

# A GUIDE FOR RESILIENT HOUSING DESIGN IN ISLAND COMMUNITIES



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ASOCIACIÓN DE CONSTRUCTORES DE PUERTO RICO





## **PASSIVE HABITABILITY**

Strategies that improve a housing facility's ability to maintain habitable conditions in the event of extended power loss or in the event of hazardous conditions related to natural hazards.



This chapter introduces the concept of "passive habitability," or how building components and ways of operating them can help households survive during an extended outage of municipal energy, water or gas systems. Passive survivability is a holistic concept: a building's structure, energy system, water system and immediate surroundings all work together so that people can live "off the grid." Some techniques of passive survivability are useful for new construction, such as shaping a house in relation to the sun and prevailing breezes in order to keep the interior temperature comfortable with little or no power. Other methods of managing your current home on an everyday basis, such as optimizing air flow and natural light, can reduce your dependence on electricity for cooling and lighting. This is especially important as the number of hot nights on the island rises, increasing the need for 24-hour cooling.

#### STRATEGY # 5 •(I)• 2 4 STRATEGY NAME/TITLE REDUCE CONTROL **THERMAL HEAT** INCREASE **BENEFIT FROM MOISTURE AND TRANSFER** VENTILATION **NATURAL LIGHT** MOLD **MANAGE PESTS** DESCRIPTION This strategy This strategy Natural light This strategy focuses This strategy on mold prevention by focuses on shows how using improves a home's focuses on actions quality and comfort slowing down heat mechanical-free or eliminating sources of that individual transfer to reduce "passive" ventilation by efficiently moisture. homeowners or dependence on actions can promote illuminating interior communities can cooling systemsand air movement spaces while take towards maintain a habitable through and within a lowering the overall preventing and indoor temperature, building to maintain energy consumption. mitigating pests in year round after a comfortable indoor Increasing natural a way that promotes a storm or during temperature without light or daylighting non-toxic solutions power outages. electricity. a room can provide to manage specific pest problems, light to occupants when electricity is referred to as unavailable. This Integrated Pest strategy shows you Management (IPM). how to increase natural light. \$\$ \$\$\$ \$\$\$

### TYPES OF STRATEGIES LISTED IN THIS SECTION

## INTRODUCTION

This chapter explains the principles of what makes a home heat up ("thermal heat transfer"), and how manage sunlight and air currents to keep it as comfortable as possible with minimal use of electricity. Incorporating passive survivability strategies into the way you live now will reduce your energy bill and protect residents in hazardous conditions, like extreme heat or long power outages.

Staying cool, safe air, a pest-free environment and nutritious food are essential to good health. Ways to reduce common health hazards and increase food security are also addressed in this chapter.

### **REDUCE THERMAL HEAT** TRANSFER

Materials and orientation of homes on a site impact the indoor temperature of a living space. Reflective surfaces and shading prevent heat gain directly from sun while insulation slows heat transfer from the outside building surfaces through walls and roof toward the cooler interior environment. In Puerto Rico's tropical climate, depending less on mechanical systems to cool a space reduces energy costs and increases day-long and year-round space comfort. This strategy focuses on slowing down heat transfer to reduce dependence on cooling systems and maintain a habitable indoor temperature, year-round, after a storm, or during power outages.

### WHAT YOU NEED TO KNOW

- ► Thermal heat gain is how much sunlight raises indoor temperature and is determined by:
- ► Materials The characteristics of the exterior materials, particularly the ability to reflect sunlight and resist heat transfer.
- Orientation Direction of building facade determines how much sunlight enters a spac.
- Construction Cracks and gaps on walls or roof allows air to enter a home
- Ventilation Changes temperature as outdoor and indoor air come into contact. See Strategy 13.

► Outdoor conditions - the sunlight, temperature and wind at the home site.

\$\$

Gain

Strategy in Action

2. Provide Cool Roots

3. Shade the Home

Materials

6. Build to Code

4. Enhance Windows

**1**. Orient Home to Reduce Heat

5. Choose Thermally Efficient

- ► Elevation The mountain region is colder than the valley or the coast.
- ► Time of Day Homes gain heat during the day and release it at night. Daytime to nighttime temperature differences will be smaller near sea level and higher at higher elevations.
- ► Elevated Outdoor temperatures-A home heats up when outdoor temperatures rise and/or surfaces become hot from sunlight.



### **SUPPORTING STRATEGIES**

02	07	13	14
Fortify	Anchor,	Benefit	Benefit
your Site	Seal and	from	from
with Green	Protect	Cross	Natural
Infrastructure	Openings	Ventilation	Light

### REDUCE THERMAL HEAT TRANSFER

### **STEP 1 - ORIENT HOME TO REDUCE HEAT GAIN**

The critical facades for heat gain are east, south, and west. Lower sun angles on the east and west sides of a building mean greater heat gain for east and west facing windows and walls. To minimize morning and afternoon heating, orient a building such that the longer sides (typically having more windows) face north/south, and the narrower sides (with less windows) face east/ west. See Strategy 11 for more on orientation of windows.



WEST In the afternoon, the West façade receives direct sunlight.



**SOUTH** Throughout the day, the South façade receives direct sunlight – from low in the sky in winter to high angle in summer.





**NORTH** Throughout the day, the North façade receives indirect sunlight.



EAST In the morning, the East façade receives direct sunlight.

### **STEP 2 - PROVIDE COOL ROOFS**



White or light colored roof surfaces that are highly reflective are recommended because they reflect heat from sunlight and prevent heat from entering a home and heating it up, while dark roofs absorbs sunlight which can heat up the home and surrounding site. Look for roof products or coatings with an aged solar reflectance greater than or equal to 0.55 which means that 55% of the heat is reflected away from the home keeping it cooler.

Provide roof or ceiling insulation of at least R-30.









Light colors reflet most of the sunlight, thus they absorb little and do not heat up the space.





Dark colors absorb most of the sunlight, thus they reflect little and do heat up the space.

For painting your roof, loof for Energy Star roofing products: these products reflect the sunlight and reduce the amount of heat transferred to the interior of the space. EAST

**STRATEGY** 

## **REDUCE THERMAL HEAT** TRANSFER

### **STEP 3 - SHADE THE HOME**

Use vegetation and add architectural features to provide shade and prevent the Sun's heat from entering the home.

- ▶ The foliage of the tree provides the most shade. Ensure that the tree's height and location will cast shade on the right surface, at the desired time of the day.
- ► Keep a considerable distance between vegetation and the home to avoid damage during strong winds. The distance from the tree to the house should exceed the tree's height.

### SOUTH

- ▶ Vertical and horizontal Shading around an eastfacing window provide shading for late morning.
- ▶ Plant tall shrubs or short trees on the East side to reduce morning direct.







▶ Plant tall trees on the South side to reduce daylong direct sunlight. Awnings or shaded porch can also serve this purpose.





### **OPERATIONS AND MAINTENANCE TIPS**

- ▶ Ensure roof overhangs, windows, and shading devices can withstand hurricane winds. Inspect them for for loose anchors or other parts, rust and corrosion. Repair as necessary.
- ▶ Trim trees regularly to prevent damage from loose limbs.
- $\triangleright$ Remove awnings that do not provide sun protection and can possibly become projectiles.

### **WEST**

- Vertically and horizontally shade west facing windows to block afternoon sun.
- ▶ Plant tall shrubs or short trees on West side to reduce afternoon direct sunlight.







### NORTH

► Interior shade for glare control or if window is an accordian "miami" style curtain, close them slightly.

► Plant light greenery on the North side for glare control, if necessary.



### **STRATEGY REDUCE THERMAL HEAT** TRANSFER

### **STEP 4 - ENHANCE WINDOWS**

Add architectural features or enhance windows to provide shade and reduce thermal heat gain.





### AWNINGS OR BAHAMA

- Available in canvas, wood or metal.
- Operable ones can be deployed as necessary in response to the sun.
- Anchor well to avoid breakage or detachment.



**RETRACTABLE OR INTERIOR** 



CURTAINS Can reduce solar heat gain and provide light level control and glare control

### **STEP 5 - CHOOSE THERMALLY EFFICIENT MATERIALS**

► Cover south, east, and west facing glass windows, glass doors or skylights with a tinted film to keep visibility to the outside, but reduce heat gain. For new construction and alternatively for existing homes, replace unshaded south, east and west facing glass windows, glass doors or skylights with newer windows that have a solar heat gain coefficient (SHGC) of 0.40 or lower. Low SHGC windows help minimize solar heat gain into the home.



### ROOFS

- Roof aged solar reflectance >= 0.55
- Insulate to at least R-30.
- Consider radiant barriers.

#### **GLASS WINDOWS, GLASS DOORS AND SKYLIGHTS**

 Window film or low solar heat gain coefficient (SHGC) products for unshaded glass.

### **STEP 6 - BUILD TO CODE**

- ► Code compliance is required in Puerto Rico.
- Energy codes provide "one-stop shopping" for the minimum cost-effective building efficiency standards.
- Consider exceeding code levels where costs are low.

► Look for roof products or coatings with an aged solar reflectance greater than or equal to 0.55 and insulate roofs to at least R-30.

Select white or light colored paint for unshaded walls and insulate walls to at least R-4.



► Energy code compliant buildings are typically more comfortable than those not built to code.

► It is significantly less expensive to improve energy efficiency in new construction than in a retrofit.

### STRATEGY

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## **INCREASE VENTILATION**

As outside air moves through a space, it affects both the temperature and the moisture content of air inside. Ventilation -replacing indoor air with outdoor air without the use of mechanical fans-- reduces moisture, equalizes air temperature and humidity, and cools our bodies as it evaporates sweat. Even humid air moving quickly across our skin will make us feel cooler, so increasing the speed and volume of air exchanged between the inside and outside of a space makes the environment feel more comfortable.

This strategy shows how using mechanical free or "passive" ventilation actions can promote air movement through and within a building to maintain a comfortable indoor temperature without use of electricity. The key to managing ventilation is making the most of prevailing winds received by Puerto Rico, which are affected by local conditions such as topography and adjacent buildings.

### \$-\$\$

- Strategy in Action
- **1**. Place Openings in the Building to Maximize Air Movement
  - a. Cross Ventilation
- 2. Orient Your Home to Increase Natural Ventilation
- 3. Use Vegetation to Ventilate Your Space
- 4. Install Wind Chases and Vents

### WHAT YOU NEED TO KNOW

- Creating clear paths for air to flow through the home encourages passive ventilation.
- ► Passive ventilation relies on air currents generated by prevailing breezes, adjacent buildings and terrain and differences in temperature between spaces.
- ► Window and door placement, size and operation affect ventilation rate and effectiveness.
- Cross-ventilation refers to the concept of placing window and door openings to allow air to move into and out of a space or the whole house.
- ► Island Location Puerto Rico is exposed to Caribbean Trade Winds, which determine the predominant wind direction (North-South).



### **SUPPORTING STRATEGIES**



## **INCREASE VENTILATION**

### **STEP 1 - PLACE OPENINGS IN THE BUILDING TO MAXIMIZE AIR MOVEMENT**

Cross Ventilation means that outside air moves into and out of a house in response to air pressure differences in such a way that air flow is induced in a large portion of the house or space.

### **OPERATIONS AND MAINTENANCE TIPS**

- Reposition furniture that blocks air flow.
- Make opening and closing windows easy.
- ▶ For jalousie, awning, and casement windows, replace broken window cranks and lubricate cranks periodically when you notice they do not fully extend the window.
- Trim landscaping away from windows.

CONS

### PROS



Maximize the amount of space that the air circulates through by misaligning windows.



Exit openings should be slightly smaller than entry openings to increase wind acceleration and maximize flow. Partially closing exit windows enhances air flow.



Install windows or openings near ceilings to drive hot air up and out.



Cross Ventilation requires a minimum of two openings per room but If rooms have only one window, open the room's door and windows in other rooms so air travels through the house.





Maximize constant flow by having parallel windows. Keep in mind that this will only ventilate the area that the wind passes through. NOT the best advice. Contradicts figure above. Wind tunnel effect. Ill-advised because it won't provide any mixing.



Protect Openings from rain and pests, by installing overhangs and screens. (See Strategy 12 | Reduce Thermal Heat Gain and Strategy 15 Manage Pests)Health improvement from controlling pests is a high priority because it impacts the health of residents.



If walls and doors block the air path, implement openings in walls. louvered doors and transoms so air can go through.



Cross ventilation between windows on the same wall can be induced with wing walls.



Ensure interior walls do not disrupt air flow.

Place windows near occupants to maximize comfort provided by wind.

# 11

## **INCREASE VENTILATION**

### **STEP 2 - ORIENT YOUR HOME TO INCREASE NATURAL VENTILATION**



- ► Orienting a house or housing facility will impact ventilation in addition to capturing solar gain and controlling water.
- ▶ When determining how to orient your home as a new construction, or if you are substantially retrofitting a home, orient the longest facade and place windows north or south to capture prevailing winds.
- ► The ideal proportion for maximizing passive systems is 1:3
- ▶ When building a new structure or an addition, ensure there is adequate distance from adjacencies. Discuss this with a building professional.

**03 PASSIVE HABITABILITY** 





### **STEP 3 - UTILIZE VEGETATION TO VENTILATE YOUR SPACE**



- $\triangleright$
- ⊳ should exceed the tree's height.



### **STEP 4 - INSTALL WIND CHASES AND VENTS**

Hot air moves up. Installing towers or channels that allow hot air to exit the building cools a space.





A continuous space throughout floors, such as staircases or a central atrium, can captures hot air from individual units and expels it upwards. For the technique to work, ensure each unit has an appropriate entry that allows wind to move.



### WIND CHASES

temperature inside.

▶ Plant trees to direct breeze towards the house and openings.

Do not plant trees very close together because foliage can work as a massive horizontal wall through which wind cannot permeate.

Keep a distance between trees and the building to avoid damage during strong winds. The distance from the tree to the house

An opening near the cusp of the ceiling that allows hot air to exit the space, thus reducing the



### **TRANSOM WINDOWS**

An opening above the doors that allows hot air to exist space thus reducing temperature inside.

## **BENEFIT FROM NATURAL LIGHT**

Natural light improves the quality and comfort of homes by efficiently illuminating interior spaces while lowering the overall energy consumption. Increasing natural light or 'daylighting' a room can provide light to occupants when electricity is not available. Windows and doors bring in light, but they can also make a space too bright or too hot. While placement and size of windows and doors is an important aspect of new construction, modifying shading on existing buildings can make the most of daylight while reducing temperature rise indoors. See Strategy 10 Reduce Thermal Heat Transfer.

### \$-\$\$

Strategy in Action

Orient Your Home to Maximize Natural Light

- 2. Control Natural Light
  - A. Vegetation
  - B. zWindow Size
- 3. Choose Your Shutters
- 4. Create Light Shelves
- 5. Create Skylights

### **STEP 1 - CHOOSE THERMALLY EFFICIENT MATERIALS**

- The critical facades for sunlight are the ones located to the east, west and south. Orient a building in a way that the longer side faces north/ south, and the narrower side faces east/west.
- Remember that the ideal proportion for maximizing passive systems is 1:3.
  Ensure that building façades are protected against direct sunlight.

### WHAT YOU NEED TO KNOW

- Daylighting is the utilization of sunlight to illuminate interior spaces.
- The lighting quality in your home is determined by:
- Adjacencies: nearby structures, such as terraces or your neighbor's home, as well as vegetation, impact how much natural light goes into your house.
- **Building Openings:** mechanisms, such as windows, doors, or skylights, that allow natural light in.



### **OPERATIONS AND MAINTENANCE TIPS**

- ▶ Trim plants on ongoing basis.
- Check anchorage at shutter systems. Check for rust in metal elements and joints.
- Wipe windows and glass to reduce glare from grease and exposure to dirt and dust which can impede visibility.
- Ensure windows and penetrations into building appropriately water sealed to prevent water intrusion and pests.
- Orient new Units of Housing to take advantage of Light.
- Locate Vegetation Location to manage light exposure
- ▷ Size Windows to take advantage of light.
- Create Light Shelves and use Skylights to Open up Spaces to Light.

### **SUPPORTING STRATEGIES**

02	08	12	13
Reinforce Site with Vegetation	Anchor, Seal and Protect Openings	Benefit from Natural Light	Control Moisture and Molo



#### WEST

- In the afternoon, the West façade receives direct sunlight.
- Place your porch on the West side if you intend on using it in the afternoon.



SOUTH Throughout the day, the South façade receives direct sunlight.

- Ensure that building facades are protected against direct sunlight.
- Remember that the ideal proportion for maximizing passive systems is 1:3.



### NORTH

Throughout the day, the North façade receives indirect sunlight.



#### EAST

- In the morning, the East façade receives direct sunlight.
- Place your porch on the East side if you intend to use it in the morning.

## **BENEFIT FROM NATURAL LIGHT**

### **STEP 2 - CONTROL NATURAL LIGHT**

### **A. VEGETATION**

- ► Trees reduce direct sunlight.
- ► The foliage of the tree will provide the most shade. Ensure that the tree's height relates to the opening you wish to protect.
- Keep a distance between the greenery and the building to avoid damage during strong winds. The distance from the tree to the house should exceed the tree's height.



WEST Plant tall trees on the West side to reduce afternoon direct sunlight.



**NORTH** Plant light greenery on the North side for glare control, if necessary.



**B. WINDOW SIZE** 

exposure in the home.

Size your windows according to sun

**WEST** Minimize the quantity and size of openings in this façade. Since it is exposed to direct sunlight in the afternoon, it will increase heat gain.



**SOUTH** Plant tall bushes on the South side to reduce day-long direct sunlight.



**EAST** Plant tall trees on the East side to reduce morning direct sunlight.



**SOUTH** Shade openings, since they are constantly exposed to sunlight.





#### NORTH

Maximize the quantity and size of openings in this façade. Near sunrise and sunset in the summer, the North facade can briefly receive direct sun, but the energy impact is low. In May, June and July, the sun can be slightly north of directly overhead but with the slightest overhang it will miss the north facade.



#### EAST

Minimize the quantity and size of openings in this façade. Since it is exposed to direct sunlight in the morning, it will increase heat gain.

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### **BENEFIT FROM NATURAL LIGHT**

### **STEP 3 - CHOOSE YOUR SHUTTERS**

- ► Choose a product that is rated to be hurricane proofed.
- ► Choose a product with following attributes for shades and curtains:
  - Higher RS (Solar Reflectance) values mean lighter colors reflect more heat away
  - Higher VLT (Visible Light Transmission) values mean more daylight is allowed to pass through
- ► The most common types of shutters are jalousie windows.
- ► If suitable for your building, lockable, exterior shutters anchored into a concrete frame will withstand an extreme weather event better than shutters anchored to a wood frame.
- ► Choose your shutter materials based on your available budget, durability and availability.

### **STEP 4 - CREATE LIGHT SHELVES**

- ► A horizontal unit installed in the interior of a space that:
  - Blocks direct light from entering the home
  - Redirects light to the ceiling to illuminate interiors indirectly.







### **SHUTTER STYLES**



Movable horizontal devices: Provides full protection from the sun when completely open, and offers space to isolate heat between the shutter and the outside surface. Operable systems are recommended.



- Movable horizontal louvers: Protects opening from direct sunlight coming in
- Movable louvers: Allows the user to open during the part of day where the sun is not directly hitting each façade. Operable systems are recommended.

### **STEP 5 - CREATE SKYLIGHTS**

Skylights are openings in the roof that help illuminate spaces that are not contiguous to the building's façade.





\$ Lets in diffused light

▶ Some systems in the market are operable and protect from high winds when shut.

### **ORNAMENTAL GLASS BLOCK**



### SKYLIGHT TOWERS

\$\$\$ Lets light in and filters out radiation. They can be customized to your home.

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## CONTROL MOISTURE AND MOLD

Mold is a fungus that compromises indoor air quality and the material integrity of windows, doors, foundations, walls, roofs, and interior finishes. Even small amounts of mold pose health threats to people who are immunocompromised or have respiratory conditions such as asthma. Mold thrives in moist and humid environments. Flooding, heat, humidity, and precipitation are perfect conditions for mold development, while porous materials are the perfect medium for its growth. This strategy focuses on mold prevention by eliminating sources of moisture.

### WHAT YOU NEED TO KNOW

- ► Mold development is propelled by:
  - Amount of moisture: Mold needs water to grow. Controlling moisture levels on exterior home surfaces and in indoor spaces reduces the potential for mold growth. Even though spores are present year-round, higher than usual temperatures, sudden temperature changes, humidity, and moisture accelerate their growth by dissolving the nutrients present in materials. Moisture occurs through:
  - **Precipitation:** rain enters a home through holes and cracks in the roof or walls.
  - Humidity: moisture occurs through condensation (when moist warm air meets cold surfaces) or though spills and plumbing leaks. It can also occur from cooking or bathing.
  - **Floods:** water enters a home through the ground. In other words, water filters through floor structure, foundation, and soil.

### **SUPPORTING STRATEGIES**



The high moisture content that precedes mold growth can seriously compromise home components before mold appears.

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Strategy in Action

Prevent Mold

b. What to Look for

c. Condensation

2. Reduce Sources of Moisture

a. Check for Water Leaks to

1. Inspect Your Home

a. Floods

b. Leaks

- ► Type of materials: A material's chemical characteristics and how much moisture it can absorb make it nutrient rich in substrates that feed mold.
- Natural ventilation and daylight keep spaces dry and less prone to mold. See Strategy 11 and Strategy 12 for information on ventilation and how to benefit from natural light.

► REMEMBER

- Hire a professional mold remediation professional!
- The United States Environmental Protection Agency (EPA) and Centers for Disease Control (CDC) recommend hiring trained mold remediation professionals if mold growth covers more than 100 square feet (a 10 ft. by 10 ft. area).
- Inappropriate treatment can spread fungi to other surfaces and into the air, thus worsening the situation.
- Inform the hired professional of any water leaks, flood incidents, and/or previous moisture problems.
- "Ensure that the moisture problems have been resolved as part of the remediation process, otherwise the mold is likely to return."



- Reasons for hiring a professional mold inspector:
- The inspector will recognize the different types of mold.
- The inspector will find mold in places you might not think there is mold.
- The inspector will bring industrial equipment, like moisture meters, to find all hidden mold growth without disturbing your home.
- The inspector will know the best way to contain and remove large colonies of mold without spreading spores (also known as mycotoxins).

### **STRATEGY CONTROL** 13 **MOISTURE AND MOLD**

### **STEP 1 - INSPECT YOUR HOME**

If you suspect you have mold, hire a mold inspector (see inset).

- ► Olfactory Inspection: Not all mold species are visible. Musty/moldy smell is an accurate indicator of the presence of mold.
- ► Visual Inspection: Look for changes on color and/or texture on the surface of the materials. Molds show usually as dark sets of rounded spots, although they can take other shapes and colors. Note however that not all stains caused by humidity are always mold. Molds are often confused with efflorescence, discolorations and substance infiltrations.
- ► Moisture Inspection: Look for evidence of water intrusion such as drip lines, water marks, mildew, and bubbled paint. Determine the source of the water and take action to eliminate or control it. Use a moisture meter to monitor your space and find concealed mold and water damage. A moisture content above 14% indicate that your space is humid enough to develop mold.



### **B. WHAT TO LOOK FOR**

 $\triangleright$ 

⊳

	MOLD	EFFLORESCEN
NHAT IT IS	A superficial growth produced by a fungus.	Efflorescence is in the surface or It manifests itse coating.
NHERE IT DEVELOPS	Nutrient rich and moist materials like wood or concrete such as lumber, plywood, and paper facing of drywall and batt insulation. Even dusty surfaces since dust is a mold food.	Materials compo ingredients, whio presence of salt
How to Prevent It	See Strategies in the following pages.	 Apply a hydroph prevent water al

### **A. CHECK FOR WATER LEAKS TO PREVENT MOLD**



#### BATHROOM

Clean toilet bowl, tiles, and sink regularly to prevent mold growth.

# LAUNDRY ROOM

Pay close attention to the area behind and under the washer.



Pay close attention to sinks and fridges, checking also their backs and underneath areas.

Check cabinets' interior regularly.

KITCHEN

Keep dry the backsplash and/ or any other surface prone to condensate moisture coming from cooking and/or boiling.

### SURFACES

- Identify condensation in openings, walls, or ceilings, both inside and outside.
- Identify condensation in areas that generate sudden temperature changes, such as kitchen backsplashes and surfaces nearby airconditioning (AC) units.
- Inspect areas that regularly flood or are prone to flooding.
- Inspect any plumbing connections under the sink or to an ice-maker.





the deposit of salt f a porous material. elf like a white

osed of soluble ch disintegrate in the . such as concrete.

obic sealant to bsorption.



### **RUST STAINS**

A discolored spot on a particular surface.

Concrete walls or ceilings, because of rebar rusting.

Contact a contractor and/ or specialist to provide advice regarding potential required repairing of the impacted/damaged area

# STRATEGYCONTROL13MOISTURE AND MOLD

### **STEP 2 - REDUCE SOURCES OF MOISTURE AND KEEP THE BUILDING DRY**

Floods, stormwater, and humid air are sources of water which bring about moisture. Identify the source to protect your home and keep it mold-free.



### A. FLOODING

A temporary condition of partial or complete inundation of normally dry land areas.



### **B. LEAKS**

Cracks in roofs, ceilings, or walls allow entrance of moisture.





- Place container underneath the leak while you seal it. Empty container at least daily to reduce indoor humidity.
- Ensure the home's drainage is working properly.
- Keep drainage paths clear.
- Drain rain to ground from foundations and crawl spaces by establishing capillary breaks to separate the ground from the structure.
- Eliminate low spots of roofs, standing water seeps into porous materials to ceiling.





- Avoid interior finishes that are vapor flow retarders.
- Seal or flash leaks on your doors or windows. See Strategy 08 | Anchor, Seal + Protect Openings.



 For new construction ensure there is a capillary break, like a vapor barrier is placed below a concrete slab before pouring the concrete.

### **STRATEGY CONTROL MOISTURE AND MOLD**

### **STEP 2 - REDUCE MOISTURE AND KEEP THE BUILDING DRY**

### **OPERATIONS AND MAINTENANCE TIPS**

- ▶ In areas with regularly high temperatures and high humidity, inspect regularly for leaks and verify drainage takes water away from house (see Safe Site).
- Check plumbing connections to verify there are no drips. Include ice maker lines and washing machine hose connections in your inspection.
- ▶ Keep ceiling and exhaust fans clean and in good condition to maintain air flow.

### **C. CONDENSATION**

- Occurs when moist air encounters a cold surface. and turns into water.
- Condensation may hide inside or behind household materials.



▷ HOW TO PREVENT IT Naturally or mechanically ventilate your home specifically areas with high humidity kitchen, bathroom & laundry. See Strategy 13 Increase Home Ventilation.





Use a dehumidifier to reduce moisture level and make sure to empty it regularly. For continuous dehumidifier use, connect a condensate line to drain water outdoors or to another drain. A small portable dehumidifier may not be sufficient by itself to remove all necessary moisture in a space that is not air conditioned.



Indoor air circulation: mechanical fans can also even out interior humidity and force air out of building



### **D. MATERIAL**

Porous materials absorb and retain moisture. Wall paper, gypsum board, wood, paint/primers that are not treated with antimicrobial agents, lumber, plywood, paper facing of drywall, batt insulation, and dusty surfaces since dust is a mold food.



- HOW TO PREVENT IT
  - Remove materials that have been wet for more than 48 hours.
- crawl space floors. Recommended material is concrete floors or a surface
- concrete. Use 6 mil poly under slabs,
- space floors.

Ensure that drainage paths are maintained going from the roof, down the wall, away from the house, and away from the site, into the street gutters to avoid dumping water onto your neighbor's site.

Maintain drainage by cleaning gutters, removing debris off the roof, evening out the surface of the roof to prevent ponding, keeping landscaping next to the foundation below finish floor level.

Use materials without cellulose and other natural fibers to deprive mold of food and limit growth.



■ No vinyl flooring, 6 mil poly under slabs, footers, and on bare earth

finish such as terrazzo or stained

footers, and on bare earth crawl



 Use waterproof materials or sealers so when water retreats, it is easy to clean and repair.



## **MANAGE PESTS**

Pests are organisms that transmit disease. Under the right conditions, they can reproduce quickly and cause an epidemic. Pests create waste that can impact health of housing occupants by impacting air quality, leaving waste and biting occupants. Pest-transmitted disease like ZIKA impact the health of communities leading to a public health crisis. This strategy focuses on actions that individual homeowners or communities can take towards preventing and mitigating pests in a way that promotes non toxic solutions to managing pests-referred to as Integrated Pest Management.

### WHAT YOU NEED TO KNOW

- Pest growth and spread is determined by disruptions to their habitats:
  - Natural events
  - Hurricanes
  - Earthquakes
  - Heavy rains
  - Soil Movement

### SUPPORTING STRATEGIES

03	05	08	29
Plant and	Build a Stronger	Anchor,	Inspiring Post-
Garden	Foundation	Protect	Disaster
		Openings	Planning for
			Community

SIGNS OF PESTS Droppings around food packages, in drawers or cupboards and under the sink.

Strategy in Action

**1**. Protect against Flying Pests

2. Protect Against Crawling Pests

Musty smell

\$-\$\$

- Signs of nests built out of shredded paper, fabric or dried plant matter.
- Signs of chewing on food packaging and in the walls and on furniture
- Black or brown streaks on the walls between packages and furniture (rodents like to squeeze through tight spaces)
- Holes chewed through walls and floors that create entry points into the home.

### **STEP 1. PROTECT AGAINST FLYING PESTS**



### WEAR PROTECTIVE CLOTHING AND REPELLENT

Some protection is offered by protective clothing such as long-sleeved shirts, head nets, collars, and hats.

Repellents are only partially effective against swarms of biting midges. When choosing repellants, look for products that are DEET-free and effective at repelling a wide range of mosquitoes, ticks, and other bugs. Be careful when using repellents since they can irritate eyes and in intense doses may induce neurological damage.

Alternatives include Picardin, referred to as "Icaridin" which is a synthetic compound derivative of compounds found in black pepper. Studies show that it performs as well as DEET. The repellent is so effective, the World Health Organization recommends Icaridin, alongside DEET and another repellent called IR3535, as one of the best choices for preventing mosquito bites that can lead to disease.

The oil of lemon eucalyptus is a natural insect repellent. The oil of this Australian plant is refined into a substance known as PMD, which can be an effective aid to ward off mosquitoes and can be found in several brands of repellent.







### OPERATIONS AND MAINTENANCE TIPS

- Ensure wood is treated to prevent termites.
- Inspect window and door screens for holes since pets can break the mesh with their claws and beaks.
- Maintain a sufficient supply of your preferred insect repellent.
- Call an expert or pest control service to fumigate the home at a time when no residents or pets are inside.
- For multi-family buildings, develop standard pest management protocols and best practices for preventative maintenance, occupancy turnovers, and storage spaces.
- Place food in a pest proof container.

### **MANAGE PESTS**

### **REMEDIES AGAINST FLYING PESTS**



INSTALL WINDOW SCREENS

Install a metal mesh screen so flying pests cannot access the interior of your home, especially at nighttime.



**REMOVE STILL WATER** 

Stagnant water attracts flying pests. Drain flower pots, garbage cans, or street holes. If you cannot remove the water, cover with a lid.



### **PLANT AN HERB GARDEN**

-Plant lemon, basil, lemon balm, lavender, and peppermint which are traditionally used to ward off flying pests.



### **PASSIVE VENTILATION**

- Use passive ventilation systems to push pests out of your home and prevent them from coming in.
- See Strategy 11 Increase Ventilation for more information.



### **ACTIVE VENTILATION**

Low energy fans can divert flying pests from entering your home or approaching you.



### **MOSQUITO LAMPS**

UV mosquito lamps can be used to repel mosquitoes from a site, your deck, or patio. These devices use butane heaters or candles to warm up pads containing the insecticide allethrin which is the same chemical used in most mosquito coils. The products claim to offer up to 15 feet of odorless bug protection, but their effectiveness drops when there's a breeze.



### CITRONELLA-BASED CANDLES **OR LAMPS**

This citronella candle can be effective at creating a perimeter around outdoor areas to keep mosquitoes away. It can somewhat help ward off mosquitoes because the smoke from candles or lamps can confuse the bugs and prevent them from smelling you. It is often combined with other essential oils such as lemongrass and spearmint. For maximum benefit, it is best to combine this method with other stated methods.

Mosquito coils: Like citronella candles, mosquito coils produce a smoke that confuses mosquitoes. The coils contain the insecticide allethrin.

### **Bees are not Pests!**

The greatest contribution of bees and other pollinators is the pollination of nearly three quarters of the plants that produce 90% of the world's food. A third of the world's food production depends on bees. This means that every third spoonful of food depends on pollination (i.e., fruit, vegetables, seeds, nuts, and oil seeds). Bees are vital for the preservation of ecological balance and biodiversity in nature.

Bees also act as indicators of the state of the environment. Their presence, absence, or quantity tells us when something is happening with the environment and that appropriate action is needed. Climate change and the use of pesticides causes some flowers to bloom earlier or later than usual, leaving bees with fewer food sources at the start of the season. Also, bees suffer habitat loss from development and the lack of bee-friendly flowers.



### STRATEGY

## 14 MANAGE PESTS

### **STEP 2. PROTECT AGAINST CRAWLING PESTS**







### CENTIPEDE

> THEY CARRY

 Venomous bite that can cause anaphylactic shock



 Can contaminate food and carry Salmonella

### RODENTS

 Carry Leptospirosis, Typhoid fever, Cholera, Dysentery.

### **REMEDIES AGAINST CRAWLING PESTS**



### CONTROL VEGETATION GROWTH

- Ensure vegetation is maintained and trimmed to prevent crawling pests from creating a colony.
- Protect trees and plants by wrapping chicken wire barriers around the trunk.



### SEAL OPENINGS

- •
- Seal all wall, floor and joint small holes with steel wool and low VOC caulk. For holes greater than ¼" use rodent and corrosion proof screens (stainless steel or copper) or cement.
- See Appendix for locations.



### IGUANAS

THEY CARRY

Destroy gardens, crops and native species.



### INSTALL RODENT BAIT STATIONS

- Install a rodent bait station, a child and pet friendly box that traps rodents in a safe and humane way.
- Works indoors or outdoors.
- Use as directed by manufacturer.

## 14 MANAGE PESTS

### **REMEDIES FOR CRAWLING PESTS**



### **ELEVATE YOUR HOME**

- Elevate your home min. 3' from the ground.
- Maintain a gap between entry and stairs to avoid pests from crawling inside.
- (See Strategy 05 | Build a Stronger Foundation)



### USE SCARECROWS/PLASTIC BAGS

 Iguanas are startled easily by sounds and movement. Place a scarecrow or a plastic bag in your backyard to scare them off.



### USE PEST PROOF TRASH RECEPTACLES







**Interviewees:** Jose J. Oquendo y Carlos A. Vazquez; PECES, Inc.

Description: Programa de Educación Comunal de Entrega y Servicios (PECES, Inc.) provides prevention, education, and professional training services for communities in Puerto Rico. Its mission is to promote educational, economic, and social development throughout the southeast area of the island. After Hurricane Maria, PECES, Inc. formed an alliance with GlobalGiving in an effort to help the Punta Santiago community in Humacao, to repair and rebuild 100 homes, whose residents, a year after the disaster, have been unable to repair. PECES also works to promote the local economy by hiring local builders and contractors for repairs and appraisals. Moreover, whenever possible, the program buys all the necessary materials through local companies. In July of 2018, PECES reported that their services had helped a total of 28,874 families, 18 municipalities, and 40 communities, with the support of about 565 volunteers.

### INTERVIEW

PECES, Inc. is a non-profit organization that focuses its efforts on the municipalities in Puerto Rico's eastern region, from Canovanas to Maunabo, as well as the island municipality of Viegues. We are currently also serving the island's mountain municipalities of Barranguitas and Aibonito. PECES' main objective is to promote education. Bearing this in mind, we provide an alternative educational setting for students who haven't been able to obtain a continuous education. Our alternative school has been operating for 25 years, and we receive around 200 students every year. Another one of our initiatives is focused on the community's economic development, as a way to eradicate poverty by holding solidarity economy as a pillar for growth. An example of this initiative is the Punta Santiago Natural Reserve. In this project, we paired the conservation of natural resources and assets with the community's economic growth through the small shops we have established there for visitors and eco-tourists. Since our organization is located in Punta Santiago, we thought we knew and were aware of everything that happens in the area. Nonetheless, we came to realize that this just wasn't the case. Maria helped us identify the main needs of our community. For example, even though residents had no food, the home was seen as the foremost priority because people here literally didn't have a roof over their heads. Maria came to redefine this process, the way we approach immediate response, and what we take into account when a disaster hits.

For one of our first response efforts, we all gathered as an organization and began visiting every single home in the community to let neighbors know what was happening, and they in turn kept others informed as well. It basically became a communication chain and we started developing small "clusters" of information. The documentation of all events through social media proved useful for us as well. This also helped put Punta Santiago in the public eye. If we had to share something about our own experiences, I believe that the hardest challenges we faced were:

1. Upholding transparency and prioritizing ethics during the process. We follow a well-structured work flow, but we knew we were all going through the same situation on different levels and under particular circumstances. So, to protect our image as an organization as well as our team, we worked hard to organize and document the delivery of purchases, water, and materials. We documented everything in case somebody questioned our integrity; that way, we had the information available to show donors, residents, and whoever requested proof that the aid supplies had been distributed among members of the community, not PECES staff.

2. How to give ourselves some space (as a team) to process the situation before working with and for the community. As I mentioned beforehand, we all experienced this event in different ways and had additional family-related concerns that came up as we worked as an organization within the community. Therefore, before working with the community, we equipped our team with the space and tools (such as access to psychologists) to receive emotional support and be able to carry on with their duties.

3. Prioritizing the community's needs.

4. How to distribute all aid supplies received and manage disaster capitalism. It became very hard for us to deal with this matter because, thanks to everything we documented on social media about what was happening in Punta Santiago, we were able to obtain financial aid and donations of food, provisions, etc. However, there were always companies and/or celebrities visiting us to promote their product or image. We noticed this was the case when they showed up with production teams, cameras, music, among other things. We always got people who came to help because they truly wanted to, but others came just for the publicity.





COMMUNITY

### **PLENITUD, LAS MARIAS**



For more information, visit https://www.plenitudpr.org/

**Description:** Plenitud is a non-profit organization located in the municipality of Las Marias that provides agricultural education and sustainability services. Part of its mission is to inspire the immediate community to embrace more sustainable practices and a culture of service. This project was launched in 2008 and was incorporated as an organization in 2010. Afterwards, in 2011, Plenitud established its 15-acre farm in Las Marias.

### INTERVIEW

Since the idea to develop Plenitud was born, we were already getting ready for a scenario where climate change and the system's instability could affect us. Consequently, we began a project to collect rainwater to use for compost, crops, food, and cooking, among other things. We have 2 tanks (5,000 gallons each) that enabled us to help the community. Additionally, we had bought food in bulk prior to the hurricane, such as grains, rice, some spices, which we stored in large buckets.



After the hurricane, we first tried to clear the path to leave the farm. Once we did this, we sent people with first-aid kits and gallons of water to check up on our neighbors who live in the surrounding areas. Afterwards, we took a walk to identify which roads were closed off and which ones could serve as fast and easy access. We then started clearing the roads that provided the most direct access to the main roads. We also participated in multi-sectoral gatherings coordinated by the municipality as part of their community outreach efforts. The goal was to provide health services, food, and clothes for people in different communities.

Just as it was for everyone, communication was one of our biggest challenges. However, we have walkie talkies, which we use to communicate with each other in the farm. We use them because the farm spans 15 acres and we sometimes work well into the night. Maria helped us realize how important these are to stay in contact with one another. Another challenge related to the lack of communication was that, at the time, we had 5 student volunteers that had come from the United States and had to spend the hurricane here. Although we were at ease because we had collected water and had bought and stored sufficient food, those first days were hard, because we wanted to be able to tell the parents of these students that they were all right.

I think that the main lesson we learned was that, at times like these, collaboration between different sectors is important. We also witnessed the importance of religious leaders and churches. The people who go to church are usually the ones who know where other neighbors live, whether it's the little old lady that lives alone, the single mother, the bedridden old man, etc. At least here, in Las Marias, there are no well-known community leaders, so in this case, the churches have become that community liaison.



