

= Typhoon Sudal =

Typhoon Sudal , known in the Philippines as Typhoon Cosme , was the strongest typhoon to strike the island of Yap in the Federated States of Micronesia (FSM) in about 50 years . Yap is one of the four administrative divisions of the FSM . The entire island , only 17 km (11 mi) in length , experienced typhoon force winds , and 90 % of the structures were damaged or destroyed . Damage was most severe in southeastern Yap , where the eyewall struck and winds exceeded 185 km / h (115 mph) , but the center of the typhoon passed south of the island .

Typhoon Sudal originally formed on April 2 , 2004 , out of a persistent area of convection east of the FSM . It moved mostly westward for the first week of its duration , with brief northerly and southwesterly turns . Sudal attained tropical storm status on April 5 , and it gradually intensified into a typhoon , which is a tropical cyclone with winds of at least 119 km / h (74 mph) and is the equivalent of a hurricane in the Atlantic Ocean . On April 9 , it passed just south of Yap , and shortly thereafter its peak winds were estimated at 240 km / h (150 mph) . Later , Sudal moved to the northwest and eventually to the northeast , becoming an extratropical cyclone on April 16 and dissipating two days later .

In addition to the damage on Yap , the typhoon dropped heavy rainfall in Chuuk in the Federated States of Micronesia , where some minor crop damage occurred . Sudal also brushed the United States islands of Guam and Rota with high waves and light rainfall , and later moved very close to the uninhabited Japanese island of Iwo Jima . Overall damage was \$ 14 million (2004 USD , \$ 16 @. @ 1 million 2010 USD) , most of which was on Yap , although no fatalities or serious injuries were reported . Due to the heavy damage , the name was retired and replaced with " Mirinae " . The name " Sudal " was contributed by South Korea for the Pacific tropical cyclone list and is the Korean name for the otter .

= = Meteorological history = =

The origins of Typhoon Sudal were from a persistent area of convection , or thunderstorms , southeast of Pohnpei in the Federated States of Micronesia toward the end of March 2004 . Initially , it was in an area of high wind shear , which is the change in wind direction with height and is unfavorable for tropical cyclogenesis . The unfavorable conditions gradually abated , which allowed convection to increase over a broad , developing circulation center . On April 2 , the Japan Meteorological Agency (JMA) classified the system as a weak tropical depression near Chuuk in the FSM . It was later classified with the international designation of 0401 , meaning it was the first tropical cyclone of 2004 . Slow development continued as the system moved slowly westward , and two days later it was classified as Tropical Depression 03W by the Joint Typhoon Warning Center (JTWC) ; this was the third tropical cyclone tracked by the agency . Shortly thereafter , the JTWC upgraded the depression to tropical storm status , after convection increased over the circulation .

While steadily intensifying , the system turned toward the north . On April 5 , the JMA named the system Sudal , after assessing its maximum sustained winds at 65 km / h (40 mph 10 @-@ min sustained) . Concurrently , the JTWC estimated winds of 100 km / h (65 km / h 1 @-@ min sustained) . After crossing over the island of Poluwat , a building ridge to the north caused Sudal to turn west @-@ southwestward . On April 6 , an eye feature began forming , and the JTWC upgraded Sudal to typhoon strength about 540 km (340 mi) southeast of Guam , a small island under possession of the United States . The JMA did not follow suit until late the following day , by which time the eye had become more distinct . Around that time , the typhoon turned toward the northwest , and initially it was thought that Sudal would pass safely north of Yap in the FSM . Instead , it turned to the west @-@ southwest toward the island as the ridge intensified . On April 8 , the typhoon intensified rapidly ; the JTWC reported winds of 215 km / h (135 mph 1 @-@ min sustained) , or the equivalent of a Category 4 on the Saffir ? Simpson hurricane scale . Weakening slightly as its forward motion slowed , Typhoon Sudal passed about 45 km (28 mi) south of Yap at 0000 UTC on April 9 , which was its closest approach to the island .

Intensification continued throughout the day on April 9 , with the appearance of concentric eyewalls

on satellite imagery ; such a feature is indicative of an intense tropical cyclone . Early on April 10 , the JTWC estimated that Sudal attained peak winds of 240 km / h (150 mph 1 @-@ min sustained) , making the cyclone a super typhoon . At the same time , the JMA estimated peak winds of 165 km / h (105 mph 10 @-@ min sustained) , as well as a barometric pressure of 940 mbar (27 @.@ 76 inHg) . Also on that day , Sudal entered the area of warning responsibility of the Philippine Atmospheric , Geophysical and Astronomical Services Administration (PAGASA) , which provided the name " Cosme " for local advisories . For several days , the typhoon continued to the northwest , fluctuating in intensity but remaining powerful . On April 12 , Sudal turned toward the north and northeast through a weakness in the ridge , and its eye increased to a diameter of about 85 km (53 mi) . The next day , the typhoon attained a secondary peak intensity of 230 km / h (145 mph 1 @-@ min sustained) , although it gradually weakened subsequently due to a combination of increasing upper @-@ level wind shear and cooler water temperatures .

Early on April 15 , Sudal passed very near the uninhabited Japanese island of Iwo Jima as a rapidly weakening typhoon ; at the time , its circulation center was exposed from the deepest convection . Shortly thereafter , both the JTWC and JMA downgraded Sudal to tropical storm status . Late on April 15 , the JTWC assessed the storm as becoming extratropical , although the JMA maintained advisories until the following day . As an extratropical storm , Sudal continued northeastward until losing its identity early on April 18 , well east of Japan and far south of the Aleutian Islands .

= = Impact = =

Early in its duration as a weak tropical storm , Sudal passed near Chuuk state in the Federated States of Micronesia (FSM) . One station reported 17 cm (6 @.@ 68 inches) of rainfall in a 24 ? hour period . The passage of the storm left minor roof damage and some crop damage , due to storm surge contaminating groundwater . No deaths or injuries were reported in the state . The storm briefly threatened Guam , and as it passed south of the island , Sudal produced 5 @.@ 5 m (18 ft) waves and a 0 @.@ 9 m (3 ft) storm surge . A station at Apra Harbor recorded a 69 km / h (43 mph) wind gust , and light rainfall of around 5 cm (2 @.@ 0 in) was reported , although no damage was reported on the island . High waves also occurred on Rota in the Northern Mariana Islands . The FSM is an independent nation in Compact of Free Association with the United States , and the latter nation is responsible for aid and protection .

Further west , Typhoon Sudal intensified quickly as it moved through the Caroline Islands and later Yap state . On Ulithi , a wind gust of 132 km / h (82 mph) was reported , and 6 @.@ 34 inches of rainfall occurred in a 24 ? hour period . High waves of over 5 m (18 ft) struck the island , causing severe beach erosion and damaging subsistence crops . The winds downed a few trees and wrecked some poorly built homes . On nearby Faraulep and Fais islands , similar meteorological conditions and damages were reported . The small Ngulu Atoll received gale force winds and heavy rainfall , which destroyed half of the island 's water storage tanks . Later in its duration , Sudal passed near Iwo Jima , producing wind gusts of 141 km / h (87 mph) .

= = = Yap = = =

The worst of the damage occurred on the island of Yap . Initially , the typhoon was expected to pass north of the island without affecting it significantly , but instead the island experienced the brunt of the storm . Typhoon Lupit affected the island in the previous year , from which the islanders were still recovering . With the last minute change in direction , government officials rushed to complete preparations on the island . On the day before the typhoon struck , storm shelters were opened in schools and government buildings that could withstand the winds of Sudal . In anticipation of significant damage , Yap officials sent a request to the FSM government for emergency aid to clean up after the storm .

On April 9 , the eye of Sudal briefly passed over the southern portion of the island , and winds of 185 km / h (115 mph) struck the island for about four hours . The entire island , only 17 km (11 mi) in length , experienced typhoon force winds . Yap International Airport recorded a peak wind gust of

181 km / h (112 mph) ; a subsequent survey estimated wind gusts on the island reached 226 km / h (140 mph) . Heavy rainfall occurred during Sudal 's passage , including 20 @. @ 0 cm (7 @. @ 88 inches) in a 48 ? hour period at the airport . The lowest pressure on the island was 958 @. @ 5 mbar (28 @. @ 30 inHg) . Along the coast , the typhoon produced waves of 6 @. @ 7 m (22 ft) in height , along with a 3 @. @ 7 m (12 ft) storm surge ; the combination sunk several ships and heavily damaged the island 's coral reefs , the latter which is one of Yap 's primary tourism attractions .

When Typhoon Sudal struck the island , there were about 8 @, @ 000 people living on Yap , with about 1 @, @ 700 houses . The typhoon destroyed 700 homes , and left another 900 damaged ; many of the destroyed homes were wooden . Damage was heaviest in the southeastern portion of the island , including in and around Colonia , the capital city . The strong winds downed trees across the island . Over 90 % of the structures on the island were damaged or destroyed , including the hospital , airport , most government facilities , and the water , power and communications systems . One of the five hotels on the island was also destroyed . About 80 % of the residents lost power or water after the storm . In the southeastern portion of the island , high waves wrecked most of the coastal homes , and also severely damaged the seawall . The intrusion of salt water destroyed almost all of the food crops on the island . Following the typhoon 's passage , about 1 @, @ 000 people were left homeless , and another 500 were forced to stay in shelters .

Overall damage from Typhoon Sudal totaled about \$ 14 million (2004 USD , \$ 16 @. @ 1 million 2010 USD) , most of which on Yap from property damage . Despite the heavy damage , there were no deaths , although there were initial reports of one fatality . Only 8 people required hospital treatment due to injuries , none of them serious . Typhoon Sudal was the strongest typhoon to strike Yap in about 50 years .

= = Aftermath = =

Following the passage of Sudal , officials in Yap declared a state of emergency , and a day after the typhoon struck , United States President George W. Bush ordered federal disaster aid for the FSM . The latter declaration provided funding for 75 % of the debris removal cost and emergency services . Less than a week after the storm , the Pacific Islands Forum provided \$ 11 @, @ 500 to Yap for relief efforts . Over the subsequent weeks , the FSM government established a typhoon relief fund of about \$ 250 @, @ 000 . Additionally , the United States government allocated \$ 7 @, @ 443 @, @ 000 for relief efforts .

Within a few days , the Federal Emergency Management Agency (FEMA) identified primary concerns for the small island , including fixing the water supply , distributing water , clearing roads , and fixing damaged shelters . On the island , the water supply was rapidly diminishing ; more than 80 % of the islanders were without clean water , and the water from the treatment plant needed to be boiled for extended periods of time . Health issues included dehydration , sickness , and gastrointestinal problems . Without running water , several people bathed in the oil @- @ contaminated harbor where many boats sunk , which caused skin irritations .

Initially , telephone service onto the island was disrupted , and the only method of outside contact was by radio to the University of Guam . The Guam Memorial Hospital dropped a package of medical supplies to Yap , although planes containing aid flying onto the island were disrupted by the damaged runway . About a day after Sudal 's passage , the runway was cleared and repaired , which allowed a United States Coast Guard plane to provide relief supplies , including building materials . By April 12 , or three days after the typhoon , communication links to the island began to be restored . By four days later , the water treatment plant was repaired . One power station on the island was repaired , but since the strong winds damaged most of the power lines , about 85 % of the population remained without electricity . Primary roadways were largely cleared , and all bridges were reopened .

About two weeks after the typhoon 's passage , there were still 500 people in 18 shelters in Colonia , the capital city , as well as about 400 people in shelters elsewhere . Many others were either residing with relatives or staying at their damaged properties . The United States Army Corps of

Engineers arrived on Yap to coordinate debris removal and installing generators . Officials sent 23 flights of aid to the island , as well as one each to the outlying islands of Ulithi and Fais . About 76 @, @ 000 litres (20 @, @ 000 gallons) of water were sent to the island , and five large water tanks were installed . Members of the United States Forest Service arrived to coordinate the receiving and distribution of relief supplies . The Yap hospital was poorly suited to handle the typhoon , due to the lack of medications or emergency medical equipment . About 60 FEMA personnel worked at the hospital , who required additional items , such as their own supply of water and food , to prevent them from acquiring local diseases . During their stay on the island , the group assisted 163 people , mostly for minor issues . Overall , there were about 100 FEMA workers involved on the island , although only 20 stayed there due to lack of hotels and rental cars .

By 26 days after the storm , more than half of the island had power restored , and the cell phone system was fixed . In the weeks and months after the passage of Sudal , water temperatures around Yap decreased from 30 ° C (86 ° F) to 24 ° C (75 ° F) , due to significant upwelling . The drastic decrease caused unusual amounts of fog over the island , as well as significantly lower tides . By September 2004 , rebuilding was still underway , and half of the schools , which had previously been used as shelters , reopened to students . Power and water lines were completely restored . The hospital remained damaged with a temporary roof , and although private businesses quickly re @-@ opened , government buildings took longer to be rebuilt ; this was due to the lengthy process of receiving aid from FEMA . Additionally , officials required a land survey to determine where structures were safe to be rebuilt .

Due to the heavy damage on Yap , the name Sudal was retired during the 38th session of the Economic and Social Commission for Asia and the Pacific and World Meteorological Organization typhoon committee in November 2005 ; it was replaced with the name Mirinae .