



# RESETTING EXPECTATIONS

// THE VALUE OF NATURAL SYSTEMS AND  
GOVERNMENT'S ROLE IN PROTECTING WATER



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*Cover photo: Lake Michigan meets the Chicago skyline.  
Inside photo: West Grand Traverse Bay in Traverse City, Michigan.*



# EXECUTIVE SUMMARY

The health and well-being of our state, our country, and our planet are dependent on maintaining the productive capacity of nature and the services it provides. Though not widely recognized or acknowledged, “natural capital” and the services provided by healthy ecosystems have always been the foundation upon which societies thrive and prosper.

The relatively new science of ecological economics now provides the means of assessing and quantifying the value of natural capital and related ecological services. The science indicates that natural systems endow trillions of dollars of annual benefits that society overlooks and takes for granted, yet undergird all global economies. Determining the value of natural capital and the associated ecological services provides a means of measuring and understanding the economic value of the natural world. Accurate data and unbiased information about the value of nature and the services natural systems provide are essential to inform public policy and legislative action.

Although there are many human impacts that impair and diminish natural systems, reducing the value and economic efficiency of natural systems, no greater threat exists than the warming of the planet caused by the continued emission of anthropogenic greenhouse gases, primarily from the combustion of fossil fuels. Recent assessments indicate that greenhouse gas emissions will cause future damages of more than \$50 trillion by 2050, and the economic burden will disproportionately fall on developing economies. Decarbonization of the global economy by transition to clean energy sources is imperative. The good news is that there is a clear consensus emerging that the energy transition is not only technically and economically feasible, but also that the global economic benefits from decarbonizing the global economy are substantial, including safeguarding the Great Lakes freshwater system from the worst effects of climate change. Government’s role in accelerating the energy transition is essential.

Michigan’s water resources are a rich source of natural capital and provide significant ecological services that will become more valuable over time. Our abundant water resources will increasingly weigh to Michigan’s competitive advantage, but more likely than not, Michigan will face future challenges



*Both the Flint water crisis and PFAS concerns are incidents of a much larger systemic problem – groundwater contamination that is pervasive, yet is being ignored by policymakers and political leaders. (Photo: White Pine Press, Northwestern Michigan College)*

from states that will be stressed by inadequate water supplies and from water-dependent agricultural, commercial, and industrial interests. Our legal and moral authority to resist appropriation of our water wealth will be a function of how adept and effective we are as Great Lakes stewards in the conservation and protection of our water.

In this, governance in Michigan is failing. The Flint water crisis is a stark lesson in the pitfalls of overriding and ignoring government standards intended to safeguard public health and safety. The PFAS crisis is attributable to the inadequacies of existing environmental laws, exacerbated by failed government leadership that ignored the findings and recommendations of the scientific professionals. Both the Flint crisis and PFAS concerns are incidents of a much larger systemic problem – groundwater contamination that is pervasive, yet is being ignored by policymakers and political leaders.

The water-related exigencies Michigan is experiencing call for broader application of the Public Trust Doctrine to reestablish and reaffirm government’s responsibility to protect and safeguard water resources for the benefit of the public. Recognizing the interdependence of natural systems and the importance and value of the ecological services that water resources provide, the Public Trust Doctrine must be applied aggressively and proactively to address conditions that have the potential to harm or impair commonly held water resources.



*The Cuyahoga River and Cleveland, Ohio, waterfront today.*

## GOVERNMENT'S ROLE IN PROTECTING HUMAN HEALTH AND THE ENVIRONMENT

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Since the 1970s, history has shown that government interventions requiring protection for human health and the environment through more stringent environmental laws have not only improved baseline conditions of our environment like air and water quality, but have also improved overall economic conditions. These studies, some of which were described in the first policy brief in this series, demonstrate the economic value of government-mandated protective standards by quantifying the benefits of protections aimed at improving public health and safeguarding the environment, as well as the high cost to the economy and public health of failing to protect the environment through adequate regulation.

Our politics fail to take into account the overwhelming benefits accruing to the public by the protections and safeguards effectuated by environmental standards. Though the political narrative has recently evolved to the point where some political leaders publicly acknowledge that there is “no conflict between economic performance and environmental protection” recognizing that society can have both, the reality, clearly found in the relatively new field of environmental economics, is that economic prosperity, indeed the world's

economies, are ultimately dependent on protecting the planet and the valuable resources that well-balanced natural systems provide. In economic terms, there is not only an absence of tension between environmental protection and economic performance, but in fact, the health of the environment and long-term economic sustainability and prosperity are mutually dependent and inextricably interconnected.

It is imperative that political leaders, policymakers, and citizens come to understand this critical association.

*In economic terms, there is not only an absence of tension between environmental protection and economic performance, but the health of the environment and long-term economic sustainability and prosperity are mutually dependent and inextricably interconnected.*



# NATURAL CAPITAL AND THE VALUE OF ECOLOGICAL SERVICES

The natural world provides a continuous stream of abundant, valuable goods and services. Air, water, soil, flora, and fauna upon which we all depend are relentlessly harvested, used, and abused without an appreciation of our dependency upon this natural capital and the value we derived from it. Nature-based capital, when unimpaired by outside stressors, is continuous and sustainable, providing a constant, renewed flow of natural resources that undergird the global economy.

Natural capital is the feedstock; nature also provides processes that continuously provide beneficial services. The list of ecological services nature provides is limited only by our evolving understanding of science. Fertile soils assisted by microbial action enabling nutrient absorption produce food and fiber and enable life. The hydrologic cycle purifies and refreshes our waters, absorbing floodwaters and recharging aquifers. Terrestrial and aquatic plants purify the air, sequester carbon dioxide, and produce oxygen. As integrated complex systems that thrive in the absence of human interventions, these ecological processes only scratch the surface of the sustainable services nature provides.

The primary benefits and functions provided by nature-based services are set forth in the National Climate Assessment, a requirement by federal law calling upon the U.S. Global Change Research Program to “conduct a state-of-the-science synthesis of climate impacts and trends across U.S. regions and sectors every four years.” Those benefits and functions of natural capital include:<sup>1</sup>

1. Providing provisioning materials, such as food and fiber,
2. Regulating critical parts of the environment, such as water quality and erosion control,
3. Providing cultural services, such as recreational opportunities and aesthetic value, and
4. Providing supporting services, such as nutrient cycling.<sup>2</sup>

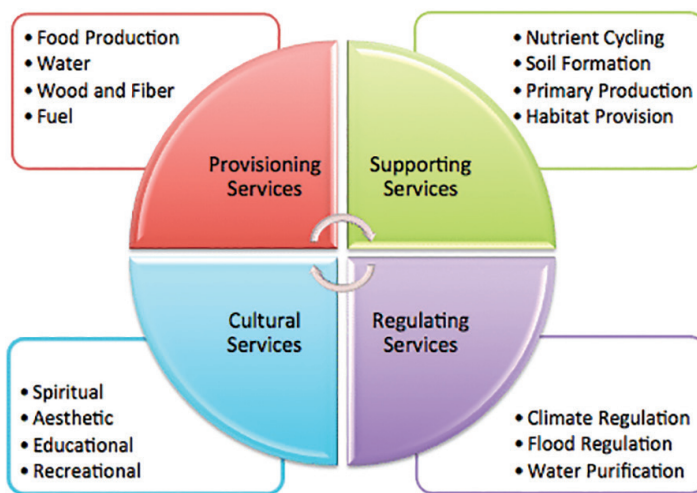
The work of understanding and quantifying the economic benefits of natural capital and ecological services is very recent. Herman Daly, a Senior Economist in the Environment Department of the World Bank and co-founder and associate editor of the journal, *Ecological Economics*, is credited with

Calculating the services natural systems provide in dollars and cents does not mean that money is the only measure of nature’s value to human beings. Humanity depends on nature for inspiration, beauty, and spiritual and physical renewal. Scientific research has shown that living close to nature and spending time outside has significant and wide-ranging health benefits, reducing the risk of stress and disease. An economic measure of ecosystem services is merely one way of expressing their value.

being among the first to document both the value of natural systems and the costs of degrading the services nature provides. Robert Costanza, Paul Hawken, and Amory Lovins were also among the first to write widely on the abundant benefits of nature-based services as well as to probe deeply into the economic consequences of diminishing these services by degrading the environment.

The field of ecological economics is now well established. A recent report from the United Nations International Science & Policy Platform for Biodiversity and Ecological Services (IPBES), *Regional Assessment Report on Biodiversity and Ecosystem Services for the Americas*,<sup>3</sup> quantified the annual value of eco-

## VALUABLE SERVICES NATURE PROVIDES



Source: Millennium Ecosystem Assessment, 2005.



logical services provided by natural systems in the Americas. The analysis, involving the collaboration of over 100 scientists who reviewed more than 4,100 scientific publications, found that 40 percent of the planet's capacity to provide nature-based services lies in the Americas, having a total annual value estimated at \$23.4 trillion. This figure, incomprehensibly large, is even more remarkable given the fact that only 13 percent of the world's population resides in the Western hemisphere.

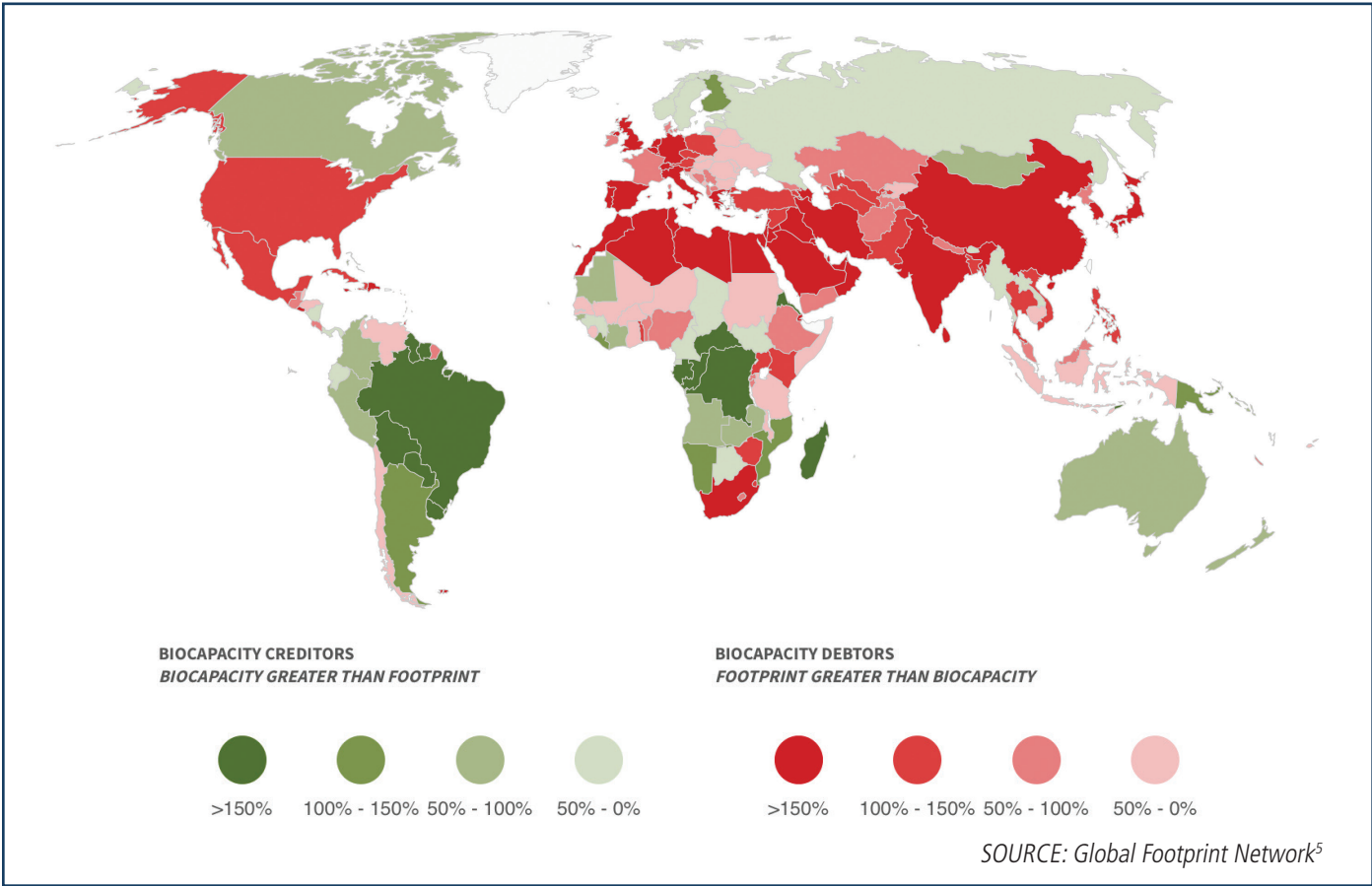
We who reside in the United States and Canada enjoy a surfeit of world's capacity to produce natural capital and ecological services. Eighty-seven percent of the world's population lives in areas of the planet that offer only 50 percent more nature-based capital and ecological service value than the Americas have with one-sixth the population. North Americans also have a much larger ecological footprint;<sup>4</sup> our relative wealth in natural resources works to conceal both our disproportionate consumption of global ecological services and the magnitude of the environmental challenges facing the rest of the world.

The global capacity to produce nature-based capital and ecological services is finite. The "biocapacity" of the earth's natural systems is a measure of the planet's ability to supply and reproduce nature-based goods and services and absorb society's waste products. It is nature's banking system - a natural

*"The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide."*

~IPBES Chair, Sir Robert Watson

endowment that provides trillions of dollars of benefits annually to the global population - that is now being overdrawn. In most of the developed world the consumption of natural resources exceeds the regenerative capacity of the earth's natural systems. Quantifying and monetizing the earth's biocapacity, as well as the ecological footprint of nations, are difficult and complex endeavors, but essential to advancing our understanding of our impacts on the environment and to formulating and implementing strategies that enable better stewardship of the natural systems on which we depend.







*The damage wrought to water intakes and related infrastructure by quagga and zebra mussels, top left, in the Great Lakes is estimated at \$500 million per year. Quagga mussels recycle phosphorus, contributing to avian botulism and catastrophic bird kills, top right, along the Great Lakes shorelines. (Photo: Wikimedia Commons)*

## ECOSYSTEM SENSITIVITY AND FRAGILE EQUILIBRIUMS

**A** further challenge of quantifying the value of ecological services is a full appreciation of the complexity and vulnerability of natural systems; stressing one component may yield unanticipated outcomes, with cascading effects ultimately destabilizing the entire ecosystem. Nature's ecosystems, though sometimes remarkably resilient, can also be thrown off kilter by impairing a single key component of the system or through the subtle unbalancing of a sensitive niche within the system.

The introduction of zebra and quagga mussels into the Great Lakes is a case in point. Originating in the Caspian and Black seas, zebra mussels were identified in the Great Lakes in 1988 and were quickly followed by the discovery of quagga mussels in 1989, the latter originating from the Dnieper River in the Ukraine.<sup>6</sup> Discharged from ballast water from transoceanic ships, they rapidly transformed the marine ecosystems of all the Great Lakes except Lake Superior, which is colder and lacks some of the nutrients and minerals that allow the invaders to proliferate.

The damage wrought to water intakes and related infrastructure by zebra and quagga mussels in the Great Lakes is estimated at \$500 million per year<sup>7</sup>—damages that may have been avoided if Canada and the United States had imposed regulations requiring the exchange of ballast water prior to entering the Great Lakes freshwater system. Yet the societal costs imposed by the introduction of zebra and quagga mussels from their impacts to water-related infrastructure are only

### FOURTH NATIONAL CLIMATE ASSESSMENT (2018)

Many benefits provided by ecosystems and the environment, such as clean air and water, protection from coastal flooding, wood and fiber, crop pollination, hunting and fishing, tourism, cultural identities, and more will continue to be degraded by the impacts of climate change. Increasing wildfire frequency, changes in insect and disease outbreaks, and other stressors are expected to decrease the ability of U.S. forests to support economic activity, recreation, and subsistence activities. Climate change has already had observable impacts on biodiversity, ecosystems, and the benefits they provide to society. These impacts include the migration of native species to new areas and the spread of invasive species. Such changes are projected to continue, and without substantial and sustained reductions in global greenhouse gas emissions, extinctions, and transformative impacts on some ecosystems cannot be avoided in the long term. Valued aspects of regional heritage and quality of life tied to ecosystems, wildlife, and outdoor recreation will change with the climate, and as a result, future generations can expect to experience and interact with the natural environment in ways that are different from today.



part of the damage calculus ultimately remitted to the public.

The ecological effects of the invasive mussels are pervasive and widespread. Quagga mussels, now dominant in the four lower Great Lakes, have devastated native mussels. They consume phytoplankton and zooplankton, critical intermediaries within the food chain for the Great Lakes' fishery. Given their ubiquity and density (as many as 8,000 organisms per square meter of lake bottom), they efficiently filter the water column, removing particulates and greatly improving water clarity.<sup>8</sup> The aesthetic improvement has a cost – sunlight now penetrates to more of the lake bottom, propagating *Cladophora*, a native algae that now, in a destabilized ecosystem, fouls Great Lakes shorelines, harming property values.<sup>9</sup> The quagga mussels also recycle phosphorus, a nutrient that would otherwise be sequestered over time in the lake bottom, but now fertilizes the *Cladophora* and stimulates growth, ex-

acerbating the problem. As the algae propagate and die, they provide an anerobic environment where botulism thrives and bioaccumulates in forage fish. These toxin-rich fish are then eaten by waterfowl including common loons, accounting for the catastrophic bird kills along the Great Lakes shorelines.<sup>10</sup>

And Toledo, a major American city, had its water supply shut down for 72 hours.

The havoc wrought to the Great Lakes ecosystem by the introduction of a single new organism like the quagga mussel is only a microcosm of the wide-ranging risks and vulnerabilities, both known and unknown, flowing from the introduction of anthropogenic greenhouse gases and the resultant changes we are experiencing in our climate. The impacts of climate changes are systemic and profoundly disruptive and threaten the productive and regenerative capacity of natural systems. All of the earth's natural systems now face existential challenges.

## Transformational Impacts of the Climate Crisis

Profound systemic changes to ecosystems worldwide are well underway and accelerating with increasing global temperatures. The effects of these changes are multidimensional. The complexity and interconnections within ecological systems test the limits of our scientific understanding regarding the impacts of climate change, yet predicting and measuring the many effects of climate change are scientific imperatives.

By federal law, the impacts of climate change must be assessed at least every four years. The Global Change Research Act of 1990 requires a National Climate Assessment (NCA) be prepared by the U.S. Global Change Research Program (USGCRP), which is charged with delivering a scientific assessment to Congress that includes analyzing "effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity."<sup>11</sup>

The latest NCA finds that ecosystems and the services and benefits they provide to society are being irreversibly altered by climate change. Degraded ecosystems and the impaired ecological services they provide have already resulted in broad socioeconomic impacts and have undermined nature's capacity to meet the needs of future generations.

Many profound and wide-reaching impacts of climate change are in plain sight. The increased

severity and frequency of storm events like the record-setting spring rains in the Midwest and South, the devastation Hurricane Harvey brought to Houston, and the unprecedented wildfires in the western United States and Canada are tangible manifestations of a warming climate. Ice loss in the Arctic, melting glaciers across the continents, and rising sea levels are now readily discerned by the people affected by these changes, if not society as a whole.

Beetle populations once held in check by sustained cold



*Storm events like Hurricane Harvey in Houston are tangible manifestations of a warming climate. (Photo: Air Force Special Operations Command)*



winter temperatures, but now surviving and reproducing at higher rates due to the warmer temperatures,<sup>12</sup> have visibly scarred the landscape, extirpating more than 85,000 square miles of pine and spruce forests in western states and 65,000 square miles of forests in British Columbia.

Other effects of climate change and warming temperatures are more subtle. Animals, birds, and insects are moving north and to higher elevations as temperatures rise.<sup>13</sup> Allergenic pollens and crop pathogens are moving northward as well.<sup>14</sup> Climate change is also affecting the seasonal cycles of plants, insects, birds, and mammals – patterns established over millennia are being disrupted, straining the capacity of natural systems to adapt. Climate-induced changes in the timing of plants flowering, the arrivals and departures of migratory species, and the timing of reproductive cycles are perturbing ecosystems, resulting in the availability of food supplies falling out of sync with the arrival of birds and insects. “Tropic asynchrony,” or mismatches between repro-

ductive timing and the availability of food sources, is altering both population dynamics of species as well as the biogeography of suitable habitats.<sup>15</sup>

Recent studies point to widespread and likely irreparable ecosystem losses. The United Nations Global Assessment on biodiversity and ecosystem services reports that “nature is declining globally at rates unprecedented in human history.”<sup>16</sup> Ecosystems are in marked decline worldwide with one million species – one-eighth of all species on earth – threatened with extinction. Eighty-five percent of the world’s wetlands have been lost, 75 percent of the land surfaces have been significantly altered, and 66 percent of the oceans have cumulative negative human impacts.<sup>17</sup> Another recent study indicates that 40 percent of the global insect population faces extinction in the next several decades.<sup>18</sup> The degradation of global ecosystems, loss of biodiversity, and threatened extinctions are our legacy to future generations. We are heedlessly robbing our children of the wealth nature provides.

## Climate Impacts in the Great Lakes Region



*Climate science makes clear that the frequency and severity of storm events will increase the potential for unprecedented rapid changes in Great Lakes levels. (Photo: Holly Wright/FLOW)*

Chapter 21 of the National Climate Assessment addresses the impacts to the Midwest, including the Great Lakes Region.<sup>19</sup> The NCA forecasts increased precipitation with a larger percentage of annual rainfall occurring in heavy precipitation events. Periods of intense rain will result in more

flooding, increasing soil erosion and nutrient loadings to tributary streams and rivers. More precipitation will also increase the frequency and amount of sewage overflows and further the propagation of algae, including cyanobacteria resulting in declining water quality and beach health. Warming of the



*More precipitation will also increase the frequency and amount of sewage overflows and further the propagation of algae, including cyanobacteria resulting in declining water quality and beach health. Warming of the Great Lakes will likely increase lake stratification and delay the seasonal lake water “mixing” that serves to resupply oxygen and nutrients to lake ecosystems.*

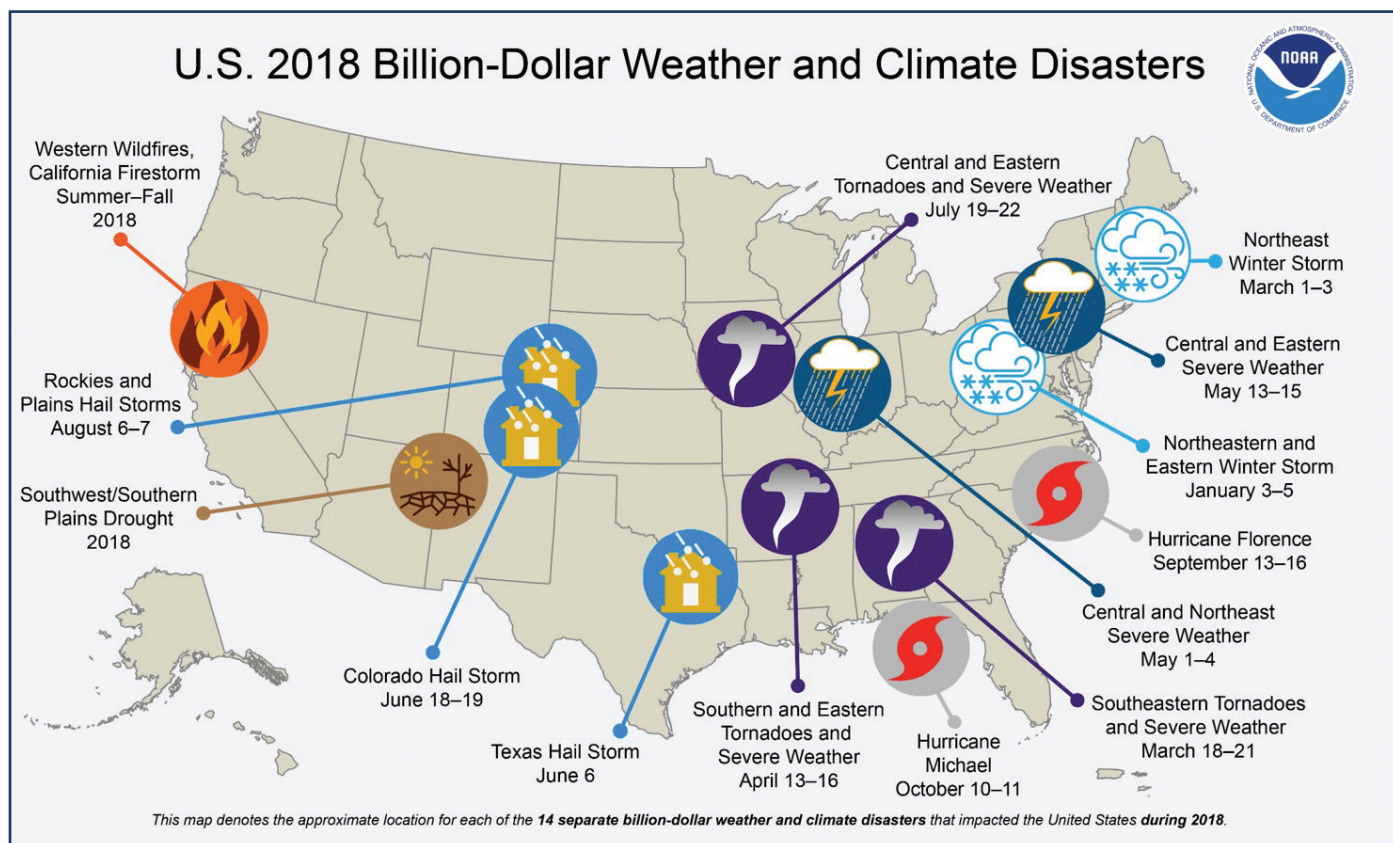
Great Lakes will likely increase lake stratification and delay the seasonal lake water “mixing” that serves to resupply oxygen and nutrients to lake ecosystems.

Warmer lake water temperatures will affect the distribution of fish by advantaging warm-water species over cold-water species, change aquatic plants and benthic communities, and accelerate eutrophication. There is uncertainty as to whether Great Lakes levels will rise or fall in response to climate change as increases in precipitation may be offset by increased evaporation from higher temperatures and reduced ice cover. Modeling suggests that long-term lake levels may be reduced by 6 inches.<sup>20</sup> Climate science makes clear, however, that the frequency and severity of storm events will increase the potential for unprecedented, rapid changes in Great Lakes levels.<sup>21</sup>

The Michigan Department of Health and Human Services

(MDHHS) Climate and Health Adaptation Program in partnership with the Great Lakes Integrated Sciences Assessments Program (GLISA) has assessed potential health effects from climate change, identifying an array of health impacts Michigan will likely experience in the new future:

- Respiratory diseases from air pollution and more allergenic pollen.
- Heat Illness from air mass stagnation, high humidity, and prolonged heat waves.
- Water-borne diseases from flooding, sewage overflows, septic failures, and development of harmful algal blooms.
- Vector-borne diseases associated with warmer winters, earlier springs, and warmer summers, conditions suitable for infectious disease, mosquito and tick vectors.





# MONETIZING THE CLIMATE CRISIS

The increasing severity and frequency of storm events and drought attributable to climate change are destabilizing crop production and commodity markets. The National Atmospheric and Oceanic Administration (NOAA) reports that in 2018, the U.S. experienced 14 weather and climate-related storm events each causing more than \$1 billion in costs, with the aggregate amount of damages estimated at \$91 billion.<sup>22</sup> Morgan Stanley estimates that climate-related storm events in the last three years resulted in \$415 billion in damages in the United States alone.<sup>23</sup> The Intergovernmental Panel on Climate Change (IPCC) reports that global warming

may inflict \$54 trillion in damages to the global economy by 2040.<sup>24</sup> In the absence of significant global efforts to reduce greenhouse gas emissions and implement adaptation measures, the NCA projects the U.S. economy may contract by 10 percent.<sup>25</sup>

Climate change will diminish natural capital and reduce the productivity and output of the ecological services on which we all depend. But many of the worst projected impacts of climate change can still be avoided. Acting now to decarbonize the global economy would yield massive economic and social benefits.

## The Economic Benefits of Addressing Climate Change

There is a remarkable consensus within the scientific community as to what actions must be taken to avoid the worst effects of climate change. The United Nations Intergovernmental Panel on Climate Change (IPCC) 5th Assessment – a report to guide international governmental policymaking, is unequivocal in its findings:

*“Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.”<sup>26</sup>*

The product of hundreds of scientists operating in climate-related fields reviewing thousands of scientific papers, the findings and recommendations of the IPCC’s 5th Assessment are categorical – continued systemic changes to the climate system can only be arrested by decarbonizing the global economy.

Similarly, the consensus of the hundreds of scientists who collaborate in producing the National Climate Assessment are in full concurrence with the IPCC:

*“Achieving the [low emission scenario] path would require substantial decarbonization of the global economy by century’s end, implying a fundamental transformation of the global energy system”<sup>27</sup>*



*The costs of renewable energy, particularly solar, wind, and energy storage, are falling dramatically and far faster than experts predicted. (Photo: Wikimedia Commons)*

The good news is that there is also a strong consensus, supported by a growing body of literature, that the global transition to clean energy will not only reduce greenhouse gas emissions, but will also result in trillions of dollars in economic benefits over time.

The International Renewable Energy Agency (IRENA) recently released report, *Global Energy Transition, Roadmap to 2050*, estimates the economic benefit of the global energy transition would range from \$65 - 160 trillion by 2050.<sup>28</sup>

*“For every USD 1 spent for the energy transition, there would be a payoff of between USD 3 and USD 7 – or, put in cumulative terms over the period to 2050, a payoff of*



*between USD 65 trillion and USD 160 trillion. . . . The level of additional investments needed to set the world on a more climate-friendly path above current plans and policies is USD 15 trillion by 2050 – a significant sum, but one that decreased by over 40% compared to the previous analysis due in large part to rapidly falling renewable energy costs.”*

The costs of renewable energy, particularly solar, wind, and energy storage, are falling dramatically and far faster than experts predicted. In 2013, wind and solar were the least expensive new source of power in only one percent of the world. Today, only six years later, wind and solar is the cheapest new energy source in two-thirds of the world.<sup>29</sup> By 2030, electricity from wind and solar will be cheaper than electricity from *existing* coal and natural gas plants worldwide.<sup>30</sup> The economics of clean energy are so compelling that multinational companies like Google, Apple, Facebook, Intel,

GM, Dow Chemical, and many others have committed to power all of their global operations with renewable energy.<sup>31</sup> The International Energy Agency (IEA), which provides policy guidance on energy issues to the 36 member states of the Organization for Economic Co-operation and Development (OECD), estimates that decarbonizing the global economy would yield *net savings of \$71 trillion* by 2050 in avoided fossil fuel costs alone.<sup>32</sup>

Despite the compelling economics, there are formidable economic and institutional forces at play that are resisting the transition to clean energy. The energy transition is disruptive and established economic interests in the energy and financial sectors are at risk. “Business as usual” and preservation of the status quo is the operative strategy to long-established vested interests. The role of government in advancing clean energy and accelerating the transition from fossil fuels, therefore, is paramount.

## Government’s Role in Accelerating the Energy Transition

In the year 2000, members of the National Academy of Engineers (NAE) were asked, “What is the greatest engineering accomplishment of the Twentieth Century?” The answer may surprise. In a century that witnessed the transition from horses to interplanetary spaceflight in transportation, and from crude telephones to a wireless internet in communications, there were many candidates for the greatest engineering achievement.

The NAE members ranked nuclear power and splitting the atom 19th; space exploration 12th; the advent of computers 8th; and the automobile 2nd. According to the surveyed engineers, the greatest engineering achievement of the 20th Century was electrification and the electric grid.<sup>33</sup> The interconnected network of power generating stations, transmission lines and distribution wires radically changed all aspects of society, enabling all the technologies in the modern world. Lighting, refrigeration, transportation, communications, food production, and entertainment are all dependent on the continuous flow of electricity provided by utilities.

The global power system became so effective and reliable that its basic design of burning fossil fuels supplemented by hydropower and nuclear energy remained essentially unchanged throughout the 20th Century. But decades of operating one basic power system design rendered the utility sector complacent and resistant to change. As natural monopolies, sanctioned by law, with captive customers and guaranteed rates of return authorized by public utility commissions, utilities had no incentives to change business models. Nor did public utility commissions



Photo: SaskPower/Flickr

### GOVERNMENT INTERVENES TO CONNECT THE COUNTRY

Rural electrification, in particular, was a huge challenge in the national enterprise of building out the grid. It made no business sense to sink poles and string wires to connect remote homes and farms. The cost greatly exceeded any possible return from the sale of electricity. Government intervened in the creation of the Rural Electrification Administration (REA) – forming electric cooperatives that connected even the remotest parts of our nation to the power grid. The REA provided loans to cooperatives, but there were no extraordinary charges assessed to farmers for building out the grid. The cost of rural electrification was rolled into rates and the added cost of serving rural and remote end users was paid by all of us. A similar intervention by government would enable universal broadband access throughout the United States.



encourage research and development in new technologies. Continued capitalization and long-term investment in fossil fuel power infrastructure designed to operate for a half century has slowed the effort and compounded the problem of transitioning to clean energy technologies.

## INTEGRATED RESOURCE PLANNING

It took government interventions in terms of legal mandates, tax policies and incentives to refocus the utility sector – a task that is still ongoing. Thirty-three states have laws and regulations mandating “integrated resource planning” (IRP), a requirement that utilities plan future investments in electric generation infrastructure and energy efficiency programs in order to meet future power needs.<sup>34</sup> IRPs require utilities to anticipate future energy demand, assess evolving energy technologies, and take into account policies like greenhouse gas emission reduction standards when making investments. IRPs are typically required to be updated every 3 – 5 years and have forward-looking planning horizons of at least ten years.

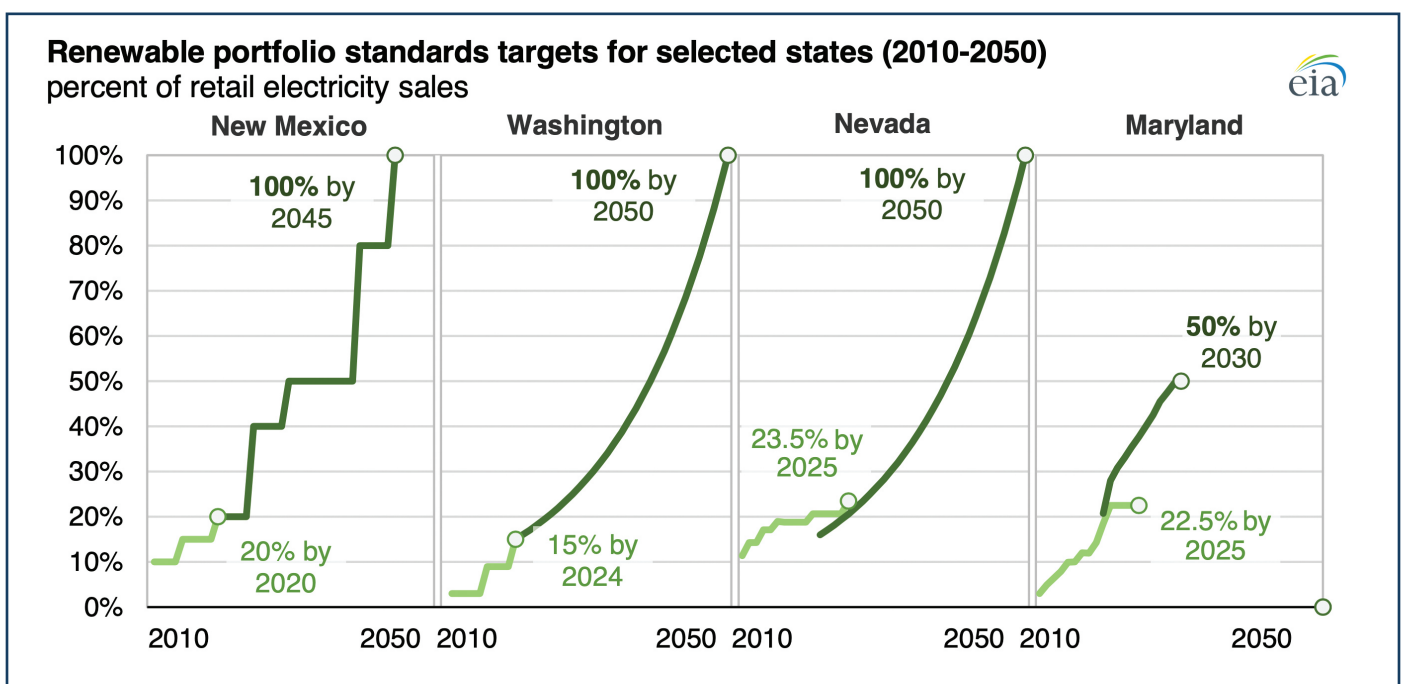
## RENEWABLE ENERGY STANDARDS

Twenty-nine states have legally established renewable portfolio standards (RPS) that require a set percentage of electricity to be generated by clean energy sources, typically wind and solar energy, by a date certain.<sup>35</sup> The RPS requirements imposed by states have spurred technological inno-



*Twenty-nine states have legally established renewable portfolio standards (RPS) that require a set percentage of electricity to be generated by clean energy sources. (Photo: Wikimedia Commons)*

ventions and economies of scale that have improved energy outputs and the reliability of these systems while reducing costs. The economics are so favorable that states are increasing their RPS requirements. In 2018, California, the fifth-largest economy in the world, enacted into law a requirement that 100 percent of electricity be generated by zero carbon



SOURCE: U.S. Energy Information Administration

energy sources by 2045. In the first quarter of 2019, New Mexico, Washington, and Nevada revised their RPSs to require 100-percent renewable electricity, joining Hawaii, the first state to mandate 100 percent renewable electricity in 2015.

In Michigan, House Bill 6466 would increase renewable electricity requirements incrementally from the current 15 percent by 2021 to 25 percent by 2025, 50 percent by 2032, 75 percent by 2040, and 100 percent by 2050.<sup>36</sup> Though that legislation is unlikely to move anytime soon, newly elected Governor Gretchen Whitmer is on record supporting a 100 percent renewable energy requirement.<sup>37</sup> Meanwhile, Senator Tom Udall (D-N.M.) has introduced a bill in Congress that would establish a RES (renewable energy standard) for all states by 2035.

## TAX POLICIES

Government's strategic support for the energy transition includes tax policies, and temporary subsidies to help stimulate renewable energy growth by improving the economics for renewable energy project developers as well as benefiting the manufacturers of renewable energy technologies.

The "production tax credit" (PTC) provides a tax credit of 2.3 cents for every kilowatt of electricity produced by a wind turbine for a period of ten years.<sup>38</sup> The PTC has had to be reauthorized periodically by Congress and is now being phased out. Absent Congressional reauthorization, the PTC will not be available for projects initiated after 2019. Congress has

provided the solar industry with an "investment tax credit" (ITC) for the installation of solar energy projects that allows a 30-percent reduction in tax liability. The ITC is available for residential, commercial, and utility solar systems but will be reduced over the next two years, reaching 10 percent in 2022.<sup>39</sup> In addition to the PTC and ITC, federal tax law provides for accelerated depreciation of wind and solar projects that further enhance the attractiveness of renewable energy projects to investors and developers.

That being said, federal tax laws favor fossil fuel development over investment in clean energy. Renewable energy tax credits have always had expiration or "sunset" dates built into them, requiring affirmative acts by Congress to reauthorize the tax credits, sometimes on a yearly basis. Clean energy investment has fluctuated with the availability of federal tax incentives, resulting in an up-and-down pattern of investment. The tax breaks for fossil fuels, on the other hand, are hardwired into the tax code and continue indefinitely in the absence of Congressional action to limit or terminate them.

Despite providing imperfect market signals to investors in clean energy, renewable energy technologies have matured and improved so dramatically that subsidies for renewable energy will no longer be needed in the future. Although fossil fuel development will continue to be heavily subsidized, the environmental, health, and climate benefits accruing from clean energy will continue, with the rewards flowing from the energy transition going far beyond the avoidance of higher fossil fuel costs.

## The Global Benefits of Clean Energy

Renewable energy brings significant societal benefits to vulnerable populations, particularly the 840 million in the global population that are without electricity today<sup>40</sup> but to whom electrification from solar and wind energy represents the first critical step in meeting the most basic human needs in sanitation, food, water, and education. Eradicating energy poverty is fundamental to improving the quality of life for the 3 billion people who still cook with kerosene, wood charcoal, and dung<sup>41</sup> and are without the basic services upon which the modern world depends.

Developing countries will largely forego baseload generating plants and the costly attendant transmission and distribution infrastructure. For developing nations, the electrification revolution is following the same path as telecommunications. As cell phones obviated the need for telephone poles and wires, so distributed energy systems utilizing local clean energy

resources – solar, wind, and energy storage – avert the need for large-scale baseload infrastructure. In this way, electrifying developing nations also presents opportunities for the global reduction of carbon pollution and the broad adoption of clean energy technologies.

Decarbonization of the global economy is now within sight. With the transition to clean energy comes the prospect of preventing the worse effects of climate change on natural systems and the ecological services they provide. Maintaining the health and resilience of natural capital and the productivity of ecological services nature provides is the only pathway to a sustainable future, eradicating endemic poverty in the developing world, and the security and prosperity of all nations. It is also the only means of ensuring intergenerational equity – the moral imperative that we protect the planet for future generations.



# GOVERNMENT'S ROLE IN PROTECTING WATER

**M**ichigan lies at the heart of the Great Lakes, the largest fresh surface water system in the world. Harboring 95 percent of all fresh surface water in United States and 84 percent of all fresh surface water in North America, the Lakes are an enormous source of natural capital, providing direct health, economic, environmental, and ecological services to 40 million people. The Great Lakes system is a magnificent natural endowment. Sculpted by ancient retreating glaciers that left the largest interconnected body of fresh surface water in the world, the Great Lakes are truly globally unique.

We in Michigan are water rich. The Great Lakes support a \$6 trillion regional economy.<sup>42</sup> Water is our most valuable source of natural capital, bestowing billions of dollars in ecological services by providing fresh, potable water for consumption, recreation, agriculture, and industry. Freshwater aquatic ecosystems — our lakes, streams, rivers, groundwater and wetlands — provide drinking water, produce fish, nourish unique biological niches at the land and water interface, and provide diverse recreational opportunities. Wetlands are prolific biological nurseries harboring birds, insects, waterfowl, and aquatic organisms throughout the food chain, while purifying water, storing stormwater, recharging aquifers, and buffering nutrients — essential services that are largely unknown and unappreciated. Great Lakes fisheries alone provide more than \$7 billion in annual economic benefits and support more than 75,000 jobs.<sup>43</sup>

With our water wealth comes special obligations of stewardship. The Great Lakes and their tributary rivers and streams belong to the public and are held in a public trust. Government, as trustee, has the responsibility to protect the trust waters from impairment and cannot allow diminishment of water quantity or water quality. Our people, our businesses, and our economy depend on the health and viability of our Great Lakes, and others less gifted by geography will set their sights on the Great Lakes. There will soon come a time when discussions about human rights in water,



*The Great Lakes are an enormous source of natural capital, providing direct health, economic, environmental, and ecological services to 40 million people. (Photo: Wikimedia Commons)*

growing water scarcity, and the need for a more “equitable” distribution of Great Lakes’ water wealth will elevate in Congress and state legislatures.

A recent study conducted under the Resources Planning Act, a federal law requiring periodic resource assessments on forest lands and rangelands, indicates that of the 204 water basins in the United States, 145 basins will show decreases in yield over the coming decades and nearly half may experience monthly water shortages.<sup>44</sup> While climate change is projected to increase precipitation in some northern regions of the United States, increased frequency of droughts will result in reduced river flows,<sup>45</sup> less reservoir capacity, and decreases in soil moisture.<sup>46</sup> Globally, the situation is much worse. The United Nations reports that today “over 2 billion people live in countries experiencing high water stress, and about 4 billion people experience severe water scarcity during at least one month of the year.”<sup>47</sup>

Our abundant water resources will increasingly weigh to Michigan’s competitive advantage, but, more likely than not, Michigan will face future challenges from states that will be stressed by inadequate water supplies and who will look to our region with the belief and expectation that our water resources need to serve a larger geography. Our water wealth will be certain to attract a broad universe of water-dependent

agricultural, commercial, and industrial private interests as well. At the same time, the chasm between the water rich and the water poor will grow. Great Lakes freshwater resources and the vital services they provide will only increase in value in a future where national and international water supplies become more stressed and attenuated.

Government, as the fiduciary charged with the protection of public trust resources, must use the tools and resources it has in terms of laws, regulations, and best practices to conserve and protect our water as a *public* good. Greater public understanding of the vital services water resources provide would empower citizens to participate more effectively in the political process and demand that policymakers and legislators take active measures to protect water. Intelligent, sensible water management and conservation practices and effective application of laws and regulations on the part of government to protect the waters upon which we all depend are imperative. Ultimately, our le-



*Great Lakes fisheries alone provide more than \$7 billion in annual economic benefits and support more than 75,000 jobs.*

gal and moral authority to resist appropriation of our water wealth will be a function of how adept and effective we are as Great Lakes stewards in the conservation and protection of our waters.

And we must learn from our mistakes.

**BENEFICIAL SERVICES FROM WETLANDS:  
Michigan Wetlands Protection Act (1979) — Legislative Findings**

The legislature finds that:

- Wetland conservation is a matter of state concern since a wetland of 1 county may be affected by acts on a river, lake, stream, or wetland of other counties.
- A loss of a wetland may deprive the people of the state of some or all of the following benefits to be derived from the wetland:
  - Flood and storm control by the hydrologic absorption and storage capacity of the wetland.
  - Wildlife habitat by providing breeding, nesting, and feeding grounds and cover for many forms of wildlife, waterfowl, including migratory waterfowl, and rare, threatened, or endangered wildlife species.
  - Protection of subsurface water resources and provision of valuable watersheds and recharging ground water supplies.
  - Pollution treatment by serving as a biological and chemical oxidation basin.
  - Erosion control by serving as a sedimentation area and filtering basin, absorbing silt and organic matter.
  - Sources of nutrients in water food cycles and nursery grounds and sanctuaries for fish.
  - Wetlands are valuable as an agricultural resource for the production of food and fiber, including certain crops which may only be grown on sites developed from wetland.



# The Flint Lead Crisis

The lead crisis in Flint, Michigan, is a tragic yet instructive case study demonstrating the limitations and pitfalls in supplanting local governance and regulatory systems with “market principles” aimed at cutting government red tape. A business decision to save money by sourcing the community water supply from the Flint River instead of the Detroit municipal system resulted in government employees at all levels ignoring and overstepping environmental rules designed to ensure healthy and safe public water supplies.

When Michigan Governor Rick Snyder appointed the Flint “emergency manager,” circumventing the Flint mayor and city council, he empowered him to make decisions without due consideration of management procedures and rules governing the operation of the Flint’s drinking water system. The residents of Flint were the victims of malfeasance initiated by a governance philosophy that deliberately short-circuited regulations and protocols designed to ensure drinking water was safe and human health was protected.

The first governor-appointed emergency manager, Darnell Earley, initially resisted switching sources of Flint’s water supplies from the Detroit municipal system to the Flint River but eventually relented. Earley was informed that the switch would require treatment of the water to meet regulatory criteria. The applicable regulation, the Lead and Copper Rule, administered by the Michigan Department of Environmental Quality (MDEQ), required the City of Flint to: (1) develop and maintain an inventory of lead service lines needed for sampling, and (2) maintain corrosion control treatment after the water source switch in April 2014.<sup>48</sup> The MDEQ did not enforce the regulations, and EPA failed in its oversight role.<sup>49</sup> As a result, children and adults ingested

## THE ECONOMIC COST OF LEAD

A new online tool estimates the lifetime economic cost of lead exposure for children born in 2019. The tool, designed for state and local community leaders, quantifies the lifetime health care costs, diminished productivity and earnings, mortality and morbidity. The economic burden to Michigan households, the private sector, and the federal and state governments is estimated at \$2.3 billion for the 2019 cohort of children alone. The aggregated costs attributable to lead exposure for children born before and after 2019 constitute an immense economic and social encumbrance that is unlikely to inform public policy or decision-making, yet imparts profound consequences for families, communities, and governance.

*Source: <http://valueofleadprevention.org>*

lead, a potent neurotoxin,<sup>50</sup> and a community was devastated and irreparably altered, socially and economically.

Regulatory frameworks, in addition to protecting health, safety and the environment, promote consistency and public accountability in decision making. When properly administered they foster transparency, public participation, and inclusion. The key lesson from the Flint water crisis is that ignoring regulatory safeguards can have devastating and catastrophic effects. The events in Flint would have been avoided if fundamental principles of good governance were not supplanted by politicians who valued expediency and cost-cutting measures over safeguarding public health, and safety.

# PFAS and Groundwater Contamination

PFAS is an abbreviated term for a group of man-made chemicals in the fluorine family that includes PFOA, PFOS, GenX, and many other chemicals. Dubbed “forever” chemicals, PFAS have been manufactured and used in a variety of applications including food packaging, non-stick surfaces, carpets, waterproofing, and fire-fighting foam. PFAS chemicals bioaccumulate and do not readily breakdown.

The health effects of PFOS and PFOA have been more widely studied than other per- and polyfluoroalkyl substances.<sup>51</sup> Studies in humans have shown that certain PFAS may affect growth, learning, and behavior of infants and older children,

lower a woman’s chance of getting pregnant, interfere with the body’s natural hormones, increase cholesterol levels, affect the immune system, and increase the risk of cancer.<sup>52</sup> The Centers for Disease Control and Prevention has found that nearly all Americans have detectable levels of PFAS chemicals in their bodies.<sup>53</sup>

The companies that manufactured and used PFAS knew of its chemical properties and health effects early on. *The New York Times* reports that Dupont commenced secret testing of PFOA in the 1970s, finding possible health effects in its employees. By the 1990s, Dupont’s own research showed

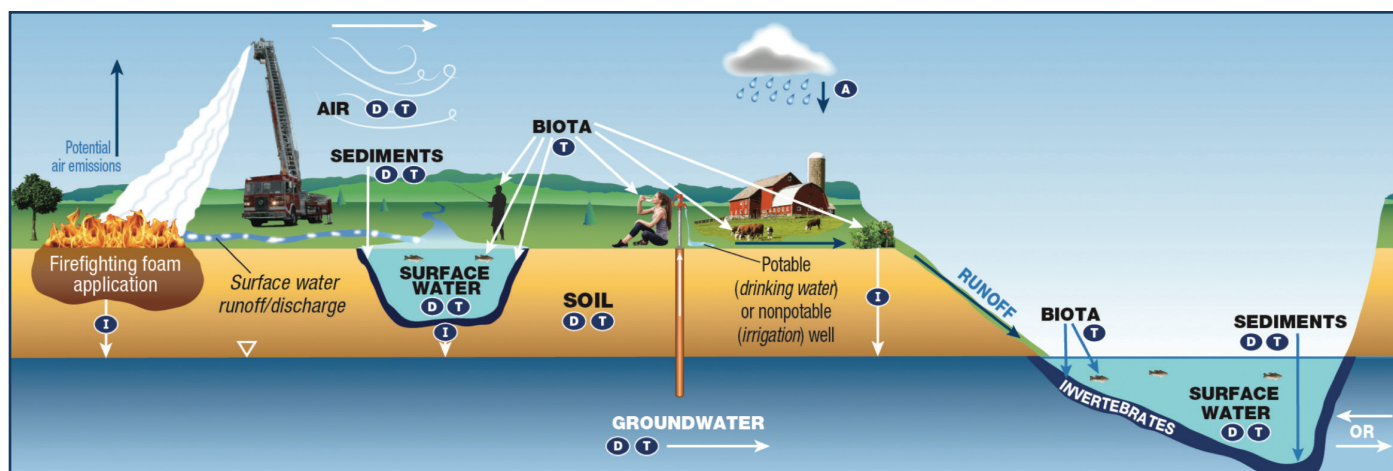
that PFOA may result in damage to DNA and cause testicular, pancreatic, and prostate cancer.<sup>54</sup> Documents disclosed as a result of a lawsuit filed by the Minnesota Attorney General's Office suggest that 3M Corporation, the company that invented and manufactured PFAS and sold it to Dupont, concluded that PFOS was "toxic" based upon animal studies, but deliberately concealed the results of that research as well as studies that showed its employees' health had been impaired.<sup>55</sup>

Michigan has the highest number of known sites of PFAS contamination.<sup>56</sup> There are 610 known locations of PFAS contamination nationally, almost one-third (192) are located in Michigan. The disproportionality is due to the broad and aggressive campaign Michigan has undertaken to investigate

and identify PFAS contamination in the environment – an effort necessitated when it became public that a detailed PFAS report identifying the public health threats from PFAS written by an MDEQ professional had been ignored for six years by the same administration responsible for the Flint crisis.<sup>57</sup>

The root cause of the PFAS crisis is a failure to adequately regulate the manufacture, testing, and use of chemicals that have adverse effects on human health and the environment, as well as laws that require, under threat of criminal sanctions, the public disclosure of information of such information. Unfortunately, PFAS contamination of our waters is only the tip of the iceberg.

Michigan has pervasive and expanding groundwater contamination statewide.



Graphic by L. Trozzolo, Interstate Technology Regulatory Council

## Groundwater Contamination in Michigan – The Hidden Menace

Groundwater contamination in Michigan is pandemic. As documented in FLOW's landmark report, *The Sixth Great Lake: The Emergency Threatening Michigan's Overlooked Groundwater Resource*,<sup>58</sup> Michigan's groundwater is imperiled. A resource upon which 45 percent of Michigan residents rely for drinking water, this vast invisible yet critical resource underlying the land area of the Great Lakes Basin contains as much water as Lake Huron. As of August 2019, 17,188 sites of known environmental contamination have been identified in Michigan. These sites are the legacy of 150 years of essentially unregulated disposal of industrial wastes, oils, chemicals, solvents, and other hazardous substances that have leached into aquifers and contaminated our groundwaters. The database maintained by the Department of Environment, Great Lakes and Energy (EGLE) indicates there are 8,143 sites with

active leaks of petroleum products from underground storage tanks (LUSTs).<sup>59</sup> Five counties alone – Wayne, Oakland, Genesee, Macomb, and Kent – have more than 3,400 leaking underground storage tanks (LUSTs).

For the vast majority of these contaminated sites, no active measures will be taken to clean up these sites or even to assess the threats posed to human health and the environment. According to a 2017 report by the Office of Auditor General, there are 6,477 contaminated sites identified by the Michigan Department of Environmental Quality (predecessor to EGLE) in its Environmental Cleanup and Redevelopment Program (ECRP). The MDEQ was only able to prioritize 291 sites for action. However, because of lack of funding, the MDEQ suspended or had not begun cleanup at 245 of the 291 sites, and did not have the resources to commence even



an initial assessment at the remaining 6,186 sites of known contamination.<sup>60</sup>

The fact that Michigan is without funding to track, investigate, or remediate these sites means they will worsen over time. When contaminants reach the water table, they penetrate the aquifer, dispersing the hazardous substances in groundwater. Groundwater is not static – it flows slowly through the spaces within soils, sands, and rock, transporting pollution along with the movement of groundwater. As groundwater flows, the contaminated area within the aquifer will expand, increasing in size, and becoming more intractable and difficult to remediate. As a consequence of the ever-broadening plumes of contamination, each site will also become more expensive to clean up.

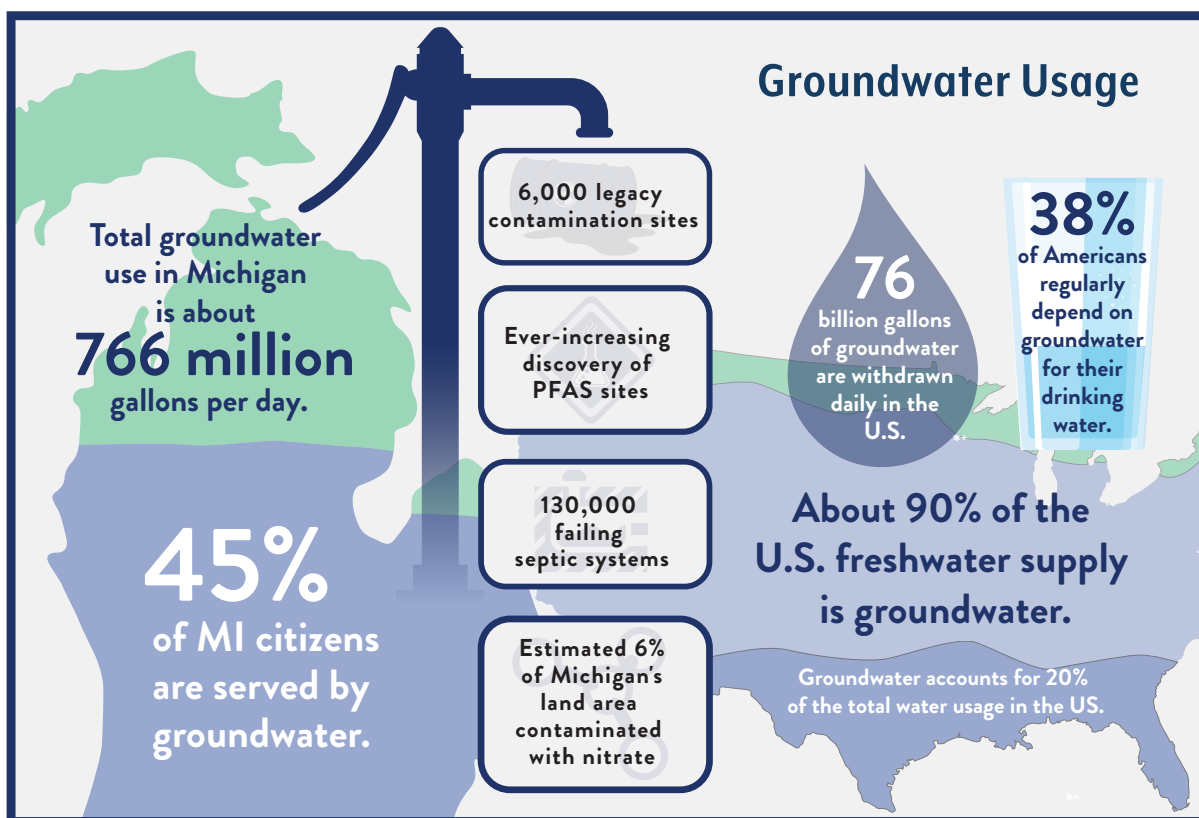
As threatening and unmanageable as this situation is, the legislative response made it much more difficult to clean up environmental contamination. In 1995, legislative changes to Michigan's "polluter pay" law reduced the number of liable parties and allowed contaminated groundwater to go untreated if the risk of human exposure was reduced.<sup>61</sup> Instead of cleaning up contaminated groundwater, responsible parties could instead rely on restrictions on the use of property and associated contaminated groundwater. "Restrictive covenants" and institutional controls prohibiting or limiting the use of land and groundwater contaminated with hazardous substances could now be substituted for active cleanup of

contamination, allowing by default, the continuous expansion of contaminated groundwater.

These changes assured that far fewer responsible parties would expend far fewer dollars on remedial actions and that the responsibility for the oversight, management, and cleanup costs of contaminated sites and associated groundwater would be shifted from actual polluters and abusers of ecological services to the public and future generations.

To make matters even worse, on his last day in office, Governor Snyder signed into law Senate Bill 1244, which further weakened cleanup standards and actually wrote into law "scientific findings" that certain dioxins - polychlorinated dibenzodioxin and dibenzofuran congeners - could be left in soils because there was little risk of them contaminating groundwater.<sup>62</sup> The bill, enacted without public hearings or public comment, was reportedly the work product of a lobbyist for Wolverine Worldwide,<sup>63</sup> the corporation responsible for widespread PFAS contamination of groundwater found in Rockford and Belmont, Michigan.<sup>64</sup>

As it stands today, Michigan, by retreating from its regulatory responsibilities and weakening its rules governing cleanups, is leaving a legacy of groundwater contamination to future generations that will remain unremediated, spreading and metastasizing over time, and affecting human health, the environment, and Michigan's economy in ways that are both obvious and not yet fully understood.



# USING THE PUBLIC TRUST DOCTRINE TO PROTECT GROUNDWATER RESOURCES

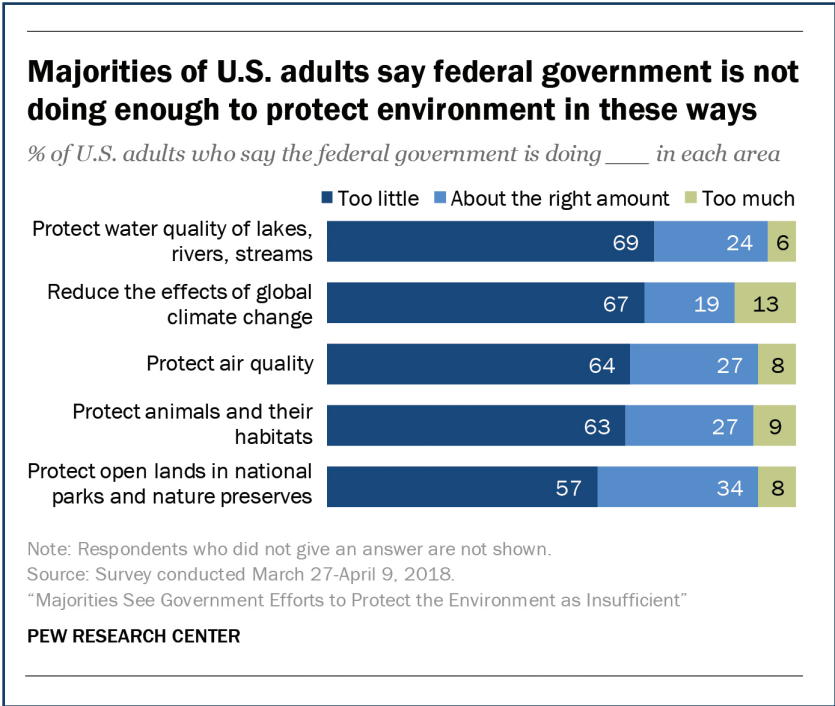
More than 1,000 cubic miles of fresh groundwater underlies the Great lakes Basin.<sup>65</sup> Almost all groundwater ultimately discharges to surface water. It is estimated that groundwater directly and indirectly contributes 80 percent of the surface water flowing from the Lake Michigan watershed into the lake.<sup>66</sup> A vital component of the hydrologic cycle, groundwater nourishes our interconnected wetlands, lakes, rivers and streams; it is the lifeblood upon which most all of nature depends. Groundwater contamination threatens the entire water ecosystem, devaluing the innate natural capital that groundwater resources sustain and diminishing the vitality and functionality of the ecological services that groundwater provides.

By large majorities, Americans have an expectation that government should actively intervene to protect the environment. According to a 2018 survey by the Pew Research Institute, 69 percent of Americans indicate that the federal government is not doing enough to protect water quality, and 67 percent believe government measures to reduce the effects of climate change are inadequate.

The Public Trust Doctrine provides a necessary and appropriate means of redressing decades of inadequate public protection of water resources and weakened government regulation. The Doctrine imposes an obligation upon government, as trustee of Michigan’s water resources, to address and eliminate external conditions that may directly or indirectly harm surface waters. In the words of the Michigan Supreme Court, the Doctrine ordains “a high, solemn and perpetual duty”<sup>67</sup> to protect the waters of the Great Lakes and its navigable rivers and streams from harm or impairment.

The complexity and interconnectedness of ecological systems require the application of legal principles that are capable of adapting to new scientific understanding. “As our understanding of ecology progresses, it becomes clearer how traditional public trust resources are interrelated with and dependent on ecosystems.”<sup>68</sup> Science now demonstrates that groundwater is part of an integrated hydrological system nourishing wetlands, lakes, rivers, and streams as it ultimately

discharges to surface water. The Great Lakes Compact administered under the auspices of the International Joint Commission (IJC) declares that the “waters of the Basin are precious public natural resources held in trust,” and are part of an “interconnected single hydrologic system.”<sup>69</sup> In addition to the IJC, others states have embraced an expanded application of the Public Trust Doctrine applying it to limit conditions or activities that would degrade or harm groundwater because of the well-established scientific consensus finding that contaminated groundwater will ultimately impact and potentially impair navigable waters.



Safeguarding water resources and the ecological services they provide will become more challenging in a world where rising demand encounters growing water scarcity. Escalating future demand and competition for water resources, intensified by a warming climate, will enhance the value of Great Lakes water, potentially increasing the chasm between the water rich and water poor. An expanded application of the Public Trust Doctrine could act as a shield to protect water resources against activities that would reduce the quantity or quality of water or threaten to diminish or reduce the value of



the ecological services the waters provide to the public. A broadened application of the Public Trust Doctrine could also command a duty of ensuring water equity, as all waters belong to the public with no person's right to water being greater than another's.

An expanded Public Trust Doctrine could be used to enjoin discharges of toxins and hazardous substances at their source, including the nutrient loadings and non-point source contamination responsible for the cyanobacterial algae blooms in Lake Erie, which, unless rectified, will cost the Lake Erie economy an estimated \$272 million a year for the next 30 years.<sup>70</sup> It has also been suggested that the Doctrine should now be used to accelerate the transition to clean energy by compelling reductions in the loadings of mercury, other heavy metals, and acid gases from fossil fuel power plants.<sup>71</sup> The deposition of these hazardous substances from the combustion of fossil fuels pollutes all waterbodies in the Great Lakes Region – conditions that are no longer necessary in light of the availability of low-cost, zero-carbon energy sources.

Policymakers must come to recognize the importance of applying the Public Trust Doctrine to modern societal needs and the imperatives of evolving science. The Public Trust Doctrine should inform the administration and judicial



*An expanded Public Trust Doctrine could be used to enjoin discharges of toxins and hazardous substances at their source, including the nutrient loadings and non-point source contamination responsible for the cyanobacterial algae blooms in Lake Erie.*

*(Photo: Wikimedia Commons)*

interpretation of environmental statutes and administrative rules so that the public interest in water resources is vindicated and protected and the benefits and ecological services water resources provide are not diminished, but maximized. The best pathway forward would expand application of the Public Trust Doctrine as a framework to sustainably manage our water wealth, protect water resources from future threats, inform future legislative action, and provide a definitive legal doctrine that courts can apply consistently for the benefit of the public.

*“A possible answer is the immediate adoption of a new narrative, with principles grounded in science, values, and policy, that views the systemic threats we face as part of the single connected hydrological whole, a commons governed by public trust principles. The public trust is necessary to solve these threats that directly impact traditional public trust resources like the Great Lakes and its tributary waters. The most obvious whole is not a construct of the mind, but the one in which we live – the hydrosphere, basin, watershed, through which water flows, evaporates, transpires, is used, transferred, and is discharged in a continuous cycle. Every arc of the water cycle flows through and effects and is affected by everything else, reminiscent of what Jacques Cousteau once said, ‘We forget that the water cycle and the life cycle are one.’”*

~Jim Olson<sup>72</sup>

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**FLOW (For Love of Water) is working to build deeper awareness among all stakeholders—including groups, governments, and citizens—regarding the public trust framework that protects the Great Lakes.**

## **ABOUT THIS REPORT**

This paper is the second of four policy briefs that elaborate the critical role government policy and government protections play in safeguarding human health and the environment. The first policy brief – *Resetting Expectations: Government’s Role in Protecting Human Health and the Environment*, demonstrated that the benefits of government protections are both measurable and overwhelmingly favorable in the realm of environmental protection, where the quantifiable benefits of protections greatly exceed the costs imposed on business and the economy.

This paper advances a complementary theme: Nature and ecological systems provide trillions of dollars in annual benefits to humanity. The Great Lakes and their tributary rivers and streams, wetlands, and groundwater – the largest fresh surface water system in the world – are an immense source of natural capital that will become increasingly valuable as the accumulating effects of climate change stress the global environment and worsening water scarcity draws attention to the water wealth of the Great Lakes Region.

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