

NOW, THINK AGAIN ABOUT ADAPTATION

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I. INTRODUCTION: WHY IT'S HARD TO DECIDE WHAT TO DO

There is a growing consensus in the scientific community that we know enough about global climate change to begin to take action.¹ Unfortunately, there is little agreement on how to respond to the problem. The possible adverse consequences of global warming, especially in arid areas, present the most difficult environmental problem yet faced by the United States and the international community. On one level the problem is no different from any other environmental issue: we must make difficult and costly risk assessments in the face of considerable scientific uncertainty. Prudence counsels a "conservative" response. However, the magnitude of the uncertainty and the multiple facets of the science of global climate change pose unique resource allocation and risk management problems. There are four aspects of global climate change that distinguish the appropriate response from a wide range of other environmental problems, thus requiring a more extended debate prior to taking action.²

First, the costs of response will be borne by present-generations but the benefits will span far into the future. As a society, we prefer the present to the future. It is difficult to generate support for immediate sacrifices to prevent uncertain harms far into the future. We lack both economic and ethical concepts to prefer future generations to the present.³ Second, we have a number of legal institutions that are, in theory, designed to allocate the risks of dealing with nature's uncertainties. But, in the face of global climate change, these institutions may prove to be less flexible than we anticipate. Many institutions respond to risk proactively by reducing it to as close to zero as possible. Others adapt to risk reactively by accepting some of the adverse effects when they materialize. Zero risk reduction is not a realistic option with respect to global climate change, for both physical and economic reasons,⁴ This wisdom is difficult to implement politically. Potential victims

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1. Cheryl S. Silver & Ruth S. DeFries, National Academy of Sciences, *One Earth, One Future: Our Changing Global Environment* 76-77 (1990).

2. Professor Christopher Stone has developed a similar but more extended list of difficulties with global warming responses in the context of a discussion of the negotiation of a global warming treaty. Christopher Stone, *The Global Warming Crisis, If There is One, And The Law*, 5 Am. U. J. Int'l L. & Pol'y 497, 504-511 (1990).

3. For a lucid discussion of these problems see David Pearce et al., *Sustainable Development: Economics and Environment in the Third World* 1-22 (1990).

4. Daniel H. Henning and William R. Margun, *Managing the Environmental Crisis: Incorporating Competing Values in Natural Resources Administration* 221 (1989).

in both natural and human disasters have come to expect that they will never actually bear the costs of serious risks even if those costs in fact materialize. As a result, they may engage in strategic behavior to preserve their expectations. Third, the economic costs of error are much higher when dealing with potential global climate change than when dealing with many other environmental protection efforts. Fourth, effective responses are dependent on international cooperation, but it is not in the self-interest of all nations to cooperate equally, if at all. In addition, we do not have adequate international legal mechanisms in place to induce the necessary level of cooperation.⁵

The global climate change policy debate is currently framed as a choice between mitigation and adaptation. Like all dichotomies, the choice between mitigation—the reduction of greenhouse gases—and adaptation—the minimization of adverse impacts in activities most vulnerable to increases in temperature—only has meaning when one strategy is chosen over the other. Even though the United States has not yet chosen a global warming policy, there is a growing split between environmentalists who advocate mitigation, and “rational” resource policy analysts who have strongly endorsed adaptation. Paul E. Waggoner, who chaired the adaptation panel of a recent National Academy of Sciences Report: *Policy Implications of Greenhouse Warming*,⁶ builds on this expanding fissure in his paper, *Now, Think of Adaptation*.⁷ The *Synthesis Panel Report* is a synthesis of panels studying both mitigation and adaptation. The full committee endorsed both approaches, but on balance the report endorses adaptation over mitigation. Not surprisingly, both the National Academy Report and Dr. Waggoner’s article argue that we should adopt the easy, low cost mitigation strategies to reduce energy use and then concentrate on selecting the most efficient adaptation strategies.

II. ADAPTATION: SOME OVERLOOKED PROBLEMS

The case for adaptation is powerful and seductive for a number of reasons.⁸ Adaptation carries forward the Enlightenment tradition of using

5. See Dunwood Zaelke & James Cameron, *Global Warming and Climate Change—An Overview of the Legal Process*, 5 Am. U. J. Int’l L. & Pol’y 249 (1990), for a survey of existing international efforts and the barriers to effective international law making.

6. Comm. on Sci., Eng’g, and Pub. Pol’y, Nat. Academy of Sciences, *Policy Implications of Greenhouse Warming—Synthesis Panel* (1991) [hereinafter “Synthesis Panel Report”].

7. Paul E. Waggoner, *Now, Think of Adaptation* (elsewhere in this issue—Eds.).

8. National Academy of Sciences, *Global Environmental Change: Understanding the Human Dimensions* 104-116 (1992), summarizing the pros and cons of mitigation versus adaptation. The basic case for adaptation over mitigation is that the uncertainty of specific effects is too great to take anticipatory action. Action may be unnecessary since subsequent developments will obviate the need for the action and mitigation will make any adjustment unnecessary. The case for mitigation is that it is cheaper to take action now. Also, present mitigation investments will make it easier and less costly to adapt to change because the rate of change will have been slowed. *Id.*

science and technology to eliminate the adverse consequences of nature.⁹ It is a more direct response to global warming than concluding that the current state of knowledge counsels nothing more than continuing research¹⁰ and using existing resource allocation institutions.¹¹ Finally, adaptation mechanisms that produce a more efficient or environmentally sensitive resource allocation can be justified independently of global warming concerns.

This paper concentrates on three problems with adaptation that are often overlooked by its advocates. First, adaptation is based on the ideology of scientific progress, a faith that is open to question. The principle message of environmentalism is that the tenets of Enlightenment thinking must be re-evaluated since science and technology may not always prevent serious harm or make things better. Second, the degree of friction in the proposed institutional responses is often underestimated so institutions may not perform as expected. Adaptation clearly exposes winners and losers in a reallocation. It is not reasonable to expect losers to accept all losses. More generally, institutional inflexibility is increasingly being adopted as a means to protect legitimate interests excluded from dominant resource allocation regimes. Doctor Waggoner posits a constructive role for lawyers “who shorten the hold-up between decision and action,” but we may often do the opposite *for good reasons*. Third, many institutions have no fair and adequate mechanism to deal with global warming. In these cases, adaptation is the adoption of a no action strategy, which may often be the most costly one.¹²

This list is not exhaustive and these possible objections do not rebut Doctor Waggoner’s arguments. My purpose is more modest. It is to raise a series of problems for optimistic arguments illustrated by *Now, Think of Adaptation* in the global climate change policy debate. I aim to provide a new lens through which existing institutions can be evaluated by focussing more clearly on the winners and losers in global climate change-triggered resource reallocations. First, I will briefly discuss the philosophical basis for the first objection. I will then illustrate the second and third objections with two problems: the reallocation of western water and the use of land use controls to protect coastal and inland areas from the adverse consequences of global climate change.

9. See, e.g., Committee on Engineering Implications of Changes in Relative Mean Sea Level, National Academy of Sciences, *Responding to Changes in Sea Level: Engineering Implications* (1987). The presence of Dr. Orrin H. Pilkey, a forceful advocate of non-structural solutions to coastal protection, ensured a balanced assessment of sea rise retardation technologies; however, retreat is still discussed as a secondary response.

10. See, for example, United States Bureau of Reclamation, *Hydropower: Reclamation’s Energy Initiative 30* (1991), which argues that the Bureau should play a lead role in developing additional hydropower capacity with only one reference to global climate change—a ritual bow to the need for more research. *Id.*

11. For example, the Synthesis Panel Report, *supra* note 6, at 38, concludes with respect to possible sea level rises, “[a]t present, the potential for human intervention to ease adaptation in marine ecosystems seems limited.”

12. Lynne Edgerton, *The Rising Tide: Global Warming and World Sea Levels 21-23* (1991).

III. PHILOSOPHICAL BASIS

The current analysis of adaptation rests on an ideology which is increasingly at odds with the development of environmental ethics, causing many possible approaches to be quickly dismissed as unnecessary or unfeasible. Adaptation rests fundamentally on the Enlightenment faith in scientific progress. There is also, however, a streak of pre-Enlightenment fatalism in adaptation proponents' assumption that we can live with climate change because we have always lived with it. One can see both strains in the rather remarkable statement in the *Synthesis Panel Report* that "[p]eople in the United States likely will have no more difficulty adapting to . . . future changes than to the most severe conditions of the past, such as the Dust Bowl."¹³ The statement is simultaneously fatalistic and optimistic, but primarily it reflects a western heritage of hubris with respect to the biosphere which is at odds with the environmental ethic of stewardship.

Environmental ethics are a reflection of a profound re-examination of the duality between man and nature, triggered by Aldo Leopold's *A Sand County Almanac*.¹⁴ The common theme in the welter of writings in the past two decades is that we should collapse the Greco-Christian dualism between man and nature and replace it with principles that place natural systems on par with humans.¹⁵ It is an ambitious and problematic effort, but the central lesson is that we need to approach nature with greater humility than we have in the past, adopting stewardship as the basic resource use norm. One application of this attitude is the adjustment of world output models to account for resource base degradation. As Lester Brown has counseled, the failure to adjust for resource losses creates an illusion of progress.¹⁶ A lack of humility can lead to over reliance on one dimensional technological adaptation solutions and the continued reliance on skewed balance sheets. The National Academy of Sciences recently examined the range of possible responses to projected sea level rises. Even though structural and more

13. Synthesis Panel Report, *supra* note 6, at 45. Waggoner, *supra* note 7, at nn. 34-35 and accompanying text, elaborates on this statement by setting forth the Resources for the Future study on which the NAS conclusion was based. Another panel member, Jessica Tuchman Mathews, strongly dissented from the statement because "[t]he analysis does not support the conclusion that greenhouse warming will be no more demanding than past climatic changes." *Id.*

14. Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (1949). See Eric Freyfogle, *The Land Ethic and Pilgrim Leopold*, 61 *Colo. L. Rev.* 217 (1990).

15. See generally Roderick Nash, *The Rights of Nature: A History of Environmental Ethics* (1989) and Holmes Ralston, *Philosophy Gone Wild: Essays in Environmental Ethics* (1989).

16. Lester R. Brown, *The Illusion of Progress, in The State of the World 1990: World Watch Institute Report on Progress Toward A Sustainable Society* (Lester R. Brown project director, 1990).

environmentally sensitive non-structural solutions were examined, the report continues the traditional focus on structural solutions.¹⁷

Many of the arguments for adaptation apply traditional methods of rational policy analysis to global climate change and are at odds with the ethic of stewardship. Proponents need to be aware of the severe limitations of rational analysis in the face of uncertainty. The traditional response to uncertainty has been to use seemingly neutral concepts, such as discount rates, to ignore solutions that call for present sacrifices to generate future benefits. For example, the *Synthesis Panel Report* treats response as a public investment choice which should be decided by benefit-cost techniques.¹⁸ Benefit-cost analysis has limited capability to deal with future benefits because it relies on a discount rate to compare different choices. The selection of the rate determines the strategy. The problem is that we have no effective way to choose a high or low discount rate.¹⁹ Speculation about discount rates becomes a disguised debate about our ethical duties toward future generations.²⁰ At a minimum, this issue ought to be interjected into the debate as a possible constraint on rational solutions. Difficult policy questions cannot, of course, be solved simply by labeling the issue as "ethical", but ethical perspectives can suggest approaches to uncertainty issues that benefit-cost analysis ignores. The major one is to constrain conventional benefit-cost analysis by the principle of sustainability.²¹

IV. WATER MARKETS AS THE PARADIGM ADAPTATION TECHNIQUE: A (VERY) QUALIFIED ENDORSEMENT

To adapt to global climate change, existing institutions must be capable of an appropriate response. Adaptation assumes that institutions will respond to changed conditions with appropriate speed and effectiveness, but this will not always be the case. Risk adaptation proposes quite radical shifts in the way in which risks are borne by members of society, raising hard questions of fairness. For example, there are a number of water shortage scenarios for the arid West which predict increased shortages and more intense competition for water. The *Synthesis Panel Report* and others advocate water marketing to shift water to new areas of high demand. This can be both an efficient and fair solution since society benefits from the transfer of water to new uses and existing entitlement holders receive the fair market value for

17. Committee on Engineering Implications of Changes in Relative Mean Sea Level, *supra* note 9. Cf. Committee on Coastal Zone Management, National Academy of Sciences, *Managing Coastal Erosion* (1990).

18. *Synthesis Panel Report*, *supra* note 6, at 34.

19. *Id.* at 27-33.

20. See Pearce, et al., *supra* note 3, at 23-35, for a review of the environmental critique of the use of discounting to deal with future generations.

21. *Id.* at 58.

their water rights. However, there is reason to question whether water markets and other reallocations will play the role in reallocation that proponents urge.

Water use is one of many activities sensitive to increased temperature. Increased shortages are predicted in the Western United States. When they occur, they will exacerbate existing tensions between agricultural and other users. Agriculture uses between 75 and 90% of the West's water under early entitlements.²² Apart from global warming, the economic and social rationality of irrigated agriculture in many parts of the West is being questioned. Water marketing, the voluntary sale and transfer of existing rights to new uses, is the current remedy of choice to reallocate more water to higher valued uses. Water marketing is thus a ready made adaptation strategy because it seems to adjust to increased temperatures by fairly and efficiently allocating more water to areas of high demand.

Adapting to global warming places a premium on both technical and allocative water use efficiency. Users in water-short areas will have to conserve existing supplies by using less. Economists and many western water critics have long criticized western water law because it ignores higher, alternative values of water.²⁴ They assert that too much water is used to grow surplus or low-valued crops and too much water is used in a wasteful manner.²⁵ In almost all areas of the West, agriculture took precedence over large urban concentrations in receiving water.²⁶ For most of this century, water allocation has been relatively static because the three major uses—agriculture, hydroelectric power generation, and municipal and industrial use—were able to share the available water supply without unduly disrupting each other.²⁷ This pattern is unlikely to hold for the future. The Bureau of Reclamation era of large reservoir construction is over but demands continue to intensify in many parts of the West.

The question is how flexible the water transfer system will be in the future. Two sets of problems, one institutional, the other distributional must be addressed. The first question is whether water users will respond sufficiently to market incentives. The second and more difficult question is whether the redistributions commanded by the market are fair in both the short and long run.²⁸ Water transfers can produce severe adverse effects on areas of origin,

22. Marc Reisner & Sarah Bates, *Overtapped Oasis: Reform or Revolution for Western Water* 30 (1990).

23. *Id.* at 111-38.

24. *See, e.g.*, National Water Commission, *Water Policies for the Future: Final Report to the President and to the Congress of the United States* 260-61 (1973).

25. Reisner & Bates, *supra* note 22, at 58.

26. *Id.*

27. Committee on Western Water Management, National Research Council, *Water Transfers in the West: Efficiency, Equity, and the Environment* 18 (1992).

28. *See generally* David L. Feldman, *Water Resources Management: In Search of an Environmental Ethic* (1991).

and the doctrine of prior appropriation has by and large ignored these effects. More attention is now being given to the full range of third party effects causing more friction in the system.

Prior appropriation allocates the risks of shortages by a simple principle—priority of use. The problem is whether the extreme risks of global climate change²⁹ can be allocated within the framework of prior appropriation. The law has never been used for this function. There are major political, institutional and legal barriers to declaring winners and losers, which must be done if water is to be allocated in times of severe water shortages. Western water law is premised on shortages allocated by priority schedules that provide a clear and complete risk allocation scheme in advance of the shortages. However, such risks do not occur with any regularity. The whole thrust of federal and state water policy from the conservation era has been to minimize the risks of shortages by constructing large carry-over storage facilities.³⁰ Thus, reservoirs and groundwater basins probably will be subjected to only the mildest form of rationing during droughts. States have tried to accommodate unlimited growth on a limited water budget by providing ample margins of safety against shortages.³¹ Most irrigators have been buffered against the harshness of prior appropriation by carryover storage and formal and informal mechanisms that share the burdens of shortages by pro rata rather than pro tanto delivery reductions.³² Since the law of prior appropriation is a risk allocation mechanism, the expectation that it will be used during water shortages on a large scale is low.

The strong expectations of user security will especially impede the Federal Bureau of Reclamation Resources (the Bureau) should it seek to introduce flexibility, such as reallocation, into its mission.³³ Historically, that mission

29. The risks of global climate change include the following: a rise in sea levels which could cause low-lying land masses to disappear under the ocean, a shift in rainfall patterns which could result in a massive failure of crops as farmland turns to dust, climatic changes which could cause summers to become longer and drier while winters could become shorter and wetter, the rise in temperature and decreased rainfall for much of the earth's current grain-producing regions resulting in disaster for world production, and finally, animals and forests may not adapt to the predicted rapid climate change. Jennifer Woodward, *Turning Down the Heat: What the United States Laws Can Do To Help Ease Global Warming*, 39 Am. U. L. Rev. 203, 213-17 (1989).

30. See Marc Reisner, *Cadillac Desert: The American West And Its Disappearing Water* (1986) for a history of the politics of the damming of the West.

31. For example, Los Angeles water planners use a strategy of constructing projects in a pattern that is designed to keep the actual water supply a step ahead of population projections. Parsons & Mathews, *The Californization of Arizona Water Politics*, 30 Nat. Resources J. 341, 352 (1990).

32. But see the conclusion of Professor Leshy that "prior appropriation more resembles a ghost of the past than a vibrant contemporary presence." John Leshy, *The Prior Appropriation Doctrine of Water Law in the West: An Emperor with Few Clothes*, 29 J.W., July, 1990, at 5, 12.

33. The Bureau has been responsible for providing water for farms, towns and industries; the generation of hydroelectric power; river regulation and flood control; outdoor recreation; and wildlife habitat preservation in the Western United States. See Doris O. Dawdy, *Congress in its Wisdom: the Bureau of Reclamation and the Public Interest* 1-6 (1989).

has been to support local users, minimizing the risks of shortages by providing sufficient carry-over storage facilities and keeping water flowing downstream from its reservoirs during dry years.³⁴ Fear of shortage has been used as the rationale for constructing large projects and has pushed other adaptation strategies off the political agenda.³⁵ The strategy has worked because shortages have been avoided, but the Bureau of Reclamation's February, 1992 announcement that it will not deliver water to approximately 7,000 California farmers³⁶ (since modified) may force a re-evaluation of basic assumptions and a greater willingness to move to more flexible reallocation institutions. There are no per se legal barriers to transfers of Bureau of Reclamation entitlements,³⁷ but to date there has been little political incentive for users to market their water.

To further complicate matters, the risk allocation schedules produced by the strict application of prior appropriation or interstate compacts will be widely perceived as perverse since the highest priorities are often the lowest valued uses. When water deliveries have been reduced or stopped according to a strict priority schedule, the losers have generally been small farmers, Indian tribes, fish and wildlife.³⁸ For example, the highest priority use on the Colorado River is irrigation, although the highest water values are for municipal and industrial supplies. The enhancement of environmental values, and thus the law, may produce unacceptable climate change adaptation results.³⁹ Reservoir management to enhance navigation is another example of perverse priorities on the Missouri River. Navigation is preferred over

34. This model of natural disaster is the seven-year cycle of plenty and famine experienced by Egypt in the book of *Genesis*, rather than Anasazi long-term drought scenarios. Compare *Genesis* 41:47-57 (Egypt) with Allen Kneese & Gilbert Bonem, *Hypothetical Shocks to Water Allocation Institutions in the Colorado Basin*, in *New Courses For the Colorado River* 87, 87-108 (Gary D. Weatherford & F. Lee Brown eds., 1986) (Anasazi). Tree ring investigations at Chaco Canyon posit an extreme drought between 1130 and 1180 A.D., which appears to have driven the Anasazi from the Colorado plateau. *Id.* at 106. Just as the Pharaoh heeded Joseph's advice and stored the harvests of plenty, *Genesis* 41:47-57, 53:33-57, so too has the Bureau heeded the vision of scientists and western promoters by storing spring runoffs in wet years for reserve in dry years.

35. Wallace Stegner, *The American West as Living Space* 47-49 (1987); see also Reisner, *supra* note 30, at 500, 504-05.

36. Robert Reinhold, *U.S. Cuts Off California Farmers' Water Supply*, N.Y. Times, February 15, 1992, p. 1, col. 2.

37. See Brian Gray et al., *Transfers of Federal Reclamation Water: A Case Study of California's San Joaquin Valley*, 21 *Env'tl. L.* 910 (1991).

38. See Charles Meyers et al., *Water Resource Management* 779 (1988), for a discussion of the hardships suffered during the 1980s by the first tribe to win an Indian reserved water right.

39. I have explored this problem in Helen Ingram, A. Dan Tarlock and Cy Oggins, *The Law and Politics of the Operation of Glen Canyon Dam*, in *Colorado River Ecology and Dam Management* 10 (Comm. to Review the Glen Canyon Env'tl. Studies, Comm'n on Geosciences, Env't, and Resources ed., 1991) and A. Dan Tarlock, *Western Water Law, Global Climate Change, and Risk Allocation*, in *Managing Water Resources in the West Under Conditions of Climate Uncertainty* 239 (Comm. on Climate Uncertainty and Water Resources Management, Comm'n on Geosciences, Env't, and Resources ed., 1991).

recreation and fish and wildlife maintenance, but the benefits of dedicating large amounts of water to downstream navigation are less than 2% of the total system benefits generated by the six mainstem reservoirs on the Missouri.⁴⁰

Perverse priorities are not an absolute barrier since water can be voluntarily reallocated among users. The historic assumption in the West is that the allocation of western water is eternal.⁴¹ In reality the allocation system was never completely static. It has always contained reallocation mechanisms to allow minor adjustments in use patterns.⁴² These adjustments—transfers in the shift of water from its initial use to another use—were the exception rather than the norm. Today, the exception may become the norm. There is a growing consensus in the national environmental community⁴³ and among urban suppliers⁴⁴ that water should be reallocated from agricultural uses to municipal, industrial and instream uses in order to protect a broad range of environmental and recreational values.

Prior appropriation can be adapted to global climate. Appropriative rights are fully transferable usufructuary property rights⁴⁵ and because water has both a private and social value, it can only be used for a beneficial purpose. In this century, beneficial use has been defined as non-wasteful use.⁴⁶ Waste has long been defined by local custom,⁴⁷ with few irrigation practices found to be non-beneficial. A re-defined concept of beneficial use could play a large role in the future.⁴⁸

Adaptation is not a realistic option when an allocation regime lacks a mechanism to deal with changed conditions. International water allocation is a prime example of the lack of adaptation mechanisms in existing alloca-

40. Kenneth Frederick, *Economic Consequences of Climate Variability on Water in the West*, in *Managing Water Resources*, *supra* note 39.

41. See A. Dan Tarlock, *New Water Transfer Restrictions: The West Returns To Riparianism*, 27 *Water Resources Res.* 987 (1991).

42. *Id.*

43. A. Dan Tarlock, *Law of Water Rights and Resources* (1988) § 8.04[3].

44. See Zach Willey, *Economic Development And Environmental Quality in California's Water System* 8-10 (1985).

45. Tarlock, *supra* note 43, at § 5.17[2].

46. Steven Shupe, *Waste in Western Water Law: A Blue Print for Change*, 61 *Or. L. Rev.* 483, 488-89 (1982).

47. *Id.* at 491.

48. For example, beneficial use could be defined as efficient use. Under the efficient use doctrine, water conservation measures may focus on the use which produces the greatest economic benefit. The system imposed on the Newlands Project in the Truckee-Carson basin of western Nevada is a possible model for applying the beneficial doctrine as the theoretical basis for increased rural and urban water-use conservation requirements. U.S. Dep't of the Interior, *Draft Environmental Impact Statement for the Newlands Project, Proposed Operating Criteria and Procedures* (May 1986). The beneficial use doctrine can be complemented by the public trust doctrine. The classic public trust doctrine recognizes public servitudes to use navigable waters for commerce and recreation and prevents the alienation of the beds of these waters without a clear showing of public benefit. *Illinois Cent. R.R. v. Illinois*, 146 U.S. 387 (1892).

tion institutions. Agreements are usually negotiated so that a dam can be built accompanied by the expectation that any shortages will be short-term. The treaty often provides only for temporary reallocations and contains no mechanism to address long term declines in expected available supply. For example, the Nile Waters Agreement allocates a fixed amount of water to Egypt and the Sudan.⁴⁹ It binds other basin states, but provides only a weak mechanism for short term drought relief. The Mexico-United States treaty, which allocates the Colorado River between the two countries, provides that the United States need not fulfill its delivery duty in extraordinary drought.⁵⁰ It is not clear that this would apply to global warming, so Mexico is not guaranteed a clear entitlement. The United States' delivery duty is uncertain. It could range from the full 1.5 million acre feet to a much lesser figure.⁵¹

Customary international water allocation law is equally unsuited to provide a framework for co-riparians to adapt to global climate change. The international community has accepted the principle of equitable apportionment as the ground rule of international water allocation.⁵² However, existing apportionment standards are vague and open ended. They establish little more than the principle that all co-riparians are entitled to press for a share of the river. The standard is not well suited to deal with long term shortages, gradual water quality degradation or ecosystem stability generally.⁵³ The International Law Commission ("ILC") is struggling to incorporate these factors into allocation rules within the constraints of international law. A sharing rule is a necessary condition for negotiations among co-riparians in order to develop international drainage basin strategies to deal with global warming, but it is only the first step.

V. LAND USE CONTROLS: THE NEED FOR NEW APPROACHES

Global climate change may adversely effect both coastal and inland areas. We can adapt to those changes by controlling the way in which impacted land is used. Rising sea levels may inundate coastal areas, destroying

49. Agreement on the Full Utilization of the Nile Waters, Nov. 8, 1959, 433 U.N.T.S. 51.

50. Treaty on the utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande, 59 Stat. 1219 (1944). Commentary on drought provisions of the Treaty includes Albert Ulton, *An Assessment of the Management of U.S.-Mexican Water Resources: Anticipatory Resource Needs in the Year 2000*, 364-389 (1984) and Alberto Szekely, *An Uncertain Future: Climate Change and the U.S.-Mexico Agenda*, S. Transboundary Resources Report No. 3, P.1, Winter, 1991.

51. See Greta Goldenman, *Adapting to Climate Change: A Study of International Rivers and Their Legal Arrangement*, 17 Ecology L. Q. 741, 762-766 (1990).

52. Stephen McCaffrey, *Background and Overview of the International Law Commission's Study of the Non-Navigational Uses of International Watercourses*, 3 Colo. J. Int. Envtl. L. and Pol'y 17 (1992).

53. Alberto Szekely, "General Principles" and "Planned Measures" provisions in the International Law Commission's draft articles on the Non-Navigational Uses of International Water Courses: A Mexican Point of View, 3 Colo. J. Int'l Envtl. L. & Pol'y 93 (1992).

wetlands and delicately balanced estuaries. In interior regions, belts of mountain vegetation may move upward, endangering species habitat. If the forecasted adverse effects occur, adaptation must include the protection of coastal areas through shoreline armoring and retreating from shorelines. Inland, species loss can perhaps be retarded by the designation of new inland areas for species protection or innovative island biology management practices.

All of the coastal protection approaches are feasible, but the consequences of the various approaches are dramatically different. The biggest problem is that coastal armoring will protect existing uses at the expense of wetland destruction. Environmentally sensitive adaptation techniques must rely on regulatory and compensatory schemes as well as on structural solutions. The case for less reliance on structural measures to protect coastal areas exists independently of projected increases in global warming, but projected temperature rises strengthen the case. Non-structural adaptation requires primary reliance on land use controls and related schemes to both deflect growth in vulnerable areas and to compensate landowners that must abandon property if sea levels do rise.

There are two related institutional barriers to the use of land use controls to adapt to global climate change: fairness and the lack of effective precedents. The constitutional prohibition against the taking of property without due process of law severely limits government's power to forbid productive use of land unless development will cause some form of immediate harm to surrounding property.⁵⁵ The concept of harm encompasses land use activities which threaten to destroy natural systems and damage other land owners and society, but the Supreme Court is moving toward a narrow rather than expanded concept of harm.⁵⁶ Beyond the substantial constitutional questions, land use controls have been primarily used to either ratify the status quo or to control the rate of urbanization. We do prevent development in flood plains and erodible slopes, but these controls respond to immediate hazards to the future users of the property and surrounding property owners. The lack of nexus between the prohibition and the anticipated harm makes it difficult to sustain land use controls directed solely at future harms.

54. Dennis Murphy and Stuart Weiss, *Effects of Climate Change on Biological Diversity in Western North America Species Losses and Mechanisms* 333, in *Global Warming and Biological Diversity* (R. Peters and T. Lovejoy eds. 1992) (forthcoming).

55. Compare *Keystone Bituminous Coal Association v. DeBenedictis*, 480 U.S. 470 (1987) with *Nollan v. California Coastal Commission*, 483 U.S. 825 (1987). The literature of what government intervention constitutes a taking is legion but the jurisprudential and constitutional basis of the nexus between the common law of nuisance and the exercise of the police power is nicely put in Douglas Kmiec, *The Coherence of the Natural Law of Property*, 26 Val. U. L. Rev. 367 (1991). Cf. Michael Davis & Robert Glicksman, *To the Promised Land: A Century of Wandering and a Final Homeland For the Due Process and Taking Clauses*, 68 Or. L. Rev. 393 (1989).

56. *Lucas v. South Carolina Coastal Council*, 404 S.E.2d 895 (S.C.), cert. granted, 112 S.Ct. 436 (1991).

We have limited experience with the use of land use controls to deflect development away from sensitive areas beyond flood plains and erodible slopes. Our existing "growth management" techniques are limited to controlling the pace of urban development only.⁵⁷ For several decades cities and counties have tried to control the housing market, but experience to date merely illustrates the difficulties of using land use controls to adapt to global warming. Cities and counties initially tried to control the rate of new development as well as to distinguish among high, moderate and no growth areas.⁵⁸ In California and Florida, cities have had some success in regulating the tempo of urban development, and they have shifted the burden of infra-structure planning from the general tax base to developers and new entrants.⁵⁹ The record of growth distribution is more mixed.⁶⁰

In recent years, local governments have overlaid existing land use control schemes with sensitive area controls, deflecting growth away from wetlands, flood plains, erodible slope lands and now sensitive lands and endangered species habitat. These are promising land use initiatives. However, the success of more aggressive environmental land use programs is far from assured⁶² and the harmony between these programs and global climate change is not complete. Our current land use strategy is to trade environmental mitigation for development permission. They may not serve as models of advance damage avoidance.

The problem with using conventional growth management and sensitive area techniques to adapt to global warming is that drastic prohibitions are difficult to justify given the existing state of uncertainty. It will be too late to apply them after the rise in sea level starts to cause damage. There are creative answers to this dilemma, but the solutions come with substantial problems. For example, governments could buy the development rights should the land become inundated. But, land owner strategic behavior, such as lobbying for armor when this happens, could undermine the objective of the program. Professor Joseph L. Sax has suggested that strategic behavior can be bested by acquiring development rights now, at heavily discounted rates, and postponing payment until the damage occurs.⁶³

57. Daniel R. Mandelker, *Land Use Law* § 10.01 (2d ed. 1988).

58. *Id.*

59. See Richard T. LeGates, *The Emergence of Flexible Growth Management Systems in the San Francisco Bay Area*, 24 *Loy. L.A. L. Rev.* 1035 (1991).

60. For a good history of development tier policies in San Diego, California and Sarasota, Florida, see Douglas Porter, *Do State Growth Management Acts Make A Difference? Local Growth Management Measures Under Different State Growth Policies*, 24 *Loy. L.A. L. Rev.* 1015 (1991).

61. *Gardner v. New Jersey Pinelands Commission*, 593 A.2d 251 (N.J. 1991).

62. For a brief argument against endangered species protection see S. Mann, *Uplands Regulation: Habitat for Man or Beast*, 7 *J. Land Use & Envtl. L.* 59 (1991).

63. Joseph Sax, *The Fate of Wetlands in the Face of Rising Sea Levels: A Strategic Proposal*, 9 *UCLA J. Envir. Law & Pol'y* 143 (1991).

VI. CONCLUSION

The gradual nature of global climate change gives societies the luxury of carefully considering a wide menu of response options. There are many existing potential institutional candidates for adaptation. At the present time, the fit between existing institutions and the threats posed by global climate change is not an optimum one. However, many of the adjustments suggested by the global warming debate can be justified on independent grounds such as efficiency or fairness. The environmental movement has triggered a far-ranging debate about the existing allocation of natural resources⁶⁴ and global warming *considerations* are now beginning to permeate this debate. Thus, there is a decent chance that as part of a more societal consideration of the current allocation of natural resources, the necessary response flexibility will be incorporated into existing and new institutions.



64. See, e.g., Tarlock, *supra* note 41.

