

# **Global Climate Change, Environmental Change and Water Law**

**Paper presented at the Law Seminars International  
Conference**

**"What is Next for Washington Water Law?"  
May 20, 2005**

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## **Global Climate Change, Environmental Change and Water Law**

### **Inevitable Surprises, Inescapable Change**

The native peoples of this continent arrived before the salmon, during a time of great environmental upheaval and ecological change as the glaciers receded in the late Pleistocene. Indigenous peoples watched and learned as the roiling waters lost some of their youthful exuberance and settled into their channels, offering their veins for the abundant stream of life that flowed into them. This life overflowed the banks of the rivers and streams and wove the life of the streams deeply into the landscape, so that the life of the watersheds and the life of the waters became richly connected. They watched as the salmon first brought the flash of silver, pink and red into the streams.

Already rich in traditional lore and knowledge of how to adapt to changing climates from their ancient history, they learned anew how to live in the constantly moving landscapes of the Pacific Northwest. The times were not always good, and the salmon and the pulse of life ebbed and flowed. Indigenous peoples developed extensive networks of alliances and trade that helped them to survive environmental changes and upheavals, and themselves moved with the changes of the waters and lands.

The great encounter of native peoples and settlers brought great changes to all sides, and to the environment. Much of the law relating to water and the environment was brought to this continent through European settlers, who saw these lands primarily through the lens of English common law and sensibilities. One hallmark of this worldview is that the world was seen primarily as static and unchanging, and while change may come and go, it cycles around a relatively fixed state. When the new nation of the United States signed treaties with the Indian tribes, the common phrase "as long as the rivers run" was used to describe the permanent relationship between the new society and the first inhabitants. By this, it was understood by all that the resources and the land base could forever be assumed to exist in a relatively fixed state and provide abundant and sufficient resources for all.

Standing at the beginning of a new Millennium, we now see that this worldview was overly optimistic. In 1987 the World Commission on Environment and Development (WCED), chaired by Norwegian Prime-Minister Gro Harlem Brundtland, issued the report "Our Common Future", which shifted the earlier focus of environmental policy on pollution control to a wide range of environmental changes with large impacts on human livelihoods and well-being. In 1992, over 1,500 world scientists, including a large number of Nobel Laureates, issued the "World Scientists' Warning to Humanity" that began:

"Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about."

Globally, the nations of this world have recognized the potential severity of this current environmental crisis, negotiating the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 at the United Nations Conference on Environment and Development (UNCED) (the "Earth Summit"). While the debates still swirl around both of these conventions, it is clear that there is a strong scientific consensus that climate change will likely occur, warming the global mean temperature from between 1.4-5.8°C. Even were someone to wave a magic wand and all human greenhouse gas emissions to cease today, many of the greenhouse aerosols already in the atmosphere will take up to two centuries to be disassociated and taken from circulation. It is now virtually undisputed that the Earth has been subject to natural climate variation on the scale of a decade to centuries and longer.

Reinforcing the social, economic and ecological impacts of climate change and climate variation are the impacts of the vast changes in the human occupation of the land. No longer are humans able to move relatively freely around the landscape to move with changing conditions, as we now have to contend with burgeoning numbers of human beings, and expanding ecological footprint, urban sprawl, rural sprawl, and a hardening of the landscape with pavement, houses, buildings, and property rights. Many of these changes reinforce and amplify the impacts of climate change and climate variation.

We are entering a period when we have diminished or removed many of the natural buffers for adapting to environmental change. Recent science has underscored that when similar conditions have been encountered in the past, they have led to many abrupt changes in climate dynamics and ecological organization that severely disrupt the ecosystem services on which human communities deeply depend. Cumulative impacts, threshold effects, and unpredictability are less seen as occasional environmental risks to be handled at the margins, but core principles in the dynamics of nature. We are entering the Anthropocene Era, in which the functions of these processes are dominated by human activities, and we are committed to inevitable surprises and inescapable change.

## Causes for Concern

Space and time do not allow for anything but a very cursory treatment of the many aspects of the repercussions of climate change, climate variability and land use change. Several preliminary observations frame the assessment of climate change and environmental change.

1. The impacts of these changes are not isolated from one another, but that changes are interconnected in a web of relationships. Large-scale climate phenomena, for example, may be highly influenced by abiotic factors impacted by thermal forcing, such as ocean-atmosphere interactions that affect thermohaline circulation, the ocean circulation patterns created by ocean temperature differences. The interactions of the oceans with the atmosphere are not wholly abiotic. Carbon storage is affected by the "biological pump", in which phytoplankton capture atmospheric carbon which becomes a rain of carbon sediment that drifts to the ocean floor when they die. Abiotic factors affecting the production of phytoplankton, such as acid precipitation or iron fertilization from continental dust storms ("brown clouds") can push phytoplankton productivity down or up, affecting whether the ocean is a net sink for carbon or a net emitter of carbon. Scientists have used the concept of "bioclimatology" to describe the relationship of the life history and physiology of individual organisms to climate, and more recently of "ecohydrology" and "ecoclimatology" to conceptualize and describe the feedback interactions between ecology and the water cycle and ecology and climate.

2. Many of the changes work synergistically. Land use changes and climate change can have similar and reinforcing impacts. Land clearing and climate-induced warming and drying may both lead to opening forest canopies similar impacts on stream temperatures, plant growth, stream sedimentation rates, and so on.

3. We must avoid "shifting baselines" by referring climate adaptation and mitigation goals to historical conditions. Daniel Pauly has observed that environmental managers are often assume that the conditions of the environments to which they were first exposed is the "normal" state of the natural world around which management and restoration goals should be built, though they are willing to allow for some "slippage" in an imperfect world. As each generation accepts some amount of degradation, ignorant of the significant losses that have already occurred, species and ecosystems suffer the "death of a thousand cuts" as losses accumulate. The purpose of an historical baseline is not to try to define a world in a bell jar or return to a mythical Eden, as change has always been with us. The purpose is to attempt to define the set of historical conditions at a time when the waters, air, soils, and living things were in a much healthier state than they are today, and provided a wealth of goods and services that sustained cultures and provided substantial buffers against change. Defining historical conditions is also an exercise to define "natural" rates of change in order to better define those forces leading to extreme, abrupt and odious changes in order to attempt to avoid turbulent changes that break apart communities, destroy economies and livelihoods, and ruin our collective well-being.

## **A Brief Catalog of Impacts**

Each of the following vignettes is a composite of some general phenomena, and merely meant to indicate how climate-induced changes in hydrology can negatively affect native biota and ecosystem functions, and climate-induced changes in ecosystems and species can alter hydrologic regimes. The chains of causation are complex in any real cases, and would require detailed assessment in any policy or legal case.

### **1. Ecohydrologic Alterations**

Change in the timing of precipitation: The winter season in the Pacific Northwest has been reduced by approximately two months. The warm fall water lasts longer into the winter season, and the spring freshet appears earlier than historically. Precipitation falls as rain rather than snow in the fall, reducing snowpack. The snow melts more rapidly and earlier in the spring, resulting in higher peak flows. The high peak flows work to increase channel erosion, and deliver higher sediment loads, nutrient loads and contaminants to downstream receiving waters. This damages salmon and other in-stream habitat through scouring and sedimentation. The high flows also may damage streambanks and destroy streamside vegetation. This can lead to more erosion and weaken streambanks, which both brings more sediment from slumps, decreases the ability of the riparian to filter nutrients and toxins in runoff, and decreases the transfer of important stream nutrients (such as those derived from salmon carcasses) to the forest riparian zone.

The high volume of water reduces infiltration and passes the soup of unfiltered sediments, pollutants, and nutrients downstream, degrading instream habitats. The mix is passed to receiving waters, such as estuaries, increasing their loads of these materials, and reduces estuarine salinity. Similar impacts occur with the increasing amount of impervious surfaces conveying stormwater into streams and estuaries. The loss of streamside vegetation and structures that slow the passage of water further reduces the infiltration of snowmelt and rainwater. The freshwater in the nearshore environment may interfere with salmon development and increase the stressors acting on salmon in their critical transitional habitats. Agricultural compaction of soils also increases surface water runoff and reduces infiltration.

## **2. Temperature Alterations**

Both climate change and common land use practices fragment the landscape and create open canopy in areas with long histories of closed canopy ecosystems. Climate change can break up canopies through reductions of base flows and general drying, which is paralleled by clearing streamside forests and vegetation. The clearing of riparian forests reduces stream overshadowing, raising stream temperatures. Many northern aquatic invertebrates are dependent on cold winter temperatures to activate diapausing eggs, and scientists have documented dramatic declines in many temperate aquatic invertebrates. The warm water also induces whirling disease in salmon, and increases their susceptibility to other aquatic diseases. The problems are amplified by the decrease of cold water seepage into streams that normally comes from groundwater. Climate- and land-use related damage to streamside vegetation further reduces sediment and nutrient trapping, and contributes further to channel erosion and simplification of stream habitats.

Higher temperatures may also favor increased damages from diseases, pests and invasive species. The generation times of many pathogens and pests decreases with increasing temperatures, with may increase their pathogenicity. Since pests and pathogens and hosts both have longer active seasons under increased temperatures, this may allow pests and pathogens to build up to epidemic proportions. Forests where trees have been weakened from such attacks have been shown to be more susceptible to forest fires, which further reduces ground cover and increases erosion, reducing the overall infiltration capacity of the soils.

Open canopies and riverside soil compaction also reduce the survival of soil mycorrhiza. These are important for nutrient cycling in forest ecosystems, and also linked to hydrology. A number of forests grow on relatively poor soils, and the majority of nutrients are cycled through the mycorrhizal "biological pumps". The mycorrhiza are also important in water cycling, slowing and holding water in the soil leading to greater groundwater infiltration. Soil compaction, drying, and fire-related mycorrhizal mortality thus decrease the ability of soils to support native vegetation and decreases groundwater recharge.

## **3. Invasive Species**

Climate change is known to foster the intrusion of invasive alien species. Invasive species commonly invade disturbed ecosystems. Disturbed riparian corridors provide an invasion pathway into new uncolonized areas for a number of invasive plants. Invasive vegetation often provides poor habitat to native species, and can reduce burrowing and other activities that turn and aerate soils, reducing infiltration capacity and nutrient turnover. Invasive plants can alter stream hydrology by narrowing stream flood channels and trapping sediment. This can lead to extreme overbank flooding and further erosion of the streambank. Some invasive plants have been shown to have different root systems and may provide less cover than native vegetation, causing increases in erosion.

Invasive species may have characteristics that severely alter hydrology, as phragmites that choke river channels and saltcedar or tamarisk (*Tamarix ramosissima*), that draws enormous volumes of water from rivers and has invaded riparian areas throughout the Southwestern United States.

Invasive species also replace many native species of importance to Native American tribes that are not only important economically, but have great significance in religious, social and cultural practices.

#### **4. Species Range Shifts**

Some species are plastic enough in their characteristics to adapt to a range of environmental changes and remain in place, although they may possess characteristics that put them at risk of extinction. Some species, for example, may be tolerant of a wide range of temperature and moisture conditions, but have genetically fixed times for reproduction and feeding. For example, if predators and prey appear at shifted times or the timing of reproduction and availability of mates or offspring rearing conditions become separated by climate- or land-use-induced changes, species population will decline.

Other species may shift their ranges to follow their preferred bioclimatic envelope or preferred habitats as environments change. Some of these shifts are vertical, as species move up mountains, where they may become "trapped" if unable to escape from the tops of the mountains as situations degrade. Other species shift laterally across the landscapes, if they can. Range shifts may also put species at risk from the existence to human-made barriers and natural barriers to dispersal. Unlike historical episodes of change, species now have to cross roads, pass through cities, move across open agricultural landscapes providing little shelter from the climate and predators, and so face innumerable barriers.

Such lateral shifts disturb ecosystem functions, and can move economically and culturally important resources away from local communities, impact local economies and community health for those who depend on the species for food. For Native American tribes, such range shifts may threaten their cultural existence. The treaty-protected rights of tribes to hunt, fish and gather traditional cultural resources are based on tribal territories and usual and accustomed areas on public lands. Species, such as medicinal plants and game animals, shifting away from these areas are no longer available to the tribes. Even if rights to these species can be secured, if tribal members cannot realistically access them they are effectively extinct.

## **5. Emerging Diseases**

Temperature alterations have been mentioned one cause of the increase in diseases that effect the health of forests, streams, and other ecosystems. Hydrological changes can also increase disease incidence in ecosystems in a number of ways. Increases in nutrient load can favor the growth of algae or phytoplankton that creates conditions for hypoxia and red tides. Increased surface- and storm-water runoff from compacted soils and impervious surfaces can also increase the delivery of pathogens and toxins into aquatic ecosystems. The loss of riparian ecosystem services, such as riparian vegetation that prevents erosion and filters diseases and toxins from runoff also increases disease burdens in aquatic ecosystems. Stirring up sediments can stir up trouble, as pathogens that are normally benthos-dwelling are pushed into water columns and move downstream. Pathogens such as aquatic viruses in this way sometimes are able to meet and exchange genes to produce more virulent strains.

Invasive species can bring their foreign pathogens with them, and cause "virgin water epidemics" in aquatic organisms never exposed to them, and virgin soil epidemics in riparian zone species. Similarly, species range shifts can move disease-carrying plants and animals into new, often disturbed, environments that provide opportunities for the pathogens to infect new hosts. Many of these diseases have been called "emerging diseases" that although they may have existed for some time, are becoming new and prevalent threats to public health, wildlife health, livestock health, crop health and vegetation health because of the rapid changes in human and non-human populations and the environment.

## **6. Water for Humans and Nature**

Hydrological changes related to climate, environmental degradation and land use have caused significant and often unappreciated declines in water supply and quantity. Recent ecohydrological models developed jointly by the Tulalip Tribes and Battelle Pacific Northwest have attempted to estimate some of these losses. In a typical annual water budget for forested land cover in the Cascades, the models estimate that:

- 37.4% of the water budget occurs as evapo-transpiration
- 25.7% occurs as subsurface interflow
- 36.6% is absorbed into groundwater
- 00.3% is transported to the ocean as surface flows

Under urbanized land cover:

- 25.0% of the water budget occurs as evapo-transpiration
- 25.0% occurs as subsurface interflow
- 15.6% is absorbed into groundwater
- 35.0% is transported to the ocean as surface flows

These estimates vary with slope, soil type, cover type and other variables, but in all simulations where tree cover was 50% or less, surface flow runoff ranged from 25% - 57%, with parallel declines in groundwater infiltration. The freshwater flows, laden with pollutants and sediments, are dumped into estuaries which provide essential habitat for 75% of the state's commercial fish & shellfish. Water quality is in good condition in only 35% of these estuaries. In almost 2/3 of Washington State estuaries, fishing and shellfish harvesting is limited by pollution and disease.

More than 90% of the wetlands have already been lost in urban areas, and the loss of water storage and filtration capacity is expected to be augmented by climate-induced wetland loss in the rural areas.

60-70% of State relies on groundwater for drinking water, which has the 3rd highest number of water systems violating the Safe Drinking Water Act in the country. In 1998 636 lakes, streams and estuaries did not meet water quality standards set by EPA. The two main water quality problems were fecal coliform and temperature.

Currently, 50% of the State now has inadequate water to support all the needs of people, plants and animals. Between 30,000 and 80,000 acres of fish and wildlife habitat (wetlands, estuaries, and forests) are altered each year in the state. Loss and fragmentation of habitat is the main factor threatening more than 80% of the species listed under the Endangered Species Act.

All of these numbers are expected to rise under climate impacts coupled with the projected building out of our urban and rural areas under the demands of an ever-increasing population. While the stocks of water for humans and other living things are dwindling, and projections suggest that they will fall even more, become more polluted and carry more toxins and disease under climate change, and while we are already failing to provide enough clean water to the existing needs of the State, we are adding citizens every day.

### **The Law of Thirst**

Q'uranic Law contains a water law principle of the "Law of Thirst", the idea that each living thing should receive water according to its need. This concept was transferred to the Spanish by the Moors in Spain, and in the American Southwest, you can still see vestiges of the system in some of the old Spanish lands. In the modern American system of land use, farms are often set off in square blocks, with center pivot irrigation with a circumference that reaches to the edges of the squares. Old Spanish agricultural plots are arranged very differently, in long, irregular strips that follow the contours of the land and stretch for miles from the valleys into the mountains in a way that attempts to capture a variety of functions in the watershed. These are served by an irrigation system that is leaky. Rather than being seen as inefficient, however, these leaks, or little veins as they are called, are seen as obligations to allow water to flow to the other-than-human beings that are in thirst.

Native peoples in the Pacific Northwest and elsewhere have a similar water philosophy or "hydrocosmology", allowing them to live sustainably for Millennia with their non-human relatives. By helping one another to survive, and taking judiciously from the land, native peoples were able to persist through many difficult times and adapt to environmental change while maintaining the natural world around them. Traditional harvesters know to always leave some berries for the bear, and enough for the generations to come.

The Tribes of Washington State are particularly threatened by these forecasts. Unlike other citizens, the Tribes are tied to their homelands in a unique relationship to their lands and to the United States. Their identity is deeply rooted to their lands - the places from which they emerged, where their ancestors dwell, about which their stories and language refer, and to which they have continuing spiritual and collective obligations. Because of their unique political history, their recognized prior rights and treaty rights only apply to their reservations and usual and accustomed lands. Moving from these lands to adapt to large-scale environmental decline would cut them off from their origins, from the places of their collective memory, and the rights to self-determination the Tribes possess as peoples.

The Tribes, who have contributed very little to these large-scale changes, have few options but to stay in place and attempt to survive and sustain their cultures. The Maldivians, who have had no discernable contribution to global warming, must face the possibility that sea level rise will obliterate the Maldivian nation. The indigenous peoples of the United States face the risk of seeing their homelands washed over by waves of climate change, over which they have very little control. Climate change has the potential of scattering the resources on which their cultures are based. These same resources have the potential to be quashed by the ever-growing footprint of the surrounding society that on bad days seems intent on squandering every cent of its natural heritage.

But there are good days, and it doesn't have to be this way. Tribes are calling on all citizens to work together to find sustainable solutions that will benefit everyone in a common future. To do so will require that we pay close attention to the proximate factors of change above, and create means to mitigate them or adapt to them. Mitigation or adaptation alone, however, will likely be insufficient without a clear vision of where we've come from and where we want to go collectively.

Many things can become lost when we constantly dwell on the small decisions of our lives. The ecologist William Odum many years ago wrote of the "tyranny of small decisions". Large-scale loss of wetlands doesn't occur because we have made a collective decision to remove them. They are lost by thousands of small, private decisions that favor draining them over keeping them. At some point, people begin to notice the accumulating harm to all of all of those decisions. The tyranny of small decisions can be avoided in two ways. The first is to reverse the tyranny into the "miracle of small decisions" - taking individual responsibility to take actions to avoid foreseeable harms. The other way is to understand the impacts, our history, our values, and come to a collective decision about our future. Responding to climate change and land use management will require both to secure a future "as long as the rivers run"

## **Adaptation and Mitigation Policy Frameworks for Climate Change**

For our region in the Pacific Northwest to cope with our current environmental changes, we must stop treating the natural world as static, but incorporate policies and law into our planning and management that allows us to sustainably maintain healthy, resilient communities in the face of change. These policies and law need, among other things, to be:

1. Integrated - they must involve multiple sectors, often moving independently of one another, in the creation of holistic solutions that address:
  - a) health, housing, transportation, labor, economy, production, population growth, consumption, environment and development; and
  - b) a full range of climatological, hydrological, environmental and ecological relationships;
2. Cross-scale - they must address problems at multiple environmental and societal scales, and devise action appropriate to each scale, while working to ensure that policies and actions at other scales do not work to defeat measures taken at any one scale;
3. Adaptive - they must be flexible to respond to changes in the environment and in scientific and local knowledge, and should be designed to monitor and respond to the effectiveness of their objectives, and to change the objective themselves when necessary;
4. Restorative - they must be built on the recognition that even in the face of environmental changes, mitigation must look to historical baselines, not current baselines, for the environmental and hydrological processes that maintain healthy watersheds and communities;
5. Participatory - they must include the entire range of stakeholders, federal, state, tribal and private, in the development of objectives, adaptation measures and mitigation measures and be based on the principle of stakeholder equity in a manner that respects the rights and privileges of all stakeholders and is transparent and legitimate; and
6. Sustainable - they must be built on the basis of ecological and cultural sustainability, and include mechanisms to ensure the sustained financial and administrative support for their implementation.
7. Started **NOW!**

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