SOUTHERN INDIANA FLASH FLOOD EVENT

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1. Introduction

On the morning of 5 October 2000 flash flooding occurred in the southern portion of the National Weather Service Forecast Office (NWSFO) Indianapolis County Warning Area (CWA). A stationary front over the Ohio Valley aided in the development of back-building and training echoes that moved west to east over portions of southwest and south central Indiana. One death occurred in southern Indiana as a result of the flooding.

This paper will examine the events of 4 and 5 October 2000 and the efforts to mitigate the flood problem in the area where the death occurred. The purpose of this study is to heighten awareness of flash flood potential, particularly in the southern half of the Indianapolis CWA. Since terrain was determined to be an influential factor, an overview of the terrain where the incident occurred is included. A discussion of the synoptic conditions is followed by a summary of events.

2. Terrain

The location of this flood event was along Moore's Creek in Eastern Monroe County , Indiana. The precipitous terrain surrounding the creek is among the steepest in the state of Indiana.

The drainage area of Moore's Creek at the site of the incident is 2.2 square miles. The local watershed is very elongated, estimated to be 4 times longer than wide. Two local tributaries converge about one half mile upstream from the crossing where the flood death occurred. According to a 1966 United States Geological Survey topographical map of Indiana, the elevation falls more than 150 feet in 600 feet of linear distance for a slope greater than 25%. The watershed is primarily wooded.

According to the Indiana State Police, Moore's Creek habitually floods. At approximately 0500 UTC 4 October 2000 an Indiana State Police officer estimated water flowing 3 to 4 feet above the surface of Moore's Creek Road. The woman whose vehicle was swept off the road by the fast moving stream was new to the area and not aware of the flood hazard. According to the State Police, all of the residents near the creek were aware of the flood danger.

3. Synoptic Overview

Model forecast data from the 0000 UTC 5 October 2000 and the 1200 UTC 5 October 2000 run of the ETA Model (ETA), Nested Grid Model (NGM), and Aviation Model (AVN) were obtained along with WSR 88D archive level 2 data from the Indianapolis radar, cooperative observer, and Automatic Surface Observation System (ASOS) rainfall data.

Light to moderate rain fell on southern Indiana during the daylight hours of 4 October 2000. A stationary front was located just north of the Ohio River from the morning of 4 October to the morning of 5 October 2000. The weather pattern resembled a frontal unstable flash flood event. In a "Frontal Unstable" case, flooding occurs near an east-west frontal boundary (Junker 1992). There is plenty of moisture to its south and precipitable water values are at

least 160 percent of normal. Heavy rain usually falls on the cool side of the boundary as warm moist unstable air from the south overruns it. Often a nocturnal low level jet forms, increasing convection and the potential for heavy rainfall to occur (Junker 1992). In a frontal unstable case, the air mass is unstable south of the front and elevated thunderstorms occur as warm moist air rises up over the cooler air to the north. There is often little vertical wind speed sheer, but significant veering. Upper level winds are parallel to the front.

Surface and upper air charts showed many of the previously mentioned features. First, the surface map at 0000 UTC 5 October 2000 (Figure 1) showed a quasi-stationary front from southern Indiana to southern Missouri. South of the front, dew points were in the 60s F.

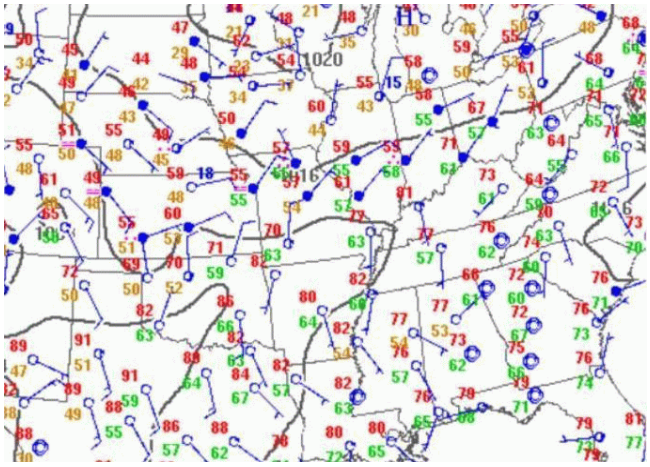

Fig. 1 0000 UTC 5 OCT 2000 Surface Chart

Surface observations also showed weak low pressure over Oklahoma while high pressure was over the northern Great Lakes. Wind fields showed low level conflluence along the front just north of the Ohio River.
The Skew T Log P chart (not shown) at Lincoln, Illinois at 0000 UTC 5 October 2000 showed a very moist atmosphere below 600 mb. The sounding was located just north of the surface front. The front aloft was at about 900 mb. The wind field showed veering below 750 mb by more than 90° and little speed sheer or veering above 750 mb.

The 0000 UTC 5 October 2000 850 mb chart (Figure 2) showed a 0° C dew point depression at Lincoln, IL and Wilmington, OH and a weak zone of moisture and wind confluence across northern Indiana. The 850 mb chart also showed a weak southerly jet south of the confluence zone with an average wind speeds of around 10 kts from the lower Mississippi Valley to central Indiana.

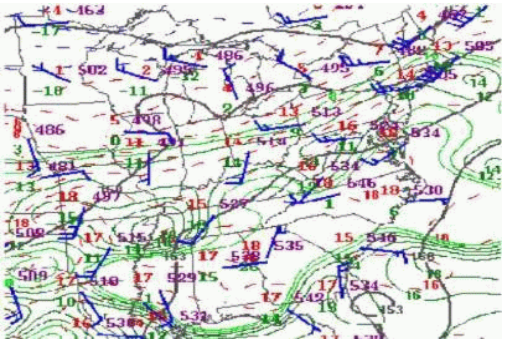

Fig. 2 0000 UTC 5 OCT 2000 850 mb

The 700 mb chart (not shown) showed approximately a 2° C dew point spread with a west southwest flow of about 25 kts. Finally, the 250 mb chart (Figure 3) showed diffluence over the Ohio Valley. A 140 kt jet was moving across the Great Lakes, while a much weaker jet was over the Southern Plains. As both jets progressed eastward overnight, the Ohio Valley ended up being in the right rear quadrant of the Great Lakes jet streak and in the left front quadrant of the Southern Plains jet core. This positioning of jets increased upper level divergence across Indiana (Keyser and Shapiro 1985).

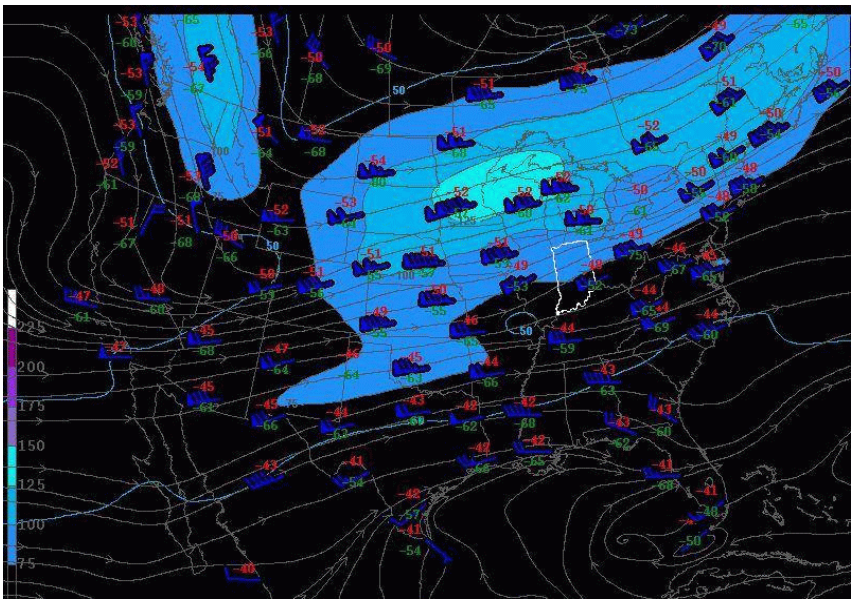

Fig. 3 0000 UTC 5 OCT 2000 250 mb

Briefly looking at precipitable water data, both the ETA (Figure 4) and NGM (Figure 5) showed values in the 1.5 to 1.6 inch range at 0600 UTC 5 October 2000. The axis of maximum precipitable water was over southern Indiana. Normal precipitable water for October is around 0.90 inch (NOAA Technical Report 1976). The values that occurred the night of 5 October 2000 were about 160 to 170 percent of normal.

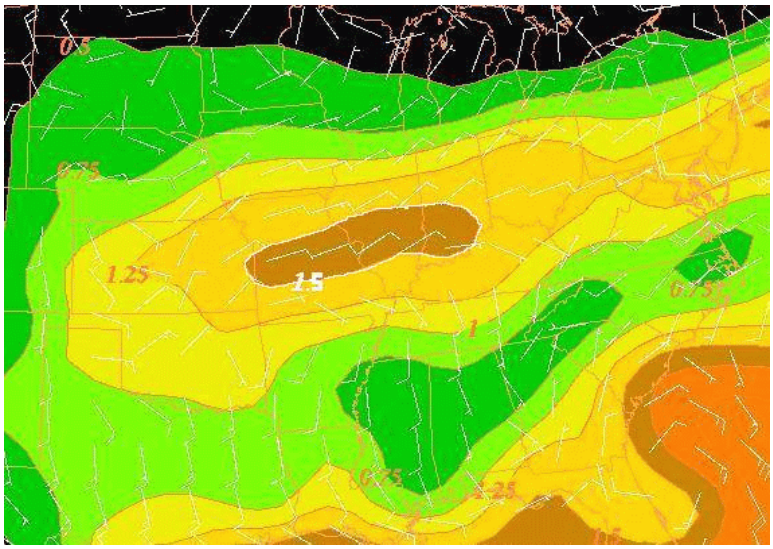

Fig. 4 0600 UTC 5 OCT 2000 ETA Precipitable Water

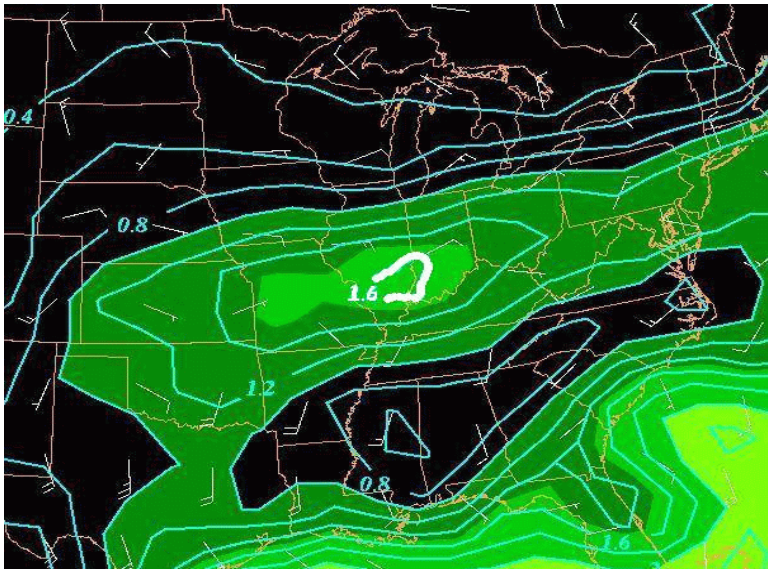

Fig. 5 0600 UTC 5 OCT 2000 NGM Precipitable Water

Even though many parameters favored heavy rainfall that night in southern Indiana, a weak jet at 850 mb and moderate wind speed sheer above 750 mb made forecasts a little dubious. All computer models forecast the front to move north overnight. The models and the National Center for Environmental Prediction's Hydrometeorological Prediction Center also forecast the heaviest rain to fall about 100 miles farther north than what actually occurred. By 1200 UTC 5 October 2000, the front had moved to just north of a Indianapolis, Terre Haute line. Flash flood guidance issued the morning of 4 October 2000 by the River Forecast Center at Wilmington, OH indicated 3 hour

rain amounts needed for flooding to occur in the area of interest to be near 2 inches, and twenty four hour amounts to be around 3.5 inches. Twenty four hour rainfall observations ending at 1200 UTC 5 October 2000, showed a band of 3.5 to 4.5 inch rainfall amounts across southern Indiana (Figure 6). According to ASOS and NWS cooperative observer reports, most of the rain that occurred fell during the night of 4 October 2000. Some places exceeded the 24 hour flash flood guidance by as much as 1 inch.

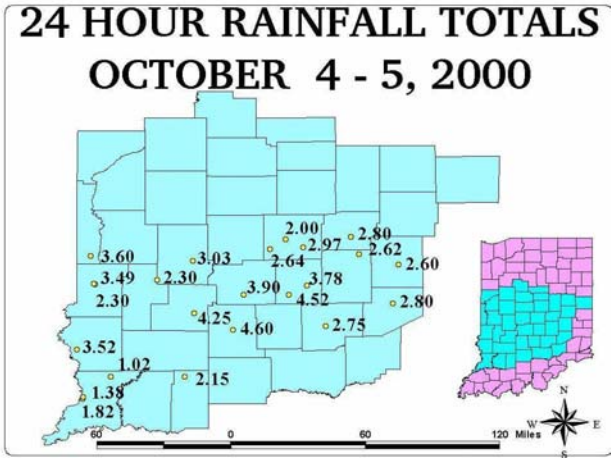

Fig. 6 24 Hour Rainfall Totals

4. Summary

Terrain was the leading factor causing this tragic flash flood event. With the steep inclines and narrow creek, the amount of rain that the watershed took on was more than it could handle without jeopardizing human safety. The Monroe County Highway Department had targeted that particular low water crossing as a site for repair. According to the Highway Department's Highway Engineer, improvements of the crossing began one week after the accident occurred and were completed by the middle of January 2001. Figure 7 is a photo of the crossing before mitigation and Figure 8 is after mitigation. Although the crossing was known to be a hazard by local residents, this particular motorist was not privy to that information. As a result of this tragedy, the Monroe County Highway Department has identified all other low water crossings in their county and placed signs at those crossings to warn of the hazard.

Fig. 7 Low Water Crossing Prior To Mitigation

Fig. 8 Low Water Crossing After Mitigation

Acknowledgements

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