



Flood Preparation Toolkit

**PERMACULTURE SOLUTIONS FOR
REDUCING RISK FROM FLOODS,
MUDSLIDES, AND SURGES**



FLOOD

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Introduction

This toolkit will help you to understand the **different types of flooding, when you are at risk, and give you a variety of ways to become more flood resilient.** Understanding your flood risk is not always straightforward, but it can give you a great deal of peace of mind and help you to make better decisions, so that is the first step.

One thing to keep in mind is that we are having historic flood patterns around the world. Floods are reaching stages higher than in recorded history in some places, and are happening in places they generally haven't happened in the past. *How can we predict where they will occur?*

This document is a summary of advice from a range of resources, FEMA, rescue agencies, builders, scientists, and our own experience.

We start with an introduction explaining the different types of floods. This is to orient you, as some people are subject to more than one type of flood risk and there may be differences in how they are addressed.

Regarding actions you can take, we focus first on life saving immediate triage actions. A flood is expected, and you are not prepared. **The tips in “Surviving a Flood” can save your life.**

The second section is **short term preparation before a storm.** You haven't had time or resources to deeply prepare - this section can prevent or reduce damage for low cost and in minimum time.

The final section, **Deep Dive** (a separate guide), is a deep, **regenerative and resilient approach** to preparing for various types of flooding. This is where, if you can, we strongly recommend you put your energies. It will create much more resilience in your life from multiple angles. You can relax in a variety of circumstances because you are as ready as you can be for them. This section also includes information relevant to communities and policy makers that can reduce flood risk substantially on a community wide basis.

The first step is understanding what types of flooding you might be subject to.

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Part 1:

Types Of Flooding

Different types of flooding may require different strategies. Will you be subject to salt water damage? Flash floods? Long, slow floods or mudslides? Some locations may experience more than one type of flood.

Heavy rain storms

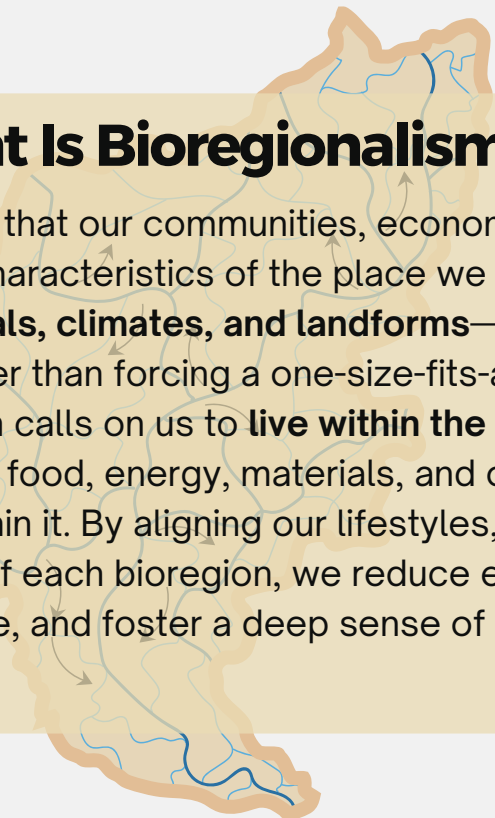
Just one inch of rain falling on a 1000 square foot roof is 623 gallons. That is more than eleven 55-gallon rain barrels. Rainstorms tend to drop that one inch over a period of time. When a storm is heavy and slow moving, it can deposit a foot or more of rain in a few hours and up to five feet in a “rain-bomb” in a few days.

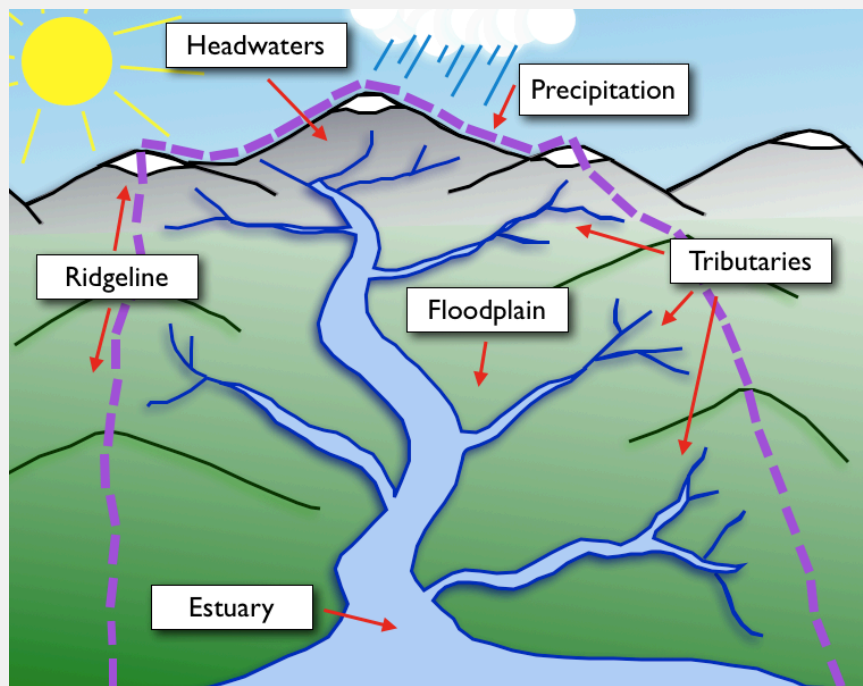
Such rain far exceeds the capacity of land with even excellent drainage to absorb it. A 10 inch rainstorm drops about 270,000 gallons on an acre and almost 10,000 gallons on a 1500 sq.ft. roof. Water heads downhill, so whatever is down the street or down the river will accumulate a lot of it. at

Cities and suburbs are especially vulnerable, because wetlands, prairies and trees have been removed and filled or built over. These natural areas, which act like sponges and can absorb millions of gallons of rain, were replaced with impermeable surfaces that cannot absorb rainwater. If the pipes and drainage systems are overwhelmed, there is no place for the water to go but into streets and homes.

What Is Bioregionalism?

Bioregionalism is the idea that our communities, economies, and identities should be rooted in the natural characteristics of the place we inhabit—**its watersheds, soils, native plants, animals, climates, and landforms**—instead of political borders or abstract markets. Rather than forcing a one-size-fits-all model onto every landscape, bioregionalism calls on us to **live within the ecological limits of our home region**, drawing our food, energy, materials, and culture from what can be produced sustainably within it. By aligning our lifestyles, governance, and trade with the unique patterns of each bioregion, we reduce ecological footprints, strengthen local resilience, and foster a deep sense of belonging to the land itself.





<https://www.cserc.org/wp-content/uploads/2012/04/LabeledWatershed1.png>

A watershed is an area of land that is sloped toward a low point. All rain that falls and is not evaporated or absorbed by the land ends up flowing toward the lowest point in the watershed. This is often a river that again flows to a low point like an ocean. When a watershed is large, millions of gallons of water that lands anywhere in that watershed can end up in the lowest parts of the land. This can cause massive flooding.

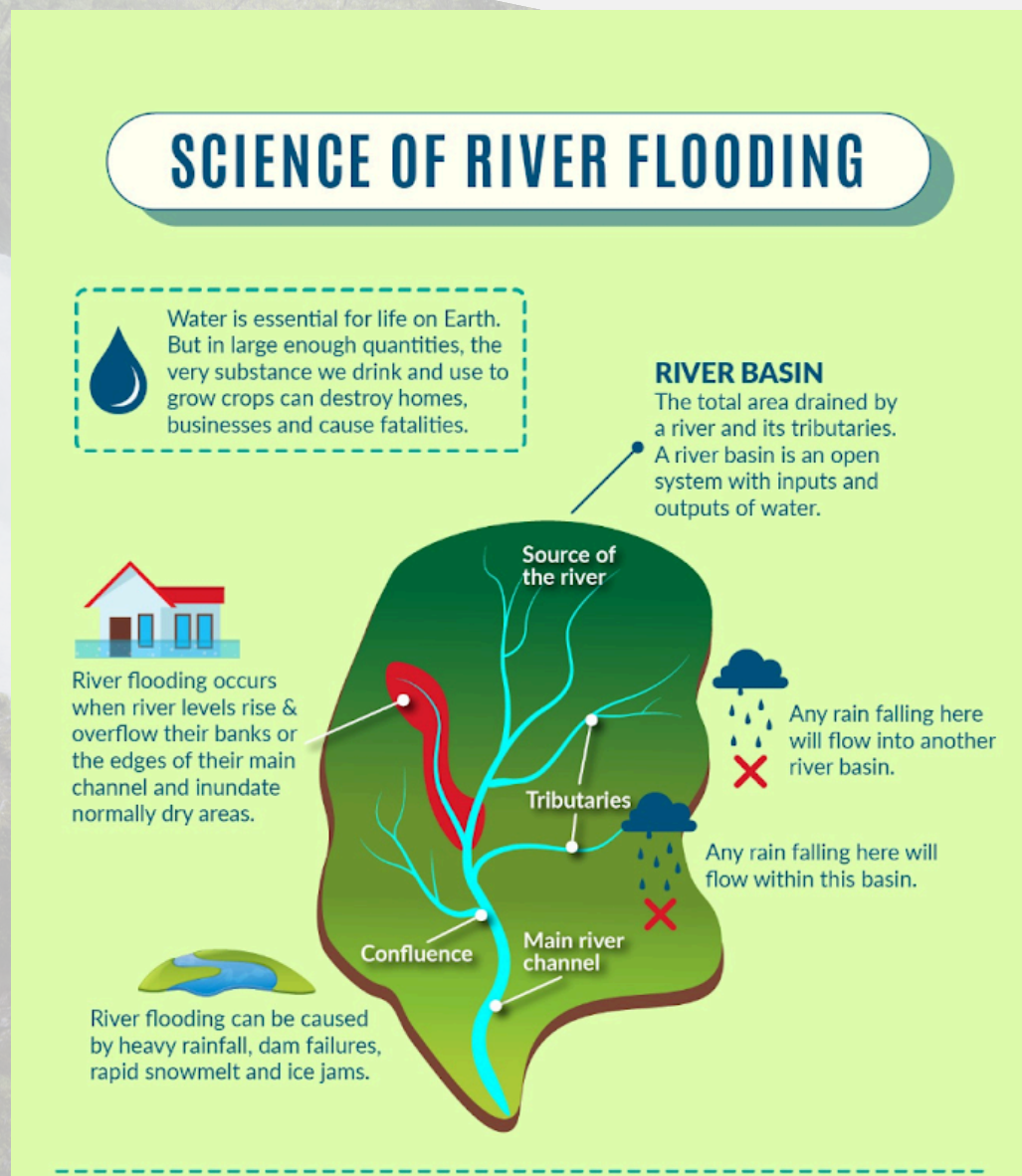
Even in relatively flat areas, water runs downhill where it can, and in canyons, foothills and mountains, rainwater ends up being concentrated in valleys and can cause major flooding downstream. Imagine taking that 62 gallons from an inch of rain and concentrating it into a couple of square feet instead of 10 square feet. Now imagine making that 620 gallons, equivalent to 10" of rain in a "rain-bomb" event.

Mountains and hill country can have massive watersheds that extend for miles. Even relatively flat land has slope and sheds water to the lowest point.



The Mississippi River watershed is the largest in the country. Rivers drain from mountains both east and west to end up in the Mississippi River valley, and eventually, the Gulf of Mexico.

Different types of river systems drain differently depending on how steep slopes are, the geology of the drainage system, and what sort of development has taken place upstream. River channel management has in the last several decades become a skilled engineering science and river dwellers can get, if they are contemplating major changes, advanced education. See for example <https://wildlandhydrology.com/>.



6 Steps to Create a Flood Model



HYDROLOGIC CYCLE

Hydrologists try to understand and simulate the natural hydrologic cycle, which is the intricate combination of many processes such as evaporation, transpiration, precipitation, infiltration, interflow, groundwater storage, and runoff.



PRECIPITATION

Precipitation is the primary input to basin hydrologic processes and serves as the primary driver of hydrologic models. Accurate representation of precipitation input is an important initial step. Small river channel systems are very sensitive to rainfall.



RUNOFF

The next step is to compute the amount of precipitation that appears in surface water within a relatively short time from the onset of a storm event. This is runoff. Runoff consists of 3 components: overland flow, rain falling directly on surface water bodies, and interflow.



UNIT HYDROGRAPH

After computing basin runoff, the next step is to calculate a forecast hydrograph in units of discharge. A hydrograph is a plot of the change of stage or discharge with respect to time. Discharge is the volume of water flowing past a location per unit time and is usually expressed in cubic feet per second (cfs).



STREAMFLOW DATA

Scientists use streamflow measurements to capture the vital relationship between discharge (volume flow rate) and stage (height) for a given location. This can only be done by taking streamflow measurements at different river levels and noting the corresponding stages. This relation is called a rating curve.



ROUTING

Hydrologists analyze and interpret how the water moves once it's in the river and how a flood wave is modified due to the effects of storage and friction as it moves downstream. So, what happens upstream affects the entire downstream community.

[weather.gov/flood](https://www.weather.gov/flood)



https://www.weather.gov/wrn/flood_infographics

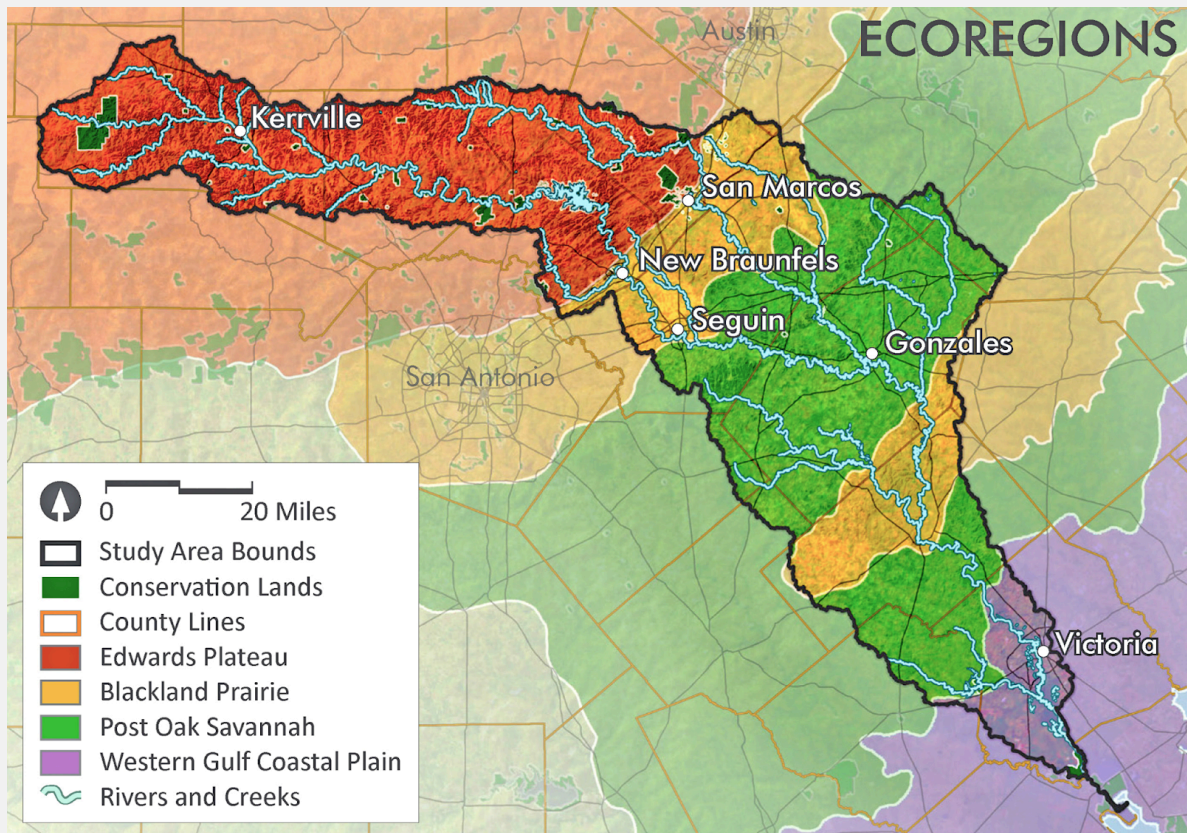
Flash flooding

Sometimes, because of rocky terrain or other features, it isn't feasible to capture enough water to mitigate flooding in major storm events. Flash floods are a specific type of flood that often happens in hilly or mountainous regions, especially deserts or drylands. These ecosystems often experience many weeks of dry weather and suddenly will experience a major storm. The water, with few trees or other plants to absorb or slow it, rushes to the lowest point and travels downstream. Canyons many miles downstream from any rain, on a sunny day, can experience a flash flood with no warning.

As one example, a deadly flash flood occurred in July of 2025 in the Guadalupe River watershed in Kerr County, Texas, where water rose between 7 and 37 feet in 4 hours, killing more than 100 people.

Flash floods occur in most drylands and many mountainous areas, as well as wetter and flatter areas. Be aware! If you're in a valley or canyon, you may be at risk of experiencing a flash flood. You may not see any rain or even clouds - the storm could be many miles away upstream. Heavy rain upstream can occur with little or none downstream, but because of topography, flooding can occur downstream hours or days later.

There are methods that can be used to slow and reduce water volume in some cases (see our Deeper Dive guide). Where detention or slowing of water is impractical due to cost and steepness of the terrain, it is still possible to locate cost efficient electronic rain gauges upstream that trigger cell phone warnings and/or sirens whenever water climbs too fast or too high in channels. Houston has such a system, but more rural counties where people vacation often have difficulty funding such systems through taxes.



Guadalupe River Watershed

<https://storage.googleapis.com/drnhpeoncsfzue/what-city-is-the-guadalupe-river-in.html>

Storm surges

Hurricane winds can cause storm surges at the shore where the winds are blowing hardest toward land. Winds push water towards shore, and when the ocean becomes shallow, or the coast has bays or inlets, it has nowhere to go but onto land. Initially the water surges onto land but unlike a wave, it is essentially a sea level rise of many feet for many hours.

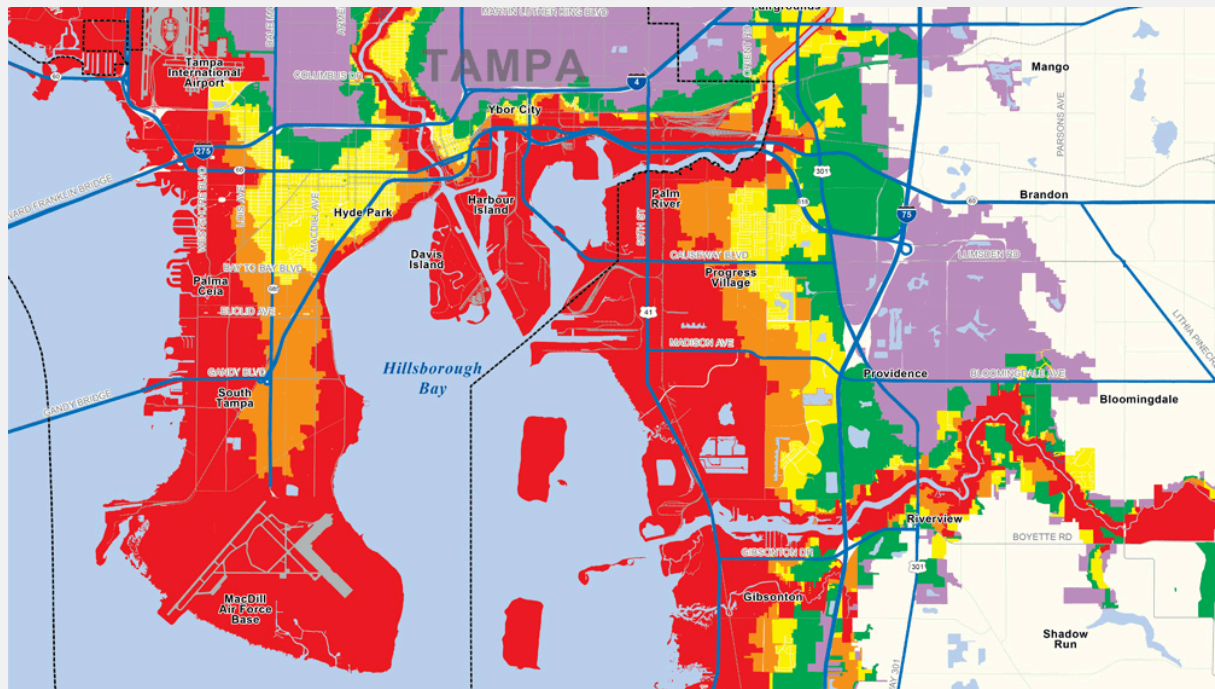
These surges can be more than 20 feet high, which would cover the roof of most two story buildings for hours. The weight of the ocean and force of heavy winds create an unstoppable force that can move buildings from their foundations or reduce them to matchsticks in the churning of the waves. Storm surges can easily become unsurvivable and no directed escape movement is possible in them.

Surges often last for hours, the duration of the hurricane and beyond. Homes, businesses, schools, utilities, roads, and vegetation can be severely damaged by the force of the waves, the salt water, and long term exposure to moisture and many plants will have permanent difficulty with the soil salinity. Storm surges can be influenced by high tide, heavy rain, topography, and already saturated ground, especially where rivers meet the ocean. The biggest amount of damage is usually on the homes near the seashore or waterways, but an inlet or bay connected to low lying land can cause a surge to travel many miles inland. In some regions of southwestern Louisiana and southeastern Texas, the surge from Hurricane Ike traveled inland for approximately 30 miles.

Storm surges are affected by the wind speed of the hurricane, by how fast the storm is moving, the angle of approach and the topography of the land. A fast moving Category 5 hurricane with strongest winds hitting an area of extensive low lying land will have a devastating storm surge. A slow moving storm can cause a surge to build in an inlet or bay more than a fast moving storm. Storm surges can impact a wide area on low lying barrier islands or by inundating low lying land many miles inland around deltas, estuaries, bays and rivers.

Urban development can create more vulnerabilities to storm surge by removing natural barriers like mangroves, wetlands and trees.

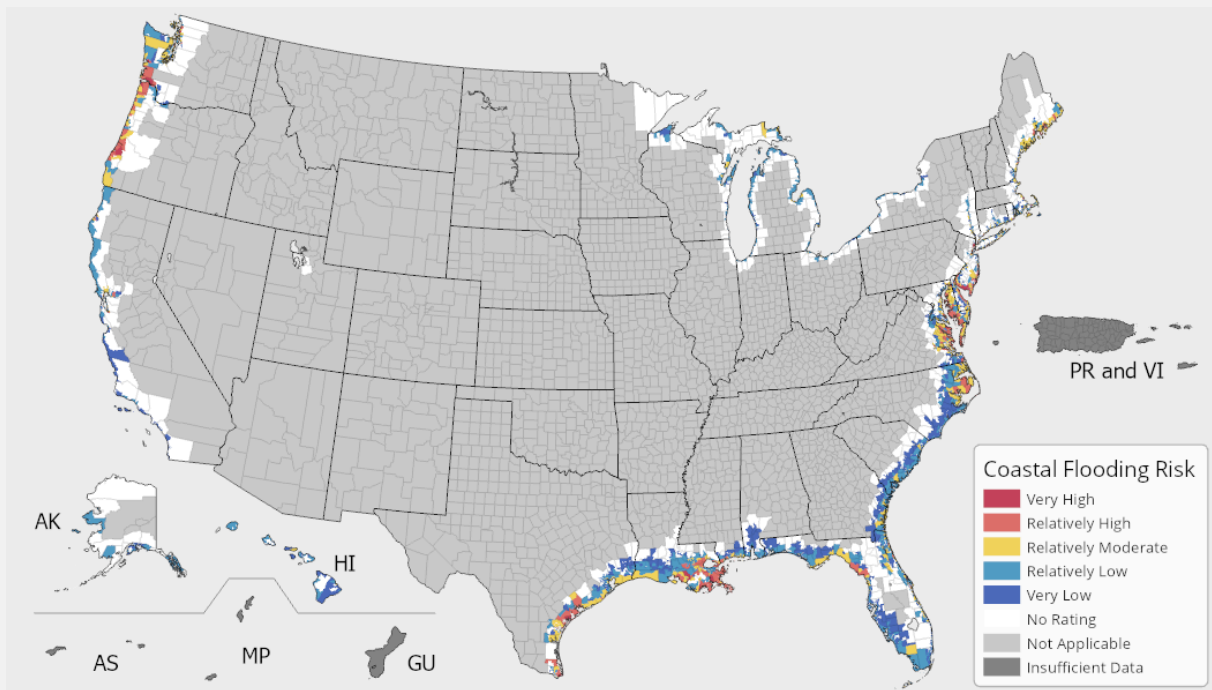




Map of evacuation zones for Tampa Bay with red being Zone A, the most vulnerable, with gradiently less vulnerability as the colors change. Multiple factors in this region create large swaths of red. There is significant amounts of low lying land near the shore, the bay narrows and forces the water inland, rivers allow the surge to flow further inland, and concentrated **development has removed ecological barriers like mangroves that could mitigate the surge**, while covering significant amounts of land with concrete, preventing water from soaking into the ground.

What is true in Tampa is somewhat similar to all coastal areas likely to experience tropical storms. Here is a map of the entire US susceptibility in various categories of hurricanes, see <https://experience.arcgis.com/experience/203f772571cb48b1b8b50fdcc3272e2c/page/Category-1>.

Storm surges are one of the major causes of death in hurricanes. If you are in an evacuation zone, it means you are vulnerable to a storm surge which may be unsurvivable depending on the severity of the storm.



<https://hazards.fema.gov/nri/coastal-flooding> (click for an interactive look at individual counties)

Tsunamis

Tsunamis are large waves or swells generated by an earthquake at sea. If the quake occurs far away from where you are, the wave, if it is strong enough, will take hours or days to arrive, so warnings may be easily transmitted. And if it is weak, it will be insignificant. But if it is strong and close by, you may only have a few minutes to move to higher ground. Like storm surges, tsunamis can move large buildings from their foundations and turn structures into matchsticks. If you are in an area with a history of earthquakes, and there is a quake where you are, seek higher ground as soon as the quake ends and move away from the shore immediately.

Keep in mind that there are often a series of quakes. Sometimes aftershocks can be almost as strong as the initial shock. Be aware that there may be more than one wave, a distant quake can cause high waves and rough waters for hours, and quakes can weaken infrastructure including bridges and buildings. Tsunami risk can continue in low lying areas for hours or days.

Because of the extensive infrastructure damage that can happen in an earthquake, there is a risk of multiple other risks including toxic gas plume release, fires, and inability of rescue agencies to reach the area. See our Earthquake manual for more information on how to prepare for these factors.

Large quakes near Japan have caused small tsunamis on the west coast of the Americas and elsewhere throughout the Pacific.

The Ring of Fire is a strong earthquake zone that exists near most major landforms that border the Pacific Ocean. Tsunami risk is high in those regions. If you are in one of these areas, investigate whether there are tsunami evacuation zones locally. See <https://www.tsunamizone.org/knowyourzone/>. Washington state has a well developed system and most locations on the Pacific Coast have some maps directing people where and when to evacuate.

Tsunami Warning

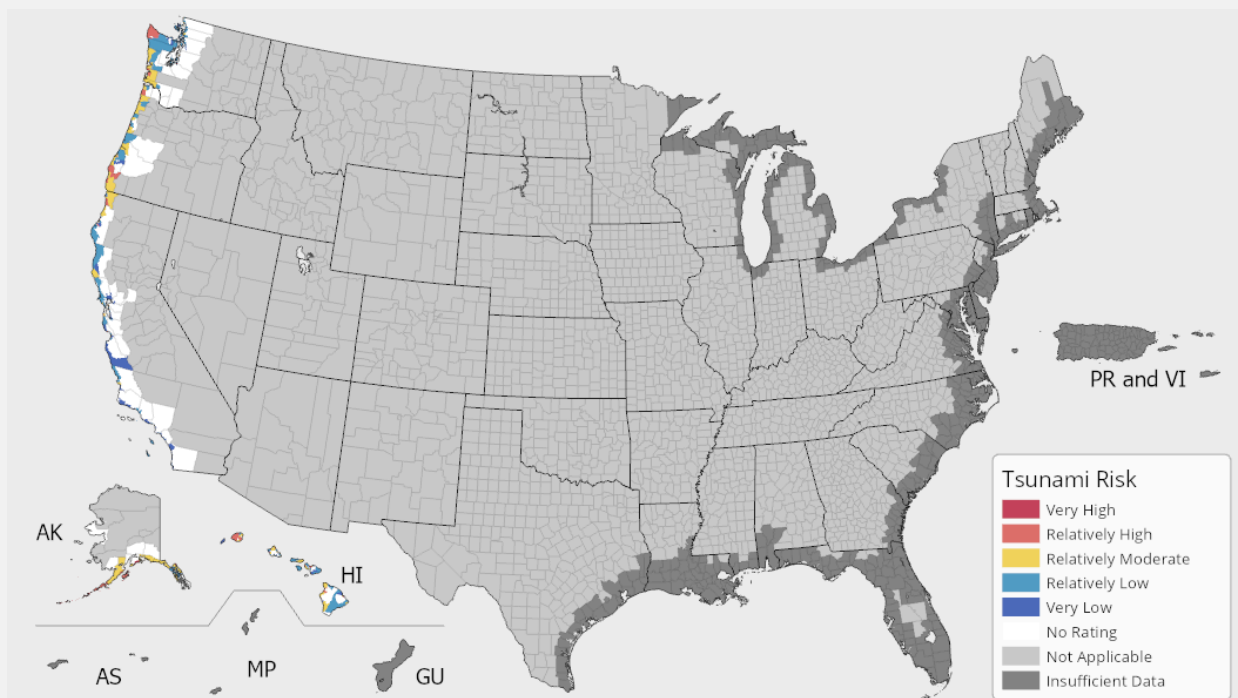
A tsunami could cause widespread flooding of the coast and nearby waterways. Move inland or to high ground immediately.

Tsunami Advisory

A tsunami could cause dangerous currents, rip tides or waves. Stay out of the water and away from beaches and waterways.

Tsunami Watch

A tsunami is possible, but the details are not yet known. Monitor reliable sources of information and be ready to take action.



[Tsunami | National Risk Index](#) (click for an interactive guide per county)

Mudflows

Floods often carry heavy debris flows which increase the risk and impact. There's a specific type of material flow which carries its own risks, however.

Mudflows occur when clay soils in hilly or mountainous areas become so saturated that they liquify. Mudflows can become more voluminous than a flood and can thoroughly scour whatever is in their path because of the volume and weight of the soil. They've been known to move rocks as large as houses, and anything else in their path, adding to their bulk as they move downward. They can be as high as 20 feet or more. Mudflows often occur when a massive storm occurs after repeated rainstorms that have already saturated the soil. When this condition exists, there is a greater chance a mudflow will occur.

Other factors that predict where mudflows may occur:

- In areas where landslides have occurred before
- In channels along streams and rivers
- On steep slopes and areas at the bottom of slopes or canyons
- In volcanic eruptions with rapid, heavy snowmelt
- Where wildfires have destroyed vegetation
- Where human modification of the land has destroyed vegetation
- On slopes that have been altered for the construction of buildings, roads, and other purposes.
- In areas where surface runoff is directed or channeled
- In areas where glacial melt may release a volume of water rapidly

Understanding your watershed and how water moves through it is the first step in understanding your flood risk and what to do to mitigate it.



Part 2:

Are You Vulnerable To Flooding?

There are a number of ways to determine how vulnerable you are to being flooded. Because flood risk assessments are changing, it's important to understand how to estimate your risk independently of traditionally used resources.

Your storm surge evacuation zone: You can find your specific zone by searching your county or state name plus "evacuation zone." Most vulnerable areas have a database where you can enter your address and see exactly what zone you are in. If you're in a low lying zone, the chances are greater you will be ordered to evacuate. People who stayed have ended up trapped in their attic or on the roof by storm surge, or worse. If you're in a "non-evac" zone, there are some circumstances where you may still want to evacuate, but you can also choose to shelter in place.

Often, when evacuating for hurricanes, Zone A will get the order first, and then additional zones if the hurricane is expected to strengthen.

This website illustrates what the evacuation zones are for Florida.

<https://floridadisaster.maps.arcgis.com/apps/instant/lookup/index.html?appid=aa18a2d8737c4d66bb6434a09e17203a>

Your flood risk: Because you can't tell how flood prone you are by looking at your immediate surroundings, it's important to know what your watershed and topography is. To determine what your approximate risk is, go to the FEMA website at [FEMA's National Flood Hazard Layer \(NFHL\) Viewer](#) and zoom in on your state and neighborhood. It will generate flood zone maps, known as [Flood Insurance Rate Maps \(FIRMs\)](#), that show areas of high and moderate to low flood risk. High-risk areas have a 1% or greater chance of flooding in any given year. The FIRM is used to determine building and flood insurance requirements.

Note that flood risk is increasing in many areas of the world for two main reasons. Record flooding is occurring in a number of regions.

Print a National Flood Hazard Layer FIRMette or a portion of the flood map showing surrounding areas to give you an idea of which roads to avoid during heavy rainfall. Understand that the FEMA maps are outdated and risks have risen, so if you are near a flood zone and only a couple of feet higher in altitude, you may want to consider yourself at risk, especially if rainfall could be exceptional. We are experiencing record floods in many parts of the country that are rising many feet beyond previous flood stages.

It is better to be prepared than to unexpectedly lose your home or valuables because you underestimated flood potential. Flood risk is increasing for two main reasons:

1. Because of changes in climate such as ocean heating, rainstorms and hurricanes are dumping more rain in shorter periods of time, creating more flood pressure in many areas.
2. New development may reduce or eliminate drainage provided by wetlands, forests and meadows, which can absorb many millions of gallons of water. More information on how to remedy this and reduce risk in the Deep Dive section.

Oftentimes, county websites will provide additional flooding information, such as the outlines of all the watersheds in the county, and links to the FEMA website. If you are near a river, the US Geological Survey (USGS) collects water level data on most major streams and rivers in the U.S., Visit [USGS | National Water Dashboard](#), and before and during a storm, you can use USGS's [Real-Time Flood Impact Map | U.S. Geological Survey](#), that shows warning icons when stream levels are rising and predicted to overflow stream banks.

What are 100 and 500 year flood zones?

These terms are quite misleading. This doesn't mean that the land only floods every 100 or 500 years. It means that based on historical records over the last several decades, there is approximately a 1% chance the area could flood in any given year. So, if flood risks in the past will be the same in the future, over a 30 year mortgage, there would be a 26% chance of serious, destructive flooding. Most people wouldn't get in an airplane that had a one in four chance of crashing, but they often build, buy, farm, or rent in such areas and plan to occupy it for decades.

There are some types and volumes of flooding that cannot be protected against but can only be avoided. These include extreme events where homes in even 500 year flood plains are completely engulfed, extreme mudflows, dams failing, sudden glacial failure, or rapidly moving volumes of water (in mountains, storm surge, etc). Many of us have seen photos of the village that was completely buried by glacial melt in Switzerland or homes buried in landslides or roofs covered in extreme rain events. Water is extremely powerful and can move even large, well built buildings from their foundations. ***Our best advice is to move out of the area if you suspect you are in the potential path of such an event.*** This guide offers solutions to milder cases of flooding, which can be devastating if you're not prepared.

We are not communicating this to scare people but to share on the ground realities that millions of people around the world have already experienced so that you can take steps now to be more prepared for the potential.

Flooding warnings and advisories

Most local news stations will provide up-to-date warnings of potential flooding, but they sometimes hype weather issues to promote ratings or are staffed by people with poor meteorological skills, so confirm with weather.gov if there is any doubt.

Flood Warning Stages:

--**Flood advisory** - Issued when flooding might happen but may not result in a warning. Stay aware of changing conditions.

Flood watch A flood watch will be issued when there is prediction that heavy rain could cause local rivers and or roads to rise above flood stage. This does not mean that a flood will occur, but that it could. The old saying is "Flee from water, shelter from wind."

In many locations, this may be a good time to evacuate - if you wait for a warning, your evacuation route could be cut off. In a flash flood situation, it's possible you won't get a warning in time to move to higher ground. Be aware of the risks. Overestimating them saves lives.

--**Flood warning** - This is issued when the flood is already happening or is imminent. Because flooding can cover large areas, happen quickly, and make evacuation difficult, don't wait for a warning to evacuate if you're in a flood plain or near one. You don't want to be in a floating car or hit by a falling tree or power line.

Part 3:

What To Do When A Storm Is Coming

A major storm is headed toward you. What do you do?

Note: This guide covers issues specific to flooding, but in our [General Guide](#), we share much more information of use to most disasters. The two guides are meant to work hand in hand, so please refer to our General Guide for more details on what you can do to prepare for any disaster and be maximally resilient.

You will need to decide whether to evacuate or not. This will depend on several factors:

How vulnerable your home is to flooding. As we've seen in a number of recent flood incidents that have gotten national news, sometimes floods exceed expectations. Usually, the severity of the storm is predicted by meteorologists, though their accuracy suffers several days out. Be sure to get information from reliable sources such as NOAA or meteorologists who go into details about risk, in order to make your decisions. Ultimately, you will need to decide your risk tolerance.

How vulnerable your neighborhood infrastructure is to flooding, including roads out. Even if you're not at risk of flooding, infrastructure you're dependent on can fail. This includes communications, roads, bridges, food, water, medicine, and other local services. If your region may be flooded, even if you're not at risk, you should prepare.

Often, in floods, electricity and water supplies are compromised for days or weeks. You might not be able to travel to your usual grocery store and that store may not be able to be stocked. So be prepared to provide for yourself if you stay - we recommend for weeks. Even if you don't need it, you will have that stability. See our [General Guide](#) for a robust list of things you may need to have and to do, to prepare.

Your evacuation route. In some watersheds, the evacuation route itself can become blocked by flooding. Be aware of flooding potential along your evacuation route. In many flood situations, bridges and low lying roads have been blocked or destroyed by water before people could evacuate. Mass evacuation can also cause traffic jams. If you evacuate, do so early to ensure a safe exit. And study potential evacuation routes for those on higher ground and during lesser rainfall events.



What Is Permaculture?

Permaculture is a contraction of the words ‘permanent’ and ‘agriculture’ which reconcieves annual tillage and soil disturbance-based agriculture into a **perennial-plant based agriculture** favoring tree crops, cover crops, and minimal soil disturbances. From agriculture comes fibers, fuels, medicines, foods, and other essential requirements for culture to persist and thrive. Permaculture has come to now mean ‘**permanent culture**’. As a design science, permaculture studies and catalogues **natural solutions** to flood, fire, extreme heat, droughts, climate adaptation, and ecosystem management techniques both old and new. Using permaculture design, we can build **landscapes, buildings, and communities** that resist disasters by their very design.

Protect property from flooding checklist

If you are in a potential flood or evac zone, you should take appropriate precautions whether you stay or evacuate. Find out what the storm surge or flood level is expected to be on the high end and prepare for that. It is best to go through this list before a flood warning arrives, and organize things so you can get everything done in a short period of time. Practicing doing these steps will quickly let you know what you may have forgotten or overlooked. These steps are not in any particular order; your individual circumstance will dictate which order you do them in.

- Prep and ready any pumps** you may have such as sump pump, pond or puddle pumps (see Deep Dive for more information on these - highly recommended).
- Move necessity items and valuable items** to higher positions in your home, on countertops or second floor or attic, or to a different location on higher ground. This can include food, appliances, computers, important papers, and valuables like art. Think about what you will need when you return, and what you will most miss. Figure this out and have a plan before a hurricane hits or flood happens. We strongly recommend storing valuable documents and other valuables in a waterproof bag. See our “Overall guide” for a checklist of items to take with you.
- Shut off electricity at the breaker panel**, turn off gas and unplug appliances if you expect to be flooded.
- Turn off furnaces and water heaters.** This can help prevent petroleum toxin damage to your home.
- Move gas cans and other toxins as high as possible.** This includes your generator, if you have one.

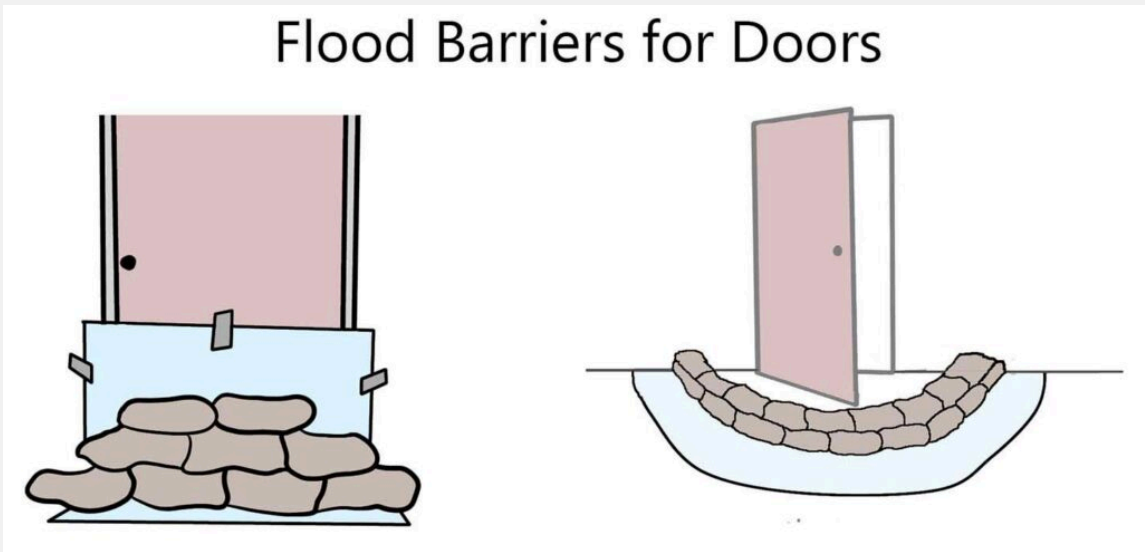
These can create a toxic stew that can make parts of your home non-recoverable or much more expensive to recover when flooded if toxins soak into the walls or floors/subflooring. If you have water resistant containers, put valuables in them.

- Elevate major appliances onto concrete blocks.**

- Move any vehicles you aren't driving out of the flood risk area.** Vehicles release toxins and are often, on a practical basis, unrepairable once flooded.
- Move any EVs, E-bikes** or other lithium ion battery powered equipment out of the flood zone. They can combust after being flooded; houses have been burnt down because of a battery fire, sometimes days after flooding.
- Anchor your fuel tanks** if you can't move them to higher ground. Unanchored tanks can float, rupture, and release fuel.
- Clean gutters, downspouts,** and splash pads, along with any nearby drainage ditches or storm drains, ensure water can flow freely away from your home.
- Close sewer or septic backflow valves,** if you have them
- Plug sinks, tubs and toilets** with plugs or bungs and weigh them down to inhibit backflow, if no backflow valves
- Move frozen/refrigerated items** to a friends house out of the flood zone (if time)
- Deploy temporary flood barriers,** such as portable flood gates or shields, sandbags, inflatable floodwalls, and flood skirts to entrances to your home and other areas that may help prevent flooding. These likely won't stop major flooding but can prevent damage from minor flooding. Local cities or counties usually give them away for free if a hurricane or flood is imminent.
- Sandbags and flood barriers are the most effective means of flood damage protection for the cost. If you do nothing else, do this.**

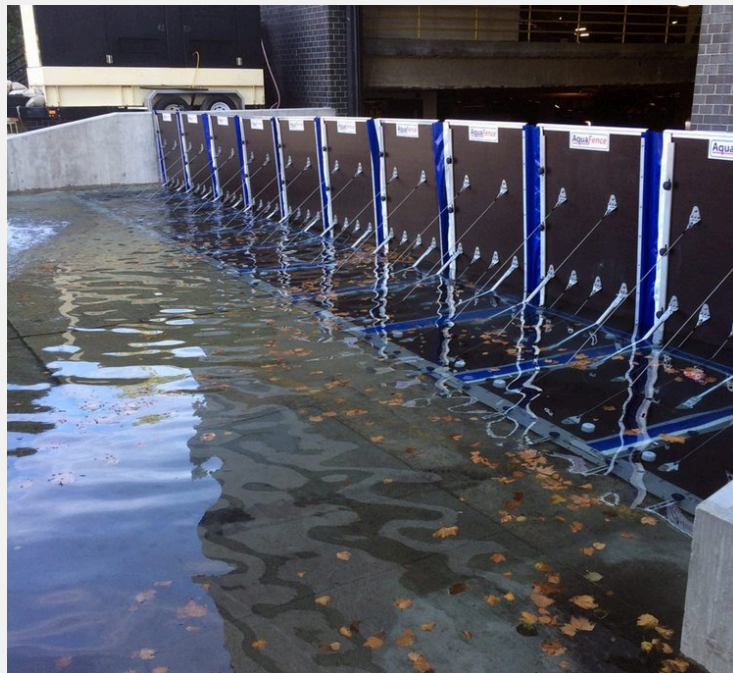


Flood Barriers for Doors



Using a tarp or other barrier under the sandbags reduces the possibility of leaks. The second illustration shows a barrier that allows the door to open. There are “sandless” sandbags and other flood barriers you can purchase. We don’t recommend a particular brand, but if properly constructed, they do work and industrial versions are used by hospitals, universities, companies and more. There are many types of flood barriers including inflatable, metal, and plastic.

There are also inexpensive threshold barriers that prevent water from entering garages and homes through the threshold, one of the key entry points. We recommend due diligence and reviewing any purchased products as some work better than others. Some have been tested and are FEMA compliant.



This Aquafence floodwall is one example of a FEMA compliant flood barrier.

Note: Record flooding is happening around the world. Ensure your flood wall is high enough for a record flood. Some of the worst damage has occurred because people didn't predict how bad flooding could get. Having some simple but adequate preparation in place can make the difference between extensive or catastrophic flood damage and remediable damage or no damage.

Community preparedness

A successful action for some has been to prepare with neighbors. If someone isn't home, neighbors can install barriers and prep their home for them, and vice versa. In attached homes or homes that are close together, a coordinated plan can make the difference between success and failure, especially when using flood barriers. In some cases, it might make sense for the neighborhood to invest in a barrier to prevent floodwaters from entering the entire neighborhood. This may need permitting, as it will be sent elsewhere, which might have worsened flooding.

Lessons learned: When surveyed, a number of people who have been flooded in the UK wish:

1. That they kept all flood related materials in one place that is quick and easy to access (extra pumps, flood barriers, tools for installation, etc)
2. That they coordinated more with neighbors.
3. That they had done more of the simple preparation steps beforehand
4. That they documented damages better.
5. That they had followed the clean up steps exactly; they would have salvaged more items.

Simple preparation

These steps should be done if you think you may have flood issues or have flooded in the past, and have some time to prepare but want to or need to limit your commitment.

Flood Insurance:

If you are in a flood zone, chances are you are required by mortgage lenders to have flood insurance. If not, it is something to consider, especially if your home is likely to be badly damaged in a flood (because of the materials it's made of and other factors). Flood insurance is not available in every flood

prone area. Communities and individual homeowners must meet certain requirements before it is made available to individual homeowners. Check with your local insurance agent for more information.

Landscaping:

The key short term actions to take with landscaping is to move water away from your home and areas of the yard you don't want flooded, and create more places water can go and be absorbed.

Our Deeper Dive guide goes into a variety of approaches to both of these, but here are a couple of things you can do on a short term basis.

Ensure rain from your roof drains away from your home and doesn't pool. If you have gutters, make sure the downspout sends water to a place in your yard where it moves away from your home. A short or absent downspout directs water against your home where it is more likely to penetrate through cracks or insufficiently sealed doors or windows. If you don't have gutters, note where rain pools nearest your home from your roof, and create emergency drainage away from that area. In an emergency, this can be done with crude earthworks or plastic sheeting. See Deep Dive for multiple solutions to this.

Reroute water with simple berms. If there are sections of your yard where you know water pools near your home from a driveway or street, you may be able to reroute it with simple "earthworks" such as a berm that guides it around your house to an area where it can drain. Logs can be helpful in rerouting water to some degree.

Buildings:

A building does not have to be inundated by a river or flood waters to experience severe damage from an extreme rain event. Basements are often a source of flood damage because of pressure from saturated soil. Bad drainage can cause water to seep under door sills or through basement windows. Any steps you can take to move water away from your home will reduce your chances of flood damage.

Please see the Deep Dive section for more in-depth solutions. These steps are relatively quick and inexpensive.

Your roof produces a tremendous amount of water and concentrates it around the foundation of your home. Moving it away from your home is important.

Seal any cracks in your basement walls or floors with water resistant mortar and masonry caulk or hydraulic cement, which expands when wet.

Seal cracks in windows and doors; there are materials that are waterproof and meant to keep out water and moisture.

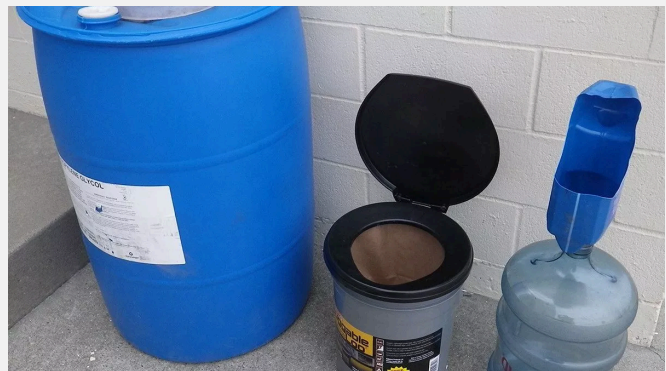
Install a toilet bung to prevent flood water from coming up through your septic or sewer system. If flooding is severe, this doesn't always work.

Install check valves on sewer or septic pipes. Plan to spend \$100 or more per valve to have a pro install them, or do it yourself for \$10-\$15 each to ensure sewage can't back up into the standing water in your home. This can create major health issues and complications. Toilet bungs are not always sufficient. Don't skimp on this. Install at a point in the pipe that's easy to access for repair.

See "compost toilets" in our Overall Deep Dive guide for an alternative toilet to use while it's flooding and afterwards during cleanup, if needed.

Raise utilities such as furnaces, HVAC and hot water heaters above the expected flood line by placing them on blocks.

Acquire and prepare easily stored and assembled scaffolding, shelving, boxes, etc, to use to raise furniture before a flood



Compost toilets can help manage wastes in an emergency

Part 4: After The Flood

Safety

Significantly more people die or are injured from accidents while driving through damaged areas, cutting up trees, repairing roofs and other flood preparation or recovery work than from the flood itself. So, safety first!

You may not be able to return to the area if there is a toxic release, downed electrical wires or other safety issues. This is why the contents of your go bag are so important.

Don't travel through water, especially if it's moving. Even six inches of water can cause loss of control of the vehicle, and 18 inches can move it off the road. Drowning is the leading cause of death in hurricanes and floods, and drowning in vehicles is the #1 way that happens. Flooding can crest hours or days after a major storm passes, depending on the topography of the land.

Keep in mind that flood water can be contaminated and contain dangerous debris. Underground or downed power lines can also electrically charge the water. Wading in it can be a risk.

Use safety equipment for clean-up if there is a possibility of toxic exposure, mold or other injury. If you're in a populated area, it is a safe assumption that the floodwaters likely have toxins, pathogens, or sharp objects such as broken glass in them. See "Toxins" below for more information.

We recommend:

--**N95 mask or better**

--**Hard hat**

--**Safety goggles**

--**Hard toed boots or rubber boots**

--**Heavy gloves**

--**Disposable coveralls** may be appropriate in some cases to protect your skin and clothing

If you are exposed to flood waters through a cut or your nose/mouth, clean thoroughly and consider seeing a doctor. If your tetanus shot isn't current, get a shot.

Wash thoroughly after working on your home.

Your property

Home

--Ensure the home is structurally stable. If it has damage from tree fall or wind and you're not sure how it has been damaged structurally, get a professional to inspect it before entering.

--Open windows and doors to let the air circulate. Allow some time for this to occur before beginning work. This ventilation will help remove foul odors, protect you from collected gas, and will also help dry out the house.

--Run fans in every room if possible, to assist with circulation and drying. Keep generators outside and at least 20 feet from any open windows or doors to avoid carbon monoxide poisoning.

Electricity and gas

--Avoid contact with loose or dangling electrical wires, and report them to the power company. Inspect all areas of your property for loose wires.

--Be aware that electrical appliances can be wet and electric shocks can occur. Turn off the electricity if you're able to do so, especially if there is still residue flood water in the home.

--Check for gas leaks. Do not strike a match or lighter or relight appliances until they have been inspected.

Water

--City or well water may be contaminated and not be safe to use without filtration. Don't give it to your animals either. Your city or water management district or water utility will have more information, but don't assume that your water has been tested, especially immediately after the event.

--Drink, wash dishes, bathe, clean with bottled, boiled or treated water only until you get the all clear on your water supply. Keep in mind that while this protects you from pathogens, it doesn't protect you from chemicals or PFAs, etc, that might have ended up in the water. This is an excellent reason to have an enclosed rain water storage system with a filter.

--Report broken sewer or water mains to the water department.

Personal items

--There are methods of salvaging art, books and other items damaged by floodwater. This is a specialty area if items are too damaged, but drying them out aggressively and quickly is the #1 action that should be taken. Use the sun, fans, heat, whatever is available to speed the drying process. In some cases, this could injure items (like art or musical instruments). See our library entries for specialized instructions on salvaging valuable flood damaged items.

Toxins

--Flood waters and mudflows can carry many forms of toxins. These can include pesticides, agricultural chemicals, heavy metals, and petroleum products. Biological contamination may include bacteria, parasites, and viruses such as *E. coli*, *Listeria*, *Salmonella*, and *Norovirus* originating from upstream farms, rural septic systems, sewage systems, and raw manure, including raw human sewage.

--If your home has been wind damaged and ceilings, insulation, etc, are exposed, keep in mind that asbestos and lead based paint are common in building materials of older homes especially.

--Mold can be a significant health issue in flood damaged homes. Be sure to wear a mask, and wet mold thoroughly before cleaning to reduce spread of spores.

--If you suspect asbestos or other serious toxins may be present, call your local Health Hazards agency. You could expose others or their pets to toxins if not properly cleared. In many cases, governments will require a professional team to clean up some locations before allowing homeowners to return; the risk is too great.

--Always wear an N95 mask minimally and protective clothing in flooded homes. Be sure to sanitize whatever gets dirty. Keep your pet safe from being exposed to toxins they may ingest or absorb through skin.

--Dispose of perishable, contaminated, or water-soaked foods, including any water or food for animals. This will also ensure that stray or wild animals cannot eat it.

--If your home flooded, get clothing and other cloth material out of the house --as soon as possible to reduce mold and mildew. Hanging them on a clothesline in the sun can do wonders. You may have to discard them however.

--If your garden or farm was flooded, there is a risk that flood waters were contaminated. You may need to remove the soil from your garden completely or bioremediate and start over. Start by testing your soil for likely toxins. We strongly recommend using bioremediation techniques rather than removing soil, if possible. See our guide on Toxins for more information.

Repairs

--Assess for any repairs and analyze which are most important to fix, and which can wait. What will be further damaged if not repaired? It's essential to dry things out fast to reduce further damage.

--If the roof has any damage, get it effectively protected right away with a strong tarp or suitable material until it can be repaired. Waterproof canvas tarps tend to last much longer than plastic tarps. Make sure your temporary fix doesn't leak.

--Dry everything out as fast and thoroughly as possible, before mold sets in (see water damage section). This is the key action to focus on (other than structural) to reduce further damage and expense. Powerful fans and good air circulation are one of the most effective ways to dry out floors and walls. Use many large fans to do this.

--Pump out the basement if it is flooded, but do it gradually. Drain one third of the floodwaters each day to minimize further structural damage.

--Simultaneously get the mud out of the house that can cause mold and may have toxins in it. See below for more details on cleaning.

Insurance

--Document every bit of damage as you assess, with photos, video and notes before you start cleaning or repairing anything. Continue to document as you go. This will be used for insurance purposes or other potential funding, later. Don't skimp on this. It may be the last thing you want to do, but it could mean the difference between getting financial help or not.

--File a claim as soon as possible. While most insurance companies don't cover flood damage without a specialized policy, there may be other damage, such as wind, that is covered. There may also be grants or other funds from local government, non-profits or other sources.

--Save receipts for any repair related expense. See our "Overall Guide" for more information about what to track and why.

--If you repair things yourself, verify whether insurance will pay, and if so, what they need from you exactly in order to do that. Get it in writing, preferably in your contract with them.

--Make any temporary repairs necessary to prevent further losses, including repair to fencing needed to keep animals confined.

--If electrical outlets were flooded, change them.

--Take insurance money for your flooded car. It will continue to give you problems (much better to move it before it gets flooded!)

--Use only licensed, insured and verified contractors for repairs you don't do yourself. There are far too many scammers out there preying on disaster victims. And you will need permits/contractors for insurance purposes.

--Important: If your home flooded once, it could happen again. While we recommend considering moving away from any flood prone area as your best defense, if you do rebuild in the same location, we strongly recommend you research our "Deeper Dive" guide for flooding. You can prevent future damage if you rebuild for resilience.

Cleaning a flood damaged building

Step by step:

<https://restorationmasterfinder.com/restoration/10-tips-to-follow-after-a-flood-damage/>

The biggest issue will be persistent mold. Thus, you must either clean or remove everything that could allow it to survive, including under the floor, crawl space, subflooring, etc.

1. **Get the mess out** - remove all debris, mud, furniture, and other items from the house that got wet. Sort it into three piles:
2. **Things you want to save:** clothing and cloth can usually be washed in bleach and salvaged. Books and similar can be dried; Red Cross has directions. Other valuables like art can also be cleaned. All must be cleaned and dried.
3. **Things of value that must be thrown away.** Furniture cushions, beds, particle board, computers or other electronics, etc. Place it all together and take good photos. The insurance adjustor may also want to see it so don't throw it out yet.
4. **Garbage:** Flooded carpet, food exposed to flooding, papers you're not salvaging, etc, should all be disposed of. Ensure you check with your local waste management as to how to sort or discard it.
5. **Clean up any dirt on non-porous surfaces thoroughly** (any surface that is porous (like drywall) will need to be replaced. Scrub with soap and water to remove any surface dirt and mold. Apply bleach to all surfaces (follow the label directions) and leave for 15 minutes. Some have used Effective Microorganisms to clean up mold, even black mold, successfully. They may even be able to get into hard to reach spaces to destroy mold because they actually consume the mold.
6. **Check the floors.** Remove carpet if flooded, it can't be recovered. Remove any flooring or subflooring that has been soaked and can't be thoroughly cleaned and dried out.
7. **Dry out the walls.** This may entail removing any drywall and insulation that got wet, and opening up the wall to the studs. Outside walls should be checked too. Plaster, brick or concrete should be ok but other materials may need additional handling. (See below for details)
8. **Check heating and AC systems.** If water got into the ducts, it can create a very unhealthy mold situation that will be sent airborne through your home. The system will need special attention.
9. **Everything needs to be fully dry** before you start rebuilding.

Drying out your home

1. **You will need electricity to do this rapidly.** This can be provided with a generator or solar panels if the grid is down (which is likely in a mass flood).
2. **If there is still water in the home**, once it starts receding, use a puddle pump or pond pump to remove water and silt
3. Once water is drained, open the house when humidity is lower outside, close it up when humidity is higher
4. **Open closets, remove drawers.** Get as much air exposure and circulation to anything that is wet as possible.
5. **Use fans**, as many as you can.
6. **Run dehumidifiers and/or air conditioning**, especially in enclosed areas like closets.
7. **Use desiccants**, like clay cat litter, biochar.
8. **Consider hiring a professional** if the damage is very bad.
9. **Be patient** - the drying process can take several weeks. Don't cover up anything until it is fully dry.

What to clean with?

It's important to kill mold and pathogens left behind by flood waters. The earlier you address mold, the better. Once it penetrates surfaces or spreads extensively, it is much more difficult, and dangerous, to clean. Consider using professionals if it gets to that point. There is a point where materials, including under floor or structural supports may need to be removed which can be quite expensive.

Not every surface can be cleaned - porous materials like carpets, clothing, books and drywall, are usually better discarded if there is extensive mold. There are many references on how to remove mold and water damage from clothing, art and books. It can be a laborious process to ensure all mold is safely removed from these items. However, it is well worth it to clean surfaces that can be more easily cleaned.

Bleach is often the first choice to kill microorganisms, but it also adds to the toxic load in the environment, including your body, and can be damaging to many surfaces. It also cannot be mixed with other substances, like vinegar, as it can produce a quite toxic gas. There are better alternatives.

Vinegar - Less toxic than bleach, it effectively kills most mold and bacteria, including black mold, because of its high acid content. Use full strength, let sit on mold for 10-15 minutes, and wipe off. It can also help remove stains left by mold. Use vinegar on moldy glass, plastic, porcelain, stainless steel, or vinyl. Undiluted vinegar is safe to use on almost any material that isn't wood, granite, marble, or some other type of stone. Spray it on plastic, stainless steel, and glass to kill mold on these surfaces. You can also apply it to mirrors, non-stone tiles, grout, sinks, toilets, bathtubs, and showers.

Borax is a type of salt considered safe for household use as long as you don't inhale or ingest it. It kills mold by disrupting its pH level, allowing it to break down. Mix 1 cup (204 grams) Borax with 1 US gal (3.8 L) of water in a spray bottle, then spray it on the moldy area. Brush the solution into the mold, then wipe the area with paper towels.

Effective Microorganisms eat black mold and other forms of mold. It can be more effective than other forms of cleaning in some situations because it is living, and can pursue the black mold into places difficult for other cleaners to reach. Spray it on the affected area and let it sit. It doesn't work on every material. More study on how effective this is in relation to other cleaners and to determine the most effective ways to use it would be helpful. There are companies that specialize in using microorganisms to clean up pollution and toxins.

Tea tree oil is a natural antifungal agent that can kill mold. Add 2 tsp (9.9 ml) of the oil to 2 c (470 mL) of water or 2 c (470 mL) of distilled white vinegar in a spray bottle. Then spray it directly onto the mold and let it penetrate for 1 hour. Scrub or wipe the area to finish cleaning it. Clean the area again if you still see mold.^[14] Make sure the tea tree oil contains at least 30% Terpinen-4-ol and at least 10-15% Cineole. In one study, tea tree oil killed mold better than vinegar, alcohol or some commercial mold cleaners.

There are three ways to clean mold from wood:

- Sanding the moldy area away
- Cutting out the moldy wood and replacing it with new material
- Painting the moldy wood with fiber lock paint to seal it in, so it will die off.

Tree aftercare

If trees have been flooded:

--**Remove salt.** If you feel there may be saltwater damage on plants, flush them with fresh water. You can save your plants by doing that. Hurricanes often carry salt with them, especially if you live within a few blocks of the sea. Some plants are more sensitive to salt than others.

--**Remove sediment.** Once most of the water has drained, remove sediment, trash or dirt that may have been deposited. A layer of sediment 3 or more inches deep can suffocate tree roots. Remove sediment from around the tree trunk and bark especially; this area is especially vulnerable to diseases present in moist soil and organic material. No more than 1" of sediment against the trunk should remain.

--**Protect the roots.** Tree roots can be eroded by severe flooding. This makes the tree more vulnerable to uprooting and health issues. Fill in around the roots with soil similar to what the tree has been growing in, ensuring there are no air pockets underneath the roots. You should see the beginning of roots at the base but no more than that.

--**Remove dead branches.** Once the tree bark has fully dried, prune any broken, dead, damaged or diseased branches. When the bark is wet, pruning can expose the tree to disease pathogens. Don't leave short stumps on pruned branches. Rather do a "natural target cut". See <https://crfg.org/wp-content/uploads/Natural-Target-Pruning-Handout.pdf>

--**Remove mulch.** While this is counterintuitive to permaculturists, removing mulch can allow the saturated soil to dry and tree roots to breathe.

--**Straighten trees.** Is the tree leaning? A large tree that is partially uprooted may need to be removed, depending on the circumstances. A certified arborist can help determine this. Smaller trees can often be straightened and staked until roots have regrown.

--**Support health.** Don't fertilize right away, the tree needs time to recover. Ensure there is minimum stress on the tree from other sources, if you can, as recovery time could accelerate.

Large animals

--**Provide fresh water.** If pastures have been flooded, especially with seawater, the water could cause illness or death of animals. Hauling fresh, uncontaminated water to pastured animals after the event should be done.

--**Remove mud.** It is especially important to remove mud from barns as horses and livestock will develop foot problems which can be severe or even fatal if they stand in mud for too long.

Waste

--**Keep your trash well contained.** It may take a while to pick it up and if it gets scattered or blows around, it could contribute to the toxicity in the area.

--**Organize trash.** Though it is often the last thing on one's mind when cleaning up damage from a hurricane, if possible, the trash should be organized into categories such as organic material (downed trees, etc), building materials, metals, etc. Some locations require this in order to pick it up, so check with your local waste management division.

How much damage can a flood cause?

A flooded creek can move a parking lot of cars

<https://www.youtube.com/watch?v=kYUpkPTcqPY>



About

This Flooding Toolkit is one of a series of **free guides** designed to help you prepare for disasters. It provides regenerative solutions to create more resilient landscapes, ease recovery, build long-term resilience, and restore local ecosystems.

These guides were created in response to the widespread damage caused by Hurricane Helene, southern California wildfires, and other recent devastating disasters. The Permaculture Institute of North America (PINA), Association for Regenerative Culture (ARC), and WeRegenerate have come together as the **Disaster Resilience Initiative** to produce this series of educational resources on disaster management viewed through an integrated, multi-solution, permaculture lens.

Our guides outline **step-by-step** actions to lessen impacts and protect yourself from imminent disasters, prepare quickly, and develop longer-term resilience strategies. In addition to these resources, we offer monthly town halls, an online forum, and are developing a comprehensive online library of regenerative solutions, online summits, a resource directory, and other educational and networking opportunities.

These collated, targeted resources support community leaders, groups, and individuals in preparing for and responding to fire, flood, hurricane, tornado, landslide, other extreme weather, and economic or social crises—helping to **rebuild homes, communities, and environments in a more resilient and regenerative way.**

We've gathered best practices from a wide range of sources, including wildfire specialists from California, Australia, and Canada, as well as permaculturists working in flood-prone regions. We are grateful to the many experts who contributed to this document through their generous advice and free materials.

This is a **community based project** and a living document. We are actively seeking input from others to improve this information. Please contact us if you have resources to share or if you'd like to contribute to this project in other ways.

If you print, printing in black and white will save ink. A print copy of checklists is **[here](#)**, to place in your bug-out bag. We will continue to update this toolkit. For the most up to date versions and access to all other guides see: **PcX.earth/disaster**

PROJECT OVERVIEW



Project Information	Details
Project Name	Disaster Resilience Initiative
Project Managers	Jesse Tack, Lee Barnes, Suzanne Bonefas, Elizabeth Lynch, Koreen Brennan
Project Start Date	September, 2024
Project End Date	Continuous

1. Project Summary

Objective	To create a complete set of free resources for all disaster types in North America and Hawaii from the permaculture perspective
Scope	Across many media types, we will produce: checklists, printouts, guides, research libraries, town halls, summits, interviews, etc.

2. Project Milestones

Milestone	Date	Result	Status
Overall Preparation Guide	Sep, 2024	<u>Guide</u>	Complete
1st Town Hall	Nov 15, 2024	<u>Video</u>	Complete
Open Disaster Resiliency Working Group	Nov, 2024	<u>Open Working Group</u>	In Progress
2nd-8th Town Hall	Dec 13 th , 2024-July, 2025	<u>Video</u>	Complete
Fire Preparation Toolkit	Mar, 2025	<u>Guide</u>	Complete
Disaster Regeneration Summit	Aug, 2025	<u>Replays for PINA Members</u>	Complete
Winter Prep Toolkit	Coming soon	N/A	In Progress
Extreme Heat	Coming soon	N/A	In Progress
Earthquakes	Coming soon	N/A	In Progress

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