

The 2:1 Resilience Factor, Education for Mitigation and Adaptation

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Introduction

Canadian Prime Minister Justin Trudeau's January 2017 observation that his country needed to phase out fossil fuel production in the oil sands as part of the response to climate change drew a mixed response (Muzyka 2017). Though grounded in science and fact and acknowledged by some, it was greeted with howls of outrage by others including politicians and citizens. Rhetorically they asked, how could the Prime Minister threaten the well-being of so many? It highlighted an urgent challenge for Canada in upholding the Paris Accord, ratified by Canada on 5 October 2016, while providing a healthy and prosperous future for its citizens.

It demonstrated a large scale ignorance about climate change, the level of urgency, and the necessary responses. Anthropogenic Climate Disruption (ADC) has the potential to challenge everything from water supplies and energy use to food production as well as a host of other quality of life issues. Public commitment to policies required to shift the economy, so that carbon usage is reduced and ecosystems are restored, is essential. Going forward, life will be changed by this issue for which decisions must be made and policies crafted. Prime Minister Trudeau was laying the groundwork for a broader conversation. Canadians need to be informed and aware of the problem, open to imagine its implications for the future, and ready to act individually and corporately.

This chapter examines two aspects of the problem for education around the changes having an impact on Canada. After a brief review of the attitudes that led Canada to this point, we will look at the need to educate all and then offer an approach to formulate content for a new curriculum. We, the authors want to be clear with our intent. Neither of us are scientists, we are educators. Together we have significant experience teaching in Ontario's colleges and universities. We have experience teaching in programs that do and do not emphasize environmental education. We speak as educators seeking a means to insure that today's students become tomorrow's innovators and involved citizens able to craft solutions for their world and increase our resiliency together.

Evolution of attitudes in Canada. In addressing the issue of climate change and resilience from an educator's perspective it's worth considering how we got to this point. A quick Canadian history lesson will provide some context.

The 17th century settler arriving in New France, today's province of Quebec, or the United Empire Loyalist of the late 18th century fleeing the new United States of America for the wilds of Upper Canada, today's province of Ontario, encountered forbidding landscapes of trees, swamps, wild animals and other threats. These challenges were interpreted in different ways by these newcomers as opposed to the people who were familiar with and had lived in these landscapes for upwards of ten thousand years.

As late as 1842 the English novelist Charles Dickens, on his tour of North America, wrote, "There was the swamp, the bush, the perpetual chorus of frogs, the rank unseemly growth, the unwholesome steaming earth..." and he meant none of it in a good way (Dickens, 1842).

It was an imperfect world of natural obstacles. Overcoming these was a priority for those with roots largely in Europe for whom advances in comfort, well-being and prosperity were ideals to be pursued. In the case of First Nations peoples they had arrived at an uneasy balance with this imperfect world. Their own practices over a ten thousand year, or more, residence had likewise transformed this world as first encountered, though in ways less apparent to European settlers whose increasingly sophisticated technology made for a more radical transformation.

For the new settler, whether of French or British extraction, or possibly a one-time free African fleeing slavery in the American states, trees were an impediment to farming and their removal required back-breaking labour. Swamps were wasted spaces in which pests and mosquitoes, carrying diseases including malaria, might be found. Wild animals from bears to wolves threatened the very life of an unarmed pioneer.

The elimination of vegetation, the draining of swamps and the killing of those bears and wolves was a priority. Trees were burned for potash, underground aquifers were tapped for water, and rivers were dammed to build mills to produce flour for bread. Such measures reflected a bias for tackling and subduing nature in contrast to the more balanced relationship achieved over the long-term by First Nations peoples. Few would want to undo the consequent raising of human prosperity and longevity to levels never before attained, and within a period of five to six generations.

European settlement brought artisan-based industries which in turn were often replaced in the latter half of the 19th century by those with a pronounced management-labour size and separation. Cities were enlarged to provide goods and services beyond the imagination of even the first European settlers. Human comfort was enhanced by predictable internal heating systems and labor-saving kitchen appliances. Means of mobility advanced from trains and bicycles to automobiles and airplanes. Air conditioning finally created the last piece for the year-round comfort most people in the developed world take for granted. New entertainment systems and finally digital devices have made it possible for most people to have a virtual library of learning and culture at their personal disposal.

Erasing aspects of the natural world made sense within this development model. Only gradually has the wisdom of these actions been turned on its head. The natural world and its associated bio-capacity including all those annoying items listed by Dickens are now recognized for their essential role. A grudging acceptance of the balanced perspective of First Nations peoples is likewise acknowledged.

The swamp is a wetland which not only holds water during times of active weather and flooding, but harbors places for wildlife and other living things in the natural world, The bush defines landscapes, provides pathways for living things to move within, and supports vegetation, allowing for carbon sequestration and climate change resilience, The perpetual chorus of frogs is a sign of heightened bio-diversity while their decline is an early warning of a threatened nature, The rank unseemly growth are those diverse natural settings free of both pesticides and a monoculture of crops allowing pollinators such as bees to flourish, and The unwholesome steaming earth is the mixture of fine soil and loam within which food is grown and which has significantly declined in depth since the arrival of Europeans. Bio-capacity has multiple benefits. As well as the above-noted regulating services for climate resiliency, its bounty also includes aesthetic and cultural attributes, provisioning for food, and support for habitat enhancement, nutrient cycling, soil formation and photosynthesis. Absent these services humans would have to find a means of providing them through labour and ingenuity. There is no guarantee that we would be successful. Today Canadians and those in advanced western societies need more bio-capacity, not less as was the case in the days of the pioneers.

The reduction in the essential ecological services of a healthy bio-capacity, has been matched by unhealthy accumulations of carbon in the atmosphere associated with emissions from buildings, transportation and various industrial processes. These correlate with rising temperatures and uncertain weather patterns. Thus today's population needs an informed-environmental perspective so they have the capacity for urgent action.

Application to education

In November 1999, a report was tabled on outreach and education in conjunction with the National Climate Change Implementation Process (Reaching out to Canadians on Climate Change 1999). The report called for government funded outreach on the topic to several audiences including youth up to age 29 and educators in order to increase support for required economic shifts. In 2003 the organization, Environmental Education Ontario (EEON) issued an appeal to address a lack of environmental education in the province of Ontario. They specifically called for strategic interventions to insure that post-secondary faculty and students were well informed about environmental issues in the province (Greening the Way Ontario Learns 2003). In 2015 the organization issued a report card for Ontario to assess the populace's general environmental awareness and commitment to action. This report card, based on a telephone survey of 1000 Ontario residents found that 21% of the sample population was

aware of issues of water pollution and 16% were aware of issues of climate change and energy. Only 6% were aware of biodiversity loss and another, perhaps the same, 6% were aware of invasive species (Omnibus Survey Report, 2015).

Since the initial 2003 report and the more recent report card, the issues of climate change, energy, and biodiversity have only become more urgent. If the world has not already gone past the 1.5 degree Celsius temperature rise goal of the Paris agreement, then it is very close to it. Once that is past then there is only the hope of sufficient action to prevent the next threshold of 2 degrees. The current rise in temperature is unprecedented, not only in the short amount of time in which it has occurred but also the extent to which it correlates with human activity. Together we barely understand how it will change the world. For example, melting tundra regions would release quantities of methane with even more profound impact on climate. A severe reduction in the greenhouse gases that have caused increased temperatures is required at this moment. Likewise, we are now in what some call the 6th Great Extinction, a rapid and substantial loss of biodiversity often caused in part by loss of habitat as it is appropriated for human uses. Urgent action is required and citizens must support new policies and laws to address the potential for runaway ADC and other environmental issues.

The results of the EEON report card therefore are cause for dismay. Not enough of the population is sufficiently engaged especially if new policies appear to be costly both individually and corporately. One of the other findings of the phone survey for the 2015 report card was that people are most willing to modify their behavior towards the environment if it saves them money or contributes to their health. While those are reasonable personal motivations they appear to demonstrate a fundamental misunderstanding of the gravity of the situation. To achieve the hoped for low-carbon economy and then to engage in the process of environmental restoration the original goals of the EEON must be implemented and even furthered.

In addressing the issue of climate change and resilience, the role of educators outside of those engaged in university scientific environmental research is essential, since the latter, classified as scientists concerned with either pure or applied investigation, generally appreciate the challenge ahead. The majority of educators from university lecturers, to community college faculty have the ultimate challenge of molding the critical faculties of students while embedding certain facts and ideas as givens. This can present an immediate conflict in the market driven model of contemporary academic institution. Over the past few decades many post-secondary institutions have shifted their mandate from training up citizens who can engage critically to producing graduates who can enable economic growth. Scott (2010) believes that in order for environmental education to be successful civic values must once again be balanced against economic imperatives in order to lead students to develop cooperative behaviors and wise ethical approaches.

While the number of programs offered in Ontario with some form of environmental programming has increased over the years alongside an expansion in environmental work, students exposed to this education are primarily self-selecting, environmentally informed and motivated. It is the rest of the student population for whom there should be concern. They are led by educators who are not climate or environmental specialists, who may lack informed environmental behavior themselves, and teach in programs that ignore or may even resist a foundation of environmental knowledge. Just as an awareness of human diversity issues, and health and safety protocols, should inform all education programs, so has the environmental imperative entered this essential realm of understanding.

In a world of fake news, false hypothesis, self-interest, and corporate/government manipulation of information and conclusions, and particularly around an issue like ADC and its impact on the resilience of taken-for-granted systems from water and food to energy, how can educators overcome the biases in various points of view? How can they prepare students to reach reasonable conclusions as to the most likely explanation for the phenomenon they learn about, observe and upon which they can act? Indeed with the rise of vast amounts of information available to all on the internet the educator has the additional task of countering narrowcast media that can easily negate the content of a course attempting to lead students to an informed environmental perspective and appropriate action (Hamilton 2011). In fact, just facts may be a problem within a context that invites contradicting analysis from the general scientific consensus. Thus education that enables critical thinking about all environmental knowledge is essential (Yamashita 2015).

The word “act” is particularly significant for the manner in which it recognizes that the goal as functioning citizens is not bemoaning a world that cannot be changed, or blindly running off in all directions attempting to cure all maladies, or for that matter accepting as gospel the first thing that is read or heard about an issue, but rather to examine it as fully as possible from multiple perspectives, and to act, if such is appropriate, on this knowledge.

As well, educators need to be cognizant of the role their graduates will play. Community college educated persons for instance largely take up second tier positions in their respective fields. In medicine they are the nurses, first responders, and physiotherapists. In the built environment they are the technicians, technologists and operators. There is nothing pejorative about these definitions, simply an acknowledgement that ultimate decision-making resides, in the case of medicine with university trained doctors, and in the built environment with university-trained engineers and architects who have legal signing authority.

As second tier practitioners in the built environment however those technicians and technologists are effectively the life cycle guarantors of whatever sustainability features are embedded in either new or retrofitted construction. Their ongoing role contributes to both the long term financial integrity of a project but also helps realize its essential contribution to climate change mitigation and resilience.

Beyond first and second tier practitioners who work in a field normally associated with environmental issues, there are all the graduates who work in other professions and fields. They may receive no education in environmental science or environmental studies unless they personally seek it in an elective. Their program may not even offer the possibility of such an elective. Thus, these students can easily go through their program and graduate without basic environmental knowledge.

The first requirement of educating young people is to prepare them for the world in which they will live. The mentoring adult has the responsibility to give them their best chance to survive and thrive in their context. Failing to do so is ethically harmful by abdicating the first responsibility of adulthood. At this point in Ontario, we are failing our students. Only a select few, those inclined towards programs that prepare them for environmental careers or recognize the multiple crises that will impact their field, are truly getting the information they need for the future. In a look at communities in Brazil it was found that those who had received some education, particularly so with women, were able to better assess climate change risks and respond to them (Wamsler et. al 2012). In the end, educating people about resilience and adaptation may reduce costs for dealing with crises and disasters.

Every graduate in Ontario must be ready to live in a low carbon economy, one that must be achieved quickly. Every graduate must be prepared to deal with the crises that accompany ecosystem failure and flips, for shifts in water regimes, potential food shortages, changes in agriculture, new approaches to energy, waste management, manufacturing, living arrangements, and habitat conservation and restoration. These issues and more will affect and determine their quality of life. They will all have to make decisions within this new context, one that might be characterized by a chaotic climate. And yet, most will graduate their college or university program this year completely unprepared. Worse, due to faculty that as of yet are not fully convinced about ADC or simply ignore the topic, these new graduates could well be hostile to the policies and legal approaches designed to engage the population in required remediation efforts.

Facing so much fundamental change in one's world can be terrifying. How then to bring along the population that will be most affected by these changes, those who will be forced to accept change and even plan for it? Post-secondary education is a last chance to really address these students. For those who will go straight to the work world and never again engage in any kind of academia, it is a final moment to grab their attention and give them the information and skills they require for the future. For all those who immigrated or arrived as international students, it is a chance to inform them when they might have come from a culture without such education. For those raised in Canada and in Ontario, it is a final opportunity to shape opinions, to inform, and to encourage positive action.

Some universities and colleges have attempted to make environmental awareness more universal in their institution through their own sustainability programs. These are often programs that engage

with students around issues of recycling or managing food waste. They may go further and educate around green roofs when they construct a new building, or redesign their landscape in a more naturalized manner and install bee hives. All of these initiatives are important and useful to create a context in which students are more aware of their environment and aware of useful action. However, even these initiatives do not go far enough. Stressed out students can easily walk past the information displays, ignore the call for their attention, and focus on what they perceive to be their needs. Greener universities and colleges are important but they are a start rather than an end of the work needed to prepare graduates for the world in which they will live.

There is some encouraging news about post-secondary environmental education in Canada. When students are engaged about the environment their motivations and attitudes are changed. They develop an informed environmental perspective. In 2003 as a graduate student, McMillan at Dalhousie University investigated the effectiveness of an Environmental Studies course offered by the Science department. She found that over the course students became more nuanced in their understanding as their knowledge deepened (McMillan et. al 2004). However, as she also notes, this group of students, like those in most environmental programs, are self-selected and generally also aware of many environmental issues. In a recent presentation members of the Canadian College and University Environmental Network (CCUEN) noted that by 2015 the Association of Universities and Colleges in Canada had listed over 200 programs focused on environmental and sustainable development in Canadian post-secondary institutions (O'Connor et. al 2015). We appear to be reaching those students who are eager to learn more, motivated to do the work, and seek to be employed in professions with an informed environmental perspective. But what about the rest of the students?

There has been much research done on learning, motivation, and how to overcome denial especially associated with climate change. This knowledge means that any curricula written for a more general post-secondary audience has to be different from the usual environmental science or even an environmental studies course. To convince students who are not drawn to environmental education of their own accord the educator has to understand the starting point of the students, their world views, and insure that the course offers opportunities for affirmation of the individual student's identity (Storks-dieck et. al 2005). The course has to be something that is understood as a communication tool first, a tool to change behavior and to motivate to action. This may demand a shift in content and in the mode of presentation.

As we consider the content of a general education course in environmental issues for post-secondary education, we must first acknowledge all of the good work already out there. There are programs available at many levels that address issues well. But two things suggest a re-examination of content. The first issue is the sheer urgency in what is happening to the climate and to the planet in terms of changing weather patterns, ecosystem shifts, ocean acidification, and sea level rises, species extinc-

tion, and all the associated effects and outcomes associated with such changes. The second issue is that environmental education must move quickly to a new audience or several new audiences, from self-selecting and already concerned to those who are in a general post-secondary program. It will require a means of addressing the whole institution through transdisciplinary, multi-faculty cooperation and teaching (Pearson et. al 2005).

A shift in focus and presentation

The challenge as citizens has become one of modifying the environmental impacts of our lifestyles with particular emphasis on reducing greenhouse gases which currently, and long into the future, will abet climate unpredictability and ocean acidification. Reducing these emissions has become an urgent public priority, alongside means for contributing to bio-capacity enhancement. Or at least this is the generally held scientific conclusion of over 95% of that community. The challenge as educators is how to communicate the problem and potential solutions to a general student population destined for a wide variety of job outcomes. Part of the task for educators is choose how much consideration should be given to the outliers from the consensus point of view. To suggest this is a “one or the other, or a 50/50” disagreement is to unfairly load the dice in favor of those outliers whose conclusions might be one of nuance rather than opposition, or who themselves are proprietors of self-interest funding or business opportunity.

As problematic however are the recommendations for action by those who generally agree with the 95% plus scientific community. Arguments for varying types of action range on the one hand for a return to a nature more in tune with the world accepted and managed by First Nations peoples, either through willful intention, or imposed necessity, or on the other hand to an accelerated speeding up to greater prosperity and a development agenda based on the conclusion that wealthy, prosperous citizens are the best advocates for, and ingenious developers of, greener more efficient technologies and lifestyles.

If we might risk a conclusion it is that most citizens would opt for both possibilities in the range, i.e. both a heightened health and management of natural features, and increased human comfort and prosperity world-wide. The scientists might scoff at such a possibility citing entropy (all things must eventually run down and die), relativity (we’ve had a good run of luck and invention but even our brightest discoveries like antibiotics are short-lived respites from reality), and the deep contradictory expectations implicit in such a world view.

For a moment however let’s look at its possibility from the perspective of educators rather than scientists, and particularly of students not already engaged in the conversation around environmental issues. When it comes to extending environmental education into the general population of post-

secondary students, and further into the adult population, two issues arise. First is the issue of content. What content is useful to educate, inform, encourage action and motivate the desired behavior? The second issue is presentation. How should such a curriculum be structured and presented? Is it a kind of dumbed down shadow of most sustainability or environmental science courses? Or should it be something different reflecting the nature of the audience? This audience is critical. The various graduates of the many diverse programs across the province and Canada will engage in important decision making during their lifetime in response to environmental issues. Their shopping choices will influence how food is produced, how water is managed and what kind of energy is used to produce it. Their decisions and commitment to waste management will influence agriculture, processing and manufacturing. What they learn and how they learn is important. Arguably, it is this yet to be fully engaged audience who will have the most impact on how Canadians adjust systems and infrastructure to respond to ADC and other environmental issues.

Environmental education has been around for some time, long enough for research to have been done on what works best. Accordingly the UNESCO report of 2012 that concluded the Decade of Education for Sustainable Development comments that ultimately a variety of teaching approaches appears to elicit desired behavior. Responses to their research demonstrated that “all seem to point to a need for well-rounded, interactive, integrated and blended forms of learning” (Shaping the Education of Tomorrow 2012, p29). It is imperative to begin by understanding the audience, their beliefs, attitudes and values and how people construct their attitudes about climate change and other environmental issues (Brownlee et. al 2013). Pedagogical methods that stimulate self-determined behavior also appear more successful in motivating students to make better decisions regarding the environment (Darner 2009). Newman and Fernandes (2016) tested and found a wide range of variables within different contexts influence behavior towards environmental issues which continues to point towards educational methods that account for multiple influences on the student’s decision making.

However, while education overall correlates with motivated and informed care for the environment in students and adults (Meyer 2015), increased knowledge is not necessarily the answer for the general population. It is an easy assumption by educators that it is simply lack of information that causes poor responses. Accordingly, most educators seek to inform first. But much research demonstrates that people’s decisions are based on a host of variables that have little or nothing to do with knowledge acquisition and that those variables tend to be weighted differently when it comes to decision making (Heeren et. al 2016, West 2015). Beyond that, there is a reason these students are not in environmental programs. They may not be interested but sometimes it is due to an aversion to the required material especially science and mathematics. And these may be key differences between the self-selected population who sign up for environmental programs and courses and those who do not. Attempting to meet this larger and crucial general population of students requires a re-evaluation of pedagogical approach and materials.

As the government moves forward in making the required changes to promote a low carbon economy it needs the general population on board with the policy shifts. However, research shows, that with adults their world view often outweighs knowledge when it comes to support for such policies. And that additional knowledge can actually increase polarization and resistance. Yet, young people, teens and perhaps young adults, are still formulating their world view and are more open to change (Hobson and Niemeyer 2012, Stevenson et. al 2014). This means that addressing the post-secondary population not engaged in environmental programs may be critical for future policy support.

Research has gone into determining how to motivate behavior in caring for the environment. But aside from campus wide initiatives that often involve food waste or energy use, little has been asked about the general population of students not involved in environmental programs and career choices. However, research into the factors that influence decision making demonstrate that people are led by everything from their own sense of self-determinism and self-affirmation (Sparks et. al 2010), to peer and social pressure (Gifford and Nilsson 2014), to a context of collective action or its lack (Pongiglione 2014, Sweetman and Whitmarsh 2016, Obradovich and Guenther 2016), or as is often described as intrinsic and extrinsic motivations to moral emotions in general (Xie et. al 2015), to the morality inherited from the parenting style of their family (Barker and Tinnock 2006) and finally, to a need to justify existing systems (Feygina et. al 2010). The general population of students on a Canadian campus today brings all of these variables to a course on the environment. They come from varied backgrounds, diverse countries and cultures, different religions and ethnicities. All of these influence how they perceive their own and collective responsibilities towards the environmental context in which they live. Course content and teaching approaches must account for these variables to be effective (Heimlich 2008, Brownlee 2013, Klockner 2013).

Course content may be able to address some of these variables. Certainly, environmental science and studies classes include components on morality and environmental justice for human beings and other species. But this material would have to be tailored to a population where the educator cannot assume a starting point of general agreement. Thus the course content needs to provide a means, perhaps subtly, of speaking to the often hidden factors that impede both learning and sustained post-course behavior. It is for that reason that it may be useful to shift the focus in a general education course from sustainability to resilience and regeneration. These concepts, resilience and regeneration, may better address those students with more conservative moral frameworks. Resilience speaks of strength, both individual and community and the ability to withstand hardship and difficulties. Regeneration addresses the nostalgia often a part of a conservative moral framework. It seeks to restore what has been lost. This content shift is also much more in tune with the current situation, the urgency of swiftly shifting ecosystems and water regimes along with the mandate for both mitigation and adaptation.

One way to measure resiliency is to compare bio-capacity to carbon footprint. First there's some apparent good news at least from a Canadian perspective. Unlike virtually every country with an advanced industrial economy Canada has the distinction of having twice as much bio-capacity in comparison to its ecological and carbon impact. Why? Simple answer – it's a big country with a relatively small population. On a per person basis however each Canadian is as profligate, or more so, than the highest consuming polluters in the world.

So is there a Canadian model that might provide a way to tackle the current challenge of advancing prosperity while at the same time lowering environmental impact? Canadian bio-capacity as measured against the absolute Canadian ecological/carbon footprint is at a ratio of roughly 2:1, providing perhaps an inadvertent but useful heuristic as a go-forward approach.

We need to be careful however about suggesting that this is a scientific conclusion. The 2:1 is a loose and crude calculation that comes from a particular set of data points put together by the Global Footprint Network. They use over 200 data points to calculate a national ecofootprint and the biocapacity to sustain the population under the current management practices. They have data that starts in the 1960's.

The problem for Canada is that its calculation ratio has been decreasing since then. Canada has not held steady like Finland (at around 2.27:1). Instead the 2:1 is actually a less than stellar outcome born of poor management of resources. In other words, if the world is looking for good models Finland is much better than Canada.

The Canadian ratio is based on 2012 data so it has likely got worse since then. It does retain currency however as a target to maintain and in some measure to regain, or as a model to be approached for greater certainty on a scientific basis. Perhaps more useful however is relying on this simple heuristic as a marketing tool - a way to organize and mobilize a population. It provides a simple, easily understandable goal to mobilize the general population of students and graduates. This framing in terms of motivation appears important. A study in Ontario demonstrated that, more so for men than for women, framing the issue of climate change as a motivational message rather than one of sacrifice elicits a more positive response (Gifford and Comeau 2011). Negatives do not motivate people well. The real use of the 2:1 ratio is perhaps as a motivator for changes in human behavior, beginning in Canada but also as a goal in other developed countries.

This is the problem with using footprint calculators in academic institutions. We are essentially handing students a negative number. Even one of the authors of this article, a resident of a solar powered 'green' house, with a commitment to transit use, and reduced meat consumption still comes out at three planets worth of carbon footprint. A significant aspect of this is simply how hard it is to reduce

carbon footprint within the social and physical structures of where most people live in the developed world.

One of the ways to motivate climate change deniers and the politically adverse, those that tend toward a conservative morality, may be to focus on how much has been lost and the need to restore what was once plentiful or healthy in the past, that is, a conservation approach. This is actually what the ratio measures. It shows what we had in the past and what we are losing. Restoration is what we are looking for first. Research has shown that while the moral framework for those who lean politically conservative includes in-group identity, compliance and purity, such people are really not that different from those who are more progressive politically. Both groups seek to reduce and mitigate harm (Schein and Gray 2015). Content in general education courses should be shifted to reflect this desire in all students to assess and then reduce harm to themselves, their loved ones, communities and society as a whole. Pushing further in terms of ethics, the ratio could then be adjusted for an optimum regeneration level and restoration of biodiversity, though more work needs to be done on what that would be and from where the data would come. Concurrently, erroneous approaches and false facts that produce skepticism should not be affirmed as it can cause confusion in the classroom. Critical thinking and constant references to scientific consensus are recommended by Torcello to counter such skepticism (2016).

There is one large gaping hole in the current data sets measured by the Global Footprint Network. Their measure of biocapacity is purely human centred. They measure the capacity of local fishing grounds, inland fish production, forest production, and cropland to satisfy the needs of the population. There is no measure of biodiversity or any kind of measure for the satisfaction of the needs of other species. In terms of regeneration, this is a significant problem. In other words, using their data, the heuristic of 2:1, may fall short of being truly regenerative.

Recognizing the tentativeness of the above conclusions, it is suggested that environmental education be shifted to emphasize resilience and regeneration. Students could be taught that for each unit of ecological/carbon footprint humans expand by their activities they should as a beginning point and at minimum add two units of bio-capacity. Means range from restoring, upgrading, renewing or creating the conditions, places, and investments for this action. A simple action to increase bio-capacity is to plant a tree, this helps mitigate greenhouse gas emissions, deals in urban areas with the heat island effect, manages rainfall, and provides habitat for birds and perhaps other species. A naturalized yard is similar in its outcomes. Collective actions can deal with areas and issues that are larger in scope. Yet the motivation is rewarded with a positive outcome rather than the struggle of trying to reduce a carbon footprint within a cultural context which can make that very difficult to accomplish. Additionally, such actions are real and measurable outcomes to environmental education. As Heimlich advocates, rather than measure individual knowledge and attitudes, the real shift is in the measurable conservation actions that make a difference (2010).

This approach acknowledges two realities. On the one hand the world's ecological/carbon footprint will increase for the simple reason that despite reduced per-unit energy use in the way modern cars operate and building efficiencies are achieved, cumulative intensification is inevitable in a world of increasing population and an improving quality of life with associated middle class consumer expectations. As well, the mixture of sources of carbon release and the environmental impact of continuing resource use will likely retain a similar character as today into the foreseeable future. This will occur even with the use of alternate renewable energy means. Wind turbines and solar collectors after all require the use of rare earth and other minerals and materials, a construction process, transportation to a site, mounting, maintenance and finally the eventual disposal, all with degrees of carbon and ecological impact.

Countering this is the necessity therefore not simply for bio-capacity replacement through a series of one-for-one measures but its increase as a function of enhancing and increasing natural resources fecundity and associated ecological services. This creates ecosystem redundancy, a necessary component of resilience and regeneration. This takes students beyond discussions of sustainability and onto action that can both mitigate and enhance adaptation to climate change.

Such an approach actually takes seriously the current situation. It surpasses the checklist approach of so much sustainability programming which is based on reducing impact, or simply slowing the rate of decline often through perceived or real sacrifice. It is a net positive development philosophy that responds to a real potential catastrophe rather than one playing about the edges for the feel good sense that “well at least we tried!”

Tools and protocols are required which link bio-capacity increase alongside inevitable carbon/ecological impact and ones which refine the ability to measure these initially on a 2:1 basis. A necessary step is appreciating the accordion-like nature of this examination, i.e. as more eco/carbon impact occurs the accordion is necessarily much wider necessitating a doubling in the size of the bio-capacity piece, but as efficiency and less impactful means of meeting human comfort are implemented, and which possibly conserve or add to bio-capacity, a narrower accordion is required in which the bio-capacity enhancement though smaller is more strategically aimed at crucial points of repair or replenishment. Students will need to understand that resilience 2:1 is a process dependent upon its context.

Ironically this approach may be the best resilience strategy for coping with climate unpredictability as well. The re-institution of aspects of an enhanced bio-capacity provides measures for protection from violent weather conditions, cleans the air, provides shade, stores water, contributes to food provisioning, and acts to mitigate climate change causal factors by sequestering carbon. Informed environmental behavior based on resilience and regeneration offers the best chance for an individual or community to make an essential difference.

For decades sustainability and sustainable development have been the foundations of many of the university and college environmentally focused programs. This creates potential problems when approaching a general education course and in preparing young adults for the future they face. Resilience is based on disaster preparation. It acknowledges the crisis facing humans and other species and seeks not just mitigation but adaptation. Such content may actually contradict what has been taught in sustainability courses. At this point, in light of reality, environmental education courses as they have been taught may actually impede required preparation in resilience (Krasny and DuBois 2016, Lundholm 2010). This shift in content is one that honestly acknowledges the new reality and has the possibility to address at least some of the variables that motivate human behavior. It has the possibility of engaging the general population of students who have shown no interest in an environmental professional career, or are frustrated with the sense of doom, have little information on how to positively respond, and possibly are science adverse.

Conclusion

In conclusion what does this mean for the educator?

One of the main issues regarding climate change preparedness and associated resilience planning is the lack of understanding of basic climate change issues in the population. Most data is too complex to motivate changes in behavior. And there is a crucial population sitting in classes every day who desperately need to understand the situation and have a positive motivator given to them to insure changes in daily life and the required social, economic and political action.

Beyond that, while some planners and cities or subnational entities have the capacity to deal with complex data production and application, many do not. The heuristic ratio of 2:1 could be developed so that smaller groups right down to the neighborhood level have a means of analysis and action within their own locales. 2:1 is a tool that needs to be developed for particular audiences to achieve particular results and, above all, become a foundation for action to mitigate climate change as well as to create greater resilience at all scales.

The heuristic 2:1 should be developed as a motivational tool to promote action. However, with one significant change, that is, to add in some sort of biodiversity indicators beyond those simply in service to humankind. Through the heuristic of 2:1, information can be created and formatted for use in college and university classrooms as well as for the use of planners, and smaller scale polities.

The latest innovations in communication through mobile apps and social media need to be employed to communicate this tool as means for popular education and motivation regarding climate change. This is the crucial need right now. Canada needs an educated public in order to support the changes required through policies and legislation not only to return to a 2:1 ratio but then to better it. 2:1 is a starting point not the end goal.

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