United States Department of the Interior

NATIONAL PARK SERVICE

ORGAN PIPE CACTUS NATIONAL MONUMENT

10 Organ Pipe Drive

Ajo, Arizona 85321

Alamo and Kuakatch Wash floods of the 2012 monsoon: a short summary from Organ Pipe Cactus National Monument Natural Resources Division

November 13, 2012

The North American monsoon and Organ Pipe Cactus National Monument (OPCNM)

The North American monsoon occurs from July to mid-September in the southwestern United States. Intense daytime heating causes low pressure to develop over western Arizona while high pressure builds to the east. This combination causes prevailing winds to shift from westerly to southerly, drawing in moisture from the Gulf of California and Gulf of Mexico. Because OPCNM is located near the northwestern edge of the monsoon pattern, rainfall is generally less abundant and less predictable than areas to the south and east. July and August rainfall accounts for 30-40% of the annual total (Fig. 1a) at OPCNM. Monsoon intensity can also vary greatly across the region and between years (Fig. 1b).

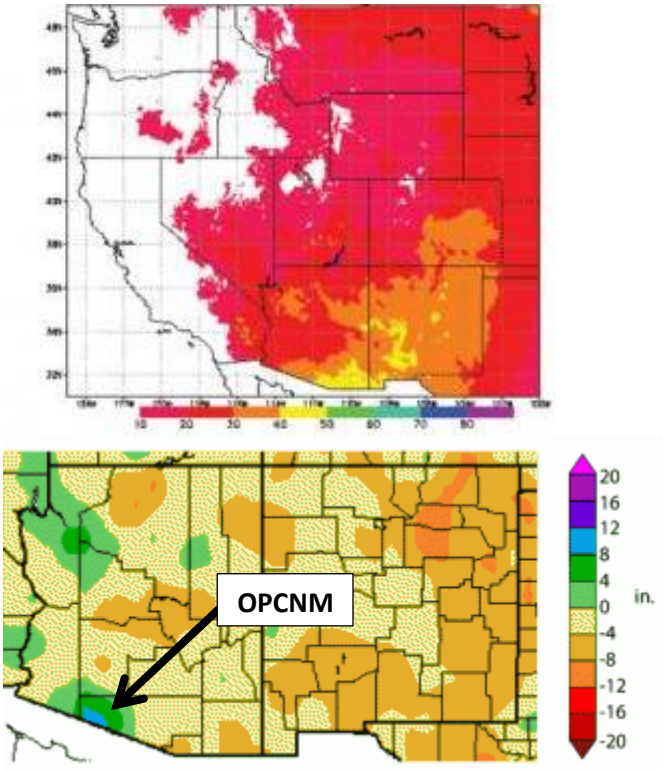

Figure 1.a) Percent of average annual precipitation received during July and August in the western United States (above) and b) departures from normal precipitation from October 2011-September 2012 in Arizona and New Mexico (below). Figures reproduced from University of Arizona's Climate Assessment for the Southwest "Water Year in Review" for 2012 available at [http://www.climas.arizona.edu/outlooks/wyir].

The monsoon of 2012 in OPCNM

In 2012, monsoon rains began on July 4 and ended on September 16. Weather stations in OPCNM recorded 1.2 to 4.5 inches during July, 0.8 to 6.6 inches in August, and 1.3 to 7.8 inches in September. Monsoon totals (July-September) ranged from 4.9 inches at Dripping Springs to 16.7 inches at Alamo Canyon, compared to averages of 4.1 inches and 5.4 inches, respectively. The greatest rainfall occurred at stations above 2000 feet elevation in and adjacent to the Ajo Range (Fig.2).

The combination of drainage area and the timing of rainfall, led to two major flood events in larger canyons of the Ajo Range. The first occurred on August 16 when 2.3 inches fell in early afternoon west of Tillotson Peak, joined by 2.8 inches in Alamo Canyon in mid-late afternoon. By that evening, floodwaters were rushing through the culvert located at mile 66.5 on Highway 85 (Fig. 3) and Monument employees driving home were delayed by floodwaters across the highway, especially at Kuakatch Wash further north on Highway 85 (Fig. 4). Significant rain had already fallen the previous day.

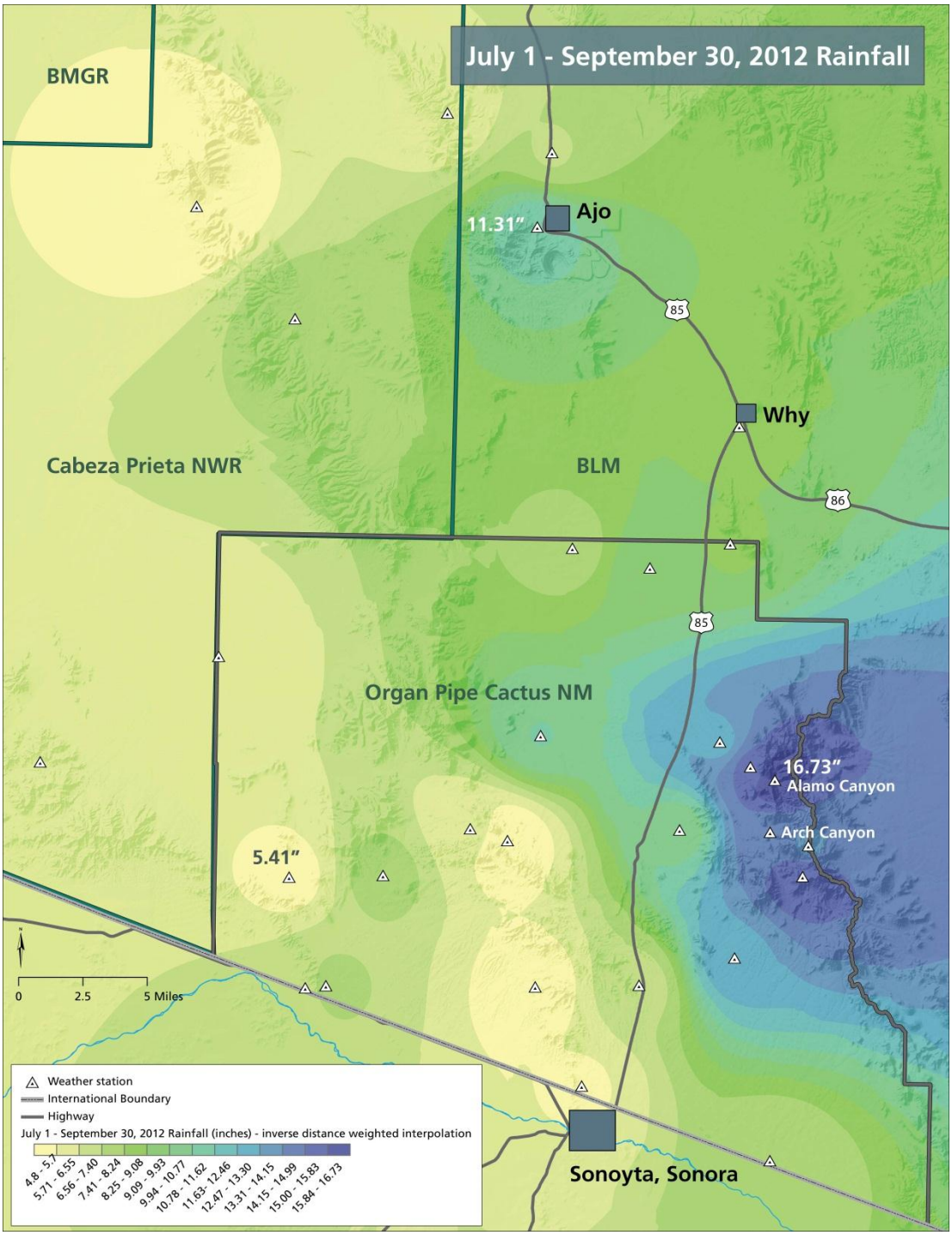

Figure 2. Rainfall totals for the 2012 monsoon season at Organ Pipe Cactus National Monument.

Figure 3. The culvert crossing at mile 66.5 after floodwaters reached Highway 85, August 16, 2012.

Figure 4. Highway travelers waiting for floodwaters to subside at one of the Kuakatch Wash crossings on Highway 85, August 16, 2012.

During the second and larger event that peaked on September 10, flood waters at both the culvert at mile 66.5 and bridge at Alamo Wash overtopped Highway 85 and several sections of backcountry road were left impassable. This flood was the culmination of six continuous days of rain in the Ajo Range, which began on September 6 and lasted until September 11. This was the final surge of the 2012 monsoon season.

Figure 5. The first storm to hit the Ajo Mountains during a series of early September storms, on September 6, 2012.

On the first day, September 6, the weather station in Alamo Canyon recorded 2.0 inches of rainfall from 2:00 PM to 11:00 PM (Fig. 5). Rain began again the following morning on September 7, dropping another 0.5 inches between 7:00 AM and 10:00 AM. On the third day, September 8, 0.3 inches of rain fell 3:00 PM and 10:00 PM. On the fourth day, September 9, 0.9 inches of rain fell between 5:00 PM and 9:00 PM. The greatest daily and one-hour totals occurred on September 10 when 3.5 inches fell between 8:00 PM to 11:00 PM and 2.7 inches fell in the first hour. Although the subsequent flooding may have been caused by just the storm event of the 10th, the preceding four days of rain undoubtedly enhanced the size of the flood due to near- or already-saturated soil conditions. The rain finally came to a close on 11 September, dropping a final 0.6 inches between 8:00 AM and 2:00 PM.

Highway 85 was closed during the night of September 10 as Arizona Department of Transportation workers began clean-up of flood debris and OPCNM rangers responded to stranded travelers. By the next morning, the highway was again open to traffic. It would take several weeks to complete repairs and reopen the Ajo Mountain Loop Drive.

Witnessing the aftermath of the floodwaters on the morning of September 11, most employees could not recall seeing a similar event within the past 20 years of collective experience at OPCNM. The damage done to the well in Alamo Canyon (located near the canyon mouth) also indicates that a similar flood has probably not occurred, at least in the canyon proper, since the well was first built ca. 1913. Flood waters in Alamo Wash scoured a large extent of the adjacent flood plain and uplands, removing large trees and saguaro cacti that were hundreds of years old. A substantial portion of the flow overtopped the Alamo Wash floodplain and flowed through a pass in Tillotson Ridge and into the wash at mile 66.5 (Fig. 6).

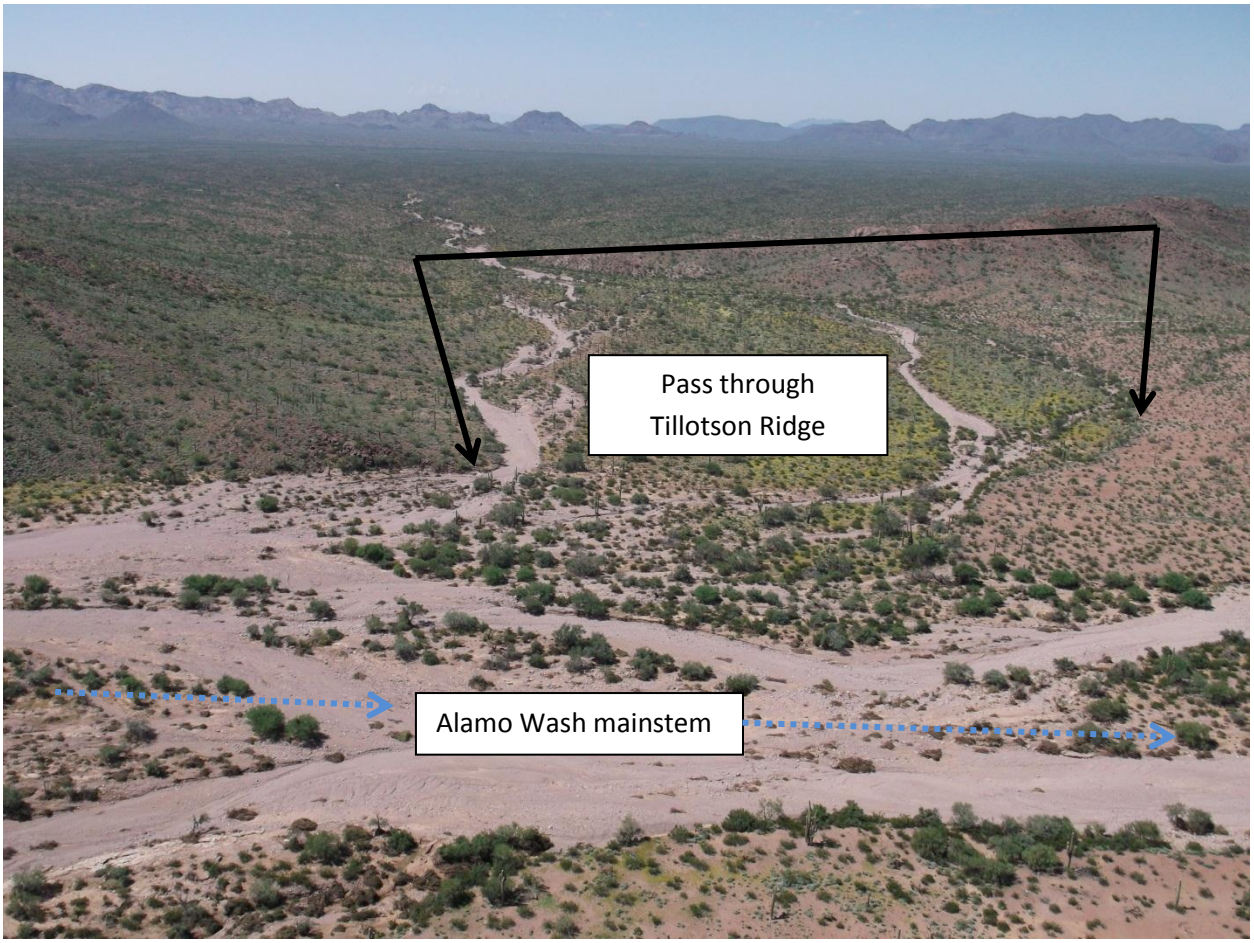

Figure 6. Water from the mainstem of the Alamo Wash was diverted through a gap in the 66 Hills to the southwest during September monsoon storms in 2012. Most of the water probably flowed down the channel visible on the left edge of the floodplain, although the entire floodplain was filled with water at certain flood stages.

A preliminary interpretation of the deeper geologic history of Alamo Wash by Arizona Geological Survey tells us that the wash reoccupied much of its floodplain during the 2012 storms, and has probably been diverting water to the mile 66.5 wash through "overflow" channels (also called a distributary area) for the past several thousand years

(P. Pearthree and A. Youberg, personal. commun., September 14, 2012). Close inspection of aerial photographs (Fig. 7) reveals these old floodplains, which are detectable by terraces on the landscape and by xeroriparian vegetation visible all along Alamo Wash and the diversion through Tillotson Ridge. Overflow channels in the pass through Tillotson Ridge that are barely visible in 2010 emerge as bright white channels in aerial imagery taken from a satellite after the flood events in 2012.

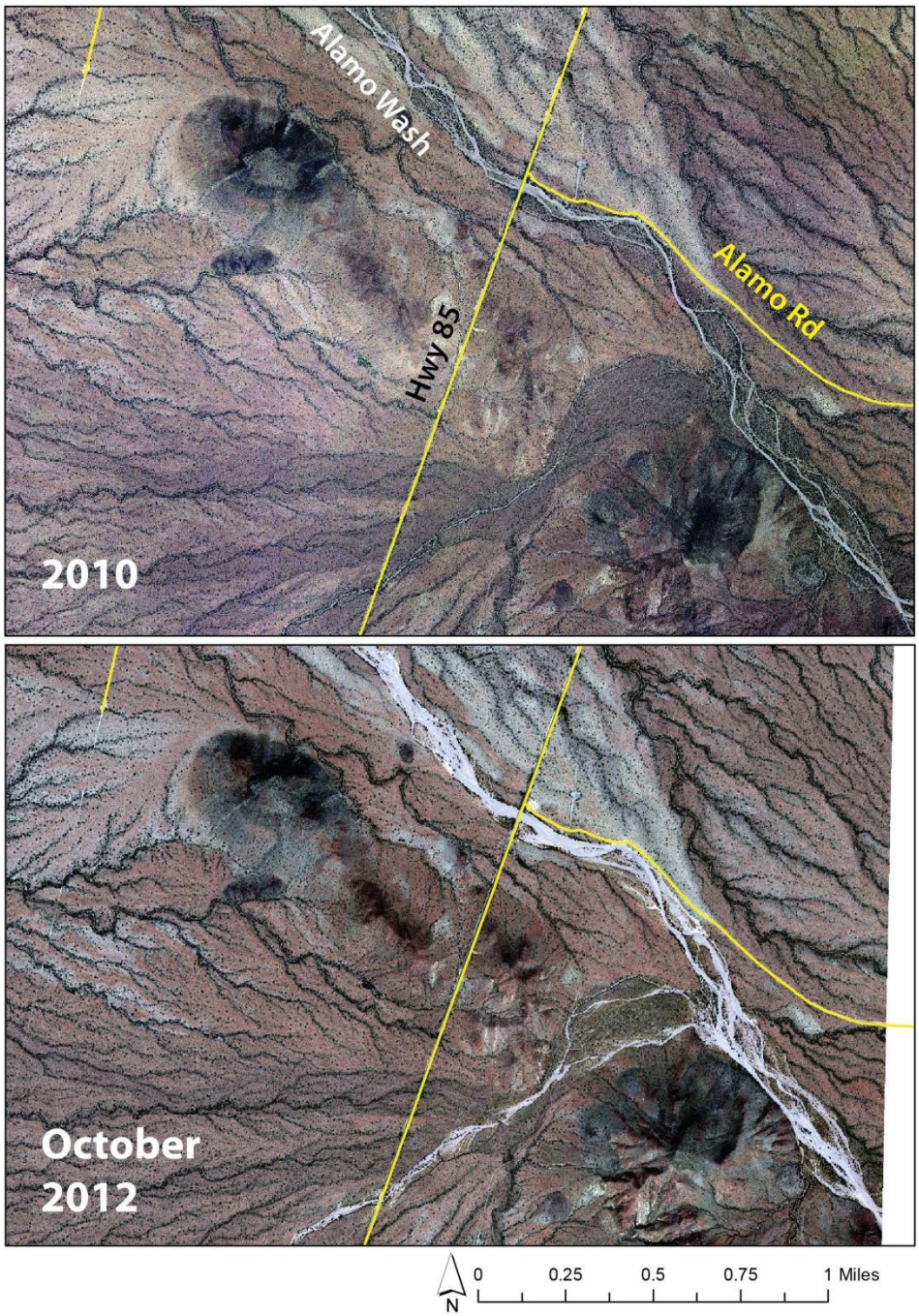

Figure 7. Before and after satellite images of the Alamo Wash highway crossing and the 66 Hills floodplain, where water was diverted during a series of early September monsoon storms in 2012.

The Ajo Mountain Drive was closed for several weeks as OPCNM maintenance staff began to clear debris and grade road surfaces that had been eroded by floodwaters. A number of wash crossings on the Ajo Mountain Drive also had to be cleared after being filled with rubble and boulders deposited by floods. The most notable deposition was seen at Estes Canyon, which drains Bull Pasture, where the weather station recorded precipitation totals comparable to Alamo Canyon.

OPCNM Resource Management staff are currently working with the Arizona Water Science Center of the U. S. Geological Survey in Tucson to evaluate the flooding and perform what is referred to as an "indirect discharge estimate". This type of estimate gives an 'after-the-fact' measurement (as opposed to 'direct' measurements of stream flow during a flood by stream gages) of how much water flowed down Alamo Wash during the September storms. This type of estimate relies on detecting high-water marks left by flood debris and sediment and mapping elevation profiles or cross-sections of the wash channel with high-precision GPS. Discharge estimates are then typically compared within a region or to historic flooding events to help understand the relative magnitude and frequency of floods and how the Alamo flood event of 2012 compares.

Acknowledgements

Ami Pate created the before and after graphic of the Alamo Wash highway crossing and the monsoon totals graphic. Peter Holm provided the narrative of precipitation timing during the floods. Caleb Kesler captured the image of the Alamo mainstem and 66 Hills floodplain during a helicopter flight. The hard work of both the OPCNM Visitor and Resource Protection and Maintenance Divisions allowed roads to promptly re-open to curious scientists and the visiting public, and kept employees and the public safe while traveling during the flooding.

Author: Sarah Howard, Biologist, Natural Resources Division