

Climate, Energy and Community: Vermont 2008

Alan K. Betts
Atmospheric Research, Pittsford, VT 05763

akbetts@aol.com

<http://alanbetts.com/writings>

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Abstract:

The responsibility of the climate scientist in the public discussion of the societal response to the global climate change issue is presented and illustrated using a series of columns, written in 2008 for the Environment section of two Vermont newspapers. These columns go through the seasons, dealing with weather, climate, climate change, energy and policy issues. They blend science with a systems perspective, and encourage the reader to explore alternative and hopeful paths for themselves, their families and society. They are written them so that a scientist will perceive them as accurate (although simplified); while the public can relate their tangible experience of the weather to the much broader issues of climate and climate change. The writer is the past-President of the Vermont Academy of Science and Engineering.

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1. Introduction

This is a synthesis of a series of articles dealing with climate change, sustainable energy and community issues that were first written in 2008 for the environment section of two Vermont Sunday newspapers. Although I am by profession a climate scientist, these columns are written from a holistic perspective to communicate with the public. I will first discuss what I see as the role and ethical responsibilities of the ‘public scientist’, and then I will provide some background to the articles themselves, and the frame of communication.

2. The public scientist, climate change and a holistic world view

There is a long tradition that science will lose its integrity, and scientists will lose their impartial reputation, if scientists stray into the domain of public policy. I have worked as a researcher in weather and climate for forty years, but this issue has concerned me for a long time [Atlas, 1975; Betts, 1976]. This is a comfortable doctrine for scientists, because it limits their sense of personal responsibility to their technical field of expertise. It can be comfortable for those in the policy arena, because science often presents an uncomfortable reality to entrenched ideologies. The principal is enshrined in the ground rules for the U.S. National Academy of Science panels, which examine and analyze the scientific evidence, but may not make ‘policy recommendations’ in their reports. This ensures a separation between the realm of scientific advice and the political process; but from my experience it can lead to Academy reports that accomplish little, because they must ignore fundamental structural issues in society.

The issue of global climate change, which directly involves the interaction of economic policy and the earth system, presents a direct challenge to this paradigm. Our human civilization is dependent on ecosystem services, and these are dependent in turn on the earth’s climate. The circle became closed once greenhouse gases from global industrial society began to shift the global climate to a new warmer state, with a dramatic long-term impact on the earth’s ecosystem (IPCC, 2007, www.ipcc.ch). Our scientific understanding of the earth’s climate and ecosystems is very incomplete, but it is all we have to guide policy that must look ahead for decades.

The climate change issue presents a direct challenge to traditional human-centered political and economic ideologies, and their implicit authority. Many in the policy arena lack a deep understanding of earth system science; and our global society faces many difficult choices, because our present development path is unsustainable. A holistic vision is needed which draws on expertise across all societies, if we are to move towards a truly sustainable global society. We are moving into a new realm for humanity and there are no authoritative ‘experts’.

3. Responsibility of earth scientists

Earth and ecosystem scientists have a broad ethical responsibility in this, and I will use my personal experience for illustration. Elected as President of the Vermont Academy of Science and Engineering (VASE) for 2005-2007, I walked the line between science and policy, trying to help Vermont understand the big scientific picture of climate change as it is transforming this northern state. Many in business and politics thanked me, saying that getting an understanding of the big picture helped them realize that fundamental changes of policy are needed. But ironically, some on the political side suggested they are more comfortable listening to advocacy groups than to scientific reality in all its honesty and complexity. But, as a matter of scientific ethics, this is a scientist’s role: to present the uncomfortable reality of a complex earth system, whose stability is now threatened by human industrial society. Some would rather ignore this, because there is so much wealth at stake; and the mismatch between legislative terms and the long timescales of the earth system has made this possible.

But the fate of the earth should not be left to a struggle between lobbying and advocacy groups who have other agendas, and a rather limited interest in the integrity of the science. Our democratic political system needs to hear from many voices, not just those with narrow self-interests, whether the fossil fuel lobby, or the many environmental groups, or the proponents of an unregulated global financial system. Society needs to hear also from those who see the big picture, which include the science of the

earth and its ecosystems; as well as from the many who understand the profound moral issue of our responsibility for the future of the earth.

4. Responsibility to the public

Scientists also have a responsibility to communicate clearly to the public, not just to their colleagues and to those in power in society. The responsibility of scientists to the public is two-fold. Without a much deeper understanding of climate change and the earth system, citizens cannot see the need for change, so they cannot support governments when they have to make difficult decisions to move away from ‘business as usual’. It is also true that science and society are interwoven. Money for scientific research comes from society and with it comes an obligation to share what we learn with society. The scientific agenda is also set partly by the scientific community and partly by society – with all its political agendas. When scientists accept money for research to address issues that confront society, their research is interwoven with the assumptions of these political agendas. But scientists have the responsibility to both humanity and the earth to look deeper, and tell the truth as far as we know it, in all its richness and complexity.

I have been fortunate to have been funded by the National Science Foundation (NSF) as an individual for more than thirty years, and NSF has accepted my educational contribution to society. Every scientist has different skills, and I am suggesting that we recognize as a scientific community that some of us need to be embedded more deeply into society, if we are to find creative solutions to the challenges that are facing both humanity and the earth. Certainly scientists need to preserve the very high level of honesty and integrity that is central to science. At times this will conflict with a culture that often ranks persuasive deception higher than honesty, but integrity is one of the gifts of science to society. Clear communication should be another!

Elected as president of VASE for 2005-2007, I was drawn into the public discussion of climate change in Vermont. I was confronted by a public, eager to understand climate change and seeking information, understanding and guidance. Initially I simply responded to a flood of requests in 2006-2007 to give talks to schools, business and professional groups, as well as the legislature and the State Climate Change Commission. Talks and interviews on public radio and in newspapers then followed.

5. Newspaper columns in 2008

Late in 2007, the editor of the *Rutland Herald*, Randal Smathers, a community activist, Carol Tashie, and myself met to discuss starting a new Environment section in the paper. We selected the section editor, Elizabeth Gibson, and this new Environment section was launched in January 2008 in the Sunday edition of the two state-wide newspapers, the *Rutland Herald* and the *Barre-Montpelier Times-Argus*. I have two roles. I am one of five columnists (at present), but I am also the science advisor to the section editor. This gives the section a distinctly different journalistic model. Although we publish a wide variety of ideas and opinions, our emphasis is on scientific and technical accuracy; rather than ‘journalistic balance’, which has led to the extensive publication of deliberately deceptive information in the press in the past decade.

The intent of my columns is to cover, in an accurate informative way, the broad issue of climate change, as it affects Vermont and the Earth; and to suggest strategies for individuals and communities that could lead to a sustainable society. The framework is holistic: attempting to explain both the underlying science of what is happening, as far as it is known; and how we the people, through our industrial society, are now deeply interwoven with the future of the earth and its ecosystems. This is

clearly a much broader task than simply communicating estimates of global temperature rise for 2100; so I will make some issues explicit.

My columns go through the seasons, dealing with weather, climate, climate change, energy and policy issues. They blend science with a systems perspective, and encourage the reader to explore alternative and hopeful paths for themselves, their families and society. I have written them so that a scientist will perceive them as accurate (although simplified); while the public can relate their tangible experience of the weather to the much broader issues of climate and climate change. Although they are written for a Vermont audience, which is thoughtful and eager to understand the issues, they are of wider interest to northern latitudes, and to U.S. and global policy discussions.

In places I have to define and explain important concepts; and there is always a friendly and valuable struggle with the section editor to balance her perception of the use of language with my need for a precision that means something to the scientific reader, but is transparent to the public. Most articles include some technical discussion, but the choices we face are framed using imagery and emotive language.

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a) Welcome to the Planet **(20 January, 2008)**

This is an exciting moment for Vermont: the beginning of the “Weekly Planet” column and the new environmental section of this Sunday newspaper (the *Rutland Herald* and *Barre-Montpelier Times-Argus*). The journey before us will be a great adventure. We have reached a critical time for the earth. This past year, four reports from the Intergovernmental Panel on Climate Change mapped out in remarkable detail the scientific evidence that our fossil fuel economy is driving irrevocable climate change by increasing the heat-trapping greenhouse gases in the atmosphere. These reports also outlined what our society can do both to change direction, and to adapt to the warming of the planet that is already under way.

We started 2007 in Vermont with record temperatures in January. By September, 40 percent of the

Arctic icecap had melted. For the first time the fabled Northwest Passage was ice-free. The frozen north is melting rapidly as the Earth warms, and droughts are spreading in the subtropics.

The discovery of fossil fuels centuries ago drove the industrial development of our world. Until the last few decades, we had no idea of the consequences for the earth's climate. Oil supplies may now be running scarce, because we burn it so wastefully; but centuries of coal reserves remain. If we simply burn all this coal as we have consumed oil, the earth will warm so much that the ice on Greenland and western Antarctica will eventually melt, although it may take many centuries. Sea level will rise by as much as 50 feet to flood our coastal cities and plains. Whole ecosystems will be destroyed as the earth continues to warm, and hundreds of millions of people will become refugees, driven from their homes by environmental disasters, floods, drought and starvation.

It is difficult for us to grasp the scale and magnitude of the issues that we face. For many years a wealth of opposing interests have been spreading misinformation about the global climate change that is under way, in an effort to deny that our wasteful use of fossil energy is responsible. Time is running out. We must change direction and reshape our infrastructure to be energy efficient and powered by renewable energy sources. We now have less than a generation to do this, because we have delayed so long. We need ideas, inspiration, and ways of working creatively and more humbly with the earth, not against it, as we make the transition away from fossil fuels. We need clarity and hope to find our way through the web of confusion and doubt that those who stand to profit in the short run will continue to weave.

How can we recognize the landmarks on our way to a sustainable society? Think of some simple examples! Does it make sense to drive a heavy, inefficient truck or SUV to work, when an elegant and powerful hybrid gas-electric car will do the same job and get 50 miles to the gallon (4.5litres/100km)? As our heating oil bills skyrocket, isn't it time to fix those drafts and double the insulation in our homes? Either measure alone each year could save per household about \$1,000 in fuel costs, and put 7,000 fewer pounds (3200kg) of CO₂ into the air.

Using fossil fuels to ship most of our food thousands of miles is not sustainable. Growing more of our food locally is not only sustainable but also benefits Vermont farms. It's even easier for us now, as the warming of the earth has extended our growing season by one month in the past 30 years. For the last few years, I have been able to grow magnificent sweet potatoes in Pittsford!

We need to develop new, renewable energy sources and new business models that are sustainable and earth-friendly. Anything that makes our communities more self-reliant is a step in the right direction. As our society functions more efficiently and we use less fossil fuel, we save money and reduce the growth of the CO₂ burden in the earth's atmosphere.

This is a huge but exciting transformation of our society, and it will require sustained community effort. The rewards for us, our children and grandchildren and our planet are immense. The price of continuing to ignore what our inefficient fossil-fuel society is doing to the web of life on this earth is beyond words.

b) Looking back at 2007, and looking ahead (10 February, 2008)

As we look back on 2007, what strikes you as the most important environmental event?

Do you remember the extraordinary warmth of January 2007? In the first 10 days of that month, I managed to turn over most of the rye cover crop in my garden in Pittsford, Vermont. The whole of Eurasia saw record temperatures that month, as well. Do you remember that an astonishing 40 percent of the Arctic ice cap melted by September, and how this contributed here to our balmy October and a late crop harvest? Or are the Vermont snowstorms of December still fresh in your minds, some of them fueled by evaporation from the warm Great Lakes to our west, and one by the remnants of tropical storm Olga in mid-December? Do you have relatives in Georgia, which saw one of the worst droughts on record? Or maybe you have family in California, where massive wildfires raged; or in Texas, where repeated flooding occurred during June. As the earth's climate warms, rainstorms in the tropics and in summer are getting more intense, while at the same time the dry regions of the earth in the subtropics are slowly expanding.

Or is your view a global one? Do you remember the terrible fires in Greece, the floods in England, the drought in Australia, the dust storms in China, the tens of millions displaced by floods in Bangladesh, or the two Category 5 hurricanes that struck Mexico's Yucatan Peninsula and Nicaragua? (Category 5 storms have winds greater than 155 mph (250km h⁻¹) and cause catastrophic damage.)

For our planet, 2007 was one of the warmest in the past 150 years. As we continue to burn fossil fuels, carbon dioxide is steadily increasing in the atmosphere much more quickly than it can be removed by our forests and oceans. The earth's greenhouse blanket is getting thicker, and consequently the climate on our planet is shifting to a warmer state. This in turn leads to the increasing extremes in the weather we are experiencing.

In my columns this year, as the seasons come and go, I am going to sketch out the interplay of weather and climate and the warming of the earth. I will discuss how, for better or worse, these changes are affecting our lives here in Vermont. This may seem to be a more "normal" winter for Vermont, but it really isn't. Just as I did in 2007, I walked out to my vegetable garden during the January thaw a few weeks ago. Since the ground was unfrozen, I was able once again to dig under my green cover crop in preparation for an early spring planting. As our climate on average warms, we must adapt where we can in our gardens and on our farms. We need to understand what is happening to the earth, so that we can care more deeply for our planet and the intricate web of life that it sustains, just as we care deeply for our family, friends and neighbors and all of humanity.

Our society is coming to the final decades of our fossil fuel binge. Our (former) president cheerfully said, "We are addicted to oil." Our addiction has been so, so profitable for the oil companies. I hope you have all enjoyed the binge! I remember fondly the first American car that my colleague and I rented on arriving in Miami from the U.K. in 1969, a Plymouth Fury 2. What fun! How it purred as it smoothly accelerated away with its powerful V-8 engine, getting a magnificent 12 miles per gallon (19litres/100km). But nearly 40 years older and wiser, I also have fun driving a hybrid that accelerates just as fast, yet goes four times as far on each gallon of gas.

Ah, the relentless march of technology; it gave us the technological marvels of human civilization, along with all the waste and pollution. It just needs a little more guidance. There are many paths ahead. We must choose our way much more carefully. The deeper our understanding and our gratitude and the richer our joy in life, the easier it is for us to sober up and face our future, our children's future and the future of the earth with hope and an open heart.

Web reference:

Perspectives on the climate of 2007, National Climatic Data Center
www.ncdc.noaa.gov/oa/climate/research/2007/perspectives.html

c) The integrity of science: the IPCC process (2 March, 2008)

Remarkable developments in 2007 furthered our understanding of climate change. In February 2007 the Intergovernmental Panel on Climate Change (IPCC) released its first report, "Physical Basis for Climate Change." This report presents unequivocal evidence that the climate system is warming as a result of rising greenhouse gas levels, mostly coming from burning fossil fuels (coal, oil, and gas). Later in the year the IPCC issued two more reports and a final summary. These discuss how our society will be forced to adapt to major climate changes later this century and describe how we can reduce the severity of these changes if we act soon.

The scale of effort involved in these exhaustive scientific assessments is hard to grasp. Thousands of scientists volunteered to draft these reports, which took five years to complete. Thousands more reviewed the conclusions carefully. In December, the IPCC was honored with the Nobel Peace Prize for this work – a historic event symbolizing the growing recognition that we face global conflict and immense suffering if society is foolish enough to continue on an energy path based on fossil fuels.

The IPCC report describes how the scientific evidence now fits together: The air and oceans have warmed, snow and ice are melting in many regions, and sea level is rising. The climate is warming faster over land and in the Arctic. Heat waves, heavy precipitation and droughts have become more frequent. The past 50 years have been warmer than any time in the past thousand.

The projections of our models for the future are consistent with what we see happening now. For Vermont, this means a further mean warming close to 2 degrees Fahrenheit (1.1°C) by the year 2030. The Earth is now committed to this warming, because with a stronger greenhouse atmosphere, the planet must warm further, just to radiate into space the heat it gets from the sun. In fact, much of the added carbon dioxide coming from the burning of fossil fuels will not be removed from the atmosphere for centuries.

Developments during 2007 revealed that the IPCC may have underestimated how quickly our climate is changing. Scientists were stunned when an additional 20 percent of the Arctic ice cap melted by fall. In December, a report in the journal *Science* warned that even if we reduce our emission rates dramatically, most coral reefs will still vanish from our oceans later this century. Perhaps the worst news was that global emissions of carbon dioxide are currently running above the highest scenarios considered by the IPCC.

The painful truth is that we have delayed taking action to reduce our dependence on fossil fuels much too long. Does this mean it is too late to start? Not at all; the sooner we begin, the larger the beneficial impact for the earth and our children. We can still reduce the warming later this century by about half and so give the earth and our grandchildren a better chance to adapt.

For the past 15 years, a concerted effort has been underway to spread false information, confuse the public, and delay the essential transformation of our industrial society. I have given more than 40 talks around the state in the past year, and I find people want to know the truth. They know their

government has deceived them on this issue. They know that lies spread confusion and fear, while the truth sets people free.

But I am still asked why what I say doesn't resemble at all what they hear on some radio talk shows. It is hard not to chuckle. We are exposed to such a deluge of pseudo science: propaganda being fabricated and distributed by those with specific political, economic and environmental agendas. I tell people that science has a fundamental integrity that is lacking in much of our public discourse, particularly in an election year.

The work of climate researchers gets reviewed, published and then examined carefully by a global community of scientists, who are trying to understand the living earth-system of land, atmosphere and oceans. It's quite simple to check scholarly credentials. For instance, if you want to know whether I am a credible scientist, just enter my name, A K Betts, at www.scholar.google.com. You'll get a public window not only into my work, but also the work of all the scientists that have found it useful. You don't have to read much to get the feel for it. Then type in your favorite talk show "expert" on climate change. Instead of science, you will find something quite different that will help you understand their specific agenda.

The choices before us may be a little stark, but they are very real. They are filled with possibility and hope, unless we choose to turn away and hide.

Web references:

IPCC is honored with the Nobel Peace Prize: www.ipcc.ch

Overview of the global carbon cycle: www.globalcarbonproject.org

d) The challenge we all face

(23 March, 2008)

Why are our global environmental problems such a challenge?

Despite our reluctance, we must face the conflicts between personal choice (that is so precious to us), the public interest and the interests of life on this planet. Put rather starkly, do we as Americans have the right to trash the planet to maintain our treasured way of life? So take a deep breath, let it out with a sigh, think of our children and remember that spring is coming!

Sometimes I reflect on the analogy between smoking and the global carbon-dioxide pollution that comes from the burning of fossil fuels. We now have public health advertising to warn teenagers of the long-term hazards of smoking. Why? Because for decades the tobacco industry encouraged teenagers to start smoking as a way of building its future market. Since lung cancer can take 30 years to develop, immediate pleasure all too often prevails over the long-term risk of ill health and death. The realization that infants and children are harmed by tobacco smoke has helped turn the tide of public opinion, but that shift has occurred slowly in the face of false advertising from the tobacco industry.

The biggest consequences from all our carbon dioxide emissions are also in the future, so it's hard to grasp the significance of our addiction to fossil fuels for our children. Yet as the decades pass and we steadily ignore the vast scale of the issue, the transformation of the earth's climate and the melting of the glacial ice caps are well underway. Powerful interests again invest in propaganda to keep us addicted, so as to prop up their profits, their ideologies and their way of life for a few more years. This

is a profound issue for our society, because the value and integrity of our scientific knowledge are vulnerable to ideological attack.

Here the analogy ends. If you stop smoking, generally your health improves in a few years. But the earth is now so far out of energy balance that even if we stopped burning fossil fuels tomorrow, our planet would go on warming for more than 50 years. Unlike cigarette smoke that quickly dissipates, the extra carbon dioxide we are adding to the atmosphere will stay for a century or more. Forests will remove some, but globally our forests are shrinking. It will take centuries for this extra carbon dioxide to be removed as it sinks again in sediments to the bottom of the oceans.

We try to ignore the long-term consequences, even though they are plain to see. Millions of people may starve as more food is converted to biofuels to drive our inefficient cars. Millions more may drown when tropical storms intensify and sea levels rise, as the oceans warm and the polar ice melts and the glaciers slide into the sea. Yet this will be the cumulative effect of our lifestyle choices and our deeply rooted belief that we have the right to waste fossil fuel energy, as long as we pay for it. (We are of course having trouble paying for it, and our society is sinking deeper into debt and warfare.)

For every American, about 20 tons of carbon dioxide are added to the atmosphere every year. As rising seas and stronger storms flood vulnerable coasts like Bangladesh, we will see the tragedy of New Orleans repeated over and over around the world. Will we just blame someone else? This is uncomfortable news for our society, but it must be faced. It is time to change course and start asking what is good for the Earth (not just me): for all its creatures and all of humanity, too. It will take decades to rebuild an efficient society, powered by renewable sources of energy.

But you protest: "My contribution to global warming is so small. I can do so little by myself. I cannot be responsible for all the suffering on this vast Earth. Please leave me alone; I have my own struggles in life!"

All this is true. This global crisis was not created by any one individual; but by our consumer societies, largely in ignorance, from our collective values and priorities. So yes, this crisis calls for a community solution beyond the personal commitment that each of us must make.

Our community is now the whole planet, not just human society, but the interconnected web of life on Earth that sustains us all. We must confront where we are headed, and change direction — soon — away from business as usual. This will take courage, humility and creativity, but it will give us a new vision, and transform hopelessness and despair into joy. Spring is coming, and it's time to plant new seeds of hope.

Web references:

Scientist speaks out: http://www.seedmagazine.com/news/2007/03/the_new_scientist.php

EU told to prepare for flood of climate change migrants:

www.guardian.co.uk/environment/2008/mar/10/climatechange.eu

e) Spring, carbon dioxide and the rebirth of life (13 April, 2008)

This past winter in Vermont did not have many really cold days, with temperatures below minus 10 °F (-23°C); but it was stormy, with a lot of snow, slush and freezing rain. Probably we will get more of

the same as the climate warms — more days in the 20s and fewer of those chilly nights with temperatures below -20°F (-29°C) that were more common in Vermont winters a few decades ago.

Climate models predict winters with increased precipitation in New England. The main reason is simple: warmer air holds more water vapor. At warmer temperatures, we get more wet heavy snow, rather than the light powder that falls when temperatures are cold.

Now spring green-up is here, and the earth is coming back to life. Garlic is sprouting like a weed in my garden. My seedlings are up, and soon I will be able to put the frost-hardy ones like broccoli outside. I just planted lettuce and snap peas, as they can take cold nights. Once the ground melts, the roots of plants can take up water and nutrients. Peas sprout, and trees resume their growth as leaves burst open.

Leaves take in carbon dioxide and make carbohydrates (food stores) in the process we call photosynthesis. Leaves are green because photosynthesis uses the red part of the light spectrum from the sun; the unused green light is reflected. The process returns oxygen and water vapor to the air. This is of huge importance to the planet, as well as for us.

All winter over the northern continents, plants and photosynthesis are dormant. To stay alive through the winter, plants take in oxygen to convert food stores into energy and give off carbon dioxide, just as we do. So during the northern winter, carbon dioxide rises and oxygen falls (just a little!) in the atmosphere. But with the return of new growth in the spring and through the summer, plants replace carbon dioxide with oxygen in the atmosphere, and the balance is almost restored.

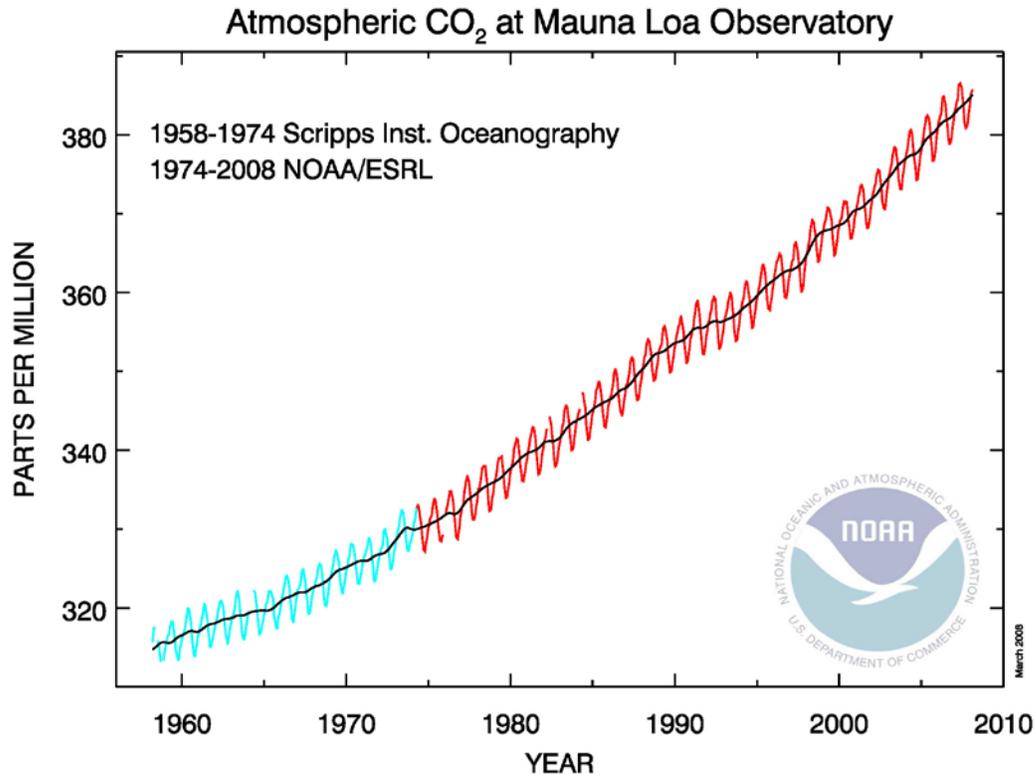
But not quite! This global balance was upset when humanity discovered the fossil fuels — coal, oil and gas — made by plants and tiny ocean creatures from carbon dioxide many tens of millions of years ago. Back then there was a lot more carbon dioxide in the air, and because of the greenhouse effect the earth was quite a bit warmer and had no icecaps at the north and south poles. (Carbon dioxide and water vapor are called 'greenhouse gases' because they trap the earth's heat radiation.)

Now we are burning these stored reserves of fossil carbon very rapidly to power our economies, heat our homes and fuel our cars. The accompanying graph of the Mauna Loa (Hawaii) carbon dioxide record, with its sawtooth pattern, shows that in most years since 1958 atmospheric carbon dioxide has come down less in summer than it has gone up the winter before. Consequently there is an upward trend. The growth of plants and trees can't keep up with our fossil-fuel burning. As a result, carbon dioxide is increasing in the air by about 2 parts per million (ppm) per year. That may not seem like much, but it amounts to a 30 percent increase in the past 60 years.

Actually we are very fortunate because plants, forests and the oceans are removing about half of the carbon dioxide we humans are producing. But we are burning so much fossil fuel that the rest is just steadily accumulating. The upward trend isn't smooth. The earth has good and bad years, with more or less growth in the tropics. And sometimes, when regions are dry, large forest fires put lots of carbon dioxide back into the air.

So where are we headed? If we continue on our present path, rapidly burning our fossil reserves of oil, natural gas and particularly coal (the Earth has large stores of coal), carbon dioxide in the air will double and triple as it climbs back to the values it had perhaps 50 or 100 million years ago. The Earth was a very different place then, long before humanity. Have we thought carefully where we are going?

So plant your flowers and vegetables; we need food and beauty. But go further into the woods and fields and reflect deeply on this web of life that bursts forth every spring to restore the balance of our atmosphere and climate. How much do you value and appreciate it?



Northern hemisphere atmospheric carbon dioxide from measurements on Mauna Loa in Hawaii since 1958. http://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/co2_data_mlo.pdf
 See also: Mauna Loa Observatory, National Oceanic and Atmospheric Administration: www.mlo.noaa.gov/home.html

f) The Spring climate transition

(11 May, 2008)

The transition from April to May in Vermont is always extraordinary, and this year perhaps even more so than usual. I live in the lowlands of Pittsford (elevation 450 feet; 140m), so the snow was melting fast here in early April. By mid-April, I had finished turning over my rye cover crop. (The task was easy, as I had dug over more than half of it back in the January thaw.)

Then came almost two weeks of warm dry days, many in the 70s (about 22°C), with the daffodils and forsythia in bloom. I soon forgot winter. Peas and lettuce sprouted in our vegetable garden, even as Vermonters up in the mountains still had snow on their north-facing slopes. Friends familiar with my field of research thanked me for giving them all this dry, sunny weather. A few then added, a little worried, "When is it going to rain?"

Of course, I had nothing to do with it! The spring transition happens every year, and it illustrates beautifully the subtle interrelation of weather, climate and climate change. In spring the weather gets warmer because the sun is returning to the north and moving higher in the sky. But temperatures

remain low until the snow melts, because the snow reflects a lot of the sun's energy (and melting the snow sucks up a lot of heat).

If there's a ridge of high pressure over the east to give us a clear sky, the sun can warm the earth quickly. This year the transition from snow-melt to warm dry days seemed especially sudden. A couple of days in April, I even had to put on sunscreen to work in the garden, with the noonday sun burning in a clear, blue sky.

These warm spells are typical of Vermont's spring climate. The weather can stay dry for a while, when there are no leaves on the trees. But it gets so warm that in a couple of weeks, the trees quickly leaf out. Leaves take in carbon dioxide to grow, and they pump (or "transpire") huge amounts of water vapor into the atmosphere. This process, transpiration, moistens the air and cools the forests, much in the same way that we cool ourselves by sweating. Addison County forester Chris Olson explains that on a sunny day in the growing season, a large, healthy maple or oak tree will pump 300 gallons (1100 litres) of water out of the soil and into the air.

On average, afternoon temperatures drop more than five degrees F (2.8°C) as the leaves come out. With all the transpiration, the air becomes more humid, so that clouds can form. Clouds reflect some sunlight, and this cools the earth also. Afternoon showers are again possible, and passing fronts get more vigorous. This spring in Vermont, a big rainstorm came through at the end of April, and temperatures plunged. Weather and these spring climate transitions are intertwined. The past week has been warm and damp, with morning dew on the grass and some morning fog. What a contrast to those hot, dry days in the second half of April!

What about climate change? As the years pass and the earth gets warmer from increased greenhouse gases in the air, the spring transition arrives earlier. At my elevation, the maples used to leaf out at the end of the first week of May, but this year the leaves were open by May 1. Frosts in mid-May used to be common, and many Vermonters did not plant their summer gardens till Memorial Day. This year, we had a light frost on May 1, which could be our last frost until fall – a sign of springs to come.

The link between vegetation and climate goes both ways. Once the trees are fully in leaf, it is much harder to get a frost. The air has become moister, thanks to all those transpiring leaves. Water vapor is a powerful greenhouse gas (along with carbon dioxide) that traps the earth's heat at night, protecting my young tomato plants from a frost. Additional protection can be provided by clouds or morning fog. Optimistically, I planted a couple of cherry tomatoes on April 26. But I had to cover them on May 1, when the north wind behind the big rainstorm blew cold, dry air down from Canada (where spring comes later).

Weather, climate, life, humanity and climate change are woven together every spring. Yes, I am grateful that winter is past, and my peas will be ready sooner. But I spent two weeks cutting and splitting trees felled by winter storms, getting ready for next winter, and thinking about our future civilization after fossil fuels. I also spent a weekend adding yet another layer of insulation to our attic. Here in Vermont we have a lot to do to get our homes and businesses ready for the changes to come.

Web reference: Vermont State Climate Office: www.uvm.edu/~ldupigny/sc/

g) The mid-summer solar moon

(8 June, 2008)

Back in the late 1970s, during the first oil and energy crisis (when Presidents Nixon and Carter called for energy independence by 1980!), I coined the term "solar moon" for the full moon in midsummer. This is because the full moon near the summer solstice shows us the approximate path of the sun near the winter solstice.

How can this be? The moon is full when it is on the opposite side of the Earth from the sun. It then rises in the east just as the sun sets in the west. On June 21, the summer solstice, the sun's position in the heavens is in the constellation of Gemini, opposite where it is on Dec. 21 in the constellation of Sagittarius. At the full moon in June, as the sun sets in the northwest, the moon rises in the southeast in Sagittarius and traces *roughly** the same low path across the southern sky that the sun follows at the winter solstice.

This year's solar moon falls next week on Wednesday, June 18. Watch it carefully, because it can give you a sense of how much or how little solar energy enters your house in winter. For a day or two near the full moon, your south-facing rooms will be filled with light in the very late evening.

You can see whether trees will shade the sun in winter. Even without leaves, the branches block quite a bit of the sun's energy. The moonlight won't heat your house, but is strong enough to give you a powerful visual sense of the sun in winter. Go outside in the summer warmth, and see where the winter shadows lie.

If you are going to build a house, or put in a solar water heating system, or install solar panels to make electricity, you especially need to know where the sun will be in winter, when it is lowest in the sky. At the solar moon in June you can see both the summer sun, and at night the path of the winter sun: a glimpse of the whole year in one day!

If it is cloudy for several days around this coming full moon, try again next month, when the moon is full on July 18. It won't be quite as low in the sky, since then it will roughly trace the path of the sun in mid-January. (The moon will in fact be at its lowest in Sagittarius in July a couple of days before it is full.)

We love the warmth of summer, when the sun is high in the sky. We will have to rediscover the warmth and light of the sun in winter - it didn't matter when we had cheap fossil fuel, but those days are gone. This means large, insulated windows that face south and let in the low winter sun, with overhangs that shade the windows from the summer sun, when it is high in the sky. And homes must be well-insulated to keep the heat in through the long winter nights. Homes built like this are called passive solar homes.

Of course, the sun gives us more energy in summer, when the days are longer and often less cloudy. This makes heating water an easy task in the warm season.

Solar panels that make electricity are called photovoltaic panels. They can be mounted on south-facing roofs, or on poles driven into the ground. In sunlight, they convert about 20 percent of the sun's energy directly to electricity. Typically these systems are connected to the power grid, and the utility buys back the power generated in the daytime.

For the home or business owner, this arrangement reduces utilities bills, as the owner may only have to buy power at night, especially on sunny days in summer. For the utility, this solar power is very valuable, as it is traditionally very costly to buy power to meet the daytime peak electrical load. And there is a large environmental benefit. The sun provides renewable, sustainable power - a far more preferable option during the daytime peak to fossil-fuel generation, which puts greenhouse gases into the air and changes the climate of the earth.

It is important to start thinking ahead, even if your plans take a few years to come to fruition. We must plan more carefully, because the cost of heating water and drafty houses with fossil fuel has been steadily rising. It is not just the dollar cost to us personally, but the cost to life on earth.

Web references:

Orbits of the earth and moon: http://en.wikipedia.org/wiki/Phases_of_the_moon ,
<http://en.wikipedia.org/wiki/Ecliptic>

**Footnote:* The moon's orbit is tilted from the earth's. This year, the summer solstice, the June full moon and the southern *lunistice*, when the moon is furthest 'south', are all close in time; and so the full moon this June is a few degrees lower than the December sun.

h) The interdependence of water and life

(6 July, 2008)

In early summer we celebrate in the United States the Declaration of Independence from colonial rule; it's also a good time to celebrate our interdependence. Our culture reveres independence and personal and national power, but today I am going to discuss the interdependence of water and life.

Water is the medium of life – from the oceans, to the blood in our veins, to the sap in a tree that flows from the roots to the leaves and then passes as vapor into the air.

Let's start with the oceans, that vast reservoir not only of water, but all the DNA building blocks of life. We revere the whales, dolphins and polar bears, but like us they depend on the web of life. When we burn fossil fuels, carbon dioxide gas is released into the earth's atmosphere. Some of this CO₂ stays in the atmosphere, where CO₂ levels are now rising rapidly. And some of the CO₂ is dissolving in the oceans and making the water more acidic.

The microbial life in the oceans, the genetic memory of life for the past billion years, must now adapt to this new environment, evolve and restore a new balance for the oceans and our planet. We have set this process in motion, but we don't know where it will lead. We don't know what the new balance will be, or what species of life it will support.

Water evaporates from the oceans into the air. This water vapor is a greenhouse gas that helps keep our planet warm and prevents the oceans from freezing (except close to the poles, where the sun is low). As increasing CO₂ in the atmosphere warms the planet, there is more evaporation and more water vapor in the air – and so the warming cycle is accelerated.

Moisture and clouds from the oceans blow over the continents and give us rain that moistens the soil and gives life to plants and trees. The rain fills the reservoirs (underground and man-made) that supply the water we drink.

As moisture in the air increases, heavy rainstorms and flooding become more frequent. We rely on plants and trees to bind the soil, so it does not wash away in storms. Forests buffer the climate of our planet by absorbing sunlight and transpiring water that cools the surface. Through long droughts, their deep roots can draw on water stored in the ground. Without them we might have a desert climate.

June was very wet this year. Frequent rains gave us moist soils and forests, with lots of evaporation every day. This process is very obvious when the leaves are dripping wet, and you can see clouds blowing off the forested hills: water evaporating and condensing at once as it rises. My garden was lush – but some vegetables that prefer hot weather and sunshine, like eggplant and basil, grew rather slowly. In any case, there certainly was no need to water anything all month! In fact, enough water is now stored in the ground to support two weeks of summer growth.

Evaporation cools the earth directly and also indirectly during the daytime because it encourages the formation of clouds that reflect the sun's rays before they reach the earth. However, at night the clouds and moisture in the air keep the earth from cooling much. More clouds produce more rain showers, and the wet cycle goes on. This pattern can only be broken by a shift in the large-scale weather – what the forecasters call a "ridge of high pressure," where subsiding air gives us a dry spell with no rain. If it lasts long enough, the ground dries out.

As the climate gets warmer, the cycle of water on the earth is altered. Summer rains get heavier (think of downpours in the tropics). More rainwater runs off into rivers, because it comes down so fast. And because there's more evaporation as the climate warms, the ground dries out faster between storms.

Some plants grow well as the temperature goes up. But for much of the warmer regions of the United States, summer temperatures are approaching limits where plant growth starts to slow down. Up here in Vermont, where our average climate is cooler, we can withstand more summer warming than, say, the southeastern United States. But our forests, which are used to cooler temperatures, will suffer. If we go on burning fossil fuels at our present rate, the climate of Vermont in the year 2100 will be like the climate of northern Georgia in the year 1980.

Right now Vermont has enough water, but looking ahead, we should be concerned. As rainfall gets heavier, we must store more water and let more sink into the ground, where it will be available for later use – not only for us but also for our crops and forests. One point of reference is this: Every summer month in Vermont, about 3000 gallons (11000 litres) of rainwater fall on the roof of your home. That seems like a lot, but some households use more than this in a month.

Drink the precious water of life and celebrate our interdependence. Many traditions consider it the spirit of life, the spirit of forgiveness that cleanses us and washes away our mistakes.

i) Facing the truth about our policies

(3 August, 2008)

Last year the Vermont Governor's Climate Change Commission issued its recommendations and final report. You can see all the details at the Agency of Natural Resources Web site. Among them are lots of great ideas for reducing Vermont's "carbon foot-print": the greenhouse gas emissions that we produce when we burn fossil fuels. The ANR Web site also describes what the state government is doing and gives advice on what citizens can do.

The bottom line is that Vermont could reduce its greenhouse gas emissions by 50 percent in 20 years and save a great deal of money. That estimate is based on the 2007 price of oil. With the 50 percent increase in the price of oil since then, you would think the Legislature would be rushing to implement proposals, but progress is very slow. Two bills were passed this year.

One bill, S.209, accomplishes several useful things. It expands net metering for electricity and encourages in-state renewable electric energy generation from wind, solar, biomass and hydropower. This approach got a major boost recently when Green Mountain Power introduced a plan to pay homes and businesses a 50 percent bonus rate for solar electricity. Solar power, which peaks in the daytime, reduces the need to buy expensive peak power on the spot market. Time is running out to build new renewable energy generation in Vermont, as our long-term contracts for relatively cheap electricity start to phase out in 2012.

This same bill sets higher efficiency standards for commercial and residential buildings. It also directs Efficiency Vermont and the Department of Public Service to establish new programs to help retrofit homes and businesses for greater energy efficiency to save fossil fuels. With heating oil above \$4 a gallon, this is a matter of urgency. A useful goal would be to retrofit all of Vermont's older houses in 10 years or less. It would take a large investment, but the savings in dollars would be even larger, not to mention the small step we'd be taking towards reducing our impact on the Earth's climate.

Another bill, S.350, recognizes the need to measure greenhouse gases, and it sets up a Vermont Climate Change Oversight Committee to report back to the Legislature next winter. This same bill sets worthy "goals" to improve public transportation options in the state but avoids tackling the obvious. Most of our travel in Vermont is in heavy, inefficient vehicles with a single occupant. With gas prices at \$4 a gallon, Vermont's transportation system is facing a crisis.

People who can afford it are buying more fuel-efficient cars. But many Vermonters will be stuck driving old vehicles getting 20 miles per gallon or less for another 5 to 10 years. It's important to remember how we got into this mess. For 20 years, since the mid-1980s, the federal government has bowed to pressure (that is financial contributions) from the oil and auto industries and refused to pass higher mileage standards for cars and trucks. It has been a profitable business plan for the oil industry, but at immeasurable cost to the earth.

Change is coming, whether we like it or not. How do we choose a new path when there is much uncertainty? Uncertainty is inevitable in dealing with complex systems like the earth's climate and biosphere, as well as our own human political, social and economic systems. Our old familiar ideas and ideologies don't help much. We must look first at our assumptions. The days of an exponentially growing consumer economy based on cheap fossil fuel and raw materials are over. The Bush administration has kept its head deep in the sand, believing that denial would carry it safely into retirement. I think sadly of the French King Louis XV, who said near his end "Après moi le deluge." ('After me the flood')

But here in Vermont we can choose differently. This will take courage and leadership, and an open honest discussion of choices and trade-offs. We must try a wide range of local options that keep investment dollars in our communities. The local food movement is growing rapidly, and now we need to support a similar, diverse local energy movement. Both will enrich our communities and give Vermont long-term security.

Where will we get the cash to invest in the new technologies and infrastructure that will ultimately save us so much money? We need private and public investment. Individual and corporate investors should be encouraged to shift resources to local tangible investments. As a state, we should tax carbon fuels to fund alternatives.

Yet last year a 1-cent "efficiency charge" on heating oil to fund efficiency improvements in homes was considered politically unacceptable. This is politics at its silliest. Would we rather let the poor in Vermont freeze in winter than retrofit their homes with insulation and save them enough to get by? Have our politicians forgotten the market? If we reduce demand for heating oil in the Northeast, might not the price (currently near \$4.50 a gallon) drop by that 1-cent tax? We had the sense to do this for electrical efficiency eight years ago, and the rewards have been large.

Why is it so hard for our leaders to face the truth? We all know why! We the people are also afraid to face the truth, and politicians need our votes! Elections are coming. Start with honest discussions among your friends and in your communities. Can you come up with local solutions for some of our energy and environment issues that you and your community can implement?

Web reference:

Vermont Climate Change actions: <http://www.anr.state.vt.us/air/Planning/htm/ccvtactions.htm>

j) From the European Weather Centre

(31 August, 2008)

I am sending this column from the European Weather Centre in Reading, England. For the past 17 years, I have spent a few weeks every summer working here, helping with the development of their global forecast model. Why would someone from Vermont be doing that? Well, for two reasons:

Theirs is the best forecast model in the world; and I grew up in England — so I get to visit friends and family each year.

The "Centre," as it is known, is an independent international organization, supported by 31 countries who have decided to pool their efforts to tackle something that none of them can do as well alone: global weather forecasts for the next two weeks, and seasonal forecasts for the next six months.

Their efforts have been very successful, because the Centre is under scientific direction, rather than political control. The director and senior staff are scientists or computer specialists who are free to focus on their central objective — improving their global analysis and forecast system for the atmosphere, oceans and land. This is a very large computer model, running on one of the biggest computer systems in the world. The present system was built by IBM, and it is upgraded every couple of years so the forecasts can provide better details of fronts and storms.

Every day this analysis-forecast system takes in millions of observations collected by surface weather stations and ocean buoys, weather balloons, aircraft and dozens of satellites that look down at the earth. Its task is to integrate them into the global model to improve our picture of the current global situation; and then to forecast in some detail the statistics of the evolution of the weather for the next one to two weeks, and in broad outline for the coming season. It is very satisfying to watch the forecasts improve a little every year, as we understand how to model better what is going on.

The Centre provides forecasts to Africa, and to the World Meteorological Organization and other international organizations. The United States is not a financial supporter of the European Weather Centre. We have our own weather forecast models — the National Oceanic and Atmospheric Administration has the primary public responsibility, but other agencies and the military also have forecast systems. Instead of one central facility, the United States has a wide diversity (there is a residual fear of "central planning"). Agencies and Congress control agendas and budgets, and funding is rather uncertain from year to year. Forecast centers are motivated more by institutional concerns and financial pressures, rather than being driven by a scientific vision.

The result is the kind of chaotic inefficiency we are all very familiar with in U.S. government. The diversity is often good for innovation, but the lack of thoughtful long-range planning, committed funding and careful scientific review of progress have caused the United States to fall behind in this challenging area of global modeling. We have huge resources, but it is so difficult for us to plan wisely.

But we have to understand and model our human impact on the earth. This is a global endeavor, because our impact now is global. Fortunately we have other organizational examples around the world. We are one world, and we are coming up against many limits in terms of resources. We must broaden our sharing of resources and ideas and reach out to help each other in all the ways we can.

Back in July, I talked about the wet weather we were getting; and how more precipitation gives more evaporation, which gives more precipitation. This pattern continued into the first half of August, helped by the position of the jet stream over us. After two months of above-normal precipitation, the ground was saturated, mist rose from the forests in the mornings and the cloud cover was extensive. Consequently the daily maximum temperatures were lower than usual, and with less sunshine, plant growth was slower. Afternoons were dominated by heavy rain from showers and thunderstorms, and flooding washed out many roads. At times I felt like I was in the Amazon in the rainy season and I could hardly work in the garden because of the mosquitoes! The weather pattern shifted two weeks ago, just about the time I left for England, and the recent sunshine has been great for our gardens.

This column was written in time for press last Thursday, so here is Thursday's 10-day forecast from the European Weather Centre for Pittsford, Vermont. Is it any good for this weekend?

Ten-day forecast for Pittsford, Vermont from Thursday. August 28th

Here is a 10-day forecast for Pittsford, Vermont from the European Weather Centre [www.ecmwf.int/]. It starts Thursday at 00 Universal Time (which is actually 8 p.m. EST on Wednesday). The top graph shows the forecast precipitation in millimeters every three hours for the first six days. Did central Vermont get the rain it shows for Saturday? The second graph shows pressure and predicts a high pressure system moving in and peaking tomorrow, Monday, when it will be very sunny; followed by a low pressure system coming through on Thursday. Third is wind speed and direction, and this graph shows light winds out of the northwest all day Sunday and Monday. The bottom graph shows daily rise and fall of air temperature. With the high pressure over us, it will get steadily warmer till Tuesday and Wednesday, when afternoon temperatures will reach the low 80s. Then the temperature will fall as the low pressure moves in. The temperature higher up in the atmosphere (at 850 millibars, the height of the White Mountain peaks) is also shown.



k) Caring for our forests

(5 October, 2008)

In autumn it's good to spend some time in our forests. They are Vermont's treasure a rich source of beauty as the leaves turn, and a source of warmth and hope in the face of our cold winters. As the climate warms, we are now responsible for their future, and they will need our respect and care.

Climate change and shrinking petroleum supplies are driving a shift from fossil fuels to more sustainable biofuels. For Vermont, this will mean a larger wood harvest, a change that will affect us all, from our tiny woodlots to our forested hills. How do we balance our human needs with the needs of the forest and of wildlife? At present, much of our forest land grows, dies and decays to nourish the forest floor, touched little by humanity in recent decades. So we clearly have choices to make here! What we harvest, what we plant, will matter not just for ourselves but for our children.

In my 30 years in Vermont, I have planted quite a few trees, mostly spruce, to offset those I used to construct my post-and-beam frame house in West Pawlet in 1978. Every year I plant ten "free" trees

that I get from membership in the Arbor Day Foundation (probably still not enough though to balance all the firewood I have burnt over the years to keep warm).

Five years ago, I planted our first hazelnut bushes, also known as filberts. Two out of three survived and grew, and we had the excitement of harvesting the first crop of nuts last month. We are looking forward to all kinds of tasty nut dishes this winter.

Our personal relationship to the trees and forests around us matters. It affects our thinking and choices, what we teach our children, and what we leave for them and their children. Trees are fundamental to the web of life. The forests protect habitat, store water and remove CO₂ from the air; and of course they supply us with building materials, fuel wood and maple syrup!

The history of Vermont's forests is fascinating. The early settlers of Vermont logged and cleared half of Vermont's forests for agriculture. Some clearing was unwise: crops and potatoes were planted on hilly land, and much soil was lost to erosion. Vermont experienced several floods in the early part of the twentieth century (1927, 1936, 1938), which were made more severe by the reduced forest cover. But people and agriculture moved west; and the forests have regrown to cover about 80 percent of the state.

The Biomass Energy Resource Center in Montpelier, Vermont has been looking at the availability of wood fuel in our region and estimates that only about 15 percent of the new forest growth is presently being harvested for sawlogs, pulp, firewood and biomass. This means our forests are soaking up CO₂ and delaying the warming of the earth's climate. Of course, a lot of forest is protected or inaccessible. As winters get warmer, it is also harder to work in the woods when the ground is unfrozen. But as heating oil gets costly, demand for firewood, wood chips and wood pellets is growing rapidly. When it was so wet this summer, it was again difficult to cut timber in the forests, so wood supplies may be short for the coming winter. If you end up burning green wood, please take extra care to keep your fires hot.

Our forests could provide double the current harvest for fuel, but they need careful long-term management. The climate change we are facing this century will stress our forests, and we may be faced with extensive replanting, as in the 1930s. For ten years, when I was younger, I cut and split my own firewood: it is a lot of work. We need more skilled people working in the woods; and at present, few young people are entering this demanding work.

Transport costs are rising with diesel prices. I remember well a train journey across Austria a couple of years ago. I was struck by two things: the neatly managed forests along the railroad, and the stacks of wood waiting to be removed by rail.

There is a second alternative in Vermont for winter fuel, as fossil fuels become scarcer and more costly. Vermont has quite a lot of marginal, underutilized land. Grasses can be grown and converted into pellets as well. You can get a higher yield in tons/acre, but grass pellets have lower energy content than wood pellets. However, there may soon be competition, as processes are being developed to turn perennial grasses into alcohol for cars.

The local food movement has been growing rapidly, and this has benefited many Vermont farmers. There are many opportunities for us to grow our own local fuels, and stimulate other parts of the Vermont economy, rather than send our dollars overseas. A sustainable society needs to become a

reality. But don't forget efficiency comes first. It's so much easier to stay warm if you seal and insulate your home; and you then won't need to burn as much fuel!

Web references:

Arbor Day Foundation: <http://www.arborday.org/>

Vermont's Forests: <http://www.anr.state.vt.us/Env99/vtforest.html>

Biomass Energy Resource Center: <http://www.biomasscenter.org/>

1) Sustainable Systems

(9 November, 2008)

Sitting outside the last few weeks on glorious sunny days, watching the leaves fall, I have been reflecting on the natural cycles of life. This October mirrored in many ways the spring transition that I talked about back in May. Nature delays the first frost as long as possible. When the forests are green, they are transpiring water, keeping the air moist and providing vapor to form clouds. Clouds and water vapor, a greenhouse gas, blanket the earth. This reduces night-time cooling, so temperatures before sunrise can stay in the 40s (above 5°C). Dew may form, but there is no frost.

In September as the nights get longer and the sun drops lower in the sky, the earth cools, until one night cold dry air blows down from the north, and the temperature falls until frost forms. Our summer vegetables die, and our forests recognize frost as a signal to prepare for winter. The leaves turn, and transpiration falls dramatically. The air gets drier, cloud cover diminishes and so frosts become more frequent.

Nature goes through a cycle of growth and decay. The forests grow slowly and respond to the supply of nutrients, water and sunlight. All parts of the system – soil, roots, trees, leaves and air – are exchanging and ‘communicating’ with each other. There is a balance, with a complex network of regulatory controls providing stability.

Sure, I harvest some trees for fuel and compost some leaves to feed my garden in the spring. But if I am wise, I do so in moderation.

Contrast this with our human economic and financial system. Against all evidence, we believe that we have unlimited material and financial resources. We think that we can grow our economies, our wealth and our debt without limit, with less and less regulation and control – and without proper information flows and feedbacks to keep the system stable. What arrogance! Blinded and driven by greed we have created an unstable financial system that grows like a cancer until it collapses, most recently into a bottomless sea of ‘toxic debt.’ Trillions of dollars of complex financial instruments (think ‘virtual money’) have sucked all the real wealth out of business.

We don't know how to uncouple one part of the financial system from the whole. We have not built in a way to ‘compost’ this toxic debt and separate it from the basic banking system that we all need for commerce. We got drunk with greed, and failed to notice we had coupled the real world, which has real limits, with our virtual world of limitless leveraged debt. With so much money and ideology at stake, no one wants to discuss the reality of the mess and admit the truth, especially in an election season. And it is silly to expect economists and financiers to sort it out. It was their false assumptions and dishonesty that created it in the first place. Ecologists understand sustainable systems much better – we should listen to them!

A sustainable society is not just a slogan; we know better and could do better. So let us spend this winter in all our communities, planning a better future, where the rules are designed to work for us, the earth and the whole of creation! There are many places to start. Here is just one, with a rich thirty-year history.

The Institute for Local Self-Reliance has proposed we develop a set of new rules that restore human-scale politics and economics and rebuild our communities. These rules are an extension of the ‘localism’ movement which has been discussed on these pages. They embrace three principles:

- Decisions are made by those who will feel the impact of those decisions.
- Communities accept responsibility for the welfare of their members and for the next generation.
- Households and communities possess or own sufficient productive capacity to generate real wealth.

These seem like common-sense principles, but they are a radical shift from the unregulated global financial system, which accepts no responsibility for communities or for the earth. We feel its impact, but it is by design out of control. Contrast the rapid rise of the local food movement in Vermont, which meets a real need, is under local control and generates real wealth in our communities. You could feel the excitement and satisfaction last weekend when the Rutland winter farmers market re-opened in the old Strand Theater.

What would it take to transform our communities so that our citizens and entrepreneurs are active and informed, with the skills to generate real wealth and the authority to be self-governing? We have still a little precious time, and one rich, unlimited and sustainable resource in our spirit and collective wisdom. Here lies the source of our faith, honesty and trust. But our expertise has been scattered and weakened by a sea of deception. Across Vermont we need to gather together in groups in our communities to collect ideas and inspiration, and then get to work.

Web references:

Institute for Local Self-Reliance: www.ilsr.org

New Rules Project: www.newrules.org

m) Our Common Planet

(14 December, 2008)

Sitting just inside the Tropics in southern Brazil, I am looking out across the green hills from a farm I have been visiting occasionally for the past 25 years. Brahman cattle graze in the pastures below, and mango and tangerine trees line the farm roads. The rainy season has started, and all is green. I may be far from Vermont’s hills, but the environmental concerns for the future are similar all over the world.

I have been invited to Brazil to talk about the impact of climate change on the Southern Hemisphere. I’ve also spent a week at the national weather forecast center and attended a conference in Manaus on the Amazon River in the heart of that vast forest. The conference was huge – a thousand researchers, mostly from Brazil, discussing Amazonia: its ecosystems and biodiversity, forestry and agriculture, and the economic and cultural concerns of its people. The Amazon River drains a vast area about two-thirds the size of the continental United States. Charting a sustainable path for the future of this region is an enormously challenging task. Human needs and economic pressures must be balanced with preserving the forest and the rich life it sustains.

In the western state of Amazonas (twice the size of Texas), plans for a sustainable future are underway. Village by village, the people are gathered to discuss their basic needs and the need to preserve the forest. These community discussions, including dance and song, are held until agreement is reached. If the community makes a unanimous commitment not to cut the primary forest and to protect it from fire, the state pledges to help them with a community clinic, micro-financing for projects and a small monthly payment to families (represented by the wife). Funds for this plan are coming from several sources, including oil-rich countries like Norway, who understand their responsibility to the planet as a whole.

The couple who own the farm I am visiting were atmospheric science students in Colorado 30 years ago when I met them. She is now the director of the national weather forecast center, and he is the director of the national supercomputing center. Ninety years ago, his grandfather cleared the forests here to start a coffee farm, and later the land was grazed. Agricultural practices in Brazil, like Vermont, were not as good a century ago, and Brazil has millions of acres of degraded land. But with careful management land can be restored. Twenty-five years ago, I rode across these hills on horseback. Now coffee is grown in neat rows along contoured hills. The contouring maximizes the infiltration of water, because there is a long dry season. The rows are mowed and mulched to increase the organic matter in the soil. Some slopes have tangerines, and five varieties of delicious mangos have been planted on the hilltops. The hills are now carpeted with productive trees and plants. What is left of the native forest has been preserved.

Because my friends are mindful of the need to help the local economy and community, a sizable fraction of the mangos are sold locally, well below the cost of trucking fruit from distant wholesalers. The local market for fruit has grown substantially. The coffee is marketed through the local co-op in a neighboring town. A well-managed farm can restore the landscape and enrich the local community – but it takes years of sustained effort.

External pressures are everywhere. Fertilizer prices have been rising but these higher prices have the beneficial effect of driving diversification and a shift towards organic agriculture. Global commodity prices for coffee fluctuate wildly. Wages are rising, so the farm, which pays above minimum wage, must look for ways to manage with fewer people. Perhaps they will plant some eucalyptus*, which grows so fast with little management, that it can be harvested for paper in only 5-6 years or for timber in 8 years.

Readers in Vermont will recognize many common themes. How do we balance local needs and global pressures? How can our farms prosper, and how will we deal with the growing demand for forest products? We all live in one world with common needs and hopes, a world that is connected by the air, rivers and oceans, a fragile economic system and an electronic web. We have a long journey ahead of us to restore the balance on this planet. It will take time, but so do all things that we value. They must be built, stone by stone, or planted and nurtured with care. This takes vision, effort and patience.

We are full of hope that the new administration understands these global issues. But we are enmeshed in unsustainable economic and financial systems that are not designed to work for the well-being of the whole. We must revisit our goals and patterns of behavior both individually and as a society. It will take wisdom and patient creativity to recreate a sustainable society and rebuild what we have lost. An important step is to reconnect to the natural world with more understanding and respect for her diversity, patterns of organization and generosity to us and all of life.

Web references:

Amazonas Sustainable Foundation: www.fas-amazonas.org/ [choose English; see Bolsa Floresta program]

**Footnote:* Eucalyptus is not a native species. But southern Brazil now has extensive eucalyptus plantations on degraded land. Conservation laws call for mixing in 20% of native forest.

7. Concluding Remarks (updated 12/11/2014)

This series of columns is ongoing (2008-2014), and annual collections are available at <http://alanbetts.com/writings>. The Sunday Environment page shrunk to a single page in 2009 as the newspapers faced difficult economic times. In 2014 the Sunday paper was reorganized further, and the environmental articles and columnists, becoming mainstream, were merged with the Sunday Perspective section.

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References:

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Betts, A. K. (1976), Letter to the Editor on "Scientists in Society". *Bull. Amer. Meteorol. Soc.* **57**, p. 460.

Footnote: All my articles can be freely reused under a Creative Commons license. The old Herald web references have not been maintained. You can find these articles at <http://rutlandherald.com/section/archives>. However, they charge for access.