

# Application of the Enhanced Fujita Scale in Damage Surveys

James G. LaDue<sup>1</sup>, Ed Mahoney<sup>1</sup>, Gregory J. Stumpf<sup>2,3</sup>, Kiel L. Ortega<sup>2</sup>

<sup>1</sup>NOAA/National Weather Service/Warning Decision Training Branch, Norman, Oklahoma, USA

<sup>2</sup>Cooperative Institute for Mesoscale Meteorological Studies/University of Oklahoma, Norman, Oklahoma, USA

<sup>3</sup>NOAA/National Weather Service/Meteorological Development Laboratory, Norman, Oklahoma, USA



## Objectives of the new scale

- To provide more guidance to damage surveyors in the form of more Damage Indicators (DI).
- To adjust the wind speed estimates closer to our best understanding.

## A Brief Description of the EF-Scale

- For each DI, a Degree of Damage (DoD) describes the damage and an associated range of wind speeds.
  - The lowest DoD indicates the level at which damage begins.
  - The highest DoD corresponds to a wind speed in the EF5 range, or the level at which the DI has been completely destroyed at a lower wind speed.

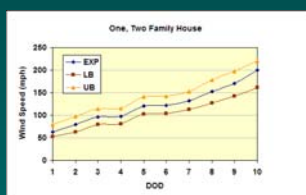


FIG 1. DODs for a One- and Two Family House vs. Lower Bound (LB) wind speed, Expected wind speed (EXP), and Upper Bound wind speed (UB).

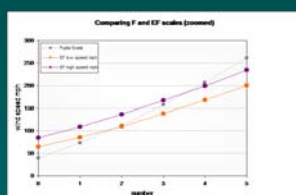


FIG 2: Lower- and upper-bound wind speed vs. rating for the EF-Scale in solid lines. The lower bound wind speed vs. rating is indicated for the F-Scale in a dotted line.

## Damage Indicators (DI)

- The "FR12" DI, known as single- and double- family U. S. residences, was the primary basis for the original Fujita Scale (F-Scale).
- The current list of 28 DIs is mostly U.S. Centric.
- The EF-Scale is designed to accommodate new Damage Indicators.
- New DIs can be added to include man-made and natural objects from other locations worldwide (e.g., modern residential housing in Northern Italy, automobile sedans, empty railroad boxcars, etc.).

## Wind Speed Estimates

- Fujita's original wind speed estimate for the "FR12" DI have been revised.
  - The higher end speeds have been greatly reduced.
  - The lower end speeds have been slightly increased.
- Wind speed estimates were developed for the additional DIs.
- Wind speed estimates are tagged to each DI via Degrees of Damage (DoD).
- Revised wind speed estimates can be made at any time science provides them, and the original DoDs would remain unchanged.

## F-Scale vs. EF-Scale for FR12

- For FR12, there is no difference in the way a damage surveyor will determine the Degree of Damage between both scales. Thus,
  - a home rated F1 is rated EF1,
  - a home rated F2 is rated EF2, and so on,
  - a home rated F5 is rated EF5.
- The only difference being that the wind speed estimates for that particular DoD has been adjusted.

## Challenge

- To effectively conduct a survey with a new system without suffering from increased workload.

## Solutions

- Two online asynchronous lessons were developed by the NWS Warning Decision Training Branch with help from Subject Matter Experts (SME).
- On online BB forum to exchange lessons learned from applying the EF-Scale in surveys.
- A Windows-based "EF-Kit" that works on a laptop PC, or a Windows CE based PDA with a 480 X 680 pixel display.

## Opportunities for Advanced Damage Survey Techniques

- A greater precision in damage surveys when the EF-scale is combined with GIS-based surveying techniques.
- For several surveys in 2007, the following equipment was used (all time synched):
  - Laptop equipped with mapping software (e.g., DeLorme).
  - PDA equipped with Bluetooth, GPS logger software, and EF-Kit.
  - Handheld Bluetooth GPS receiver.
  - Digital Camera.
- Once photographs are "geo-tagged", can be ingested into Google Earth™.
- The photos and satellite images can be used to reconstruct a GIS-based damage survey.

## Potential Worldwide Application

- ATTENTION ESSLI!
- The F-Scale is U.S. Centric.
- The EF-Scale can be expanded to included non-U.S. DIs.
- The DoDs will never change. That is what is recorded.
- The wind speeds may change, but there is no reason to re-survey.

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## Enterprise, Alabama (1 March 2007)

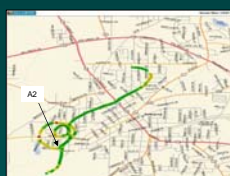
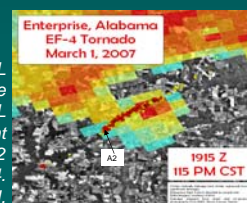


FIG 3: A GPS track of one segment of an aerial survey of the Enterprise, AL tornado. The arrow labeled A2 shows the location of the photograph in figure 4.



FIG 4: Aerial photograph marked A2 in figure 3 showing two FR12 DIs destroyed by the tornado.

FIG 5: The damage track of the Enterprise, AL tornado superimposed on the 0.5 degree reflectivity product from the Tallahassee, FL WSR-88D. The yellow (red) circles represent EF0-1 (> EF1) damage. The label A2 represents the destroyed houses in figure 4. Map courtesy of Parks Camp, WFO TLH.



## Minco, Oklahoma (19 August 2007)



FIG 6: (left) Digital geotagged photos imported into Google Earth™.



FIG 7: One "enhanced" image, which is placed into Google Earth™ with image three-dimensionally oriented in direction photograph was taken.