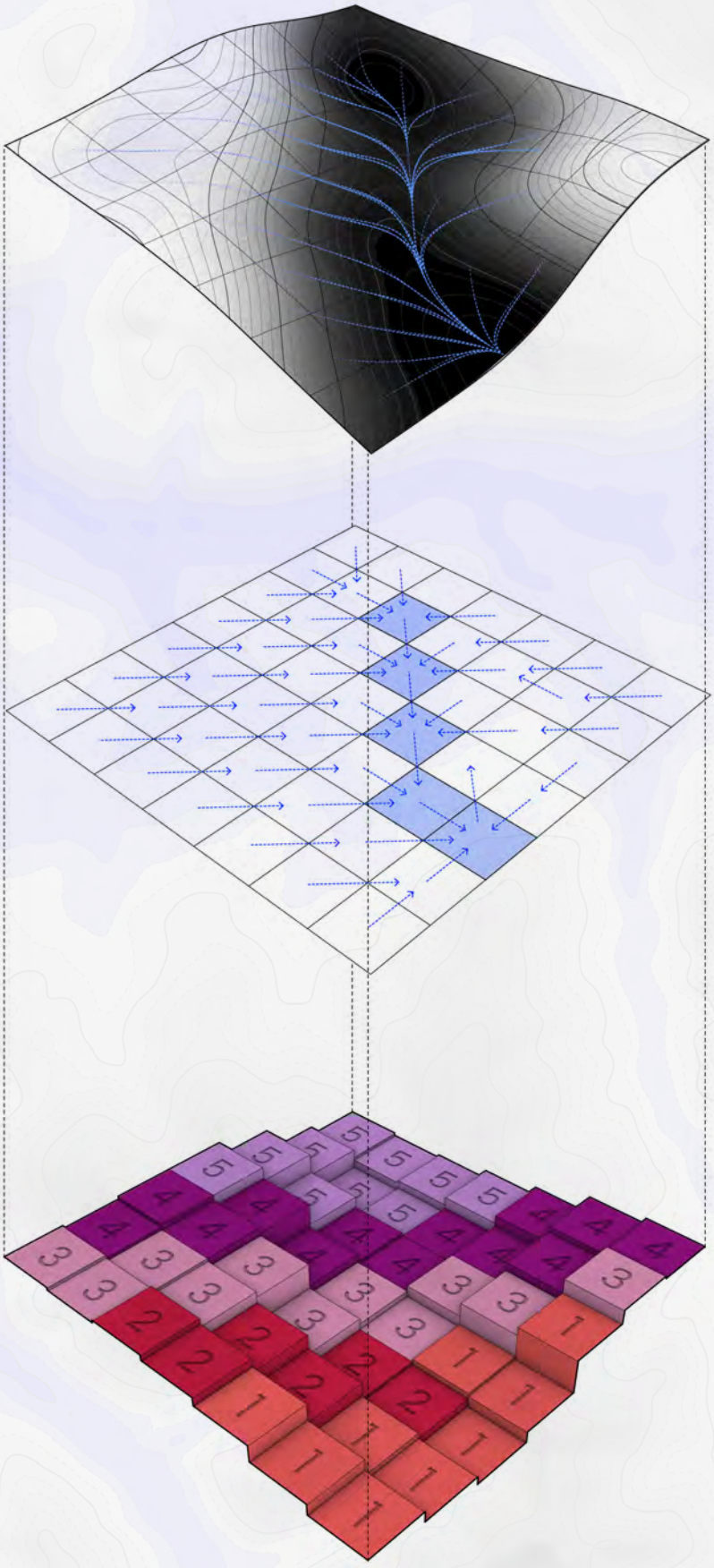
Height Above Nearest Drainage [HAND] FIM Method Factsheet [Public Domain]

The Height Above Nearest Drainage Flood Inundation Mapping [HAND FIM] Method is essential for various National Water Center [NWC] Flood Inundation Mapping [FIM] services. This factsheet serves as a resource, detailing this critical method and outlining some of its limitations.

The HAND FIM Method Schematic Model

HAND is the method used to delineate FIM developed by the NWC, by which water elevation in a stream reach is spread out over a grid representing the land surface to depict inundation extent. Catchments, reaches, and Digital Elevation Models [DEMs] are the primary inputs used to generate a HAND grid. First, a hydrographic network such as the National Hydrography Dataset Plus High Resolution [NHDPlus HR] is used to identify stream reaches, which define the geometry of the river and the conveyance for surface runoff. The stream reaches are segmented into ~1.5km flow lines. Next, the slope and flow direction raster is generated using the DEM, and the resulting drainage network is used to delineate discrete catchments draining into each channel thalweg cell. Next, the DEM representing the land surface is converted to a Relative Elevation Model [REM], which relates the elevation of the terrain to the elevation of the channel thalweg [zero reference point] for the entire local catchment. Once that processing takes place, the HAND value of each REM grid cell indicates the water depth needed to inundate that cell to allow for the rapid depiction of inundated areas within the catchment. The following pages provide a visual representation of the HAND FIM Method.



01.

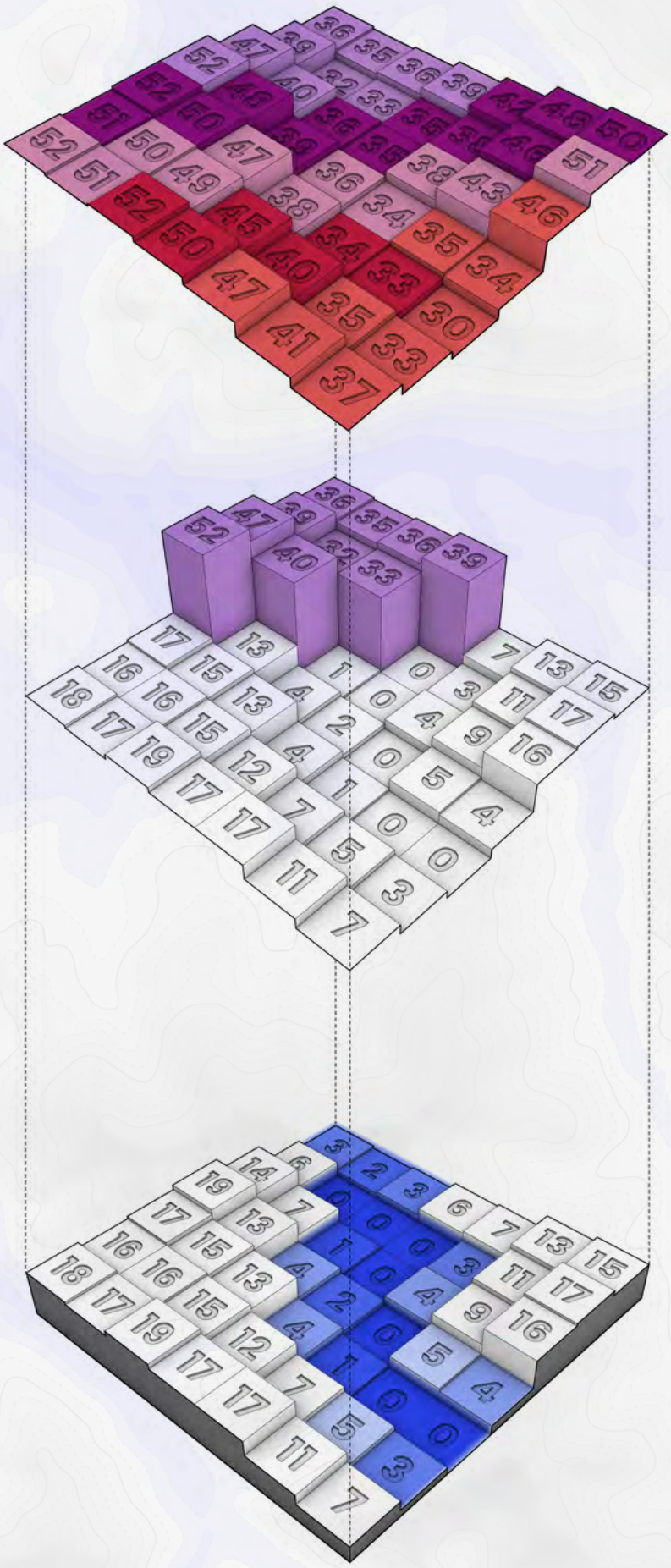
The HAND Method begins with a DEM produced by USGS. Currently, DEMs used to generate the HAND model have a 10m resolution.

02.

The DEM then undergoes geoprocessing techniques also known as hydroconditioning, which helps identify drainage cells and surface waterflow.

03.

Cells in this 10m grid matrix are grouped according to their nearest drainage cell forming a drainage network.



04.

The elevation values of the drainage cells are normalized to a 0 value.

05.

The topography is then normalized with respect to the drainage network by converting elevations above MSL into relative elevations [vertical difference of each cell in the terrain relative to its nearest draining cell].

06.

The HAND Method converts DEM data into a Relative Elevation Model [REM] or HAND grid used to create FIM.

Limitations

The HAND FIM Method itself is not subject to much alteration, and as such, the following limitations will remain in place throughout your work with various NWC FIM:

01. Catchment Boundaries & Related Issues

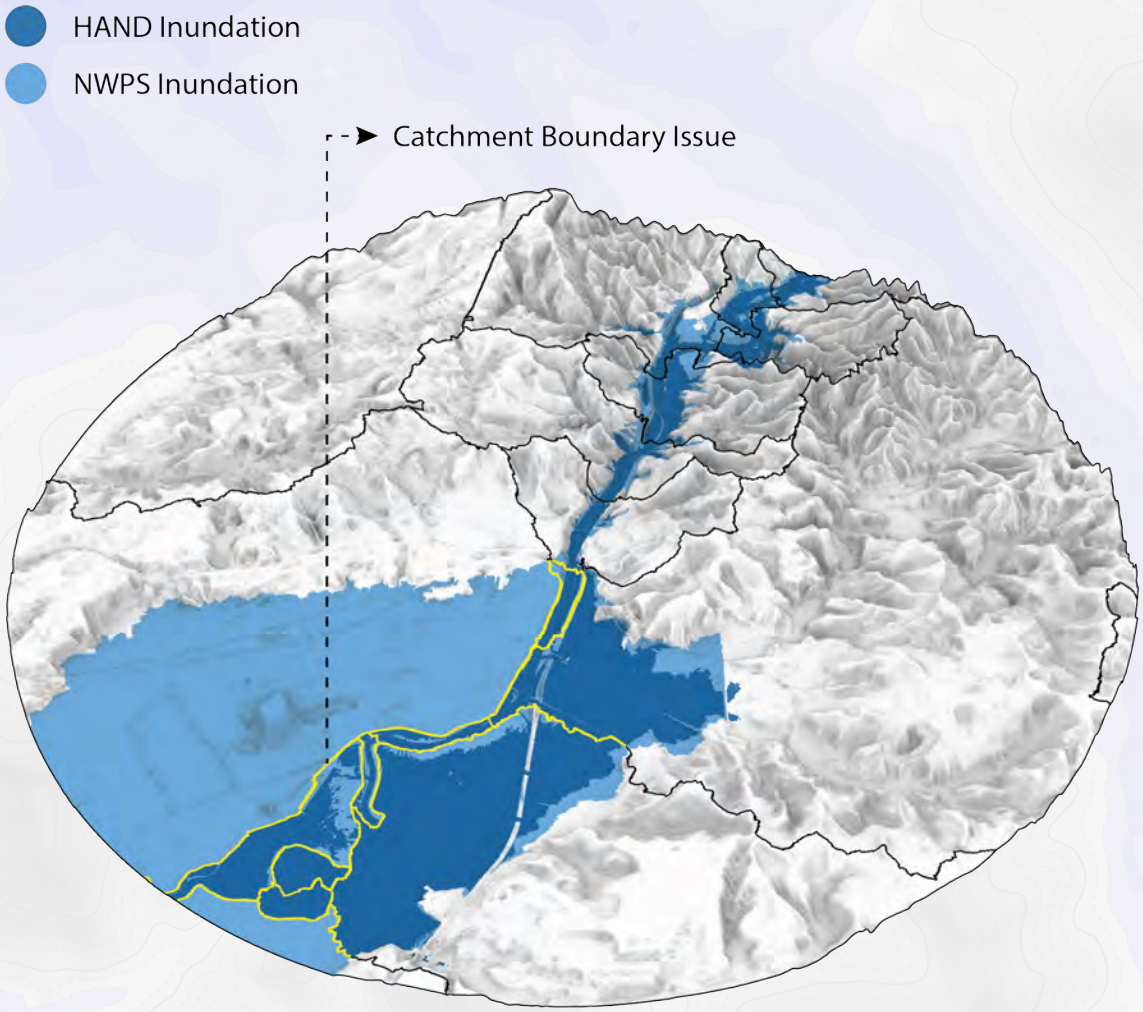
02. DEM Does Not Account for Bathymetry

03. HAND Does Not Produce Accurate Waterbody Inundation

04. FIM Inaccuracies In/Near Leveed Areas

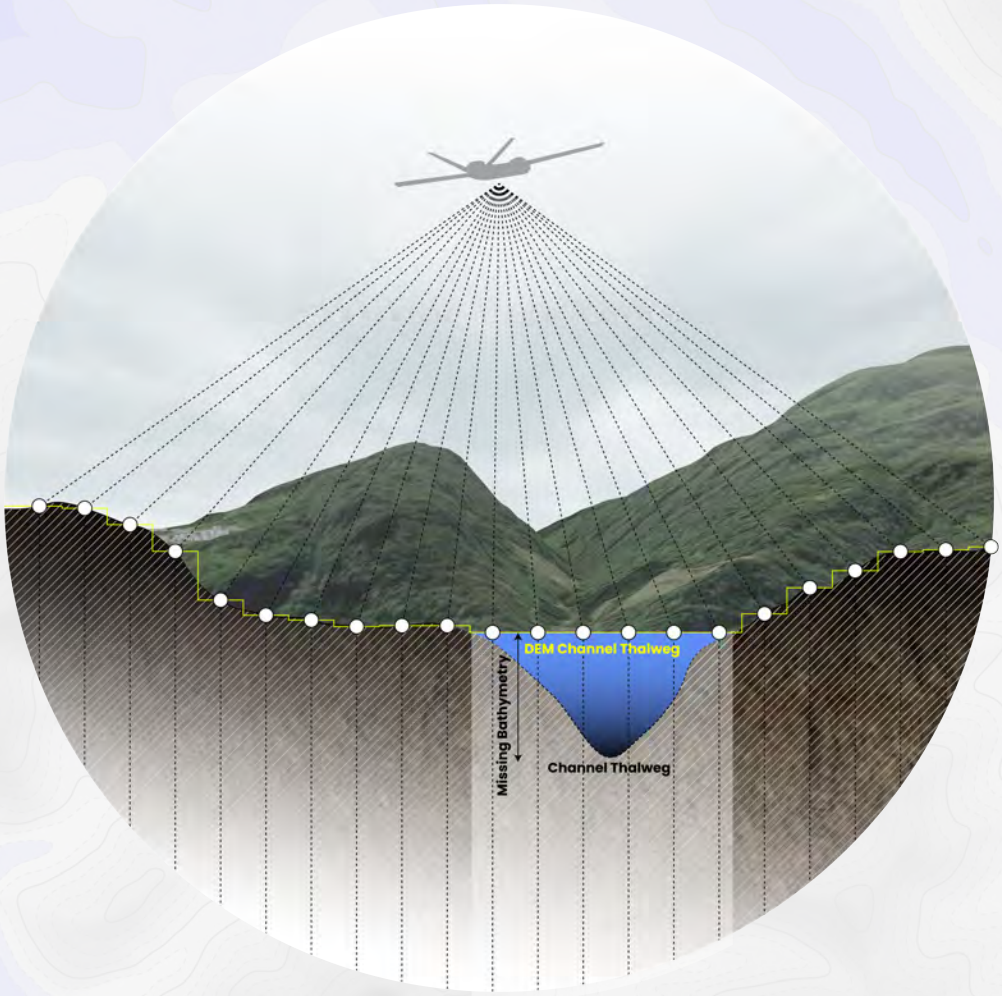
01. Catchment Boundaries & Related Issues

Because the HAND workflow operates on relatively small local catchments, at higher flood stages, these catchments may inundate up to the boundary of the catchment. The simulated inundation is isolated within a given catchment and there is no mechanism currently in place to simulate catchment "spillover" into neighboring catchments. FIM 4.X attempts to reduce this artifact by producing multiple and overlapping catchments for mainstem branches [stream orders >= 3].



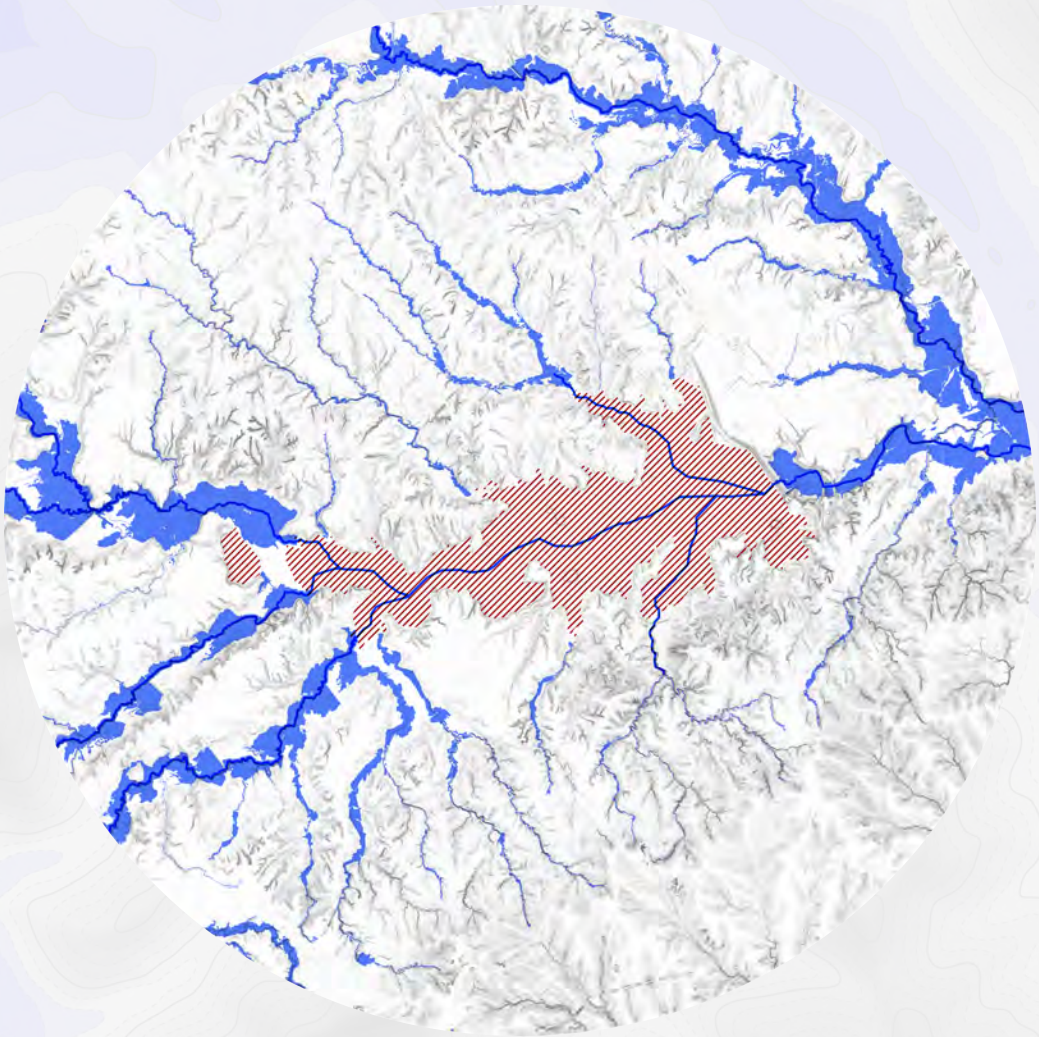
02. DEM Does Not Account for Bathymetry

The NHDPlus HR 10-meter terrain does not account for bathymetry because, in most instances, the elevation along streams reflects a water surface elevation at the time the DEM was captured, not the channel bottom. This means that the drainage elevation, or 0 values, in the HAND grid [REM] do not represent the elevation of the channel bottom. As such, FIM developed by the NWC often underestimates a portion of the channel conveyance area/volume and will typically lead to overestimates of FIM extent during smaller magnitude flood vents. Overestimation of FIM extent caused by missing bathymetry is lessened during larger flood events, as missing channel volume accounts for a smaller proportion of the overall volume of the flood event.



03. HAND Does Not Produce Accurate Waterbody Inundation

Waterbodies such as lakes, reservoirs, and ponds are typically masked in the NWM FIM [masking National Water Model waterbody polygons]; however, many smaller waterbodies are not removed from the FIM workflow and users should exercise caution when interpreting the inundation at these locations. Erroneous FIM at waterbodies is caused by unreliable estimates of channel/floodplain geometries often because bathymetry is represented. In the current version of the NWM, waterbodies represent only a fraction of those present across the Continental United States [CONUS], so for those not included in the waterbody dataset, FIM is often unreliable at those locations.



04. FIM Inaccuracies In/Near Leveed Areas

While FIM 4.X does incorporate surveyed levee elevation data from the United States Army Corps of Engineers [USACE], areas where levees are featured should be reviewed closely by the user. Users are suggested to overlay a levee dataset [e.g. USACE National Levee Database] to quickly determine where levee features may lead to errors in the simulated FIM. The current HAND workflow attempts to represent levee features in the DEM by "burning" flood protection elevation values into the DEM using the USACE levee database. However, even if a levee feature is represented in the DEM, the HAND methodology is not well suited for capturing the dynamic flow conditions [e.g., overtopping] within and near artificial flood protection features.