Spring 5-15-2013

Integrating Science & Policy

Abigail A. Carson
Coastal Carolina University

INTEGRATING SCIENCE & POLICY
2012

BY

ABIGAIL A. CARSON

MARINE SCIENCE

Submitted in Partial Fulfillment of the
Requirements for the Degree of Bachelor of Science
In the Honors Program at
Coastal Carolina University

May 2013

Introduction

The politicization of science is undermining the credibility of both political and scientific institutions. The George W. Bush Administration and their approach to addressing scientific issues, specifically climate change, has been known to politicize science to meet the needs of the administration's political agendas. A petition was signed in February of 2004 by more than 9,000 scientists in opposition of the way the George W. Bush Administration handled issues regarding science and scientific institutions. Over the next four years, over 15,000 scientists expressed concern about the misuse of science by the George W. Bush administration. The petition stated:

> When scientific knowledge is in conflict with its political goals, the [Bush] administration has often manipulated the process through which science enters into its decisions. This has been done by disbanding existing advisory committees, censoring and suppressing reports by the government's own scientists, and by simply not seeking independent scientific advice. Furthermore, in advocating policies that are not scientifically sound, the administration has sometimes misrepresented scientific knowledge and misled the public about the implications of its policies. (Restoring Scientific Integrity in Policymaking, 2004)

In the twenty first century, science and policy do not go hand in hand; the integration of science and policy has been a source of much heated debate. The foundation of the issue is that researchers and policymakers lack a common ground of understanding. If the two groups do not understand each other, then they will not effectively work together. As tension mounts between the groups, conspiracy theories are generated. The motives and morals of policymakers and researchers are questioned for being able to maintain political neutrality.

If researchers and policymakers do not settle their differences and policies are not based on sound science, insufficient protection of mankind and the environment may be a consequence. As a result of inadequate environmental policies, governments will likely experience financial deficits, resulting in national security issues. This is especially an issue with regards to maritime law. Over two thirds of the Earth is covered by water. If two thirds of the Earth is not adequately protected serious environmental and security issues will arise.

Insufficient past and present policy issues that were not based on available or needed scientific information include the issue of maritime protection laws, marine protected areas and the current issue of sea level rise as a result of climate change. These three examples show the problems that result from the "disconnect" between science and policy making; an analysis of these failures can illuminate the importance of the relationship between science and policy to prevent these problems from happening in the future. The two groups have failed to work together in the past because decisions were based on politics rather than science, but if attention were to be focused on the benefits of integrating science into policy the obstacles preventing the groups from working together could be overcome.

Despite the controversies, with the right approach, the gap between science and policy can be narrowed, allowing for effective and practical policies to be put in place. However, if humans are to protect the environment, they should be proactive rather than reactive. By taking the necessary precautions and basing their decisions on the available sciences, economically governments could save millions. By backing sciences and furthering their research humans will be able to further the understanding of the environment and help prevent future environmental devastations.

Millions already owe their lives to scientists for their research and implementation of early warning devices such as a tornado warning. These warning systems are the beginning for what is to come if science continues to receive backing. Think of what could be accomplished in the next century if science and policy were to unite in the interest of protecting humans and the environment. It is imperative that environmental policies be based on sound science; to achieve this, political and scientific sectors must be integrated to produce effective and practical policies.

Literature Review

Realizing the importance of protecting the environment is fundamental to this debate. Life on earth relies on the proper functioning of ecosystems within the environment. Ecosystem services provide supporting, provisioning, regulating, and cultural services; these services then allow for constituents of well-being such as security, basic material for good life, health, good social relations, and ultimately freedom of choice and action. (Millennium Ecosystem Assessment, 2005) Sylvia Earl supports this point in *The World is Blue* (2009) by saying, we are supported by the ocean and without it, we will fail; for this reason, we must protect the ocean and takes the necessary steps to sustain this intricate ecosystem by making personal changes and taking steps towards protection of all ecosystems.

The Environmental Policy Paradox

People and the environment are intrinsically bound together. All human actions affect the environment and vice versa. Jacques and Smith (2003) state, it is now understood that human relationships to nature are inextricably intertwined with human survival and can be related to human violence as well. The two have come together so much now that environmental politics is now a permanent part of security politics.

Jacques and Smith (2003) focus on the issue of policy and the ocean. They discuss the various problem areas that need to be addressed in order to protect and preserve the oceanic environment and meet the needs/wants of various nations. They explain their idea of an environmental policy paradox in which scientists identify several appropriate solutions that could be applied to an environmental problem, but often, those solutions are not used. The solutions are often not used because policy is about making decisions regarding human actions. When human desires come into play decisions regarding the environment are based on the wants and needs of humans. An individual's wants and needs play a significant role in most if not all political decisions. By taking the focus off of what is best for the environment, policy is being used as a means to an end to further certain individual's interests. However, environmental politics should focus on people and how they relate to nature. The scope of environmental politics encompasses history, economics, psychology, ecology and international affairs; environmental politics has to do with every aspect concerning people and nature.

Scholarly Consensus

Gibbons et. al (2008), Russell (1987), Haas (2004), Rykiel (2001), Ozawa (1996), Jacques and Smith (2003), Policansky (1998), Malone and Corell (1989), and Milton (1987) all agree that science and policy need to work together to implement scientifically sound policies. To what degree they should work together varies among scholars. Gibbons et al. (2008) suggests a high level of integration and development of strong relations between the groups as a stepping stone for future work. Russell (1987) suggests a higher level of understanding be developed between the two groups so that they can better comprehend each other's work. Haas (2004) and Rykiel (2001) support integration but stress that political agendas discredit scientific authority leading to science not being used. Ozawa (1996), Jacques and Smith (2003), and Polincansky

(1998) felt that science should play a role in policy decisions, but other factors should be weighed in the decision making.

Bridging the Gap

Gibbons et al. (2008) addresses the issue of how researchers and policymakers could work together to more effectively narrow the gap between science and policy in natural resource management. Gibbons et al. reports on a meeting between researchers, policymakers, and managers convened to identify practical solutions to improve engagement between researchers and policymakers. The main question addressed was how can researchers and policymakers work together to more effectively narrow the gap between science and policy in natural resource management?

The solution proposed was that researchers and policymakers must develop personal relationships with one another. They can do so through discussions, meetings, workshops, or field days in hopes that research will increase the influence on policy decisions. There will inevitable be more of a crossover between the two groups if each group strives to be involved in the others projects. Russell (1987) stated that it is essential to build bridges across the cultural rifts that now hinder decision making. Russell suggested that policy makers and scientists must effectively explain their views in terms that others can understand, and that by breaking the misunderstanding barrier there will be a more uniform understanding among policymakers, science, and the public.

Challenges to Scientific Authority

In order to better understand the rift between policymakers and scientists, Haas (2004) proposed three challenges to scientific authority. First, scientists lack independent structure (they may be influenced by a sponsor). Secondly, sometimes political authorities intervene on the use

of science and thus possibly distorted by the political goals of potential users. Thirdly, science is political in its consequences, because some benefit and others suffer as a consequence of policy options that are supported by the application of scientific understanding. Haas further explained that the relevant scientific knowledge for policy should be "useable knowledge". Haas defines "useable knowledge" as, accurate information that is of use to politicians and policymakers. It must be accurate and politically tractable for its users, and must meet the four criteria for usable knowledge: adequacy, value, legitimacy and effectiveness.

Haas's conclusion was that if recipients are not confident in the usefulness of scientific knowledge, they will not use it. Supporting Haas's conclusion, Rykiel (2001) states that scientists who are perceived to have a political agenda lose their credibility, and the policymakers can therefore ignore the scientific information they provide.

Degree of Science in Decision Making

Rykiel takes more of a philosophical approach on the issue of science being integrated into policymaking. He focuses on the question as to whether scientists can be objective when relaying science to policymakers and the issue of science in society. Rykiel finds a central problem when scientists get involved with policydecisions. By getting involved with the policy process researchers are percieved as having a political agenda and lose their credibility. As a result policymakers then discredit the researchers as a scientific authority. This led to the conclusion that there is a fine line drawn between not enough involvment and too much involvement. Too much association draws much skeptism to scientific authority.

How large a role should science play in policy matters? Ozawa (1996), Jacques and Smith (2003), and Polincansky (1998) felt that science should play a role in policy decisions, but other factors should be weighed in the decision making. Ozawa (1996) felt that rather than

having a role of equal standing with the human actors in a conflict, science ought to be viewed as a prop in the hands of those enacting environmental conflicts. Ozawa holds the view that science plays a major part in environmental conflict. However, how that role is defined is determined by the human actors engaged in the conflict and the legal and institutional constructs that structure discourse. The role that science plays in the environmental conflict is progressively regressing in its ability to aid in a resolution.

Some argue that environmental issues should be viewed as all-inclusive. Not only addressing the political and scientific aspects but the social, cultural, and ethical aspects of the issue. Polincansky (1998) explained that much of resource management lies outside science, involving economics, values, politics, and other factors.

To support his opinion, Polincansky researches several controversial topics recently studied by the National Research Council: the Mono Basin ecosystem, wetlands delineation, anadromous salmon in the northwestern United States, and the science underlying the Endangered Species Act. For each case, he briefly describes the report, its conclusions and the events that followed the report's publication. He then related them to various political and economic factors, including the relevance of the disputed issues to the scientific issues addressed. In the end he draws some general conclusions about the roles of science in decision making in resource management.

Polincansky (1998) finds that there are six common barriers when trying to resolve the controversial topics studied by the National Research Council. Common barriers to resolving the controversies include: varying policy goals among the parties, mutual mistrust, the amount of money and time needed to solve the problem, the lack of a coherent management authority or

multiple jurisdictions, scientific uncertainties, and the nonscientific nature of the issues in dispute.

In response to these barriers Policansky concludes that sound science alone will not lead to effectively overcoming these obstacles but it is an essential starting point. He suggests that along with innovative and workable policies sound science can help resolve these and related issues. This is why it is often appropriate for decision makers to weigh other factors as, or more, heavily as science.

Waiting for Certainty

Jacques and Smith (2003) hold the view that science in policy making is necessary, but not in itself, sufficient to guide that endeavor. Environmental policy concerns are not simply focused on the environment, but are deeply rooted in social, cultural, and ethical aspects. Jacques and Smith also address the question: should policy makers wait for certainty within science before using it as a base for policy matters? They stress that good science acknowledges where the most uncertainty resides in scientific findings, and waiting for certainty in policy is a good way to endorse the status quo and do nothing. An example of an environmental policy issue pushed aside in order to wait for "sound science" is the George W. Bush Administration addressing the issue of climate change. The George W. Bush Administration used the excuse that they were waiting for sound science in order to ride the fence on the political matter and avoid having to address it all together. Jacques and Smith (2003) state, "Even if doing nothing sounds like a rational decision, it also means putting off any change to an existing policy, which more than likely is also not based on any scientific certainty."

Today most standing environmental policies are not based on scientific certainty and/or have very little scientific backing. Some existing policies, not based on any scientific certainty,

include policies regarding Marine Protected Areas, the Law of the High Seas, and issues regarding sea level rise due to climate change. These policy issues all share an important common ground, they lack a scientific foundation. Therefore, these issues cannot provide adequate protection for what they were put in place to maintain.

Marine Protected Areas in Politics

There are lots of ecosystems that lack adequate protection, the largest of these being the marine ecosystem. Existing maritime protection laws need to extend from waters under the protection of national jurisdiction to areas of high seas which extend beyond this jurisdictional protection (Warner, 2001). Warner addressed the fact that there is a need to develop more extensive laws that will protect the marine ecosystem that lies beyond current jurisdictional protection of any individual state. Cripps and Christiansen (2001) add to Warner's opinion that there is a need to address different levels of government protection of the environment. Cripps and Christiansen (2001) explain different resolutions should be given for different levels of government and for different international organizations, because what works for one place may not work for another. One working solution may not be universally adequate; different solutions are needed for different areas and different levels of governing.

Cripps and Christiansen (2001) address the importance of High Sea Marine Protected Areas (HSMPAs), how to go about declaring the need for protection of the areas, and the legislation that would implement this protection. The World Wildlife Foundation (WWF) funded and ran the research to address these questions. The goal of the WWF is to establish and implement a network of effectively managed, ecologically representative Marine Protected Areas (MPAs) covering at least 10 % of the world's oceans. MPAs were created as a way to conserve

areas of high, valuable, or rare biodiversity that are threatened or potentially threatened (Cripps and Christiansen, 2001).

In establishing an effective network of MPAs the most important ecological marine habitats needed to be established first. In order to create this "ranking" of important habitats the WWF attempts to determine focal regions of which they call, the Global 200 ecoregions. These ecoregions involved a ranking of the Earth's most biologically outstanding habitats. However, the high seas are not protected in the Global 200 ecoregions because of a lack of understanding of the biodiversity in high seas and lack of knowledge of the threats to waters away from the coastal region.

Cripps and Christiansen (2001) address the fact that many marine protected areas are scattered apart from one another, they stress the importance of a network being built around the protected areas. By creating a network of protected areas the "up-stream" influences that are deteriorating the biodiversity of the protected areas can be limited. Cripps and Christiansen find that the effectiveness in which MPAs are governed is affected by the following: political will, available governance structures, infrastructure development, the capacity of authorities and degree of isolation.

MPAs protection varies greatly with the state that protects the territory. In order for MPAs to receive the protection they need, the MPAs would need to be adequately managed. It is understood that different legislation will be needed to suit the needs of different problems that are presented in MPAs. It is important to take into consideration the future impacts an area might encounter in determining if an area requires protection and what protection it might need.

Voluntary Measures as a Conservation Tool

In a case study of endangered whales and commercial whale watching (Wiley et al., 2008), it was found that the effectiveness of voluntary measures as a conservation tool in the whale watching industry was minimal and needed revision. In the northeast region of the United States both government agencies and nongovernmental organizations started a voluntary conservation program for whale watching.

The purpose of the voluntary conservation program was to help commercial and recreational whale-watching vessels avoid hitting whales. The study investigates the actual compliance of the whale watching industry, in Gerry E. Studds Stellwagen Bank National Marine Sanctuary, to measure the effectiveness of the voluntary conservation program set in place. The study area, Gerry E. Studds Stellwagen Bank National Marine Sanctuary, is a government marine protected area.

The whale watching vessels involved in the study had a three speed zone rule in approaching a whale. As a whale watching vessel approaches a whale it is supposed to decrease its speed as the distance between the vessel and the whale decreases. The compliance of vessels to the three speed zone rule was measured in the study. To gather the information on speed zone compliance researchers posed as paying customers on commercial whale watching vessels. The compliance analysis showed that very few vessels are complying with the speed zone buffers. The max speeds were reached if not well exceeded by the vessels. However, it was observed that compliance to speed zone buffers differed among speed zones and the companies that owned the vessels. It was observed that vessels were less compliant in the zones that were furthest from the whales and reached maximum speeds in transit from one whale spotting to another whale spotting.

The case studies main finding was that the people involved in the whale watching industry around Gerry E. Studds Stellwagen Bank National Marine Sanctuary felt that compliance to voluntary agreements could be ignored. Despite conditions that seemed supportive of compliance to the voluntary measures for management it was observed that the whale watching industry is reluctant to follow the rules. In response to the findings of the case study Wiley et al. (2008) concluded that the effectiveness of voluntary measures as a conservation tool was minimal. They further concluded that conservation efforts need to be revised so there effectiveness of protecting the environment increases.

The lack of effective policy in the case study of Wiley et al. (2008) illustrates the need for policymakers to work with scientists to implement the most appropriate and effective environmental policies. The study found that the regulations already set in place are not effective thus need revamping. If policymakers used the information gathered in this study they could implement more effective regulations protecting both human and environmental interests.

The results confirm the concern that voluntary approaches and regulations to conservation management should be viewed with caution and monitored carefully. The challenge to scientists and managers is to bring participant behavior up to the standards needed for conservation, rather than dropping standards to a point where high levels of compliance can be achieved. This case study could be used as an example for revamping of other environmental policies that are not effective and need readdressing.

Surveying the First International Marine Protected Areas Congress

Gray and Campbell (2008) agree with both Wiley et al. (2008) and Cripps and Christiansen (2001) that in order to achieve the objectives of MPAs, sound science or the best available science must be integrated into policy decisions. Gray and Campbell (2008) assess

attitudes toward science and policy advocacy with regards to MPAs. In their study Gray and Campbell conduct a survey of the delegates at the First International Marine Protected Areas Congress. The delegates were all members of the international marine conservation community and embodied academic, government and nongovernmental establishments.

The main question Gray and Campbell ask of the delegates is to what extent scientists should engage in the policymaking process. The survey finds that almost all respondents support scientists being integrated into MPA policymaking, and around half of the respondents agree that scientists should actively advocate for particular MPA policies. The results also illustrate that scientists with a positivist view of science support a minimal role for scientists in policy, whereas government staff with positivist beliefs support an advocacy or decisionmaking role for scientists. Policymaking processes for MPAs need to account for these divergent attitudes toward science and advocacy if science-driven and participatory approaches are to be reconciled. (Gray & Campbell, 2008)

Gray and Campbell (2008) acknowledged that a key issue with properly integrating science into policy is that a constructive role of science must be determined in order for science to effectively play a role in policymaking decisions. The role of science in the selection, design, and management of policy matters needs to be laid out. Gray and Campbell clarified that there are divergent attitudes toward science and advocacy. These divergences in what role researchers should play needs to be addressed in order to reconcile science-driven and participatory approaches to environmental policy.

Case Study: Climate Change & Sea Level Rise

Much of the focus on the role of science in policy is centered on why there is disconnect between science and policy; however, there is little focus on why it is important for this divide to be eradicated. There is no urgency to reconcile the matter of science in policy due to the fact that the importance of science in policy is not widely understood. Without understanding why science and policy should come together there will be no rush to solve the problem. Environmental policies need to be based on sound science; and to achieve this, political and scientific sectors must be integrated to produce effective and practical policies.

Does Climate Change Exist?

In response to Jacques and Smith (2003), it is argued that issues such as climate change and the resulting sea level rise has been fabricated and/or exaggerated. Thus, governments should not waste money and time on combatting something that does not exist and not a pressing matter. However, reports on climate change and sea level rise are not just coming from one entity, but from numerous reputable institutions internationally.

Current debate regarding climate change is centered around the cause of climate change; whether climate change is manmade (anthropogenic) or natural. The debate over the cause of climate change is a political one. Those that favor the use of unsustainable resources and energy tend to be on the conservative, right handed side of the political spectrum. These conservatives tend to favor the idea that climate change is natural, not occurring at as high a rate as projected by scientists, or not occurring at all. Because the conservatives feel that humans have not accelerated climate change, nor is there much that can be done to stop it, the conservatives justify continued use of unsustainable/nonrenewable energy.

Those that support the idea that climate change, to some extent is anthropogenic, tend to be on the liberal, left handed side of the political spectrum. These liberals tend to favor developing new renewable and sustainable energy sources such as energy generated by water or wind power. Thus, an individual's political views tend to sway their opinion on climate change, the environment, the continued use of unsustainable resources, and development of new energy sources. Humans tend to follow the agendas of the political party they affiliate themselves with; because of this, their views are shaped to that of their political party's views. This leads a country to be divided on important environmental issues. As a liberal one supports the view that climate change is manmade. As a conservative one supports the belief that climate change is natural and there is little that humans can do to change the effects that climate change may be having on Earth.

However, the consensus among scientists is that climate change is occurring and will continue to occur. Climate change has been having many adverse effects on humans and will continue to do so as time goes on. As climate change continues to increase so does the sea level. The resulting sea level rise will continue to affect mankind for centuries to come, regardless of political views.

Sea Level Rise & The Intergovernmental Panel on Climate Change

The issue of protecting the marine environment is not the only issue needing to be addressed regarding the ocean. The issue of climate change and sea level rise has become a focal point of science and policy. There is strong and convincing evidence and consensus among scientists that climate change is occurring, along with a rise in sea levels.

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It is recognized as the most authoritative scientific and

technical voice on assessment of climate change. In 1988, United Nations Environment Program (UNEP) and World Meteorological Organization (WMO) jointly established the IPCC as concern over changes in the climate became a political issue. The UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC. The IPCC is an intergovernmental body and is open to all member countries of the United Nations and the WMO.

The purpose of the IPCC was to assess the state of knowledge on the various aspects of global change including science, environmental and socio-economic impacts and response strategies. It was formed to provide policymakers with an objective source of information about climate change. The IPCC reviews current scientific and technical literature relevant to global climate change and provide reports on their findings at regular intervals. Their reports are designed to be politically neutral and of high scientific and technical standards. Its assessments had a profound influence on the negotiators of the United Nations Framework Convention (UNFCCC) and its Kyoto Protocol.

The IPCC is an international authority on climate change because it holds itself to demanding scientific and political standards. Every five to six years, approximately 450 experts from some 130 countries are directly involved in drafting, revising and finalizing the IPCC reports and another 2,500 experts participate in the review process. The IPCC authors are nominated by governments and by international organizations including nongovernmental organizations. The reports are ratified by the roughly 180 member nations. The scientists involved in the IPCC include Geologists, Climatologists, ecologists, atmospheric physicists etc. The 2007 Nobel Peace Prize was awarded jointly to the Intergovernmental Panel on Climate Change and Al Gore for their efforts to build up and disseminate greater knowledge about man-

made climate change, and to lay the foundations for the measures that are needed to counteract such change (www.ipcc.ch).

The IPCC determines global climate change by the radiation balance of the planet. The radiation balance is determined by the amount of solar radiation that reaches the Earth's atmosphere, is reflected back, absorbed, and/or transmitted back by the atmosphere (www.ipcc.ch). The IPCC explains that there are three fundamental ways the Earth's radiation balance can change, thereby causing a climate change. The first fundamental way is by changing the incoming solar radiation; this can be done due to changes in the Earth's orbit or in the Sun itself (www.ipcc.ch). Secondly, changing the fraction of solar radiation that is reflected, called the albedo; the albedo can be changed by changes in cloud cover, small particles called aerosols, or changes in land cover (www.ipcc.ch). Thirdly, altering the longwave energy radiated back to space can cause changes in the climate. Changes in longwave radiation radiated back to space may be due in part to changes in greenhouse gas (GHG) concentrations trapped in the atmosphere (www.ipcc.ch).

The overall finding of the IPCCs Fourth Assessment Report is: "It is unequivocal that the Earth's climate is warming. This is evident from the observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global sea level" (IPCC, 2007). Anthropogenic, manmade, warming and sea level rise would continue for centuries, even if greenhouse gas concentrations were to be stabilized at or above todays levels (IPCC, 2007). The IPCCs Fourth Assessment Report estimates a 0.2 to 0.6m sea level rise per degree Celsius at equilibrium due only to thermal expansion of sea water.

Properly preparing for sea level rise could save not only governmental funds but could save the lives of those living in low lying coastal regions. Partial loss of ice sheets on polar land

which could imply meters of sea level rise causing major changes in coastlines and inundation of low-lying areas, with greatest effects in river deltas and low-lying islands. The IPCC Fourth Assessment Report (IPCC, 2007) projected global average sea level rise to range from 0.18 meters to 0.59 meters by 2100 (Figure 1). These projections are on the conservative end of the spectrum because many factors come into play with projecting sea level rise. For instance, the contributions to sea level rise of melting Greenland and Antarctic ice is uncertain and is therefore not included in the IPCCs sea level rise projections (IPCC, 2007). Numerous studies that used semi-empirical relationships between sea level and climate (Rahmstorf, 2007; Pfeffer et al., 2008) predict up to 1.4 meters of sea level rise by year 2100 when ice sheet contributions are included. Thus, the consensus is that the rate of sea level rise will increase during the 21st century and beyond (North Carolina Assessment Report, 2013).

Sea level rise already affects island nations and coastal cities worldwide. The Maldives is a prime example of an island nation currently having to address sea level rise. The island nation is faced with the pressing matter of being drowned by increasing water levels due to sea level rise. Increases in sea level will bring with it security, health, and economic issues on top of the environmental devastation that will ensue.

Even if it is acknowledged that there is an issue, the urgency to address the issue is minimal. The common approach to environmental issues today is to wait for an issue, such as a natural disaster, to arise and then address the problem. This reactive approach could cost countries hundreds of millions of dollars economically and cause irreversible environmental damage. Financially and environmentally, it is very important to be proactive rather than reactive when it comes to environmental changes.

Most coastal cities have not considered the implications of sea level rise. With sea level rise projections of up to 1.4 meters by 2100 (Rahmstorf, 2007; Pfeffer et al., 2008), nations should start gearing up for coastal changes. By taking the proper precautions in coastal areas, nations can minimize the damage due to rising seas. But the question is what happens when a government intervenes with deciding what constitutes correct sea level rise projections and what projections will suffice for policies to be based on. This is what recently happened in the state of North Carolina.

Sea Level Rise in North Carolina

Recent debate in North Carolina has been centered on the issue of sea level rise and the science behind it. In the state there is a battle over a bill that would decide who in the state of North Carolina would be authorized to predict the impact of sea level rise in coastal counties. The bill would ban the state of North Carolina from basing coastal policies on the latest scientific projections of sea level rise.

The bill was in response to a commission, put in place by the state of North Carolina, to estimate future sea level rise projections along the Atlantic coast of North Carolina's coastline. The panel consisted of regional and international experts on sea level rise and coastal geophysics. The experts were from academically renowned scientific institutions including the US army Corps of Engineers, UNC-CH's Institute of Marine Sciences, UNCW, East Carolina University, and NC State.

The North Carolina Coastal Resources Commission's (CRC) Science Panel on Coastal Hazards was invited by the Division of Coastal Management (DCM) staff to provide input into DCM's sea-level rise (SLR) initiatives. The Science Panel prepared a report, based on peer reviewed published literature, on the known state of sea level rise in North Carolina. The CRC

and DCM asked the Science Panel to provide the best available information on the following concerns regarding sea level rise (North Carolina Report, 2010):

1. An explanation of how SLR is measured: globally, and at the state and regional scales
2. Relative SLR ranges for different sections of the North Carolina coast, as appropriate to account for regional differences
3. Relative SLR ranges for North Carolina expressed in time slices for the years 2025, 2050, 2075, and 2100
4. Relative SLR rate curves for North Carolina through 2100
5. A discussion of the confidence level or margin of error for the reported ranges and rate curves
6. Recommendations as to what needs to be done for improved SLR monitoring in the State of North Carolina
7. Recommendations as to how frequently the State of North Carolina should update its projected SLR ranges and rates

The report gives a basic introduction to what sea level rise is and several ways in which it can be measured, and describes the empirical findings of several past sea level rise studies conducted in North Carolina. The study finds that the North Carolina state sea level rise had averaged around 5mm/year from the year 12,000 BP (Before Present) to 1mm/year in recent times. Eight tide gage stations in North Carolina indicate that recent sea level rise has varied from 2mm/year in the southern part of North Carolina to 4.3mm/year around the states northern border with the state of Virginia (Figure 2) (Table 1). That is nearly twice the rate of the southern part of the state.

The Panel found that all of the historical tide gauge records over the last century and geologic evidence over the last several centuries offer undisputable evidence that the sea level has been steadily rising in North Carolina, and based on multiple indicators suggesting that global climate is warming, the Panel believes that an acceleration in the rate of SLR is likely (North Carolina Report, 2010 pg 13). To project possible scenarios for future sea level rise off the coast of North Carolina the panel uses the best available science on sea level rise that relates to North Carolina specifically. They based these projections on different degrees of sea level rise acceleration. After reviewing the available information relevant to the sea level rise off the coast of North Carolina, the Panel's consensus was to recommend creating a plan for a rise in sea level of 1 meter by the year 2100.

The Panel's report was immediately scrutinized after publication. The report attracted the attention of North Carolina real estate investors and developers who stood to be affected financially with the Panel's sea level rise projections. Members of the developers' lobbying group NC-20 especially did not like the Panel's projections because the projections are a great inconvenience for their building plans for counties along the coast. These projections could trigger a steep rise in home insurance and jeopardize the permits of many planned development projects along the coast of North Carolina.

The Panel's findings are not only being ridiculed by lobbyist groups like NC-20, but are being discredited by state politicians. Replacement House Bill 819, section 2 paragraph e, with regards to rates of sea level rise states, "These rates shall only be determined using historical data, and these data shall be limited to the time period following the year 1900. Rates of sea level rise may be extrapolated linearly". This means that the Replacement House Bill 819 holds that sea level rise rates can only be determined using data since the year 1900. The bill also bans

scientists in state agencies from using exponential extrapolation to predict sea level rise, requiring that scientists use linear projections based on historical data. However, the consensus from reputable sources projects that sea level rise will likely increase exponentially rather than linearly, and to fully understand climate patterns historical data needs to be used far beyond the year of 1900. This will result in policy matters in North Carolina not being based on sound science and therefore the gap between science and policy will continue to widen.

Following international disapproval of the bill, North Carolina's House of Representatives rejected the bill less than ten days after the state senate approved it. However, an amended version was passed that says the rates of sea level rise shall be determined using statistically significant, peer-reviewed historical data generated using generally accepted scientific and statistical techniques. Which seems like a decent compromise were it not followed by, "historic rates of sea level rise may be extrapolated to estimate future rates of rise but shall not include scenarios of accelerated rates of sea level rise unless such rates are from statistically significant, peer-reviewed data and are consistent with historic trends".

This was and is a problem because predictions of sea level rise are not linear, rather projections exponentially increase over time (Figure 3) and projections do not follow historic trends. North Carolina justified using historical trends and linear projections because sea level rise projections based on exponential projections and date from before 1900 are not based on certainty. However, the same is true of sea level rise projections based on historical trends after 1900 and linear projections. No sea level rise projection is based on certainty, there is still much scientists need to learn about climate change and sea level rise. This is the reason scientists use the best data available to them to make an educated prediction. However, the decision to use linear and historical data from after 1900 mainly came from individuals with little to no scientific

background. The logical sea level rise projections, to use in the decision making process, would be the sea level rise projections backed by internationally reputable institutions that study climate change. The projections supported by climate change institutions are not those of linear growth but exponential growth. Yet, the exponential sea level rise predictions are being discredited by individuals whose job is in politics not science. This is a clear cut example of politics regulating science as a means to an end, in this case the end is economic gain.

Sea level rise projections are not good news for coastal developers looking to expand development along the coast of North Carolina, but developers have a standing on the matter, while it appears science does not. The political agenda of North Carolina, to continue to develop along the coast for economic gains, seems to be of greater significance to the state than protecting its citizens from sea level rise and keeping people and their belongings out of harm's way.

Environment & Security

The relation of the environment and national security has been at the center of much debate recently. The environment and its security is an important dimension of peace, national security, and human rights that is just now being understood. The Institute for Environmental Security holds that the precise roles of the environment in peace, conflict, destabilization and human insecurity may differ from situation to situation and there are growing indications that it is increasingly an underlying cause of instability, conflict and unrest (http://www.envirosecurity.org).

The ocean needs protection not only because it is possibly the most important environmental asset, but because it is also a matter of security politics. Jacques and Smith (2003) explain that security politics is the politics of physical survival. They explained that the ocean is

key within security politics because the ocean is one of the main avenues of interstate military disputes and that there is a strong correlation between nations that are strong at sea and those that are strong economically. Also, as Earle (2009) explains, the ocean is a foundation for all life on Earth. The possibility of disrupting this foundation is a serious security concern.

Science Does Not Belong in Politics

Many times scientists and policy makers do not work together because of the argument that scientists do not belong in political decisions. However, it is important to understand that policies based on science could save the environment and human livelihood, provide the means for better national security, and help governments save money (Brown, 2011). Scientists are often the first to perceive effects and processes that may be harmful to humans that are in effect an early warning system (Rykiel, 2001). As a result, science can help develop policies that are proactive at combatting degradation rather than the less effective reactive approach currently taken. If the information presented by scientists to policymakers is policy neutral, not policy perspective, policies can be based on sound science and the bridge between science and policy can be met.

Political Neutrality

How can scientists remain politically neutral in presenting their findings? No one is completely objective. Rykiel (2001) asks the important question, how can someone tell scientists they have no right to be involved in policymaking because they cannot be completely objective, when all politicians are themselves not objective and have an agenda for every issue? There are many proposed solutions to ensure policy advice is politically neutral. The need for scientific information to come through legitimate channels is stressed. The science should be developed authoritatively, through independent scientific institutions rather than government-sponsored

ones. Sponsors of scientific groups should be different from sponsors of the basic research and activities that generate initial consensus. Policy advice should also be based upon peer-reviewed materials and their findings should be delivered by liable individuals to politicians (Haas & Kanie, 2004).

Understanding Science & Building Relationships

If policymakers do not understand the scientific information presented to them, how can this issue be resolved? First, scientists must take into consideration that their data is meant for individuals that may have little scientific understanding. Those that communicate the scientific findings to the policymakers should be well versed not just in the discipline of science, but they should also be able to communicate to individuals outside the discipline of science. The relay of information should be on a level that individuals not well versed in science can understand.

To minimize the misunderstanding between scientists and policymakers the two need to meet and/or converse on a regular basis. Strengthening the lines of communication between the two will allow for better understanding of each other. Arrangements should be made for focused interactions between scientists and policymakers to discuss the technical substances of the issues and more venues should be created for the two groups to come together (Haas & Kanie, 2004).

Actively building and maintaining relationships with key individuals through discussions, meetings, workshops or field days will increase the likelihood that research outcomes will inform policy decisions (Gibbons et al., 2008). Understanding what drives the other group is the foundation for creating effective partnerships between science and policy. Researchers and policy-makers should understand, and tap into, the motivations and reward systems of the other, when seeking engagement (Gibbons et al., 2008).

Motivations

It is essential to understand what motivates the research sector and what motivates the political sector. For example, by understanding what motivates the politicians, researchers might be able to spur political interest on the issue and elevate the likelihood of political involvement. Gibbons et al. (2008) explains that researchers and policymakers operate under different demands, constraints and reward systems.

Researchers are motivated by policy activities that: generate long term research activities, have a teaching spin-off, raise their profile (e.g. in the media), have a demonstrable impact on public policy, and seek objective knowledge rather than support for an existing position. Policy makers are motivated by research that is, (1) relevant for a contemporary issue, (2) acceptable to the current government (political agendas), (3) identifies practical solutions, (4) can be used to identify policy options, (5) has been demonstrated to work, (6) does not attract controversy, and (7) is effectively communicated (Gibbons et al., 2008). Although not all of these interests can be met with each environmental issue if some motivations can be achieved, researchers and policymakers may be more likely to work together. The involvement between the two groups relies on building successful, personal relationships between researchers and policy makers.

Scientific Certainty

A lack of personal relationships and common understanding leads policy makers to believe that they should wait to make decisions based on science until there is certainty in the science behind it or believed to be “sound science”. Sound science is heard quite frequently when talking about science in policy. It is often used to describe the scientific research used to justify a claim or position by a congress member or government chairman. The lack of sound science is often a frequent criticism of politicians when trying to discredit proposed

environmental policies. The George W. Bush administration used “lack of sound” science as a means to avoid having to address policy matters involving climate change. The George W. Bush Administration held off on implementing the necessary policies to protect the environment until there was sound science to provide evidence of climate change.

However, there is overwhelming scientific evidence supporting the notion that climate change is occurring. In 2004, during George W. Bush’s time in office, the national science academies of all of the G-8 countries made a joint statement saying: climate change is real, human activities, through the increased concentration of greenhouse gasses, are causing temperatures to rise, the causes of climate change need to be addressed, and the negative consequences of climate change may be very severe.

This consensus among scientific authorities from around the world should have been evidence enough that there is sound science supporting the notion of climate change. However, George W. Bush, who claimed to be a strong believer in sound science, did not see this as sufficient evidence to support the theory of climate change. This contradicts the Administration’s approach to other issues that lacked scientific certainty. Such an issue is the effectiveness of abstinence-only education programs that the Administration chose to use; preventing the use of more inclusive/broadly based sexual education programs teaching safe sex which could have lowered teen pregnancy.

Scientific uncertainty has not stopped the Administration from making policy decisions so why did it with regards to climate change? It is a matter of realizing that the issue is not whether there is certainty behind the science of climate change but about the political agenda of those in charge. There will always be uncertainty regarding the environment and climate change. Such a complex system that is ever evolving and changing with time means humans have much

they still need to learn about the environment. However, lack of scientific certainty or sound science should not be a reason to delay policy action that could prevent catastrophic environmental disasters.

Using scientific uncertainty or lack of sound science is a central cause of why researchers and policy makers have apprehensions about working together. Researchers present their best findings but politicians work around using these findings. Politicians use the excuse that the finding is not certain, therefore they wait or completely neglect the research. The never ending cycle, of excuses on why not to use science as a base for policy, severely hinders the relationship of researchers and policymakers.

Policymakers fail to understand that rarely will science be certain; if they wait for certainty within science, inevitably there will be no change. If they wait for certainty behind science, it will be too late to address certain pressing environmental issues. Even if doing nothing sounds like a rational decision, it also means putting off any change to an existing policy, which more than likely is also not based on any scientific certainty (Jacques & Smith, 2003).

In 1988, Mostafa Tolba explained, it may take another 15 years before scientists can give reliable predictions of what warning will mean in each region. But by then it may be too late to act (Malone, 1989). Tolba called on political and industrial leaders to cooperate with one another and with climate scientists to finance more international research and coordination that will produce more information more quickly. With increased support of scientific research, more science will be available providing the necessary foundation for environmentally sound policies. The more support and funding research receives, the quicker pressing environmental issues can be addressed and more lives can be saved in the future.

Limitations

There are many limitations to the conclusions of other scholars who address the issue of science in policy. The primary limitation of scholars writing about science and policy are either solely science-based or policy-based; therefore there is no cross-over. This allows for only one view to be voiced on the matter. This is the foundation for why the issue is not properly addressed; without either side understanding the other's vantage point, they cannot resolve their issues and work together. To encourage more cross-over between the groups, scholars should, as best they can, incorporate both side's opinions when writing and/or speaking about science in policy.

Science meets Parliament

Science and Technology Australia (STA) is an example of where researchers and policy makers are actively working together on a regular basis. Science and Technology Australia annually holds the Science meets Parliament forum. STA is a venue that brings together over 200 of Australia's top scientists with politicians, lobbyists, and parliamentary staffers.

Science meets Parliament aims to help scientists better understand how politics, policymaking, and the media work. The forum strives to provide scientists with unique personal development opportunities; a stimulant and informant for Parliament's discussion of scientific issues that underpin Australia's economic, social and environmental well-being; and improvement in the understanding of science through the wider community. The forum also aims at building links between scientists, politicians and policy makers that open up avenues for information and idea exchanges into the future, and work to give scientists an outlook for opportunities that may require the input of scientific knowledge to further the interests of the nation.

In 2004, the founder of Science meets Parliament was awarded the Australian Government Eureka Prize for Promoting Understanding of Science. This award is given to individuals or groups for outstanding works of science communication. It is significant that an organization working to integrate science in policy is being recognized for its achievements. It highlights that the forum has been successful and that in the future other forums could be modeled after Science meets Parliament to further integrate science into policy on an international scale.

Conclusions: Bridging Science & Policy

Influencing science to meet the needs of politicians or those that financially support those politicians is a common occurrence. This is the exact reason that there is a divide between science and policy. At times politicians use science to their advantage by manipulating science in their favor. Science can be manipulated to only show the results desired or information may have been fabricated to support an idea, both making the science unreliable. This creates animosity between the two groups, increasing the divide and making it difficult for the two groups to find a common ground to work together.

Science stands at the threshold of an unprecedented opportunity to study and learn the far-reaching implications of both anthropogenic and natural environmental changes (Malone & Corell, 1989). The role of science in policy making is necessary but not in itself sufficient to guide the endeavor of putting in place effective environmental policies. Science is only a part of the solution to effective environmental policies, although it is an essential part.

If scientist and policymakers were to come together and work on developing lasting relationships together, effectively integrating science into policy would be more probable in the

future. In order for the groups to work together a foundation between the two groups must be established. Several steps need to be taken by the research sector and political sector to help bridge the gap between science and policy.

First, the two sectors should meet and/or correspond on a regular basis. Venues should be created to allow science and policy to commune on a regular basis, a good model of this would be the Science meets Parliament. Scientists also would need to work on presenting scientific data that is understood by those without a scientific background. If a policymaker does not understand the science presented to them they are unlikely to use it. However, if science could be presented in such a way that the policymaker understands it he or she is more likely to apply the information in their policy decisions. Researchers and policymakers need to work towards understanding what motivates the other group; this will help boost involvement from both sides.

If science and policy are going to work constructively together and trust each other scientific institutions should not be appointed by governments, when a government appoints a scientific institutions to do research for the government, the credibility of the institutions results are questioned. Rather, scientific institutes should be appointed by independent organizations as to prevent scientific findings from being biased and credibility questioned.

Researchers and policymakers should ensure that scientific findings are not misrepresented. This includes making sure that policymakers do not use one sided data to claim scientific support for a decision when there is none and developing policies publically based versus privately based, along with publishing scientific findings. This will help resolve the issue of secret political agendas underlying any scientific or political outcome.

These suggestions are merely the minimal guidelines for bridging the gap between science and policy. If these guidelines can be met, it is likely that policies can be made that are

more effective at protecting humans and the environment. Each environmental issue will have special circumstances that will be unique to its case but overall these guidelines can be used to further integrate science into policy decisions.

New obstacles arise daily hindering the capability of these two groups to eliminate their issues and come together to best protect humans and the environment. It is important to bridge the gap between these two groups sooner than later. The more issues the sectors face apart, the less likely they are to work together in the future because the gap will continue to grow with each new problem faced. Until the two groups can work together policy decisions will continue to lack a sound science foundation and may not be able to provide its maximum potential. Environmental policies need to be based on sound science, and to achieve this, political and scientific sectors must be integrated to produce effective and practical policies.

Figures & Tables

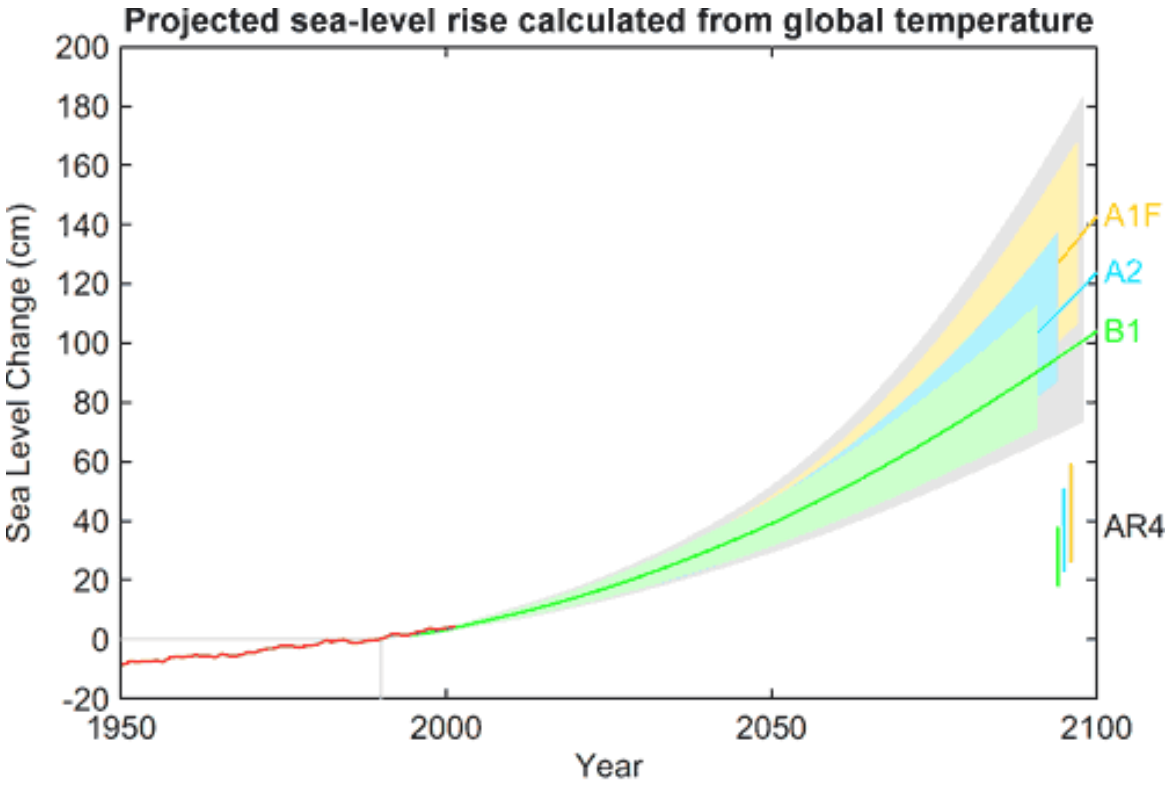

Figure 1 Projection of sea-level rise from 1990 to 2100, based on IPCC temperature projections for three different emission scenarios. The sea-level range projected in the IPCC AR4 for these scenarios are shown for comparison in the bars on the bottom right. Also shown in red is observed annual global sea-level (from Intergovernmental Panel on Climate Change, 2007).

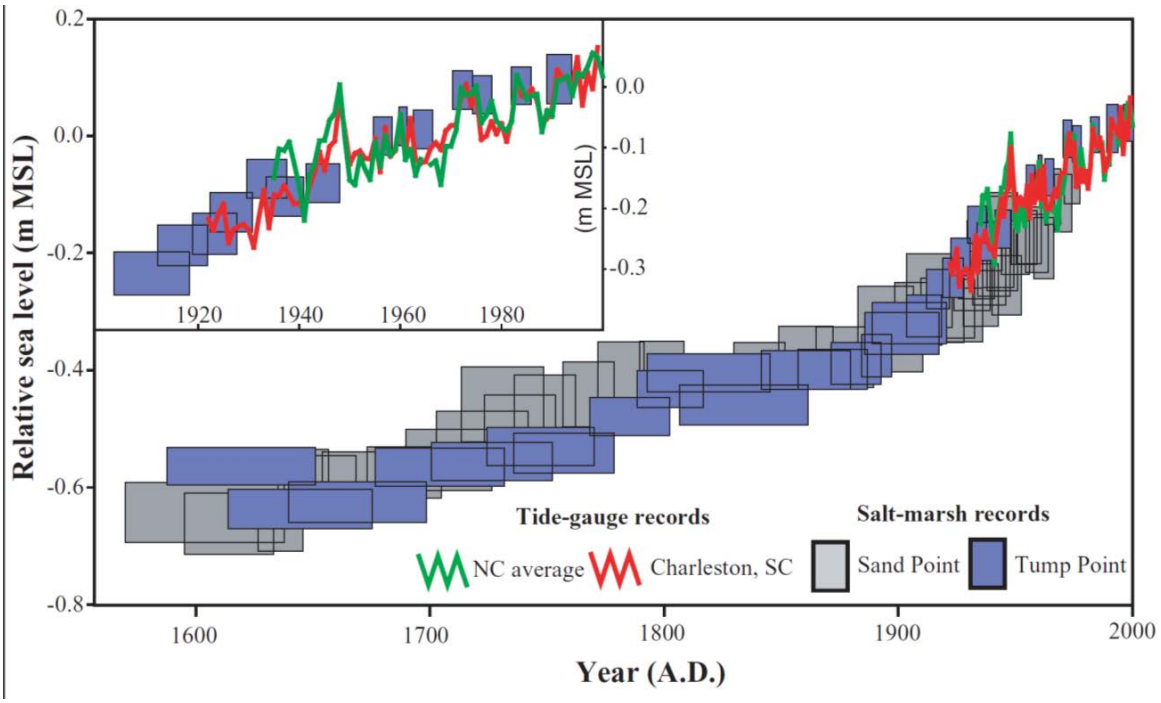

Figure 2 Reconstructions of RSL at Sand Point (grey boxes) and Tump Point (blue boxes) for the period since AD 1500. An average tide-gauge record from North Carolina (green) and the record from Charleston, South Carolina (red) are also shown. Inset: 20th century RSL reconstructed at Tump Point is compared to tide-gauge records (from Kemp et al., 2009)

Global mean sea level (GMSL) from Jan 1870 to Dec 2006

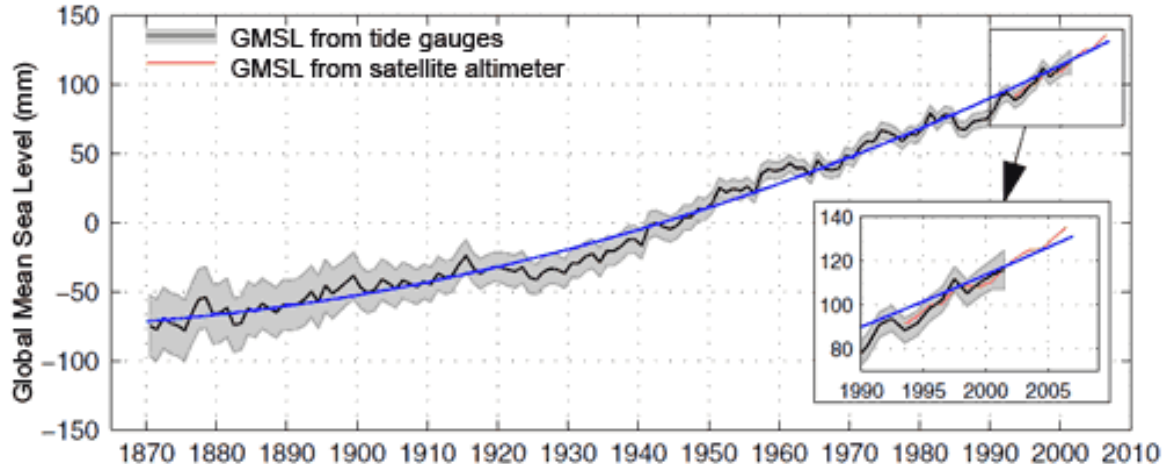

Figure 3: Global mean sea level from 1870 to 2006 with one standard deviation error estimates (from Church et al.,, 2008)

Station Number	Station Name	Mean Sea-Level Trend mm/yr	Mean Sea-Level Trend inches/century	Period of Data
8651370	Duck	4.27 ± 0.74	16.8 ± 2.9	1978-2002
8652587	Oregon Inlet Marina	2.55 ± 1.21	10.1 ± 4.8	1977-1980, 1994-2002
8654400	Cape Hatteras	3.46 ± 0.75	13.6 ± 3	1978-2002
8656483	Beaufort	3.20 ± 0.54	12.6 ± 2.2	1973-2002
8656590	Atlantic Beach	2.48 ± 1.99	9.7 ± 7.8	1977-1983, 1998-2000
8658120	Wilmington	2.12 ± 0.23	8.4 ± 0.8	1935-2002
8659084	Southport	2.04 ± 0.25	8 ± 1	1933-1954, 1976-1988
8659182	Yaupon Beach	2.92 ± 0.77	11.5 ± 3	1977-1978, 1996-1997

Table 2 Mean Sea Level trends for N.C. water-level stations in mm/year (adapted from Zervas, 2004).

References

Brown, M. A. Science Versus Policy in Establishing Equitable Agent Orange Disability Compensation Policy. *Military Medicine*, 2011; 176:35-40.

Church, J. A., White, N. J., Aarup, T., Wilson, W. S., Woodworth, P. L., Domingues, C. M., Hunter, J. R., Lambeck, K., 2008. Understanding global sea levels: past, present and future. Sustain Sci. 3:9-22.

Cripps, S. J., Christiansen, S., 2001. A Strategic Approach to Protecting Areas on the High-Seas. Bundesamt für Naturschutz. 111-121.

Earl, S., The World is Blue. Washington D.C.: National Geographic Society, 2009.

Gibbons P., Zammit C., Youngentob K., Possingham H., Lindenmayer D., Bekessy S., Burgman M., Colyvan M., Considine M., Felton A., Hobbs R., Hurley K., McAlpine C., McCarthy M., Moore J., Robinson D., Salt D., Wintle B., 2008. Some practical suggestions for improving engagement between researchers and policy-makers in natural resource management. Ecological Management & Restoration. 9(3), 182-186.

Gray, N. J., Campbell L. M., 2008. Science, Policy Advocacy, and Marine Protected Area. Conservation Biology. 23, 460-468.

Haas, P. M., Kanie, N., Emerging Forces in Environmental Governance. Tokyo: United Nations University Press, 2004.

Intergovernmental Panel on Climate Change, 2007. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change, eds Solomon S, et al. Cambridge Univ Press, Cambridge UK.

Jacques, P., Smith, Z., Ocean Politics and Policy. Santa Barbara: ABC-CLIO Inc., 2003.

Kemp, A.C., Horton, B.P., Culver, S.J., Corbett, D.R., van de Plassche, O., Gehrels, W.R., Douglas, B.C., 2009. Timing and magnitude of recent accelerated sea-level rise (North Carolina, USA). Geology 2009 37: 1035-1038.

Malone T., Corell R., 1989. Mission to Planet earth, Revisited. Environment, 3(3), 6-11,31-35.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: Wetlands and Water (Synthesis). World Resources Institute, Washington, DC.

Milton, R., 1987. Risk-Based Environmental Protection. Issues in Science and Technology. 3(3).

North Carolina Sea-Level Rise Assessment Report, 2010. North Carolina Coastal Resources Commission Science Panel on Coastal Hazards, North Carolina.

Ozawa, C.P., 1996. Science in Environmental conflict. Sociological Perspectives. 39(2), 219 230.

Pfeffer, W.T., Harper, J.T., and O'Neal, S., 2008. Kinematic constraints on glacier contributions to 21st-century sea-level rise. Science, 321: 1340-1343.

Policansky, D., 1998. Science and Decision making of Water Resources. Ecological Applications. 8(3), 610-618.

Rahmstorf, S., 2007. A semi-empirical approach to projecting future sea-level rise. Science, 315: 368-370.

Restoring Scientific Integrity in Policymaking. Union of Concerned Scientists, 2004.

Russell, M., 1987. Risk-Based Environmental Protection. Issues in Science and Technology. National Academy of Sciences. 3(3).

Rykiel E. J., 2001. Scientific Objectivity, Value Systems, and Policymaking. BioScience. 51(6), 433-436.

Warner, R., 2001. Marine Protected Areas Beyond National Jurisdiction- Existing Legal Principles and Future Legal Frameworks. Bundesamt für Naturschutz. 149-168.

Wiley, D. N., Moller J. C., Pace R. M. III, Carlson, C., 2008. Effectiveness of Voluntary Conservation Agreements: Case Study of Endangered Whales and Commercial Whale Watching. Conservation Biology. 22, 450-457.

Zervas, C. 2004. North Carolina bathymetry/topography sea level rise project: determination of sea level trends. NOAA Technical Report NOS CO-OPS 041.