




Hawaii Hazards Awareness & Resilience Program


Produced by
Hawaii State Civil Defense



HAWAII HAZARDS AWARENESS & RESILIENCE PROGRAM:

GOAL: To enhance community resilience to multiple hazards through a facilitated education and outreach program that promotes hazard understanding and awareness, and offers tools and information resources to guide mitigation, preparedness, response and recovery.

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TROPICAL CYCLONE BASICS

Module 1: Hazard Awareness

Contents

- What is a Tropical Cyclone?
- Tropical Cyclone Impacts
- Historical Hurricanes in Hawaii
- Where to Get More Information?

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Module 1: Hazard Awareness Photo courtesy of NOAA

WHAT IS A TROPICAL CYCLONE?

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What is a Tropical Cyclone?

- A **Tropical Cyclone** is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation. Tropical cyclones rotate counterclockwise in the Northern Hemisphere. (NOAA NWS)

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Tropical Cyclone Rotation

Northern Hemisphere

Southern Hemisphere

Tropical Cyclone Formation

- Tropical Cyclones tend to form just north or south of the equator (between 5 and 20 degrees latitude) in areas of low pressure with converging surface winds.

<http://www.comet.ucar.edu/rsflab/web/hurricane/312.htm>

Tropical Cyclone Designations

- “Tropical cyclone” is a general term. Designations vary according to maximum sustained wind speeds:

Tropical Cyclone Designations	Maximum Sustained Wind Speeds
Tropical Depression	Less than 39 mph (34 knots)
Tropical Storm (assigned a name)	39 to 73 mph (34 to 63 knots)
Hurricane – Category 1	74 to 95 mph (64 to 82 knots)
Hurricane – Category 2	96 to 110 mph (83 to 95 knots)
Hurricane – Category 3	111 to 129 mph (96 to 112 knots)
Hurricane – Category 4	130 to 156 mph (113 to 136 knots)
Hurricane – Category 5	157+ mph (137+ knots)

Illustration of a Hurricane

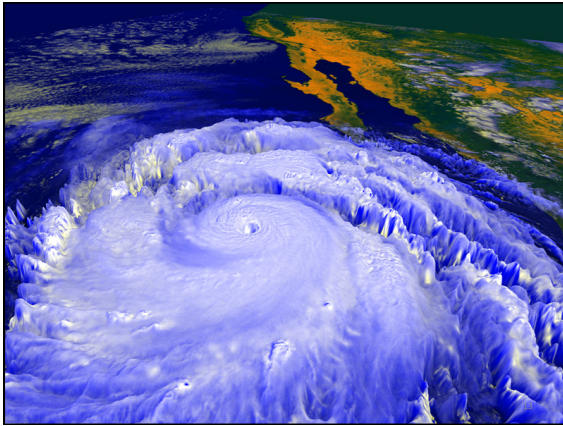
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Hurricane Characteristics

- Sustained wind speeds of 74 to 157+ mph (64 to 137+ knots)
- Require warm ocean water of at least 80°F (26°C) to supply thermal energy.
- May have a diameter of 100 to 300 miles (160 to 480 km).
- Viewed from a satellite perspective, hurricanes have a circular appearance with cloud bands spiraling toward the storm center.

Hurricane Characteristics

- Eye of the storm
 - Low pressure
 - Calm winds
- Eye wall
 - Strongest winds
- Spiral rain bands
 - Heaviest precipitation



Hurricane Characteristics

- Movement is guided by surface winds, other weather systems, and warm ocean currents.
- Hurricanes lose strength due to a number of factors:
 - Landfall
 - Loses source of warm water
 - Friction with terrain features
 - Wind shear, or strong winds at high altitudes.
 - Movement into region of cooler water.
 - May pull in drier, cooler air from its surroundings.

Saffir-Simpson Scale




Category	Wind Speed	Storm Surge	Description of Damages
Cat 1	74-95 mph (64-82 kt)	Storm surge generally 1.2 – 1.5 m (4-5 ft) above mean sea level.	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Some coastal road flooding and minor pier damage.
Cat 2	96-110 mph (83-95 kt)	Storm surge generally 1.8 – 2.4 m (6-8 feet) above mean sea level.	Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees. Considerable damage to mobile homes, poorly constructed signs, and piers.
Cat 3	111-129 mph (96-112 kt)	Storm surge generally 2.7 – 3.7 m (9-12 ft) above mean sea level.	Some structural damage to small residences and utility buildings. Damage to shrubbery and trees with large trees blown down. Mobile homes and poorly constructed signs destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by battering from floating debris.
Cat 4	130-156 mph (113-136 kt)	Storm surge generally 4 - 5.5 m (13-18 ft) above mean sea level.	More extensive curtain wall failures with some complete roof structure failures on small residences. Shrubs, trees, and signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows.
Cat 5	Greater than 157 mph (137+ kt)	Storm surge generally greater than 5.5 m (18 ft) above mean sea level.	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage.

Module 1: Hazard Awareness

TROPICAL CYCLONE IMPACTS


Tropical Cyclone Impacts

- Damage and losses due to:
 - High winds
 - Heavy rainfall
 - Flooding
 - Large breaking waves and high seas
 - Storm surge

Tropical Cyclone Impacts

- High winds
 - Hurricane winds can tear apart structures, down trees, and hurl loose debris that can cause further damage.

Tropical Cyclone Impacts

- Heavy rainfall and Flooding
 - Can bring intense precipitation over a short period of time.
 - Slow-moving storms concentrate rainfall over one area for a period of time.
 - Sudden, heavy rainfall causes stream levels to rise swiftly and result in flash flooding in downstream areas.
 - Ground saturation can cause landslides to occur.


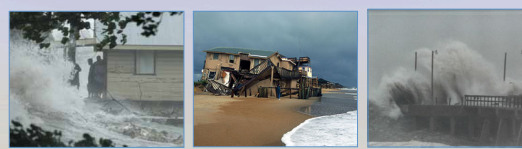


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Tropical Cyclone Impacts

- Large breaking waves and high seas
 - Large ocean swells are capable of capsizing large ships out at sea.
 - Large waves reaching the shore can inundate shallow coastal areas with salt water, damage or destroy port facilities and other infrastructure, and erode beaches.



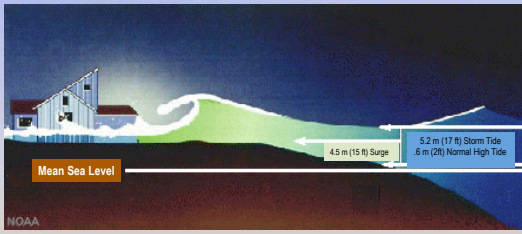
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Tropical Cyclone Impacts

- Storm surge
 - An abnormal rise in sea level accompanying a hurricane or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. Storm surge is usually estimated by subtracting the normal or astronomic high tide from the observed storm tide. (NHC)

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Storm Surge Illustration



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Storm Surge Impacts

Before...




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...After



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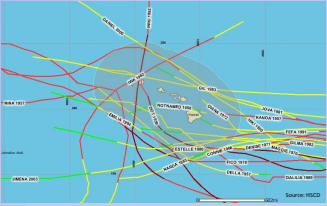
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Learning Check

1. What is a tropical cyclone?
2. What are some of the impacts of a tropical cyclone?
3. What causes a hurricane to lose strength?

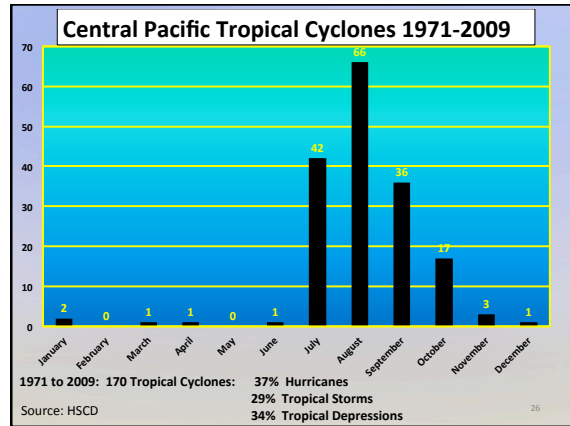
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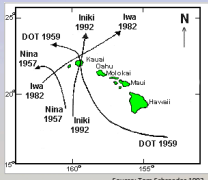
HISTORICAL HURRICANES IN HAWAII

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Historical Hurricane Events

- On average, between four and five tropical cyclones are observed in the Central Pacific every year. (CPHC)
- Five most damaging since 1950:
 - Hurricane Nina – 1957
 - Hurricane Dot – 1959
 - Hurricane Estelle – 1986
 - Hurricane Iwa – 1982
 - Hurricane Iniki - 1992

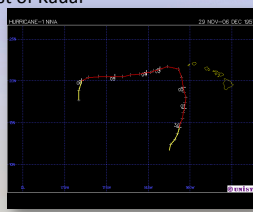


Source: Tom Schroeder 1993

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Hurricane Nina

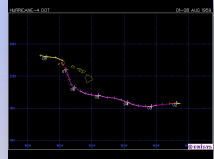
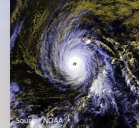
- December 1-2, 1957
- Category 1; Late season cyclone
- No landfall
 - 120 miles west-southwest of Kauai
- Damages - \$100,000
 - Kauai
 - Heavy rains and flooding
 - Oahu
 - Heavy rains
- Fatalities:
 - 1 Oahu
 - 3 in fishing boat



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Hurricane Dot

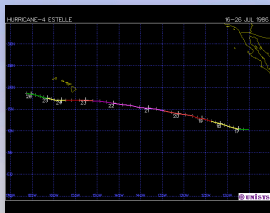
- August 5-6, 1959
- Category 3/4
- Landfall on Kauai
- Damage - \$6 million
 - Kauai
 - Severe wind, flood, wave damage
 - Heavy losses to agriculture
 - Oahu
 - Wind, flood
 - Hawaii
 - Minor flooding and wave damage

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Hurricane Estelle

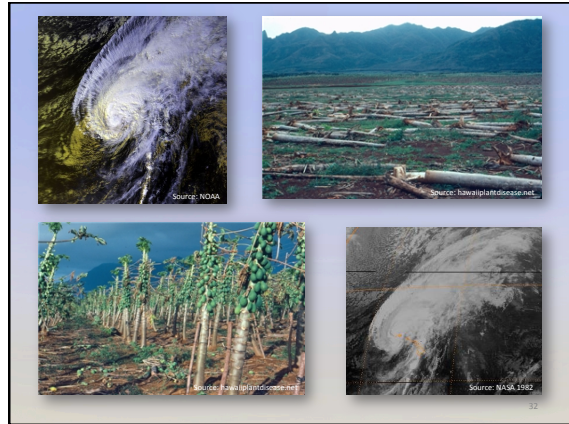
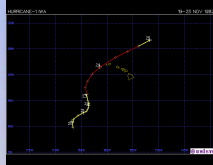
- July 22, 1986
- Category 3
- No landfall
 - South of Hawaii
- Damage - \$2 million
 - Hawaii
 - Severe wave damage
 - Mau
 - Minor wave damage
- Fatalities:
 - Oahu
 - 2 persons drowned



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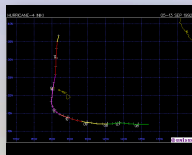
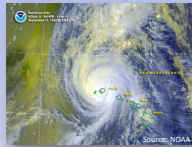
Hurricane Iwa

- November 23-24, 1982
- Category 1
- Landfall on Kauai
- Damages – \$250 million
 - All islands
 - Wave damage
 - Kauai
 - Wind
 - Oahu
 - Wind
- One fatality aboard a Navy vessel offshore of Oahu



Hurricane Iniki

- September 10-11, 1992
- Category 4
- Landfall on Kauai
- Damages – \$3 billion
 - Kauai
 - Extensive – wind and wave damage
 - Heavy losses to infrastructure and agriculture
 - Oahu
 - Flood and wave damage
 - Maui/Hawaii
 - Wave damage
- Fatalities
 - 2 Kauai
 - 2 Oahu
 - 2 aboard a fishing vessel off Kauai



Learning Check

1. What was the name of the hurricane that made landfall on the island of Kauai in September 1992?
2. Can anyone name the five most damaging hurricanes in Hawaii since 1950?
3. True or False: All of the Hawaiian islands can be affected by tropical cyclones.

Module 1: Hazard Awareness

FOR MORE INFORMATION

For More Information

- Hawaii State Civil Defense
 - www.scd.hawaii.gov
- NWS Honolulu
 - <http://www.nrh.noaa.gov/pr/hnl/>
- Central Pacific Hurricane Center
 - <http://www.prh.noaa.gov/cphc/>
- National Hurricane Center
 - <http://www.nhc.noaa.gov/index.shtml?epac>
- Joint Typhoon Warning Center
 - <http://www.usno.navy.mil/JTWC/>
- City and County of Honolulu Department of Emergency Management
 - <http://www1.honolulu.gov/dem/index.htm>
- Maui County Civil Defense Agency
 - <http://www.co.maui.hi.us/index.aspx?nid=74>
- Hawaii County Civil Defense Agency
 - <http://www.hawaiicounty.gov/civil-defense/>
- Kauai Civil Defense Agency
 - <http://www.kauai.gov/civildefense>

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For More Information (Continued)

- NOAA NWS StormReady Program
 - <http://www.stormready.noaa.gov/howto.htm>
- Red Cross – Hurricane
 - <http://www.redcross.org/prepare/disaster/hurricane>
- Pacific Disaster Center
 - <http://www.pdc.org>
- U.S. Naval Research Laboratory
 - <http://www.nrlmry.navy.mil/TC.html>
- Hawaii Weather Today
 - <http://www.hawaiiweathertoday.com/>





Image: courtesy of NOAA

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Questions?






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MAHALO

The Hawaii Hazards Awareness & Resilience Program (HHARP) is the result of a collaborative partnership between Hawaii State Civil Defense and the Pacific Disaster Center.

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