laugh. *Hypatia* **2000**, *15*, 41–54. [CrossRef]
45. Wynne, B. Elephants in the Rooms Where Publics Encounter "Science"?: A Response to Darrin Durant, "Accounting for Expertise: Wynne and the Autonomy of the Lay Public". *Public Underst. Sci.* **2008**, *17*, 21–33. [CrossRef]
46. Wesselink, A.; Buchanan, K.S.; Georgiadou, Y.; Turnhout, E. Technical Knowledge, Discursive Spaces and Politics at the Science–Policy Interface. *Environ. Sci. Policy* **2013**, *30*, 1–9. [CrossRef]
47. Lynch, M. Against Reflexivity as an Academic Virtue and Source of Privileged Knowledge. *Theory Cult. Soc.* **2000**, *17*, 26–54. [CrossRef]
48. Dahlberg, L. The Habermasian Public Sphere: A Specification of the Idealized Conditions of Democratic Communication. *Stud. Soc. Polit. Thought* **2004**, *10*, 2–18.
49. Pellizzoni, L. Responsibility and Environmental Governance. *Environ. Polit.* **2004**, *13*, 541–565. [CrossRef]

50. Grati, F.; Biochemtex, Tortona, Italy. Personal communication, 2015.
51. Arca, P. *Cropping Systems for Biomass Production under Mediterranean Conditions: Implantation Techniques and Soil Carbon Balance*; Sassari University: Sassari, Italy, 2017.
52. GovSard. *Protocollo Di Intesa Per La Definizione Di Obiettivi E Condizioni Generali Di Sviluppo E La Attuazione Dei Relativi Programmi Nel 'Sulcis-Iglesiente'*; Office of the Presidency Sardinia: Carbonia, Italy, 2012.
53. Brown, T.C. The Concept of Value in Resource Allocation. *Land Econ.* **1984**, *60*, 231–246. [CrossRef]
54. Bozeman, B. The Privatization of Public Value. In *Public Values and Public Interest: Counterbalancing Economic Individualism*; Bozeman, B., Ed.; Georgetown University Press: Washington, DC, USA, 2007.
55. Voinov, A.; Kolagani, N.; McCall, M.K.; Glynn, P.D.; Kragt, M.E.; Ostermann, F.O.; Pierce, S.A.; Ramu, P. Modelling with Stakeholders—Next Generation. *Environ. Model. Softw.* **2016**, *77*, 196–220. [CrossRef]
56. Cash, D.W.; Clark, W.C.; Alcock, F.; Dickson, N.M.; Eckley, N.; Guston, D.H.; Jäger, J.; Mitchell, R.B. Knowledge Systems for Sustainable Development. *Proc. Natl. Acad. Sci. USA* **2003**, *100*, 8086–8091. [CrossRef] [PubMed]
57. Lovell, S.; Johnston, D. Designing Landscapes for Performance Based on Emerging Principles in Landscape Ecology. *Ecol. Soc.* **2009**, *14*, 44. [CrossRef]
58. Lai, M.; Sardinia Water Agency, Cagliari, Italy. Personal communication, 2015.
59. GovSard. *Piano Regionale Delle Bonifiche Delle Aree Contaminate—Rapporto Preliminare*; Office of the presidency Sardinia: Cagliari, Italy, 2013.
60. Innes, J.E.; Booher, D.E. Consensus Building and Complex Adaptive Systems: A Framework for Evaluating Collaborative Planning. *J. Am. Plan. Assoc.* **1999**, *65*, 412–423. [CrossRef]
61. Cuhls, K. From Forecasting to Foresight Processes—New Participative Foresight Activities in Germany. *J. Forecast.* **2003**, *22*, 93–111. [CrossRef]
62. Fischhoff, B.; MacGregor, D. Subjective Confidence in Forecasts. *J. Forecast.* **1982**, *1*, 155–172. [CrossRef]
63. Barben, D.; Fisher, E.; Selin, C.; Guston, D. *Anticipatory Governance of Nanotechnology: Foresight, Engagement, and Integration the Handbook of Science and Technology Studies*; MIT Press: Cambridge, MA, USA, 2008; pp. 979–1000.
64. Kliskey, A.; Alessa, L.; Wandersee, S.; Williams, P.; Trammell, J.; Powell, J.; Grunblatt, J.; Wipfli, M. A Science of Integration: Frameworks, Processes, and Products in a Place-Based, Integrative Study. *Sustain. Sci.* **2017**, *12*, 293–303. [CrossRef]
65. Selin, C. Negotiating Plausibility: Intervening in the Future of Nanotechnology. *Sci. Eng. Ethics* **2011**, *17*, 723–737. [CrossRef] [PubMed]
66. Roberts, R. Involving the Public. In *The International Handbook of Social Impact Assessment: Conceptual and Methodological Advances*; Becker, H.A., Vanclay, F., Eds.; Edward Elgar: Cheltenham, UK, 2003; pp. 258–277.
67. Felt, U.; Fochler, M. Machineries for Making Publics: Inscribing and De-Scribing Publics in Public Engagement. *Minerva* **2010**, *48*, 219–238. [CrossRef]
68. Voinov, A.; Bousquet, F. Modelling with Stakeholders. *Environ. Model. Softw.* **2010**, *25*, 1268–1281. [CrossRef]
69. Keller, E.F. *Reflections on Gender and Science*; Yale UP: New Haven, CT, USA, 1985.
70. Bardsley, D.K.; Weber, D.; Robinson, G.M.; Moskwa, E.; Bardsley, A.M. Wildfire Risk, Biodiversity and Peri-Urban Planning in the Mt Lofty Ranges, South Australia. *Appl. Geogr.* **2015**, *63*, 155–165. [CrossRef]
71. Dalglish, C.; Leslie, A.; Brophy, K.; Macgregor, G. Justice, Development and the Land: The Social Context of Scotland's Energy Transition. *Landsc. Res.* **2018**, *43*, 517–528. [CrossRef]
72. Leibenath, M.; Otto, A. Local Debates About 'Landscape'as Viewed by German Regional Planners: Results of a Representative Survey in a Discourse-Analytical Framework. *Land Use Policy* **2013**, *32*, 366–374. [CrossRef]
73. Owen, R.; Stilgoe, J.; Macnaghten, P.; Gorman, M.; Fisher, E.; Guston, D. A Framework for Responsible Innovation. *Responsib. Innov. Manag. Responsib. Emerg. Sci. Innov. Soc.* **2013**, *31*, 27–50.
74. Dale, V.H.; Kline, K.L.; Buford, M.A.; Volk, T.A.; Smith, C.T.; Stupak, I. Incorporating Bioenergy into Sustainable Landscape Designs. *Renew. Sustain. Energy Rev.* **2016**, *56*, 1158–1171. [CrossRef]