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The Wicked Problem of Climate Change: A New Approach Based on Social Mess and Fragmentation

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Abstract: The 21st century has been the warmest period on record since 1880, making the problem of climate change a central issue in the global political arena. While most approaches to climate change emphasize setting and imposing thresholds for greenhouse gas emissions, this paper argues that the issue of climate change and its solutions should be viewed in a more dynamic and complex way, involving social messes and the fragmentation of industries and organizations. In this context, learning models can offer a starting point to understand the reasons why organizations engage in certain types of corporate environmental strategies with regard to climate change, and can help in the search for solutions to the problem of climate change.

Keywords: climate change; wicked problem; social mess; fragmentation; learning models; complexity theory

1. Introduction

Climate change is increasingly understood to be one of the most important and urgent problems of our time, one that requires a global, integrated (i.e., mitigations and adaptation) response. Only in this integrated way is it possible to limit the effects of climate change and to achieve sustainable development (as defined in [1]) and social equity, including poverty eradication [2]. According to NASA (National Aeronautics and Space Administration) and NOAA (The National Oceanic and Atmospheric Administration), the year 2015 was the warmest year on record since 1880. According to NOAA, the average global temperature for 2015 was 0.90 °C higher than the 20th-century average of 13.9 °C. This was not only the highest calendar year temperature, but also the highest temperature ever recorded during a 12-month period while 15 of the hottest 16 years have occurred since 2001 [3]. Not surprisingly, this issue has taken a central position in the international political agenda. While the notion that climate change is a global problem is widely accepted, the issue of what to do remains highly controversial, with different disciplines providing a variety of recommendations. As such, it is a problem ripe for future studies, particularly as they relate to ecological modernization and sustainability, in that climate change is 'complex, interconnected, contradictory, located in an uncertain environment, and embedded in landscapes that are rapidly changing' [4] (p. 183). Moreover, the interwoven social, political, and cultural differences across countries make the issue of climate change difficult to address on a global scale.

This paper argues that complexity theory, often considered an extension of general systems theory [5], can offer a valuable foundation from which to examine organizations and their frequent lack of, or inadequate, environmental response. Unpredictable and inconsistent environmental actions by an organization often derive from the organization's inability to decipher the complex problems it faces. Unlike a simple linear, static system, in which the outcome of a certain decision can be predicted according to the observed regular-pattern behavior of the system's component parts, complexity arises when dynamic interactions take place between a number of independent and/or

poorly understood variables. No type of behavior can be distinguished and understood on its own. It is rather unpredictable due to the interrelated actions and reactions of these variables [6]. A complex system consists of hierarchies, each with its own interrelated subsystems. In turn, subsystems have their own complexity due to the dynamic interactions of variables between subsystems, and between subsystems and the overall system [6,7]. Altering any given system often creates a domino effect, setting other actions into motion in unpredictable ways and—most importantly—with unpredictable consequences [8].

The problem of climate change has been increasingly described as a 'wicked problem' [9,10]. The notion of wicked problems is an approach to understanding the dynamics of a major proposed change with multiple and conflicting inputs and multiple possible outcomes, all of which play over time against, or occasionally with, each other. Wicked problems occur at the interface of human/environmental interaction and are characterized by the fact that solutions create a 'plethora of new problems' [4] (p. 183). Rittel and Webber [11] used 'wicked' as a term "akin to that of 'malignant' (in contrast to 'benign') or 'vicious' (like a circle) or 'tricky' (like a leprechaun) or 'aggressive' (like a lion, in contrast to the docility of a lamb)" (p. 160). They [11] based their definition of wicked problems on their previous work in city planning and public policy, where they discovered ill-structured problems featuring complex interrelationships between many social and environmental factors [12]. They concluded that understanding the true nature and scope of complex socio-psychological/environmental problems is both the most important and the most elusive part of the solution-finding process.

The concept of wicked problems has evolved to include a series of characteristics that differentiate this approach from other problem-solving theories [12]. Rittel and Webber [11] note at least ten distinct properties of wicked problems, including (pp. 161–166):

- Wicked problems have no definitive formulation
- Wicked problems have no ends to the causal chains—'no stopping rule'
- Wicked problems do not have 'true-false' solutions, rather 'good-bad' ones
- Wicked problems offer no 'immediate' or 'ultimate' tests for a solution
- Wicked problems mean that every attempt at a solution is consequential
- Wicked problems do not have an 'exhaustively describable' set or series of solutions
- Every wicked problem is unique—having at least one 'distinguishing property that is of overriding importance'
- Every wicked problem points to another wicked problem—each a symptom of another
- Wicked-problem discrepancies can be explained in multiple ways—each 'choice of explanation determines the nature of the problem's resolution'
- Wicked problems pose particular problems for those aiming to resolve them—exempting them from the right to be wrong.

Notably, that solutions offered for the problem only serve to uncover other aspects of the problem that need to be addressed illustrates the extent of misunderstanding and stakeholder disagreement about the true scope of the problem [11]. Whelton and Ballard [13] theorize that this tends to happen because 'different stakeholders view problem formulations and alternative solutions with different performance criteria and value sets' (p. 4) and, thus, judge the potential solutions with different levels of approval. The failure to reach an agreement on the desired outcome further exacerbates the original wicked problem, therefore transforming it into a 'super-wicked' problem [14–16]. This description can be applied to the process of climate change negotiation, including different perceptions of the true extent of the problem, the role and responsibilities of each country in tackling climate change, and the severity of the consequences for economies and societies alike if climate change is not addressed.

To change this unwise behavior, resulting in 'doing the same thing over and over again and expecting different results' [17] (p. 310) and break out of this impasse, stakeholders need concrete reasons, definitely a new paradigm able to explain, objectively, the complexity of the problem.

To offer complexity science [17] as a means to address climate change as a wicked problem, this paper is structured as follows: Section 2 explores climate change as a wicked problem; Section 3 introduces the theory of social mess to examine climate change, while Section 4 discusses the issue of fragmentation in climate change; Section 5 examines possible strategies for finding solutions to the climate change problem; and Section 6 provides concluding remarks.

2. Wicked Problems in Environmental Response

The debate on climate change is inherently political. It takes place in the political arena, is shaped by networks of power, and it is impacted by political maneuverings. These include strategic inconsistency, which are contradictory rules created in the hope of undermining other rules in other agreements; forum-shopping—the selection of an international venue most beneficial to their own policy; and regime shifting, where loyalties are shifted to parallel regimes that will acquiesce in their policy priorities [18]. It can be argued, therefore, that such complexity makes it more difficult to understand causality. This can confound the ability to '[identify] optimal policies and [assign] accountability for problematic decisions' [18] (p. 18).

Fiol and Lyle [19] suggest that organizations need both to learn (develop insights, knowledge, and associations of past actions) and to adapt (make incremental adjustments where required). As both of these aspects seem to be lacking within climate change processes at the present time, the slight interest shown by Parties to the United Nations Framework Convention on Climate Change (UNFCCC) towards the Doha Amendment [20] (which, if entered into force, will establish the second commitment period of the Kyoto Protocol [KP]) seems less surprising, while the ability for any comprehensive policy on climate change may be limited at best.

There has been widespread reluctance to exchange the traditional profit-oriented business model—valued for its history of promoting countries' economic development—for a new business model tied to environmental processes, which may or may not deliver the same level of profitability and economic development [21,22]. It can be argued [23] that a new economic model that integrates ecological modernization and sustainable development offers 'win-win scenarios', and the reluctance on the part of policy-makers to adapt such a model is a discursive failure to recognize, articulate, and press for the potential of these scenarios. On the other hand, as pointed out by Sezgin [24], it can be claimed that ecological modernization represents 'an attempt to green capitalism rather than challenge its environmental contradictions' (p. 241); this is due to different causes, including 'a weaker interpretation of sustainable development, namely an ecological modernization policy strategy [. . .] opted for by major environmental policy actors such as the UN, the OECD and the EU' [25] (p. 240).

One of the main problems that afflicts the current regime on climate change is the disconnect between stakeholders, which include the scientific community, politicians of various countries, large corporations, small to medium-sized enterprises, industries, social activists, consumers, and the media, among others. The various forms of disjunction derive from what both Hoffman [25] and Helm [26] theorize as a lack of shared understanding of climate change as a problem of the roles and responsibilities that organizations must play, and of the potential solutions offered by clean technology. Stakeholders, these authors say, seem to have mixed motives, which depend on how they assess the existing debate on climate change, along with a long-held uncertainty about the consequences of behavioral change. They appear to have difficulty in balancing the perceived value of their current path against changes that may or may not lead to future value [27,28].

Lacking a definitive scope or end-point, which is a feature of tame rationality-responsive problems, a wicked problem receives only cursory attempts at solutions [29]. Stakeholders resort to what Rittel and Webber [11] called 'good enough' measures that seem neither right nor wrong, and which do not necessarily result in any quantitative change to the problem. This was possibly the case during the 2009 Copenhagen Conference, which discussed the Kyoto Protocol and other agreements under negotiation. Stakeholders appeared to believe that the apparently rational linear solution of setting targets for the reduction of emissions and cutting back on the use of fossil fuels are the key means by

which the climate change problem should be addressed. While not necessarily right or wrong, these target-setting imperatives are clearly not working. Moreover, they are not viewed by all stakeholders as an appropriate solution, with some countries even ignoring the targets altogether. In addition, these efforts do not entail the radical changes necessary to tackle climate change on a global, national, industrial, and organizational level.

2.1. Wicked Problems and Linear Rationality

Every wicked problem is unique due to its social complexity and the diversity of its causes, consequences, and constituent factors. Moreover, in attempting to solve a wicked problem, each proposed solution carries with it the risk of creating new problems that may also be 'wicked'—unlike solutions to simplify or tame problems, which may or may not work, but pose no risk of exacerbating the existing problem [11]. A further dilemma is that it is difficult to trace or predict the 'waves of consequences' caused by a wicked problem [13], especially as such problems consist of many complex issues or roots that have become tangled together [28]. The impossibility of understanding the full repercussions of climate change and the impact of each decision at both an organizational and a national level make many stakeholders reluctant to move forward toward proposing or implementing potential solutions.

We can see clearly that wicked problems do not fit comfortably into the customary linear-rational model of science, which takes the straightforward analytical approach of solving problems through cause–effect mathematical equations, or with reference to specific assumed logical–positivist laws. Indeed, the linear model of science may even have contributed to the formation of wicked problems—Batie [29] argues—as a cumulative effect of the technology that has sprung up from linear scientific methodology.

At first glance, since scientific knowledge is necessary for a full understanding of climate change, it might seem sensible to approach the problem from a positivistic scientific approach. The problem of climate change, however, has economic, social, and political ramifications, and relies on behavioral decisions made by countries and organizations (that generate high levels of socially constructed uncertainty), making positivist approaches less appropriate to solve the climate-change problem. Stiglitz [30], for example, contends that effective solutions to the problem of climate change cannot be created by means of equations or parsimonious figures, or indeed, cause–effect linearity. There exists some evidence suggesting that the application of a linear approach to decision-making and negotiations on climate change has repeatedly led to an impasse [31]. Even more problematic is that positivist approaches do not even provide clear answers when modelling different scenarios of emissions' reductions to test their relative effectiveness [32]. Additionally, communicating climate-change knowledge to the public is difficult, and knowledge of climate change does not always translate to human behavioral change [33,34].

Wicked problems have often resulted, in part, from social constructions and conflicting perspectives held by the stakeholders or decision-makers involved in an issue, which lead them to focus solely on their own bounded and situated interests, or to believe that another stakeholder should shoulder responsibility for resolving one or more of the problems which, once connected, form a wicked problem [35]. These competing constructions of the future, which vary according to an organization's or country's socially constructed, performance-criteria value-sets [13], and the different levels of knowledge about climate change create an environment of conflict that simply deepens the underlying divisions between stakeholders, such as [36].

Adding to the dynamic nature of this conflict is the continual temporal variation in the levels of interest, beliefs, power, ability, resources, and intent held by the different countries, industries, and organizations involved. Since the extent of the problem's complexity or 'wickedness' is not yet fully understood, the first step in developing an approach to resolution must be to determine what elements of complexity are truly involved in climate change, while being aware of the inherent bounded or situated rationality that climate change involves.

2.2. Super-Wicked Problems and Climate Change

Over time, the concept of a wicked problem has been further delineated to create a new category: the 'super-wicked problem' [14–16], which displays all of the features of a wicked problem, as previously described, with a few additional traits. Building on the initial definition proposed by Rittel and Webber [11], Levin et al. [15] describe these additional characteristics as follows:

- No central authority holds the responsibility for controlling all of the factors, which contributes to a super-wicked problem.
- The division of responsibility is essential, especially when addressing a problem like climate change, with many choices, perspectives, needs, and alternatives to consider.
- The absence of a central authority to coordinate efforts, respond to queries, and establish the common ground needed to maintain cooperation from all stakeholders results in further chaos and conflict among those involved.
- No single body is capable of enforcing the necessary changes clearly and consistently across all countries, industries, and organizations.

The variety (and variability) involved in stakeholders' understandings of climate change issues, as well as their existing knowledge of the problem from their individual perspectives, calls for a central authority capable of levelling understanding. Aldy and Stavins [31] claim that such an authority is necessary in order to remove the handicap for countries lacking an adequate understanding of the aspects of the problem, thus preventing them from responding effectively. Additionally, this authority could provide individualized research and development programs specifically tied to climate change policy for developing countries. For example, these specialized, systematic responses may be particularly important to ensure justice and equity in designing a new climate agreement [37], especially for less developed countries that have faced, and will continue to suffer, the brunt of climate change consequences in increasingly frequent and severe natural disasters.

Problems defined as super-wicked may have a time-limited option for resolution, and it is widely felt that the world has few options with regard to slowing the pace of climate change. As Levin et al. [15] argue, it is possible that the problem may have become 'too acute, have had too much impact, or, in the case of climate change, owing to the time lag effects of various greenhouse gases (GHGs), be too late to stop or reverse' (p. 8). The crucial point they emphasize is that 'human beings can [. . .] control their behavior to alter their impacts, but they cannot control the response of the natural system once a decision is made' (p. 8). In many cases, these researchers argue, those who seek to solve the super-wicked problem of climate change are at least partly responsible for bringing about some of the factors that have caused the problem. This appears to be a vicious circle, since no matter how hard humans try to avoid damaging their environment, we will inevitably have some adverse impact on it. It is, thus, very difficult to differentiate the 'antagonists' from the 'protagonists' in the climate change debate and negotiation process—an ambiguity that further obstructs momentum toward a clear and common understanding [38].

Social mess and fragmentation are constituents of super-wicked problems and pose, perhaps, the greatest challenges as to how human beings learn and how they process information. It may be the case that these dynamic, fluidly interacting aspects of the wicked problem of climate change are interfering with stakeholders' ability to think through the various interrelated components of the climate change issue, thereby preventing them from addressing the problem effectively. It is important, therefore, and necessary, to define social messes and fragmentation in order to understand how complexity science offers a solution to a future characterized by climate change.

3. Social Mess

The theory of a social mess states that no problem exists in isolation, but is influenced by other issues afflicting society [39]. Social messes, therefore, foreground the part played by social actors, rather

than by objectively identified material issues. In Ackoff's [40] words, 'every [social] problem interacts with other problems and is therefore part of a set of interrelated problems, a system of problems' (p. 423). Simon [41] characterizes these types of problems as ill-structured and lacking well-defined parameters. Social messes have also been described as occurring when 'individuals in interdependent situations face choices in which the maximization of short-term, self-interest yields outcomes leaving all participants worse off than feasible alternatives' [42] (p. 1). Inevitably, narrow self-interest generates harmful side effects and isolation, which can be controlled and compensated by communities or governments, only through well-enforced laws and strict liability legislation [1] (pp. 43–44). This is often seen in countries in which political, economic, and ideological constraints have resulted in a fundamental resistance to change. However, as reported by the Brundtland report [1] (p. 27), the increase of social and ecological stability can be achieved only by abandoning old approaches and past patterns.

Complicating matters further is the fact that social messes originating within particular countries, both developed and developing, have tended to become global problems [43]. To a large extent, this is due to the increase in globalization over the last few decades, which has led to what Ackoff [40] calls a 'systems age'. He argues that countries have become reliant on each other for the goods and services necessary to fuel their own economic development (e.g., as a result of increased outsourcing and foreign direct investment globally), which results in a social mess on a global scale, with the internal social messes of individual countries tangled up together. For this reason, climate change has, itself, been described as a social mess [14] and, insofar as these global problems are connected in ways that cannot be readily identified or understood, the theory of a social mess resembles that of a wicked problem.

Whether occurring at a national or a global level, social messes are invariably difficult to conceptualize. Governments must first address the task of 'designing and managing systems so that they can cope effectively with increasingly complex and rapidly emerging sets of interacting problems in an increasingly complex and dynamic environment' [40] (pp. 426–427). This particular assessment of the situation for both developed and developing countries suggests that governments must find ways to 'serve the purposes of the parts of a system more effectively' [40] (p. 427). This includes the economic, social, cultural, and political components of a given system. This is all the more relevant given that, as Sanderson [44] outlines, institutional complexity often prevents policy-makers from simplifying the dynamics involved in social messes, which could then be more readily addressed through effective policy mechanisms.

It is possible that a more modest approach to social change would prove more beneficial than seeking to tackle the entire social mess of climate change. For example, scholars have recommended that expectations be redirected toward local approaches rather than universal solutions, thereby allowing countries to identify the components of their own problem—the social mess—in order to achieve a better understanding of its global context [45]. This, in turn, requires that the wicked problem of climate change be handled by means of multiple innovative approaches to governance and institutional frameworks, as well as new problem-solving techniques [44]. Andersson, Törnberg, and Törnberg [46] offer their solution of 'wicked systems' that combine theorizing of complexity and complicatedness to overcome recalcitrant approaches to complex future problems such as climate change. Perry [27] insists that 'clumsy solutions', while intrinsically inefficient, provide the way forward (p. 8). Clumsy solutions recognize that conflict among stakeholders is inherent to complex issues and, as such, these solutions incorporate dialogic methods that bring together disparate perspectives in a manner that is at once, adaptive, participatory, and transformative. Finally, governments have been advised to find ways to address their countries' respective environmental contexts as components of an overall system [40]. However, for various reasons, all of which are unique to their respective countries, there may be significant obstacles to overcoming the central problem responsible for the social messes that countries are now experiencing, which is how to balance economic and social needs with environmental obligations.

Looking more deeply into the causes of social messes, it seems that theorists identify a set of complex systems within every country, which has further hindered understanding of certain problems. In essence, they say, each country is dealing with increasing fragmentation at the industry level. The fragmentation of industries is widely held to be among the reasons why specific international agreements on climate change have failed to work. There are too many different types of business structures, and negotiations rarely take a sector-based approach to dealing with climate change [21,45,47,48].

4. Fragmentation

Conklin [12] explains that fragmentation occurs when decision-makers each believe that they have defined the problem correctly to the exclusion of other definitions. As a result, individuals and organizations alike perceive themselves 'as more separate than united, and [. . .] information and knowledge are chaotic and scattered' (p. 1). The fragmented organizations or individuals hold different perspectives. They either show no interest in collaboration, or they fail to realize that their differing opinions prevent them from collaborating [12]. This has been manifested throughout the current international regime's response to climate change. Fragmented information about the real issues involved in climate change, and the extent of its impact, have further divided those involved in the regime due to differences in understanding and agreement [47,49,50].

The lack of shared understanding and commitment may have a number of causes, including a breakdown in communication between stakeholders [12,25]. The outcome, however, as claimed by Bazerman and Hoffman [51], inevitably involves misunderstandings, frustration, and animosity, all of which prevent stakeholders from making progress in addressing or solving a complex problem. Organizations and individuals involved as stakeholders may also be facing 'a cultural condition of resignation, denial and grim determination' that further exacerbates fragmentation [52] (p. 34). This is especially noticeable in situations in which emissions' reduction targets are set for industries. Carbon trading and taxation on industries seem to be an unfair responsibility for both creating and solving the problem of climate change, especially on those industries whose rapid development requires them to deliver on a social and economic level [47,53,54]. Industries and organizations are then obliged to address the problem by meeting identical, pre-determined targets for emissions' reduction, despite their extreme differences in size, technological development, innovation protocols, financial backing, and market share [54,55]. The responsibility for a problem like climate change is spread among many industries and organizations, each of which may be internally fragmented due to a lack of standardized procedures for measuring, monitoring, and comparing the effect of clean technologies available, a common language and financial mechanisms, and—most importantly—the absence of a central authority to create and manage these standardization imperatives [47,53,56,57].

Intrinsic within human nature is the need to bring rationalistic order to all actions and decisions, and to maintain some level of organizational structure within them [12,58,59]. Yet international negotiations have, thus far, failed to bring order to industry and sector-based approaches, or to unite various industries within the same sector, such as those involved in providing electric power to countries around the world [58,60,61]. Instead, the attempts at negotiating emissions targets have furthered the fragmentation already present within the climate change problem, especially as the grounds for setting targets are base-weighted on past emissions. With its implicit apportioning of blame, this approach seems only to have alienated certain countries and industries further [26,48]. As a result, other problems have emerged. Prins and Rayner [49] (p. 5) describe the Kyoto Protocol as the 'wrong instrument' relying on the 'wrong agents' who are exercising the 'wrong type of power', a view shared by Bodansky [62]. If a problem-solving process merely serves the separate agendas of some of its most powerful stakeholders and does not seek to establish significant content and consistent collaborative action, a complex or wicked problem can hardly be addressed, let alone solved, especially if there are no central authorities to put the pieces of the puzzle back together [63].

Despite the positive achievements reached globally during the first commitment period of the Kyoto Protocol [64], overall the KP has been found to be more symbolic than substantive in delivering conditions for countries and industries alike and does not address the considerable variation in the emissions already produced by countries and various industrial sectors [48,65,66]. This shortfall further complicates the efforts to generate an appropriate collaborative environmental response [30,67,68]. Hepburn [54] theorizes that the fragmented and inconsistent approach to complex or wicked problems actually drives stakeholders apart, leading to further fragmentation of the relationships between industries and countries, rather than creating opportunities for collaboration. Thus, in this scenario, these types of efforts to solve climate change ensure that that they remain impossible to solve. However, a more hopeful approach would argue that the issue of climate change opens up 'pluralistic potentials' for future solutions [4] (p. 184).

5. Strategies to Enable Possible Solutions to the Climate Change Problem

This section discusses how to develop possible solutions to the problem of climate change using the idea of fragmentation and learning models.

5.1. Address the Fragments

Seeking ways to redress wicked problems, Conklin [12] argues that addressing the fragments individually—with an emphasis on human learning and interaction—may help to pinpoint areas in which shared understanding can be most likely achieved. The result, Conklin suggests, will be consensus-building at various levels, thereby lessening fragmentation at the industry level, and remedying social messes on a national and global scale, a view shared by Sterman [68]. Fiol and Lyle [19] argue that organizations have choices about how to adjust and adapt to a changing environment and the fragmentation of networks, processes, and systems, since they have the ability to learn from complexity. In the case of climate change, they suggest that it would make sense to dissect the problem by addressing manageable 'chunks' on an individual basis, with the eventual aim of joining these fragments together again and learning from them. Collaborative efforts to solve the smaller issues thus offer a means of untangling the larger problem and reducing uncertainty about the issues involved, which otherwise prove to be a significant cognitive barrier to understanding [69]. In order to address the smallest possible components of the problem, however, it may be necessary, first, to tackle fragmentation at the organizational level within individual firms in a given sector. In this context, learning theory approaches may be appropriate to address the problem.

5.2. Learning Systems

It is important to understand that due to bounded rationality, an idea introduced by Simon [69,70], what one is able to know may be limited. Bounded rationality, he claims, explains the inherent limitations placed upon organizations and individuals with regard to 'knowing all of the alternatives, uncertainty about exogenous events, and inability to calculate consequences' [69] (p. 502). Rationality, he theorizes, is nested within case-specific socio-cultural, economic, and political behaviors and limitations. Essentially, rationality is situated. The very nature of climate change, and its inherent complexity—across not only social, economic, and political lines, but also cultural and global lines—may limit the ability to understand all the processes involved at all times, and across all sectors. The role that bounded rationality plays in how we conceptualize and approach climate change is important when discerning how best to approach it, particularly with regard to learning.

Some level of 'forward reasoning' could be applied to help recognize contingency and alternative outcomes, based on what Levin et al. [15] refer to as 'contingent causal mechanisms and critical uncertainties' (p. 10). The accumulation of knowledge is necessary to shape human and organizational thinking, which require processes of learning, reacting to change and complexity, and developing cognitive ability through learning [71,72]. Given the complex nature of climate change, however, it is often useful to simplify a problem by reducing it to smaller, more readily-digested ideas.

In fact, based on Weber's sociological stratification theory, a group of individuals, communities, or governments can be seen as a multidimensional system, increasingly fragmented and formed by smaller components [73]. These components can then be pieced back together in ways that are both clear and comprehensible, allowing negotiation to take place. Often, as Fisher and Ury [74] recommend, incremental decision-making could be achieved in this way, without the impediments of frustration and conflict.

In the organizational context, individuals seek to impose order, stability, consistency, and clarity on issues that impact their lives. If this is not possible, they attempt to make rational decisions leading to solutions, which themselves yield the desired order, stability, and consistency [72,75]. Even within the loose and frequently complex structure of organizations, individuals continue to seek a semblance of order and meaning framed by their work, role, and level of responsibility [76]. Often, this involves processes of learning by doing or by craft skills, from which employees gain practical understanding of the nature of the problems and how they might be addressed [77,78]. In the context of climate change, small changes, based on increasing knowledge and making rational decisions, permit more complex decisions toward seismic change.

5.3. Reflexivity

In addressing wicked problems, some scholars suggest that there may be other ways in which the learning process might be focused. For instance, basing their theories on cognitive behavioral models (see discussion by Rescher [79]), they refer to the fact that human beings often benefit from thinking processes that exist outside the realm of rationality, namely imagination and creativity, tied to emotional responses or affect. These, as claimed by Rescher [79], have led to innovations and breakthroughs throughout history, which have provided solutions that restore order, stability, and consistency. In relation to complexity theory, he suggests that affective aspects of human thought can be of use in abstract or challenging situations or chaotic environments, producing necessary adaptation.

Building on the potential of the human mind to learn and to expand its diversity of thought and imaginative processes, those looking to solve the cognitive processing shortcomings that perpetuate wicked problems, including climate change itself, also seek to create new models for learning, capable of breaking down the barriers and biases that prohibit freely shared understanding [80]. Such new models include the use of specific functionalities of human thought, like reflexivity, to improve learning capacity, in order to more fully 'reflect upon our actions, intentions, and motives' while, at the same time, noting the fallibility of the human mind in matters of egocentrism and related traits, in order to avoid error and enhance cognitive processing [81] (p. 1145). Climate change and its vast unpredictabilities will force innovation, and reflexivity will be key to ensuring that it can be tackled on a global scale.

5.4. Knowledge Clusters

Knowledge clusters—networks of accumulated knowledge to foster technological innovation—are partly responsible for industry fragmentation that creates difficulties for solving wicked problems. Yet when used in the right way—as part of a learning model—clustering may help disperse learning at a faster rate, building a critical mass from widely varying perceptions of a problem [82]. This is especially evident when addressing starkly different levels of competitive pressure, resources and knowledge, skill sets, technology adoption, innovation, and economic development. It may be possible to build the shared understanding necessary to put the pieces of the wicked puzzle back together [82]. Knowledge clusters also have the advantage of stimulating and levelling social interaction and personal exchanges of information and innovation, which constitute another means of observation and learning [83].

At the organizational level, many organizations seek out knowledge clusters in order to develop their competitive advantage in today's business environment with the understanding that, at present, wealth accumulation most often comes from knowledge rather than from manufactured items [84,85]. The talent behind products and services may hold the real value for current organizations, allowing

them to fulfill their purpose of generating wealth and stimulating the economy. Individuals and organizations alike seek technical innovation, intellectual property, and ideas. All of these are, to a greater or lesser degree, intangible assets, and far removed from a reliance on rational thinking processes. Instead, these are predicated on risk, play, experimentation, and flexibility [83,85,86] that lead, in turn, to adaptation and innovation. Knowledge clusters embedded in rapidly changing landscapes create vast potential to solve climate change. Nowadays, scientific knowledge in tackling climate change is widely accessible. However, its effective use by the concerned policy-makers and corporate managers, who attempt to respond to environmental problems with constitutional actions, is, to a certain extent, limited and challenging [87].

5.5. The Creative Workforce and Tacit Knowledge

Due to the anxiety about the availability of resources necessary to compete in the market or address complex problems, organizations often forget one of their most important existing resources: the creative individuals already within the company [79]. For tacit knowledge to be transferred to the system from these talented and creative individuals, members of the system must be open to receiving it and willing to trust that the knowledge being transferred is useful and valuable to their own understanding of a particular problem. According to Collins [88], this requires an organization, or other group, to adapt its working culture to embrace knowledge from the surrounding environment.

It may be a challenge for organizations to leverage new kinds of knowledge quickly and effectively, especially in light of the current scope and nature of learning. It may also prove difficult to determine which factors facilitate and which ones inhibit the learning process [89]. The concept of tacit skill and craft knowledge presupposes that an individual or organization knows what type of information or knowledge will be most useful in helping them to achieve their objectives. This is especially relevant if the quest for tacit knowledge then leads a person to question the status quo of organizational processes and cultural norms, as individuals and organizations are not always certain what knowledge they need, and indeed, whether change is necessary at all [90,91].

The consensus among many learning theorists, including those referenced earlier in this paper, is that previous models based on linear rationality do not represent the optimal approach to a complex or even wicked problem [92]. Rather, innovation, they claim, comes most frequently from the human mind at moments of pressure, emotion, and imaginative play. The role and use of heuristics, skill development, and sense-making or interpretation, such as the use of scenario-planning or strategic mapping, are vital in responding to a wicked problem like climate change. Organizations would do well to foster the type of human capital required to make complex and compelling solutions for addressing an impending global crisis.

6. Conclusions

Future studies, by their very nature, are dedicated to solving the world's most wicked problems, not least of which concern climate change and ecological sustainability. This paper forwards complexity theory to address the problem of climate change. An examination of the recent research on climate change revealed that it is appropriate to move away from theorizing linear solutions to climate change that simply involve setting targets for the reduction of GHG emissions for each country, industry, and organization, and expecting people to change their practices for the sake of the common good. Theorists and futurists who adopt the notion that climate change can be described as a wicked problem appear to view both problems and solutions in more dynamic and complex terms, involving social messes and the fragmentation of industries and organizations. Thus far, stakeholders involved in negotiations on climate change have reacted to the problem based on a limited, bounded, and somewhat inconsistent understanding of the issues involved. Our objective is to tackle the complexity of climate change by breaking through fragmentary knowledge and learning how to build effective solutions that address the social, economic, political, and scientific complexities that make climate change an impossibly difficult—but incredibly important—problem to solve.

Future research could incorporate the role of social mess and fragmentation more explicitly when analyzing the issue of climate change. This may help produce innovative solutions that policy-makers could implement in collaboration with organizations of developed and less developed countries. While this paper offers a new perspective on how to address the problem of climate change, the discussion of specific solutions is left for future research.

To create momentum towards a shared understanding of climate change, the learning models reviewed in this paper recommend that organizations serve as the starting point for breaking down the problem into smaller components. These components could possibly be addressed through a number of learning techniques that make use of tacit knowledge as an intrinsic part of the cognitive process, essential for gaining new insights into how others perceive the same problem. These learning models are a possible useful starting point for an exploration of learning and its connections with fragmentation and complexity, as they may help to determine the underlying reasons for why organizations engage in certain types of corporate environmental strategy in regard to climate change. Once this has been accomplished, strategies for solutions to address the wicked problem of climate change can, and must, be implemented.

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References

1. World Commission on Environment and Development. *Our Common Future*; Oxford University Press: Oxford, UK, 1987; p. 27.
2. Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Core Writing Team, Pachauri, R.K., Meyer, L.A., Eds.; IPCC: Geneva, Switzerland, 2014; p. 151.
3. NOAA (National Oceanic and Atmospheric Administration): National Centers for Environmental Information. Global Analysis—Annual 2015. Available online: https://www.ncdc.noaa.gov/sotc/global/201513 (accessed on 3 December 2016).
4. Sardar, Z. The namesake: Futures; futures studies; futurology; futuristic; foresight—What's in a name? *Futures* **2010**, *42*, 177–184. [CrossRef]
5. Grobman, G.M. Complexity theory: A new way to look at organizational change. *Public Admin. Q.* **2005**, *29*, 350–382.
6. Simon, H.A. The architecture of complexity. *Proc. Am. Philos. Soc.* **1962**, *106*, 467–482.
7. Williamson, O.E. The economics of organization: The transaction cost approach. *Am. J. Sociol.* **1981**, *87*, 548–577. [CrossRef]
8. Barabasi, A.L. *Linked: How Everything Is Connected to Everything Else and What It Means*; Plume Books: New York, NY, USA, 2003.
9. Head, B. Wicked problems in public policy. *Public Policy* **2008**, *3*, 101–118.
10. Incropera, F.P. *Climate Change: A Wicked Problem*; Cambridge University Press: New York, NY, USA, 2015.
11. Rittel, H.W.J.; Webber, M.M. Dilemmas in a general theory of planning. *Political Sci.* **1973**, *4*, 155–169. [CrossRef]
12. Conklin, J. Wicked Problems and Social Complexity. Available online: http://www.cognexus.org/wpf/wickedproblems.pdf (accessed on 6 May 2016).
13. Whelton, M.; Ballard, G. Wicked problems in project definition. In Proceedings of the 10th Annual Conference on International Group for Lean Construction 10th Annual Conference, Porto Alegre, Brazil, 6 August 2002; pp. 1–11.
14. Lazarus, R.J. Super wicked problems and climate change: Restraining the present to liberate the future. *Cornell Law Rev.* **2009**, *94*, 1153–1234.

15. Levin, K.; Bernstein, S.; Cashore, B.; Auld, G. Playing it Forward: Path Dependency, Progressive Incrementalism, and the 'Super Wicked' Problem of Global Climate Change. In Proceedings of the International Studies Association Convention, Chicago, IL, USA, 28 February–3 March 2007; pp. 1–26.
16. Levin, K.; Cashore, B.; Bernstein, S.; Aud, G. Overcoming the tragedy of super wicked problems: Constraining our future selves to ameliorate global climate change. *Policy Sci.* **2012**, *45*, 123–152. [CrossRef]
17. Espinosa, A.; Walker, J. *A Complexity Approach to Sustainability Theory and Application*; World Scientific Series on Complexity Science, 1755-7453; Imperial College Press: Singapore, 2011; Volume 1, p. 361.
18. Alter, K.J.; Meunier, S. The politics of international regime complexity symposium. *Perspect. Politics* **2009**, *7*, 13–24. [CrossRef]
19. Fiol, M.C.; Lyle, M.A. Organizational learning. *Acad. Manag. Rev.* **1985**, *10*, 803–813.
20. United Nations Framework Convention on Climate Change (UNFCCC). Decisions Adopted by the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol: Decision 1/CMP.8 Amendment to the Kyoto Protocol Pursuant to Its Article 3, Paragraph 9 (the Doha Amendment). Available online: http://unfccc.int/resource/docs/2012/cmp8/eng/13a01.pdf (accessed on 3 December 2016).
21. Newman, J.A.; Anand, M.; Hunt, S.; Gedalof, Z. *Climate Change Biology*; CABI Publishing: Oxfordshire, UK, 2011.
22. Seligsohn, D.; Heilmayr, R.; Tan, X.; Weischer, L. China, the United States, and the climate change challenge. In *World Resource Institute, WRI Policy Briefs*; World Resources Institute: Washington, DC, USA, 2009; pp. 1–19.
23. He, C. *Modernization Science: The Principles and Methods of National Advancement*; He, C., Ed.; Springer: New York, NY, USA, 2012; p. 648.
24. Sezgin, Z. Ecological modernization: A viable option for a sustainable future? *Marmara J. Eur. Stud.* **2012**, *20*, 219–245.
25. Hoffman, A. Climate change as a cultural and behavioral issue: Addressing barriers and implementing solutions. *Org. Dyn.* **2010**, *39*, 295–305. [CrossRef]
26. Helm, D. Climate-change policy: Why has so little been achieved? *Oxf. Rev. Econ. Policy* **2008**, *24*, 211–238. [CrossRef]
27. Perry, J. Climate change adaptation in the world's best places: A wicked problem in need of immediate attention. *Landsc. Urban Plan.* **2015**, *133*, 1–11. [CrossRef]
28. Camillus, J. Strategy as a wicked problem. *Harv. Bus. Rev.* **2008**, *86*, 98–101.
29. Batie, S. Wicked problems and applied economics. *Am. J. Agric. Econ.* **2008**, *90*, 1176–1191.
30. Stiglitz, J. A new agenda for global warming. *Econ. Voice* **2006**, *3*, 1553–3832. [CrossRef]
31. Aldy, J.E.; Stavins, R.N. Designing the post-Kyoto Climate Regime: Lessons from the Harvard Project on International Climate Agreements. In Proceedings of the 14th Conference of the Parties, Framework Convention on Climate Change, Poznan, Poland, 1–12 December 2008; Harvard Project on International Climate Agreements: Cambridge, MA, USA, 2008; pp. 1–36.
32. Monastersky, R. Climate crunch: A burden beyond bearing. *Nature* **2009**, *458*, 1091–1094. [CrossRef] [PubMed]
33. Dulic, A.; Angel, J.; Sheppard, S. Designing futures: Inquiry in climate change communication. *Futures* **2016**, *81*, 54–67. [CrossRef]
34. Kollmuss, A.; Agyeman, J. Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behaviors? *Environ. Educ. Res.* **2002**, *8*, 239–260. [CrossRef]
35. Horn, R.E.; Webber, R.P. New Tools for Resolving Wicked Problems: Mess Mapping and Resolution Mapping Processes. 2007. Available online: http://www.strategykinetics.com/2007/09/wicked-problems.html (accessed on 10 May 2016).
36. Boezeman, D. Understanding the transformation of climate futures. A conceptual framework illustrated with urban adaptation policy. *Futures* **2016**, *76*, 30–41. [CrossRef]
37. Cameron, E.; Shine, T.; Bevins, W. *Climate Justice: Equity and Justice Informing a New Climate Agreement*; Working Paper; World Resources Institute: Washington, DC, USA; Mary Robinson Foundation—Climate Justice: Dublin, Ireland, 2013; Available online: http://www.wri.org/sites/default/files/climate_justice_equity_and_justice_informing_a_new_climate_agreement.pdf (accessed on 3 December 2016).
38. Depledge, J.; Yamin, F. The global climate change regime: A defence. In *The Economics and Politics of Climate Change*; Helm, D., Hepburn, C., Eds.; Oxford University Press: Oxford, UK, 2009; pp. 433–453.

39. Ritchey, T. *Wicked Problems—Structuring Social Messes with Morphological Analysis*; Springer: New York, NY, USA, 2008.
40. Ackoff, R.L. Systems, messes, and interactive planning. In *Redesigning the Future: A Systems Approach to Societal Problems*; Ackoff, R.L., Ed.; John Wiley & Sons: New York, NY, USA, 1974; Volume 10, pp. 417–439.
41. Simon, H.A. The structure of ill-structured problems. In *Developments in Design Methodology*; Cross, N., Ed.; John Wiley & Sons: Chichester, UK, 1984; pp. 317–327.
42. Ostrom, E. A behavioral approach to the rational choice theory of collective action. *Am. Political Sci. Rev.* **1998**, *92*, 1–23. [CrossRef]
43. United Nations Conference on Environment & Development, Rio de Janerio, Brazil, 3 to 14 June 1992. Agenda 21. Available online: https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf (accessed on 3 December 2016).
44. Sanderson, I. Making sense of what works: Evidence-based policy making as instrumental rationality? *Public Policy Admin.* **2002**, *17*, 61–75. [CrossRef]
45. UNEP. Industry Sectoral Approaches and Climate Action: From Global to Local Level in a Post-2012 Climate Framework: A Review of Research, Debates and Positions. Available online: http://www.unep.org/pdf/industrial_sectoral.pdf (accessed on 3 December 2016).
46. Andersson, C.; Törnberg, A.; Törnberg, P. Societal systems—Complex or worse? *Futures* **2014**, *63*, 145–157. [CrossRef]
47. Bodansky, D. *International Sectoral Agreements in a Post-2012 Climate Framework*; Pew Center on Global Climate Change: Arlington, VA, USA, 2007.
48. Cooper, R. *Europe's Emissions Trading System*; Discussion Paper; Harvard Kennedy School: Cambridge, MA, USA, 2010.
49. Prins, G.; Rayner, S. *The Wrong Trousers: Radically Rethinking Climate Policy*; James Martin Institute for Science and Civilisation, University of Oxford; MacKinder Centre for the Study of Long-Wave Events, London School of Economics: Oxford, UK, 2007.
50. Rachlinksi, J. The psychology of global climate change. *Univ. Ill. Law Rev.* **2000**, *1*, 299–334.
51. Bazerman, M.H.; Hoffman, A.J. Sources of environmentally destructive behavior: Individual, organizational, and institutional perspectives. In *Research in Organizational Behavior*; Sutton, R., Straw, B.M., Eds.; JAI Press: Stanford, CT, USA, 1999; Volume XXI, pp. 39–80.
52. Conklin, J. *Dialogue Mapping: Building Shared Understanding of Wicked Problems*; Wiley Science: New York, NY, USA, 2005.
53. Barrett, S. *A Portfolio System of Climate Treaties*; Presented at the Harvard Project on International Climate Agreements; Discussion Paper 08-13; Harvard Kennedy School, John F. Kennedy School of Government: Cambridge, MA, USA, 2008.
54. Hepburn, C. Carbon trading: A review of the Kyoto mechanisms. *Annu. Rev. Environ. Resour.* **2007**, *32*, 375–393. [CrossRef]
55. Gardiner, D.; Portney, P.R. Does environmental growth conflict with economic growth? *Resources* **1994**, *115*, 19–23.
56. Reinhardt, F.L. Bringing the environment down to earth. *Harv. Bus. Rev.* **1999**, *77*, 149–157. [PubMed]
57. Blowfield, M.E. Global warming: Why corporate transformation in response to climate change is not happening. *Bus. Strat. Rev.* **2009**, *20*, 74–79. [CrossRef]
58. Hoffman, A. Climate change strategy: The business logic behind voluntary greenhouse gas reductions. *Calif. Manag. Rev.* **2005**, *47*, 21–46. [CrossRef]
59. Anderson, P. Complexity theory and organization science. *Org. Sci.* **1999**, *10*, 216–232. [CrossRef]
60. International Energy Agency (IEA). *Sectoral Approaches in Electricity: Building Bridges to a Safe Climate*; International Energy Agency: Paris, France, 2009.
61. Stavins, N. What has Copenhagen wrought? A preliminary assessment. *Environment* **2010**, *52*, 8–14. [CrossRef]
62. Bodansky, D. The Copenhagen climate change conference: A post-mortem. *Am. J. Int. Law* **2010**, *104*, 230–240. [CrossRef]

63. Datta, A.; Sommathan, E. *Climate Policy and Innovation in the Absence of Commitment*; Discussion Paper 2011-45; Belger Center for Science and International Affairs, Harvard Kennedy School: Cambridge, MA, USA, 2011.
64. Shishlov, I.; Morel, R.; Bellassen, V. Compliance of the Parties to the Kyoto Protocol in the first commitment period. *Clim. Policy* **2016**, *16*, 768–782. [CrossRef]
65. Sunstein, C.R. Of Montreal and Kyoto: A tale of two protocols. *Harv. Environ. Law Rev.* **2007**, *31*, 9–75.
66. Arthur, W.B. Competing technologies, increasing returns and lock-in by historical events. *Econ. J.* **1989**, *99*, 116–131. [CrossRef]
67. Sullivan, R. *Corporate Responses to Climate Change*; Greenleaf Publishing: Sheffield, UK, 2008.
68. Sterman, J.D. Learning in and about complex systems. *Syst. Dyn. Rev.* **1994**, *10*, 291–330. [CrossRef]
69. Simon, H.A. Rationality as process and as product of thought. *Am. Econ. Rev.* **1978**, *68*, 1–16.
70. Simon, H.A. Bounded rationality and organizational learning. *Org. Sci.* **1991**, *2*, 125–134. [CrossRef]
71. Argyris, C. *On Organizational Learning*, 2nd ed.; Blackwell Publishing: Oxford, UK, 1999.
72. Zollo, M.; Winter, S.G. Deliberate learning and the evolution of dynamic capabilities. *Org. Sci.* **2002**, *13*, 339–351. [CrossRef]
73. Pandey, R. Max Weber's theory of social stratification: Controversies, contexts and correctives. *Sociol. Bull.* **1983**, *32*, 171–203.
74. Fisher, R.; Ury, W. *Getting to Yes: Negotiating Agreement without Giving in*; Penguin Books: New York, NY, USA, 1983.
75. McIntyre, L. *Complexity: A Philosopher's Reflections*; John Wiley & Sons: New York, NY, USA, 1997.
76. Weick, K. Educational organizations as loosely coupled systems. *Admin. Sci. Q.* **1976**, *21*, 1–19. [CrossRef]
77. Arrow, K.J. The economic implications of learning by doing. *Rev. Econ. Stud.* **1962**, *29*, 155–173. [CrossRef]
78. Smith, E. The role of tacit and explicit knowledge in the workplace. *J. Knowl. Manag.* **2001**, *5*, 311–321. [CrossRef]
79. Rescher, N. *Complexity: A Philosophical Overview*; Translation Publishers: New Brunswick, NJ, USA, 1998.
80. Clark, G.L.; Tracey, P. *Global Competitiveness and Innovation: An Agent-Centered Perspective*; Palgrave-MacMillan: New York, NY, USA, 2004.
81. Clark, G.L.; Marshall, J.C. Decision making models of the real world and expertise. *Environ. Plan. A* **2002**, *34*, 1139–1146. [CrossRef]
82. Nee, V.; Ingram, P. Embeddedness and beyond: Institutions, exchange and social structure. In *The New Institutionalism in Sociology*; Brinton, M.A., Nee, V., Eds.; Russell Sage Foundation: New York, NY, USA, 1998; pp. 19–45.
83. Porter, M. Clusters and the new economic of competition. *Harv. Bus. Rev.* **1998**, *76*, 77–90. [PubMed]
84. Teece, D.J. Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strat. Manag. J.* **2007**, *28*, 1319–1350. [CrossRef]
85. March, J. Bounded rationality, ambiguity, and the engineering of choice. *Bell J. Econ.* **1978**, *9*, 587–608. [CrossRef]
86. Teece, D.J. Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. *Calif. Manag. Rev.* **1998**, *40*, 55–79. [CrossRef]
87. Tangney, P.; Howes, M. The politics of evidence-based policy: A comparative analysis of climate adaptation in Australia and the UK. *Environ. Plan. C Gov. Policy* **2016**, *34*, 1115–1134. [CrossRef]
88. Collins, M. Tacit knowledge, trust and the Q of sapphire. *Soc. Stud. Sci.* **2001**, *31*, 71–85. [CrossRef]
89. Polanyi, M. *The Tacit Dimension*; Doubleday: Garden City, NY, USA, 1966.
90. Argyris, C.; Schon, D. *Organizational Learning: A Theory of Action Perspective*; Addison-Wesley: Reading, MA, USA, 1978.
91. Kim, D. The link between individual and organizational learning. *MIT Sloan Manag. Rev.* **1993**, *35*, 37–50.
92. Loftus, G.R.; Oberg, M.A.; Dillon, A.M. Linear theory, dimensional theory, and the face-inversion effect. *Psychol. Rev.* **2004**, *111*, 835–863. [CrossRef] [PubMed]