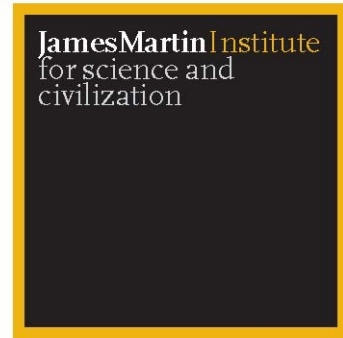


## Jack Beale Memorial Lecture on Global Environment

Professor Steve Rayner  
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### *Wicked Problems: Clumsy Solutions - diagnoses and prescriptions for environmental ills*

Wicked problems. The idea's not a terribly new one. They were first identified by Horst Rittel in the late 1960s. Rittel was a Professor of Planning at the University of California, Berkeley, and he was very concerned to characterise social problems. So the concept emerged in the context of social problems. He contrasted what he saw as some of the relatively easy challenges of the late 19<sup>th</sup> and early 20<sup>th</sup> century with the more difficult challenges that he saw facing planners at the tail end of the 20<sup>th</sup> century. In other words, he felt that we'd done the no-brainers like putting sewers underground, we'd done the sensible things like piping water into people's homes to avoid typhus and other water-borne diseases. But now we were dealing with a qualitatively different set of problems - the erasure, for example, of complete neighbourhoods in the name of urban redevelopment, the problems of siting freeways and transportation systems and so forth. Not only did he contrast the problems that he saw facing society in the late 1960s with those of an earlier historical period, he also contrasted his idea of wicked problems with what he saw as being the much more straightforward puzzle-solving kinds of activities, characterizing mathematics and the natural sciences, which he saw as really dealing with much more straightforward, as I say, puzzle-solving kinds of activities rather than the complex problems of social policy.

I'm reminded of a personal experience I had when I first started working as a junior researcher at the Oak Ridge National Laboratory in Tennessee where I, as a young upstart social science researcher, was approached by a senior chemist who said, "Oh yes, you're a social scientist, aren't you?" (Actually he said it in an East Tennessee drawl but I'm not going to embarrass myself by trying to imitate it.) He said, "You're a social scientist, you do soft science don't you, you don't do hard science?" and I replied, "On the contrary, I do hard science, you do easy science. You can repeat your experiments; you have some control over your experimental context. I don't." So I think that was picking up on the same kind of idea that Rittel was referring to here.

Remember the time at which Rittel was writing, this was the late 1960s, the time of '68 in Paris, the rise of the student movement in the United States, and one of the things that he noted was the challenges of an increasing heterogeneity of modern society and the kinds of value conflicts that implied. Particularly, he latched on to the emergence of popular protest against expert formulations of policies being imposed upon populations without their consent.

So, let's look at the characteristics of wicked problems. Now, Horst Rittel actually had a list of ten of these characteristics and some of them were overlapping and some of them were quite long winded. I've tried to boil them down to a list of six which I would say is a list in the spirit of his, although not identical. Firstly, wicked problems tend to be characteristics of deeper problems. There tends to be a sort of circularity that goes on here. For instance, how does one explain educational underperformance? Well, perhaps by poverty. How does one explain poverty? Social class. Well, what shapes social class? Well, education. So, you see, there's a kind of circularity that goes on, the same things crop up as explanations of other parts of the problem. Wherever you push it, it pops out somewhere else. The second idea was that there's really relatively little room here for trial and error learning. If you knock down an entire neighbourhood in the name of urban redevelopment, you can't put it back again if things don't work out well, so you don't get a second chance.

Wicked problems, generally speaking, don't present you with a clear set of alternative solutions. We're not talking here about selecting among well understood alternatives, which is actually the kind

of thing that decision theory is very good at dealing with. You're actually dealing with a situation in which actually the definition of the solution in many ways defines the problem. They're also characterised by what we call contradictory certitudes. This is quite a different idea from uncertainty. We're not dealing here with problems where we're just uncertain, we're dealing with problems where people know what the answer is. Different people know what the answer is. The trouble is the answers that they have are just irreconcilable with each other. So we're dealing with problems of contradictory certitude. Are people fundamentally good? Are they evil? Is nature fragile and delicate? Is nature forgiving?

Wicked problems tend to have redistributive implications for entrenched interests. Obviously that's a very important issue when we start looking at climate change and the possibility of reconfiguring our global energy systems away from our current reliance on fossil fuels. There are big implications for people who are involved in coal and oil. And, finally, they tend to be persistent and insoluble. We have to learn to cope with wicked problems, we don't really solve them, and we're really not looking at optimal solutions - the best outcome - we're just looking for something that will damn well work.

Now, I think environmental problems are looking increasingly wicked. As I say, Rittel expanded this idea purely looking at social problems. Basic clean air and clean water legislation of the sort that we had in the 1960s was a bit of a no-brainer. London suffered from recurrent fogs. The Americans even named a raincoat after it. And in 1952, those fogs actually killed 12,000 people. You had people falling down in the streets, almost literally. In the United States, there's the infamous case of the Cuyahoga River in Ohio which had this alarming propensity to burst into flames frequently between 1936 and 1969. Now, a burning river isn't something you see every day. This was due to the extensive pollution with volatile pollutants in the river. So, clearly, when you have these very publicly visible problems there's going to be a lot of support for the solutions.

But contemporary environmental issues are quite different. They're not at all, in fact, like the way Rittel was characterising science when he was writing in the 1960s. We're not dealing with puzzle-solving problems here, we're dealing with problems that actually have been identified by science, difficult to understand ones often in many cases, not ones that are directly apprehended by the public and by politicians. These are things like climate change, stratospheric ozone depletion, persistent organic pollutants. For example, our ability to identify the problem of persistent organic pollutants is very much a function of our ability to measure incredibly small quantities; parts per trillion of pollutants, which were not even measurable two decades ago.

Not only do contemporary environmental problems look like the social issues that Rittel was talking about. They actually incorporate social issues, so they're no longer just scientific problems. Now, we confront the issue of environmental justice, the almost universal propensity for minority populations and for poor people to have to put up with much worse environmental conditions than people who are better off. The whole challenge of sustainable development, of trying to reconcile the provision of welfare for more of the population, at the same time staying within environmental limits.

The list of wicked environmental problems is potentially extraordinarily long, I'm just giving you a few examples here; climate change, water resource management, energy production, GM agriculture, urban planning, waste disposal, nuclear waste, domestic waste, marine ecosystem protection, biodiversity loss - you can go on and on and on. When I originally planned this lecture, I was going to talk about three of these topics; climate, water resources and energy production. As I worked through it, I discovered I didn't have time to deal with all three adequately so I'm going to focus primarily on climate and make some references to water and energy.

Climate change is a wicked problem. I'll tell you another story from my Oak Ridge days. I got interested in climate about 1985 and I proposed at that time to the Director of the Oak Ridge National Lab that perhaps the lab could support a small programme on the social science issues potentially associated with climate change, the policy issues and the human dimensions. Being a sensibly cautious person - you don't get to be a Lab Director if you're rash - he referred my suggestion to a group of grey beards, whose advice he relied on in making policy for the lab, and asked them if they thought this was a good idea. Among these was a former deputy director of the US

Environmental Protection Agency who said it was a perfectly awful idea. Climate change was never going to be a major public policy issue. It was too far in the future, the science was too uncertain and there was no easily identifiable villain.

My response to that was those were exactly the reasons why I thought climate change was going to become a major public policy issue. Because there's so much that people could latch on to in the issue. Fortunately for me, the Lab Director didn't take the advice of his advisors on this occasion and instituted a small programme, so we were actually up and running when the 1988 heat wave and drought hit the United States which is what really propelled climate change into the forefront of the political agenda in the United States.

The framework convention on climate change, which was opened for signature in 1992 at the Rio Summit, has the objective of "stabilising atmospheric greenhouse gas concentrations", this is a quote, "at a level that will prevent dangerous anthropogenic interference with the climate system". Now, who could disagree with that? I think it's always very useful when looking at pronouncements to turn them into the negative, and I don't imagine that anybody would advocate dangerous anthropogenic interference with the climate system. The only problem was that nobody could seem to agree on the meaning of dangerous or indeed what constitutes interference.

There's actually no science behind the selection of a 2 x CO<sub>2</sub> scenario as a potential limit for atmospheric concentrations of carbon dioxide. The practice among scientists of using 2 x CO<sub>2</sub> actually dates from the original 1896 paper produced by Svante Arrhenius. Didn't they have wonderful names for journals in those days? The Dublin, Edinburgh & London Philosophical Gazette I think it was called. And the title of the paper was 'On the Influence of Carbonic Acid in the Air Upon the Temperature of the Ground', and just to do his calculations, Arrhenius arbitrarily took a 2 x CO<sub>2</sub> scenario, and that's been very much the anchoring point around which a lot of scientists have focused ever since. There's nothing magic about 450 to 650 parts per million of CO<sub>2</sub>.

Climate change, the conceptualisation of climate change and the way it's been dealt with, is very much based on the hierarchical model of the ozone regime. Some of you will be able to cast your minds back to the emergence of stratospheric ozone depletion as an issue which was finally, through a rather laborious diplomatic process, dealt with by the Montreal Protocol for the Protection of the Ozone, on Substances that Deplete the Ozone Layer and its model of dealing with the issue - for the diplomacy behind that, there was the Ozone Trends Panel providing science, there was an international negotiations process, there was basically a framework convention, the Vienna Convention, and then finally, the protocol by which the convention was implemented. People thought this was a really good idea to copy that model for climate.

The only trouble is, it's actually a very, very poor analogy because with the substances that were depleting the ozone layer you're dealing with a small number of artificially created gases manufactured by a small number of companies in a few industrial countries and for which already at that time there was fairly high confidence that there were substitutes available to act as refrigerants and fire extinguishing agents and so on. Carbon dioxide, on the other hand, is a product of everybody's daily life. It's ubiquitous, it's global, it's not something that you can simply control by choking off the manufacturer.

The Framework Convention on Climate Change also includes 195 signatory nations. Well actually, that also includes the European Union in addition to the nations of the European Union. As you all know, the more people you get involved in the negotiation the lower the common denominator drops, particularly when you're involving people who, in many cases, have a vested interest in not pursuing the course of action that you're seeking.

Another element is the potential explosion in the growth of emissions in China and India. When I started out in this business 20 years ago, China was about third or fourth in global emissions, it's now the second largest emitter of carbon dioxide on the planet, but it's still something like 20<sup>th</sup> in terms of the per capita emissions. So very small improvements in the standard of living of the average Chinese translates into potentially huge growth in China's emissions. There was a separation within the framework convention of what were called Annex 1 and non-Annex 1 countries. The Annex 1

countries were the industrial countries that were supposed to act to do something about climate change and the non-Annex 1 countries were the ones who, for the time being at least, didn't.

It led to a distinction that was made in the early 1990s between so-called survival emissions and luxury emissions and we were told by some of the developing country activists that India and China, for example, had survival emissions and the industrialised world had luxury emissions. At that time, I did a little back of the envelope calculation. I'm not really a very quantitative social scientist. I was trained as an anthropologist - for us data is the plural of anecdote by and large - but I did do a little back of the envelope calculation because I thought it would be interesting to know what the emissions of the Indian middle class were.

Firstly it's quite hard to pin down how big the Indian middle class is. The Washington Post estimated it at about, I think, 200 million. It seemed to me that was far too many. I took the viewing figures for MTV; 15 million households. I doubled those because I thought there's a lot of people who wouldn't have MTV. I then assumed that the average middle class Indian's family size was the Scandinavian 2.4 people per household, and then I decided that each of those ought to be at least as energy efficient as the average Japanese, the Japanese being the most energy efficient on the planet. And it turned out that the Indian middle class' emissions were greater than those of Australia. I thought you might like to know that.

So it's clear that the problem here is not straightforward. What I'm suggesting here is that, in many ways, using the nation state as the unit of analysis for thinking about climate policy might in itself be quite misguided.

Finally, the Kyoto protocol has proven to be very divisive internationally. It's embraced by Europe, rejected by the USA, rejected by Australia. So, what I would like to do now is simply review the view from Europe and the view from the United States. I don't know the Australian situation well enough to tell you about it but maybe you can see what the parallels are in either case.

Now, it's interesting to note the view from Europe, that 70-90% of the population of the UK sees climate as a significant problem and, to a man and woman, they see the government as being responsible for fixing it. I think it's worthwhile pondering on that for a moment. It's perhaps easier to acknowledge a problem if you can automatically assume it's somebody else's to solve. Secondly, Europe has experienced three decades of the European project, the attempt to unify the nations of the European Union, and I would argue that climate has actually been a very handy external threat to all the member countries of the European Union and has been something which has been politically quite constructive for integrating Europe. Particularly in contrast with the United States who has now thoughtfully provided the missing villain that I mentioned earlier in my talk by not signing the Kyoto protocol.

A fourth element is political leadership. Let's remember that in the 1980s when climate first really emerged as an international policy issue, Margaret Thatcher was the pre-eminent leader in Europe. This was the same Margaret Thatcher who had been a member of the Heath Conservative Government that had been brought down by the coal miners, and she was absolutely determined that no government of hers, indeed no Conservative Government, would ever again be brought down by the coal miners. And so she actually had a political agenda of smashing the miner's union, which actually meant dismantling the mining industry. And at the same time, conveniently, Britain was accessing large reserves of gas in the North Sea, so focusing on climate was actually a very convenient part of her domestic political agenda and it was easy to then move into the "dash for gas".

I'd also just throw in a couple of other things. I think that the precautionary principle has caught on in Europe much more so than it may have done in other parts of the world. That is the notion that it's more important to avoid disaster perhaps than to find an economically efficient solution to problems. And also there's quite a lot of conviction that something like climate ought to be dealt with by behavioural change rather than by technological fixes.

Now, contrast this with a view from the US. Interestingly enough, 60% of the population of the US sees climate as a significant problem, but only 40% sees the Federal Government as being the body

that ought to be taking the lead in providing a solution. In the year 2000, I was actually giving an informal briefing to a European environment minister - I won't mention which one - in New York on the US position at that time on climate, and I made this argument that in fact Americans don't look to the Federal Government to lead on this kind of issue, that, in fact, in many ways federal leadership in the civil rights era was an anomaly in American politics and that most Americans see the Federal Government as there to provide critical infrastructure and defence. This Minister's response was, "well, that's totally unacceptable, what's the government for if it's not to lead?" Unfortunately, that's very much a European dirigist notion of what a government's role is and it doesn't comport well with American political culture.

To deepen that, the US, in the past 30 years, has been undergoing the opposite process of Europe. It's, in fact, been undergoing a process of decentralisation of power back away from the Federal Government to the states. So really, the notion that we should expect the Federal Government to be taking the lead was not the case for the US. Also, there was a very different leadership situation in the critical period during the emergence of climate change from that which was the case in Europe. George Bush Senior, during his election campaign in 1987, said, "You've heard of the greenhouse effect, wait 'til you see the White House effect", apparently promising some strong action as soon as he got elected. Only two years later, halfway through his term of office, he said, "Scientists are divided on the subject of climate change, you can't possibly make policy under those conditions of uncertainty, we'll have to wait until we get the science right."

Now, I would argue that he misrepresented the scientific community at that point. He was representing it as an inverted bell curve with the concentration of scientists at either side saying either climate is a really bad problem or it's no problem at all. Whereas, in fact, the case was that you had a normal distribution and most scientists were in the middle there saying this is something that we've got to take seriously and worry about even though we don't know precisely what the potential impacts are going to be and so on. But nevertheless, by flipping that curve and misrepresenting the uncertainty, he was able to postpone political action on the topic.

I would also suggest that in the US, instead of the embracing of the precautionary principle, there's a prevalence of what I'll call the proportional principle - the notion that benefits and costs of regulatory intervention need to balance. In fact, there is legislation in the US which requires regulatory impact analysis that has come into force during the 1990s, which actually explicitly embodies this notion; that what you must do is figure out the marginal cost of damage, the marginal cost of abatement and where those two costs curves intersect, that's the economically efficient point at which to intervene with policy. This is quite different from the precautionary approach that the Europeans have taken. And finally, of course, Americans have a far greater faith in technology and technological fixes and technological change.

So, we've got a wicked problem here, right? We've got at least two fundamentally incommensurable views of climate change, it would appear, informing the politics of the United States and of Europe. How do you deal with wicked problems like this? Well, three strategies have been proposed. In fact, Nancy Roberts from the United States presented a paper here in Sydney about five years ago on this topic, and she suggested that there were at least three strategies. There's a hierarchical strategy. This is probably the strategy of the puzzle-solving scientists and of government bureaucracies; you break the problem down and you simplify it and you apply your existing decision routines and decision rules, so you do your benefit - cost analysis and so on.

The second strategy is a competitive approach. The idea here is that you use expertise to control resources to bring to bear on the problem. And finally, there is an egalitarian approach where you open up the problem to more stakeholders - "Let's get more and more people involved in discussions about how to do this". I'm going to suggest that each of these reflects a coherent organisational world view. Each of these responses itself shapes the definition of the problem - and this is part of what complicates wicked problems.

So, I have here a cartoon that I've often found very useful, produced by my colleague in the James Martin Institute, Jerry Ravetz, he generated this some fifteen or so years ago. And you can see in front of you here, this graph; along the horizontal axis, we have increasing uncertainty, ambiguity and finally ignorance as you move from left to right. On the vertical axis, you have the decision

stakes, rising from relatively minor to very serious at the societal level as you go from the bottom to top of the vertical axis. Ravetz's suggestion was that these two dimensions characterise at least three kinds of problems. I've adjusted the terminology that he used to describe them to reflect the notion of wickedness and tameness of problems.

Close to the origin of the graph, you have tame problems. These are things that are really quite familiar, we've lots of information on them, and it doesn't matter too much if we make a mistake. In my radio interview earlier today I was asked about nuclear power, so let's think about nuclear power as the example here. Selecting a valve from a supplier to install in a reactor core cooling system might be a problem down here. But then, as you increase the decision stakes and uncertainty, as you move away from the origin, you enter a realm of decision-making which is rather different. Perhaps this is the realm of reactor design that you'd be dealing with here, and this is an area where you really are relying very much more on the craft skills of an expert who can also draw on some of that well-established knowledge that informs decisions down at the origin. But a lot of judgment comes into play here. Jerry Ravetz called this clinical consultancy because he thought it reflected the way that doctors behaved before they got terrified of malpractice insurance.

And then, finally, as you go out furthest away from the origin, you're dealing with very high decision stakes, high systems uncertainty. This might be the choice of an energy technology system like are we going to build a lot of nuclear? So the stakes here if you make the wrong decision are very, very high indeed and there's a lot of uncertainty about what the implications of that would be. Those are the wicked problems.

Now, at first sight, this seems a very nice way of presenting the hierarchical form of taming - the application of well established decision rules in the bottom left hand corner, the competitive use of expertise to control resources in the middle range and the egalitarian opening up of problems to more stakeholders at the top right hand side. If you knew the nature of a problem, you could assign it to one of the categories and figure out how to fix it. There's only one problem, of course, which is that these very institutional voices - the hierarchical, competitive and egalitarian - disagree about where you put the same problem on the map.

I'm going to now draw on the water resources issue for a moment. You find that hierarchical organisations tend to push everything that they can down into the bottom left hand corner because they have decision rules, they have heuristics, they have benefit - cost analysis and so on. That's where they're comfortable dealing with problems, so they'll define as much of the wickedness away as they can to try and force the problem down into that corner. So, in terms of water resource management, this is really the water supply companies strategy very much informed by engineers and engineering disciplines, and for whom the solution to the problems of water supply is the construction of large infrastructure.

Right at the other extreme, you have people who say that the problem for water isn't one of large infrastructure, in fact large infrastructure has created a lot of the problems. What we need to do is be managing water more in tune with nature with natural limits. And the other big problem is, of course, ensuring accessibility. So, basically, these are people who are perhaps in the NGO movement - the environmental non-government organisations - who try to drive the water issue up towards the top right hand corner of this graph so that they can have a big discussion about how society ought to be organising and what's morally right to do about water use and so on. Then you have an emerging body of experts, working as entrepreneurial consultants, who say look, the problem really is pricing of water. If we actually have it properly metered and priced - by the way, there is virtually no water metering in the UK - if it's properly metered and priced then, in fact, these problems go away. Then the egalitarians say, "Ah yes, but you see you meter it and you start charging people for it, that's going to be regressive, it's going to hurt the poor". So you can see how the debate occurs.

So what we find is that you can't simply identify the characteristics of a wicked problem and put it in the top right because people are going to argue about how wicked it is. Okay?

And the way in which people try to resolve that argument is by referring to the transcendent authority of science. All three voices see conflicting values as a problem for policy, so we have demands for science-based policy in the United States and evidence-based policy in Britain. We're a

bit more liberal in Britain, we assume that there are other things in science that might factor into a decision. There's very much an attachment here to the notion that science determines policy - that nature is somehow the final trump card that you can lay down on the table to win the argument about how you should confront the problem.

Of course, more research is always needed, and we find that problems tend to expand to incorporate more and more technical disciplines. As the Vice Chancellor mentioned, I serve on Working Group 3 of the Intergovernmental Panel on Climate Change, and there's been a huge change in the character of the IPCC since the first assessment report was produced. We're now on the fourth assessment report and these take about five years a piece. The first assessment report was almost entirely populated by climatologists, atmospheric chemists and so on with a few ecologists. For the second assessment report, ecologists were well entrenched and economists began to come into the discussion. By the time of the third assessment report, IPCC even admitting sociologists and former anthropologists like myself, and so on and so forth.

Now, I think it's important to understand the necessity of bringing in appropriate kinds of expert knowledge, but I do pose the question here whether there is a possibility of a kind of hyper inter-disciplinarity. Is necessarily bringing more and more and more disciplinary perspectives going to make the problem easier to solve? I'll leave that thought with you. But I think one of the things that we have to recognise is that a surfeit of science can be as much of a problem as not enough science.

The National Acidic Precipitation Programme in the United States is a very good case of this. This was a multi-year, multi billion-dollar research programme that was designed to inform Congress' decisions on how to manage the acid rain problem, and it ended up producing what my colleague, Chuck Herrick, who worked on the programme, described as a smorgasbord of science from which policymakers who already had different views about how to deal with acid rain could simply go and select bits of science that reinforced their own views. In the end the acid rain legislation in the United States was passed without really making use of NAPAP.

So, if science can't simply solve the problems of wickedness for us, what's the alternative? In the United States, they say, 'when you're passed lemons make lemonade'. So, let's say, we're stuck with this disputation about the nature of problems. Rather than to take a line with three points on it, which I had going from the bottom left to the top right of the previous diagram, Let's take those three points as the points of a triangle and create a two-dimensional space. By doing so you no longer have to argue exactly where the problem fits, you're merely acknowledging that it fits somehow or other within this triangular space. And then you're also recognising that the multiple viewpoints of the corners may have something to tell you when they're brought together collectively about how you might grapple with the problem.

So, I'm now going to revisit the story of climate change from the perspectives of an egalitarian, hierarchical and competitive viewpoint. I'm going to start with the egalitarian. This is a story of profligacy that says that the underlying problem - remember we said about wicked problems there's always an underlying problem - the underlying problem for climate change is over-consumption. Basically, humanity is responsible for environmental degradation because of a wider malaise, which is our relationship to consumerism. We've lost our relationship with nature and each other in the pursuit of profit and the pursuit of economic growth. This is a story in which nature is fragile. If you like, it's like a ball on an upturned bowl; with any slight perturbation that ball rolls off and can't be restored to the position on the top. On the other hand, the economy is seen as being quite resilient. We're told that climate change policies will not just be inexpensive but actually will produce economic benefits. So here, the economy is seen by the egalitarian as the ball being in the bowl which you can perturb a lot and it will return to an equilibrium state.

The heroes of this story are the outspoken climate scientists and activists who've really struggled to get climate represented on the agenda. The villains are the greedy corporations that produce greenhouse gases. The problem's urgent - time is compressed - we have no time to delay, no time to waste before immediately rushing into emissions reductions. And the solution here is behavioural, it requires precaution and it requires voluntary frugality on the part of us all. And if you think this

story is perhaps a little exaggerated, here is a quotation from the Climate Action Network's presentation to the first conference of the parties in Berlin in 1995:

" 'Who cares about coral reefs?' I often heard in the corridors of the UN buildings". (In the original quotation, he says, "when the red wine seeps into the head and so" on but I left that part out.) "I care," says the speaker. "I care. I listen to the cries of millions of polyps that make up the corals. Why? Because there's more at stake for us all than just the death of polyps and corals. What is causing corals to die lies at the core of the way we humans live, especially in OECD countries. Dead corals are the victims of the injustices we continue to ignore, of greed, of selfishness and of the abdication of moral and ethical responsibility.. It is an act of genocide against the corals and so against species who depend on them, including ultimately humans.. The coral polyps' own world mirrors the human experience - the cries for freedom from foreign debt, poverty, starvation, the cries to change lifestyles not the climate, the cries to stop burning fossil fuels! To ignore the death of coral reefs is, I believe, to ignore the cries of many of the world's people of today, at the peril of our future generations and our planet."

So you see here this intimate linkage between ideas about the damage we're doing to nature and the state of human condition. (I thought that was a particularly appropriate quote given the location of the Great Barrier Reef, which I'm planning to visit with my family next week.)

The second story I want to tell you is the planning story. This says that the problem isn't about consumption. It's a problem of lack of planning. It's weak global governance. What we need to be doing is building an international regime for the governance of the global commons, and both the commons and the global economy require monitoring and managing within limits. The heroes of this story are those scientists, civil servants, NGOs, representatives, academics (I suppose serving on the IPCC) and enlightened politicians who are building management structures for the global commons. And the villains are the complacent governments who won't sign up to Kyoto, particularly, of course, the US and Australia.

This is a long term view. We're told that Rome wasn't built in a day but it's nevertheless the way we need to go. The solution to the climate problem is entirely a diplomatic and regulatory solution. Once again, I don't exaggerate. This is a quotation from the United Nations Human Development Report:

"The challenge is to find the rules and institutions for stronger governance, to preserve the advantages of global competition but also to provide enough space for human, community and environmental resources. Some of the key elements of an improved international architecture." You know, architecture, here's the planning metaphor. "A stronger and more coherent UN system, a global central bank, a world investment trust, a world environment agency. A life observatory should be established to systematically monitor major ecosystems. Long term planning should factor in projected changes in climate and changes to specific ecosystems. Intergovernmental processes tend to be difficult to organise and slow to execute but they are the only realistic way to address cross-border pollution and ecosystem degradation."

Well, "not so", says the competitive voice. The competitive voice says the problem actually is insufficient scepticism. The science is uncertain and, in any case, technological progress is rapid. If climate change is a real problem, well we're probably going to outpace it with technological development anyway. The economy is fragile here. The economy is the ball on the upturned bowl. Nature is forgiving. Nature is the ball in the bowl that returns to equilibrium. And, in fact, some of the exponents of this view have pointed to the very rapid recovery of Prince William Sound after the Exxon Valdez disaster as an example of how nature recovers very quickly. The heroes of this story are the technological innovators and venture capitalists who, in some kind of gale of Schumpeterian creative destruction, will in any case create new technologies that will supersede the ones that we're using now. The villains are the panic-prone environmentalists and planners who are trying to pick winners among energy technologies. This is a very short term focus.

Other issues, we are told, are far more pressing. Some of you may be familiar with the name Bjorn Lomborg, the author of the book "The Sceptical Environmentalist". Lomborg got a group of leading economists together and asked them to generate a list of priorities of how they would spend \$10



billion, and the final list of ten areas where those economists said that they would allocate \$10 billion if they had it to spend didn't even include climate change on the list at all. Now, I'd argue that's not surprising. If you apply standard economic discounting procedures to long term environmental problems it doesn't make sense according to make any investments in long term environmental benefits.

The competitive solution if there is a climate problem would be allowing the market forces to work. Am I caricaturing? Well perhaps a little bit but not entirely. This is a quotation from the head of the New Economics Foundation, which is a pro-market somewhat libertarian organisation, which says,

"On the whole, society's problems and challenges are best dealt with by people in companies interacting with each other freely and without interference from the State. We do not know whether the world is definitively warming. If the world is warming, we do not know what is causing the change - man or nature. We do not know whether a warmer world will be a good or a bad thing until the science of climate change is better understood, and no government action should be undertaken beyond elimination of subsidies and other distortions of the market."

So, here we are! We've got three stories. They're all very elegant stories. They're all internally consistent, logically argued. You can't reduce any one to any one of the others. They all give plausible but conflicting accounts of the problem. Each of them defines what kind of evidence is appropriate to make a case in its own terms. They're all immune to falsification by appeal to scientific facts, and they combine to create a wicked climate problem.

Now, the good news, the good news is that individually each story is only a partial vision. Collectively, each fills in a perspective of the problem that the others can't entertain. None is entirely right, but none is entirely wrong. Policies based on only two or one of these visions will fail to grapple with its wickedness, but together they offer a dynamic plural argumentative, possibly even agonistic system of policy definition. Leaving out any one voice also leads to the loss of legitimacy and public trust. That's the good news.

The bad news is that the climate regime that we're currently building internationally is overwhelmingly based on the hierarchical story. It assumes that emissions reduction is going to be very expensive and that, therefore, we have to have an international regime to police it. It focuses overwhelmingly on emissions reductions over impacts and yet, actually, any emissions reductions that we achieve now are not going to have an effect for about fifty years. My colleague, Roger Pielke at the University of Colorado, has calculated on the other hand, if we were to actually take a serious approach to adaptation to climate change, we would actually have a ratio of 14:1 better value for money. In other words, for what you spend you get 14 times the bang for the buck on adaptation.

In part, the argument for this is that a lot of the problems that we are going to experience initially from climate change are, in fact, due to not very wise decisions that we currently make, such as putting very expensive infrastructure on coastal zones and on flood plains and eliminating a lot of the natural phenomena like marshlands and so on that would absorb, say, the impact of hurricanes. And one of Pielke's findings is that contrary to what is often said about increased hurricane intensity in the United States causing increased economic losses, those losses have actually come from our own foolishness in locating infrastructure in places where we shouldn't be building expensive infrastructures, such as luxury hotels and so on. And if we were to start to think about adapting in those senses, we could get a much bigger bang for the buck much faster. That's not to say we shouldn't think about emissions reduction in the longer term but it suggests that, in fact, we should put more emphasis on adaptation than we have done historically.

The climate decision, as I say, assumes policies will be expensive requiring extensive monitoring of compliance. The regime that we have represents fourteen years of negotiation and yet, at the moment, the real goals that the Annex 1 countries are seeking to implement amount to only 2% emissions reductions, because of all the concessions that have been made in terms of including forest offsets and so on. So, we've spent fourteen years getting to 2% real targets. Well, you know, at that rate, in two or three hundred years we'll have this thing licked! The bad news also is that the regime was rejected by two major players, at least; the USA and Australia. Furthermore, Kyoto has been represented for this entire period since its inception as the only game in town. My response to

that is well, actually, if that's the only game in town it's about time you started developing a new game. The environmentalist movement has largely said that because it's the only game in town, you've got to get in behind it. And I think that in the process we've actually lost a lot of initiative that we could have been following. We need a new game.

So that's the bad news, what about the clumsy solutions? Well the idea of clumsy solutions was introduced to the world in 1988 by Michael Shapiro, another Californian, a Professor of Law at the University of California, San Diego. He devised the notion to describe the problem of judicial selection in the United States. In a nutshell, what he was suggesting was that if you think that judges are there to reflect community values you'd elect them and, in fact, some judges in the US are elected, not to the Federal bench but certainly at the state and local level. If, on the other hand, you think that judges somehow or other have some special interpretative capacity to understand the law, you would probably appoint them administratively or you might even have a peer review system of self-appointment. On the other hand, if you're really thinking that basically you should judge judges on their empirical effectiveness, it doesn't matter whether you appoint them or you vote for them, so long as you can kick them out if they're not doing any good.

Now, do these sound like familiar stories to you? It's a sort of egalitarian, hierarchical and competitive way of dealing with the issue of judicial selection. And what, of course, Shapiro pointed out was that societies and individuals are committed, in fact, to conflicting goals in this process of judicial selection, and he recognised the importance of essential contestation in providing a sustainable system of judicial selection. He pointed out that it's very important to avoid alienating significant constituencies. I think that's part of the argument that I've already begun to develop in relation to these wicked problems. And also, extremely important, he said that you need to maintain a set of values over time. You don't want to push one particular value set - the hierarchical, egalitarian or competitive - one out of the picture because they all have something to bring to the table in terms of solutions.

So, if we were to apply Shapiro's idea of clumsiness to climate, what would a clumsy climate strategy look like? Well, I've already mentioned that we would probably increase the initial focus on adaptation. In any case, I'd argue that emissions reduction is always seen as somebody else's problem. It's too difficult for the average citizen at least to get their head around, so no wonder 90% of the British population think it's the government's responsibility to deal with. It's too abstract, it's too distant, it's too far in the future. Maybe if we started trying to mobilise people around some feature of their own daily lives, something in their landscape that they treasure, and got them to think about how they would adapt to preserve that, whether it's a piece of coastline, whether it's a snow capped mountain top, whether it's a river valley that might dry up with changes in precipitation regimes, how would you preserve that? Begin with something that people can begin to relate to and then, as they learn the limits of adaptation there's the possibility of them taking that sense of empowerment and their learning about the climate change issue into a mitigation programme. So you could build up public support for it in that way.

I think also we should really move away from thinking that this is a problem to be dealt with by the governments and nation states, at least by governments and nation states alone, and should move the focus down to lower levels of decision-making, provinces and cities and perhaps individual nations, rather than neglecting all the world's 195 governments to sign up to one agreement to do the same thing for the same reasons.

When I explained to that European Environment minister who I mentioned earlier that Americans didn't look to the Federal Government to lead on these kinds of problems, in addition to saying that that was unacceptable he said, "But this means that we can't do anything with the Americans." And I said, "Wrong! It merely means you can't do anything with Mr Bush Junior. You can do lots of things with the Americans. You can do it with the state governments." In fact, the state of New Jersey - New Jersey, yes - was the first state in the US to come out with its own climate action programme, and New York followed suit soon afterwards.

New Jersey and New York are two states who have actively considered the possibility of bringing law suits against electric generating companies in the United States to recover the costs of damages that those states would incur as a result of climate change. This is based on the model of the tobacco

lawsuits, and I would suggest that, in many cases American business leaders are more scared of litigation in the courts than they are of the regulatory power of the Federal Government.

All of the sixty-odd major cities in the United States have signed up to the Mayor of Seattle's climate programme for cities, and it is actually at the level of urban life that many of the activities that cause greenhouse gas emissions to take place. So there's lots of potential here for dealing with different actors other than the central government. The more progressive elements of industry could be brought in and, of course, the United States has a huge voluntary and philanthropic tradition which could also be tapped in that if we could just get away from the notion that it has to be government to government relations that define the solution.

To the extent that we are focusing on international negotiations about emissions reduction, for heaven's sake, let's focus on the political units that matter. I would argue that at the most, counting the European Union as one, there are only ten that really matter, and if they want to negotiate among themselves some kind of an emissions trading regime might be appropriate. I cannot personally envisage both an environmentally effective and economically efficient global carbon emissions trading scheme, but I don't have the space in this particular talk to go into the reasons for that.

Another thing that would be really important for a clumsy strategy here would be to reverse the precipitous collapse of energy research and development funding that has taken place in the world over the last fifteen years. We've seen something like a 40% cut in energy R&D, and also a shift away from government funding to the private sector along with the increasing privatisation of the energy industry. And, of course, private-sector investment tends to be very much more conservative, looking at incremental changes. So we really do need to revitalise investment in energy R&D.

I think the important thing here is to focus on processes. Let's understand that the energy system wasn't planned. Nobody ever sat down and designed it. It came into existence by the accretion of all kinds of bits of technology and bits of behaviour and so on, to create a system that's enormously complex and over-determined in one way at the moment. We've got to shift that in a different direction. It seems to me that focusing on the process of shifting direction is far more important than setting 5% targets or 10% targets over ten or twelve-year time periods, which, in many cases, can be fulfilled within the existing technological framework, so it doesn't fundamentally shift you on process.

And finally, we should consider the benefits of international competition as well as cooperation. This is a scenario that I have entertained and discussed with various economists over the past couple of years and none of them's told me that it's completely impossible or whatever. Europe has to renew about 200,000 megawatts of power in the next fifteen years. If the Europeans were indeed to do that with a strong focus on efficiency and renewables, that that could indeed have an initial braking effect on the European economy but, nevertheless, within a relatively short period of time one ought to see those improvements in the energy system and its modernisation translating into improvements in the economic performance of the European economies as a whole, vis-a-vis a United States that doesn't modernise its energy sector. I lived in the US long enough to know that as soon as US businessmen saw that they were losing ground competitively on that basis, you could see a very rapid shift towards modernising the US energy sector, and it is at least a plausible scenario that you would much more rapidly move away from carbon intensive energy generation through that means than through, as I say, phased 5% and 10% emissions reductions over periods of decades. So the notion here is that there are tipping points of that sort that might be found, I think that is extremely important.

Finally, or almost finally, key characteristics of clumsy solutions. I think we have to say the major key characteristic is to observe what we've called here the law of minimum requisite variety. You can't have fewer than three voices and have this kind of emergent solution occur, because if you've only got two voices all you have is a binary opposition. All you have in terms of changing a system is a switch from to another. You need the three as the minimum number for a complex solution to a wicked problem to emerge. You can have more if you want but certainly you can't have fewer than three. I'd argue if you get more than about five voices, actually you then start to lose the benefits

of parsimony. But you want to also make sure that all of the voices get heard and responded to, and you find that the clumsy solutions are often emergent and often informal.

I was asked, as I said, to talk a little bit about nuclear power this morning on the radio and it reminds me of a situation when I was once again a young researcher in Oak Ridge and I used to attend seminars that were led by Alvin Weinberg. Alvin Weinberg, some of you may know, he's now in his mid-eighties, was the father of the commercial pressurised water reactor. And Al used to say, "The United States needs a nuclear energy policy, we don't have a nuclear energy policy." And I said, "Al, of course, the United States has a very clear energy policy. Everybody knows what it is. It's we continue R&D into nuclear but have a moratorium on adding new nuclear capacity." He said, "But where's the Presidential Order? Where's the Act of Congress? Where is the entry in the Code of Federal Regulations?" And I said, "Look, everybody knows what the policy is. It's been agreed but the parties concerned, the nuclear industry and the utilities, the government, and the environmental movement, can't agree that they've agreed. They have to maintain that they still disagree although they have alighted on a stable settlement for the time being." So you can see how these clumsy solutions, in fact, are not just responding to all three voices in that case but were also emergent.

Now, there are challenges of course for these approaches. The media and voters expect policymakers to fix problems. It is a hard sell for a policymaker to say well, you know, I'm going to wait for a clumsy solution to emerge, I'm going to make sure all the voices get heard. Policymakers, generally speaking, demand scientific bottom lines for decision-making. Although we know from the knowledge utilisation literature that they rarely use them to make policy, they still demand them. And scientists are committed to improving knowledge, so often hold out unrealistic expectations to policymakers that they will produce knowledge that will cut the Gordian knot of a wicked problem.

And we also have the hammer problem, which is the success of rational choice theory in solving more straightforward problems which exacerbates expectations for their appropriateness for application to wicked problems. We often hear that there are claims that there are no alternatives to the application of benefit cost analysis and other kinds of rational choice tools.

So there are hard challenges ahead for a clumsy approach. But, a very good friend of mine, Shiv Visvanathan, pointed out recently that democracy is not merely a design problem, it's a challenge to the imagination. So I'm offering clumsy solutions to wicked problems as a challenge to the imagination. I believe that embracing clumsiness moves us from techniques for selecting among well defined alternatives towards looking for new skills for creating imaginative solutions.

And, with that, I would just mention that for those of you who are interested in looking further at this, there is a book which is being published in September, edited by two of the Fellows of the James Martin Institute, Marco Verweij and Michael Thompson. I'm the co-author of two of the papers in the book and you can find much more about these ideas in there.

Thank you very much for your attention. I really appreciate it.

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