

= Cyclone Pat =

Severe Tropical Cyclone Pat was a small but strong tropical cyclone that passed directly over Aitutaki , Cook Islands , in southern Pacific Ocean on February 10 , 2010 . Part of a series of storms to impact the group of islands early that year , Pat was first identified as a tropical depression on February 6 well to the northeast of the Samoan Islands . The storm steadily organized as it moved generally southeast , becoming a tropical cyclone on February 8 . Turning to the south , intensification began in earnest and the system acquired hurricane @-@ force winds within 48 hours of being named . The 445 km ( 275 mi ) wide system displayed annular characteristics and a 19 km ( 12 mi ) wide eye . Pat reached its peak strength early on February 10 as a severe tropical cyclone with winds of 140 km / h ( 85 mph ) and a barometric pressure of 960 mbar ( hPa ; 28 @.@ 35 inHg ) . Hours later it struck Aitutaki , producing gusts in excess of 185 km / h ( 115 mph ) on the island . Hostile wind shear then prompted rapid weakening of the cyclone . The system degraded below gale @-@ intensity on February 11 , just 24 hours after it peaked , and was last noted early on February 12 .

Battering Aitutaki with wind gusts in excess of 185 km / h ( 115 mph ) , Cyclone Pat devastated the island . Approximately 78 percent of homes were damaged , with 72 structures destroyed . The electrical grid was left completely offline and supply of water was largely lost . Agriculture also experienced tremendous impact , with most crops completely lost . Damage on Aitutaki amounted to US \$ 13 @.@ 7 million ; however , casualties were minimal with only eight minor injuries reported . Recovery efforts began immediately after the storm , with the Red Cross and the Government of New Zealand aiding the local government . A reconstruction plan was enacted by the Cook Islands within a month and subsequently funded by New Zealand . Owing to its destructive effects , the name Pat was later retired and replaced with Pili .

= = Meteorological history = =

Between January and March 2010 , the Australian monsoon trough extended unusually far east over the southern Pacific Ocean . With above @-@ average sea surface temperatures , stemming from a moderate @-@ strength El Niño , multiple low pressure systems were able to develop across the region . An unusual spree of tropical cyclogenesis in rapid succession ensued , including four hurricane @-@ strength storms : Oli , Pat , Rene , and Tomas . On February 6 , the Fiji Meteorological Service ( FMS ) began monitoring a tropical depression , dubbed 09F , well to the northeast of the Samoan Islands . Embedded within a well @-@ developed trough , the system displayed curved convective banding features . Environmental conditions in the area , including low wind shear , high ocean heat content , and upper @-@ level outflow , favored cyclogenesis . Additionally , an active Madden ? Julian oscillation phase moving into the region was expected to bolster development . Steady improvement of the system 's convective structure ensued and early on February 7 , the Joint Typhoon Warning Center ( JTWC ) issued a Tropical Cyclone Formation Alert . The low trekked generally east @-@ southeast in response to a near @-@ equatorial ridge anchored to the north . The storm 's appearance continued to improve and Dvorak classifications rose to T2.5 , indicating gale @-@ force winds were likely present . Accordingly , the JTWC began issuing advisories on the system at 18 : 00 UTC and dubbed it Tropical Cyclone 14P . Forecasters noted , however , that the small size of the cyclone could lead to erroneously low Dvorak estimates . The FMS followed suit six hours later and assigned the name Pat to the cyclone , assessing it as a Category 1 on the Australian cyclone scale .

Convection became increasingly symmetric on February 8 , and a small eye feature appeared on microwave satellite imagery . Spanning no more than 445 km ( 275 mi ) , the developing storm began a gradual turn to the south as steering currents shifted from the equatorial ridge to a subtropical ridge . Based on increasing Dvorak numbers , the JTWC assessed Pat to have reached hurricane @-@ intensity by 06 : 00 UTC on February 9 . The eye feature became more pronounced throughout the day , with convection consolidating inward and becoming more symmetric . Accordingly , the FMS accordingly upgraded Pat to a Category 3 severe tropical cyclone by 18 : 00

UTC . The system became annular in nature on February 10 , characterized by a lack of prominent banding features and uniform convection which surrounded its 19 km ( 12 mi ) wide eye . Pat reached its peak intensity at 06 : 00 UTC that day as it began turning to the southwest . Maximum winds were estimated at 140 km / h ( 85 mph ) alongside a barometric pressure of 960 mbar ( hPa ; 28 @. @ 35 inHg ) . At the same time , the JTWC assessed Pat to have been a Category 2 @-@ equivalent on the Saffir ? Simpson hurricane scale with one @-@ minute sustained winds of 165 km / h ( 105 mph ) . Weakening began shortly thereafter as wind shear over the system increased . Pat passed directly over the island of Aitutaki between 12 : 00 and 18 : 00 UTC .

The low @-@ level center of Pat began decoupling from convection late on February 10 once it cleared Aitutaki . The storm rapidly weakened amid strong shear , with the center being left completely exposed early on February 11 . A solitary band remained along the south side of the storm by that time , and the FMS no longer considered it a tropical cyclone after 06 : 00 UTC . The lone band of convection dissipated later that day and with no residual thunderstorm activity , the skeletal low turned westward in response to westerly flow . The JTWC maintained Pat as a tropical storm until 18 : 00 UTC and as a tropical depression until its dissipation early on February 12 .

= = Preparations = =

Starting on February 7 , tropical cyclone alerts and later gale warnings were issued for the northern Cook Islands under the anticipation of gale @-@ force winds impacting populated islands . The first of these islands were Manihiki , Rakahanga , and Suvarrow . As the storm moved southward , the advisories shifted accordingly . Strong wind warnings were raised for Pukapuka , Nassau , and Penryhn on February 8 ; however , they were dropped later that day as Cyclone Pat moved away . Alerts on potential gales in the southern Cook Islands also began on February 8 , including the islands of Atiu , Aitutaki , Manuae , Mitiaro , and Takutea . Gale warnings for Aitutaki , Palmerston , and Rarotonga began on February 9 and extended to Mauke the next day . Early on February 10 , a hurricane warning was issued for Aitutaki . With the core of Pat 's destructive winds forecast to pass close to or over the island , sustained winds of 140 km / h ( 85 mph ) and gusts of 185 km / h ( 115 mph ) were anticipated . The aforementioned warnings were allowed to expire once Pat cleared the Cook Islands on February 11 and was no longer a threat .

Emergency centers were prepped across the northern Cook Islands on February 8 . The Cook Islands Chapter of the Red Cross took early action with Cyclone Pat and began stockpiling relief supplies on February 9 . Volunteers from the organization assisted elderly residents with preparation and evacuation on Aitutaki . Anticipating high winds , residents tied down homes with rope and wire and boarded up windows with shutters . Similar preparations took place on Rarotonga , though the main concern there was storm surge . Government offices and schools there were closed on February 11 . Most residents and all tourists along the coast in Aitutaki evacuated inland to designated shelters . Authorities later announced that they were under @-@ prepared for Cyclone Pat . The lack of an official process during an emergency was cited as a core issue .

= = Impact = =

Passing directly over Aitutaki on February 10 , Pat produced wind gusts in excess of 185 km / h ( 115 mph ) making it one of the most powerful storms ever experienced by residents on the island . It is also considered among the most damaging on the island . Aitutaki Mayor Tai Herman claimed the winds to be much stronger , with gusts up to 240 km / h ( 150 mph ) during the worst of the storm . These winds were above building codes at the time , which required structures to be able to withstand winds of 176 km / h ( 109 mph ) . Numerous trees and power lines fell amid the powerful winds , cutting power to the entirety of the island and severing communications . According to the Government of the Cook Islands , 78 percent of the homes on the island sustained damage . Of the 277 affected homes , 59 sustained minor damage , 51 moderate , 95 major , and 72 were destroyed . Severity of damage correlated with the age of each home , with buildings over 25 years old suffering the greatest impact . Collateral damage took place when debris from damaged or

destroyed structures became airborne and struck other buildings . Hardest hit were the villages of Nikaupara and Tautu . Costs to homes amounted to NZ \$ 15 million ( US \$ 10 @. @ 6 million ) .

One building at the Seventh Day Adventist church primary school collapsed while another sustained severe damage . Although damage occurred at Vaitau School , it was utilized as an evacuation shelter . The primary school and college in Araura also suffered damage . The island 's electrically run water supply was substantially effected . A total of 568 homes lost access to clean water , with many waters tanks damaged or destroyed . Aitutaki 's only hospital fared well through the storm , with some roof damage and flooded rooms . Infrastructural losses totaled to NZ \$ 2 @. @ 3 million ( US \$ 1 @. @ 6 million ) , mainly stemming from the power grid . The agricultural sector sustained extensive damage , amounting to US \$ 1 @. @ 5 million , with some crops experiencing a total loss . The severity of damage raised concerns about food security in the months after the storm . Particularly hard @-@ hit was the mango crop , which was to be harvested two weeks after Pat struck . Approximately 60 ? 75 percent of the coconut trees and 75 percent of java plum , mango , and kapok trees sustained damage . Most trees had at least one branch torn off and in most cases , multiple branches . Additionally , the blue lorikeet ( *Vini peruviana* ) , a bird native to French Polynesia and the Cook Islands , population suffered dramatic losses due to the storm , with the population on Aitutaki dropping by more than 50 percent .

All told , losses from Pat amounted to US \$ 13 @. @ 7 million . However , Dr. Russell Howorth from the Secretariat of the Pacific Community ( SPC ) stated that damage reached US \$ 8 @. @ 2 million . In comparison , the collective damage from cyclones in the Cook Islands since 1955 was US \$ 47 million according to the SPC . In contrast to the severity of damage , no fatalities and only eight minor injuries took place .

Fearing similar damage to Aitutaki , a pre @-@ emptive state of emergency was issued for Rarotonga . This was soon lifted as Pat ultimately spared Rarotonga and little damage took place there . Gale @-@ force winds and heavy rains impacted Rarotonga and Palmerston islands . Large swells affected the uninhabited Penrhyn atoll , interfering with a study of marine turtles .

= = Aftermath = =

Immediately following Pat 's passage , the Government of the Cook Islands declared Aitutaki a disaster zone . In accordance with the FRANZ agreement , the Government of New Zealand made an initial donation of NZ \$ 350 @, @ 000 for recovery efforts prior to the formal request for assistance on February 13 . Following said request , New Zealand prepped a C @-@ 130 Hercules aircraft with emergency supplies and New Zealand Defense Force ( NZDF ) personnel which arrived in Aitutaki on February 15 . The aircraft made four trips in all which provided several tonnes of aid to the island . The NZDF priority was repair of schools and hospitals , though they assisted the Red Cross with clearing debris , restoring power , and setting up temporary shelters for affected residents . The lack of access to clean water prompted significant concern , and a water and sanitation expert from the Australian Red Cross flew in on February 12 to assist with restoration efforts . Immediate provisions of 600 water bottles were sent to the island on February 16 . The Red Cross subsequently began pumping and filtering water , using a truck to distribute it to the island 's villages . Through September 24 , they provided over 100 @, @ 000 litres of clean water . Distribution of 2 @, @ 050 collapsible containers and 200 hygiene kits lessened dependency on the Red Cross 's water pump .

An extensive repair and recovery plan was enacted by the Government of the Cook Islands within a month of Cyclone Pat , which covered agricultural , infrastructural , and societal sectors . Financial restraints hindered the expected progress of this operation , with more than two @-@ thirds of it not being funded by the final plan report on March 4 . Of the NZ \$ 15 million ( US \$ 10 @. @ 6 million ) in home damage , NZ \$ 7 @. @ 2 million ( US \$ 5 @. @ 1 million ) was covered . New Zealand later provided a NZ \$ 5 @. @ 5 million ( US \$ 3 @. @ 9 million ) grant to assist in this effort . Priority was placed on repairing damaged homes , with lesser emphasis on destroyed ones . Labor costs would ultimately reach NZ \$ 6 million ( US \$ 4 @. @ 2 million ) for this project . Finalization of the funding for reconstruction was delayed and had not started by early June , with some residents still living in

tents . Farmers were provided with NZ \$ 195 @, @ 000 ( US \$ 138 @, @ 000 ) worth of seeds , seedlings , and various supplies to jump @-@ start agricultural recovery . Since the majority of the island 's electrical grid was destroyed , an earlier plan to convert the network to underground cables was accelerated due to a convenience factor .

By February 17 , 80 percent of the grid was restored ; however , only 10 percent homes were actually connected . The presence of dead vegetation left behind by the storm created fire hazards across the island , prompting the government to issue a ban on burning . The Seventh Day Adventist church primary school resumed classes on February 15 despite losing a building . All other schools suspended activities until February 22 ; however , the approach of Tropical Depression 11F delayed this until the following day . On February 23 , the European Union provided US \$ 110 @, @ 000 in emergency funds to the Cook Islands . Habitat for Humanity later sought to assist in the rebuilding process in April , with a funding goal of NZ \$ 300 @, @ 000 ( US \$ 210 @, @ 000 ) .

Depression set in among members throughout the storm @-@ battered community once the rebuilding process began . Fears of possible emigration stemming soon arose . Mayor Tai Herman feared that survivors would consider selling their homes and leave the Cook Islands altogether . Even Prime Minister Jim Marurai was reported to be left in shock by the scale of damage . The government enacted a three @-@ month psychological support plan accordingly to help residents cope with the disaster and maintain social integrity among victims . Through September , 265 people took advantage of this program .