

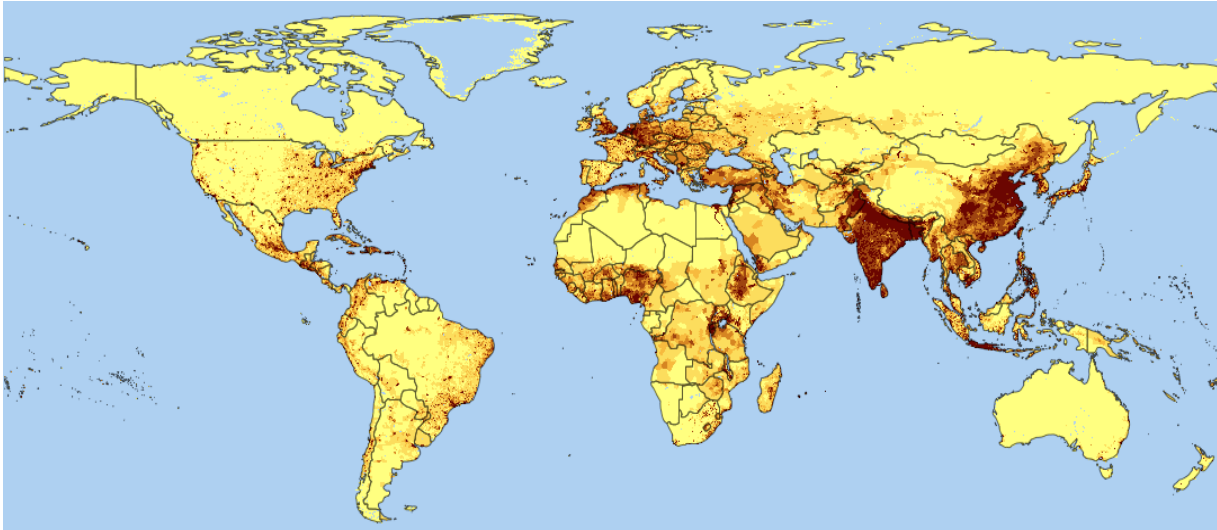
A Revised Population Model for ESA's Re-entry Risk Analysis Tool SERAM

4th International Workshop on Space Debris Re-entry



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Credits: SEDAC; Population Density Future Estimates 2015

- Introduction
- Model Overview
- UNWPP
- GPWv4
- Population Estimation
- Output

- **Spacecraft Entry Risk Analysis Module (SERAM)**
 - On-ground risk calculation for human population



Credits: ESA

- **Survival And Risk Analysis (SARA) module**
 - Demise survivability and on-ground risk



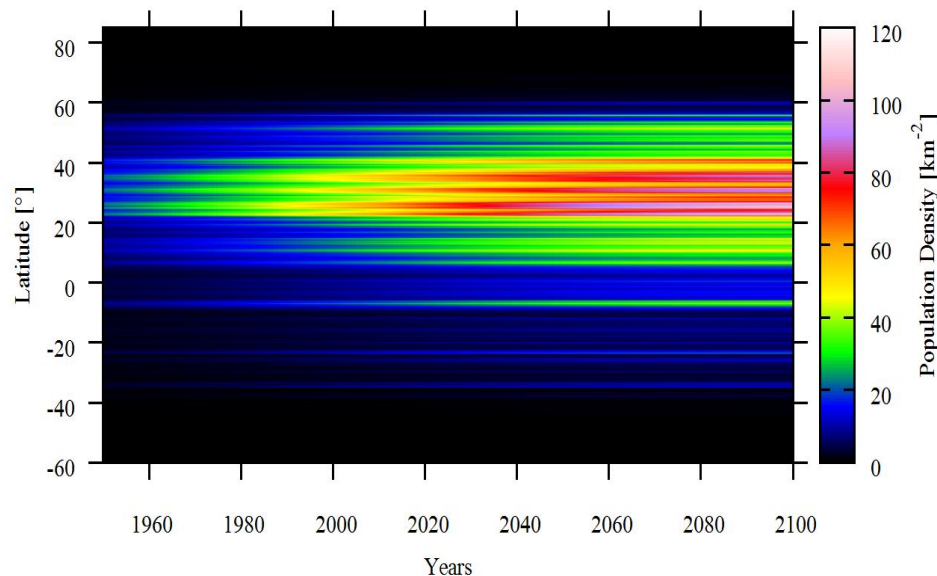
Credits: ESA

- **Debris Risk Assessment and Mitigation Analysis (DRAMA) Tool**

- DRAMA 2 population model status
 - Individual compact format of global demography project data from 1994
 - Resolution: 0.25 deg
 - Earth global population growth rate
 - based on user global population input
 - or exponential growth
- Revised population model for DRAMA
 - GPWv4 in GeoTiff format (as distributed)
 - Resolution 30" (0.0083 deg)
 - UNWPP predicted population growth scenarios up to 2100

- **United Nations World Population Prospects**

- Average annual count estimates/prediction by major countries
- Identification of the countries by UNSDCODE
- Estimates available from 1950 to 2015
- Predictions available up to 2100
- 8 different population evolution scenarios are available

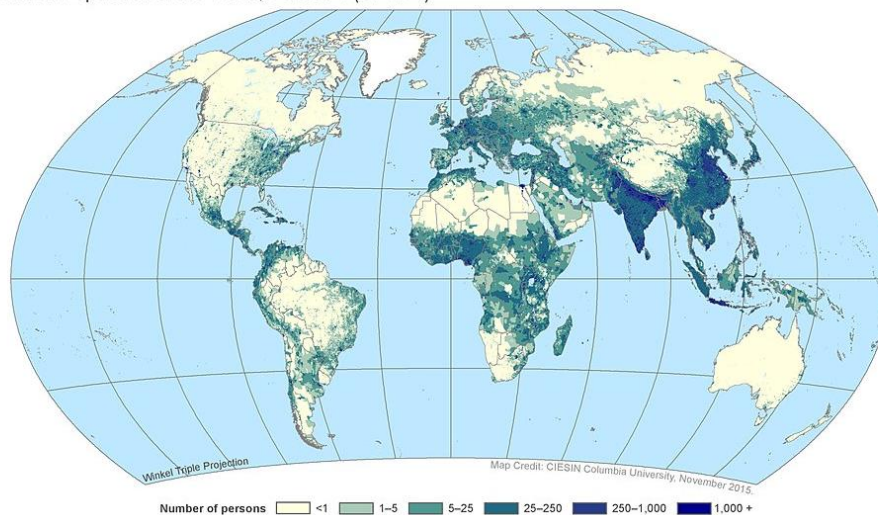


1D population density evolution from 1950 to 2100, Medium-Variant scenario

- **Gridded Population of the World, Version 4**
 - UNWPP adjusted population count grid
 - National boundaries information (GPW own IDs)
 - Mapping GPW IDs to UNSDCODE used in UNWPP
 - Finest resolution of 30" in GeoTiff format
- Pre-calculated annual 1D population density distributions

Population Count, 2015: Global

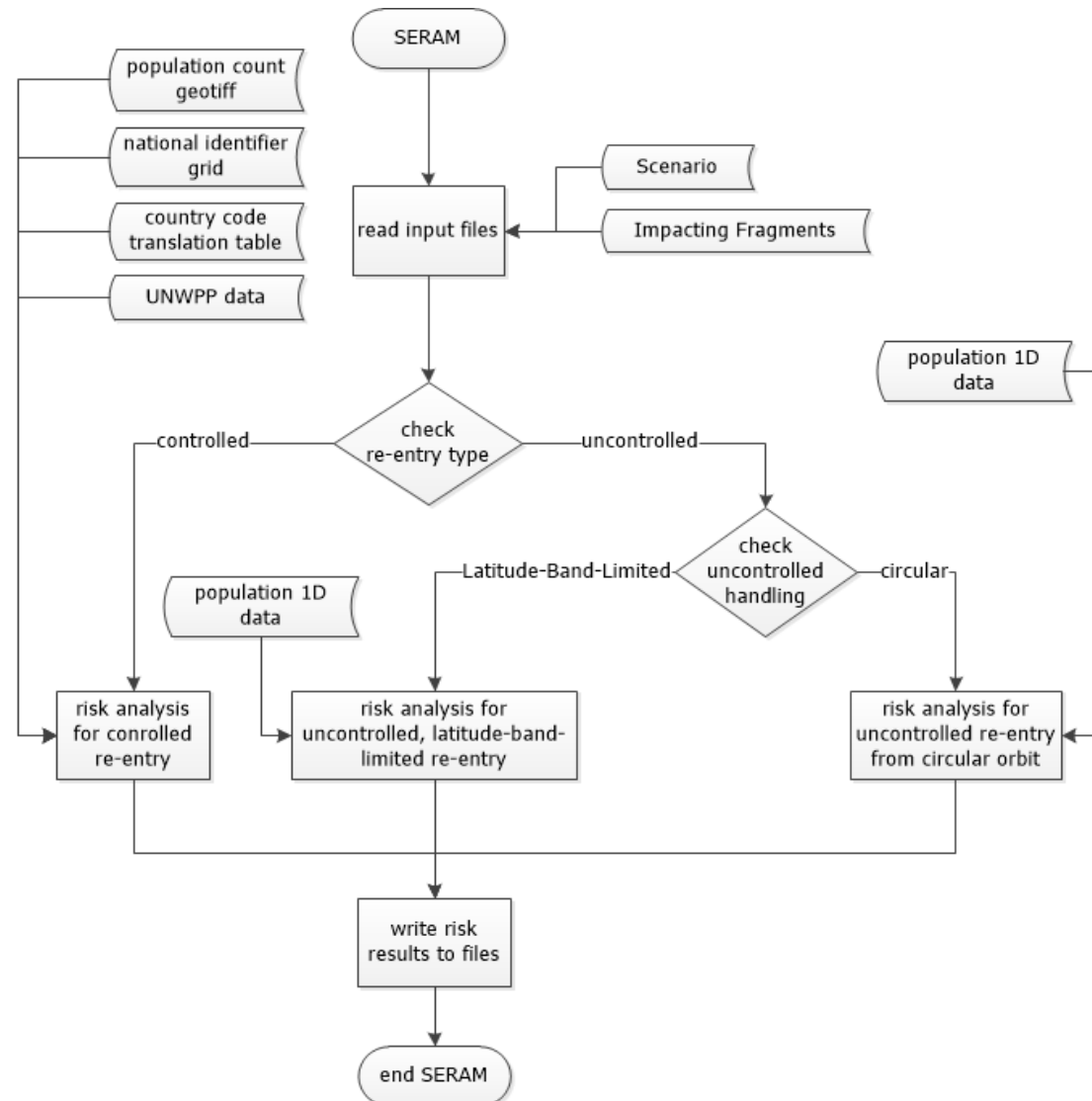
Gridded Population of the World, Version 4 (GPWv4)



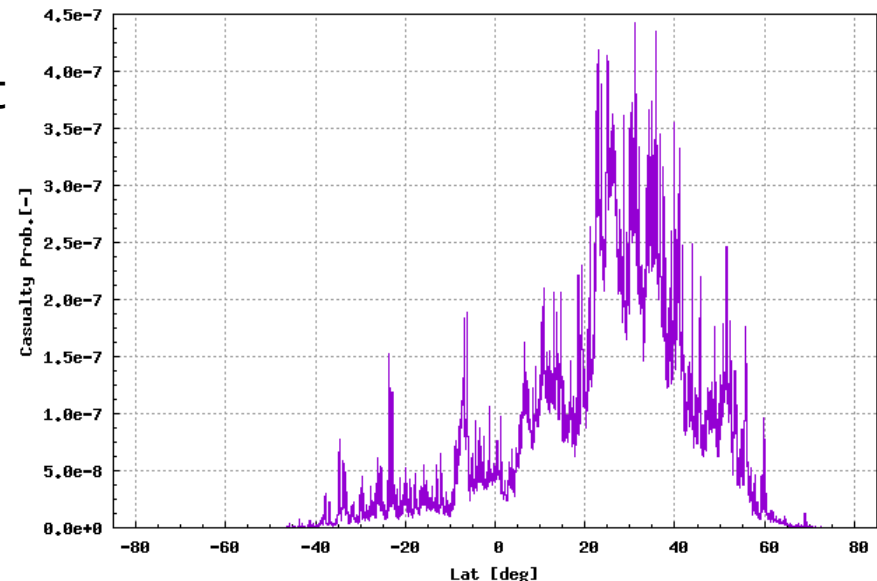
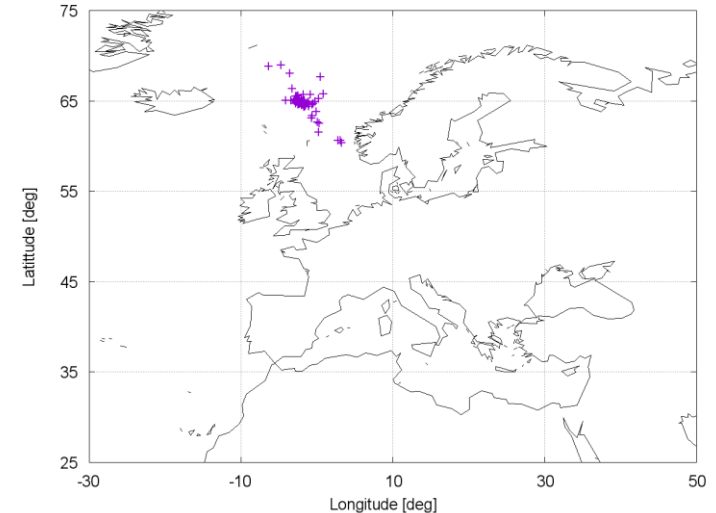
Credits: SEDAC; Population Count
Future Estimates 2015

Population Estimation

- Definition of scenario and impacting fragments
 - Scenario defined by user
 - List of impacting fragments
- Risk analyses classes:
 - Controlled re-entry
 - Circular
 - Latitude-band-limited
 - Uncontrolled re-entry
- Casualty & fatality
 - For each fragment
 - For entire event



- Output general:
 - Deterministic result calculation
 - Embedded in Monte Carlo for statistics
- Risk results:
 - Casualty and fatality probability
 - Controlled: 2D and 1D results
 - Uncontrolled: 1D results
 - For each fragment and entire event
- Graphical output:
 - Impact location (controlled re-entry)
 - Impact probability vs. latitude
 - Casualty probability vs. latitude
 - Fatality probability vs. latitude



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