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Philosophical, institutional, and decision making frameworks for meeting obligations to future generations

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A B S T R A C T

Humanity needs to become more futures-oriented to address global catastrophic and existential risks, create sustainable societies and economies, and achieve its most laudable and worthy goals. Seminal work by Bell and Slaughter is cited to answer the question about why current generations should care about future generations. A new set of twelve obligations that current generations have to future generations is presented that reflects contemporary threats and issues. For example, this set explicitly communicates that current generations have an obligation to reduce threats of human extinction from a combination of risks such as climate change, pandemics, and nuclear war. It is also argued that current generations have an obligation to be stewards of what is means to be human and what the very nature of nature is against advances and unwitting implementations of emerging technologies. It is argued that current generations also have obligations to protect human knowledge from being lost over time and generating new knowledge to support survival into the distant future. A new institution, the Intergenerational Panel on Obligations (IGPO), is proposed to measure how well the obligations are being met. A second new institution, World Court of Generations (WCG), is proposed to judge whether current generations are meeting their obligations to future generations and if not, what level of actions are needed to rectify matters. The Obligations to Future Generations Protocol (OFGP) would be negotiated amongst the countries of the world and other public and even private sector stakeholders to assign responsibilities for action. Leadership from the futures community and others is needed to overcome the many socio-cultural barriers to implement these frameworks and establish these proposed institutions.

1. Introduction

Humanity needs to become more futures-oriented. We need to explicitly recognize, internalize, accept and embrace the fact that spaceship Earth will be our only home for the next tens of thousands of years, if not millions of years. We need to have longer-term perspectives with respect to many current and potential risks that face humanity and life on earth. We need to be able to implement solutions to these problems that may require many years of unwavering effort. We need to practice responsible foresight and make decisions that mitigate risks that could impact generations of humans before cataclysmic crises hit.

The list of problems facing humanity is long and well-known and includes: terrorism, energy shortages, flu pandemics, HIV/AIDS, air and water pollution, water shortages, soil erosion, starvation, drought, species extinction, and forest fires. One should add emerging threats such as the hacking of key computer and telecommunication systems and release of genetically modified organisms into the environment. Simply overusing and exhausting resources poses threats to civilization (Diamond, 2005). A small but more

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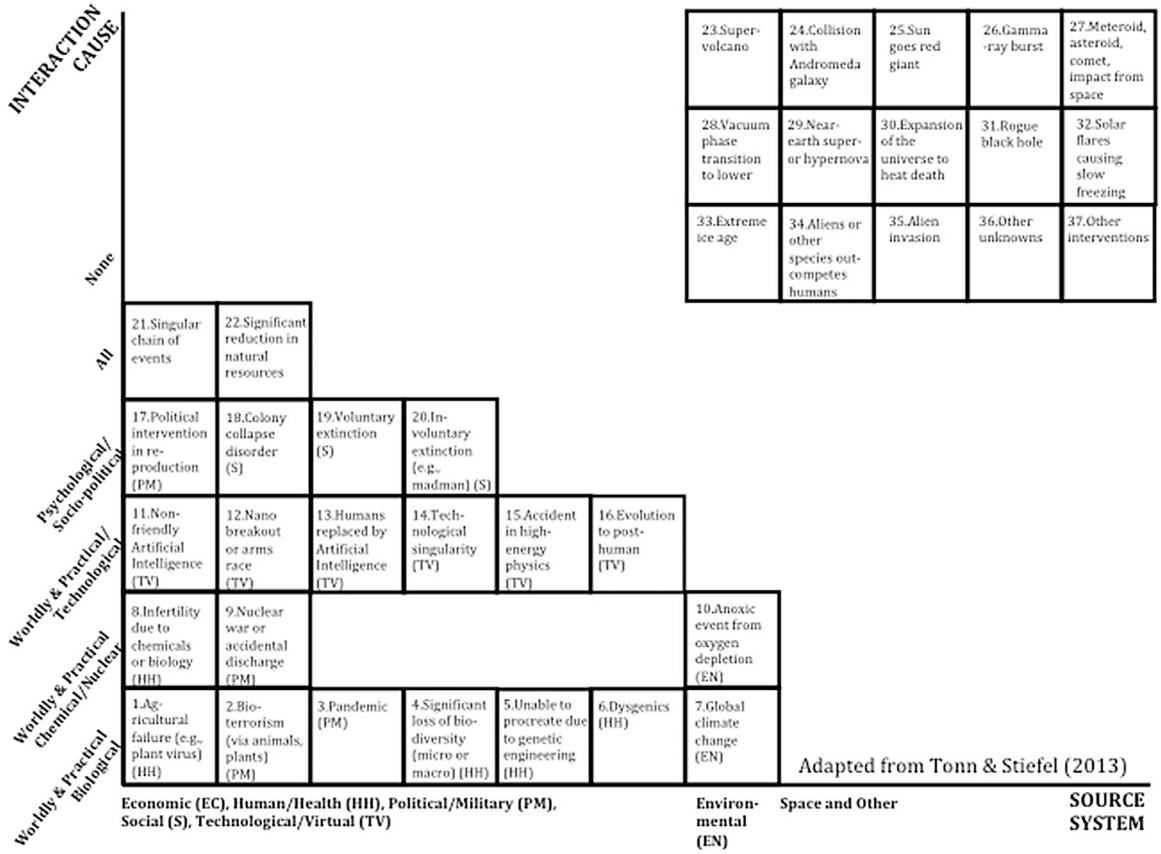

Fig. 1. Existential Risks Facing Humanity.

potent set of risks can result in global catastrophes (Baum & Tonn 2015; Coates, 2009; Posner, 2004). The set of catastrophic-scale events includes: nuclear war (Baum, 2015), global climate change, massive volcanic eruptions, famine (Denkenberger, 2015), and collisions with near-earth objects (Bostrom, 2002; Leggett, 2006; Matheny, 2007). Last but not least is the set of potential exotic catastrophic events, which includes: out-of-control nanotechnologies (i.e., the grey goo scenario) (Joy, 2000), the emergence of threatening super computer intelligences (Bostrom, 2014; Vinge, 1993), bombardment of earth by deadly gamma rays emanating from explosions of super novae (Dar, 2008), and the creation of tears in the fabric of space–time caused ever more powerful high-energy physics research machines (Busza, Faffe, Sandweiss, & Wilczek, 1999; Dar, De Rujula, & Heinz, 1999). Fig. 1 graphically illustrates these and other existential risks to human existence.

Because of the perceived weight of these threats, many believe that the situation facing humanity is extremely dire (Horton, 2005), so dire that human extinction not only seems quite possible but also very probable. For example, Rees, 2003Rees (2003) puts the chances of human civilization surviving another 100 years to be just 50–50. Bostrom (2002) argues that the imminent chances of human extinction cannot be less than 25%. Leslie (1996) estimates a 30% probability of human extinction during next five centuries. The Stern Review conducted for the United Kingdom Treasury (2006) assumes probability of human extinction during next century is 10%. In a special issue of Futures, Morgan (2009), Lopes et al. (2009), Carpenter and Bishop (2009), Bainbridge (2009), Jones (2009), Goux-Baudiment (2009), and Tonn & MacGregor (2009a) all presented human extinction scenarios. In the overview for this special issue, Tonn & MacGregor (2009b) opine that because humans are so adaptable, the probability of human extinction is probably very low but could still exceed an ethical threshold.

Being more futures-oriented requires better decision making. To achieve this goal requires better foresight methods and processes, and more sophisticated techniques to deal with the high levels of uncertainty that plague long-term decision making. However, it is argued herein that overcoming these technical challenges is only a small part of the solution. It is vitally important that futures-oriented decision making embraces ethical values with respect to why current generations should care about future generations and what obligations current generations have to future generations. Effective and respected international and intergovernmental institutions are needed to assess situations, decide on appropriate courses of action, and negotiate responsibilities for action.

Answers to the questions of why current generations should care about future generations and what obligations current generations have to future generations are inherently philosophical and represent deeply held values on par with values associated with honestly, justice, courage, and humility. Obligations are understood here to be actions that current generations are compelled ethically to take on behalf of future generations under certain, explicitly defined situations.

It is useful to ground futures-oriented decision making within a sound philosophical framework for four reasons. First, the framework provides explicit reasons to support and embrace futures-oriented decision making. Second, this positively-motivated framework is needed to counter some who argue that current generations have no obligations to future generations because, for example, we do not know the preferences of future individuals nor their explicit identities (Parfit, 1984). Third, the philosophical framework is needed to motivate people to resolve technical problems that afflict long-term decision making to proactively and confidently take on decisions that have implications for future generations. Lastly, the framework provides the guiding principles for new institutions and agreements needed to meet obligations to future generations.

The next section provides a brief review of the futures and philosophical literatures that address the questions of why current generations should care about future generations and what our obligations are to future generations. Assessment of this literature reveals that the list of obligations to future generations proposed can be improved in many respects. In response, the third section of this paper presents a new list of twelve obligations to guide long-term decision making with respect to future generations. The fourth section addresses metrics and what should be done if one or more of our obligations to future generations are not being met. The fifth section addresses the need for new intergovernmental and international organizations to work on behalf of future generations.

2. Why care about future generations

Futurists, philosophers, and others have written extensively on the topic of future generations (Partridge, 1981). Caring for future generations is a decisive intuition (Mulgan, 2006). It also argued that we should care about future generations because they have rights not to be harmed by actions taken today (Brannmark, 2016).

Two eminent futurists, Wendell Bell and Richard Slaughter, have each developed thoughtful statements on this subject. Bell (1993) puts forth these seven statements:

- A concern for present people implies a concern for future people;
- Thought experiments in which choosers do not know to which generation they belong rationally imply a concern for both present and future people;
- Regarding the natural resources of the earth, present generations have no right to use to the point of depletion or to poison what they did not create;
- Past generations left many of the public goods that they created not only to the present generation but to future generations as well;
- Humble ignorance ought to lead present generations to act with prudence toward the well-being of future generations;
- There is a *prima facie* obligation of present generations to ensure that important business is not left unfinished; and
- The present generation's caring and sacrificing for future generations benefits not only future generations but also itself.

In a similar vein, Slaughter (1994) makes these points concerning future generations:

- The human project is unfinished;
- Caring for future generations is ethically defensible;
- We are partly responsible for the dangers to their well-being;
- The global commons has been compromised by human activity and restorative actions are necessary;
- To not care about future generations diminishes us; and
- Caring for future generations is a cultural force that is valuable now and for the foreseeable future.

One could argue that to Bell and Slaughter, any life lived without thought or consideration for future generations—in other words, a life consumed solely in pursuit of individual wants and goals—is a life not worth living. It is a life that does not enrich future lives but is a developmental dead-end. It is a life lived in contradiction to the great archetypes and myths that underlie our collective consciousness: birth and death, the journey, courage, and heroism (Campbell, 1988; Jung, 1936). It is a life lived without concern for children, great grandchildren, or, really, the extinction of the human species. It is a life lived without contribution to the greater good and to our important unfinished business.

Conversely, a life lived that embraces caring for future generations is purposeful, fulfilling, and enriching. This life helps humanity maintain continuity (Anderson, 2013; Del Savio, Loi & Stupka, 2015) and its journey through time and space. It is a heroic life in that one sacrifices part of the self, probably in ways that do not garner much recognition, for a larger purpose. Heilbronner (1975) sees caring for posterity as a duty. Feldman (1995) argues that utilitarian attitudes towards nature and resources inherently fail.

As mentioned above, it is important to distinguish reasons why we should care about future generations from our obligations to future generations. A careful assessment of the lists provided by Bell and Slaughter indicates that these concepts are not well distinguished. For example, from Bell's (1993) list, here is a clear statement of why we should care about future generations: The present generation's caring and sacrificing for future generations benefits not only future generations but also itself. From this same list, here is a clear statement of an obligation: Regarding the natural resources of the earth, present generations have no right to use to the point of depletion or to poison what they did not create. Slaughter (1994) also presents reasons to care for future generations—to not care about future generations diminishes us —and statements of obligations—the global commons needs to be restored. For the purposes of supporting improved futures-oriented decision making, reasons why we should care about future generations and our obligations to future generations need to be separated out.

Several other authors have written on obligations to future generations. MacLean, Bodde, and Cochran (1981) and Schrader-Frechette (1991) argue for a fairness obligation, meaning that current generations ought not to impose involuntary environmentally-based risks of death upon future generations that they would not themselves accept. Weiss (1989), Tonn (1987), Golding (1981), Balazs and Gaspar (2010) and others argue for a "maintaining options" obligation, meaning that decisions made by current generations should not restrict possible futures that could be pursued by future generations. Dator (1994) tsunamis of change envisions future worlds that enjoy maximum options. Tough (1993) states that future generations need these types of things from current generations: "Future generations need equal opportunity (a legacy as beneficial as ours was), our caring about their well-being, and attention to their needs in our legislatures and parliaments. Their particular needs are for us to focus on peace and security, the environment, the worst risks of all, governance, the knowledge base, children and learning. (p. 1041)" Kramer (2011) argues that our obligations to future generations should also be extended to extraterrestrial biological entities.

Lastly, the United Nations Educational, Scientific and Cultural Organization (UNESCO) developed a Declaration on the Responsibilities of the Present Generations Towards Future Generations, which are:

- Article 1 − Needs and interests of future generations
- Article 2 − Freedom of Choice
- Article 3 − Maintenance and perpetuation of humankind
- Article 4 − Preservation of life on earth
- Article 5 − Protection of the environment
- Article 6 − Human genome and biodiversity
- Article 7 − Cultural diversity and cultural heritage
- Article 8 − Common heritage of humankind
- Article 9 − Peace
- Article 10 − Development and Education
- Article 11 − Non-discrimination

This list captures some of the obligations mentioned previously. For example, Article 2 − Freedom of Choice is similar to the maintaining options obligation and Article 9 − Peace, is explicitly mentioned by Tough. Also, as will be seen, several are also included in the new set of obligations presented below. Even with this extensive list, the set of obligations distilled from the literature is less than complete and even outdated to some degree. The literature was, in part, originally motivated by concerns about the long-term issues surrounding the disposal of nuclear wastes, which may impose unfair risks on future generations and require active management and surveillance for thousands of years, thereby constricting society's options. In retrospect, the risks from nuclear wastes are dwarfed by new risks that have since emerged, such as those related to pandemics, climate change, and the unintended consequences of exponential technological change. The next section presents a new set of obligations to future generations informed by previous work yet constructed with these additional thoughts in mind.

3. Obligations to future generations

Presented below is a new list of twelve obligations we have to future generations. This list is updated, in part, to address new and serious threats to humanity. The list contains obligations that are measurable, scalable, and actionable. The first eight obligations focus on preventing the emergence of horrendous potential futures. If these risks are not present, then no actions are needed. The remaining four obligations are positive actions that humanity needs to take as a matter of course every year into the distant future to help ensure that disastrous futures can be avoided or mitigated. To emphasize the futures-orientedness of the obligations, assume that assessments of whether current generations are meeting each obligation and plans to meet the obligations entail at a minimum a 1000-year assessment and planning period (Tonn, 2004a).

3.1. Prevent the risk of human extinction from exceeding the ethical threshold over an appropriate time horizon

A seminal refrain found in the risk analysis literature is this: How safe is safe enough? (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978). This question is usually framed with respect to mortality risks involuntarily imposed on individuals from environmental threats, such as from drinking water polluted with arsenic. In many countries around the world, the answer that has emerged to this question is 10^{-6} (Hunter & Fewtrell 2001; Kelly, 1991). In other words, if an individual is exposed involuntarily to an environmental risk of death greater than this threshold, then society has the ethical obligation to take actions to reduce that risk to below acceptable levels. This threshold is stringent but it is well above zero because it is recognized that the costs of reducing risks towards zero quickly become prohibitive.

Rephrasing this question in terms of obligations to future generations, one could ask: At what level does the risk of human extinction pass an ethical threshold at which current generations are obligated to take actions on behalf of future generations? Tonn (2009a) addressed this question from the perspectives of three statements of obligations mentioned above: fairness; maintaining options; and avoiding regret over not finishing humanity's important business. Each perspective provided a slightly different answer but triangulating the results suggests that the ethical threshold is in the neighborhood of 10^{-20} over the next 1000-years. Thus, it is argued here that current generations have an obligation to take action if the threat of human extinction is greater than this threshold at any point in time over this planning horizon, with the scale and scope of the actions increasing as the risk soars about the threshold.

3.2. Prevent the risk of the total extinction of all life on earth from exceeding the ethical threshold over an appropriate time horizon

Current generations have an obligation to prevent the total extinction of all life on earth (Tonn, 2007a). This obligation relates directly to current and future generations of humans since human life could not exist without the existence of other species of earth life. This obligation can also be viewed as a fundamental obligation to earth life overall, since, if humans were to become extinct, if at the very least humans put in place actions to ensure earth life survives in some form, it might be possible for species to re-evolve that might have enough intelligence to find new homes for earth life in the universe before our sun extinguishes all life on earth during its dying days (Tonn, 1999). It also acknowledges the fact that human biology is infused with non-human species (McKibbon, 2003) and our bond to other species (Wilson, 1984). Thus, one can argue that the threshold for preventing the extinction of all life on earth needs to be even stricter than the previously presented threshold. It is argued that this threshold should be 10^{-23} over 1000 year time horizon (Tonn, 2009b). Similar to the human extinction obligation, current generations would need to escalate actions to satisfy this obligation as the risk of extinction of life on earth increases over the threshold.

3.3. Bequeath sustainable societies

Current generations have an obligation to bequeath to future generations strong institutions (Victor & Guidry-Grimes, 2014), traditions (Thompson, 2017), and societies that are just and peaceful, fundamentally stable and civilized, essentially following the thoughts of Tough cited above. It is not enough for humanity to avoid extinction. Life also has to be worth living in a fundamental sense. For example, one could interpret this obligation as meeting the provisions of the United Nation's Universal Declaration of Human Rights.[1] To go beyond these provisions, one could also imagine bequeathing to future generations processes that can facilitate political change without violence and genocide and cultural evolution that satisfies deep psychological needs without pathological social consequences. Current generations' actions to satisfy this obligation intensify as threats to civilization increase. At the limit, one can argue that not meeting this obligation poses an existential threat to the human race. In this light, satisfying this obligation can be considered a necessary but not sufficient condition for producing situations to help humanity meet the other eleven obligations to future generations.

3.4. Bequeath sustainable systems of production

A common distinction made in the literature about sustainability is also being made here: That sustainability can be understood to have social, economic and environmental aspects (Meadows 1994). This specific obligation focuses on the use of resources needed to produce goods and services provided by global economies. Sustainability is interpreted in a strict sense: Can the magnitudes of resources being consumed to support the global economy be sustained over the next 1000 years? Are planetary boundaries crossed (Steffen et al., 2015)? If the answer is no, then corrective actions are required. The more unsustainable the prospects appear, the more work current generations must do to rectify the situation. At the limit, a wholly unsustainable economic system could result in an existential risk to humanity.

3.5. Continuously work to reduce the risk of death from involuntary environmental risks that are greater than the ethical standard

As mentioned above, this threshold is commonly agreed to be 10^{-6}. This obligation is clearly subsidiary to the obligation to prevent human extinction and in fact can be understood to merge into this obligation if the accumulation of involuntary environmental risks threatens human extinction. This ethical threshold is a separate obligation in order to focus explicit attention on pollution, exposures to toxic substances, and environmental justice and to clearly indicate that sustainable economies also need to be clean economies.

3.6. Preserve the essence of nature

Up to this point, the list of obligations can be seen to have roots in decades of thinking about obligations to future generations, social and environmental justice, and sustainability. This obligation, to preserve the essence of nature, is motivated by more recent developments in, and concerns stemming from, new genetic engineering technologies. Without a doubt, humans have impacted the global environment for thousands of years. We have altered species though selective reproduction (e.g., corn) and domestication. In recent decades, we have genetically modified numerous species for our own purposes (e.g., rice). Recently though, the potential for humans to change nature has greatly increased though the discovery and development of clustered regularly interspaced short palindromic repeats (CRISPR) technology.[2] This relatively inexpensive technology allows us to drive human designed genes into the DNA of organisms in a way that ensures that these genes will be passed down to all succeeding generations. For example, researchers have discussed driving genes into mosquitos to prevent malaria, into Asian carp to ensure that only males will be propagated (and thereby ensuring their elimination as an invasive species), and into American chestnut trees to help them withstand the chestnut blight.

[1] http://www.un.org/en/universal-declaration-human-rights/
[2] https://en.wikipedia.org/wiki/CRISPR

The concern expressed by this obligation is that an accumulation of modifications to a broad spectrum of organisms could cross an ethical threshold at which something essential about earth life is irreversibly lost to the detriment of earth life and future generations of humans. Earth life is characterized by diversity and evolution. Diversity provides stability and adaptability to threats to ecosystem processes. Evolution produces diversity within the framework of natural experimentation. We need to respect and protect diversity and evolution even if this means restraining and even refraining from manipulating nature to meet our interests in the short term. A world full of organisms designed to meet the needs of humans is unlikely to be a healthy world, literally and aesthetically. If manipulation of nature becomes rampant and unintended consequences prove devastating, then this obligation merges with the obligation to prevent the extinction of life on earth.

3.7. Preserve the essence of the human species

This obligation is also motivated by advances in technology. If we believe that current generations have obligations to future generations, then implicit within this belief is something essential about the nature of future generations of humans. Because of the evolution of technology, one can assume that there will be growing potentials to change, alter, and redesign ourselves, to become transhuman (Bostrom, 2005). Humans are already becoming increasingly cyborgian through technologies as diverse as knee and hip replacements to heart pace makers and hearing aids. Technology is also advancing to overcome blindness and paralysis and to allow humans to mentally control artificial limbs. Future cognitive and genetic enhancements could greatly increase intelligence, memory and life spans (Kurzweil & Grossman, 2005).

These trends merely represent what is happening towards the beginning of the 21st century. One can only imagine what technology of the 22nd, 23rd, and succeeding centuries may offer. Thus, one must ask this question: at what point do we cease being human and become something else, something so essentially different that current humans have no obligations to this new life form? Or, even more starkly, do we have obligations to future generations that may be artificial, i.e., robotic or virtual? In the extreme, one could argue that the emergence of these forms of artificial life could pose an existential risk to humans. It is important for current generations to work to preserve not only the essence of nature but also the essence of the human species.

3.8. Maintain options for future generations

This obligation is taken directly from the work of Brown and others cited above. Its value in this list is to make explicit that the evolution of humanity encompasses infinite potential futures, not just one pre-determined path, and this freedom is to be explicitly valued and protected. Of course, this obligation is best met when the risks addressed by the first seven obligations are minimal or nonexistent. In the best of times, societies do not have to limit their developmental options by allocating resources or regulating behaviors to meet obligations to future generations. Of course, freedoms for future generations can be threatened in other ways. For example, a lack of creativity and innovation can stifle the development of new paths for humanity to follow. Repression and the imposition of a limited set of prescribed behaviors is even more damaging. Extreme social controls in the absence of existential risks can actually threaten the ability for current generations to bequeath sustainable societies, and pathologically, actually increase existential risks.

3.9. Preserve knowledge gained by previous and current generations for the use of future generations

These next four obligations are qualitatively different from the previous eight. The former are framed in terms of risks and if there are no risks of consequence, no actions are needed, whereas these next four are basically must dos. This obligation is for current generations to preserve knowledge gained by humanity over time for use by future generations. Knowledge can take many forms, from how to build a radio to the general theory of relativity, to archiving examples of extinct species and languages to successful and unsuccessful medical treatments. One can only speculate how much the loss of knowledge from the destruction the library in Alexandria, Egypt cost humanity over succeeding millennia. Or how the worldwide loss over time of parchments, scrolls, manuscripts and early books and letters, not to mention knowledge transmitted through oral traditions, diminished the humanities and science.

The digitization of knowledge in recent years has made the exponential growth in knowledge available to billions across the globe, but the existence of the ‘cloud’ does not necessarily satisfy this obligation. If fact, the cloud may make humanity complacent with respect to this obligation. In any case, humanity has to constantly work to meet this obligation as knowledge continues to grow and continuously needs to be preserved. The archival solutions need to be fail safe yet allow the information to be easy accessible. Resources devoted to meeting this obligation may increase during periods where archives are transitioning from one set of solutions to new, better solutions or when events pose unexpected risks to the archives.

3.10. Actively support the generation of new knowledge needed to support the survival of earth life into the distant future

New knowledge needs to be continuously gained to help humanity survive into the distant future. This knowledge needs to serve the meeting of all of the obligations already mentioned and even those addressed next. A cursory review of research and development expenditures being made by today’s societies indicates funds are mainly allocated for defense and the health (e.g., life span extension), well-being and enjoyment of current generations (Tonn, 2004b). The preponderance of this research focuses on the natural sciences and on technology design, development, and deployment. Even within this realm, relatively few dollars are being spent to reduce risks to humanity *in toto* or even to reduce involuntary environmental risks, for example.

It should be noted that new knowledge is not only restricted to the realm of the natural sciences and technology. We also need to develop new knowledge on how to better organize ourselves politically and economically. For example, momentum is building to widely implement preference voting. More innovative ideas include non-spatial government (Tonn & Feldman, 1995) and futures government (Tonn, 1996). Learning is fostered through experimentation and wisdom is gained through successes and especially failures. Failures are tolerated in the private sector and enshrined in the concept of creative destruction (Schumpeter, 1942). Humanity needs to develop peaceful and ethical means to experiment with new political innovations and macro-economic frameworks and structures.

3.11. Minimize regrets that humanity might have over not finishing its important business

Likewise, minimizing regrets that humanity might have over not finishing its important business (in the words of Wendell Bell) is best satisfied when humanity is following its enlightened interests, working towards grand dreams, instead of simply struggling to survive and having to allocate resources to meet other obligations to future generations or, more pejoratively, being focused solely on the individual. To meet this obligation, humanity needs grand dreams to pursue and a large dose of humility. Grand dreams can be pursued within numerous realms of human endeavor, from space exploration to fundamental science, from the arts to the humanities. We need to be humble enough to admit that humanity probably does not know what its important business is at this time. We need to be open minded enough to recognize what this business might be and to be able to take advantage of opportunities to achieve humanity's grand dreams. It could be that to take advantage of a one in a million years opportunity, humanity would have to bond together to devote a very substantial amount of resources to a very special project.

3.12. Fully inform current generations about futures and obligations

The need to fully inform current generations on the status and future prospects of meeting obligations to future generations cannot be overstated. Publics the world over need to have access to information and the information needs to be communicated as best as possible. Meeting obligations to future generations ought not be a subject of partisan politics and campaigns of misinformation. Those responsible for communicating information need to be mindful of the heuristics and biases individuals employ when trying to understand risk and uncertainty (Kahneman & Tversky, 1979; Slovic, 1987; Tversky & Kahneman, 1973; Tversky & Kahneman, 1974). They also need to be aware of the difficulties individuals have with respect to imagining futures even a few years out (Tonn et al., 2006) and how cultural beliefs can constrain futures-thinking (Tonn, 2005a,b; Tonn & MacGregor, 2009c). Efforts should be also considered to develop tools to assist individuals understand information and to participate in global discussions about future generations (Tonn & Stiefel, 2012).

Humanity needs to practice effective foresight and anticipation research in order to provide sound insights into how well we may or may not meet our obligations to future generations in the years to come. The entire point of this entire exercise to avoid crisis situations, where, for example, a war footing is needed to deal with imminent existential threats when lesser actions implemented decades or even centuries sooner would have been sufficient to deal with the threats.

The set of twelve obligations is designed to be exclusive, though reasonable minds could certainly reformulate the list and add additional obligations to the set. The twelve obligations should be considered incommensurable. This means that they cannot compared to each other to determine which is more important or included into a function that aggregates their values into a grand score. Fundamentally, the obligations are not to be traded off against each other. This means that if humanity lacks the resources to meet its obligations, it is not permissible to decide to devote more resources to one versus another as if one is more important than the other. This stance is especially important with respect to the first eight obligations presented. One could argue that if resources were stretched to deal with existential threats to humanity and all of earth life that resources could be reduced to protect knowledge, produce new knowledge and conduct and communicate the results of foresight. However, if the situation was so dire, then one could argue that it would be even more urgent to devote resources to those activities. Only resources devoted to finishing humanity's important business could be reduced, maybe in light that humanity's most important business will never be accomplished if humanity went extinct.

Lastly, reasons why we should care about future generations and what our obligations are to future generations should be considered timeless and universal. While well-meaning individuals may disagree on the specifics of why and what, the framework woven above assumes that all generations would agree that why and what are important. These values are immutable, not relative. Belief systems that may hold that why and what are not important at all are not equally defensible nor defensible at all.

4. Assessing whether obligations to future generations are being met

Assessing whether current generations are satisfactorily meeting the dozen obligations presented above has institutional, moral, and technical aspects. The former deals with who should be responsible for making the assessments. The latter refers to the metrics to be used to guide the assessments.

Metrics will need to be developed with respect to all twelve obligations to guide all of this work. It is an understatement to say that it will be challenging to develop the metrics and to design and implement processes to collect data to estimate the metrics. It is quite hard enough to tackle one global issue like climate change. To address the human extinction obligation requires the assessment of all risks to human extinction and how these risks could inter-relate with each other to form complex causal chains of events that could lead to extinction (Tonn & MacGregor, 2009a). Thus, climate change would represent just one risk among many inter-relating risks

captured in Fig. 1 that would need to be assessed jointly.

Some metrics related to obligations are easily stated, such as those related to obligations to prevent the extinction of humans and earth life, which are already specified in probabilistic terms. Some metrics will need to be invented, such as those related to preserving human knowledge and supporting the generation of new knowledge, though these seem to be manageable. Other obligations will require hard work and ingenuity to develop. Falling into this category would be metrics related to preserving the essence of nature, preserving the essence of the human species, and allowing humanity to finish its important business.

Some metrics may be easier to measure or estimate than others. For example, estimating the probability of human extinction is a daunting task if taken over a century much less a millennium, but various methods do exist and can be used jointly to accomplish this task (Tonn & Stiefel, 2013). It is even a challenge to estimate the risks of individuals to environmental toxins, given a paucity of dose/response data for thousands of chemicals taken individually, in combination, and by gender, race, age and ethnicity.[3] It would seem easier to measure investments in knowledge creation—simply track research and development expenditures that pertain to meeting this obligation—and even the preservation of knowledge.

Once the metrics have been defined and their values estimated, then judgments are needed on whether current generations are meeting obligations to future generations and if not, what needs to be done. In these cases, depending on the situations, current generations are obligated to take actions. Here are six categories of actions (Tonn & Stiefel, 2014) (with burden on world gross domestic product noted in parentheses):

- I. Do nothing (~ 0% GDP): The Do Nothing component of the societal action framework is self-explanatory and essentially is related to the first eight obligations presented above. As noted below, some action is always required with respect to the final four obligations presented above.
- II. Policy Nudges (~1% GDP): These could take the form of tax incentives and deployment programs and encompasses the least intrusive and least costly actions to react to situations where measured compliance with our obligations to future generations does not meet acceptable thresholds. A small amount of societal resources could be diverted to influence behavior through tax incentives, to be interpreted to include tax subsidies and taxes on unwanted behavior (e.g., taxes on emissions of pollutants). Deployment programs are relatively small efforts funded by governments to improve the energy efficiency of housing, for example. In this category, we also include standards (e.g., vehicle fuel efficiency standards), research and development programs, international law (Wilson, 2013), and plans of various sorts (e.g., plans to improve regional watershed quality). While many of these actions may face political resistance, overall the relatively limited scope and scale of these types of actions are usually politically palatable. It can be argued that current societal efforts to address climate change can be described as falling into this category or the next.
- III. Major Programs (~5% GDP): The major program and major public investments level of societal action raises the commitment to about 5% of GDP. For example, a carbon tax or cap and trade policy, combined with major investments in clean energy technologies, carbon sequestration technologies, comprehensive building retrofits, and major new investments in public transit systems could, combined, represent such a level of investment. Of course, political acceptability of this level of action is a real concern.
- IV. Manhattan Scale Projects (~15% GDP): Friedman (2004) and others call on the United States to implement a Manhattan Project-scale effort to jointly address energy independence and climate change issues facing the country. Although the Manhattan Project cost around 1% of GDP in its peak year (Stine, 2009), we envision multiple projects in this category that would have a cumulative cost that is 15% of GDP and would be so large that they would dominate the world's attention. For example, instead of producing the science, technology, and uranium diffusion plants that led to the development of the atomic bomb during World War II, in this context a Manhattan-scale project could be the colonization of space, advocated by some as one way to ensure that humans will not become extinct (Bardi, 2008; Baum, 2010). Another controversial large-scale project could be a geoengineering solution to avert or reverse climate change (Kintisch, 2010). This level of societal action would require the participation of almost every sector of society and the economy.
- V. Ubiquitous Controls (~ 30% GDP): The fifth level (e.g., rationing, population control, major command and control regulations), builds upon the fourth although it requires an estimated 30% of GDP as compared to the 15% of GDP estimated for the fourth level. It requires the imposition of major controls upon society and the economy designed to reduce emissions, energy consumption, and any other human behaviors that are directly contributing to unacceptable levels of human extinction risk. China's one-child policy could be seen as an example of this level of action.
- VI. War Footing (~ 50% or more of GDP product): If humanity is facing a clear and present massive threat to its existence, then one could argue that societies ought to completely mobilize to deal with the threat via an extreme war footing and an economy organized around reducing human extinction risk. This is analogous to a country completely mobilizing in times of war to fight for its own existence. Complete mobilization entails substantial control and direction over the manufacture of technologies needed to deal with existential threats. As a benchmark, in 1943, the United States used 48% of its GDP to support its military in World War II (Tassava, 2010). Human society could be faced with decades and even centuries of extreme war footing depending on the nature of the human extinction risks.

This list includes actions ranging from relatively minor commitments from current generations to massive commitments that are

[3] Tracking all exposures individuals have over their lifetime requires the development of the exposome: https://en.wikipedia.org/wiki/Exposome

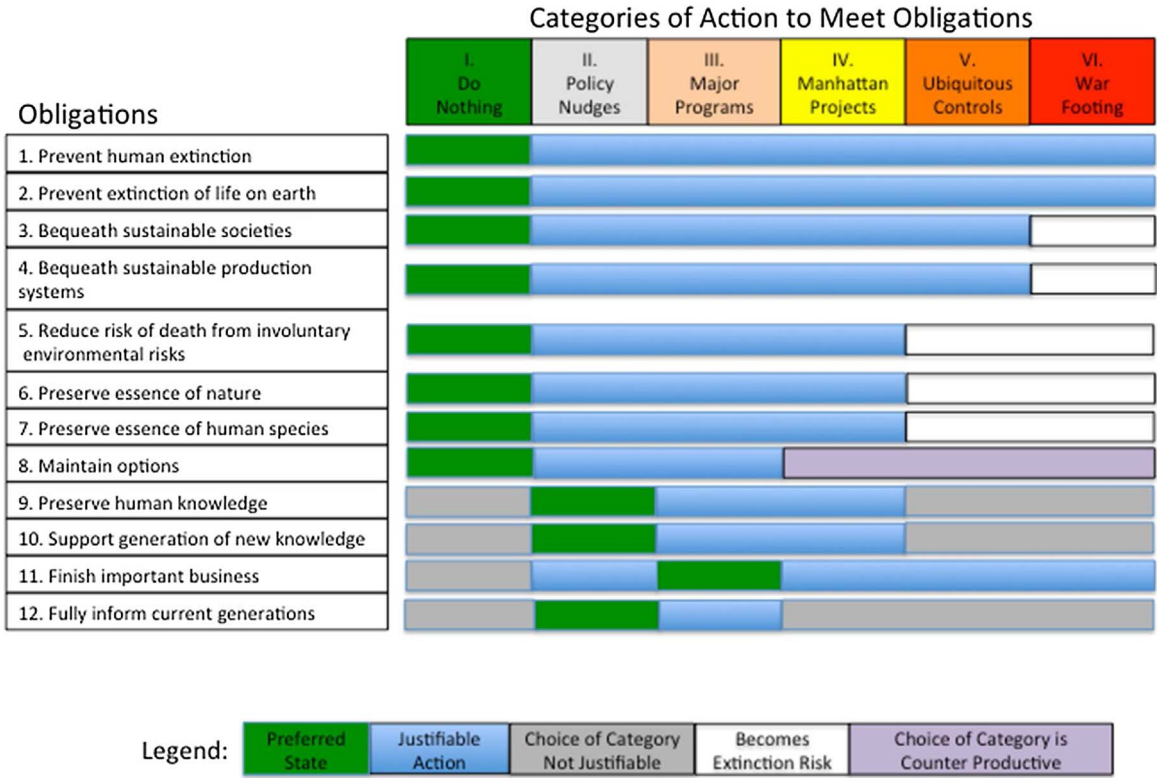

Fig. 2. Potential Actions to Meet Obligations to Future Generations. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

equivalent to mobilizing for all-out war. This last category of action is reserved for only the direst risks related to human and species extinction. Risks related to meeting the next five obligations, from bequeathing sustainable societies to preserving the essence of the human species, can be met with actions up to Category V. Ubiquitous Controls. Implicit in this part of the framework is that if risks related to these categories were even higher, then the world would be facing truly unacceptable risks of human species extinction and maybe even all of life on earth, thereby bringing in to play category VI. War Footing.

Fig. 2 presents a framework to understand what types of actions might be needed to meet obligations to future generations contingent upon to what degree each obligation is being met or not being met. The green segments of each bar indicate the preferred actions for each of the twelve obligations. For the first eight obligations, the preferred level of action is: Do nothing. In other words, it has been judged that there are no concerns (for example, about human extinction) that require current generations to take action about. The last four obligations are led off by grey segments in the Do Nothing column, signifying that this level of action is not acceptable. In other words, this indicates that some level of action needs to always be taken to meet these obligations. Thus, current generations should always work to preserve human knowledge, support the generation of new knowledge, strive towards achieving the unfinished business of humankind, and fully inform the public about futures issues and practice effective foresight.

Table 1 presents the framework and the twelve obligations, this time with the cells containing suggestions for metrics that would justify each level of action. As expected, the metrics associated with the two existential obligations are stated in terms of probabilities. The metrics spread across each of the two rows indicate what situations prompt what level of action. In this instance, the choice was made to estimate two metrics, the lower probability of extinction and the upper probability of extinction. Using lower and upper probabilities, sometimes also referred to as imprecise probabilities (Dempster, 1967; Shafer, 1976; Walley, 1991), instead of point probabilities allows for the better representation of both uncertainty and gains in knowledge (Tonn, 2005b). As expected, the Do Nothing situation is justified when both the lower and upper probabilities sit below the ethical threshold. The scale and scope of required actions then increase as first the upper probability and then the lower probability exceeds the ethical threshold.

Fig. 3 illustrates the metrics across the six action categories for the human extinction obligation. The green lines indicate probabilities that do not exceed the threshold and the red lines indicate probabilities that do. For example, in the Do Nothing case, two green lines are shown significantly below the threshold and in the War Footing case two red lines are shown very significantly above the threshold. The lower and upper probabilities are shown to stay the same over the 1000-year planning period just for convenience. The lower and upper probabilities could be curvilinear over time in very complicated patterns, which could then pose intellectually challenging situations to determine what should be done when.

The metrics for several other obligations are similarly quantitative. For example, as expected, the involuntary risk obligation is also stated in terms of probabilities. The sustainable systems of production metric is very high level and can be considered to be

Table 1
Obligations to Future Generations and Justifiable Actions. (For interpretation of the references to colour, the reader is referred to the web version of this article.)

Obligations/ Justifiable Actions	I. Do Nothing	II. Policy Nudges	III. Major Programs	IV. Manhattan-Scale Projects	V. Ubiquitous Controls	VI. War Footing
1. Prevent human extinction	UP << 10^{-20} LP << 10^{-20}	UP > 10^{-20} LP < 10^{-20}	UP > 10^{-20} LP > 10^{-20}	UP >> 10^{-20} LP > 10^{-20}	UP >> 10^{-20} LP >> 10^{-20}	UP >>> 10^{-20} LP >>> 10^{-20}
2. Prevent extinction of life on earth	UP << 10^{-23} LP << 10^{-23}	UP > 10^{-23} LP < 10^{-23}	UP > 10^{-23} LP > 10^{-23}	UP >> 10^{-23} LP > 10^{-23}	UP >> 10^{-23} LP >> 10^{-23}	UP >>> 10^{-23} LP >>> 10^{-23}
3. Bequeath sustainable societies	High quality of life, rights protected, stable and wise governance	Significant social justice issues	Major social justice issues, civil unrest	Many regions unstable, widespread injustice	Human civilization is at risk	Merges into human extinction risk
4. Bequeath sustainable production systems	UP = 1.0 LP = 1.0	UP < .5 LP < .1	UP < .1 LP < .01	UP < .01 LP < .001	UP < .001 LP < .0001	Merges into human extinction risk
5. Reduce death from involuntary environmental risks	UP << 10^{-6} LP << 10^{-6}	UP > 10^{-6} LP < 10^{-6}	UP >> 10^{-6} LP >> 10^{-6}	UP >>> 10^{-6} LP >>>10^{-6}	Merges into human extinction risk	Merges into human extinction risk
6. Preserve essence of nature	All nature essentially unaugmented	Numerous ethical situations exist	Augmented species dominant in nature	Augmentation causing serious unintended consequences	Merges into species extinction risk	Merges into species extinction risk
7. Preserve essence of human species	All humans essentially unaugmented	Numerous ethical situations exist	Transhumans, robots, AIs widespread	Natural humans close to minority	Merges into human extinction risk	Merges into human extinction risk
8. Maintain options	No regulations or expenditures to meet obligations	Investments needed to spur creativity	Major efforts to address stagnation, dogma	Choice of Category is Counter Productive	Choice of Category is Counter Productive	Choice of Category is Counter Productive
9. Preserve human knowledge	N/A	All data, intellectual work being preserved	Major transition in preservation approach needed	Crisis situation, need large effort to save archives	N/A	N/A
10. Support generation of new knowledge	N/A	0.5% of workforce; well funded	Impending crisis, 1.0% workforce	Crisis event, 1.5% workforce	N/A	N/A
11. Finish important business	N/A	May reduce efforts to address issues in Obligations 1-10	Active space programs, art, basic science, other	Need large effort to achieve next level	Take advantage of once-in-a-million-year opportunity	Take advantage of once-in-a-billion-year opportunity
12. Fully inform current generations	N/A	Fully Informed re 1-11; robust foresight	Impending crisis ramps up activities	N/A	N/A	N/A

UP – upper probability; LP – lower probability; N/A– not applicable; > greater than; > > much greater than; > > > very much greater than; < less than; < < much less than; < < < very much less than.

probabilities associated sustainability scores compiled with respect to key sustainability indicators for energy, water, food, etc. The lower the probabilities get, the less the obligation is satisfied. In the extreme case, a very unsustainable system could merge into an existential risk. Preserving human knowledge, producing knowledge, and finishing important business can be measured with archival statistics, research and development investments, and project investments, respectively. Several metrics are qualitative at this point: those relating to sustainable societies, preserving the essences of nature and the human species, maintaining options, and fully informing current generations.

5. Institutions

It is important to consider what types of institutions are needed to foster the future generations agenda described above. Three

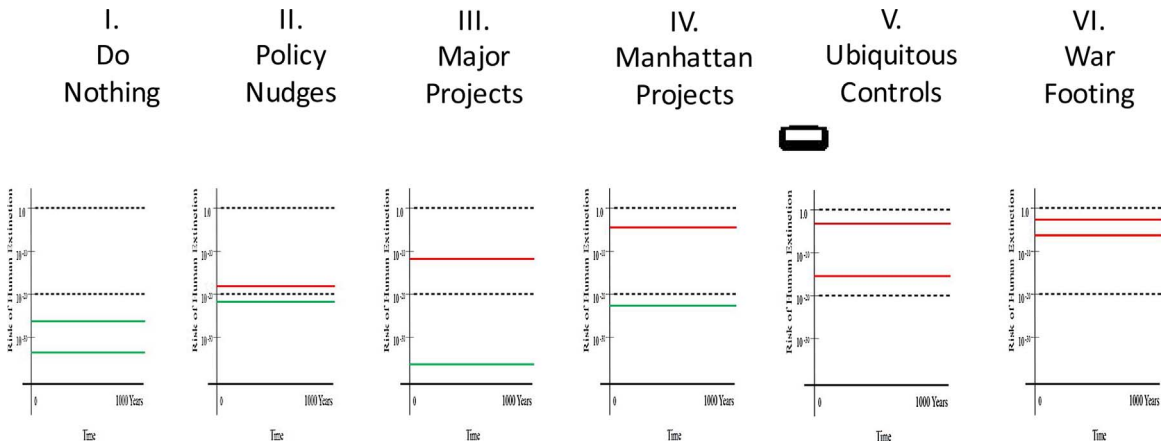

Fig. 3. Human Extinction, Obligated Actions, and Uncertainty. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

institutions are explored in the balance of this paper: a boundary organization; an evaluative organization; and an action-oriented organization.

5.1. Boundary organization

A boundary organization is a neutral party that facilitates meetings of stakeholders and provides the technical expertise and information to stakeholders (Guston, 2001). In this case, a boundary organization is needed to provide information to the global base of stakeholders *writ large* on the metrics that define our obligations to future generations.

Institutionally, one can imagine a boundary organization whose focus is on obligations to future generations as analogous to the Intergovernmental Panel on Climate Change (IPCC). The IPCC is the boundary organization that is the neutral body charged with collecting all pertinent evidence and distilling and synthesizing the evidence on climate change for use by policy makers and citizens worldwide. IPCC is a transformative organization because of these responsibilities and because it unique in taking a long-term view in its analyses, out to the year 2100 and beyond (Tonn, 2007b).

Let's call the body charged with assessing whether obligations to future generations are being met the *InterGenerational Panel on Obligations (IGPO)*. The IGPO would operate similarly to the IPCC in that it would be responsible for assessing humanity's knowledge in the many and diverse areas encompassed by all dozen obligations. The IGPO would need to work hard to define metrics related to each of the obligations presented above and to establish rigorous and credible approaches to estimate their values. Essentially, the IGPO would be responsible for the metrics presented in Table 1.

In this role, the IGPO may also take on the responsibility for facilitating the development of a whole earth monitoring system (Tonn, Rose, and Hawkins 2015) to collect data in an integrated fashion to estimate metrics and be used by other intergovernmental organizations. This endeavor would need to be undertaken with an understanding of the plethora of inter-relating earth scale systems (Tonn and Stiefel, 2015; Tonn et al., 2013) and in ways to respect individual privacy. IGPO could also be responsible for disseminating policy decisions (Feldman, 2012).

The IGPO would also be responsible for the foresight and communications aspects related to Obligation #12: Fully inform current generations about futures and obligations. For example, the IGPO would be responsible for scanning for disruptive technologies that could further bear upon the obligations related to the essence of nature and humanity. The IGPO would also need to develop signposts designed to provide early warning signals with respect to each of the obligations. The IGPO would be responsible for developing the communication and public participation tools.

A report prepared by the Institute for European Environmental Policy (2015) identifies several boundary-type organizations that have been founded around the world. These include the Commissioner for Future Generations in Hungary, Welsh Commissioner for Future Generations, and the Canadian Commissioner of the Environment and Sustainable Development. Finland, Germany, Israel, Malta, United Kingdom, and Sweden have or have had futures-oriented boundary organizations that serve at the national level. The report goes on to recommended that establishment of an European Union *Guardian for Future Generations*. One could imagine the IGPO as being a supra-intergovernmental organization, like the IPCC. To provide it legitimacy, it would need to be established and supported by an international body such as the United Nations.

5.2. Evaluative organization

An institution separate from the IGPO needs to be given the responsibility for taking the information prepared by the IGPO and judging whether obligations are being met. Previous papers proposed that the United States establish a Court of Future Generations to judge whether current generations of Americans are meeting their obligations to future generations (Tonn, 1991) and assigning this

task to the House of Lords in Great Britain (Tonn & Hogan, 2005a). Using these ideas as seeds, it is proposed that a *World Court of Generations* (WCG) be established to render these judgements. One can imagine the responsibility for forming the WCG would fall to the United Nations, with the exact nature, composition and processes of the WCG subject to negotiation with UN member states.

The WCG may judge that current generations are not meeting one or more obligations to future generations. The WCG would not only be charged with determining whether obligations are being met but also, when obligations are NOT being met, what are the appropriate scale and scope of actions required to move humanity towards meeting the obligations. Essentially, the WCG would be responsible for determining where the global community sits with respect to Fig. 2.

5.3. Action-Oriented organization

Assessing whether obligations are being met and, if not, what level of response is required will surely prove challenging for the WCG. Engaging the world community in discussions and negotiations about who is responsible for doing what to help humanity meet its obligations may even be much more challenging. It is proposed that a third body be established to negotiate the terms of the *Obligations to Future Generations Protocol* (OFGP). The OFGP would have twelve parts, each part relating to one of the twelve obligations. Once finalized, its terms would be binding, although appeals could be made to the WCG if terms are thought to be overburdening, biased or unjust. The OFGP would be considered perpetual: Though it will need to be revisited and updated relatively frequently, it will never expire. In other words, responsibilities for meeting obligations to future generations will always be present even as the composition of the global community of nations changes.

No one should be under the illusion that negotiating the OFGP would be straightforward or easy in any sense. Certainly, international dialogue and agreements to take action to mitigate climate change have been extraordinarily difficult and have not met expectations with respect to impact on greenhouse gas emissions. With respect to meeting obligations to future generations, determinations with respect to culpability could be much more complex (e.g., risks of human extinction may include climate change and also pandemics, nuclear weapons, asteroids, etc.). Agreements to deal with this obligation, therefore, may be composed of numerous inter-related sub-agreements.

One could ask that as a matter of course with respect to the OFGP whether it is ever justifiable for the international community to forcibly intervene in countries that are especially culpable in situations where obligations are not being met. After all, the world community has intervened in the affairs of other countries for humanitarian reasons, such as in Kosovo, Somalia, and Haiti. Tonn (2011) explored the question of intervention with respect to unsustainable energy policies. A simple risk analysis framework was used to organize the discussion about possible conditions for justifiable intervention. If the probability of deaths resulting from unsustainable energy policies is very large, if the energy problem can be attributed to a relatively small number of countries, and if the risk of intervention is acceptable (i.e., the number of deaths due to intervention is relatively small), then intervention may be justifiable. Tonn judged that these provisions are difficult to meet given that many countries most likely to be acting unsustainable are large with substantial militaries and concluded that interventions to promote energy sustainability should not be an actively pursued strategy. Similarly, forceful interventions with respect to rectifying deleterious situations with respect to obligations to future generations do not seem to be a viable policy option, either. The entire endeavor envisioned herein rests on the premise that discussion, persuasion, and negotiation are viable strategies

Lastly, the OFGP would cover numerous topics. It could pave the way for additional new intergovernmental organizations that may have very specific responsibilities. For example, it could help establish an institution capable of being the steward of the world's nuclear wastes through economic and political instabilities (Tonn, 2001). It could also encompass numerous existing national and international specialty organizations, such as the European Space Agency and the U.S. National Space and Aeronautics Administration with respect to grand challenge projects involving space and maybe even a large number of private sector firms, such as Google and Amazon with respect to archiving humanity's knowledge base.

6. Concluding thoughts

This paper addresses obligations that current generations have for future generations. After establishing why we should care about future generations, a new and expanded list of obligations are presented. Several new intergovernmental institutions are proposed to: assess to what extent obligations are being met; judge what levels of actions are needed to meet obligations or remediate a failure in meeting obligations; and negotiate an international protocol to arrange for actions to meet the obligations. Actions are grouped into six broad categories, from I. Do Nothing to IV. Manhattan-Scale Projects to VI. War Footing.

It can be argued that the ideas presented above represent a next logical evolution in humanity's journey into the future. Certainly, the seeds for the ideas presented above are already growing in numerous areas, from the good work of the IPCC to the numerous other intergovernmental institutions that help humanity get along and meet its responsibilities to itself. There are no real barriers to establishing new institutions such as the IGPO and the WCG and technical barriers to long-term decision making can be overcome with new ideas and hard work. The real challenges have to do with breaking through cultural barriers to caring for future generations and being more futures-oriented in thought and deed. Some may argue that the world cannot afford additional layers of intergovernmental organizations and the commitment of what could be substantial resources. The response is that the world cannot afford not to. Futurists and many, many others around the world must lead efforts to improve futures decision making to meet our obligations to future generations.

Author's note and acknowledgements

I consider this paper to represent a culmination of many years of contributions to the futures literature. I say this to explain the seemingly excessive self-referencing. It was exciting for me to see how so many ideas developed in essentially unrelated papers converged in this piece on obligations to future generations. I want to thank my many co-authors over the years who helped build this *corpus*. I also want to thank the editors and reviewers of *Futures* and other journals in this domain for their encouragement and constructive criticisms. I wish to give special thanks to Dori Stiefel, who has been a frequent co-author and reviewed several drafts of this paper. I would also like to thank Dave Feldman, Don MacGregor, and Seth Baum for their comments on drafts of this paper.

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