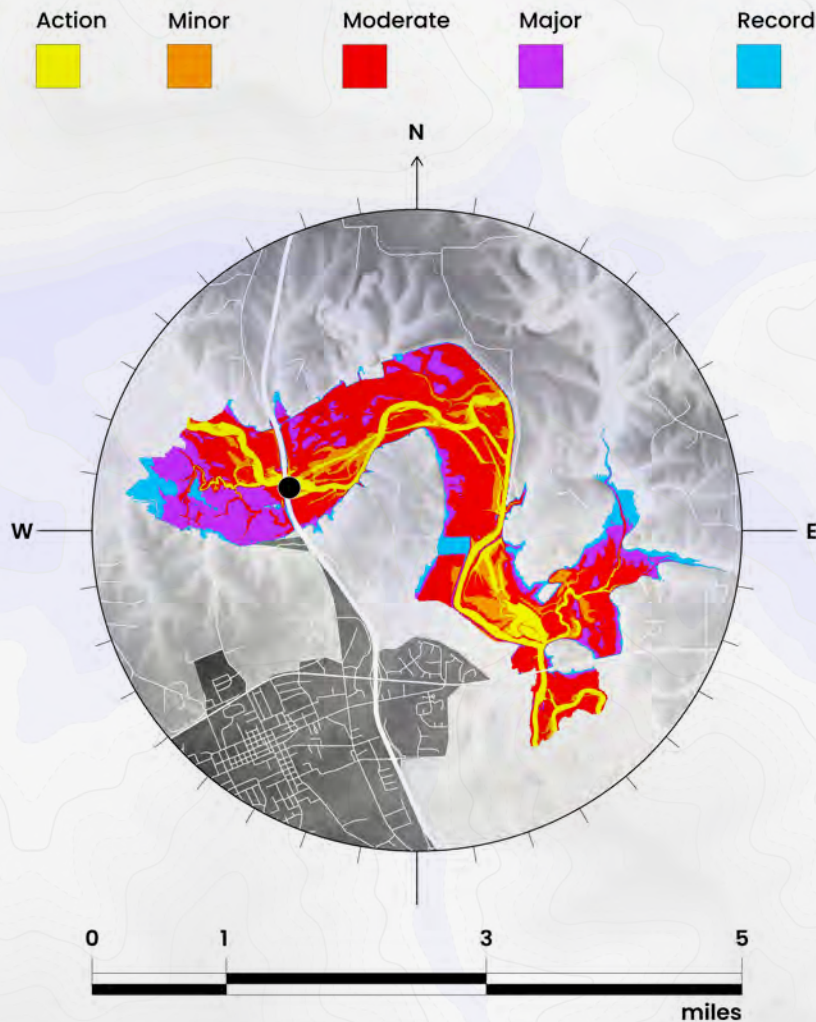# Stage-Based Categorical Flood Inundation Mapping [CatFIM] Factsheet [Public Domain]


Categorical Flood Inundation Mapping [CatFIM] uses the HAND Method developed by the National Water Center [NWC] to create FIM extents for the official National Weather Service [NWS] flood stage category thresholds [Action, Minor, Moderate, Major, and Record]. This Static FIM Library Service serves as an invaluable tool for emergency planning and delivering effective Impact-Based Decision Support Services [IDSS] on "blue-sky" days ahead of actual future flood events. This factsheet outlines the Stage-Based CatFIM Method, its limitations, and application.

Obtaining Stage-Based CatFIM

Stage-Based CatFIM uses vertical datums to convert official stage values into Water Surface Elevations [WSEs]. It also applies a vertical datum offset to align WSEs with the NAVD88 vertical datum used in the HAND FIM technique. The Stage-Based CatFIM Method begins with the official stage value [S_1] corresponding to a given NWS categorical flood stage threshold and converts this S_1 value into a WSE. Because Stage-Based CatFIM is incremental, it starts with the Action Stage threshold and generates FIM at 1.0 ft intervals, up to 5.0 ft beyond the Major Stage [subject to change in future updates]. The stage value [S_1] is the vertical distance between the gage "zero" datum and the water surface height. Zero datum is "a reference zero elevation for a stream or river gage. This zero can be referenced [usually within ten feet of the channel bottom] to Mean Sea Level [MSL] or any other recognized datum."

Stage-Based CatFIM also applies a datum offset, the datum delta, to align gage WSE values with the HAND datum. These HAND-adjusted WSE values are then mapped onto the HAND grid to visualize inundation extents 5 miles upstream and 5 miles downstream from the NWPS gage location, assuming the stream order remains unchanged. Mapping is limited to segments that drain into the gage's home catchment area [i.e., the watershed]. The NWS defines gage datum as the "horizontal surface used as a zero point for the measurement of stage or gage height. This surface is usually located slightly below the lowest point of the channel bottom such that the gage height is typically greater than the maximum water depth. Because the gage datum is not an actual physical object, the datum is usually defined by specifying elevations of permanent reference marks such as bridge abutments and survey monuments. The gage is set to agree with these reference points."
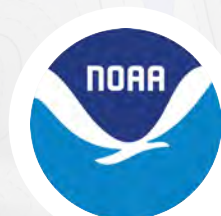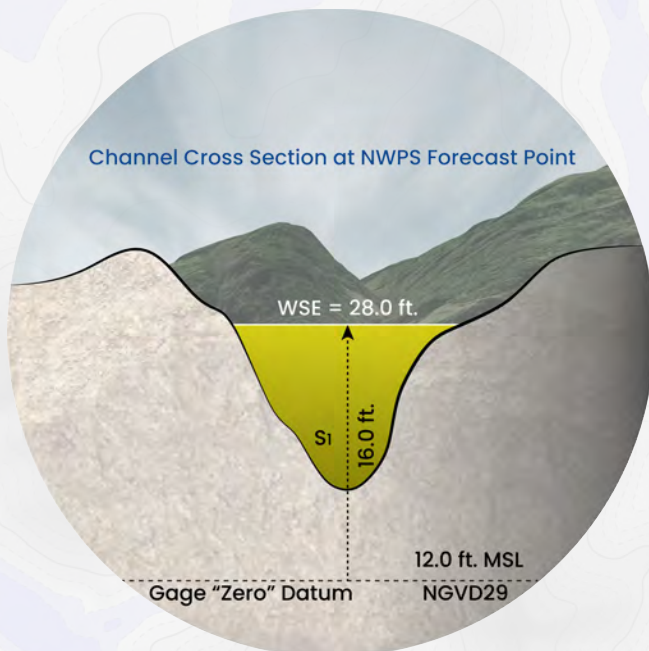
01. Start with Official NWS Stage Value [S_1]

Channel Cross Section at NWPS Forecast Point
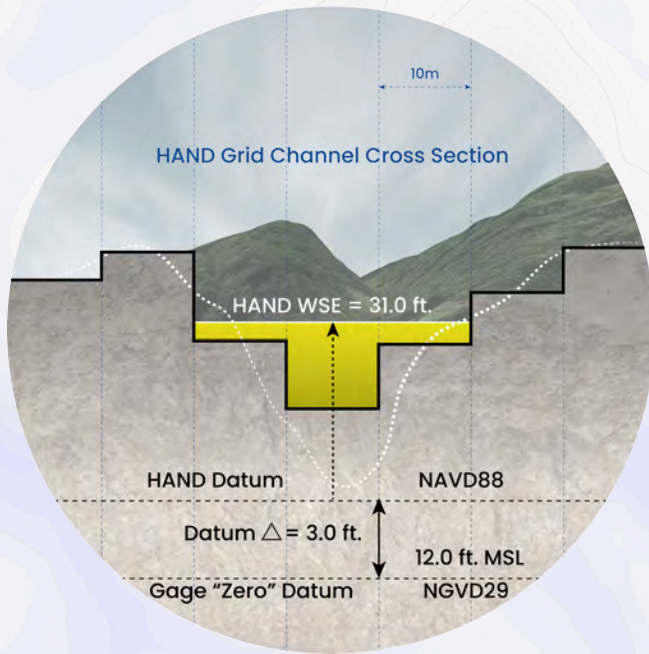
S_1 — 16.0 ft.

Gage "Zero" Datum   NGVD29
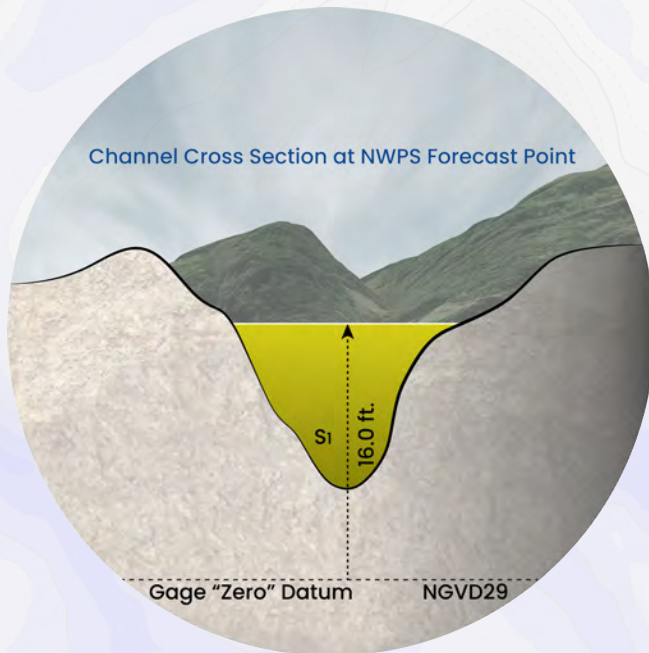
Begin with the official stage value [S_1] associated with a categorical flood stage threshold. Because Stage-Based CatFIM is incremental, generally, you would start with the Action Stage threshold and generate FIM at 1.0 ft. intervals up to 5.0 ft. beyond the Major Stage. In this hypothetical example, the Action Stage begins when the stage [S_1] rises to 16.0 ft. above the channel bottom.

02. Convert S_1 Value into WSE

Channel Cross Section at NWPS Forecast Point

WSE = 28.0 ft.

S_1 — 16.0 ft.

12.0 ft. MSL

Gage "Zero" Datum   NGVD29

Next, convert the official stage value [S_1] of 16.0 ft. into a Water Surface Elevation [WSE] by adding it to the gage "zero" datum, which in this example, sits at an elevation of 12.0 ft. above Mean Sea Level [MSL]. Therefore, the observed WSE is equivalent to 28.0 ft. above MSL [16.0 + 12.0].

03. Calculate Vertical Datum Delta

HAND Grid Channel Cross Section

10m

HAND WSE = 31.0 ft.

HAND Datum — NAVD88

Datum △ = 3.0 ft.

12.0 ft. MSL

Gage "Zero" Datum — NGVD29

If the gage "zero" datum aligns with the HAND Method's NAVD88 datum, the observed WSE is directly applied to the HAND grid for mapping inundation. However, if the gage "zero" datum differs, as in our example, a datum delta calculation is required. Assuming a gage elevation of 15.0 ft. in NAVD88, the vertical difference is 3.0 ft., yielding a HAND-adjusted WSE of 31.0 ft.

04. Map HAND WSE Value onto HAND Grid

Mapping Extent

NWPS Forecast Point
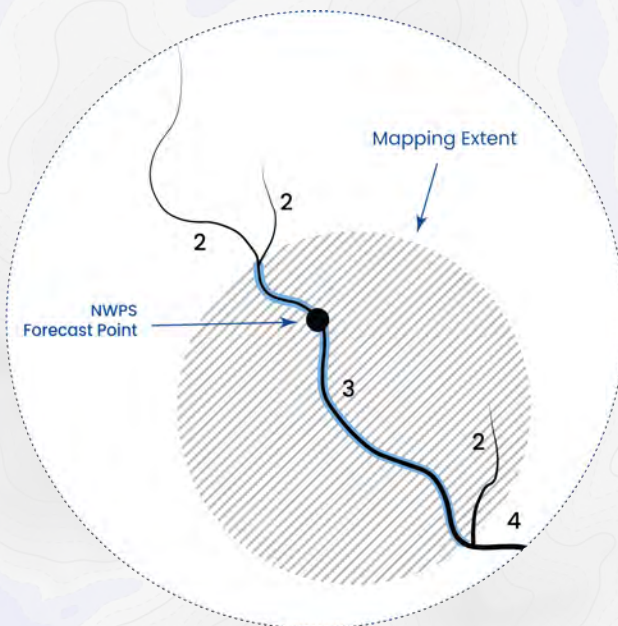
Lastly, the HAND WSE value of 31.0 ft. is mapped onto the HAND-derived REM grid to visualize inundation extents 5 miles upstream and downstream from the NWPS gage location, unless a change in the stream order occurs along this 10-mile stretch at which point the FIM ceases.
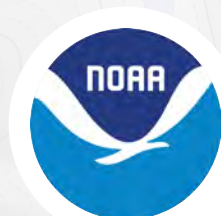
Utilizing Stage-Based CatFIM

CatFIM is a valuable tool for FIM Quality Control and informing IDSS best practices and emergency planning on "blue-sky" days ahead of an actual flood event. Stage-Based CatFIM inundations are particularly useful for assessing the performance of the HAND technique and identifying issues with the underlying DEM. Because Stage-Based CatFIM is independent of SRCs, it is a useful tool for assessing the accuracy of SRCs and identifying potential errors.

Limitations

While it generally produces more accurate inundation maps, Stage-Based CatFIM does not accurately represent how real-time NWC FIM services will perform because its method of delineating inundation extents differs from the NWM and RFC forecasts. Unlike NWM and RFC forecasts, which rely on Synthetic Rating Curves [SRCs] to generate FIM, Stage-Based CatFIM is independent of SRCs. Moreover, fewer sites are currently mapped using Stage-Based CatFIM because the technique requires sites with less than 1 ft. of vertical datum error.