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International Water Law and the Protection of River System Ecosystem Integrity

A. Dan Tarlock*

I. INTRODUCTION: COMPETING RIVER VISIONS

Adequate freshwater resources are vital to global economic development, environmental protection, and perhaps security.¹ Water is necessary for both urban development² and food production and is an important but under-appreciated component of biodiversity maintenance.³ However, it is increasingly difficult to manage many water resource systems to simultaneously perform the two core functions of economic development and biodiversity protection, because of the stresses placed on such resources by multiple, and often inconsistent, demands. Human alterations which promote economic development, such as dams, provide reliable irrigation, municipal and industrial supplies, and hydroelectric power. Unfortunately, the benefits of these uses often come at the expense of the modification of the historic flow cycle, which ultimately reduces fish runs, causes the degradation of estuarine systems, increases

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flood damage, and produces other environmental insults. These conflicts are particularly acute with regard to international rivers because national self-interest, rather than international cooperation, is often the real management principle.

International water law currently plays a limited role in resolving these conflicts, and must be augmented by new principles in order to play a more active role in the future. International water law is evolving to provide a possible framework to accommodate both river basin development and environmental management, but the existing framework continues to be premised on a management paradigm that promotes the "optimum" development of river systems. However, this paradigm has been radically reevaluated in the past two decades by scholars who argue that many multiple-use projects represent an inefficient allocation of resources, cause environmental degradation, and are socially inequitable. This argument is slowly being reflected in both domestic and international water law, though the historic development promotion management paradigm remains dominant.

It is not surprising that the old paradigm still reigns. Law takes its cues from the society it serves and, until recently, water law provided the ground rules for the intensive development of large rivers on the basin-wide, multiple-use model developed in the United States. Law thus

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4. In the United States, two celebrated examples are the loss of salmon runs on the Columbia River, see, e.g., WILLIAM DETRICH, THE GREAT COLUMBIA RIVER (1995), and the magnification of flood losses in the Missouri and Mississippi river systems from channel alternation. See DANIEL B. BOTKIN, OUR NATURAL HISTORY: THE LESSONS OF LEWIS AND CLARK 21-38 (1995).


6. The principle reason for the current limited use of international water law is that the allocation rules are so open-ended that at best they provide only a procedural framework for dispute resolution. Richard Kyle Paisley & Timothy L. McDaniels, International Water Law, Acceptable Pollution Risk and the Tatshenshini River, 35 NAT. RESOURCES J. 111, 122-23 (1995).

7. Id.


9. The theory that water projects yielded large regional economic benefits has always been more of an article of faith among politicians and water managers, rather than a rigorous, empirically verified hypothesis. One of the leading students of multiple purpose planning, Irving K. Fox, characterized the debate as one between economic rationality, which emphasized reallocation and conservation, and the development model which viewed water as the engine of perpetual economic growth. See Irving K. Fox, Policy Problems in the Field of Water
facilitates the destruction of the ecological integrity of these systems and their flood plains by allowing nations to alter the natural flow of a river through dams, diversion systems, and flood control projects.

Historically, the flow of large river systems was perceived as a natural resource that should be extensively developed to benefit everyone, whether living inside or outside the basin. River systems were largely viewed as commodities. This view lay at the heart of the "scientific conservation movement" which shaped the water resource policy of the United States and, later, the world. Eventually, however, this narrow conception of development partially collapsed under the weight of economic and environmental criticisms.

International water law reflects the dominant scientific conservation, or wise-use ethic, that prevailed in the United States and throughout most of the world during the first two-thirds of this century. The movement to conserve water resources originated in scientific surveys of the American West and in the need to find a formula to sustain the settlement of arid and semi-arid areas. "Conservation" provided the scientific and political bases for the principle of maximum water development, which flowered between the turn of the century and the mid-1960s. The scientific conservation theory, driven by theories of production efficiency, assumed that the entire river system should be intensively developed and managed to maximize its economic potential through large-scale, multiple-use projects.

Conservation grew out of the United States' experience with water development in the nineteenth century. During the twentieth century, the eighteenth and nineteenth century tradition of building mills and dams on eastern and midwestern rivers to provide power for industrial development was extended to the construction of large public and private dams on most of the major United States river systems. Multiple use became the organizing principle of both public and private water

References:
- 10. The influence of western European law and economic theory of the perception of all resources as commodities is one of the principle themes of modern environmental history. E.g., William Cronon, Nature's Metropolis (1991).
development and management. Major uses of river water included irrigation, municipal and industrial consumption, hydroelectric power generation, and flood control.14

During this period of multiple-use mentality, environmental values were largely ignored by both the public and the private sector. Even when environmental issues were addressed, they were typically given secondary importance. The twentieth century's rapid technological development enabled society to permanently alter the hydrology of large river systems and encouraged the intensive development of flood plains. After World War II, this idea of altering river systems was exported to the world.15 The Colorado River in the western United States and the post-High Aswan Dam Nile in Egypt are prime examples of "developed" large river systems.16

The theory of maximum development has been challenged and supplemented by the ecosystem paradigm. This paradigm views river systems as dynamic, ever-changing, functioning ecosystems that serve a variety of purposes ranging from the maintenance of consumptive uses to the maintenance of the river's historic natural functions for both anthropocentric and non-anthropocentric reasons. Today, calculations of the high social and environmental costs of maximum development are beginning to influence water law. In the United States, the costs are primarily environmental. However, in the developing world the costs are environmental and human; foreign-driven projects often have devastating impacts on local subsistence economies.17 The international environmental and human rights movements have challenged the idea that regional multiple-use river projects will provide fair and efficient economic development. Dam projects in developing countries have been opposed because they displace minority populations, inequitably distribute water, and often fail to deliver the promised economic benefits.18

Initially, water planners tried to accommodate these neglected uses within the multiple-use framework. As the environmental degradation of large reservoirs became evident, three secondary uses were added to the four primary uses: namely, fish and wildlife maintenance, water quality

maintenance, and recreation. In addition, land use controls were applied to supplement structural flood control measures. Still, non-consumptive uses and non-structural flood control measures remained secondary to engineering solutions to encourage maximum use and development.19

The process of "environmental accounting" has recently led to a more radical ecological ideal of the function of river systems and their flood plains.20 As a result, two alternative visions of the river systems now compete for dominance within the water community. The traditional multiple-use vision of a river system as a commodity to be used to the maximum extent possible is still the dominant vision worldwide, thriving in China and many other parts of the developing world. The newer ecological integrity vision is less clearly articulated because it rests on a more complex view of nature and humanity's role in the functioning of natural systems. This vision is not a simple river preservation concept, but rather starts from the premise that human use of a river system should be integrated with the maintenance of its natural environmental sustainability.21 This newer vision seeks to identify a river's hydrographic and natural functions, sustained by the flow over time.22 These functions include the maintenance of natural systems, such as wetlands and human economies. The flow cycle of the pre-Aswan Dam Nile is a classic example of the ecological-social vision23 and the post-dam river is a prime example of the commodity vision.


20. Professor Teclaff has been a leading advocate of the need to recognize the benefits of historic flood patterns as well as the benefits of flood control. See Ludwik A. Teclaff, Treaty Practice Related to Transboundry Flooding, 31 NAT. RESOURCES J. 109 (1991); LUDWIK A. Teclaff, THE RIVER BASIN IN HISTORY AND LAW (1967).


23. Nile irrigation began to be modified in the nineteenth century and barrages and dams were constructed to regulate the river's flow, but historic patterns were relatively maintained until the construction of the High Aswan Dam. H.E. HURST, THE NILE (1952).
The purpose of this Article is to explain the theoretical underpinnings of the laws governing the use of large river systems, in order to facilitate understanding of the problems fueled by ongoing efforts to implement an ecosystem approach to river management. This Article will examine the role of international water law in promoting these two competing visions.

Water law has taken its cue from the multiple-use vision and has developed doctrines to support that paradigm. Thus, despite recent efforts to reform international water law in light of the global environmental movement, the protection of the ecological integrity of large river systems remains subordinate to the maximum exploitation of these systems. The multiple-use view fits well with the notion that individuals have the right to modify nature. This deeply imbedded belief impedes the incorporation of a newer vision of ecological sustainability into the law and into the allocation institutions built on the legal principles developed to promote maximum human development and use. Current law, however, must be adapted to modern environmental realities. The social and economic costs of undisciplined multiple-use development are too high, and international water law should reflect the appreciated value of river systems. This Article concludes with a brief examination of the scientific and ethical underpinnings of the ecological integrity protection model, in order to develop the management concepts that could be used to incorporate the ecosystem protection model into international water law.

II. THE UNITED STATES ANTECEDENTS OF INTERNATIONAL WATER LAW

A. Domestic Water Law

To understand international water law, one must start by examining United States domestic and civil law. International water law is primarily based on the United States' experience with allocating the use of its intra- and interstate rivers and reflects the multiple-use vision. Water law developed new property rights which allowed the natural flow of rivers to be altered, either by storage or by the diversion of water out of the river's watershed. Ironically, the multiple-use vision is relatively modern. The two major western legal systems, civil and common, initially assumed that the natural flow of a river was the major "commodity" to be used in situ. Thus, non-consumptive uses, such as navigation and power generation, were considered to be primary, and consumptive uses, such as irrigation and non-domestic use, were considered second-
ary. Both civil and common law allowed small retaining structures, but carry-over storage, trans-watershed diversions, and the consumption of entire streams were legally problematic because they involved monopolization of a common resource.

In the United States, the legal barriers to large-scale water development became apparent after the Civil War, and the law adjusted to these economic pressures by making consumptive uses primary. Many states switched from the "natural flow" theory of riparian rights to the "reasonable use" rule, which allowed diversions and storage. By the end of the nineteenth century, the arid intermountain western states simply rejected the doctrine of riparian rights as unsuited to local conditions. In its place, water was "commodified" to the maximum extent possible under the doctrine of prior appropriation. Prior appropriation allows a user to acquire a relatively exclusive water right by putting water to beneficial use. Appropriate rights are rights to a specific quantity of water at a specific time of year for a beneficial or non-wasteful use. If the natural flow or storage capacity of a reservoir is inadequate to satisfy all rights, the water is allocated in the order of priority. This practice has led to the two maxims of the doctrine: "first in right" and "use it or lose it."

In the twentieth century, the function of domestic and international water law has been to promote multiple-use development, although environmental values have occasionally been protected under traditional doctrines. Prior appropriation promotes multiple use by recognizing relatively firm property rights to store and consume as much of the natural flow as possible and to use water outside the watershed. This powerful rule was developed on small streams to support hydraulic mining, but it was projected on progressively larger geographic scales. The genius of appropriative rights is that the water right is not tied to the locus of use. Thus, water rights can be acquired in the headwaters and transported long distances to areas of demand. On the other hand, this principle permits the permanent and detrimental alteration of the flow of

24. For a fuller development of this point from a comparative law perspective, see Ludwik A. Teclaff, Harmonizing Water Use and Development with Environmental Protection, in WATER IN A DEVELOPING WORLD, supra note 5 at 72-75.


26. The story has been told many times. For a recent synthesis of the cases and literature, see A. DAN TARLOCK ET AL., WATER RESOURCE MANAGEMENT 149-77 (4th ed. 1993).

27. For a history of the role that prior appropriation played in the development of California, see A. Dan Tarlock, From Natural Scarcity to Artificial Abundance: The Legacy of California Water Law and Politics, 1 W.-NW. J. ENVTL L. POL'Y THOUGHT 71 (1994).
river systems since the natural flow or hydrograph has no legal protection. The rule also encourages the rapid development of river systems by parties wishing to acquire vested rights.

B. Equitable Apportionment

Multiple use of interstate streams was promoted by the United States' law of equitable apportionment, which became the basis for international water law. Equitable apportionment projected the principle that prior uses should be protected across state lines, and ultimately national boundaries. In the early twentieth century, original jurisdiction interstate water use disputes were adjudicated by the United States Supreme Court. One case involved up-stream withdrawals along the Arkansas River in Colorado, which reduced available supplies downstream in Kansas. In another case, Missouri charged that Chicago's pollution discharged into the Mississippi, resulting from the reversal of the flow of the Chicago River, contributed to a cholera epidemic in Saint Louis. These two lawsuits required the Supreme Court to develop a law of interstate water use, using the doctrine of equitable apportionment to resolve conflicts between states.

The Supreme Court initially looked to the classic international law rule that all states have equal legal rights, and fashioned the principle of equitable apportionment. The resulting doctrine now forms the basis of the sharing rules said to apply to international rivers. The core idea of equitable apportionment entitles each state to a fair share of a common resource because each state has an equal right to enjoy the available resource. In the United States' federal system, states are only quasi-sovereign and, thus, the Supreme Court could hold that the use of common resources, such as interstate streams and groundwater basins, must be shared among co-riparian states. Concrete sharing rules are difficult to define because states often have widely different abilities to put inchoate shares to actual use. Consequently, the Supreme Court has developed a "flexible formula" that balances the need to accommodate

28. Most western states now have some form of instream flow protection. See INSTREAM FLOW PROTECTION IN THE WEST (Lawrence J. MacDonnell et al. eds., 1993).


new uses with the protection of existing economies. The Court’s open-ended equitable apportionment formula purports to weigh the comparative merits of different river uses over time.

In fact, the Court has consistently rewarded early development by protecting prior uses against subsequent uses. In 1982, the Court suggested that it would deny existing uses protection to support a new and more efficient use of the water when “reasonable conservation measures by existing users can offset the reduction in supply due to diversion.” However, two years later the Court recanted this heresy and preserved the priority of a small reclamation district, although it did leave open the possibility that a new diversion could displace an existing one if the state made a strong showing of an immediate demand for a high-valued use.

As a result of the weight given to prior use, equitable apportionment often contributes to the degradation of large river systems by stimulating a race to develop, but it can also protect river systems as a byproduct of the promotion of other values. The Supreme Court basically follows the law of the states in which the conflict arises. Thus, in common law or riparian rights states, often the flow can be protected if it is being “used in situ.” For example, the Supreme Court has protected the ecological integrity of the Great Lakes system by substantially limiting out-of-basin diversions to protect pre-existing navigation uses. The Court has also prevented diversions which might impair the waste-assimilative capacities of a river. But, in appropriation states, instream flows have not been protected. The recent attempts to claim such flows on the Platte River illustrate the resistance of the law of equitable apportionment to new management concepts.

In the 1930s, the Supreme Court adjudicated rights to the North Platte River between Nebraska and Wyoming users. In the late 1980s, Nebraska reopened the decree to protest some new diversions by Wyoming. Environmental groups unsuccessfully sought to intervene, arguing that any new decree must guarantee adequate winter flows (which were not apportioned) for whooping crane populations; the final decision in the litigation did not deal with environmental issues. Fortunately, the Court’s opinion does not preclude environmental management of the

33. Id.
Platte; it only renders it less legally secure. The three basin states, Colorado, Nebraska, and Wyoming, have recently signed a Memorandum of Agreement with the Secretary of the Interior to develop a basin-wide wildlife protection plan, but unfortunately, no public or private entity can claim rights to a wildlife protection flow under the equitable apportionment doctrine.39

III. INTERNATIONAL WATER LAW

In a similar fashion, international water law promotes multiple-use development by recognizing that each riparian state has an equal right to use common waters subject to indeterminate sharing rules.40 The law assumes that all riparian states have an equal right to common waters and, thus, an equal right to develop the resource in their national interest. Modern international law rejects the idea that upper riparian states have an absolute right, by virtue of their territorial sovereignty, to water which originates in their boundaries, and it equally rejects the idea that lower states are entitled to the natural flow of all rivers. The net result is that rapid, uncoordinated, multiple-use development is rewarded; the best way for a state to define its fair share is to put the river to use.

A. From Absolute Sovereignty to Sharing

International water law attempts to accommodate two conflicting legal principles. The first principle is a projection of the sharing duties incorporated into United States equitable law.41 The second principle denies the existence of a duty of equitable sharing among nation-states, because each sovereign state has the exclusive right to develop its resources. Under both classic and modern international law, nation-states have exclusive sovereignty over all resources within their borders and may use and exploit these resources without regard to the interests of users in other nation-states. The tension between these two concepts is illustrated by Principle 21 of the 1972 Stockholm Declaration:

39. Instream flow rights have been recognized under both Nebraska law and the federal Endangered Species Act. See J. David Aiken, Nebraska Instream Appropriation Law and Administration, in INSTREAM FLOW PROTECTION IN THE WEST, supra note 28, at 16-1.


States have in accordance with the Charter of the United Nations and principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of States or areas beyond the limits of their national jurisdiction.\textsuperscript{42}

According to most neutral commentators, international water law has progressed from a rule of exclusive sovereignty to shared sovereignty. Upstream states naturally assert the right to capture the entire flow of a stream to the detriment of downstream states. Downstream states, in turn, assert a servitude over upstream states to the entire natural flow of the river at the international boundary. International law has rejected both the extreme claims of exclusive upstream sovereignty—the Harmon Doctrine\textsuperscript{43}—and an absolute servitude in favor of downstream states because they equally permit individual states to control the use of transnational resources. The United States' subsequent practice of recognizing Mexico's claims on the Colorado and Rio Grande Rivers\textsuperscript{44} and the long history of the shared use of international waters between Canada and the United States has led to the conclusion that exclusive sovereignty was never a widely accepted practice.\textsuperscript{45}

Modern international water law starts from the assumption that all states whose territories contribute to an international drainage basin have a right to an equitable share of the waters of the basin. The doctrine of equitable utilization or equitable participation is designated as a rule of customary international law.\textsuperscript{46} This principle was adopted prior to the rise of the environmental movement in the late 1960s and has been reaffirmed in subsequent non-binding declarations such as the 1972 Stockholm Conference on the Environment, the 1977 World Water


\textsuperscript{45} Austin, \textit{supra} note 43.

Conference in Mar del Plata,\textsuperscript{47} and the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. Commentators have recently advocated an expanded sharing principle—a "community of property" model which is premised on co-riparian cooperation. Under this model, the rivers and associated resources would be jointly managed without regard to international borders on the principle that all riparian states are entitled to equitable participation in the development of the resource.\textsuperscript{48} However, this more progressive vision does not yet reflect state practice. International water law remains a modest restraint on unilateral water resources development.

Equitable utilization was part of international law before the concept of international environmental law began to coalesce in the 1970s following the Stockholm Conference. Environmentalists view the doctrine with some distrust because it seems to allow "reasonable environmental degradation." Perhaps for this reason, equitable utilization is not directly mentioned in the Declaration of Rio; however, the basic ideas are incorporated in the Declaration and in preparatory conference documents. Principle 2 reaffirms both the right to exploit sovereign resources and the duty to avoid damage to the environment of other states. This is reinforced in Principles 17 and 19, which mandate international environmental assessments and require that a state undertaking an activity "that may have a significant adverse transboundary environmental effect" notify potentially affected states and consult with them "at an early stage and in good faith." Preparatory documents reaffirm the importance of shared use of transboundary resources.\textsuperscript{49}

\section*{B. State Responsibility: The Basis of Sharing}

The sharing vision of international water law can incorporate the idea of ecosystem protection, because both international water law and environmental law rely on state responsibility for transboundary harm.\textsuperscript{50} States have a duty not to allow state agencies and private parties subject

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to the state’s regulatory jurisdiction\textsuperscript{51} to use its territories in a manner that causes substantial harm to other states.\textsuperscript{52} The basic duty seems firmly grounded in modern international practice,\textsuperscript{53} although no consensus exists as to the scope of the duty and the standard of liability;\textsuperscript{54} thus, the deterrence effect of the rule is minimal. For example, no rules of liability exist for environmental damage due to inequitable uses of water,\textsuperscript{55} and no generally recognized right of compensation exists for

\textsuperscript{51} State responsibility for the conduct of private parties who cause injury to the territory of another state is widely asserted in international law, although the basis for the duty and its scope are disputed. The basic principle is that a state must exercise due diligence to prevent conduct, performed by the state, which would breach its primary international duties. This is thought to include the duty to regulate and to enforce regulations. \textit{Developments in the Law—International Environmental Law}, 104 \textit{Harv. L. Rev.} 1494 (1991). This duty is endorsed in Section 601 of the United States Restatement of Foreign Relations which limits the state duty to take necessary environmental protection measures to “the extent practicable under the circumstances.” David Caron, \textit{Reviews of the Restatement (Third) of the Foreign Relations of the United States, The Law of Environment: A Symbolic Step of Modest Value}, 14 \textit{Yale J. Int’l L.} 528 (1989) describes this standard as conservative compared to the fault-based due diligence standard of international law.

\textsuperscript{52} The Trail Smelter (U.S. v. Canada), 3 R.I.A.A. 1938 (1949), is the basis for the two most authoritative statements of state liability which extends to the failure to police and regulate those acting within a state’s territory. State liability for acts which injure the other is reinforced by the \textit{Corfu Channel} decision. \textit{United Kingdom v. Albania}, 1949 I.C.J. 4.2. In 1946, a British warship struck mines in the Corfu Channel. Albania blamed the mines on Yugoslavia and the International Court of Justice treated the source of the mines as unknown. The Court allowed Great Britain to prove Albanian knowledge by liberal inferences since it had no access to the country due to the latter’s exclusive territorial control and concluded that Albania knew that the mines were in place. Liability was based on Albania’s failure to warn Great Britain because every state is under an obligation “not to allow knowingly its territory to be used for acts contrary to the rights of other states”—in this case the right of passage through international straits. Given the paucity of precedent and the great diversity in state practice in response to environmental insults, the international community continues to debate whether there exist substantive duties on states which make trans-frontier pollution a wrongful act. \textit{E.g.,} Karl Zemanek, \textit{State Responsibility and Liability}, in \textit{Environmental Protection and International Law} 187 (Winfried Lang et al. eds., 1991).

\textsuperscript{53} Among the best discussions are Johann G. Lammers, \textit{International and European Community Law Aspects of Pollution of International Watercourses in Environmental Protection and International Law} 115 (Winfried Lang et al. eds., 1991), and Andre Nollkaemper, \textit{The Legal Regime for Transboundary Water Pollution: Between Discretion and Constraint} (1993).

\textsuperscript{54} The issue is whether states are absolutely (strictly) liable or whether they are only liable for intentional environmental insults and the failure to use due care. The argument for a fault-based regime is that this is most consistent with the principle of sovereignty and past practice. The International Law Commission has divided international law into the old state responsibility and the new international liability to broaden the debate to include “absolute” or strict liability, but the consensus is that this is a distinction without a difference. Francisco Orrego Vicuna, \textit{State Responsibility, Liability, and Remedial Measures Under International Law: New Criteria for Environmental Protection}, in \textit{Environmental Change and International Law} 124, 139 (1992).

\textsuperscript{55} Paul R. Williams, \textit{Can International Legal Principles Play a Positive Role in Resolving Central and East European Transboundary Environmental Disputes?}, 7 \textit{Geo. Int’l L
general environmental degradation in the absence of demonstrable injury to specific consumptive and non-consumptive uses. A post-hoc duty to compensate is an inadequate incentive for states to engage in meaningful cooperation, sharing, and environmental management. Rivers should be allocated in advance of conflict, when fair options are open and environmental damage can be prevented. Damage to riverine ecosystems is extremely difficult to reverse or remedy after the fact. For many degraded ecosystems, after-the-fact remediation is the only option, and the United States and other countries have begun costly restoration experiments. The Turkey-Iraq conflict over the use of the Tigris-Euphrates system illustrates the difficulties of equitable apportionment when one state makes a unilateral allocation. Turkey built the Greater Anatolian Project upstream and promised Iraq a 500m$^3$ per second flow, but Iraq argues that 700m$^3$ are necessary to support its 6,000 year old irrigation economy. International Environmental law principles developed since the 1972 Stockholm Conference have influenced the expansion of international water law to include cooperation and prevention duties. The International Law Commission has formulated four primary prevention duties when states exercise their sovereign right to develop water resources: states have a corollary duty to inform, consult, and engage in good faith negotiations and to repair or compensate, for any damages caused by the inequitable use of water. However, only a breach of the duty to compensate is considered wrongful. The duty to inform, which does not include the duty to forego, was dropped from the Stockholm resolution at the insistence of Brazil. Many nations continue to object to the widely recognized duty of consultation on international rivers and refuse to

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58. An exhaustive study of the influence of hard and soft international environmental law on the right to develop water resources suggests that modern sharing rules are premised on the assumption that "the elasticity of the equitable apportionment principle leads to a whole series of procedural rules, because without such rules, States often recognize the limits of their rights only when they intentionally deprive another State of its equitable share." HAROLD HÖHMAN, PRECAUTIONARY LEGAL DUTIES AND PRINCIPLES OF MODERN INTERNATIONAL ENVIRONMENTAL LAW 116 (1994).

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consult.60 This duty could be expanded to include a full environmental impact assessment.61

Modern international environmental law seeks to go beyond cooperation and mitigation to incorporation of a duty to prevent the risk of harm. The precautionary principle, the most disputed prevention duty, adopts the substitution of risk for provable harm that underlies United States and European toxic pollutant regulation as an international duty between states and erga omnes.62 Precaution is a logical response to a science-based legal regime such as international environmental law;63 serious risks such as ozone depletion and global warming must be regulated before confirming evidence can be generated. For this reason, a precautionary principle is emerging out of recent regional and global agreements.64 For example, in 1983, the German government took the position that there was no need to wait until harm had been proven before North Sea pollution was controlled; this review is reflected in the Second North Sea Declaration.65 This approach has been adopted in principle

60. For a history of Brazil’s objections to the duty to consult (written by an Argentine scholar), see Guillermo J. Cano, Argentina, Brazil, and the de la Plata River Basin: A Summary of Their Legal Relationship, in WATER IN A DEVELOPING WORLD, supra note 5, at 126.


62. HOMANN, supra note 58, argues that the precautionary principle is a logical product of the trend toward planned environmental management and that it has been so widely adopted in binding and non-binding agreements that it has become an “instant” doctrine of customary international law.

63. Environmentalism derives its primary force from the universal warning messages of elite science. As James Rosenau has written:

Politicians cannot exercise control over environmental outcomes without resource to scientific findings. They may claim that the findings are not clear-cut or remain subject to contradictory interpretations, but they are nonetheless dependent on what practices in science uncover about the laws of nature . . . [C]riteria of proof are at the heart of environmental politics . . . . The outcome of environmental issues depend as much on the persuasiveness of evidence as on the various criteria of power superior resources, greater mass support, skill at coalition formation—that sustain or resolve other types of issues.


The net result is that scientific environmentalism is causing a fundamental global paradigm shift from a focus on rapid economic growth to one of environmentally sustainable development. The universal acceptance of science decreases the importance of cultural, political, and legal differences.


at other marine conventions: in UN sustainable development declarations, in the ozone convention, and in regional hazardous waste treaties. The precautionary principle posits that states have a duty to take "remedial action even in the absence of provable environmental harm, simply on the evidence of significant risk thereof." The principle is still vague, but it probably includes a duty to avoid foreseeable, significant risks, although the burden of proof issue is still unresolved. It is applicable to water projects which increase the risks of pollution and ecological degradation; but, the duty to prevent will be a function of the immediacy and severity of the projected risk.

C. Sharing Duties Encourages Rapid Development

International water law follows United States equitable apportionment law by defining the sharing duties in terms of a non-weighted, multiple-factor, reasonable use test. The tests change with different formulations but all derive from the 1967 Helsinki Rules. The geography, hydrology, and climate of the basin; past utilization; population; economic and social needs of the basin; and the availability of alternative sources of supply are among the relevant factors to be considered in determining a reasonable and equitable use of the water. In theory, the international standard gives somewhat less weight to preexisting uses and more protection to environmental values and social equity, compared to the United States doctrine. However, flexibility is achieved at the cost of indeterminacy.

D. The Tentative Incorporation of Environmental Protection Duties into International Water Law

International water law has begun to incorporate the idea of ecosystem protection into multiple-use development—but the integration remains incomplete. In recent years draft water law rules have added

70. Id. at art. V.
important environmental protection mandates, but it is very difficult to promote the protection of the ecological integrity of river systems because protection is not a conventional water use. Flood plain and wetland protection are largely excluded from these new rules which are focused on pollution prevention. Thus, the incorporation is incomplete, and considerable tension exists between the two visions for three reasons. First, the law has historically set the ground rules for comprehensive river basin development and promoted treaties among riparian states for the allocation of large rivers.\textsuperscript{72}

Second, the international rules seem to adopt the view that adverse environmental impacts are an inevitable consequence of development that can often only be mitigated rather than prevented. The principal adverse environmental impact for rivers has, understandably, been pollution from both concentrated and diffuse land-based sources. As discussed in Section IV, current water law rules can either be interpreted as adopting close to a non-degradation principle or allowing “reasonable” pollution levels.

Thus, pollution is an important component of ecosystem protection, as illustrated by the joint Canada-United States Great Lakes pollution control strategy,\textsuperscript{73} but the narrow focus on pollution ignores more subtle threats to ecosystems. Modern environmentally sensitive legal regimes try to correct this problem by mandating or encouraging ecosystem management, but the concept remains vague, controversial,\textsuperscript{74} and very difficult and costly to integrate into existing management regimes.

The core of the idea of equal development opportunity continues to be the foundation of equitable apportionment rules. The best source of international water law is the draft rules currently being considered by the International Law Commission (ILC), a United Nations Organization.\textsuperscript{75} Article V of the draft rules directs states to use watercourses in an  


“equitable and reasonable manner.” The next sentence reinforces the idea that development is primary and environmental protection is secondary. Specifically, “an international watercourse shall be used and developed by watercourse states with a view to attaining optimal utilization thereof and benefits therefrom consistent with adequate protection of the watercourse.”

Article V is followed by a section which lists six non-weighted factors relevant to the determination of what is equitable and reasonable. The factors are the subject of extensive debate, but the important point is that they promote development. For example, states which develop first are rewarded by Article VI(f) because existing uses are a relevant factor. Slower developing states are equally encouraged to develop by the ability to show a “social and economic need” for the water, the recognition of the value of “potential” as well as existing uses, and the ability to argue the comparative efficiency of different water uses—although this is a high burden to sustain.

Environmental factors play a secondary role, although the ILC has made commendable efforts to incorporate them into international water law. The proposed ILC draft rules contain several innovative new environmental protection rules. For example, Article 20 requires that states protect the ecosystems of international watercourses, and Article 22 requires that a state take all measures necessary to prevent the introduction of alien species into a river system if the species “may have effects detrimental to the ecosystem of the watercourse.” This standard comes from the objections that Canada lodged to the United States Garrison diversion in North Dakota. However, the fact remains that the protection of a river system’s ecological integrity remains secondary to the promotion of development. The next section offers four specific examples.

76. Id. at 3.
77. Id.
78. Id. at 5-6.
79. Id. at 4.
80. Id. at 3.
81. Id. at 8.
IV. THE SECONDARY STATUS OF ECOSYSTEM INTEGRITY IN INTERNATIONAL WATER LAW

A. The Isolation of River Corridors from the Water

International water law is a channel-based legal regime, as opposed to a watershed or ecosystem-based legal regime and this focus is inherently biased toward development and against ecosystem protection. The ILC rules apply to international watercourses, not river systems. The term "watercourse" is narrowly defined as "a system of surface and underground waters constituting by virtue of their physical relationship a unitary whole and flowing into a common terminus." The definition is progressive because it includes connected groundwater; however, it does not promote environmental management because land in the watershed, and probably confined aquifers, are excluded from the rules. Ultimately, this is a step backward from previous definitions of international river systems. Land use practices, such as clear cutting timber, effectively remain outside any international restraints. The exploiting nation's legal regime remains the controlling regulatory authority. Domestic and international legal regimes maintain a persistent but artificial separation of rivers from the flood plains and wetlands. This artificial separation influences (and is influenced by) the legal regimes to prevent water use rules—premised on the need to share a common resource—from becoming a basis for land use regulation. Further, under some interpretations of equitable apportionment, traditional practices such as the use of flood waters may be inefficient and may result in a duty being imposed on a riparian state to conserve water for the benefit of downstream states. Waste counts against a state in the

83. Symposium, supra note 75, at 2.
84. This statement could be contested in light of the nascent international legal regime to conserve biological diversity.
85. Noss and Cooperider note that:

Human actions that dampen or eliminate natural disturbances are likely to be a threat to biodiversity in many kinds of environments. For example, many riparian plant species such as cottonwoods become established after floods, which create new deposits of bare silt and gravel where seedlings can establish. Eliminating periodic flooding by building dams may prevent regeneration of many species and drastically alter riparian plant communities.

balancing test, and conservation has traditionally meant that water should be efficiently consumed. 87

B. Preservation of the Flow of River for Ecosystem Maintenance is Problematic

Downstream states lack control of the flow of international rivers under international water law 88 and pollution prevention is difficult despite recent ILC drafts. Although the older rule of absolute territorial sovereignty has been rejected in favor of equitable sharing, upstream states do not need to seek the consent of downstream states to make a diversion. In short, there is no natural flow rule in international water law. 89 The material injury rule, which is at the heart of equitable sharing, allows upstream states to progressively use water, thus creating a risk of environmental damage which may not rise to the dignity of legally cognizable damage. For example, upstream diversions may generally increase the salinity of rivers by allowing salt water to migrate upstream.

In the past twenty years, nation-states have been aware of the short and long term harm caused by the use of rivers as sinks. Moreover, the developed world has had considerable success in applying technology to reduce end-of-the-pipe discharges, but this technology has not yet been institutionalized in many developing countries. The development era has a continuing legacy which makes it difficult to develop international pollution norms. Development and consumption remain the norm and environmental protection is a side-constraint that must be addressed only when the adverse consequences can be quantified. Pollution is often limited to serious, identifiable pollution, rather than less visible, cumulative impacts from environmentally destructive watershed land use practices.

87. Article 6(e) of the 1991 ILC draft includes "conservation, protection, development and economy of use the water resource and the cost measures taken to that effect" and Article 5 mandates that international water courses be "used and developed . . . with a view toward obtaining optimal utilization therefrom consistent with adequate protection of the watercourse."

88. The converse is equally true. The ongoing water disputes between the Upper and Lower Colorado River Basin states stem from the fact that the lower basin states have a much higher level of economic development than the upper. However, the upper basin states are not deprived of the environmental benefits of the flow of the river.

89. The Lake Lanoux Arbitration (France v. Spain), 24 I.L.R. 101 (1957), has been widely read to reject any right to the undiminished flow of an international stream. For a full exposition of the rise and fall of the theory see Charles B. Bourne, The Right to Utilize the Waters of International Rivers, in 1965 THE CANADIAN YEARBOOK OF INTERNATIONAL LAW 187, 190-203.
The ILC draft rules promote this technological solution in at least two ways. First, Article 7 originally enjoined states to use water "in such a way as not to cause appreciable harm to other watercourse states." 90 Two problems have been found with this standard. Proponents of multiple-use development criticize the standard as a departure from the common understanding of equitable apportionment, because it subordinates development to environmental quality. 91 Environmentalists make the opposite criticism that environmental quality is subject to development. The section does add a new environmental protection dimension, which only prohibits harm "capable of being established by objective evidence;" thus, it does not include the crucial concept of risk prevention. 92 Second, the idea of appreciable harm is carried over into the pollution article. Pollution is broadly defined as any human-caused "detrimental alteration . . . of an international watercourse." 93 But, states only have a duty to prevent pollution which causes "appreciable harm to other watercourse States." 94

The new ILC reporter has attempted to preserve the subordination of reasonable use to the duty to prevent appreciable pollution harm by allowing an extraordinary circumstances exception:

Watercourse states shall exercise due diligence to utilize an international watercourse in such a way as not to cause significant harm to other watercourse states, absent their agreement, except as may be allowable under an equitable and reasonable use of the watercourse. A use which causes significant harm in the form of pollution shall be presumed to be an inequitable and unreasonable use unless there is: (a) a clear showing of special circumstances indicating a compelling need for ad hoc adjustment; and (b) the absence of any imminent threat to human health and safety. 95

Article 7 was accordingly revised in 1994 to provide that "[s]tates shall use due diligence to utilize an international watercourse in such a way as

90. Symposium, supra note 75, at 4.
92. Paisley & McDaniels, supra note 6, at 124-25.
93. Symposium, supra note 75, at 8.
94. Id.
not to cause significant harm to other watercourse States. Article 7 further provides that a state causing significant harm after the exercise of due diligence must consult with the injured state about the equity of the use and possible mitigation measures.

The controversy over the proposed Windy Craggy mine on the Tatshenshini River in British Columbia, Canada, which is upstream from two national parks in Alaska and one in Canada, illustrates the need for the inclusion of risk analysis and prevention in international water law. In 1988, a mining company applied to the government of British Columbia to open a copper mine on the river. Intense environmental opposition to the mine, because of the risk of long term acid drainage and consequent damage to salmon fisheries, led British Columbia to scrub the mining plan and to preserve the River as a World Heritage site. A recent analysis of the controversy suggests the need for a risk assessment process in international water law:

Windy Craggy illustrates the potential value of applying the principles of international water law to resolving international water controversies. The Windy Craggy controversy also suggests that there are ways in which international water law could be made more useful to decision makers. Among the limitations to existing international water law is its inability to deal with situations where risk of international water pollution is the issue. A partial solution might be to extend international water law to include a principle of informed negotiated consent that would build on the foundation set by the principle of equitable utilization and reasonable use in the Helsinki Rules and help to meld the Helsinki Rules to the ILC Draft Rules.

C. The Protection of Vested Rights Makes It Difficult to Reengineer Rivers

In the future, restoration of degraded rivers will be a major river management task. Major river systems such as the Colorado, Columbia, Missouri, and Nile, face substantial environmental problems as a result of the construction of large dams. To satisfy new and additional objectives, primarily environmental and recreational, states must modify the operation of dams built for three purposes: water supply, power, and flood control. Experiments are now underway on many river systems, large and small, to restore the system to a baseline that reverses the most

97. Paisley & McDaniels, supra note 6, at 117.
98. Id.
harmful effects of human use and alteration of natural system functions.\textsuperscript{99} The Florida Everglades are the most spectacular example, although there are many others. Reengineering international rivers will be especially challenging because of the high level of scientific and financial cooperation required, and because new flow regimes may conflict with entitlements built up under the equitable apportionment rules. Efforts to revise the operating regime for Glen Canyon Dam on the Colorado River, an international river,\textsuperscript{100} illustrate that efforts to restore a shadow of a pre-dam flow on the Colorado can be impeded by the entitlements generated by multiple-purpose development.

The construction of Glen Canyon Dam on the Colorado, and its operation for hydroelectric power generation, have altered the downstream environment throughout the Grand Canyon. The net result of the construction of Glen Canyon and other carry-over storage and hydroelectric generating dams is that the river has permanently become an artificial one.\textsuperscript{101} Ecosystems often require disturbance cycles to sustain them, but Glen Canyon Dam altered the natural hydrographic of the Colorado River. In the early 1980s the consequences of the substitution of an artificial for a natural disturbance regime began to surface: canyons were eroding; endemic fish were jeopardized by the substitution of the warmer, more turbid natural flow regime with colder, clearer water; and rafting trips were subjected to pulsating flows from the daily power release cycle. In 1982, the Bureau of Reclamation and the Western Power Administration began to collect information about these changes\textsuperscript{102} and, after initial resistance, agreed to prepare an environmental impact statement.\textsuperscript{103}

Reengineering possibilities exist to improve the canyon ecosystem, but they have been resisted because they may frustrate the expectations generated by the entitlement regime. Historically, the idea that the flow of the river was a use to be protected had no place in the law of the river. The National Park Service, as manager of the Grand Canyon, would have been the logical proponent, but the Service’s long history of

\begin{itemize}
  \item \textsuperscript{99} See NATIONAL ACADEMY OF SCIENCES, THE RESTORATION OF AQUATIC ECOSYSTEMS (1992).
  \item \textsuperscript{101} PHILLIP FRADKIN, A RIVER NO MORE (1981).
  \item \textsuperscript{102} Two National Academy of Sciences assessments of the scientific studies are available. NATIONAL RESEARCH COUNCIL, RIVER AND DAM MANAGEMENT (1987) and COLORADO RIVER ECOLOGY AND DAM MANAGEMENT (1991).
  \item \textsuperscript{103} The triggering event was the decision to upwind the dam’s generators. U.S. DEPARTMENT OF THE INTERIOR, OPERATION OF GLEN CANYON DAM, ENVIRONMENTAL IMPACT STATEMENT (1994).
\end{itemize}
trying to preserve the natural environment of the rim (with the exception of visitor access facilities) made it ill-equipped to deal with changing artificial systems such as the river; thus, the dam managers, the Bureau of Reclamation, and the Western Area Power Administration were able to run the dam as a cash register and to ignore the potential external costs of this management decision.

It was easy to generate power from dam operations because the river has historically functioned as a conduit between the upper and lower basins. The Colorado River has been allocated in perpetuity, and firm entitlements exist in the seven basin states. The seven Colorado River basin states have been given mass allocations by interstate compacts, Congressional legislation, and Supreme Court decree. In addition, the equitable claims of Mexico have been recognized by treaty and executive agreements. Under the Colorado River Compact, which allocates the river between the upper and lower basin, the river is divided at Lee's Ferry above the Canyon. Each basin is allocated 7.5 million acre feet, which was erroneously assumed to be the average annual flow of the river. Each basin shares equally in the obligation to provide an additional 1.5 million acre feet to Mexico.

To allow the slower developing upper basin states to meet their lower basin delivery obligations, the 1922 Compact defines the upper basin's delivery obligation to Arizona, California and Nevada as a 75 million acre feet obligation to be satisfied over a progressive series of 10 year periods from the two large carry-over storage reservoirs, constructed to guarantee the upper basin's ability to meet this obligation during sustained droughts. Water moves through the River from the Upper Basin's storage reservoir behind Glen Canyon Dam to the Lower Basin's reservoir at Boulder Dam in order to meet the Upper Basin's 8.3 million acre feet annual Compact and Treaty delivery obligations to Arizona, California, Nevada, and the Republic of Mexico. These mass entitlements are not affected by daily power releases.

Initially, the Bureau of Reclamation and the Western Power Administration tried unsuccessfully to make the problem disappear by funding research which would demonstrate minimal modification of the riverine ecosystem. The problems, however, did not disappear. In 1992,


Congress responded directly to the new river use and interest constituencies by passing the Grand Canyon Protection Act (Act). The Act is a direct outcome of identifying the need for a different release pattern from the dam, both to build beaches and to retard beach erosion.

In 1990, the GCES scientists proposed a research flow program to test the impacts of less fluctuating flows and the benefits of spring beach building pulses on the corridor. The Department of Interior (DOI) first opposed the legislation because the research flows had not been implemented and evaluated, but this opposition ended after the Bureau and the Western Area Power Administration agreed to an experimental interim flow regime in late 1991. The basic purpose of the Act changed from a Congressional mandate to the DOI to implement interim flows, to a more general effort to supplement the management objectives of the operation of Glen Canyon Dam. In short, the Act establishes the legality of river corridor enhancement flows consistent with the "law of the River," and is an important step toward the adoption of ecosystem protection as a management standard.

Section 1802 of the Act requires that the Secretary of the Interior operate the dam in a manner consistent with the "Law of the River," including the Endangered Species Act, "to mitigate adverse impacts to, and improve the values for which the Grand Canyon National Park and the Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use." The Act makes the Environmental Impact Statement the basis for future management. Section 1804 requires that the Secretary use the "findings, conclusions, and recommendations" of the Environmental Impact

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107. In 1987, a leading Colorado River expert, Edward R. Clyde of Salt Lake City, Utah, offered the following definition of the "law of the river:"

[The] Colorado River Compact negotiated in 1922, which divided the Colorado River between the Upper Basin and the Lower Basin states; a treaty between the United States and Mexico dated February 3, 1944; the Upper Colorado River Basin Company negotiated in October, 1948; the apportionment made by Congress in the enactment and implementation of the Boulder Canyon Project Act of 1928, as declared by the United States Supreme Court in Arizona v. California; federal statutes dealing with salinity on the Colorado River and the management of the federally constructed reservoirs; the laws of the individual states, which control individual use; and the Indian reserved rights. Beyond this we will have the continuing role of Congress which has the constitutional authority to intervene in the river administration and water allocation.

Edward R. Clyde, Institutional Responses to Prolonged Drought, Report to Central Utah Water Conservation District (1987). The central premise of the law of the river is the inter-basin apportionment. As long as dam operations do not impair basin entitlements, the law of the river does not constrain daily and seasonal dam operations. § 1802. 106 Stat. 4669.
Statement to adopt management “criteria and operating plans . . . in addition to those specified in Section 602 of the Colorado River Basin Project Act of 1968.”\textsuperscript{109} After a decade of research, the Bureau of Reclamation is releasing research flows to determine if the riverine environment can be sustained. The Bureau is also facing a potential lawsuit from the Upper Colorado River basin states who argue that the heresy of non-power, non-water supply flow releases violates the complex law of the Colorado River.

Interestingly, research has indicated that ecosystem management does not necessarily require a fundamental change in reservoir operations and, thus, may not be inconsistent with equitable entitlements. When the Glen Canyon Environmental Studies began, many scientists and others thought that the dam had trapped the sediment necessary to sustain the canyon’s beaches. Sophisticated sediment transport research done by the United States Geological Service and other federal agencies demonstrated that tributaries entering the mainstem below Glen Canyon Dam contain sufficient sand to maintain beaches and backwaters.

The problem was not the mass balance of sand in the system but the way in which it moved down the Colorado post-dam. The alteration of the pre-dam hydrographic eliminated seasonable floods, except when the reservoir could not contain the run-off, and replaced them with a combination of steady and fluctuating flows—produced by the generation of peaking power—that eroded the beaches. The scientists recommended controlled floods (or beach building flows as the Bureau of Reclamation prefers to call them) and reduced ramping rates (the decline in the rate of discharge from the turbines) to reduce beach losses. As of October 1995, the Secretary of the Interior had not yet issued a Record of Decision for Glen Canyon Dam, but the Bureau is inching its way toward a more flexible, science-based operating regime.

\textbf{D. The Inability to Adapt to Global Climate Change}

Projected changes in the global climate from CO\textsubscript{2} emissions pose particular stresses for international water allocation regimes and dependent ecosystems, but international water is not well structured to adapt to many adverse climate-induced water impacts. The scientific community continues to debate whether anthropocentric activities have in fact increased average global temperatures and how the changes will be regionally distributed. After a period of retreat from the extreme predictions of the 1980s, the scientific community seems to be coalescing

\textsuperscript{109}. \textit{Id.} § 1804.
around the view that the problem is a serious one. Existing allocation regimes are premised on the availability of a guaranteed supply of water—the average annual flow augmented by carry-over storage. If droughts and increased evaporation occur, the available water from international rivers will be consistently less than the parties to the allocation originally expected but existing allocation regimes have no mechanisms to adjust to these changed conditions.

Many "experts" have suggested that the projected effects of global climate change can be mitigated by increased reliance on markets or through existing allocation regimes. However, international water allocation is a prime example of the lack of adaptation mechanisms in existing allocation institutions. International river agreements are often negotiated so a dam can be built accompanied by the expectation that any shortages will be short-term and mitigated by the reservoir's carry-over storage. Treaties often provide only for temporary reallocations and contain no mechanism to address long term declines in expected available supply. For example, the altered Nile Agreement allocates a fixed amount of water to Egypt and the Sudan. It binds other basin states, but provides only a weak mechanism for short term drought relief. The Mexican-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. It is not clear that this would apply to global warming, so Mexico is not guaranteed a clear entitlement. To complicate matters, if the normal drought mechanisms are used, the resulting allocations may be widely perceived as inefficient and unfair, and might not be followed. In short, adaptation is not even a realistic option when an allocation regime lacks a mechanism to deal with changed conditions.

Water marketing has been proposed as an adaptation strategy. Economists and many western water critics have long criticized western water law because it ignores higher, alternative values of water. They assert that too much water is used to grow surplus or low-valued crops or too much water is used in a wasteful manner and that increased transfers are desirable. Prior appropriation allocates the risks of

113. See Meyers, supra note 44; Noble, supra note 44.
shortages by a simple principle—priority of use. The question of how flexible the water transfer system will be in the future gives rise to two sets of problems, one institutional and the other distributional, which 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 and consistent with ecosystem sustainability in both the short and long run.114

IV. CONCLUSION: WHAT DOES THE FUTURE HOLD?

International water law is undergoing a paradigm shift from multiple-use development to environmentally sustainable development in promotion of biodiversity. Principles developed between the 1972 Stockholm and the 1992 Rio United Nations’ environmental conferences provide the legal norms for environmentally sustainable river management. For example, there are some hopeful trends in international environmental law which reinforce the integration of water quality and quality considerations with land use and water management. Many of the emerging principles of international environmental law can supplement the law of transnational water allocations and help erode the artificial distinction between water and associated land resources. However, any integration and supplementation must be supported by science and ethics because the integration of the ecological integrity model in international water law must be informed by new scientific and ethical paradigms.

Modern river management is increasingly based on non-equilibrium ecology which rejects the earlier vision of nature in perfect balance. Further, non-equilibrium ecology rejects the romantic idea that nature should be a place without humans and returns to the problem posed by Genesis: how should one manage the Garden of Eden after it has been invaded by humans? In a path-breaking book, Daniel Botkin has “deconstructed” the equilibrium paradigm as a misguided effort to match science to theological and scientific visions of a perfect universe.115 His basic argument is that the images of nature that have influenced ecology are static; although the kinds of problems encountered require a dynamic view of nature. This argument starts from the premises that human action is one of the principal forces operating on ecosystems and that system disturbances are both predictable and random.

Ecosystems are more properly conceived as patches or collections of conditions that exist for finite periods of time. As a leading ecologist has written, water resource systems are "inherently variable, patchy, and often require disturbance to persist." This idea has two consequences which are partially reflected in the previously discussed Glen Canyon Dam experience. First, all future management must be adaptive. Because "[a]daptive planning and management involve a decision-making process based on trial, monitoring, and feedback," goals can be modified, as necessary, in light of new information. Second, management objectives or baselines must be consistent with the idea of altered systems. The accelerating interaction between humans and the natural environment makes it impossible to return to an ideal state of nature. At best, ecosystems can be managed rather than restored or preserved, and management will be a series of calculated risky experiments. "[N]ature moves and changes and involves risks and uncertainties and . . . our own judgments of our actions must be made against this moving target."

Most ecologists have now rejected any idea of a "balance" of nature, and the non-equilibrium paradigm is now the organizing principle of modern ecology. As one ecologist recently commented, "[t]he idea [of balance of nature] makes good poetry but bad science." The best evidence of this paradigm shift is the short, but extremely influential list of 20 Great Ideas for Ecology for the 1990s, published in 1992 by Eugene P. Odum, the distinguished ecologist who is most responsible for implanting the idea in the mind of lawyers and policy makers that natural systems tend toward equilibrium if left undisturbed. The first and over-arching great idea states that "an ecosystem is a thermodynamically open, far from equilibrium system." The others are either a specific application of the non-equilibrium principle or policy prescriptions to implement good management, commentary as it were on the first principle. One of the major implications of non-equilibrium ecology is that all management is a long term experiment and that concepts such as

116. See Botkin, supra note 22. The philosophical basis for the new ecology can be found in Bill McKibben's widely read, THE END OF NATURE, which argues that the modern mind separates humanity from nature and thus the romantic visions of harmony between humanity and nature are impossible.
118. The Restoration of Aquatic Ecosystems, supra note 99, at 357.
119. Botkin, supra note 22, at 190.
122. Id. Ironically, Odum cites the third edition of his classic text, BASIC ECOLOGY (1983).
cause and damage, which lie at the heart of existing uses, must be established over a long period of time through monitoring, and mitigated through adaptive management.

Conservation biology, a new regulatory science, is emerging to deal with the persistent problem of generating scientific information that can inform management decisions by designing research agendas tailored toward specific management issues. These issues include determining minimum viable habitat for an endangered species and the disturbance regime necessary to sustain the ecosystem. Further, conservation biology focuses on the integration and progressive nature of scientific research, so that management regimes can adjust to new information and changed ecological conditions.

The new science of river management can be informed by the assumption of an ethical obligation to future generations. The underlying philosophical principle of environmental management is the duty of intergenerational equity. The basic idea is that "[w]e as a species, hold the natural and cultural environment of our planet, both with members of the present generation and with other generations, past and future." This principle has been rapidly adopted as the ethical norm against which major international agreements and mandates must be tested. The precise contours of intergenerational duties are not self-defining. However, the core idea that each generation has a duty to manage its common patrimony for the benefit of the next generation rejects the prevailing ethic that resources should be immediately consumed because their future value is likely to be lower than their present value and rejects the more "radical" ecological visions of the restoration and maintenance of pre-human environments.

Adoption of intergenerational equity fundamentally changes the nature of water resource decision making processes and allocation norms, regardless of the precise content of the duty. Present actions must be evaluated in terms of the long term consequences, and all present value economic calculations of commodity values must be weighted against calculations that estimate the future value of resources and incorporate the

123. See NOSS & COOPERIDER, supra note 74, at 84-86.
124. The best introduction to the subject is NOSS & COOPERIDER, SAVING NATURE'S LEGACY, supra note 74.
125. See EDITH BROWN WEISS, IN FAIRNESS TO FUTURE GENERATIONS: INTERNATIONAL LAW, COMMON PATRIMONY, AND INTERGENERATIONAL EQUITY (1989). Weiss argues that present generations owe conservation duties to future generations and that "[c]onservation of quality . . . cautions against water withdrawals that may result in pollution of water supplies . . . that will be expensive or impossible for future generations to repair in the future." Id. at 238.
126. Id. at 22-24.
assumption of environmental quality that the marginal value of natural or non-degraded resources is likely to increase over time. This is the essence of the difference between the economics of sustainable development and traditional cost-benefit calculations. One example of the application of intergenerational equity is the incorporation of non-passive or passive use values into decision making. Passive use values are, in effect, a proxy to measure the aggregate value of natural resources over time because, if the values are evaluated over a longer period of time and over a broader community, they more accurately measure changing preferences.

Both science and ethics must be applied to the international law of river use and management to adapt international water law to ecosystem protection. Historically, international water law has narrowly assumed that environmental problems are ones that can be dealt with by post-project damage payments or minor project modifications in the name of mitigation. In contrast, international environmental law approaches pollution and environmental destruction from the front end through the precautionary or prevention principle. States are encouraged to prevent environmental destruction by addressing cross-media problems before, not after, development occurs. This approach is reflected in the ILC's draft rules. However, the ILC debates about the relationship between environmental quality and development illustrate the large gap that still exists between the "soft" law of international environmental protection and the "harder" law of multiple-use development. The task for lawyers is to provide modern river basin managers with a legal framework for the application of the technical expertise and ethical perspectives which will close the gap. Closing the gap will allow the development of new management regimes that do a better job of accommodating historic uses and protecting riverine ecosystems.
