



**Field Notes:**  
**Extreme Weather and Community Resilience**

**2012 DROVE HOME THE VULNERABILITY OF OUR NATION TO EXTREME WEATHER EVENTS**

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**Even though we had read the climate projections for flooding in coastal cities, we were all startled when the Atlantic Ocean invaded New York.** How could a rich, sophisticated, powerful city — a world center of finance and urban efficiency — be brought to its knees by water? Well, just like this:



**Hurricane Sandy: Oceanic Storm-Surge Floods the New York City Subway**  
Photo Credit: The Globe and Mail

By the time Hurricane Sandy moved offshore, the oceanic floodwaters had turned New York subway stations and tracks into underground lakes. Commerce in New York City and New Jersey ground to a crawl due to road and tunnel flooding, structural damage, and power outages. At least one hospital had to be evacuated. Many workers couldn't get to their jobs. Residents and office workers alike puffed up stairs because power was off in tall buildings. In the midst of the deluge, fires erupted in a Queens community that destroyed an entire neighborhood.

Sandy's massive storm system drove the Atlantic Ocean ashore and sent oceanic storm-surge flooding into New York and New Jersey.



**Sandy: Ocean Where Formerly was Land** (Photo Credit: U.S. Coast Guard)

Inland river floods from Sandy's torrential rains stretched from Ohio to the New England states, destroying roads and isolating communities. In addition to the loss of lives, the loss of property values in hard-hit communities will continue to have a domino effect on homeowners, businesses and communities for years to come.

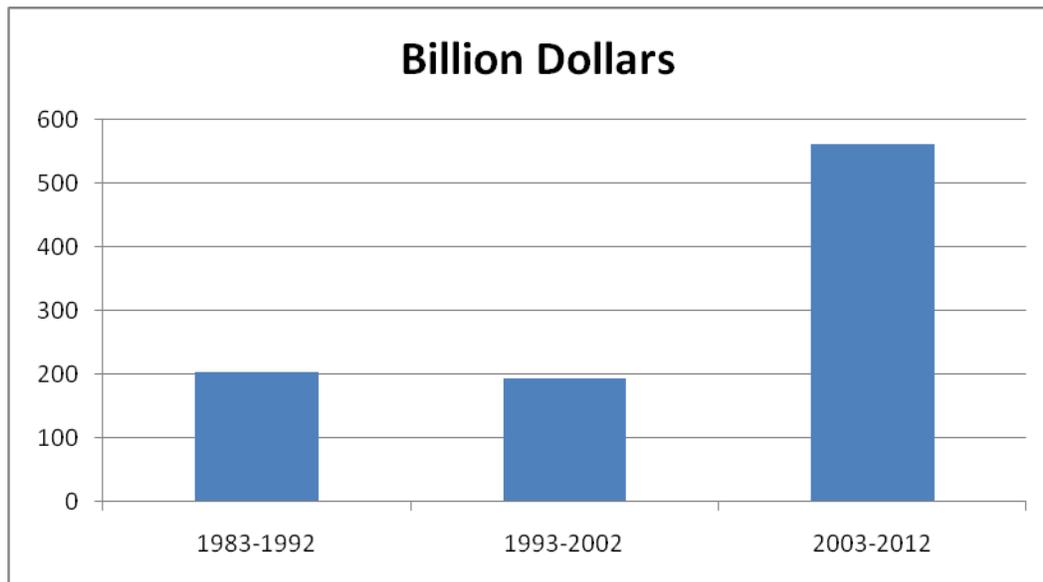
### **2012 Recorded the Second Highest U.S. Damage Costs from Extreme Weather Since 1980**

According to NOAA's [National Climatic Data Center](#): "2012 saw 11 weather and climate disaster events each with losses exceeding \$1 billion in damages...This makes 2012 the second costliest year since 1980...The 2012 total damages rank only behind 2005..."

### **The 2003-2012 Decade—an Unwelcome Surge Higher than the Previous Two Decades Combined**

During the single decade of 2003 to 2012 [2012 is the most-recent year for final National Oceanographic and Atmospheric Administration ([NOAA](#)) data], the U.S. sustained total damages estimated at \$561.4 billion (adjusted to 2013 Cost Price Index) from extreme weather events. This is \$163.3 billion more and nearly 2.8 times the costs from extreme weather damage during the previous two decades (1983 to 2002). On a decadal comparison basis, damages during 2003-2012 exceeded the 1993-2002 decade by \$367.6 billion and the 1983-1992 decade by \$357.1 billion.

While the damage cost totals are sobering, there is an even more telling statistic: From 2003 to 2012, the nation experienced 70 extreme weather events that each caused damages exceeding a billion dollars. In the single 2003-2012 decade there were as many billion-dollar events as in the entire previous 20 years. The 10-year frequency of billion dollar extreme-weather events doubled in a single decade.



**U.S. EXTREME WEATHER DAMAGE – COSTS FOR THREE CONSECUTIVE DECADES FROM 1983 THROUGH 2012** (RRI graph, based on NOAA data; costs adjusted to 2013 CPI values)

This unprecedented surge in the costs of weather damage puts teeth in the national perception that soaring weather damages are unsustainable burdens for communities, agriculture and the broader economy. The emerging scientific understanding is that, due to the extent of existing climate disruption, we are already committed to more such extreme weather events. This potential forces us to take a harder look at the preparedness of our communities.

Dramatic increases in weather damage are also forcing reassessment of casualty, flood and crop insurance programs. Homeowners, businesses and communities are already seeing insurance rates increase, even soar in some locations, creating a huge dilemma for many as to how they can afford even basic weather-related insurance.

### **U.S. Residents Now Have a Sharper Awareness of How Extreme Weather Risks Can Damage Their Homes and Families, Communities and Local Economies**

The U.S. no longer enjoys the fairly benign and predictable weather we saw in the 20th century. During the past decade the news reports of severe damage—whether from floods, wildfires, drought, rain or snow— too often brought shocking accounts of the disruption of lives and damage to homes and communities. For instance, in 2012 television brought into every home the searing images of the record wildfires in the Southwest and West, including the fires in Colorado that swept from drought-dried forests into neighborhoods.



2012 – Colorado Wildfires (Photo Credit: The Denver Post)

2012 saw media coverage of the historic flooding in the Missouri, Ohio and Mississippi river basins, which had dominated the news in 2011, fade away under the pressure of a fast-developing, severe agricultural drought across the Plains, South and Midwest that rivaled “Dust Bowl” conditions.

Whether by hurricane, flooding, drought or wildfire, the vast majority of Americans personally experienced some type of extreme weather that disrupted their lives and damaged their communities and economies.

### **Graphic Media Coverage of Weather Disasters can Motivate, not Depress**

As distressing as those experiences were, communities have responded in very different ways. Many communities have not become proactive because they focused on the disproportion between the sheer size of weather systems when compared with their limited resources to reduce the severity of the weather.

Other communities have recognized that reducing the causes of climate disruption, on a scale big enough to be effective, must be an urgent first priority for leadership by state and federal levels of government. They see that the challenge for their community is to use their existing and extensive educational, economic and regulatory tools—such as land-use planning, zoning, building standards, emergency response, public health and economic development—to adapt to these new weather conditions. Through such planning, these communities are developing greater confidence in their ability to reduce community vulnerability to weather and thereby minimize damage.

### **Climate Scientists Agree: Community Decisions that Place High-Value Buildings and Infrastructure in Weather-Vulnerable Locations Are Currently the Primary Drivers of Soaring Economic Losses**

The Intergovernmental Panel on Climate Change (IPCC) is the primary compiler of scientific information on global climate disruption. In 2012 the IPCC published a special report entitled [Managing The Risks of Extreme Events and Disasters to Advance Climate Change Adaptation \(SREX\)](#) that concluded:

*“Economic losses from weather- and climate-related disasters have increased... exposure of people and economic assets has been the major cause of long-term increases in economic losses from weather and climate-related disasters...Transportation, infrastructure, water and tourism are sectors sensitive to climate extremes. Transport infrastructure is vulnerable to extremes in*

*temperature, precipitation/river floods, and storm surges, which can lead to damage in road, rail, airports, and ports, and the electricity transmission infrastructure is also vulnerable to extreme storm events.”*

The IPCC published the SREX report precisely because the severity and frequency of extreme weather are accelerating in countries around the world. Most of the report documents those trends. But the IPCC went further and spot-lighted attention on the most critical factor in today’s weather-damage trends.

Currently the most-decisive factor in weather damage is the continuing, even increasing, practice of building high-value structures in locations that are vulnerable to today’s extreme weather. The SREX report underscores the reality that inappropriate siting decisions by people—by us—are the major driver of soaring economic damage from weather. An apt metaphor might be building a house on a freeway. It is a risky location; and as rush hour traffic increases someone is likely to hit the house.

The conclusion of the SREX report that we are creating the damage problem by weather-inappropriate siting decisions is an extremely useful insight. If people are creating and aggravating the problem, that means that people also have the power to reverse and improve siting decisions in the future and thereby help reduce the vulnerability. Today—right now—we have a readily-available degree of control over weather damage that we may not have at some time in the intermediate future.

Spot-lighting the need to avoid construction that is sited in vulnerable locations addresses a problem we can tackle now. In no way does it imply that improved siting decisions will prevent extreme weather, under further climate disruption, from creating new and expanded zones of vulnerability in the future. What it does mean is that we have some period of time—a temporary window of opportunity—in which to use the control we have to improve upon past land-use and siting decisions. The uncertainty is that we don’t know how long this window of opportunity will continue. Once we pass through it, the expanding scale of new areas affected by extreme weather and the broader extent of weather damage will preoccupy our communities and command our fiscal resources.

### **Remember that Old Saying: “If you find yourself in a hole, stop digging.”**

On a practical level, many communities today are much more vulnerable to one or more weather extremes because past decisions on land use and building standards were based on weather conditions that were common in the 20<sup>th</sup> century. In the 21<sup>st</sup> century, we have moved into a less-predictable, more-extreme weather environment. Since conditions are changing—drastically in some locations—it’s time to stop digging. Today’s land-use decisions must account for the increasing risks and frequency of less-predictable locally-extreme weather. The good news is that there are widely-used approaches to help meet this challenge.

## **Communities Already Have Tools for Adapting to Extreme Weather**

### **New Construction**

A first step for a community could be for land-use planners to consult with local disaster planners about ways to reduce vulnerability to future extreme weather. [N.B., see [Field Notes Multi-Purpose Climate Tool for Communities](#)] Together they can review existing land-use plans and zoning regulations and make changes to minimize safety threats and future damage

in known vulnerable locations (e.g., flood areas or urban/wildfire interface zones). Because such modifications are prospective, any added cost or timing issues can be incorporated into new project planning.

Second, they can review construction standards and upgrade design-safety requirements for buildings, vehicular access, and infrastructure to reduce vulnerability. Some common examples include strengthening roofs and wall-attachments against wind hazards; ensuring adequate fire engine and evacuation routes; using narrower eaves that won't trap wildfire heat, and using fire-resistant roofs and vegetation setbacks in wildfire areas. In flood-prone areas, it may be time to consider elevating new structures, building on raised earthen pads, or building grade-level structures so that the ground floor can be flooded, and ensuring reliable safety access during floods.

### **Challenges for the Already-Built**

The most-difficult decisions will involve already-built structures that are either in unsafe locations or built to standards that are inadequate to withstand changing extreme weather conditions. Communities can examine cases in which safety precautions may require applying new standards to retrofit existing structures (e.g., fire-resistant roofing or stronger roof attachments) and/or to modify existing land management (e.g., vegetation clearance for wildfires).

Vulnerability can also be reduced by relocating or elevating existing buildings and infrastructure (especially ensuring emergency access and safety for essential public facilities such as police, fire, hospitals, energy, water and sewage treatment). FEMA works with communities having vulnerable locations to purchase certain types of structures, from willing sellers, in order to demolish them and create open space. Clearly such actions will require public education and debate, due to resulting issues such as cultural values regarding private property, costs, who pays, and the timing of actions.

### **Cost and Timing will always be Critical Issues. Many Communities that Share a Weather Hazard can Also Share Costs and Staff Time to Identify Best Solutions**

It is commonplace today in the U.S for the majority of communities to experience ongoing fiscal constraints. There is no doubt that towns and counties will struggle to implement weather-protective actions, due to cost concerns about adaptation, sources of fiscal help, and when funding might be available. These factors will vary widely among communities.

In some communities, adaptive actions may be both local and small enough to be implemented relatively simply. For instance, [Cedar Falls, Iowa](#), amended its flood plain zoning in 2010 to specify the 500-year floodplain boundary as the "locally regulated floodplain," a standard that is more rigorous than the typical FEMA 100-year floodplain requirement. Together with a pre-existing 1993 flood zone buy-out program and other measures, this single zoning change represented an effective and forward-looking adaptation to increasing flooding by the Cedar River.

More frequently, several communities share common risks from regional extreme-weather hazards. In those cases, multi-jurisdictional cooperation may be the most effective and least-costly route for adaptation. The following two examples of responses to flooding and sea-level rise illustrate issues and procedures that are also highly relevant to other weather adaptations, such as wildfires:

## Red River of the North

The Red River headwaters arise in the U.S. and flow north. The river forms the state boundary between North Dakota and Minnesota, and flows north into the Canadian Province of Manitoba. It drains a watershed of 45,000 square miles, with 80 percent of the watershed in the U.S.

Flooding of the Red River is unmistakably increasing. Damaging floods have occurred in more than half the years since 2000. During that time, most gauging stations along the river have registered at or close to 100-year flood levels, some more than once in a single year. Tributaries have experienced up to 500-year flood levels.

The Red River Basin Commission, a multi-agency/public organization created to manage river flooding, issued its [Long Term Flood Solutions](#) report to the states of North Dakota and Minnesota in September 2011. The report details useful examples of regional cooperation and identifies significant benefits from a regional approach to flood damage reduction. Two illustrations of practical actions by communities on the Red River might also be useful in any number of U.S. communities:

1. The need for cooperation among agencies and communities along the river. The benefits include sharing staff expertise for better ideas and plans, spreading the costs over many jurisdictions, and sharing resources to improve success in securing state and federal funding for planning and implementation. A critically-important issue discussed in the report is the need to avoid single-city plans that might increase flood damage to others downstream.
2. The need for each community and county to improve its land use and zoning standards and to enforce development requirements in flood zones (e.g., to reduce the granting of variances from those requirements). The benefits include participation in FEMA's Community Rating System, potential reductions in flood insurance costs, and improved access to adaptation funding from state and federal agencies.

## San Francisco Bay

In 2010, the San Francisco Bay Conservation and Development Commission partnered with more than a dozen regional agencies and the NOAA Coastal Services Center to study the future impacts of climate disruption and sea-level rise on the urban eastern shoreline of the Bay. The "[Adapting to Rising Tides](#)" Project (ART) focused on the shorelines of seven cities – from Emeryville to Union City – as well as affected facilities, communities and services up to one-half mile inland. The Project area comprises the core of an extraordinarily complex network of facilities and infrastructure upon which the economies of Northern California depend.

The Port of Oakland is an economic key to the region. It is a major shipping hub on the West Coast. It serves as the export gate for the multi-billion dollar agricultural economy of the Central Valley as well as an import and export gate for manufactured goods for a region stretching to the Rocky Mountains. The Port (which includes Oakland International Airport, one of only three in the region), along with the north/south rail lines that link the major cities of the west coast; the BART subway system and other tunnels; the primary north/south freeway system in the region; and urban water and sewage-treatment facilities are all located but a few feet above existing sea levels in the Bay. Thus, sea level rise creates a major

strategic hazard not only to Bay cities, but also to every Western city that depends on the Port, or the airport, or those rail lines and freeways.

The Project's 2011 Staff Report, [Assessing Climate Change Vulnerability and Risk](#), is an extremely useful introduction to a subject that challenges planning staffs in many communities. The Project's May 2013 Issue Paper "[Adapting Governance for Rising Tides](#)" is essential reading for anyone working in a city staff position that is tasked with actually implementing weather adaptations. The paper also includes useful guidance for working through the uncertainty and complexity of environmental changes, due to climate disruption, while operating under the constraint of limited resources.

The ART Report and Issue Papers provide transparent and excellent analysis leading to some conclusions similar to those of the Red River Basin Commission:

1. Improve governance. Re-structure decision processes so that they result in actions that can be implemented.
2. Be aware that problems of a regional scale will necessarily require both more public involvement and negotiations with more agencies that have jurisdiction over some part of the solution. These two factors mean longer lead times to reach decisions. Time and budgets are the critical paths. Including all affected parties and agencies from the beginning—in defining issues and clarifying the steps needed to implement adaptive actions—is faster, more efficient, and reduces costs over all.
3. Build on the existing laws and regulations, decision processes and agencies. Explore small-scale, informal cooperation; scale up the most robust. At the same time, be alert for road-block institutional constraints, laws or regulations that may require a new structure.
4. Share information and staff expertise; cooperate in seeking federal and state resources.

### Final Thoughts

Adaptation to changing conditions is as old as human society. That doesn't mean it is easy. It is simply necessary. The extreme weather challenges we face, which are due to climate disruption that has already occurred, are likely to be of a serious scale. Everyone will be affected. We will have to "work hard and work smart" to retain our goals of stable family life existing within vibrant and prosperous communities. Fortunately, the needed tools are already in our community toolkits: land-use planning, zoning and construction standards to limit undue risk to people and property. "Work hard and work smart" means using all of the tools available.

Most communities have many of the capabilities for minimizing damage from extreme weather. Adaptation, with its sometimes unwelcome changes, will require both the education of residents and open community discussions about the hazards of extreme weather and what can be done to diminish the local impacts. Disputes over cultural values, capabilities and resources to adapt, local economies, personal interests and politics are certain to arise—even to dominate—the debate. But residents of every community must come to terms with the need to plan and adapt. They must decide who will make the decisions to act upon the realities they face, and when.

Ronald Reagan, in a different context, once posed this question more eloquently: “If not us—who? If not now—when?”

Editorial thanks to Nancy Graalman and Robert Archibald

### **How to Get Involved**

RRI would like to hear from you. If you have questions, comments, or concerns, please contact us at:

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