Hazus-MH Data Inventories: Dasymetric vs. Homogeneous

With the release of Hazus 2.2 Service Pack 01 (SP01) in May 2015, Hazus users were able to access and download the new dasymetric state datasets available via the MSC Hazus download webpage at http://msc.fema.gov/ portal/resources/hazus. The release of Hazus 3.0 in November 2015 takes the additional step of making the dasymetric datasets the default for analysis, while using homogeneous datasets for aggregation. This factsheet will break down the differences between dasymetric vs. homogeneous data analysis, provide best practices of when to use each one, and describe why dasymetric analysis is now the default for Hazus-MH.

What is Dasymetric Mapping?

We know that **homogeneous mapping** assumes that building exposure is uniformly (homogeneously) distributed throughout a Census block. Hazus-MH has historically used homogeneous Census data. These Census blocks generally cover the entire land area, except in some areas where large water features have been removed. Because of this extensive coverage of the blocks, there are areas within them that are not developed and have few or no structures. Over the years, analyses have shown that using this data may lead to an over-estimation of losses, though overestimation is not solely caused by homogeneous data.

Dasymetric mapping removes undeveloped areas (such as areas covered by other bodies of water, wetlands, or forests) from the Census blocks, changing their shape and reducing their size in these areas. Dasymetric mapping was first developed as a cartographic technique by Benjamin Semenov-Tianshansky in 1911. Today, the Environmental Systems Research Institute (Esri), developer of the industry-standard Geographic Information Systems (GIS) software upon which Hazus is built, defines dasymetric mapping as "a technique in which attribute data that is organized by a large or arbitrary area unit is more accurately distributed within that unit by the overlay of geographic boundaries that exclude, restrict, or confine the attribute in question. For example, a population attribute organized by census tract might be more accurately distributed by the overlay of water bodies, vacant land, and other land-use boundaries within which it is reasonable to infer that people do not live." (Esri 2015; cf. USGS 2015). Due to confidentiality, privacy, and other concerns, population

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FEMA Flood Map Service Center (MSC) Site (http://msc.fema.gov/portal)

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For questions or troubleshooting, please call the FEMA Map Information eXchange (FMIX) at 1-877-336-2627 or e-mail FEMAMapSpecialist@riskmapcds.com

data collected by the U.S. Census Bureau is aggregated to different levels of geographic boundaries (e.g., from a local address to a block, tract, county, or state). As such, data aggregated to those geographic units does not always reflect the actual location or distribution of human populations or the built environment.

According to the Multi-Resolution Land Characteristics Consortium (MRLC), the National Land Cover Database (NLCD) serves as the definitive Landsat-based, 30-meter resolution, land cover database for the Nation. The NLCD provides spatial reference and descriptive data for characteristics of the land surface such as thematic class (e.g., urban, agriculture, and forest), percent impervious surface, and percent tree canopy cover. (Homer et al 2012) Thus, Hazus loss estimates can be significantly improved by employing dasymetric mapping techniques to constrain Census population data to actual locations based on the NLCD.

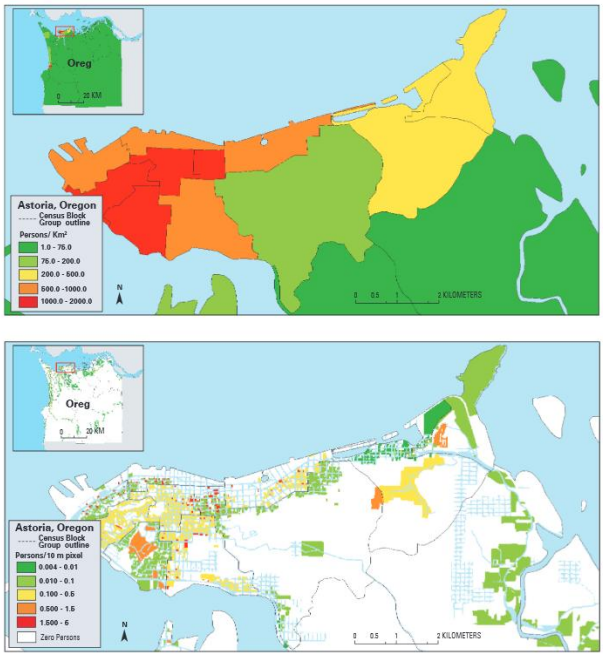
Why Dasymetric as Default?

Since the bulk of modern disaster mitigation and analysis is completed in urban areas or areas that are built out, dasymetric data can be a more accurate representative dataset here. This is not to say that dasymetric data is the ideal choice everywhere. It will not be more accurate in locations that have increasing development in previously un-developed areas. We encourage those conducting research with Hazus to determine for themselves what dataset makes sense for their particular situation.

A fundamental premise of the Hazus Level 1 Flood Loss methodology is that the inventory is assumed to be equally distributed across the entire census block. When an analysis is performed, depending on the area wetted by the flood hazard, and the depths of flooding impacting the overall area of the block, the losses are calculated for the entire block - whether or not structures exist over the entire block. The goal of the dasymetric data is to remove areas of the block where structures are not expected to be located, such as areas covered permanently by water, wetlands, and forests.

With the assistance of the U.S. Army Corp of Engineers Flood Impact Assessment Team (USACE FIA), the Hazus Census Blocks were clipped to remove areas identified as water, wetlands and forest. The data for clipping is provided by the National Land Cover Database (NLCD) prepared by the U.S. Geological Survey (USGS). This dasymetric approach provides users with an improvement of the accuracy of Level 1 census block based loss estimations, but does not serve as a complete replacement of the need for site specific data enhancements from local datasets. Newer developments or structure changes need to be captured with these local inputs as well.

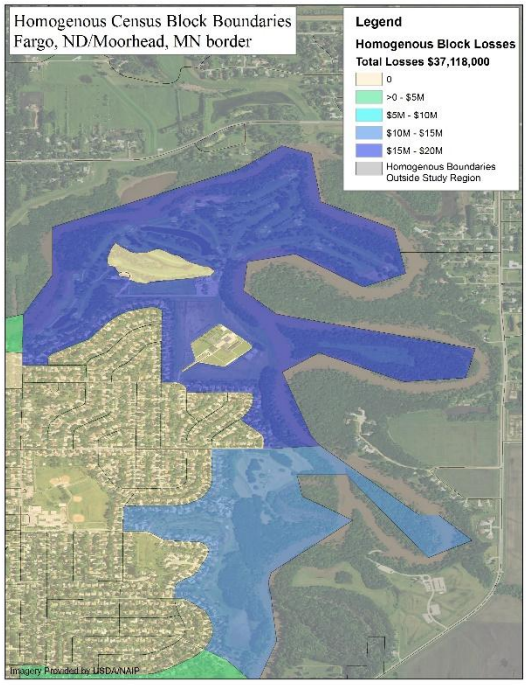
In the example to the right, population mapped at the Census block group for Astoria, Oregon is remapped using a dasymetric technique in conjunction with the NLCD (map c/o Sleeter and Wood 2006, Figure 11, p. 12).



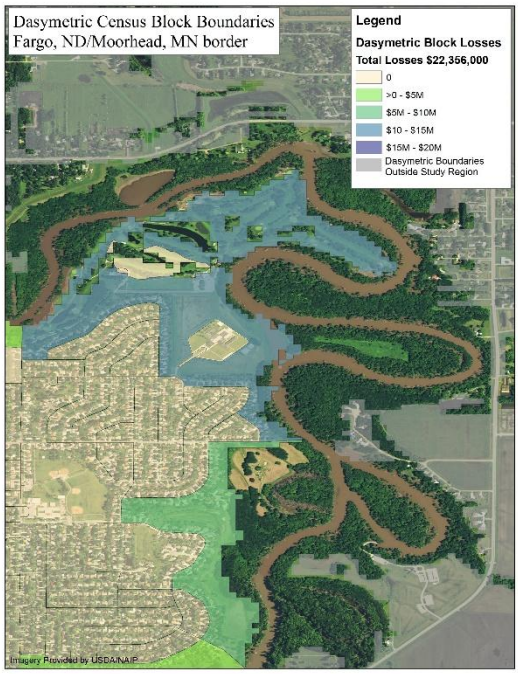
Direct Economic Loss Example

The following two maps showcase how a dasymetric distribution approach will differ from a homogeneous distribution approach when run through a Hazus Flood Loss Estimation. The maps below showcase block-level displays of losses estimated at the block/dasymetric block level. The City of Fargo is showcased.

Homogeneous Distribution



Dasymetric Distribution



Hazus Flood Level of Analysis	Building Losses	Content Losses
Parcel Updated Dasymetric Analysis	$720,993,000	$804,132,000
Parcel Updated Homogeneous Analysis	$791,012,000	$844,592,000
Parcel based (UDF Site Specific Analysis)	$400,702,000	$464,968,000

Notice the dasymetric data figures above are still higher than the site specific data as would be expected, but the figures are still much closer to the site specific results than the homogeneous data. Case examples like these are where a dasymetric approach may be more valuable to a mitigation plan.

Why use Dasymetric Mapping in Hazus?

As a loss estimation model, Hazus was originally designed in the 1990s specifically for earthquake hazards. Limitations on computing power and availability of high-resolution local datasets called for a national solution using U.S. Census data, in part due to expected decennial updates. Since then, data availability and processing power substantially increased, and additional hazard-specific modules of Hazus were released, including, to date, the hurricane wind and flood modules. While the earthquake and hurricane wind modules are considered quite accurate per numerous evaluative studies, the flood module, in particular, is prone to over- and under-estimating losses due to both the geographic aggregations of

Census data and the locally-specific nature of flood hazards (cf. Kar and Hodgson 2012; Longenecker 2009). While the use of site-specific data (e.g. residential parcel or user-defined facilities data) is optimal for loss estimation, the Hazus dasymetric inventory data represents a significant improvement over the use of Census block or tract-level data in most locations, particularly when site-specific data is unavailable or coarser resolution of loss estimation is preferred.

References

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