ADAPTATION PLANNING AND CLIMATE IMPACT ASSESSMENTS: LEARNING FROM NEPA'S FLAWS

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Given past and current emission levels, the planet is already committed to significant climate change. Strong mitigation efforts can head off some of the most serious potential impacts but cannot prevent significant harm, particularly in vulnerable areas such as the arid western United States. Impacts on water supply are particularly worrisome, but a variety of other impacts are also forecast. Coping with these impacts will require retooling water systems, changing agricultural practices, reconsidering development patterns, creating conservation measures for endangered species, and other interventions into societal practices. Many of these impacts revolve around water – its supply, its uses, its flood risks.

We need to ensure that we evaluate adaptation needs through a sensible, well-designed process – and we can learn a lot from the shortcomings of existing processes for assessing environmental impacts. When we prepare Climate Adaptation Statements, we should benefit from our experience with Environmental Impact Statements. We should take advantage of what we have learned from our experience with existing procedures rather than replicating their flaws.

As we will see, there are five major lessons to be learned from examining the shortcomings of current environmental assessment procedures:

- The need for mainstreaming adaptation assessment into the normal decision making process. In contrast, the EIS process has been isolated from governments' primary decision processes.
- The need for better monitoring and follow-up. Unlike NEPA, which provides few learning mechanisms, adaptation assessment must include consistent follow-up and monitoring of adaptation predictions.
- Better access for adaption assessment. Under NEPA, the government has not taken advantage of modern information technology to make all of the EIS documents easily available and connected with geographic information systems. Public access should be a priority for adaptation assessment.
- The inadequate treatment of uncertainty in impact statements. This is a key issue for adaptation because of the relative crudeness of regional downscaling of climate models. Fortunately, more sophisticated methodologies for analyzing risk are becoming available.
- The outdated triggering mechanism for EIS preparation. Existing environmental assessment mechanisms are triggered by agency *actions* – they do not require assessments of the status quo but only of proposed changes in the status quo.

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> Adaptation assessment may be most needed in situations where no proposed action is pending, but the agency needs to be more proactive.

We now have almost forty years of experience with environmental impact statements. We can learn from both the positive and negative aspects of that experience[2] how we can best assess climate adaptation needs. Now is the time to establish the procedures that can guide climate impact assessment in the upcoming decades.

I. Background on Climate Change, Water-Related Impacts, and Adaptation

It is important to keep in mind the scope of the adaptation issue. Key concerns include the effect of sea level rise on coastal areas, floods on coasts and inland waterways, droughts, and water quality.[3]

Floods are one serious threat. Summarizing the most recent data, the IPCC's Fourth Assessment says:

> Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea-level rise and the effect will be exacerbated by increasing human-induced pressures on coastal areas. . . .
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> Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s.[4]

The latest projections of sea level rise are even higher. The IPCC assessment also notes that in North America:

> Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Population growth and the rising value of infrastructure in coastal areas increase vulnerability to climate variability and future climate change, with losses projected to increase if the intensity of tropical storms increases. Current adaptation is uneven and readiness for increased exposure is low. [5]

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[2] The consensus among environmental law scholars seems to be that NEPA has been flawed but useful. For citations to the literature, see Alyson C. Flournoy, Heather Halter, and Christina Storz, *Harnessing the Power of Information to Protect Our Public Natural Resource Legacy*, 86 Tex. L. Rev. 1575, 1581 n. 25 (2008).

[3] *For up-to-date information about potential climate impacts, see P.U. Clark and A.J. Weaver , Abrupt Climate Change. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research (2008).*

[4] IPCC Adaptation Report Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability 9 (2007)(hereinafter IPCC Adaptation Report).

[5] Id. at 13.

Increased ocean temperatures not only leads to sea level rise but to an increased risk of damage from storms. A large proportion of the financial losses fall in the developed world, because of the high value and large amount of infrastructure at risk.[6]

The IPCC agrees that it "is *very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent."[7] There will be clear implications for water managers:

> Heavier precipitation in tropical and inland storms will increase the risks of flooding, expand floodplains, increase the variability of streamflows (i.e., higher high flows and lower low flows), increase the velocity of water during high flow periods and increase erosion. These changes will have adverse effects on water quality and aquatic system health. For example, increases in intense rainfall result in more nutrients, pathogens, and toxins being washed into waterbodies.[8]

As a recent summary of the literature explains:

> Uncertainty in prediction of anthropogenic climate change arises at all stages of the modeling process . . .. surface At each step, uncertainty in the true signal of climate change is introduced both by errors in the representation of Earth system processes in models and by internal climate variability.[9]

There seems to be a broad consensus among economists that uncertainty about climate change is not an excuse for inaction. As Thomas Schelling says, "this idea that costly actions are unwarranted if the dangers are uncertain is almost unique to climate."[10] "In other areas of policy, such as terrorism, nuclear proliferation, inflation, or vaccination," he continues, "some 'insurance' principle seems to prevail: if there is a sufficient likelihood of sufficient damage[,] we take some measured anticipatory action."[11] Nobel Laureate Kenneth Arrow suggests that we should take uncertainties into account by basing our policies on anticipated harm about 50% higher than the median expected harm, in order to account for the element of risk.[12] Innovative

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[6] William E. Easterling III, Brian H. Hurd, and Joel B. Smith, Coping with Global Climate Change: The Role of Adaptation in the United States (Pew Center on Global Climate Change 78-79 (2004).

[7] IPCC, supra note 4, at 19.

[8] Office of Water, U.S. Environmental Protection Agency, National Water Program Strategy: Response to Climate Change ii (2008).

[9] Gerald A. Meehl, et al., *Global Climate Projection*, in Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Report on Climate change 797-810 (S. Solomon, *et al*. eds. 2007) (reference omitted).

[10] Thomas C. Schelling, *Climate Change: The Uncertainties, the Certainties, and What They Imply About Action,* ECONOMISTS' VOICE 4 (July 2007) (published at www.bepress.com/ev).

[11] *Id.*

[12] Kenneth J. Arrow, *Global Climate Change: A Challenge to Policy*, ECONOMISTS' VOICE 4 (July 2007) (published at www.bepress.com/ev).

theoretical work by the eminent environmental economist Martin Weitzman suggests that uncertainty about possible catastrophic climate change should loom large as a justification for controlling climate change.[13]

The Pew Foundation collected much of the available information about adaptation strategies in a 2004 report.[14] The Stern Report contains the most extensive discussion of adaptation costs. The Report estimates that:

> Infrastructure is particularly vulnerable to heavier floods and storms, in part because OECD economies invest around 20% of GDP or roughly $5.5 trillion in fixed capital each year, of which just over one-quarter typically goes into construction ($1.5 trillion - mostly for infrastructure and buildings). The additional costs of adapting this investment to a higher-risk future could be $15 – 150 billion each year (0.05 – 0.5% of GDP), with one-third of the costs borne by the US and one-fifth in Japan. This preliminary cost calculation assumes that adaptation requires extra investment of 1 – 10% to limit future damages from climate change. [15]

Another estimate, covering only the least developed countries and the short term, is over a billion dollars for the most urgently needed adaptation measures.[16]

The difficulty of adaptation varies directly with the pace of climate change and the potential increase in extreme events. "Extreme events such as floods and drought cause extensive damage to many parts of society, and thus a critical issue for adaptation is the degree to which frequency, intensity, and persistence of extreme events change."[17]

Flood risk and water supply issues can be intertwined, as in the California Delta, where potential levee collapses would drastically impair water supplies for much of the state.[18] Meanwhile, in the Southwest, the future of the water supply is uncertain, with potentially major impacts on agriculture.[19] Indeed, the most recent evidence regarding the Southwest is particularly worrisome:

> Scientists also looked at the prospect of prolonged drought over the next 100 years. They said it is impossible to determine yet whether human activity is responsible for the

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[13] Martin L. Weitzman, The Role of Uncertainty in the Economics of Catastrophic Climate Change (May 2007), available at http://ssrn.com/abstract=992873. Weitzman shows that even a small degree of uncertainty about a single model parameter can become magnified into substantial economic risk.

[14] See Easterling, supra note 6.

[15] Nicholas Stern, The Economics of Climate Change 417 (2007).

[16] Id. at 443.

[17] Easterling, supra note 6, at 17.

[18] Louise Bedsworth and Ellen Hanak, *Preparing California for a Changing Climate* (Public Policy Institute of California 2008) (available at www.ppic.org), at p. 8.

[19] See Jason Mark, Climate Change Threatens to Dry Up the Southwest's Future, www.alternet.org/story/103366/ (Nov. 18, 2008).

> drought the Southwestern United States has experienced over the past decade, but every indication suggests the region will become consistently drier in the next several decades. Richard Seager, a senior research scientist at Columbia University's Lamont-Doherty Earth Observatory, said that nearly all of the 24 computer models the group surveyed project the same climatic conditions for the North American Southwest, which includes Mexico.
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> "If the models are correct, it will transition in the coming years and decades to a more arid climate, and that transition is already underway," Seager said, adding that such conditions would probably include prolonged droughts lasting more than a decade.[20]

This new data also reflects an important theme discussed later: the need to make adaptation strategies robust given the uncertainty and changing evidence regarding the scale and timing of climate impacts.

Not only the timing, but also the average amounts of water available and the demand for water may be affected by climate change:

> In some parts of the country, droughts, changing patterns of precipitation and snowmelt, and increased water loss due to evaporation as a result of warmer air temperatures will result in changes to the availability of water for drinking and for use for agriculture and industry. In other areas, sea level rise and salt water intrusion will have the same effect. Warmer air temperatures may also result in increased demands on community water supplies and the water needs for agriculture, industry, and energy production are likely to increase.[21]

Much remains to be learned, however, about these impacts. There are still considerable uncertainties:

> Studies of climate change impacts on U.S. water resources suggest that vulnerabilities are keenly tied to runoff changes and can vary greatly within and across regions. Estimates are highly sensitive to assumptions about future demands and to the potential for adaptive responses to mitigate impacts.[22]

We can be sure that current water supply systems will need substantial modification in light of these projected changes. Not only the amount of water, but also its quality will be affected:

> Changes in the timing of river flows and warming atmospheric temperatures may affect water quality and water uses in many different ways. At one extreme, flood peaks may cause more erosion, resulting in turbidity and concentrated pulses of pollutants. This will challenge water treatment plant operations to produce safe drinking water. . . . At the other extreme, lower summer and fall flows may result in greater concentration of contaminants. These changes in streamflow timing may require new approaches to

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[20] Juliet Eilperin, *Faster Climate Change Feared: New Report Points to Accelerated Melting, Longer Drought*, Washington Post (Dec. 25, 2008), available at http://www.washingtonpost.com/wp-dyn/content/article/2008/12/24/AR2008122402174_2.html?hpid=moreheadlines

[21] Office of Water, supra note 8, at ii.

[22] Easterling, supra note 6, at 22.

> discharge permitting and non-point source pollution. Warmer water will distress many fish species and could require additional cold water reservoir releases. Higher water temperatures can also accelerate some biological and chemical processes . . . [23]

Water quality and supply are related, because declining water quality may make it necessary to reserve more water for in-stream uses, decreasing the supply available for agriculture and other consumptive uses.

Although we can already see the outlines of the climate adaptation challenges relating to water, the details of the impact will only become clearer as we get more data and climate models develop. In the meantime, agencies that manage water supply, quality, or flood control will be faced with the need to develop adaptation plans.

II. NEPA's Flaws and Adaptation Impact Assessments

Adaptation planning requires an assessment of how climate will impact human activities and how to respond to those changes. These assessments flip current practices in environmental law around: instead of asking how human activities impact the environment, we instead begin by asking how environmental change will impact humans. A climate impact assessment would contain three key components: (1) identification of possible climate alterations, (2) analysis of how these climate changes would impact human society or natural ecosystems, and (3) an analysis of alternative methods of addressing the impacts.[24]

In designing institutional mechanisms to undertake these assessments and implement their results, we can learn a great deal from the shortcomings of current methods of environmental assessment. This paper will focus primarily on environmental impact statements (EISs) under the National Environmental Policy Act (NEPA) as a point of comparison with climate impact assessments.

A. An Introduction to NEPA

Some background on NEPA may be helpful. Implementation of NEPA has shifted over time. Section 101 of the National Environmental Policy Act (NEPA)[25] proclaims the policy of the federal government to administer federal programs in the most environmentally sound fashion.[26] (Perhaps unfortunately, the courts have held that this policy is not judicially

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[23] California Resources Agency, Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water 6 (2008).

[24] If the government proposes an action that has significant environmental impacts, major economic costs, or a potential effect on an endangered species, climate impacts might be considered through an environmental impact statement, cost-benefit analysis or biological opinion under the Endangered Species Act. But these mechanisms may not directly apply for various reasons: the magnitude of the impact may not be enough in the relevant dimension that triggers the assessment (environment, cost, or biodiversity threat) or there may be no project proposal that would trigger review. The need for adaptation rather than proposing a new project that should trigger adaptation assessment.

[25] 42 U.S.C. § 4331.

[26] For an appraisal of the statute by its principal draftsman, see Lynton Keith Caldwell, The National Environmental Policy Act: An Agenda for the Future (1998). The legislative history

enforceable.) In practice, the most significant provision of NEPA is undoubtedly section 102(2)(c). This section is designed to force agencies to take environmental factors into consideration when making significant decisions. The crucial language of this subsection reads as follows:

> The Congress authorizes and directs that, to the fullest extent possible: . . . (2) all agencies of the federal government shall:
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> . . .
>
> (c) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on
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> (i) the environmental impact of the proposed action,
>
> (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
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> (iii) alternatives to the proposed action . . . [27]

Section 102(2)(c) goes on to require the federal agency to consult other agencies with jurisdiction over or special expertise concerning the environmental problem involved. Copies of the environmental impact statement (EIS) are to be circulated among relevant government agencies and to the public (though in practice access by the general public may be more of an aspiration than a reality). Other provisions of NEPA establish the Council on Environmental Quality (CEQ), which has been designated as the lead agency in implementing the EIS requirement.[28]

There has been a long-term decline in the number of environmental impact statements (EISs), with a corresponding expansion of less detailed environmental assessments (EAs.) In recent years, the number of full-scale EISs has declined, so that we are seeing only about 250 projects with EISs annually compared to about fifty thousand environmental assessments leading to FONSIs.[29] The bulk of federal EISs (seventy percent) have come from four agencies: the Department of Transportation, the Department of Agriculture, the Department of the Interior, and the Army Corps of Engineers.[30] The average cost of an EIS at DOE was $6 million, whereas EAs cost around $100,000.[31]

In terms of information production, this means that a full-scale evaluation of environmental impacts is performed for approximately 250 projects a year. But in two hundred

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of the statute is discussed in Daniel R. Mandelker, NEPA Law and Litigation § 2.02 (2d ed. 1998).

[27] 42 U.S.C. § 4332(2)(c).

[28] NEPA §§ 202-209, 42 U.S.C. §§ 4342-4347.

[29] Bradley C. Karkkainen, 12 NYU Env. L.J. 333, 347-349 (2004).

[30] National Academy of Public Administration, Managing NEPA at the Department of Energy 6 (July 1998)(available at www.eh.doe.gov/nepa/process/napa_rep/napa_rep.html.)

[31] Id. at 26-27.

times as many cases, only an EA is performed. In an unknown percentage of those EAs, the justification for finding no significant impact is based on projections about the effectiveness of mitigation measures. As we will see later, however, there is at best haphazard monitoring of the success of mitigation measures, and even if there were compulsory monitoring, the difficulty of obtaining access to the EAs themselves by the pubic would prevent any systematic comparison of predictions with outcomes.

Although the NEPA EIS process has had its successes, time has also revealed significant weaknesses that should be addressed in designing the process for climate impact assessments. We turn to a discussion of those weaknesses and how climate impact planning can improve on NEPA.

B. The Need for Mainstreaming the Assessment Process

A key issue is that EIS process has been isolated from agencys' primary decision processes. Supreme Court decisions have allowed agencies to use the EIS as an end-of-process disclosure document rather than an integral part of the agency's decision making. In *Aberdeen & Rockfish RR v. Students Challenging Regulatory Procedures* [*SCRAP II*],[32] the Supreme Court rebuffed the claim that NEPA requires agencies to integrate the EIS into their normal decision making process; instead, according to the Court, the statute requires only that the statement be completed at the time the formal decision is announced.

This approach is unacceptable in the adaptation context. We do not need simply better public disclosure of adaptation issues; we need better decision making. Mainstreaming adaptation means using or creating mechanisms that allow decision-makers to integrate future climate risks into all relevant policy interventions, planning, and management."[33] Hence, we need to make sure that adaptation assessments are deeply embedded in agency decision making rather than being considered an inconvenient form of paperwork required to help rationalize a decision that was already made.

C. The Need for Dynamic Learning in Adaptation Assessment

NEPA provides few learning mechanisms. Once an EIS is issued, the agency has no duty to follow up and confirm whether the statement's predictions were valid. The relatively sparse studies that are available are not reassuring on this score. The one-shot nature of environmental assessment has been a frequent source of criticism.[34] As a result, the assessment process ignores "unanticipated changes in environmental conditions, inaccurate predictions, or subsequent information that might affect the original environmental protections."[35]

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[32] 422 U.S. 289 (1975). The Council on Environmental Quality does instruct agencies, however, to prepare the EIS "early enough so that it can serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made." 40 C.F.R. 1502.5. The regulation does not, however, require the agency to actually consider the EIS in making its decision.

[33]Amy Lynd Luers and Susanne C. Moser, *Preparing for the Impacts of Climate Change in California: Opportunities and Constraints for Adaptation* 24 (March 2006) (Report from California Climate Change Center).

[34] See Flournoy, Halter, and Storz, supra note 2, at 1584-1585.

[35] National Academy of Public Administration, supra note 30, at 44.

Follow-up is particularly important in connection with adaptive management:

> Adaptive management emphasizes formal experimentation with replicates, controls, and extensive monitoring. . . . Adaptive management is a knowledge driven system, and environmental impact statements can be a central supplier of the relevant data. . . . Because environmental impact statements continually revisit the environmental health of particular regions, environmental assessments build up the knowledge base as they accumulate over time.[36]

Although the viability of adaptive management as an environmental tool is debated, there can be no doubt on one point: Without monitoring of outcomes, successful adaptive management is not even a possibility.

How can we encourage agencies to mainstream climate impact assessment? First, although consultants will often have valuable expertise, the preparation of climate assessments should not be outsourced to consultants. The agency needs to have in-house expertise and buy-in. Second, climate assessments should not await the proposal of particular projects. Instead, as discussed later, the agency needs to be proactive and consider climate impacts even before specific projects are on the table. Third, the agency's attention to climate issues should be monitored by a high-level official who reports directly to the agency head.

B. Monitoring and Dynamic Learning

One of NEPA's major flaws, which climate assessment needs to avoid at all costs, is the absence of dynamic learning. NEPA does not require agencies to perform later checks on their EIS predictions, and agencies do not generally do so.[37] Evidence on predictive accuracy that does exist is not reassuring. Studies find that the predictions are often too vague to be tested at all. Among those that can be verified, the results are no more reassuring, with fewer than one out of three being substantially accurate.[38]

This is not a peculiarly American problem – studies from the United Kingdom and Canada produce similar results.[39] In contrast, however, the Netherlands does require systematic monitoring of project impacts, though compliance may be spotty.[40] Case studies indicate that "better prediction products arise more from the feedback between predictions and experience than from the introduction of more sophisticated predictive methodologies."[41]

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[36] Joseph F.C. DiMento and Helen Ingram, *Science and Environmental Decision Making: The Potential Role of Environmental Impact Assessment in the Pursuit of Appropriate Information*, 45 Nat. Res. J.283, 299 (2005).

[37] Bradley C. Karkkainen, *Toward a Smarter NEPA: Monitoring and Managing Government's Environmental Performance*, 102 Colum. L. Rev. 903, 927 (2002).

[38] Id. at 928.

[39] Id. at 928-929.

[40] Id. at 951.

[41] Daniel Sarewitz, Roger A. Pelke, Jr., and Radford Byerley, Jr., Prediction: Science, Decision Making, and the Future of Nature 369 (2000).

Without the check provided by such feedback, overly optimistic predictions can result from the "economic and political pressures placed on the technical consultants and the government managers, which lead them to use inadequate models and to misuse their predictive results."[42] As one study puts it,

> In the absence of any inducements linked to actual performance, a decisionmaker is likely to be averse to the substantial risk that an audit will prove embarrassing by documenting a project's shortcomings. Thus, with few positive incentives to self-evaluation and substantial risks, agency managers seem to live by the maxim that ignorance is bliss.[43]

The same study found that only a third of predictions in EISs were "particularly accurate," most of the remainder being "either accurate solely by virtue of the vagueness of the forecast or somewhat inaccurate in various complicated ways."[44] It should be noted that the unreliability of the predictions makes the use of mitigated FONSIs [check to make sure you have defined FONSI]a bit suspect, since we cannot have any real confidence that the mitigation measures will actually reduce the impacts below the "significance" level.

The absence of follow-up under NEPA is a serious problem in part because promised mitigation plans are not always implemented.[45] Most agencies seem to have no formal procedures for ensuring that mitigation measures are actually put in place, although the U.S. Army has recently taken the lead by imposing such a requirement.[46] Thus, the environmental impacts may be much more serious than predicted in an environmental assessment simply because mitigation commitments are not honored.

As others have observed, active learning is a key to adaptation. In this setting, "[k]nowledge is dynamic; it accumulates through observation, monitoring, and analysis."[47] One solution to this problem is to impose formal monitoring requirements on agencies.[48] While this possible solution has appeal, it may be too expensive to institute across-the-board; after all, "[m]onitoring is not free."[49] An emerging model of assessment is tied with adaptive

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[42] Robert E. Moran, *Is this Number to Your Liking? Water Quality Predictions in Mining Impact Studies*, in Sarewitz et al., supra note 41 , at 187.

[43] Paul J. Culhane, H. Paul Friesema, and Janice A. Beecher, Forecasts and Environmental Decisionmaking: The Content and Predictive Accuracy of Environmental Impact Statements 146 (1987).

[44] Id. at 253.

[45] Robert G. Dreher, NEPA Under Siege: The Political Assault on the National Environmental Policy Act 21 (2005).

[46] Id. at 22.

[47] Easterling, supra note 6, at 25.

[48] Karkkainen, supra note37, at 938.

[49]Id. at 940.

management, which involves a cycle of planning, implementation, and reappraisal.[50] Of course, this process can only be effective if the proposals, predictions, and appraisals are all available for study. (As the next section discusses, availability is a real deficiency in NEPA implementation.) In any event, we do need to institutionalize follow-up mechanisms to check on the effectiveness of climate adaptation policies.

D. Use of Modern Information Technology

The government has not taken advantage of modern information technology to make all of the EIS documents easily available and connected with geographic information systems. A huge amount of money is invested in generating data and analysis that then disappear from view. In today's digital world, one would expect that environmental assessments would be readily accessible. After all, it is practically a cliché that "wireless communications and the Internet portend the "end of distance" and the 'collapse of time.' . . . Links to virtually anyone on the planet, or to data sets anywhere in the world, are now available at any time at very low cost."[51] This is undoubtedly true for many forms of information – but not for environmental assessments. Not only is the information in the assessments hard to access, but there is not even a system for tracking what assessments have been performed, let alone their contents. Federal environmental assessments and findings of no significant impact (FONSIs) are not subject to any formal reporting requirement, and even the agencies themselves make little effort to track them:

> Perhaps the most important reason that Environmental Assessments and FONSIs have been so little explored in the legal and policy literature is that they are maddeningly difficult to ferret out. . . . [A]n EA (whether it results in a FONSI or a mitigated FONSI) need not be reported to CEQ, EPA, or any other central compiler, nor is Federal Register notice required. In most agencies, even the NEPA compliance officers at agency headquarters do not track or compile EAs and FONSIs, devolving such duties to regional or subregional offices where record keeping may be lax or inconsistent across regions. Thus, in many cases it is difficult, if not impossible, for interested persons even to learn that an EA has been produced, much less to gain access to its contents.[52]

In contrast to EAs, EISs are subject to Federal Register notice requirements and available to the public on request. Yet access to the EIS itself is not always easy. An EPA site provides chronological listings of all draft and final impact statements.[53] This itself compares favorably to the treatment of environmental assessments, the less detailed preliminary documents used to determine if an EIS is required. But if users want to actually see the environmental impact statements, the site offers very little help. Users of the site are advised:

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[50] See David P. Lawrence, Environmental Impact Assessment: Practical Solutions to Recurrent Problems 464-487 (2003).

[51] Daniel C. Esty, *Environmental Protection in the Information Age*, 79 NYU L. Rev. 115, 169 (2004).

[52] Karkkainen, supra note 37, at 946.

[53] http://cfpub.epa.gov/compliance/nepa/current/

> EPA does not have copies of Environmental Impact Statements (EISs) available for public distribution. Instead, we recommend that you request a copy directly from the agency that prepared the EIS. A good place to start is to telephone the agency "contact person" listed in EPA's weekly Notice of Availability of EISs. In addition, several agencies are publishing entire copies of EISs on the internet (check each agency's website to determine online availability).[54]

Users are also referred to a Northwestern University site, which provides a link to the library's on-line book catalogue and instructions on how to obtain copies through interlibrary loan.[55] The Northwestern site also links to a proprietary database of digests of environmental assessments which is available to Northwestern users.[56]

In addition, it turns out that about a third of current EISs (and some California environmental assessments) are available at the Humboldt State University library.[57] Humboldt State also has an index and detailed abstract, but these are unfortunately available only to university users. It is also possible to search for EISs through the First.Gov.gov site [?]by including the phrase "environmental impact statement" with a subject keyword" in order to find a notice of availability or in some cases online text. EISs as well as a host of other environmental documents relating to Southern Oregon have been digitized,[58] and there may be some other similar collections for specific regions. So bits and pieces of the complete EIS data are available here and there on-line.

Climate adaptation assessments need to be available on-line. Preferably, they should be linked to geographic information systems (GISs), so that assessments for particular geographic areas, ecosystems, or water basins can be easily identified.[59] None of this is particularly difficult technically, it merely requires organization and funding to establish the data base, and a mandate that ensures submission of documents to be posted.

E. Sophisticated Methodologies for Analyzing Poor Quantifiable Risks

One aspect of climate change is increased uncertainty: "No longer can the historical record be relied on to guide the design, construction, and planning of water projects."[60] Although we can be confident in predicting global warming and increased climate change, the magnitude of climate change cannot be predicted accurately.

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[54] http://www.epa.gov/compliance/nepa/obtaineis/index.html

[55] http://www.library.northwestern.edu/transportation/searcheis.html

[56] http://er.library.northwestern.edu/details.php?rid=213948&pn=1 (linking to Cambridge Science Abstracts).

[57] http://library.humboldt.edu/infoservices/FEIRsandEISs.htm#fedreports

[58] http://soda.sou.edu/bioregion.html

[59] For observations on the utility and limitations of GIS systems in the climate change context, see Shalini P. Vajhala and Janet Nackney, *The New Cartography of Climate Change*, Resources 16 (Fall 2008).

[60] Easterling, supra note 6, at 22.

Government agencies are beginning to realize the importance of taking this uncertainty into account. For instance, California's adaptation effort calls for:

> An assessment of the region's vulnerability to the long-term increased risk and uncertainty associated with climate change.
>
> - An integrated flood management component.
> - A drought component that assumes, until more accurate information is available, a 20 percent increase in the frequency and duration of future dry conditions.[61]

The issue of uncertainty is central to environmental policy; indeed, the "obstacles that uncertainty creates for protecting natural resources, health, and safety under existing statutes are well documented."[62] New methodologies developed by economists and decision theorists may be helpful in identifying robust strategies for dealing with nonquantifiable uncertainties, but these methodologies are not in general use.

One way to control for model uncertainty is called robust optimal control. Under this approach, to correct for uncertainty about the correctness of their preferred model, policymakers consider alternate models that are "close" to their baseline model, in the sense of being statistically hard to distinguish from the baseline model. In the climate change context, the implication is that policymakers should react more aggressively and pursue more stringent mitigation strategies.[63]

RAND researchers are developing methods to use computer assistance in scenario planning.[64] The key is a technique called Robust Decision Making (RDM):

> RDM uses computer models to estimate the performance of policies for individually quantified futures, where futures are distinguished by unique sets of plausible input parameter values. Exploiting recent advances in computing power, RDM evaluates policy models once for each combination of candidate policy and plausible future state of the world to create large ensembles of futures. These ensembles may include a few hundred to hundreds of thousands of cases. [65]

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[61] California Resources Agency, supra note 3, at 12.

[62] Flournoy, Halter, and Storz, supra note 2, at 1597.

[63] Michael Funk and Michael Paetz, *Environmental Policy Under Model Uncertainty: A Robust Optimal Control Approach* (CESifo Working Paper No. 1938 March 2007). In essence, robust optimal control requires the policymaker to consider alternative models that are in some sense close to the preferred model but that produce more drastic predictions – thus, it could be considered as a way of considering plausible worst-case scenarios. Id. at 2.

[64] David G. Groves, *New Methods for Identifying Robust Long-Term Water Resources Management Strategies for California* (2006), *available at* http://www.rand.org/pubs/rgs_dissertations/2006/RAND_RGSD196.pdf.

[65] *Id.* at 125. *See also* David G. Groves and Robert J. Lempert, *A New Analytic Method for Finding Policy-Relevant Scenarios*, 17 GLOBAL CHANGE 73 (2007).

This technique provides a method for examining many potential scenarios in order to determine which characteristics of the scenarios are critical to the success or failure of particular strategies. The RAND technique has considerable potential:

> For policy problems that have a large or unlimited number of possible policy approaches, RDM provides a systematic way of exploring these possible policies to efficiently identify and evaluate the policies that are likely to be robust. RDM first uses visualization and statistical analysis to identify policies (from the initial set) that perform well over many possible states. RDM then uses data-mining techniques to reveal under which future conditions such policies are vulnerable to poor performance. Examination of these key vulnerabilities (which can be considered "scenarios") can suggest ways to craft new policies that hedge against the vulnerabilities. The analysis then identifies one or more new candidate robust policies and re-evaluates the performance of all policies against the different plausible future states. Through each iteration, the candidate policies become increasingly robust, and those key scenarios to which the policies are vulnerable are identified.[66]

These methods may be especially useful when society must make large, long-term investments in infrastructure such as dams, water supply systems, or major power plants. Investments that fare well under some future scenarios may do badly in others, and a major purpose is to choose investments that are resilient across the most relevant risks. Computerized scenario analysis can help us determine the key areas in which investments vary in their resilience, so that policymakers can make informed choices between them.

Scenario analysis may also help determine what factual issues are critical for deciding between options. This makes it possible to focus research on policy-relevant issues. We should not consider the degree of uncertainty to be fixed forever. One role of modeling is to help us identify research priorities.

We have fairly good methods for analyzing situations in which risks can be quantified with reasonable confidence. We need improved methods for dealing with situations where such estimates do not exist or are subject to considerable uncertainty. The RAND methodology is a good start toward achieving such improved methodologies. Adaptation planners should aggressively utilize methodologies of this kind – and certainly should not rely on identifying the most likely or mean scenario as the sole basis for planning, without sensitivity analysis and consideration of the full range of possibilities.

F. Expanding the Agency's Agenda to Include "Overlooked" Adaptation Issues

Existing environmental assessment mechanisms are triggered by agency *actions* – they do not require assessments of the status quo but only of proposed changes in the status quo. There is nothing to prevent an agency from simply ignoring an emerging problem; NEPA kicks in only when the agency considers actually doing something rather than sitting still.[67]

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[66] *Id.*

[67] By its terms, NEPA requires an environmental assessment only when the agency is considering a proposal to take action, not when it is completely passive. For example, the government was not subject to NEPA when it failed to halt actions by private parties on public lands. See Defenders of Wildlife v. Andrus, 627 F.2d 1238 (D.C. Cir. 1980); Comment,

The reactive nature of the assessment process may be appropriate in contexts where the status quo is presumptively desirable, appropriate, and/or unchanging,but it is definitely not acceptable when dealing with climate adaptation, where the whole point is that the status quo will become unsustainable due to climate change. For example, "[p]roactive adaptation to climate change may necessitate periodic reassessment of the adequacy and preparedness of relief systems and programs, particularly in light of changing frequency and intensity of extreme events."[68] Yet, it is difficult to craft a general mandate that would require agencies to identify the key areas under their jurisdiction where assessment of adaptation needs is a priority.

A starting point would be to require water agencies to produce reports on adaptation planning on a regular basis, such as every five years, just as agencies in states like California are required to consider certain drought possibilities in their planning. But agencies may fail to produce adequate reports even under such a mandate. Moreover, water-related adaptation issues can arise outside of water agencies themselves, and we need a method to force other agencies to consider these issues.

There are a series of potential responses to this problem of policing agency failure to assess adaptation needs:

1) A petition process akin to that used under the Endangered Species Act for listing species, where citizens could petition the agency to list a "critical adaptation need." For this to be effective, some specific metrics to determine the significance of an adaptation need would be required.

2) Investigative reports by independent bodies such as the Government Accountability Office or the National Academy of Science.

3) A system of prizes for citizens who successfully identify high priority needs for climate impact assessment. The prize would be awarded by an independent entity but would be funded out of the agency's operating budget, providing a small "stick" in addition to publicity impacts.

4) Adoption of legal rules making agencies liable for negligent failure to engage in climate adaptation. California law in effect provides a mechanism for this in the context of flood control.[69] The use of risk markets (akin to the presidential prediction markets such as http://www.biz.uiowa.edu/iem/) trading long-term risk contracts for key climate

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Inaction as Action Under NEPA: EIS Not Required for Interior's Failure to Half Alaskan Wolf Hunt, 10 Env. L. Rep. 10055 (1980).

[68] Easterling, supra note 6, at 25.

[69] The modern development of flood liability in California began with Belair v. Riverside County Flood Control District. 764 P.2d 1070, 47 Cal. 3d 550, 253 Cal. Rptr. 693 (1988). In Belair, a flood control levee on the San Jacinto gave way, flooding parts of the City of San Jacinto. The California Supreme Court took this occasion to establish a new rule for determining the state's responsibility for flood damages, based firmly on the need to spread the risks created by unreasonably flawed flood control systems.

impacts such as water supply impairments or flood frequency, with the parameters being set at levels that would indicate a failure of current systems.

Several of these techniques are promising. The use of outside reviewers such as GAO should be regularized as a way of checking for overlooked adaptation needs. A less conventional approach is the use of prizes, but this might provide a way of opening the process to broader public participation. In any event, we need to be attentive to the danger that agencies will take the status quo for granted and consider adaptation issues only when required to do so in the context of specific project proposals.

Conclusion

As we begin to design climate adaptation into our institutions, we should be careful to learn from past failures rather than repeating them. After almost four decades, we have had many opportunities to see NEPA's system of environmental assessment in action. We can do better in approaching climate adaptation assessment.

As discussed above, we can learn five valuable lessons from NEPA's shortcomings:

- Assessment of climate impacts and adaptation needs must be an integral part of the agency's decision making process, not an afterthought as is too often the case for environmental assessments.
- Climate impact assessments should be available on-line and linked with GIS systems.
- Formal follow-up mechanisms must be institutionalized, and information about the effectiveness of adaptation measures must be readily available on-line.
- Planning should consider a range of potential adaptation scenarios to identify robust adaptation measures.
- To ensure that agencies adopt a proactive approach to adaptation, mechanisms such as a prize process should be used to ensure that adaptation needs are identified, rather than having adaptation considered only when specific projects are on the agency's agenda.

Climate impact analysis faces special challenges if it is to become an effective action-forcing technique, because of the long-term nature of climate change, the difficulty of separating current climate effects from statistical noise, and the limitations of climate modeling. Yet, if our society is to thrive in the nex century, we need to implement climate impact analysis on a large scale and take seriously the results of the analysis. Developing effective methods of identifying relevant impacts and appropriate responses will not be done overnight, but the process needs to be begin, the sooner the better.