



Designation: ~~E3032 – 15~~^{ε1} E3032 – 22

Standard Guide for Climate Resiliency Planning and Strategy¹

This standard is issued under the fixed designation E3032; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—~~5.9.1, 6.3.4.4, 6.3.4.5, and X4.2.1~~ were editorially corrected in May 2016.

INTRODUCTION

This guide provides a set of options for planning climate resiliency management. This includes adapting local business and government infrastructure to chronic, extreme weather events and sea level rise. It may not apply to entities where such assessment and risk management is already widely available through standard sets of guidance, such as the construction of green buildings. This guide provides a voluntary framework of the risk management options and steps that may be beneficial to evaluate climate resiliency solutions. It provides strategies for existing organizations, even those currently operating outside of various voluntary and regulatory schemes. The environmental assessment and risk management strategies contained in this guide recognize the overall value of existing responses. This guide references and blends similar, effective programs and extends them to provide a consistent approach that will facilitate communication and preparation for extreme weather events.

Background—This guide presents a series of options for an individual, group or entity to use. The goal is a strategy or plan to address extreme weather.

1. Scope

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1.1 *Overview*—For the purposes of this guide, ‘resiliency’ refers to efforts by entities, organizations, or individuals to prepare for or adjust to future extreme weather and related physical conditions. The primary purpose is to reduce negative economic impacts associated with extreme weather.

1.1.1 This guide presents a generalized, systematic approach to voluntary assessment and risk management of extreme climate related events and conditions. It helps the user structure their understanding of the climate related vulnerabilities and consequences they seek to manage. It helps the user identify adaptive actions of both an institutional (legal), as well as engineering (physical) nature. Options for analysis provide a priority ranking system to address the “worst first” risks of a municipality, local area or facility, addressing practicality and cost-benefit. Users may approach this analysis having initially undertaken a risk assessment to determine what they are seeking to manage, or use the guide to help determine the likely areas of greatest need.

1.1.2 These climate adaptations or adjustments may be either protective (that is, guarding against negative impacts of extreme weather), or opportunistic (that is, taking advantage of any beneficial effects of extreme weather).

1.1.3 This guide addresses adaptation strategies and planning in response to various impacts that may occur to individuals,

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organizations, human settlements or ecosystems in a broad variety of ways. For example, extreme weather might increase or decrease rainfall, influence agricultural crop yields, affect human health, cause changes to forests and other ecosystems, or impact energy supply or infrastructure.

1.1.4 Climate-related impacts may occur locally within a region or across a country and may affect many sectors of the economy. In order to meet these challenges, this guide provides an organized, uniform approach to prepare for the impacts of extreme weather through planned “resiliency” strategies.

1.1.5 This guide addresses options to deal with risk factors that may be key drivers for the economy, human health, the environment, or ecosystems. The guide is aimed at helping users understand risks and potential losses, and offers options and a generalized approach to bolster human and ecosystem resiliency to a changing climate. This includes sustainability concepts such as support of economic stability and a good quality of life.

1.1.6 Adaptation can involve responses to extreme weather and long-term preparation for future events. Local conditions will require risk evaluation and analysis of both likely weather events and/or extreme weather trends.

1.1.7 This guide does not address the causes of extreme weather.

1.2 *Purpose*—The purpose of this guide is to provide a series of options consistent with preparing for extreme weather events. This guide encourages consistent management of climate exposures and risks. The guide presents practices and recommendations for regions, zones, and planning horizons to address institutional and engineering actions for reduction of physical and financial vulnerability attributable to extreme weather. It reviews available technologies, institutional practices, and engineering actions that can be implemented by individuals and organizations seeking to increase their adaptive capacity.

1.2.1 The guide also provides some high-level options for the monitoring and tracking of performance of an individual or organization’s chosen strategy in order to evaluate its effectiveness and ensure that the approach continues to be reasonable.

1.2.2 This guide ties into the ASTM E50 standards series related to environmental risk assessment and management.

1.3 *Objectives*—The objectives of this guide are to determine the conditions of the community, facility and or/property with regard to risks of extreme weather events and actions to be taken to manage those risks.

1.3.1 The guide presents information on planning and strategies for response to extreme weather events such as: drought, flood, fire, storms, landslides, tidal surge, and extreme temperatures.

1.3.2 The guide encourages users to set priorities, using a matrix based upon regions in the United States. For each region the guide identifies key climate vulnerabilities, requiring preparation for future events. These could be extrapolated to other regions if there are similar conditions.

1.4 *Limitations of this Guide*—Given the different types of organizations that may wish to use this guide, as well as variations in State and Local regulations, it is not possible to address all the relevant circumstances that might apply to a particular facility. This guide uses generalized language and examples to guide the user. If it is not clear to the user how to apply standards to their specific circumstances, it is recommended that users seek assistance from qualified professionals.

1.4.1 The guide assumes risks are already identified and is not intended to provide assistance with identifying or evaluating risks.

1.4.2 *Insurance Industry*—The effects of climate extremes on insurers are not clear. The definition of an insurable occurrence and a commencement point for when insurable claims are made, along with when conditions were discovered and the actionable information leading to an insurable loss is not clear. It may be inappropriate to speculate on climate effects that are highly uncertain for purposes of insurance related to specific events. While there are exclusions for “acts of God,” for example, claims associated with increasing extreme weather events may still have serious impacts on the insurance industry.

1.4.3 This guide does not take a position on the causes or science of extreme weather.

1.5 The guide uses references and information on the control, management and reduction of impacts from many cited sources.

1.6 Several national and international agencies served as sources of information on existing and anticipated levels and

management of climate risks including: the Australian Ministry of Environment; the Federal Emergency Management Agency; the National Oceanographic and Atmospheric Administration; the Securities and Exchange Commission; the U.S. Army Corps of Engineers; the U.S. Department of Agriculture; the U.S. Department of Energy; the U.S. Environmental Protection Agency; and, the U.S. Department of Defense.

1.7 This guide relies on current regulatory information about risks from various state agencies, including the California Air Resources Board, the Massachusetts and Connecticut Departments of Environmental Protection, the Western Climate Initiative, and other published high-level strategies and guidance. For example, the National Academy of Sciences guidance and the Climate and Risk section of the Envision rating system published by the Institute of Sustainable Infrastructure.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and health~~environmental~~ practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- [E2114 Terminology for Sustainability Relative to the Performance of Buildings](#)
- [E2432 Guide for General Principles of Sustainability Relative to Buildings](#)
- [E2718 Guide for Financial Disclosures Attributed to Climate Change](#)
- [E2725 Guide for Basic Assessment and Management of Greenhouse Gases](#)
- [E3136 Guide for Climate Resiliency in Water Resources](#)
- [E3249 Guide for Remedial Action Resiliency to Climate Impacts](#)
- [E3312 Guide for Mitigation of Wildfire Impact to Source Water Protection Areas and Risk to Water Utilities](#)

2.2 ISO Standards:³

- [ISO ~~14001:1996~~14001:2015 Environmental Management Systems—Specification—management—systems — Requirements with guidance for use \[~~products of ISO/TC 207 for which ASTM E50 was a participant on behalf of ANSI~~\]](#)
- [ISO 14063:2020 Environmental management — Environmental communication — Guidelines and examples](#)
- [ISO ~~14064-1:2006-03-01~~14064-1:2018 Greenhouse Gases—gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and ~~removals~~removals](#)
- [ISO ~~31000:2009~~, Risk management Principles and guidelines](#)
- [ISO ~~14064-3:14064-3:2020~~ Part 3 Greenhouse gases — Part 3: Specification with guidance for the ~~validation~~verification and ~~verification~~validation of greenhouse gas ~~assertions~~statements](#)
- [ISO 31000:2018 Risk management — Guidelines](#)
- [ISO Guide 7373:2009 Risk management – Vocabulary](#)
- [ISO Draft Standard on Asset Management: Overview, Principles and Terminology \(56/1358/DC\)](#)

2.3 Standards Australia:⁴

- [AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach](#)

3. Terminology

3.1 Definitions:

3.1.1 *adaptation, n*—risk treatment and mitigation actions undertaken to reduce the adverse consequences of extreme weather, as well as to harness any beneficial opportunities. Adjustment or preparation of natural or human systems to a new or changing environment which moderates harm or exploits beneficial opportunities.

3.1.2 *adaptive capacity, n*—the ability of a system to adjust to extreme weather (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. Response to and attenuation of potential damages, to take advantage of opportunities, or to cope with the consequences.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

⁴ Standards Australia Level 10, The Exchange Centre 20 Bridge Street, Sydney GPO Box 476 Sydney NSW 2001. <http://www.standards.org.au/>

3.1.3 *climate, n*—the average and range of weather conditions in an area. More rigorously, the statistical description in terms of the mean and variability of relevant weather parameters over a period of time long enough to ensure representative values for a month or season. These parameters are most often surface variables such as temperature, humidity, air pressure, precipitation, and wind.

3.1.4 *contingency plan, n*—any plan of action that allows an organization to respond to events should they occur, includes all plans that deal with stabilization, continuity of critical business functions and recovery, sometimes called a ‘business continuity plan’.

3.1.5 *drought risk, n*—rating systems of USDA to determine appropriate planting, harvesting and water conservation activities, based upon region and expected weather events.

3.1.6 *ecosystem, n*—any natural unit or entity including living and non-living parts that interact to produce a system through cyclic exchange of materials and energy.

3.1.7 *extreme temperature risk, n*—rating systems for vulnerability, especially to high temperatures in urban heat sink areas.

3.1.8 *extreme weather, n*—significant change in physical, climactic events lasting for an extended period of time. Includes major changes in storm frequency, duration or intensity; temperature; precipitation patterns; or wind patterns, among others, that occur over several decades or longer.

3.1.9 *fire risk, n*—various rating systems to determine how likely a fire is, given weather and wind conditions. The National Fire Protection Association has a rating system

3.1.10 *flood risk, n*—various rating systems to determine the flood zone associated with flooding and water damage. Rating system terminology includes various flood zones as defined by FEMA and State agencies for rainfall and tidal events. This can include the 5, 10, 25, 50, 100 and 500 year events). The 100-Year flood level and floodplain are the typical standard to define severe flood levels and flood extent. The 100 year event risk is also defined as a one-in-100 or 1% likelihood of occurring in any given year.

3.1.11 *green buildings, n*—as defined in ASTM E2114, Standard Terminology Relative to the Performance of Buildings and E2432, Guide for General Principles of Sustainability Relative to Buildings

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3.1.12 *green roof, n*—construction of water retaining and heat lowering materials, especially plants, on the roofs of buildings to address storm-water flooding, extreme temperatures, and energy conservation. This includes systems with assemblies that support an area of planting/landscaping, built up on a waterproofed substrate at any level that is separated from the natural ground by a human-made structure. Also defined in Guide E2432.

3.1.13 *extreme weather event, n*—phenomena such as tropical storms, hurricanes, typhoons, nor’easters, blizzards, hail storms and floods. These phenomena are at the extremes of the historical distribution, including especially severe or unseasonal conditions.

3.1.14 *extreme conditions, n*—trends in climate and weather, over the long term that result in substantial impacts to the local built and natural environment, including financial impacts.

3.1.15 *land movement, n*—a threat to urban or natural systems expressed in terms of the combination of their likelihood of occurrence and their consequences. This includes soil accretion, erosion, subsidence, landslides, and uplifts.

3.1.16 *mitigation, n*—attempts to lower or compensate for risks from weather/climate related events including flood, fire, drought, extreme temperature, sea-level rise and storms.

3.1.17 *natural variability, n*—variations in the mean state and other statistics (such as standard deviations or statistics of extremes) of the climate on all time and space scales beyond that of individual weather events. Natural variations in climate over time are caused by internal processes of the climate system, such as El Niño or La Nina, as well as changes in external influences, such as volcanic activity and variations in the output of the sun.

3.1.18 *relative sea level rise, n*—the increase in ocean water levels at a specific location, taking into account both global and local factors, such as glacial ice melt (from land and in sea, with land melt having greater relative impact), local subsidence, thermal expansion, and/or continental uplift or subduction. Measured with respect to a specified vertical datum relative to the land, which may also be changing elevation over time. Can include evaluation of flood risk to coastal areas, generally associated with flood insurance ratings and maps.

3.1.19 *resilience, n*—adaptive capacity of an organization in a complex and changing environment. A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

3.1.20 *scenarios, n*—a plausible and often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and key relationships.

3.1.21 *sensitivity, n*—the degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (for example, a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (for example, damages caused by an increase in the frequency of coastal flooding due to sea level rise).

3.1.22 *storm risk, n*—rating systems for the likelihood of impacts from rainfall, snow, hail or wind from rainfall events, hurricanes and tropical storms, Nor'easters, tornadoes, blizzards and other types of storms. Can include surges or abnormal rise in sea level accompanying a hurricane, tropical storm, or other intense storm, whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the storm or hurricane.

3.1.23 *subsiding/subsidence, n*—the downward settling of soil layers and/or rock in the Earth's crust relative to its surroundings.

3.1.24 *thermal expansion, n*—the increase in volume (and decrease in density) that results from warming water. A warming of the ocean leads to an expansion of the ocean volume, which leads to an increase in sea level.

3.1.25 *tidal effects, n*—rising seas, extreme water levels, storm surges, rising sea levels, and frequent tidal events, from hurricanes, tropical storms, typhoons, and Nor'Easters

3.1.26 *vulnerability, n*—the degree to which a system is susceptible to, or unable to cope with, adverse effects of extreme weather, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed; its sensitivity; and its adaptive capacity.

3.1.27 *weather, n*—atmospheric condition at any given time or place. It is measured in terms of such parameters as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate in a narrow sense is usually defined as the "average weather", or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. [A simple way of remembering the difference is that climate is what you expect (for example, cold winters) and 'weather' is what you get (for example, a blizzard).]

4. Significance and Use

4.1 *The Use of this Standard Guide*—This guide addresses issues related solely to adaptation strategies and development of a plan to address extreme weather and related physical changes. This guide does not include specific guidance on risk assessment, however references are provided in **Appendix X3**. The matrix approach does reflect general risks for certain regions of the country, based upon the frequency of extreme weather and/or conditions such as fires, floods, storms, drought, and extreme temperatures. Adaptation strategies and planning may consist of a wide variety of actions by an individual, community, or organization to prepare for, or respond to, the impacts of extreme weather.

4.1.1 This guide does not address causes of extreme weather.

4.1.2 This guide addresses adjustment strategies and planning that a group of people or ecosystems make to limit negative effects of extreme weather. It also addresses taking advantage of opportunities that long term extreme weather patterns may present.

4.2 *Example Users:*

4.2.1 Small businesses or enterprises;

4.2.2 Service industries;

4.2.3 Federal, state or municipal facilities and regulators, including departments of health and fire departments;

4.2.4 Financial and insurance institutions;

4.2.5 Public works staff, including water system, stormwater system, wastewater system, solid waste, and other utilities (electrical, telephone, gas, et al) and other waste managers, including liquid and solid waste haulers, treatment, recycling, disposal and transfer;

4.2.6 Consultants, auditors, state, municipal and private inspectors and compliance assistance personnel;

4.2.7 Educational facilities;

4.2.8 Property, buildings and grounds management, including landscaping;

4.2.9 Non-regulatory government agencies, such as the military;

4.2.10 Wildlife management entities including government, tribal and NGOs.

4.3 This guide is a first step in crafting simplified goals for managing and communicating risks. The framework describes a process by which the user may categorize current climate risks and a priority approach to manage those risks. The technique classifies common responses for both mitigation and adaptation. The guide groups responses and examples into regions based on experience in responding to risks. The regional classifications found in this guide reflect the general structures of State, Federal and local response programs. These authorities generally classify groups of similar responses according to the timely availability and cost effectiveness of ~~responses;~~ responses (see ISO 14063:2020).

4.3.1 Adaptation strategies and planning may include actions by individuals and communities, for example, from reduced tree clearing for an individual lot, to a farmer planting more drought-resistant crops, or to a municipality protecting riparian and floodplain standards and buffers or ensuring that new coastal infrastructure can accommodate future sea level rise. However, building resilience across communities will require action at all levels; individual, business, town, county, state, and federal.

4.3.2 Some municipalities, for example Boston, Miami Beach, and Baltimore, corporate entities, and organizations have already begun taking action toward defining adaptation strategies and planning for extreme weather.

4.3.3 In an increasingly interdependent world, negative effects of extreme weather on one population or economic sector may have repercussions around the world. These effects have repercussions on populations and settlements in neighboring areas, within countries, or across the globe. They include economic disruption to productivity and the supply-chain, impacts to energy production and cascading impacts to users.

4.3.4 Many ecosystems will also be affected by extreme weather challenges and opportunities. Some species may be able to migrate or change their behavior to accommodate changes in the weather. Other species may decline or become extinct. Some species may increase in numbers. Managers of natural resources may anticipate some of the impacts of extreme weather on ecosystems. This offers one avenue in beginning to develop management programs that may help ecosystems adapt.

4.3.5 There are limits to the ability of human systems to adapt. For example, the relocation of cities and various communities or infrastructure may not be feasible in many locations, especially in a short period of time. Implementation timeframes could take 20, 50 and 100 years or longer.

4.3.6 Those communities or sections of communities that are most vulnerable, such as locations where the poor, disengaged, elderly or those in ill health live, are at greatest risk. Extreme weather may exacerbate existing issues. Addressing underlying issues that make communities or systems vulnerable will increase their resilience and support adaptation efforts.

4.3.7 The user should consider the most effective scale of adaptation, for example, site, town, catchment, watershed, City, State, or regional level. The scale will impact the relative direct and indirect costs and benefits of a solution. The guide may help users understand the most effective scale of adaptation and the appropriate level of action.

4.4 This guide defines good commercial and customary practice in the U.S. for conducting baseline assessment and reasonable mitigation/adaptation strategic options on a voluntary basis. The following principles apply to this priority system:

4.4.1 Ability to set specific goals for activities. This includes adopting a contingency plan for protection from weather related events using engineering changes while maintaining current operations. This includes “flood-proofing” “fire-proofing,” back-up energy generation, vegetation management around power lines and other measures to cope with extreme weather.

4.4.2 Marketing environmental awareness and sensitivity;

4.4.3 Assessing risks from future weather related events and extreme conditions. A compendium of applicable risk assessment tools that users may find useful are in [Appendix X1](#).

4.4.4 Risk management, underwriting; loss control and history; premiums and claims;

4.4.5 Liability assessment and qualifications for loans;

4.4.6 Standardization, consistency and certification of facility specific evaluations;

4.4.7 Educating employees, clients and customers;

4.4.8 Generating multi media and cross medium information;

4.4.9 Evaluating vendors;

4.4.10 Reducing costs and preventing pollution.

4.5 Users may consider various benefits of assessment and response.

4.5.1 This guide is a basic primer on climate impacts and may serve to introduce the subject for organizations unfamiliar with the principles.

4.5.2 Some government agencies, fiduciaries and business organizations publish strategies for climate resiliency. The public has systematic ability to access or estimate information on individual businesses. Therefore, businesses need guidance on how to assess the nature and potential risks of climate risks, and a programmatic approach for reducing or eliminating those risks through protection, accommodation, retreat, and other proactive management systems.

4.5.3 Reduced operation, insurance and maintenance costs may be realized through a tiered evaluation of weather related response opportunities.

4.5.4 Responses may be streamlined and simplified so that all levels in an organization may participate.

4.5.5 Some enterprises may be more competitive in the marketplace with improved climate-related response programs.

4.5.6 Setting priorities can allow planning and evaluation of new adaptation and response requirements.

4.5.7 Different stakeholders, such as industries or governments, will have different interests and responsibilities for taking action. For example, retreat and relocation of populations will fall under the government scope rather than industry.

4.6 *Institutional Risks*—Some of the risks posed by weather related events include damage to residences, businesses, infrastructure and agriculture from fires, floods, drought, extreme temperature, storms, hail, winds, tidal surge and sea level rise. Early, voluntary actions, including the use of this guide, may also help organizations prepare for and reduce the impacts of future government regulations. Some of the possible government programs that may be used to address climate are described below.

4.6.1 Flood Insurance Maps;

4.6.2 Water conservation requirements;

4.6.3 Fire codes;

4.6.4 Emergency response;

4.6.5 Zoning regulations;

4.6.6 Building codes;

4.6.7 Wetlands and stream buffer regulations;

4.6.8 Stormwater standards and regulations for floodplains and floodways, planning, development requirements, and infrastructure design (MS4, flood control systems, floodplains and floodways);

4.6.9 Public Works Projects;

4.6.10 Hazard Mitigation Planning.

4.7 *Managing Risk Uncertainty:*

4.7.1 It appears that weather extremes will continue to present risks and uncertainty as to the effects they will have in different regions. The ability to predict future weather related risks has improved, but efforts to understand the complete impact of those risks on society and analyze mitigation and adaptation strategies are still relatively immature.

4.7.2 The tiered analysis in this guide will help support decision-making, studying regional impacts, and communicating with wider group of stakeholders in the face of uncertainty.

4.7.3 The insurance industry has always played a role in risk management by insuring weather related risks, promoting stronger building codes, and better land-use decision-making.

5. Risk Management [.iteh.ai/catalog/standards/sist/80ae1c2d-45f1-452b-a5d5-b4d6556be0fd/astm-e3032-22](https://standards.iteh.ai/catalog/standards/sist/80ae1c2d-45f1-452b-a5d5-b4d6556be0fd/astm-e3032-22)

5.1 This guide establishes a framework of common, climate risk management strategies in the United States. The same planning principles could be applied in other countries, depending upon priorities associated with climate risks. This general guide will allow the user to evaluate the category of risk from extreme weather related issues. Responses would then be evaluated for timeliness and availability in order to continually reduce the risks.

5.2 This guide outlines adaptation strategies and planning steps that may be taken to prepare for, and respond to, the impacts of extreme weather. The guide addresses a series of adaptation and planning options for managing environmental and human risks associated with extreme weather. The guide addresses potential ways to approach managing risks. This may include adoption of regional priorities for adaptation. Strategies for preparedness for a weather event may be different than reactions to post-extreme weather events.

5.3 Extreme weather may pose a risk or threat to businesses and properties. For example, variations in air temperatures over land masses or ocean temperatures could directly and indirectly affect ecosystems, humans, and the economy. In some areas, there could be regional increases in the form of more pronounced heat waves and heavy precipitation events, which exceed the levels expected from standard variability.

5.4 Extreme weather might yield economic damages in the form of flood and storm damage, crop losses, wildfire losses, supply chain disruptions and critical infrastructure outages. This guide addresses adaptation strategies and plans, taking a measured approach to promote effective risk management strategies.

5.5 This guide does not address the uncertainty of unpredictable and severe weather events. This guide does not address

connections between impacts of rising temperatures and extreme events or the probability of the rate of increase of these events. However, this guide does discuss options for addressing vulnerabilities to the impacts of extreme weather and natural catastrophes.

5.6 Procedure for Planning A Strategy—A plan of adaptation to extreme weather should educate groups, businesses and individuals to reduce risks, and build safety restraints into their activities, increasing resiliency. The development of a strategy, and application of this guide, may be approached from a starting point of having determined the priority risks that need to be addressed (for example, through a risk assessment). Alternatively, if a risk assessment has not been undertaken, the approach outlined in Fig. 1 may be applied starting with identifying the relevant region (that is geography). For example there are eight regions shown in Fig. 2.

5.6.1 If the regional approach is followed, the user first decides on the appropriate regions for planning, selecting from one of eight regions of the United States. Certain areas of Canada adjacent to the Northeast, the Midwest, the Great Plains or the Northwest may benefit from this regional organization of the guide. Certain areas of Mexico adjacent to the Southwest or Great Plains may also benefit from guide use.

5.6.2 The priority areas of concern are shown in Table 1, based upon the selected region. There may be other priority areas, based upon local conditions and state by state priorities. Flash floods from rivers and streams are examples of local conditions requiring priority planning, in addition to regional priorities.

5.6.3 Priority areas of concern may also be based on previous, climate related, catastrophic events. The areas of New York, Long Island and New Jersey impacted by Hurricane Sandy are examples.

5.6.4 Categories of actions include adaptation, protection and retreat and are shown in Table 2.

5.7 Building a strategy or plan of adaptation to extreme weather educates groups, businesses and individuals to reduce risks, and build safety restraints into their activities, increasing resiliency. Broad examples of strategy or plan elements include, but are not limited to:

5.7.1 Putting in place a group to understand, coordinate and reduce disaster risk based on participation of multiple parties, including local alliances.

5.7.2 For businesses, climate adaptation goals in employee job descriptions, especially in key geographies in an enterprise, or in operations and supply chain.

5.7.3 Establishing a cross-function climate adaptation working group with connections to local or regional organizations.

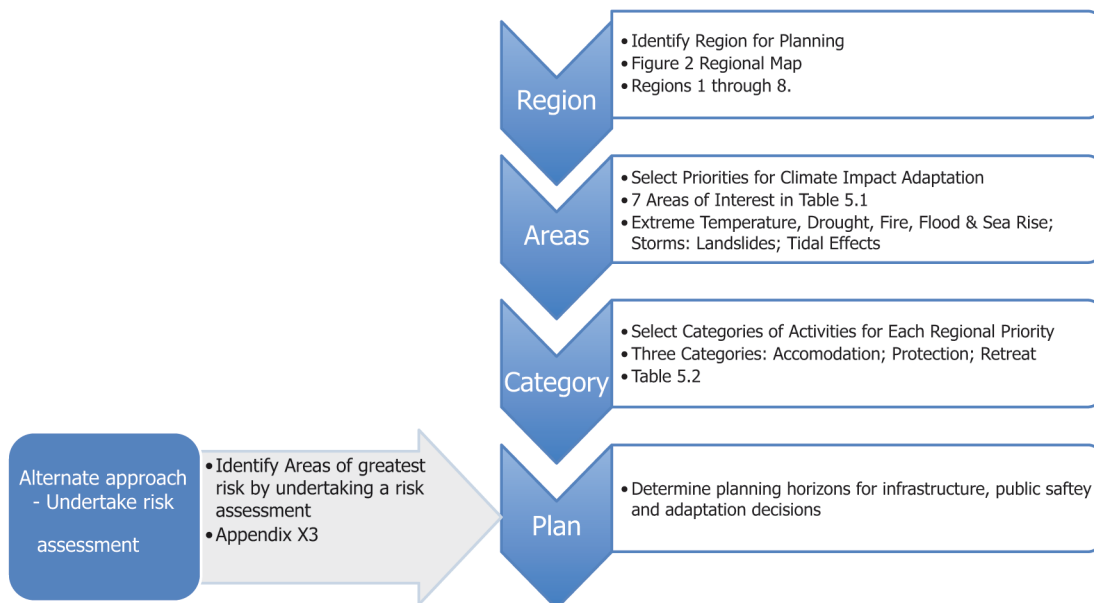


FIG. 1 Procedure for Adaptation Planning Strategy Development

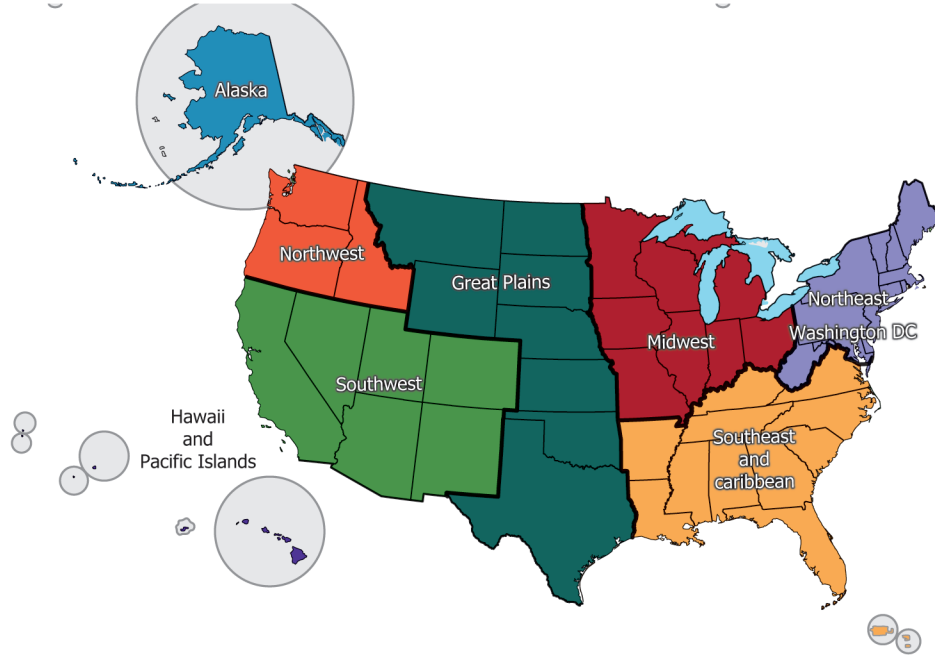


FIG. 2 National Climate Assessment Regions (National Climate Assessment, 2014)

TABLE 1 Example Regional Climate Adaptation Priorities

NOTE 1—Table 1 provides a regional overview of adaptation priorities. The lack of a ‘*’ does not indicate that other climate risks will not occur in a region. In addition, specific risks and adaptation priorities may differ within a region, at the local or site specific scale.

| Region | Extreme Temperature (hot or cold) | Drought | Fire | Flood | Storms (wind straight line and tornadic and snow hail, sleet and ice) | Land Movement Subsidence (uplifts and landslides) | Sea Rise and Tidal Effects |
|---------------------------|-----------------------------------|---------|------|-------|---|---|----------------------------|
| 1 Northeast | * | | | * | * | | * |
| 2 Southeast and Caribbean | * | | | * | * | | * |
| 3 Midwest | * | * | * | * | * | | |
| 4 Great Plains | * | * | * | * | * | | |
| 5 Southwest | * | * | * | * | * | | |
| 6 Northwest | | | * | * | | * | * |
| 7 Alaska | * | | | | * | * | * |
| 8 Hawaii | | | | | * | * | * |

5.7.4 Setting a budget and providing the necessary resources for proactive adaptation.

5.7.5 Collaborating with neighboring businesses and supply chain partners on climate adaptation planning and execution.

5.7.6 All parties understand their role regarding adaptation that requires disaster risk reduction and preparedness.

5.7.7 Making up-to-date information and plans readily available. Plans and strategies to cope with extreme weather could be integrated into an existing Environmental Management System or Disaster Response Plan. Plan (see Guide E3249, ISO 14001:2015 and ISO 31000:2018). Plan updates should include training for those responsible for response to extreme weather events.

5.7.8 Planning to maintain critical evacuation and supply routes, access (for police, fire, medical, and other emergency responders), and infrastructure (water, sewer, stormwater, communications, hospitals, shelters, power with backup generators, airports, rail lines, et al) that reduce risk, adjusted where needed to cope with extreme weather.

5.7.9 Assessment of the safety of nearby facilities that support disaster response efforts (for example, schools and health facilities) and upgrading the plan as necessary.

TABLE 2 Category of Responses to Example Climate Events

| Adaptation Risk Category | Category 1: Accommodation | Category 2: Protection | Category 3: Retreat/Relocate |
|--|--|---|---|
| Extreme Temperature | Build green roofs, conserve water, and add plantings and landscape to increase shade and oxygen. | Add insulation and energy efficient windows to buildings Provide emergency generators for temperature control centers to address extremes. | Move residences and buildings into more temperate areas; including underground zones for geothermal temperature control. |
| Drought | Conservation. Plant alternative crops or drought resistant crops. Underground water storage. Recycle of existing water supplies. (See Guide E3312.) | Integrated water resource programs for stormwater and “wastewater”. Reservoirs. Aquifer recharge and underground water storage. Water retaining soil amendments. Provide emergency water supplies. (See Guide E3136.) | Move crops, livestock and residences from risk areas. Provide for technology that uses less water or hydroponic growth with recycled water. |
| Fire | Construct firebreaks, and fire-fighting stations. Water storage in potential fire areas. Low occupancy development. Controlled burns. Strategic logging to thin out forests near residential areas. | Fire resistant coatings; Stronger regulations and oversight in areas of concern (man-made fires). Water storage in potential fire areas. (See Guide E3312.) | Move residences out of high risk areas. Realign development to provide for fire line and reduced spread. Redesign structure to include fire protective natural infrastructure (soil external covering). |
| Flood | Free-board buildings. Sumps and tunnels to move water away from buildings. Pumping stations and infrastructure control measures, including bridges, culverts, storm water systems; and run-off controls using natural systems. | Build seawalls barrier islands and dunes. Provide run-off structures to manage flooding and provide water storage, retention and detention. | Remove, relocate or raze vulnerable buildings and infrastructure. Replace and restore floodplains, wetlands and natural channels. Redesign development to retreat from flood zones and sea impact areas. Use natural designs to reduce inward flow of waters. |
| Storms include straight-line and tornadoic winds, hail and ice | Emergency Response and shelter plans. Upgrade buildings, including windows, doors, roofs, insulation and other building features. Provide supportive energy systems. Address ice and wind damage issues. | Upgrade building codes for windows, doors, roofs, insulation and other building features. Address energy issues with backup structures. | Include development plans with cooperative energy provisions; Design or redesign occupied areas to address main impacts from storms. |
| Land Movement includes subsidence | Upgrade building and community designs to address structural and emergency issues (increase strength of buildings and escape routes). | Build retaining structures and run-off structures to reduce erosional areas. Provide for green space to strengthen slope stability. | Move residences out of high risk areas. Provide for free board areas if slope failure occurs. |
| Sea Rise and Tidal Effects | Free-board buildings away from main impact tidal zones. Sumps and water tunnels to move water away from buildings. Pumping stations and infrastructure control measures, along with riparian zones to address impacts. | Build seawalls, retaining structures, levees and protective sea/flood walls. Provide run-off and storage structures. Address beach erosional issues through restoration of barrier islands and dunes. Repair, upgrade and maintain locks and other structures to control surge for navigation channels and ports. | Remove relocate or raze occupied structures from high risk areas. Provide natural run-off storage and protective structures in designs. Redesign development to retreat from tidal erosional zones and tidal impact areas. Use natural designs to reduce inward flow of waters and sea impacts. |

5.7.10 Definitions for realistic, risk-compliant building guidance and land-use planning.

5.7.11 Education programs and training on disaster risk reduction at facilities that support disaster response efforts (for example, schools and local communities).

5.7.12 Protecting specific ecosystems and natural buffers to mitigate floods, storm surges and other hazards to which participant(s) are vulnerable.

5.7.13 Periodic updates and refinements of the plan and effective risk-reduction practices.

5.7.14 Installing early warning systems and emergency management capacities in your group and hold regular public preparedness drills.

5.7.15 Post disaster needs assessment of survivors to guide reconstruction, with support from community organizations. Design and help implement responses, including rebuilding homes and livelihoods.

5.7.16 Reassessment procedures in plans to determine issues or problems which require evaluation of current processes and revisions to ensure better adaptive strategies in the future. This is an iterative process for continual improvement.

5.8 *Financial and Schedule Considerations*—Users should evaluate and compare life cycle (capital, operation, and maintenance)