Operational research virtues in the face of climate change

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Abstract

This paper argues that the virtue of righteousness sustained by raw emotions can explain the apparent deadlock of the climate change debate, and proposes virtues that are more conducive to consequential action.

The expectation that operational researchers are virtuous is based on an honorable tradition. Virtues are even more important now, especially in the context of climate change where a public debate is unfolding; in which deniers and believers accuse each other of lack of virtue. Scientists are in the midst of the debate whether they like it or not. Rational multi-criteria decision processes require deliberation involving values infused by temperate emotions, not to be caught up by strong emotions from righteous affect. They also require an instrumentality directed at practical engagement with physical reality. The origin of all values is raw affects in the emotional centers of our ancestral brains, which power the virtues that make us righteous, as well as the tempered qualitative feelings that are necessary for sound decision-making. Different communities nurture different self-reinforcing righteous positions, explaining why a meaningful climate change debate often gets side-tracked. Scientists are not exempt from righteousness but are in a position to dampen its effect by nurturing virtues that promote good science when they deal with climate related issues. In this article we identify several virtues that we believe are conducive for scientists' work with mitigation and adaption. For example is important to be *humble* and avoiding *hubris* in geoengineering. And with regards to recovery and restoration of nature it is important to be *open* and *accommodative* with ecological *sensitivity*, *care* and *patience*. In general, work with mitigation and adaption requires

respect for people, *respect for science*, *accuracy* and *concern*. A scientist should also have the courage to speak out about facts and thereby contribute to a more temperate and informed public debate. Thus *courage* and *factualism* are also important virtues.

1   Introduction

> *"We're born to be righteous, but we have to learn what, exactly, people like us should be righteous about."* Johnathan Haidth (2012)

This paper aims to follow up the challenge of Ormerod and Ulrich (2013) in their literature review of operational research (OR) and ethics where they ask: "What are the basic ethical positions, principles and criteria that OR could adopt from the philosophical discourse on ethics and which it might help to pragmatize?" They observe that the three classical approaches to ethics: virtue ethics, duty ethics, as well as consequentialism are all discussed in the OR and ethics literature, but feel that the level of understanding of ethical discourse both in OR practice and theory needs to be raised.

The ORSA Guidelines for professional practice (ORSA 1971) have a strong emphasis on virtues, describing a set of virtues that operations researchers ought to conform to: being open, explicit, objective, flexible, independent, thorough, responsive, knowledgeable, trustworthy, scrupulous, careful, imaginative, meticulous, rigorous, fair, candid, and realistic (Wenstøp 2010). In this endeavor one of the champions of OR and ethics, Jean-Pierre Brans, proposed to the participants of the EURO XVII Conference in 2000 that they swear the oath of Prometheus (Brans 2002). The oath emphasizes virtues such as freedom with respect to ideas and methods, respect with regard to colleagues, and fair ethical behavior. It ends with a consequentialistic imperative; that we do not "bring into danger the social welfare of mankind and the ecological future of Earth". So far, few OR societies have followed up the challenge (Gass 2009), but in the face of climate change the oath is even more relevant today, as it is concerned with consequences of human activities.

Recent development in neuroscience points to a strong connection between emotions and virtues. What is not much discussed in the OR and ethics literature, however, is the role emotions play in connection with different ethical outlooks and its significance for the OR process. This is especially visible in the debate around climate change, where we shall argue that the virtue of *righteousness* plays a central role and tends to polarize positions and thus delay action. Therefore, to appreciate the force of righteousness, we must also understand the role of raw emotions that sustains it. Thus, virtues and emotions are central topics in this paper, and the arena is climate change.

Many actors participate in the process around climate change; scientists including operational researchers discover facts, make models and estimates, and assist decision-makers that include politicians and governments; the public at large participate with everyone else in the public debate. Some people have several hats. There is also a broad public debate going on with extensive use of social media where scientists, politicians, decision-makers and the public at large participate. And especially scientists find themselves sometimes squeezed between what is considered scientific behavior, and what they feel is the right thing to do. All participants are subject to righteousness, however, and in this paper we will discuss its role. But our main focus is the operational analyst, and in the conclusion, we shall suggest that righteousness can be a vice and thus an obstacle to good OR,

and we will recommend as a counterforce a selected set of OR virtues that can mitigate the impact of righteousness and thereby perhaps provide for a better future.

2   Climate change and righteousness

According to report No. 5 from the International Panel on Climate Change (IPCC), climate change represents one of the most important challenges mankind faces today. The earth has been warming and will continue to warm at least throughout this century, mainly as a consequence of anthropogenic emission of greenhouse gases, especially CO_2 (IPCC 2013). The report is based on contributions from 259 authors in 39 countries working together, and 54677 comments, across several specialized scientific disciplines, and is thereby the most comprehensive scientific undertaking in human intellectual history.

Complexity aside, the basic physics of climate change are straightforward. The basic physical mechanism is that the sun radiates short wave (visible) light, which heats the earth's surface – the crust as well as the oceans. The surface in turn emits long wave (infrared) radiation which is partly absorbed by the atmosphere, and the atmosphere reemits long wave radiation down to the surface as well as out in space. CO_2 gas (and other green house gases) in the atmosphere, however, limits the radiation out to space, which upsets the energy balance, such that the earth slowly gets warmer if the greenhouse gas concentrations continue to increase as they do now. The temperature has now increased about 0.9 C^o since preindustrial times, and as a consequence the sea level is rising, Arctic ice is melting, biotopes are changing, and the strength of extreme weather events seems to be increasing.

IPCC continues to be controversial, however. To begin with, some people are suspicious of the motives of IPCC scientists, and how the political process around the IPCC may bias the results. In addition, some are skeptical at a deeper level, involving the underlying scientific reality. This is the case when someone (1) does not believe that the climate is in fact changing, (2) believes that even if it is changing, the change is not caused by humans, or that (3) even if it changing, it does not represent a serious risk. For ease of reference, we shall designate these people 'climate deniers', being aware that the label refers to many different shades of beliefs. Many 'climate deniers' prefer the label 'climate realists' because they think the reality is different from what climate science suggests. Others again believe the change is man-made, or that it does represent a risk, and that (if possible) something has to be done about it. We shall call these people 'climate believers'. There are of course positions in between deniers and believers, which we aptly might call 'skepticism'. The term 'climate denier' is, for instance, sometimes also attributed to those who are skeptical or disillusioned about there being anything we can do to stop or reverse climate change (Capstick and Pidgeon 2013); to avoid confusion we will not count this latter group as deniers. Furthermore, there are also people who believe that the assessment of the IPCC is too cautious; that it has not gone far enough in presenting the urgency and apocalyptic aspects of the situations we are in. This shows that there can be important lines of conflict also between groups that belong to the same super-group, in this case believers.

In the midst of this controversy we find the scientists, who in addition have personal beliefs as well. A study of the abstracts of 12 000 scientific papers on 'climate change' or 'global warming' found that of the papers expressing an opinion on the question of anthropogenic global warming, 97 %

expressed the belief that humans are causing global warming (Cook et al. 2013). But this can hardly be considered as a finding based on 12 000 independent observations; the result, although impressive, may well be influenced by communal righteousness. Scientists, like others, are righteous in the sense that they share virtues typical of the communality they feel they belong to or identify with. Being righteous nurtures a feeling of group-belonging that is deeply emotional. At the same time, the sense of group-belonging intensifies the sense of righteousness. Protecting and advancing the virtues of the group becomes an object of perceived importance in itself. The result is a self-reinforcing circle that over time feeds itself, unless it is undermined or countered. When two groups disagree on fundamental virtues, the scene is set for polarization of opinion and conflict. In this manner, we shall argue, righteous emotions polarize the climate change debate.

Righteousness is an attitude that involves conforming to some set of character ideals, which in turn are determined by a person's belief concerning how one ought to be and how one correspondingly ought to behave. Virtues are the building blocks from which such character ideals are constructed. Virtues depend on a range of psycho-social aspects of person; perhaps most notably group identity, role identity, and processes of socialization arising from the history of a given person's life. Thus, the phenomenon of righteousness can be characterized psychologically in terms of descriptive virtue ethics. It should be noted that righteousness has an affective – represented by the desire to conform, as well as a cognitive component – represented by the beliefs that certain ideals are the right ones. A righteous person takes the character ideals as objects, and desires, wishes, or hopes that his conduct and the conduct of others conform to these ideals. The result is a distinctive normative virtue ethics held by the person in question. Such normative perspectives can be held more implicit or more explicit, and more or less consciously.

The strength of the desire to conform to specific character ideals is based on affective emotions. Strong identification with a particular group that is seen as holding these ideals is likely to give rise to a sense of righteousness on the group's behalf. Issues affecting or involving the group's virtue ideals are more likely to generate a stronger and wider register of emotional responses in a person the more righteous this person happens to be. Because people identify with different groups, with different inter-subjectively shared sets of virtues, different righteous attitudes will sometimes collide with one another. This, we suggest, can be seen in the climate debate. In this sense, different righteous positions may be considered virtuous or vicious, depending on whether you are an insider or outsider of a particular group where a particular set of virtues is held in esteem. Righteousness is in itself a virtue – or it may be a vice (?), depending on the point of view.

3   Ethical approaches and OR

Of the three main approaches to normative ethics: duty ethics, virtue ethics, and consequentialism, duty ethics is exemplified by Immanuel Kant (1991), and has as its basic tenet that you ought to do your duty, which normally is specified in terms of basic moral principles or laws, without regards to the consequences. Virtue ethics is classically attributed to Aristotle and deals with the character of the person, and how the person fits into the social setting by virtue of living up to societal virtues, again without focusing on the consequences of actions or policies. Instead, the assumption is that a virtuous person inadvertently will act to promote human flourishing, or the general good for society. Consequentialism is different from the first two perspectives in that it focuses explicitly on the consequences of actions; or, what is perhaps more operationally relevant, the expected,

appropriately risk-adjusted consequences of available decision alternatives. These three classical ethical perspectives have been discussed to some extent in the OR literature, and there are some common ground between the different perspectives as for instance an emphasis on the decision-maker's responsibility (Brans, 2002; Gallo, 1996). The differences between the perspectives typically re-emerge, however, when we confront the practical sides of what responsibility demands of us, and in our justification for how we end up making choices.

Kenneth Boulding (1966) was one of the first to commend OR for its high ethical promise since it has the potential of maximizing efficiency and thereby limit waste of resources. This is, in effect, consequentialism. His view is especially relevant in the light of climate change as he coined the term ''spaceship earth'', presaging that energy, material, and environmental amenities are limited, and therefore require careful husbandry (Wenstøp 2010) ; a point that has since been followed up by systems thinkers, notably Meadows et al. (1972), Wright and Meadows (2012), and Nordhaus (2013).

Emotions are central, both with regard to virtue ethics and consequentialism; and although OR has long tried to keep that kind of 'irrationality' out from their field, the role of emotions in decision processes has started to be taken seriously in the OR literature. Howard (1993) points out the central role of emotions in multi-organizational decision-making; Belton (2005) advocates a stronger emphasis on emotions in an editorial for a special issue on emotions and ethics in the Journal of Multi-Criteria Analysis; Wenstøp (2005) argues that emotions are a necessary component of rational decision-making, and Brugha (2005) and Rauschmayer (2005) agree; Roeser (2006) discusses the role of emotions in judging the moral acceptability of risks; Kunsch et al. (2009) emphasize the importance of avoiding strong affect in decision-making.

Multi criteria decision analysis (MCDA) is a discipline within OR, which requires that the subjective assessment of decision-makers or relevant stakeholders, of the relative importance of the decision criteria, be taken into account. This requires the elicitation of emotions that reflect the salience of the criteria. But while it is crucial that emotions have a central place in decision-making, they need to be tempered and suited to play their designated part in deliberation (Slovic et al. 2004)when we evaluate representations of future alternative scenarios in order to guide decision-making.

4   The conflict over climate change

Michael Mann was among the scientists who first developed a northern hemisphere temperature record for the last millennium based on paleoclimate proxy data (Bradley et al. 1999). The graph resembled a hockey stick with slowly decreasing temperatures (the shaft) until an abrupt increase started in 1900. It demonstrated in a compelling way that temperatures have not been as high as now in a very long time, and although they did not draw any causal inference, "the hockey stick" immediately became an iconic symbol of man made climate change. Climate deniers therefore saw the hockey stick as an object for reproof, and Michael Mann and his co-authors soon became targets of vicious attacks from climate deniers, as he reports in the book "The hockey stick and the climate wars: Dispatches from the front lines" (Mann 2013).

Mann documents that many of his most prolific critics have ties to the fossil energy industry, which to a considerable extent managed to sustain the campaign against the idea of anthropogenic global warming. This paper is not concerned with the financing of the debate, however, but rather with its emotional nature. And also the deniers' link to oil and money is hardly sufficient to explain the war

like character of the attacks. To get a comprehensive picture of what is going on, we must also look at the role of emotions, their sources, and how they create and sustain communities and the debate among them. Emotions ran especially high when Michael Mann and his fellow scientists became the alleged culprits of the so called "climategate" scandal where his and other scientists' e-mails where hacked and their correspondence portrayed as if they were trying to conceal "the fact" that global warming had stopped, an accusation they have been acquitted of by eight committees which found no evidence of fraud or scientific misconduct (Cook 2014).

Mike Hulme (2009) has written very insightful book is "Why we disagree about climate change". He is a professor of climate and culture and has served on the United Nations' Intergovernmental Panel on Climate Change and advised the EU, the UK Government, and private and third sector organizations on climate change for years. In the book he discusses psychological and cultural reasons for the debate, naming raw emotions such as fear and the influence of religious belief as important mechanisms, and warns against hubris: we must not think we can build 'the tower of babel'. The latter point is underscored in a recent book which is a critique of solar climate engineering as a response to climate change (Hulme 2014).

As all ready mentioned, deniers of climate change direct their denial in several different ways. Perhaps most salient is (1) denial that global warming is happening or that it is happening only to a trivial extent, (2) denial that humans play any role, or any significant role, in causing global warming, or (3) denial that the science is conclusive or sufficiently certain to make assertions about global warming. Although one would expect a climate denier to take only one of these positions, all three are usually conglomerated into a uniform denier's position. Thus, the most well-known self-professed climate denier, Nigel Lawson (Lord Monckton), holds that global warming is only happening to a trivial extent (if at all; it may also be that we are in 'a state of global cooling'), that the human role is questionable, and that the science is far from conclusive (Cook 2013).

Lord Monckton (2009) presented an open letter to the head of IPCC, Dr. Pachauri, accusing him of 'fraud' and 'defective science' in relation to the IPCC's Fourth Assessment Report. The letter states that failing to correct these 'mistakes' makes one "entitled to presume that you, the IPCC and the EPA – to whose administrator we are copying this letter – intend to conspire, and are conspiring, to obtain a pecuniary advantage by deceiving the public as to the nature, degree, and significance of the global surface temperature trend." The letter ends with a request for Dr. Pachauri's "to be stripped from office". The type of argument used here attempts to undermine climate science as such by disclosing it as lacking scientific virtue and at the same time questioning the incentives and motives of the scientists involved.

James Delingpole, another prolific denier, writes that the 5th IPCC report is nothing more than "an exercise in bravura spin", questioning specifically the certainty with which climate scientists make assertions about global warming and its underlying anthropogenic causes (Delingpole 2013). This type of argument focuses on the uncertainty of climate prediction and scientific positions. Delingpole is also the author of a book, with the sub-title: "How the environmentalists are killing the planet, destroying the economy and stealing your children's future". With seemingly intended irony, this title paraphrases the accusations wielded by climate change believers against the deniers and the industrial machinery that allegedly support them (Delingpole 2011). In this sort of argumentation, the deniers hold that bad consequences are to be expected, but that climate scientists themselves

are to blame, not fossil-fuel industries nor complacent politicians, or consumers and voters. Thus we have a reversed argumentation.

The Danish scientist, Bjørn Lomborg, has built a distinctive position as 'a skeptical environmentalist', with two best-selling books, *The Skeptical Environmentalist* (2001) and *Cool it* (2007). The essence of Lomborg's position is that global warming is happening, but that we have little reason to be fearful of global warming, and that cost-benefit considerations lead to the conclusion that to focus on climate change mitigation (reducing carbon emissions) is a mistake; we should concentrate on adaptive measures. Thus, Lomborg is a restrained climate denier in the sense that he highlights the point that we should recognize all the ways in which global warming makes the world better. In a recent article (Lomborg 2013) he claims that the thing the poorest people in the world needs the most is more fossil fuels. He is also a skeptic, however, in the sense that he is skeptical about traditional climate policy instruments.

The scientist James Powell, in his book *The Inquisition of Climate Science* (2011), concludes that "I have come to believe that in the denial of global warming, we are witnessing the most vicious, and so far most successful, attack on science in history." Powell accuses the deniers of engaging in publicity stunts whose aim simply is to gain media attention and spread disinformation, making assertions without backing them up with credible evidence, and failing to provide evidence that falsifies the claims presented by climate science. Powell calls for scientist to stand together as a community, stop being so careful, and start actively fighting the fossil-fuel funded disinformation coming out of climate denial think thanks.

The environmentalist Bill McKibben (July 19th 2012) is afraid that "we're losing the fight, badly and quickly – losing it because, most of all, we remain in denial about the peril that human civilization is in" (McKibben 2012). Speaking on behalf of the community of climate believers, he claims that up until now "the paths we have tried to tackle global warming have so far produced only gradual, halting shifts. A rapid, transformative change would require building a movement, and movements require enemies." He goes on pointing-out the fossil-fuel industry as 'public enemy number one'. Other climate believers take an even more pessimistic position. The scientist and system thinker, Dennis Meadows in an interview with *Format* (2012) fears that it is already too late, thus "[t]here is nothing we can do", pointing out that the system tends to respond adversely when pushed too far: "Disasters are the way to solve all the problems of the planet."

Believers tend to portray the deniers as a small poorly educated group where the individuals are only in it because they are sponsored by the fossil-fuel industries or other commercial enterprises with dishonorable interests. Deniers, on the other hand, tend to portray themselves as individuals championing truth and freedom, fighting a false scientific community of 'climate alarmists' that are making up scary stories to scare people in order to earn money for themselves.

5   Affect and deliberation

Some of the issues at stake in the climate change debate are endangered species such as polar bears, values such as truth and freedom, and virtues like honesty and rigor. Even Climate itself is at stake (Hulme 2009), which some argue should be protected by man, others think it is protected by God (Spillius 2010) or for other reasons does not need our protection. Alarming words like 'apocalypse', 'disaster', 'catastrophe', 'terror', 'danger', 'extinction' and 'collapse' are frequently used in the

climate change debate, creating an atmosphere of fear (Hulme 2008). Applied multi criteria decision making runs easily into difficulties when decision-makers resist making tradeoffs, arguing that the value at stake cannot be compromised – or in economic terms: they have infinite monetary value. Such values are called *protected values*, and according to Baron and Spranca (1997) a typical emotional reaction at the thought of trading off a protected value is anger. They also report that those that display tradeoff resistance, will also tend to display quantity insensitivity, agent relativity (is the agent man, God or Nature?), and moral obligation. While the values mentioned above all qualify as protected values, not all values related to climate change do. Section 4.1 describes many values that can be influenced by deliberate adaption or mitigation measures and where tradeoffs are possible. If we let raw emotions such as fear, anger, and panic rule us unabated they stand in the way of good decisions. Rational decision-making requires temperate emotions (Slovic et al. 2004), and the aim of this chapter is to describe how neuroscience and the emerging field of neuroeconomics can inform us about what role affect plays in relation to virtues and rational deliberation in the climate change debate.

5.1   Raw emotional affect

All deliberate action starts with feelings, not with reason. This was first postulated by Hume, who famously wrote "Reason is, and ought only to be the slave of the passions" (Hume 1739). From a scientific point of view, however, this was not considered a falsifiable postulate since feelings could not be directly observed; either one was confined to what self-reported statements could say, but this would only capture cognitively filtered perceptions of raw affect, or one would have to rely on behavioral inferences which are shaky because any pattern of behavior would fit with a number of different explanations, and in any case it would be difficult to determine the contribution of raw affect. We had to wait until the advent of *neuroscience*, which uses techniques such as brain imaging and controlled stimulation experiments to infer where in the brain activity takes place in different situations (Panksepp and Biven 2012). More precisely, looking at what goes on inside the brain of humans as well as evolutionarily close relatives, corresponding behavioral patterns and verbal reports in combination allows for relatively solid inferences. Many areas of uncertainty and lack of scientific knowledge undoubtedly still remain, but crucially we are now in position to build on a number of key insights. Interestingly, Hume's insight that passions precede and serve as premises for cognition and reason still rings true. Moreover, neuroscientists are hard put to locate any 'faculty of reason'.

Panksepp has for several decades studied how the behavior of mammals correlates with brain activity, and highlights the close homology between human beings and other mammals. He calls his field *affective neuroscience*, and its aim is to illuminate how our most distinctive feelings, our primary affects, arise. His findings indicate that they stem from evolutionary ancient neural networks located in the subcortical brain regions. The same rudimentary emotional infrastructure is shared by all mammals, and it is already in place at birth. Even crayfish are now reported to be able to feel anxiety (Fossat et al. 2014). Since lower parts of the brain serves as a platform for higher parts of the brain, it is seems appropriate to take a bottom-up (subcortical to cortical; affect to cognition) understanding of how it works (Cromwell and Panksepp, 2011).

Panksepp (1998) and associates have identified seven emotional centers in the brain: seeking (expectancy), fear (anxiety), rage (anger), lust (sexual excitement), care (nurturance), panic/grief (sadness), and play, (social joy). They produce raw emotional affects which are not learned from

experience and in which the neocortex plays no part. The subcortical regions where these emotions arise provide the foundational infrastructure for all values that we will ever acquire during our lives, and that includes the virtues, which are character traits that we learn from family life and society and make us righteous. Raw affect is shaped and inhibited in various ways by cognitive processes, giving rise to higher order affective-cognitive conglomerate emotions such as shame, guilt, and embarrassment. These are particularly strong self-conscious emotional affects that are elicited if one breaches societal rules (Tangney 1999); they serve to make people behave righteously and be proud.

5.2 Rational decision-making

Following the early research of McLean (1952), Panksepp identifies three levels of brain activity: the primary processes which are located in the most ancient parts of the brain and where our most powerful affects arise, the secondary processes which have inbuilt emotional learning processes, and the tertiary processes with emotionally infused thoughts and deliberations that play the central role in rational decision-making. While we often think of rationality as something that only depends an logical thinking devoid of emotional feelings, Damasio (1994) has shown that emotions are a necessary ingredient in rational decision-making when important values are at stake. Without emotions, a decision-maker has no way to connect reason to action and is liable to make detrimental actions.

In this picture we will consider two important aspects. One is the difference between strong emotional affects, and the more temperate emotions that are needed in rational decision-making in order to evaluate different outcomes. There is always a threat that decision-makers get so emotional as to lose sight of relevant facts, or emotionally salient facts get over-emphasized at the sacrifice of less salient facts. Sometimes emotions sidestep facts altogether.

The other aspect is the difference between the objects to which affect is attached. There is a practical difference between taking a character ideal as an emotional object, and taking expected consequences of different courses of action as the object. When there are several criteria at stake in the practical decision context, they need to be endowed with values, and this is a key challenge in MCDA (Wenstøp 2005). In the first case, deliberation is concerned with protecting a certain self-image or identity; in the second case the concern is with what will actually happen in the world around us and the values we attach to the different things at stake. Character ideals are inward-looking and not directly practical, whereas expected consequences are outward-looking and inherently practical.
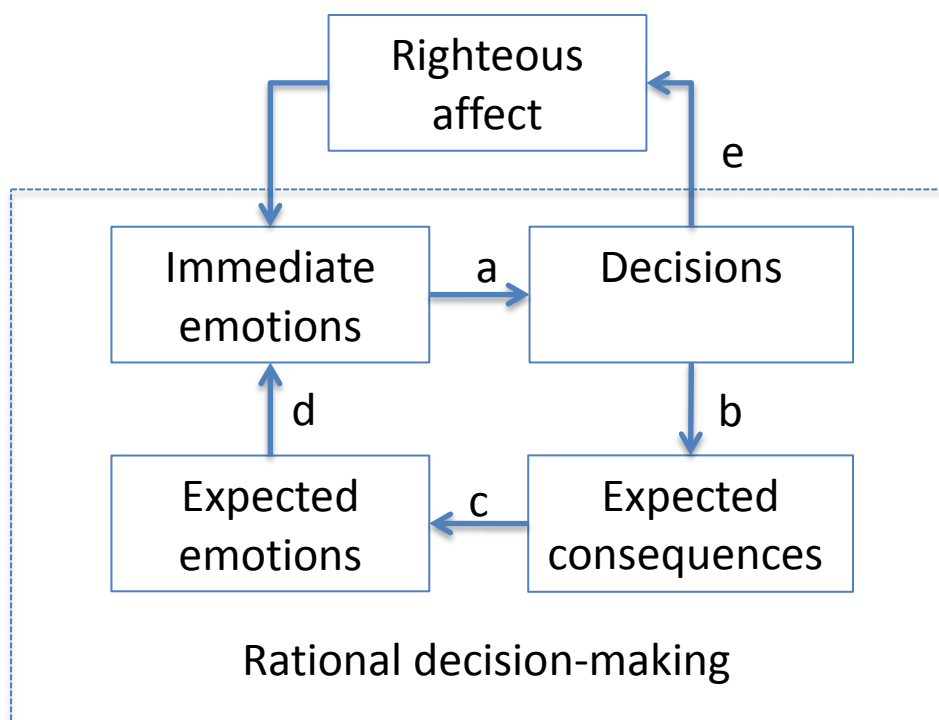
Figure 1: Rational decision-making (Adapted from Loewenstein and Lerner (2002)). Immediate emotions always prompt decisions, but rational decision-making gives time for the loop a-b-c-d where the future emotions that are expected from different alternatives have an impact on the immediate emotions before a decision is made. However, immediate arousal from strong affects, such as produced by righteous feelings, may shortcut the loop and make the process irrational.

The tension between strong affect and rationality is illustrated in Figure 1. Rational decision-making involves *instrumental reasoning* about consequences of actions, followed by deliberation of those consequences by representation of possible outcomes, and elicitation of temperate emotions about them – how good or bad will I feel if these consequences become the future reality? This evaluation then impacts the immediate emotions and prompts action. However, if a decision compromises righteousness, strong emotions may arise and shortcut the rational loop, or the need to form expected consequences will be side-tracked by feeling an over-riding need to conform to specific character ideals. Slovic et al. formulates the dual concern for affect and deliberation in a nice way: "On the one hand, how do we apply reason to temper the strong emotions engendered by some risk events? On the other hand, how do we infuse needed 'doses of feeling' into circumstances where lack of experience may otherwise leave us too 'coldly' rational" (2004) p. 320.

5.3   Two modes of thinking

Let us now turn from decision processes in the human brain to more general thinking processes. In his award-winning book 'Thinking, Fast and Slow', Daniel Kahneman (2011) summarizes several decades of research on human decision-making with the basic insight that human thinking processes uses two fundamentally different systems, which he calls *System 1* and *System 2*. System 1 is fast, automatic, frequent, emotional, stereotypic, and subconscious. System 2 is slow, effortful, infrequent, logical, calculating, and conscious. Most importantly, System 1 cannot be turned off; it is in operation all the time and responsible for most of our behavior. Human beings are therefore not well characterized by the 'rational-agent model' (Kahneman 2011) p. 411. Kahneman's description of human behavior is based on observations and it is interesting to notice that it corroborates well with

the emerging field of *neuroeconomics*, which is based on observations of neural activity in the human brain.

Camerer et al. (2005), in their seminal article 'Neuroeconomics: How neuroscience can inform economics' describe neural functioning as processes that are on the one hand affective or cognitive, and on the other hand, controlled or automatic. This gives four main categories: Cognitive and controlled processes are serial, effortful, evoked deliberately, and with reasonably good introspective access (although we cannot see what is happening in the brain). This is what we use when we set up the budget for our holidays. Affective and automatic processes, on the other hand, are parallel, effortless, reflexive, and with no introspective access. They make us jump when somebody says "Boo". Cognitive and automatic processes are involved in important processes like vision and language. Finally, affective and controlled processes are rare; they are for instance used by actors who elicit emotions in a controlled way. Human behavior generally results from interactions of all four processes, but from a decision-making point of view, cognitive & controlled processes and affective & automatic processes are of greatest interest.

Most of what goes on in our minds, and the brain beneath it, is automatic and below the radar of control and volition. As Hume, Panksepp, and Kahneman assert, we are in the grip of our affective system all the time, and our failure to be rational is therefore so entrenched and thorough that it cannot be completely corrected for voluntarily. However, it is not clear that the idea of fully correcting for emotional affect itself is cogent, for anything that we deliberate about takes its significance from the subjective experiences of our affective systems, i.e. the affective system provides qualitative input to our deliberation. A remaining question of interest, however, is which focal points we should correct for to increase the rationality of our decisions. A promising avenue, as indicated, would be to focus on *deliberation* about goals and the *instrumental reasoning* deployed to achieve these goals. By clarifying and analytically distinguishing (1) relevant facts and uncertainties anchored in reality, (2) goals that are ultimately based in subjective values, and (3) alternative courses of action that are causally linked to the goals, decision-makers can enhance decision robustness. For this decision-makers need activation of our analytical system (Kahneman's System 2), but its proper role is to support and restrict our affective system (System 1) rather than to replace it.

5.4   Perceptions of climate change risk

A conspicuous phenomenon in the US is that climate deniers tend to be politically right wing, while climate believers tend to be left wing. According to a 2009 Pew survey in the US, 75 percent of Democrats believe there is solid evidence of global warming compared to 35 percent of Republicans and 53 percent of Independents (PewResearchCenter 2009). Kahan et al. (2005) have identified underlying reasons for this pattern through a survey of 1540 US adults.

In the survey, the respondents where asked: "How much risk do you believe climate change poses to human health, safety, or prosperity?" The response was on a 10-point scale, and a reasonable assumption is that believers think the risk of climate change is high, while deniers think the opposite. In addition, they measured the respondents 'numeracy' and 'science literacy' by asking math questions and questions about scientific facts. They also measured the respondents' values on two axes: the Hierarchy-Egalitarianism and the Individualism-Communitarianism axis. These two dimensions are based on the cultural theory of risk perception by Mary Douglas (1982) and illustrated in Figure 2.

People who score high on the hierarchical end of the Hierarchy-Egalitarianism axis expect resources, opportunities, and respect to be allocated based on the formal position in the society such as gender, class and race. At the other end of the scale, we have the egalitarians who believe in an egalitarian state of affairs where everybody are equal and have the same right to participate regardless of gender, wealth or family connections. A functional magnetic resonance imaging study of brain activity indicates that this is a fundamental difference between people; it shows that a "preference for social dominance hierarchy is associated with neural functioning within brain regions that are associated with the ability to share and feel concern for the pain of others" (Chiao et al. 2009).

The Individualism-Communitarianism axis is about balancing the individual's rights against those of the community. Here, we have the individualists who believe in freedom and personal responsibility on one end, and the communitarians who emphasize social cohesion and believe in the rights of the society, such as to a clean environment on the other end.
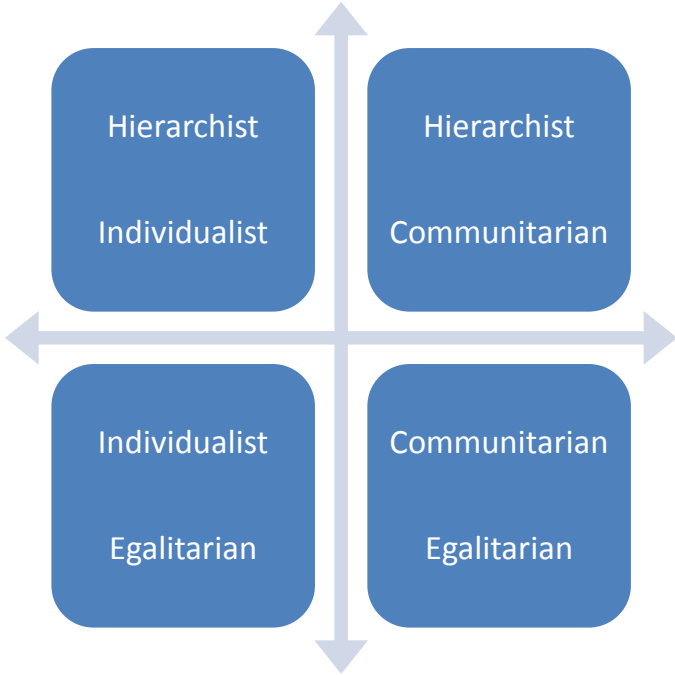

Figure 2: Cultural worldviews measured on two axes, Hierarchy-Egalitarianism and Individualism-Communitarianism. People who scored high on hierarchy-individualism scored much lower on perceived climate risk than people who scored high on communitarian-egalitarianism (Kahan et al. 2005).

In the study by Kahan et al. the climate deniers fall squarely in the upper-left quadrant of the Hierarchists and Individualists who subscribe to virtues like 'loyalty' and 'faithfulness', but also to 'confidence', 'personal responsibility', and 'individual sovereignty'. They believe in individual freedom, a free market, and a small government. The individualists do not want to let governmental actions against climate change reduce their personal freedom, and some hierarchists place God on the top of the hierarchy and assumes that His providence will make us secure here on earth; or it is actually the End of Time, climate change is brought on by God and there is nothing we can do (Hulme 2008).

The climate believers tend to fall in the lower right square of the Communitarian – Egalitarian. Their virtues are social cohesion, loyalty, shared commitment to the good, solidarity and participation, and

also fairness, equality, group before individual, and cooperation. They righteously feel that society must do what it possibly can to mitigate or adapt to climate change.

When Kahan et al. correlated the respondents' degree of science literacy/numeracy with perceived climate risk, an even more interesting pattern emerged: The risk perception of Egalitarian Communitarians increased slightly with increasing science literacy/numeracy, while the risk perception of Hierarchical Individualists actually *decreased* with increasing science literacy/numeracy. This indicates that righteousness lies powerfully behind their world views, and interferes with an ability to use reason, even tough they have a greater ability to use System 2 as described by Kahneman. There is no such thing as an axis from affect to deliberation; affect and deliberation are in two separate dimensions.

6   OR virtues in a changing global climate

We saw in the previous chapter that there is a correlation between virtues (Figure 2) and climate risk perception. Since all human beings harbor virtues, and the affective part of our minds cannot be turned off, we must assume that scientists, including operational researchers, are righteous as well. The question then becomes: what virtues are commendable for   the professional operational researcher working with climate related issues? This involves development of climate models, making predictions, and working with measures concerning mitigation – curbing climate change, and adaptation – to limit adverse effects. But it also involves an attitude to the social discourse surrounding climate change.

6.1   Mitigation and adaption

The most important mitigation area is according to IPCC (2007) switching energy supply from carbon to other kinds of clean energy. But also transport systems can be made more efficient and thereby limit CO_2 emission. Buildings can be made more energy efficient with more efficient electrical appliances and heating and cooling devices, solar photo-voltaic integrated in buildings, and so on. The industry can become more efficient with heat and power recovery, material recycling, and substitution etc. In agriculture improved crop and grazing land management can increase soil carbon storage; and so can restoration of cultivated peaty soils and degraded lands and improved livestock and manure management to reduce CH_4 emissions. In forestry better forest management to contain or absorb more CO_2 is an important measure. Also, better waste management with CH_4 and energy recovery will be helpful.

According to IPPC (2007) climate change produces many problems that need to be addressed in the best possible manner with adaption measures. We need to use water more efficiently by expanded rainwater harvesting, water storage, water re-use, and desalination. In agriculture we must adjust planting dates and crop variety, relocate crops, and improve land management. Infrastructure must be improved with seawalls and storm surge barriers, dune reinforcement, land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding. A recent example is provided by Ranger et al. (2013) about flood risk management in The Thames Estuary, and Winterfeldt (2013) advocates a merger of systems analysis and decision analysis to make systems analysis of global problems such as ground water depletion more relevant for decision making. Markl-Hummel and Geldermann (2013) provide an overview of local climate protection measures in German municipalities.

To protect human health, we must improve climate sensitive disease surveillance and control. Further, tourism must adapt to the changing climate by diverse measures, and transportation systems must be made more robust against the vagaries of the weather.

In this list of mitigation and adaption areas, which was developed by IPCC, there is a clear emphasis on ameliorating consequences, something which ethically speaking requires consequentialism with correspondingly temperate emotions attached to prospective outcomes; there is little mentioning of ethically more controversial issues like restoration of ecosystems, which includes questions around the rights of animals and invasive species. The values mentioned are typically not protected values, but values that lend themselves to tradeoffs where OR people can work together with other scientists and decision makers and deliberate to find good solutions. Rights, on the other hand, are protected values (Baron and Spranca 1997), where emotions are a formidable challenge.

6.2 Virtues

Virtues are unavoidably attached to our identities, and are important for our sense of belonging and for maintaining human relations. Virtues differ however in how they make us feel, think, and act. They also influence each other in different ways; sometimes they conflict, sometimes they coexist symbiotically. Righteousness, as a virtue, is a conglomerate and reflexive. Its content depends on and reflects the other virtues a given person harbors. Righteousness compels a person to seek internal harmony and fit within his set of virtues, and relate to the shared virtues he perceives other members of his group hold. This *coherentist* worldview my seem all good and well; after all, coherence is often taken as a respectable tenet of rationality. The problem we wish to point out is the limits of a strictly coherence-driven normative view. This becomes clear if we look more closely at its practical and decision-making implications.

In a world where different courses of action are causally linked to outcomes that we either value or disvalue, the practical decision-makers need a *correspondence*-view of rationality that connects virtues with specific courses of action. The coherence-view, by itself, cannot provide this, since it only looks at how the virtues that different actions represent coheres with a broader set of virtues. In particular, it does not show that the specific courses of action also need to correspond with expected practical results that we happen to value more.

A particular feature of righteousness virtues is that they become so powerful that they make a person apt to make the world conform to it, rather than conforming to the world. It fosters coherence without regard to correspondence, but in our practical lives we need both (Goldman 2009). A further danger of righteousness is that the passionate project of building a coherent edifice of virtues can overshadow the importance of evidence and facts that threatens one's position. This generates cognitive dissonance which, unfortunately, human beings have a psychological inclination to solve by adjusting the facts or selecting only those facts that fits, regardless of their evidence-based credibility and scientific standing. For example, deniers are liable to portray government as siding with climate scientists and environmentalists, against individual liberty and freedom and private interests such as business, whereas in fact political power thus far has tended to favor specific corporate interests without much regard for climate science and environmental groups. Righteousness in this manner represents a threat to holding a scientific worldview.

So, what virtues are important for operational researchers working with climate change related matters? We must assume that operational researchers are righteous like other people with regard

to their *weltanschauung*, and that they are also righteous with regard to their work. The question is therefore what work-related virtues one should commend that would temper emotions and avoid cognitive dissonance.

Restoration is an area where righteousness typically arouses strong emotions. One strategy is to try and heal ecosystems after they have been disturbed by climate change. But since it is hard to specify the health of an ecosystem, and even harder to improve it through restoration measures, *humility, self-restraint, sensitivity,* and *respect for the other* (Throop 2012) would be important virtues that may temper emotions and allow for more rational decision-making. Carey (2013) has examined wetland recovery programs in the US and worldwide, and found that they have largely failed and wasted millions of dollars. Instead, he recommends, we should focus on a small set of goals, and leave the rest to Nature. This agrees with Sandler (2012) who proposes that the virtues of *openness, accommodation* and *reconciliation* associated with restoration and assisted recovery become more prominent. He is concerned that restoration expresses and encourages a vice, *hubris*, which should be avoided.

Hubris is particularly noticeable in geoengineering where measures such as reducing the amount of solar shortwave radiation that reaches the surface are being considered. Improved understanding of the consequences indicates that such measures will not work (Kleidon 2013), and Hulme (2014) warns against it.

Pride is one of the classical Aristotelian virtues, but in the face of climatic challenges it can easily become a vice and serve to cement position and hinder rational, temperate consequential work. Lovelock (2006) warns against it: "Science is a cosy, friendly club of specialists who follow their numerous different stars; it is proud and wonderfully productive but never certain and always hampered by the persistence of incomplete world views".

The next question is what virtues are appropriate for a scientist with regard to the public debate, which some experience as war-like (Mann 2013). Michael Mann asks rhetorically: "What is the proper role for scientists in the social discourse surrounding climate change? Should they remain ensconced in their labs, with their heads buried in their laptops? Or should they engage in vigorous efforts to communicate their findings and speak out about the implications?" (Mann 2013). His answer is emphatically the latter, and we side with that. But participation requires the classical Aristotelian virtue of *courage* – courage to trust your own informed insight into the phenomenon of climate change and courage to speak out. The manner of speaking out is important, however. Too often do we see *ad hominem* attacks in the climate debate, and that poisons rather than informs. A scientist should be oriented towards facts, not persons. His pre-eminent ability is to use reason and that should shine through in the public debate. Thus, being *factual* is an important virtue for scientists as well. These two virtues are exemplary displayed in a public speech by James Hansen with the title "Why I must speak out about climate change" (Hansen 2012). Hansen is a leading figure among the world's climatologists. From 1981 to 2013, he was the head of the NASA Goddard Institute for Space Studies in New York City, a position he quit to be an activist for action to mitigate the effects of climate change. He is now adjunct professor at the Department of Earth and Environmental Sciences at Columbia University.

7   Summary and conclusion

Jonathan Haidth (2012), in his book 'The righteous mind' writes that we humans are born to be righteous, but must be taught what to be righteous about. In this paper, we have argued that the reason for the climate change debate is precisely that people are righteousness about different things. And the reason that the temperature of the climate debate is so high is that righteousness is built from different sets of virtues. Once a righteous community is formed, it is sustained, protected, and reinforced by social psychological group dynamics and the individual psychological quest for identity. All our values and virtues are powered by evolutionary ancient raw affects that, in turn, make the self-conscious emotional effects of shame, guilt, embarrassment, and pride so strong. These affects sustain the virtues that comprise a persons' sense of righteousness by eliciting strong negative emotions if virtues are broken. This is shown schematically in Figure 5.

Denier virtues	Scientist virtues	Believer virtues
Faithfulness, Confidence, Personal responsibility, Individual freedom, Liberty, Respect	Humility, Respectfulness, Accuracy, Concern, Truthfulness, Openness, Accommodation, Ecological sensitivity, Care, Patience, Courage, Factualism	Social cohesion, Shared commitment to the good, Solidarity, Participation, Fairness, Equality, Group-orientedness, Cooperation
Self-conscious emotional affects		
Shame, Guilt, Embarrassment, Pride		
Raw emotions		
Seeking, Expectancy, Fear, Rage, Lust, Care, Grief, Play		

Figure 3: The raw emotions power the self-conscious emotional affects, which serves to sustain the virtues that define the righteousness of the three communalities. A scientist will typically also belong to one of the other communalities.

Climate deniers are typically persons with a hierarchist-individualist *weltanschauung* that fosters virtues like *faithfulness, confidence, personal responsibility, individual freedom, liberty,* and *respect for authorities*. Climate believers, on the other hand, are typically communitarian-egalitarian who value *social cohesion, shared commitment to the good, solidarity, participation, fairness, equality, group-orientedness,* and *cooperation*.

Scientists also share such virtues, but the important issue in our context is what kind of work-related virtues are commendable in order to contribute to a rational, emotionally tempered consequentialist work climate in climate related matters. We have emphasized the importance of being *humble* and avoiding *hubris* in geoengineering. With regard to recovery and restoration it is important to be *open* and *accommodative* with *ecological sensitivity*, *care* and *patience*. In, general, work with mitigation and adaption requires *respect for people*, *respect for science*, *accuracy*, and *concern*.

Finally, a scientist working with climate change related matter also has a responsibility to participate in the public discourse to help inform people. And that requires *courage* as well as being oriented towards facts and not persons. *Factualism* is therefore also an important virtue. Science should aim to stay objective about truth, but never indifferent to the pressing practical problems humanity faces.

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