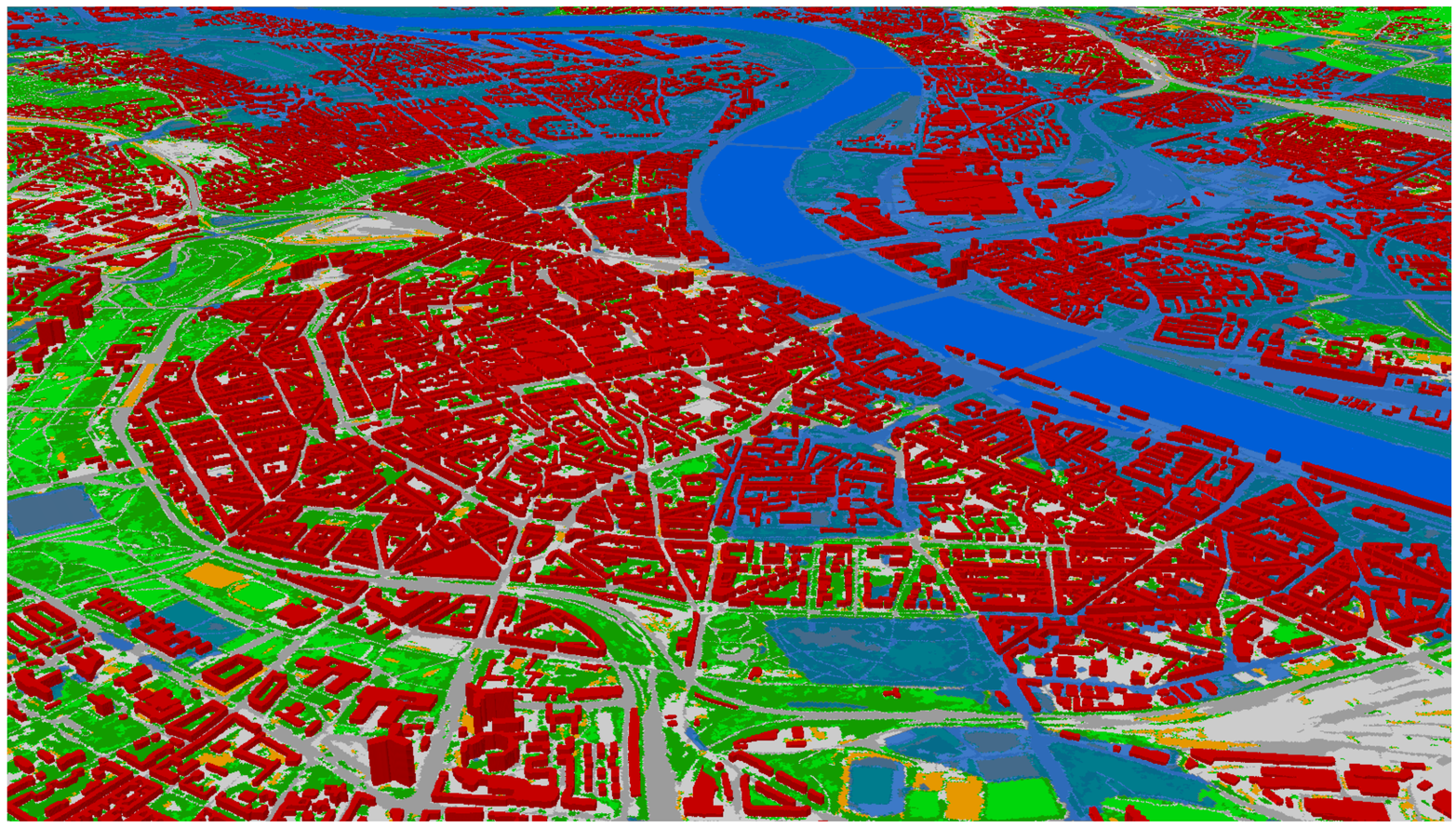
What's exposed?
Mapping elements at risk from space

Martin Klotz, Michael Wurm, Christian Geiß, Hannes Taubenböck
German Aerospace Center (DLR)



3D building model and land cover classification overlaid with a spatially modelled 500-year flood plain, Cologne, Germany

Thematic classes: Buildings | Bare soil | Trees/shrubs | Grassland/meadow | Streets | Other impervious surfaces | Surface water (HQ500)

Mapping exposure

The term "exposure" is exhaustively used in geo-risk research and describes the elements at risk, which are understood as objects potentially adversely affected by a disaster such as people, properties or infrastructures. In order to assess the vulnerability of an urban system regarding risks from natural or man-made hazards, data localizing human assets in their correct dimension and spatial distribution is on strong demand. In this context, remote sensing has evolved to a valuable tool for the area-wide and consistent mapping of human exposure on various spatial scales.

Local scale

On the local scale, the potential of remote sensing particularly lies in the generation of spatially highly resolved building inventories to assess the building stock's physical vulnerability. Especially high resolution optical sensors as well as airborne LIDAR are frequently used to derive structural vulnerability indicators such as building footprint, height, shape characteristics, roof materials, location, construction age and structure type. The combined analysis of highly detailed 3-dimensional city models and modelled hazard information further allows for the localization and quantification of possibly affected areas and structures.

Regional scale

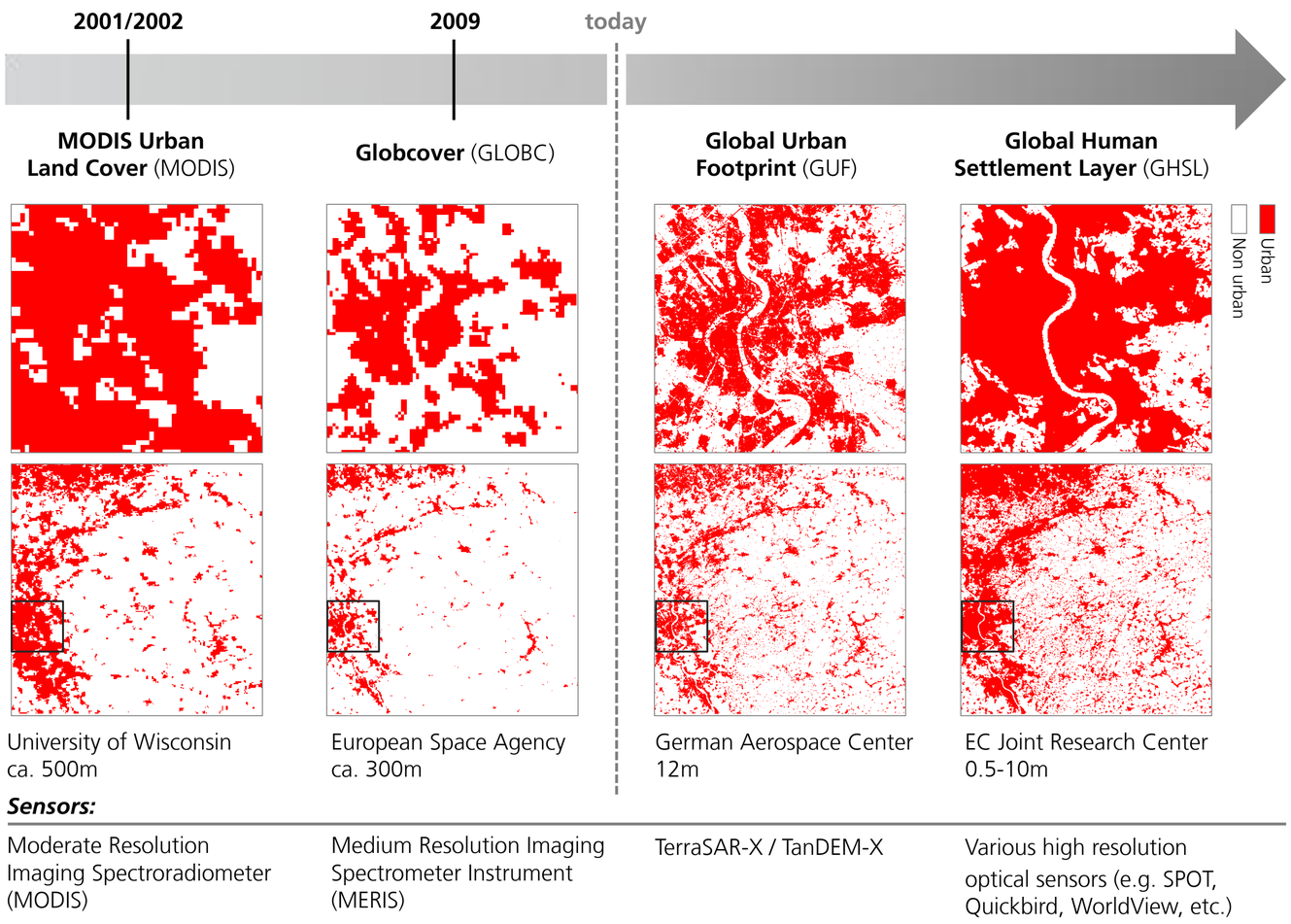
On the regional scale, remote sensing can deliver essential input for urban risk analysis and rapid loss estimation in terms of spatially aggregated, consistent and comparable land use and land cover information. To account for the large-scale extent of urban areas, information is commonly aggregated on spatial units such as grid cells or building blocks. As an example, the European Urban Atlas Urban Atlas features an enhanced thematic detail of the urban landscape discriminating urban functional areas from higher resolution optical satellite data for larger European cities exceeding 100,000 inhabitants.

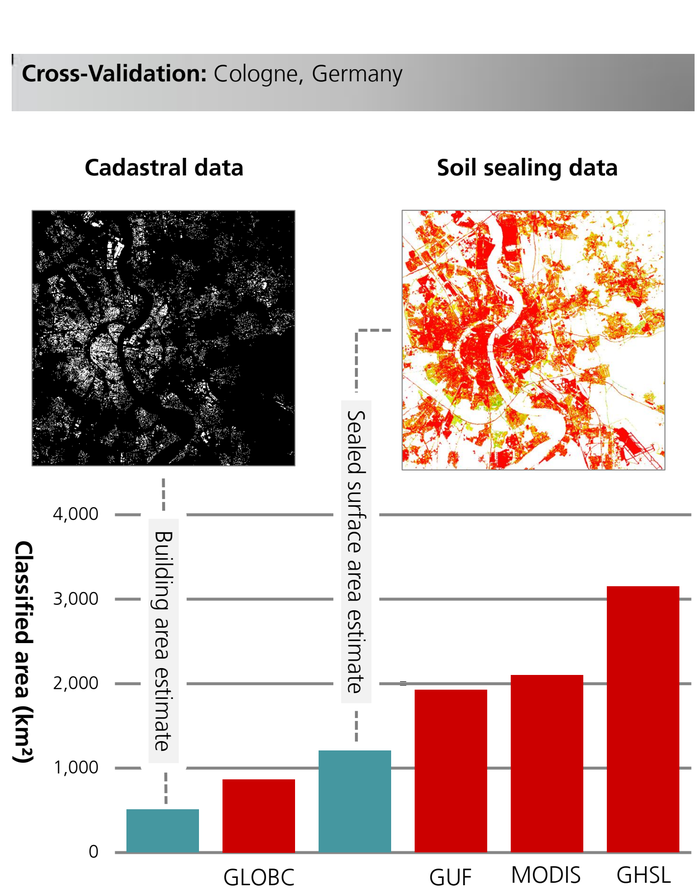
Global scale

Although local and regional scale mapping efforts employing high resolution satellite data are suitable to directly derive structural characteristics of buildings or blocks and their performance under hazard stress, they miss the capabilities to determine human exposure on a global scale. In this regard, remote sensing derived geo-products discriminating urbanized areas are essential to approximate the entity of elements. First generation maps of global urban extent produced since the millennium relied on coarse resolution satellite sensors such as MODIS or MERIS. However, global exposure mapping is now entering a new era and new products such as the Global Urban Footprint (DLR) or the Global Human Settlement Layer (JRC) will significantly improve the knowledge base for the localization of human assets by providing global settlement information at unprecedented spatial resolutions. To gain a deeper understanding of each layer's strengths and weaknesses substantial validation efforts are currently underway.

Subset of the European Urban Atlas, Cologne, Germany

Selected thematic classes:
- Continuous urban fabric
- Discontinuous dense urban fabric
- Discontinuous medium density urban fabric
- Discontinuous low density urban fabric
- Industrial, commercial, public, military and private units
- Fast transit roads and associated land
- Other roads and associated land
- Railways and associated land
- Port areas
- Green urban areas
- Sports and leisure facilities
- Forest and semi-natural areas
- Agricultural areas
- Water





DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft