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Searching for the Logic of Ignoring Earth's Global Physical Conditions

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Abstract
Knowledge deficiencies and ignorance content relating to critical physical conditions of earth in glacial-interglacial cycles are analyzed from the point of view of whether human societies are capable of adapting and dealing with radical climate change in distant future. Amplified Milankovitch theory and canopied earth theory of glacial-interglacial cycles provide conflicting signals, one seeing the current interglacial lengthened by human-induced climate change giving the human societies ample time to prepare for the next glacial and the other seeing the arrival of the next glacial to be independent of human activities and thus posing a supreme risk to unprepared human societies. Foundational analysis indicates little difference between the ancient and modern humans reacting to glacial-interglacial cycles. Both, preoccupied with daily requirements of life fail to prepare to address their knowledge deficiencies of global physical conditions and thus expose individuals and societies to immense risk without adaptive possibilities.

Introduction
Throughout Earth's history climate has varied at times quite abruptly in different time scales associated with different drivers [1]. Abrupt climate change has occurred globally in many locations in Earth's glacial-interglacial cycles, and it is especially pronounced in glacial conditions. Our understanding of glacial-interglacial cycles remains deficient in how the human societies will be affected, how to capture the eyewitness accounts of those that have experienced the glacial conditions and the glacial-interglacial transitions, and how to develop the human motivation to pay attention to events that seem to be in distant future yet the preparation to face them also extends into distant future. The purpose of this paper is to apply the modern and ancient facts to instances of societal reaction under glacial and interglacial conditions including comparative assessment of two theories of glacial-interglacial cycles, the "amplified Milankovitch theory" and the "canopied earth theory" in order to develop a foundational view of human behavior that could be used to better understand why humans have little interest in taking action to address the anticipated challenge of earth's glacial-interglacial cycles. All this is complicated by the fact that current attention is on the human-induced climate change and the danger it would pose to human societies through collapse of ice sheets and rising sea levels. In fact the data collected for glacial-interglacial cycles indicates that the variability in both the glacial-interglacial transitions and the glacial conditions would be orders of magnitude greater than the human-induced climate change, yet at present they do not receive appropriate attention.

The current knowledge of ocean sediments provides the evidence that a change in the strength and structure of ocean circulation directly relates to the variability in the Atlantic meridional overturning circulation (AMOC) and abrupt changes in global climate. Distinct features of abrupt climate change have been identified. The Dansgaard-Oeschger (D-O) events, representing millennial-scale climate variability consist of warm intervals (interstadials) and cold intervals (stadials) with fast onset in the order of years to decades [2-4]. Most important, the D-O events strongly influence the global hydrological cycle on which humans rely for food production [2,5-9].

The Dansgaard-Oeschger cycles, as rapid reorganization of the coupled atmosphere-ocean circulation typify the degree of variability in global climates [10,11]. They are recorded in diverse isotopic, geological and biological records [12]. These records can be interpreted as evidence for linking the past to the present and the future [13].

Associated with the Dansgaard-Oeschger cycles, Heinrich events are iceberg armadas identified with layers of ice-rafted grains left behind in North Atlantic sediments [14]. Heinrich events occur during stadials but are not detected in all of them. While the interstadial and stadial events have a millennial time-scale, the transition between the two occurs within decades or less [15]. It is observed that the stadial-to-interstadial transition is more abrupt [16].

In both glacial and interglacial periods the abrupt climate change is possible. For example, in current interglacial the Medieval Climate Anomaly is an unusual warm period in1000-1100 Common Era (CE) and an unusually cooler climate is the Little Ice Age in 1400-1850 CE [17,18]. Abrupt climate change is also a feature of the transition between glacial and interglacial periods. In the last glacial to interglacial transition, consecutive formations of stadial and interstadial conditions happened with rapid adjustments in each transformation [19,20]. These included Oldest Dryas (19-14.7 ka)), the Bølling-Allerød (14.7-12.8 ka), and the Younger Dryas (12.8-11.7 ka). Table 3 provides a summary view of the abrupt changes already encountered at and around the last interglacial-glacial transition [21,22].

Table 1: Chronology of the past climate events with age unit defined as thousand years (ka) before present (BP), with present defined as 1950 [13].

Holocene	11.65 ka to present
Little Ice Age	1450-1850
Medieval Climate Anomaly	950-1250
Mid-Holocene	~6 ka
8.2-ka event	~8.2 ka
Last Glacial Termination	
Younger Dryas	12.85-11.65 ka[1]
Bølling-Allerød	14.64-12.85 ka[1]
Meltwater Pulse 1A	14.65-14.31 ka[2]
Heinrich stadial 1	~19-14.64 ka[3]
Last Glacial Maximum	~21-19 ka

[1]Rasmussen et al. 2006; Thomas et al. 2007 [23,24].
[2]Deschamps et al. 2012 [25].
[3]Hemming 2004 ; Stanford et al. 2011 [15,26].

To address the abrupt climate change outlined in Table 1 we can adopt two perspectives. First, the reasons for their existence, and second, the impact of these conditions on human societies. The prevailing hypothesis for explaining such variability is the response to freshwater anomalies that cause abrupt reductions of the AMOC, thus creating abrupt cooling [27-33]. For impact of these conditions on human societies, in a later section we will consider the case of the Natufian culture which experienced both the transition into Bølling-Allerød and from there to Younger Dryas and then into Holocene.

Two Theories of Earth's Global Physical Conditions

Amplified Milankovitch theory

In the past million years the glacial and interglacial conditions alternate within a repeating 100,000-year period The widely accepted theory of Earth's climate cycles is Milankovitch theory which sees the cause of the glacial-interglacial cycles in insolation variations because of periodic changes in Earth's orbital parameters [34-39]. The Milankovitch hypothesis points at past climates as a response to periodic variations in earth's orbit and orientation relative to the sun, thus making insolation change a major element in controlling climate [40-42].

Despite its popularity, the theory faces difficulties in explaining the predominant 100 ka periodicity observed in climate cycles [43-47]. Earth's eccentricity varies with a period of 100 ka but the magnitude of that insolation change remains too small to directly produce the climate cycle thus needing other mechanisms to amplify the weak orbital signal that can only function as the pacemaker of the glacial-interglacial cycles [48]. Various "*amplified Milankovitch*" models have been developed to address this problem, for example, through build-up of "excess ice" in the Northern Hemisphere or internal climatic feedback triggers even though the ultimate physical mechanism underpinning the 100 ka periodicity remains elusive and unclear [49-60].

The amplified Milankovitch theory relies on ocean's meridional overturning circulation as the prime cause of climate change, for example, with strong overturning, more heat is transported poleward creating the warmer interstadial [27,61,62]. Yet the calculation of orbital forcing for the future cannot predict the onset of the next glacial period because the glaciation threshold also depends on other factors such as the atmospheric CO_2 concentration [63]. Models that combine orbital forcing and atmospheric CO_2 levels point at the possibility that the next glacial cycle would not happen for about 50 thousand years if the atmospheric CO_2 concentration remains above 300 ppm [64,65]. Atmospheric CO_2 concentrations below the pre-industrial level would make the regular glacial cycle possible [64,66,67]. From this information some conclude that it is "virtually certain" that orbital forcing will not trigger the glacial cycle in the next millennium [13].

Some aspects of Dansgaard-Oeschger events also do not fit the meridional overturning circulation hypothesis [68]. It is observed that the actual freshwater inputs come *after* the abrupt climate transition has taken place [69,70]. This implies that in addition to the possibility of being triggered by freshwater forcing, the Dansgaard-Oeschger events could also arise from spontaneous atmosphere-ice-ocean interactions that would alter poleward energy transport thus creating possibilities for abrupt change [71-75]. If correct, this introduces an additional source of climate risk that human societies would have to face no different than the risk faced in earthquakes [22].

Canopied earth theory

The idea of a "canopied earth" differs from the familiar blue-skied earth in that the Earth has a thin shell of cometary dirt and ice around it. The process for creating a thin comet shell resembles that which creates the meteor showers—earth passing through tiny fragments of cosmic debris left behind by disintegrated comets. The meteor showers create a brief show of light and color in the skies. In contrast, Earth's passage through a comet's larger fragments can create a "comet shell" [76,77]. That the intersection of Earth's orbit with a swarm of cometary fragments would cause glacial-interglacial cycles has not attracted scientific attention, however there are studies that approach such consideration [78].

Given that the amplified Milankovitch theory cannot explain the predominant 100 ka periodicity observed in climate cycles and it needs to be complemented with other models that address this problem through build-up of 'excess ice' or internal climatic feedback triggers, other approaches to explaining the glacial-interglacial cycles have been considered [43-47,49-60].

An unconventional approach to addressing the 100 ka problem proposes a new alternative that attributes the glacial-interglacial cycles to regular variations in the interplanetary dust particles (IDP) [79-81]. In testing this hypothesis Farley used extraterrestrial. He as a proxy of interplanetary dust and identified the 100 ka cycle in sediments at various locations [82-86]. Winckler et al. using the IDP accumulation in deep-sea sediments did not find the 100 ka periodicity implying that either the IDP flux is not the driver of the glacial-interglacial cycles or that the 100 ka cycle in 3He accumulation rate represents some other climate-related factor affecting the sediment redistribution [87-89].

The theoretical models that currently provide a framework for understanding the glacial-interglacial cycles, especially through AMOC, are focused on flow of warm and cold waters within a structure that is very much like today's earth and as such do not consider theoretical possibilities like formation of a thin cometary shell that would radically alter the conceptual, analytical and numerical models currently being used [90].

Humans Experiencing Glacial-Interglacial Transitions

The Mediterranean Levant, about 1,100 km by 350 km from southern Turkey to the Sinai Peninsula, was home to the Natufian culture, foragers, also the earliest farmers. The Natufians, coming out of the glacial world of foragers played a major role in emergence of the early Neolithic farming communities, creating the base for the agricultural revolution [91-96].

The three Early, Late, and Final phases of Natufian culture existed in sequence from 14,900 to 11,750 ka and experienced radical climate change in both Bølling-Allerød and Younger Dryas [97-99]. In the glacial world before Bølling-Allerød, humans, plants, and animals were squeezed together into limited refugia and the Mediterranean Levant was one of the areas in which wild cereals were common during glacial times.

The interglacial-like climate of Bølling-Allerød interstadial was a major shift in global climate and favored sedentism, population growth, and with it the formation of village and the beginnings of agriculture as it enhanced the growth of C3 plants which the Levant world of foragers had previously relied upon in the glacial world [96]. The opportunities for amplified exploitation of cereals led to the emergence of the Early Natufian culture [100,101]. But the transition from Bølling-Allerød to glacial conditions of the Younger Dryas stadial brought climatic deterioration that altered the availability of plant and animal resources and transformed the Early Natufian culture into Late Natufian focused more on conservative behaviors that maintained the established strategies than taking risks in pursuit of innovations [99]. As such, the Late Natufian differed in important aspects from the Early Natufian. There was a return to more mobile ways, a decrease in manufacturing ornaments, and an increase in group and secondary burials with little or no burial gifts. This especially became more pronounced in Final Natufian culture that followed the Late Natufian [102].

On the positive side, it is possible that the hardship of the transition from warm interglacial to cold glacial and the corresponding reduction in resource availability became the trigger to switch the Natufian focus from cultivation of wild cereals to crop domestication [99]. The data of this transition can also be interpreted as a strategy of broadening the plant diet to compensate for lost resources [103].

The transition from a world of foragers to Early Natufian culture in Bølling-Allerød and from there to Late Natufian in Younger Dryas takes shape through decisions humans make about the path that best suits the base from which they start and the target they intend to reach [104]. In the small Natufian community human action originated at social decisions. In face of decreasing yields of wild cereals, the decision in favor of intentional cultivation entailed the reorganization of the division of labor and its pattern of application at different times of the year. The target set as a stable supply of food and its associated population growth would only succeed if conditions similar to Bølling-Allerød returned. It is through this process of decision making that the Late Natufian culture transformed into the early farming communities-the Pre-Pottery Neolithic A (PPNA) and they in turn as descendants of Natufians flourished to become the Pre-Pottery Neolithic B (PPNB) [105]. The PPNA people were a complex of "proto-farmers" and hunter-gatherers, but the PPNB were the full-fledged successful farmers with domesticated animals [102,106]. Such transformation points at culture as being a way of knowing and a pattern of behavioral adaptations based on accumulation and transmission of observations and social learning [107-110].

The transition between these cultural entities was not continuous and always included breakdowns and major ruptures as shown in the chronology of Table 2.

Table 2: Chronology Of Natufian Cultural Community Age Unit Defined As Thousand Years (Ka) Before Present (Bp), With Present Defined As 1950

Holocene	11.65 ka to present	PPNA (12,175-11,000 ka) and PPNB (11,625-8,450 ka) cultures—descendants of Natufians continuing and connecting to the present by transformation to other sociocultural entities[3]
Younger Dryas	12.85-11.65 ka[1]	Early Natufians (14,900-13,700 ka), Late Natufians (13,500-12,750 ka), Final Natufians (12,500-11,750 ka)[3]
Bølling-Allerød	14.64-12.85 ka[1]	
Last Glacial (Heinrich stadial)	~19-14.64 ka[2]	World of small groups of foragers and hunter-gatherers

[1]Rasmussen et al. 2006; Thomas et al. 2007 [23,24].
[2]Hemming 2004; Stanford et al. 2011 [15,26].
[3]Goring-Morris and Belfer-Cohen 2011 [98].

Various pieces of a previous culture always realigned to form the new one. It is important to note that in the cultural decision making process the one dying and the one being born always took shape through sharing the knowledge of key aspects the cultural complexes acquired and constructed in the past, transferring crucial traits from predecessors. This resembles representing "generational links within an extended family rather than a simple grandfather-son-grandson chain" [97]. It raises the question of the extent to which the knowledge of key features of the Bølling-Allerød and Younger Dryas worlds were transmitted to future generations all the way to current times. We cannot answer that question, but in one instance we can point at a very unusual piece of knowledge of the glacial and interglacial worlds given to us by Egyptians through Herodotus as one such possibility. This implies that it was not just "people or ideas that moved and dispersed from one area to the next." It was both, especially in a dynamic mix of agriculturalists, hunter gatherers, and forager-farmers where the geographic distances were very small [97].

Ancient humans observing and recording the glacial-interglacial transitions

Given the fact that in the glacial-interglacial cycles a transition is not singular (Table 3), and there can be multiple short-term changes in glacial and interglacial conditions before one ceases to exist and the other becomes dominant, would it allows humans multiple possibilities to observe and record key aspects of the events associated with each condition?

Table 3: Alternations in glacial and interglacial conditions in the last transition with age unit defined as thousand years (ka) before present (BP), with present defined as 1950 [111].

Holocene	Interglacial	11,500 ka to present
Younger Dryas	Glacial	11,500-12,650 ka
Bølling-Allerød	Interglacial	12650-14700 ka
Last Glacial	Glacial	14,700 ka and earlier

It is from this perspective that we arrive at an intriguing example where Herodotus reports that the Egyptians-very distant relatives of Natufians-had observed and recorded four reversals in the direction of sunrise and sunset in a time period stretching to about 14,000 years before present [112]. This information contends to have originated from the time when human groups resembling Natufians and their descendants roamed the landscape. Can we rely on this information as a genuine observation of the features of the glacial-interglacial cycles?

Here is what we know about Herodotus. He sought to gather information and he felt "an obligation to report reported to him (7. 152.3), to record what all manner of people just as they told it (2. 123.1), although he may not believe" [113]. And this is also why his research does not always produce a single account and includes variants that differ and yet they are all recorded and reported in full. In our case of interest there is only a single account of the reversal in the direction of sunrise and sunset in a time period of about 14,000 ka. The Egyptian priests are made responsible for this information [114]. Herodotus only reports what the Egyptian priests have told him.

The scholarly reaction to this piece of knowledge is varied and includes: Herodotus is engaging in a conversion, just listening to the Egyptian priests [115]. Herodotus does not necessarily believe the information but feels obliged to record it anyway and moreover the priestly titles were borne by many people who knew little about the country's ancient history [116]. And, one "need not be very acute to perceive that we have here another instance of carelessness or want of understanding" [114].

The rejection of ancient knowledge can be direct or subtle. For example, the concept of "no-analog world" claims that each climate is unique and therefore no analog can be found between past, present, or future climates, thus "when analogs from the past no longer seem to apply, what role is left for history and historians?" [117]. This logic originates in the observation that today's knowledge, reflected in scientific models, cannot predict the plant communities that have been discovered to exist in the late-glacial world [118]. This may sound correct, but in fact is a recognition of "ignorance content" of current models.

Every aspect of human life, including the scientific models, are composites of knowledge (what we know) and ignorance (what we do not know) [104]. Pointing at the ignorance content of a model-that it cannot account for certain observed features-cannot be used to conclude that the knowledge of the past has no relevance to understanding the present and future. It is true that a "piece of ignorance" does not have relevance to anything anytime, but that cannot be extended to include "pieces of knowledge" that arrive from the past.

The no-analog type of reasoning often originates in a lack of understanding that every aspect of human life is a composite of knowledge and ignorance-a mixture of things we know and do not know. In general the ignorance content of climate change manifests in two forms. First, the recommendations to act are based on anticipated changes that may reverse, thus making the action already taken obsolete and a waste of resources. Second, the probability and timing of such events "remains fundamentally unknown" [119]. From the point of view of glacial-interglacial cycles it is clear that they might fluctuate, like Bølling-Allerød, Younger Dryas, Last Glacial, and Medieval Climate Anomaly, but it is definite that they will happen [36]. The key unknowns are the timing and the effects of impact on currently agriculture-based societies developed under the interglacial conditions.

So, were ancient humans capable of observing, recording and reporting the key features of their rapidly changing environment? We are left with the position of assessing whether or not the information transmitted through Egyptians on reversal of sunrise and sunset direction produces a theory of glacial-interglacial cycles that complements the currently dominant amplified Milankovitch theory. The canopied earth theory of glacial-interglacial cycles provides that alternative view that starts with amplified Milankovitch theory and adds the information from ancient sources that claim to have observed the past transitions and are reporting on what they saw Together the two theories provide a composite of modern and ancient knowledge critical to understanding the Earth's conditions critical to preparation opportunities to create and maintain resilient human societies [78].

Why Do Humans Ignore Earth's Global Physical Conditions? Methods of seeking solutions

In human societies the ultimate solution for any problem is the use of concentrated brute force, namely the police and the military in order to dictate the desired human behavior that would take care of an existing problem [104]. It is from this perspective that militarization of climate change is viewed as a viable solution and the example of military mobilization in the second world war is offered as how the society can behave in relation to climate change in rapid and massive change [120-122]. This view assumes that like war the militarization will make the climate change appear as direct and immediate threat. The assumption breaks down because first, unlike the enemy's weapons, climate change, at present, is abstract and distant and moreover, any concern is dampened by human conditioning that sees it as "extreme weather" and thus a "natural" aspect of life.

Following the solutions based on "brute force" management, the next foundational step is "knowledge management" and it requires the formation of "many-agree positions" if the society is to align itself with the knowledge-based solutions to climate change [104]. One example of such knowledge management is geoengineering through which humans gain the control of climate [24]. For example, a volcano sends vast quantities of particles into the atmosphere which block the sunlight and cool the planet. Replicating the volcano conditions by sending vast quantities of sulfates into the atmosphere would be a geoengineering solution to counter climate change and thus reverse the global warming [123]. In principle this is no different than modifying earth with construction of a road to get from point A to point B. It will be done if the society can create a many-agree position to do so.

All many-agree positions transform into all-agree positions-the laws-once they are backed by society's concentrated brute force. This indicates that the knowledge management approach also declares brute force as the foundational essence of societal action either in direct form through militarization or indirectly through force-backed many-agree positions that turn into laws that everyone must obey [104]. Under emergency conditions, the law can even originate at "force-backed few-agree positions" that the society's leaders develop. The force-backed few-agree positions—in effect dictatorial declarations—require no involvement of the masses to create a many-agree position and as such this methodology has close parallels to militarization and declaration of war.

A good example of formation of many-agree positions and whether they get transformed into laws or fizzle out to become either few-agree positions or many-agree positions that are simply ignored is the case of nuclear weapons [124]. In early 1980s the massive protests to stop the nuclear war were based on the many-agree position of urgency to prevent a nuclear war that would destroy human civilization and end human life on earth [125]. Everyone had a pragmatic understanding of what the exposure to intensely concentrated brute force, like the nuclear weapons, would do to humans and as such framing the issue was simple [126]. The issue was strengthened when new studies showed that the dust and smoke thrown into the upper atmosphere by nuclear explosions would block the sun, lower temperatures and create a "nuclear winter" that would bring human societies close to extinction. This brought the effects of applying the intensely concentrated brute force closer to everyone's daily life. Then in 1989 came the end of the cold war and the many-agree positions on nuclear weapons faded and disappeared.

The key observation here is that the danger had not disappeared and only pushed back into the future. That alone undermined the many-agree position opposing the nuclear weapons. From this perspective the climate change is like a many-agree position that never forms because according to current knowledge it is pushed into really distant future. This behavior permeates all social and governmental structures. In general they are only act on issues, concerns, and needs that take place within a time horizon of less than five years [127]. Anything longer can be ignored.

Action dictated by ingrained behavior

Sudden radical change or expectations of sudden radical change are not new to humans and their societies. Asteroid impacts and major volcanism are well-known examples of such events. They have happened in the distant past and are expected to happen in the distant future.

The current knowledge of glacial-interglacial conditions points at "precipitation" as the factor that can radically affect food production and at local levels the precipitation effect is most unpredictable [127]. Yet instead of a focus on "precipitation" we often come across arguments that blame the climate problem on current factors such as overpopulation, overconsumption, and overexploitation [128]. Such view endures even though it misses the reality that everything humans make and use, including all ideas and outcomes, are "knowledge-packets" that change as human knowledge changes. The argument also misses the fact that all problems and deficiencies reflect the "ignorance content" of knowledge-packets which humans as converters of ignorance to knowledge are maintaining or are incapable of addressing because of the ignorance already incorporated into the knowledge-packets through previous actions [104].

In the interglacial-glacial transition the key knowledge-packet is food. Food is directly related to patterns of precipitation. "No civilization can avoid collapse if it fails to feed its population" [128]. Starting at the Natufians, for millennia the human societies have been building their societies on the foundation of agriculture, a knowledge-packet in tune with the interglacial conditions but not so when the glacial conditions return. That is the case because human societies have not incorporated the knowledge of glacial conditions into the knowledge-packets they create and use on a daily basis. There is little recognition that "agriculture" as we know it in the interglacial condition may not be possible in the glacial condition [129].

So what is the alternative behavior that would bring focus to precipitation and food as the foundational issue in climate change, especially in glacial-interglacial transitions? Since humans always tend to align their behavior with brute force or the threat of exposure to brute force, is that the path to be taken? Ehrlich and Ehrlich do not see an effective solution originating in knowledge seeking and knowledge processing that would improve the knowledge-packets humans make and use [128]. Instead they propose reliance on "pressure" to create the new many-agree positions suitable for addressing climate change. "Without significant pressure," they argue nothing will move fast enough. But "pressure" directed at humans is always felt at three levels: resource management, force management, and knowledge management. Consider the operational aspects of each.

Force management can come through direct application of brute force, but in human societies often manifests as the network of many-agree positions and all-agree positions. The all-agree positions-the rules and laws-are many-agree positions that are backed by societal concentrated brute force to make them all-agree. While resource management can also be handled through brute force, in human societies it primarily manifests as "exchange-based resource taking." Every human is a "resource taker" and would only consider giving and receiving the knowledge-packets (especially those known as goods and services) that improve one's resource position [104]. Knowledge management manifesting through knowledge seeking, knowledge processing, and knowledge sharing, a process that "converts ignorance to knowledge" to improve the knowledge-packets that humans need in daily life. It only happens within the context of a functional force network and a balanced structure of exchange-based resource taking.

Almost all resources that individuals and societies possess are already deployed in creation and maintenance of knowledge-packets that humans need in daily life. To redirect part of those resources to "climate change" means giving up on some of the knowledge-packets that one already makes and uses. It is this aspect that Ehrlich and Ehrlich incorrectly characterize as a "psychological barrier."

Human behavior as force applier, resource taker, and knowledge processor is foundational to human existence and for addressing any aspect of human life including the knowledge-packet we refer to as "climate change [128]."

Time horizons, the collective, and societal collapse

Given the short-term view of both individual and institutional arrangements on resource commitments to rapid and abrupt change of any form, is knowledge processing to understand the behavioral dimension critical to development of adaptation strategies that require a very long term-centuries or in the extreme millennia-view of resource investments? If that does not happen, the ignorance content of anticipatory actions will trump any action and return the individual and society to the present and to the short-term time horizon of months and years [130].

The knowledge processing to reduce the ignorance content of both the anticipated future and the external forcing, at minimum, has to include a continual global commitment to "processes of signal detection, evaluation, decision and feedback" [131]. Yet, how can this happen when almost all resources are currently committed to maintenance of current conditions and little would be or can be directed at improving the understanding of future conditions especially from the point of view of external forcing? The knowledge processing view—focused on conversion of ignorance to knowledge—starts with the contention that "we have not studied nor understood sufficiently the way in which climates and societies interact with each other, over the time-scales concerned and in view of the evolving anticipation of the changes in climate that lie ahead of us" [119]. Would knowing that alter how humans currently process knowledge, apply force, and take resources?

To motivate humans to alter their way of managing force, resources and knowledge, the specter of climate change has been used to blame various instances of societal collapse when in fact all societal failures have their origin in "ignorance management." Societies that cannot convert ignorance to knowledge in key areas of their existence, especially in food production would fail to exist. The search for the underlying causes of climate change can see both agricultural production and climate change as factors in societal catastrophes but cannot see the causal ignorance at the foundation of those factors [132-134,104].

While knowledge processing is the preferred method of resource management, the backup alternative for managing resources is always brute force [104]. At minimum, if the climate effect on agriculture is profound and every society is caught unprepared and its institutional capabilities is overwhelmed and as a result the resource scarcity is exacerbated, it would set the path toward brute force confrontations [135]. Any rapid, globally adverse condition would create a complex wave of migrations within and between countries, setting migration as an agent of further conflict [136]. Thus, it should be obvious that ignorance-filled knowledge processing with respect to food production and climate change would result in brute force confrontations and create the potential for societal collapse [137,138].

Each and every aspect of human life originates at shared capabilities of millions of other humans. At the foundation the human life is based on the "societal capability sharing system" [104]. This is not a new observation. Adam Smith observed the same, saying "Every part of his cloathing, utensils, and food has been produced by the joint labour of an infinite number of hands" [139]. Instead of "societal capability sharing system" we often encounter the concept of "commons." The societal capability sharing system's relationship to climate change is clear. How are we to understand the "commons" in relation to climate change?

Climate change demands management of Earth as a common pool of resources for human societies. In current resource taking structure no one owns Earth and as such, even though everyone owns and uses a piece of it to exclude all others from that piece, there is no incentive in taking care of the whole. This phenomenon is characterized as the tragedy of the commons and involves two problems of "open access" and "free ride" in a society of resource takers where every opportunity for taking free resources is acted upon without consideration of consequences to Earth that no one owns [140].

This behavior originates at the "ignorance content" of how humans deal with Earth as a resource. Humans have a low knowledge of Earth's foundational features and even though they are often surprised by its problems, they cannot relate to participating in a common solution to address them [141]. As resource takers, the only aspect of life to which humans pay attention is where they can declare a resource their property and exclude others from accessing it. It is from the resource taking and property making perspective that the typical human reaction toward global issue of climate change is summarized at: "Why bother, if nothing will come of the knowledge?" [141]. In the prevailing societal structure where exchange-based resource taking rules, unless the human can take resources from Earth or other humans, there is no motivation to act and get involved.

Another aspect of the commons is that even though it might be degrading, humans do not see it as a problem. Here the human as "knowledge processor" complements the human as "resource taker." Through knowledge processing humans have always adapted to a variety of problems and situations. Thus, the popular solution: "Let's wait to see what happens" [141]. Any consideration of a solution would demand efficient use of resources and minimum resource taking from the individual. The pressure of minimization of resource taking from the individual permeates the institutional structures and further slows down the search for a solution and its implementation. If the problem, regardless of its seriousness, does not have a solution-meaning minimal resource expenditures matching the available resources-then ignoring the problem and pushing the solution into the distant future becomes the plausible alternative in a society dominated by humans as resource takers. This type of "motivated disbelief" stems "not from a failure to see solutions but an aversion to the solutions proposed" [141]. This is why the flow of knowledge and human action almost always align themselves with the societal force network and the resource taking processes. The knowledge not aligned with the force network and resource taking processes dies out [104].

In this view of human orientation toward climate change, it is important to note that the largest resource takers on earth are governments and corporations. Among corporations, the ones engaged in extraction and consumption of fossil fuels generate immense amounts of wealth-resources taken and accumulated. To increase and preserve their wealth they are most active in climate change denials based on motivated disbelief. This amounts to social construction of reality as a composite of promoted high-knowledge-content wealth-making positions and pushed-aside-and-ignored high-ignorance-content wealth-consuming positions even if with conversion of ignorance to knowledge a current high-ignorance-content position can become the solution to climate problems [142,143]. From this perspective, reality is the "world of knowledge-packets" that humans construct and use in life. Each knowledge-packet has its own ignorance content and the human preference for any knowledge-packet is determined primarily by the many-agree and all-agree positions that one chooses to emphasize in life [104].

Conclusion

How can we compare Natufian humans to today's humans when facing the glacial-interglacial transitions? The PPNA villages of 150-300 people cultivating plants [144] grew out of the Natufian communities of about 75-100 individuals [106] and they in turn had their origin in the small-scale, mobile foraging, hunter-gather communities of about 25 people [145]. Why are these numbers significant? They are significant from two perspectives. First the amplification of population size is a function of "agriculture-based societies" as evidenced by the size of today's cities as typical human communities. Second, we have to become aware of the reality of "point of no return" when considering the population growth in the transformation from glacial to interglacial lifestyles [94].

The size comparison of foraging and hunter-gatherer communities with agriculture-based cities reveals that when the climate goes glacial, there is a no point of return to adaptation through formation of small mobile groups. The small foraging groups could use agriculture as means of becoming humongous cities, but in absence of agriculture, humongous cities cannot revert back to small, mobile foraging groups, thus the "point of no return." Along this line of reasoning the assumption that after any destruction caused by interglacial to glacial transition the cities will regenerate and like a phoenix will rise from the ashes is not the alternative humans should entertain as the target for managing the transition between the glacial and interglacial conditions [146]. At present the alternative of "preparation" to avoid city destruction in the interglacial to glacial transition has not been considered. The key aspect of preparation is the development of the type of agriculture that fits the glacial conditions.

The same contrast and conclusions can be derived from comparison of Earth's population. Compared to today's agriculture-based population of 7.5 billion, the estimates for Earth's Pleistocene population that existed through foraging and hunting are in the range of 125,000 [147] to 500,000 [148] roughly reflecting a measure of how the Earth's glacial-interglacial conditions would determine and influence the pattern of human adaptation and the resulting population densities.

There is another significant point originating at the comparison of the two theories of climate change. The amplified Milankovitch theory assumes that except for the extent of the ice sheets, the glacial earth would be largely similar to the interglacial earth and if there are any dissimilarities, the human-induced increase in greenhouse gases would lengthen the current interglacial and thus allow ample time to recognize and react to those differences [13,64,65,149-152].

The canopied earth theory uses the same scientific information as amplified Milankovitch theory but adds the ancient knowledge of observed features of the glacial- interglacial worlds and transitions [153]. One ancient observation states that the glacial and interglacial transitions include a reversal in the direction of sunrise and sunset [112]. This cannot happen without the formation of a thin shell of cometary material around the Earth. In contrast to the amplified Milankovitch theory that sees the current interglacial extended by as much as tens of thousands of years and human societies having ample time to deal with the glacial conditions when the glacial world arrives, the canopied earth theory declares that the arrival of the glacial world is only dependent on the mechanism that creates a thin cometary shell around the Earth and it is independent of any human-induced changes to the atmosphere [78]. This implies that the current interglacial will not be lengthened and since Earth is at the back end of the current interglacial, the human societies would remain unprepared and thus unable to adaptively respond to the glacial conditions when the glacial world arrives suddenly.

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