IAA-PDC-21-09-15 ASTEROID IMPACTS - DOWNWIND AND DOWNSTREAM EFFECTS

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Mount Pinatubo in the Philippines
Credit: Dave Harlow, U.S.G.S.

Tunguska Event. Credit: Getty Images

Temescal Valley, CA. Credit: abc7.com

Phoenix, AZ Haboob. Credit: Andrew Pielage

U.S. Department of the Interior
U.S. Geological Survey

Motivation

Lots of effort into initial effects!

- air blast with overpressure shock
- thermal radiation
- crater formation and ejecta deposition
- seismic shaking
- tsunamis

Are there other effects as a result of these initial effects?

- displaced in distance
- displaced in time

Down wind effects

- How far is debris blown down wind?
- Does that debris pose a threat?
- How do you characterize that threat?

Down stream effects

- How much debris will end up in the watershed?
- Is the water shed interconnected to other watersheds?
- Does that debris pose a threat to the water supply?

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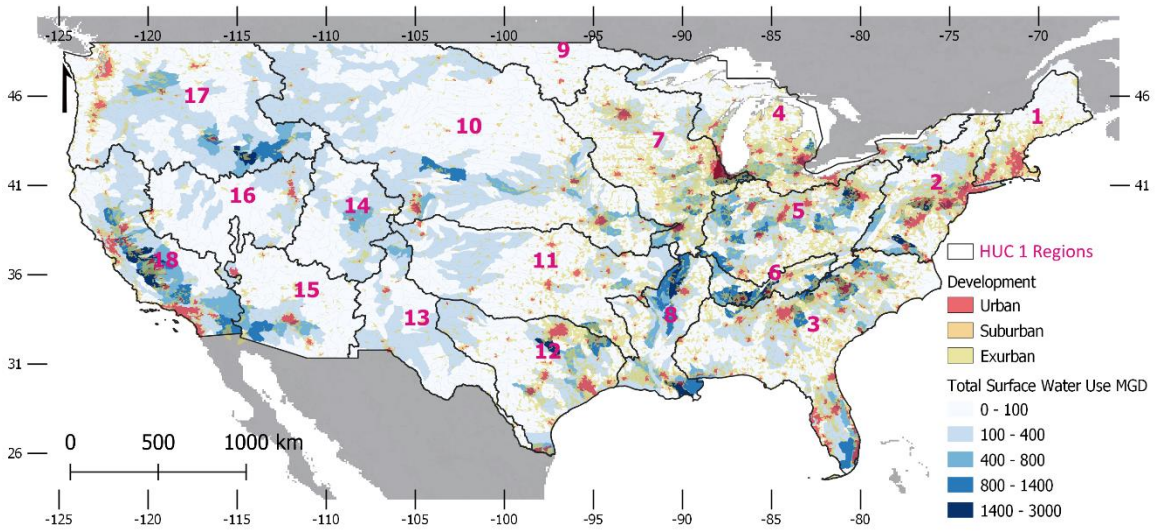
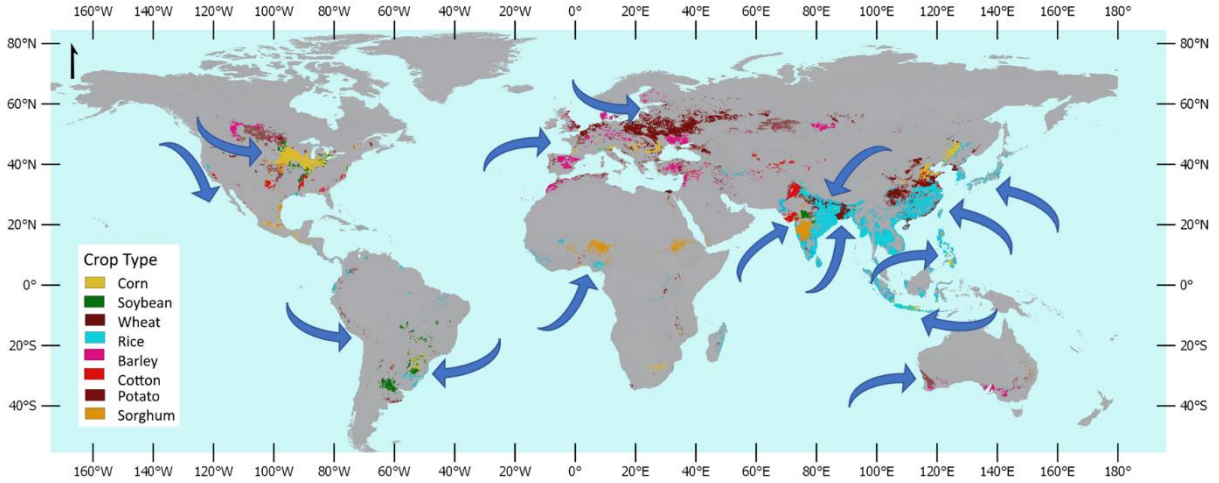
Motivation

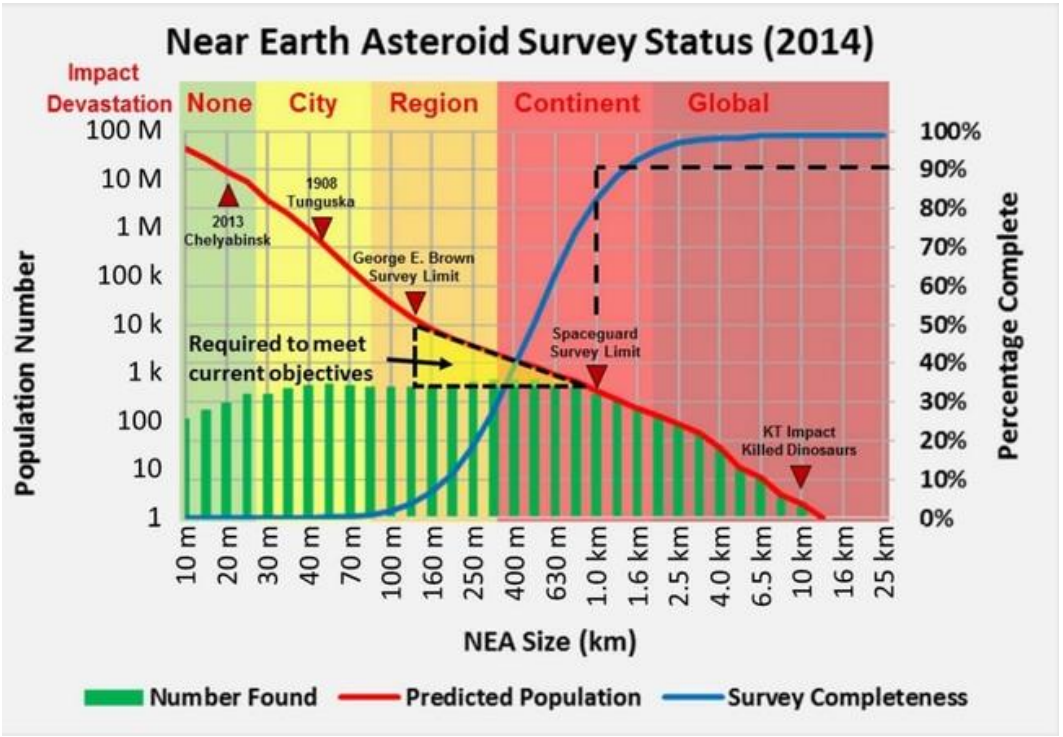
At what size of impactor do downstream and downwind effects matter?



Data sources: HUC watersheds boundaries from Watershed Boundary Dataset (USDA 2019, Accessed September 1, 2009.),



Data sources: Crop data from Sacks et al. 2010. Wind data from IRI 2020, accessed 5/20/2020. Credit: Adam Oliphant.



Credit: White House

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Characterization using more common hazards

Downwind

- **Volcanic eruptions**
- Dust storms
- Wildfires

Mount Pinatubo. Credit: Dave Harlow, U.S.G.S.

Phoenix, AZ Haboob. Credit: Andrew Pielage

Downstream

- **Wildfires**
- Landslides
- Floods

Tunguska Event. Credit: Getty Images

Near Williams Lake, B.C. Credit: © PC/DARRYL DYCK

Temescal Valley, CA. Credit: abc7.com

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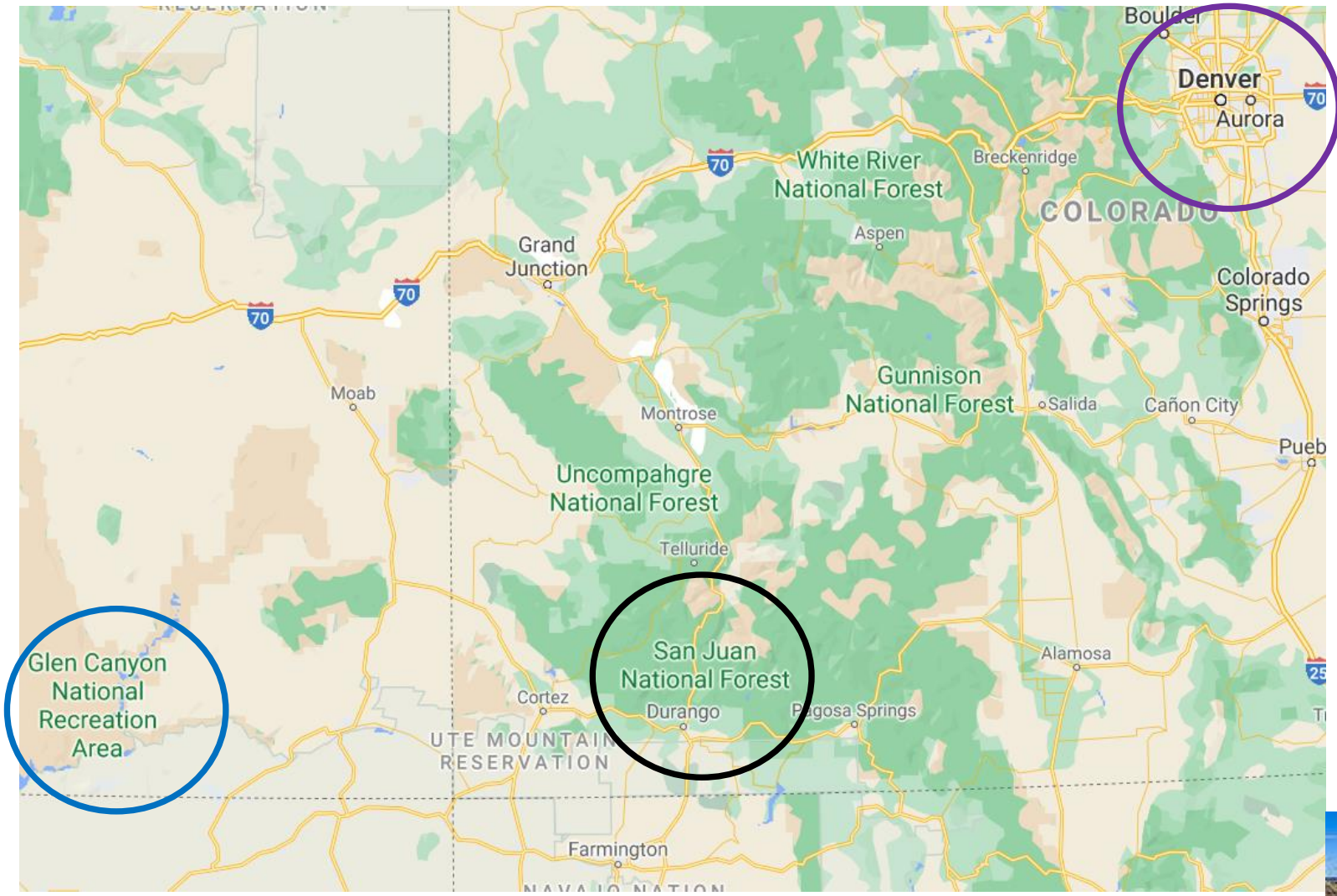
Impact scenario:



Credit: Google Maps

San Juan Mountains, in southwestern Colorado :

- Low population
- Headwaters of the Colorado River
- Upwind from Agriculture and Transportation hubs and corridors.

A 120-meter impactor is the median expected size. We chose impactor sizes ranging from 42-meters to 600-meters

Tunguska Event.. Credit: Getty Images

Meteor Crater, AZ Credit: CC BY-SA 4.0

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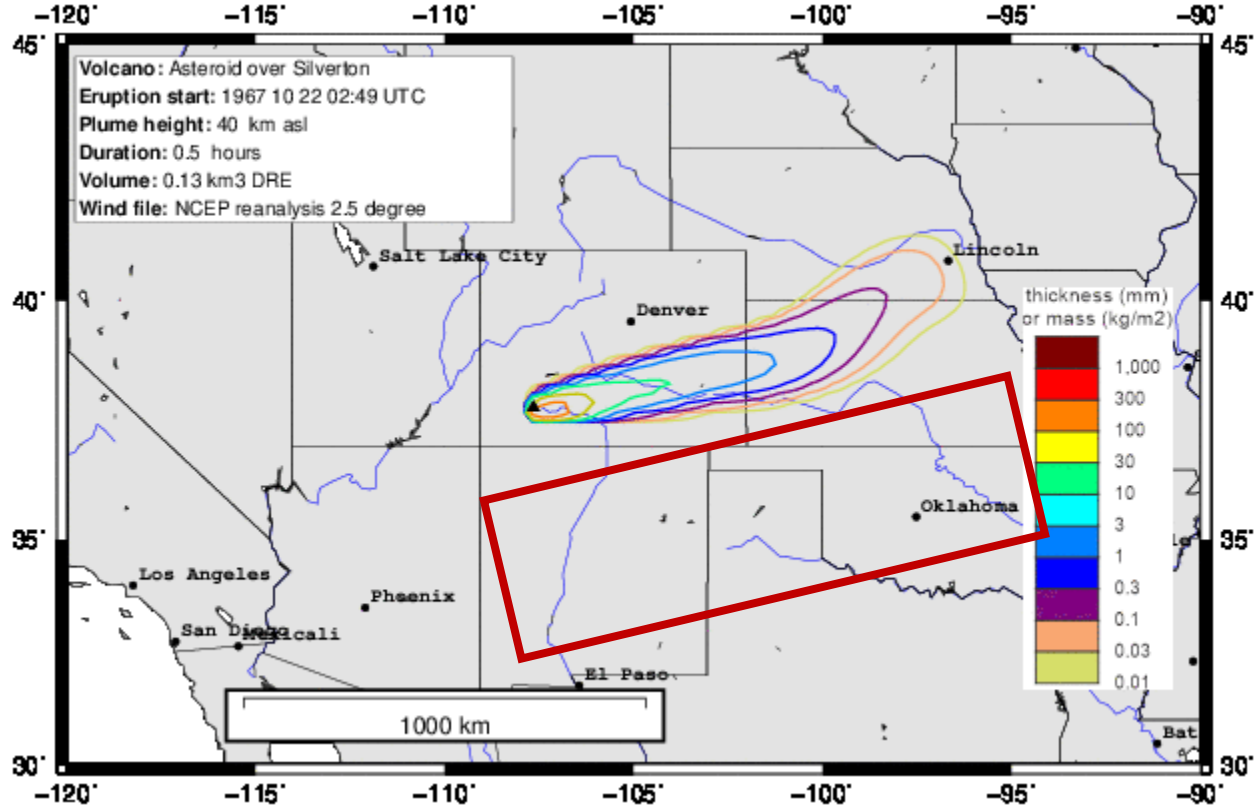
Downwind

- USGS Ash3D
  - Date/Time → Wind Patterns
  - Mass of the impactor deposited at 40 km AGL.
- → Downwind distribution



- Results for Oct 22 (1967):
  - Above – 120-m Impactor
  - Lower Left – 600-m Impactor
  - The lowest contour is 10 um of dust/ash/debris.
  - Within hours, will affect air quality and transportation corridors.

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Downstream

Diameter (m)	Radius of Ignition (km)	Burn Area (km2)	Burn Area (ha)	Sankey et al. (2017) Annual Post-fire Sediment Yields (Mg/ha)	Watershed Sediment Yield from Post Impact Soil Erosion (Mg)
42	3.90	47.78	4,778.22	0.83	3,966
65	6.50	132.73	13,272.84	0.83	11,016
120	13.40	564.09	56,408.77	0.83	46,819
350	47.20	6,998.76	699,875.94	0.83	580,897
600	89.20	24,995.78	2,499,578.46	0.83	2,074,650
42	3.90	47.78	4,778.22	6.76	32,301
65	6.50	132.73	13,272.84	6.76	89,724
120	13.40	564.09	56,408.77	6.76	381,323
350	47.20	6,998.76	699,875.94	6.76	4,731,161
600	89.20	24,995.78	2,499,578.46	6.76	16,897,150
42	3.90	47.78	4,778.22	60.80	290,516
65	6.50	132.73	13,272.84	60.80	806,989
120	13.40	564.09	56,408.77	60.80	3,429,653
350	47.20	6,998.76	699,875.94	60.80	42,552,457
600	89.20	24,995.78	2,499,578.46	60.80	151,974,370

- Impactor size → debris area
- Debris area + Yield rate → annual yield
  - Yield rate is determined from modeled erosion rates
  - Does not include effect of blast generated debris
- Annual yield / normal annual yield → Increase in annual sediment yield
- Current Annual Yield → 1.83×10^7 Mg/yr
- Comparison
  - 350m: x 2.3
  - 600m: x 8.3

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Summary

Downwind

- 120-m impactor will have effects on
  - Southern Colorado
  - Air quality (Human/Livestock)
  - Ground Visibility (e.g I-25)
  - Air Corridors
- 600-m impactor
  - Colorado, Nebraska, Kansas
  - Air quality
  - Ground Visibility
  - Air Hubs & Corridors

Downstream

- 350-m/600-m impactors will have effects
  - Southern Colorado/Northern New Mexico
  - Flooding potential
  - Water Quality (turbidity, toxicity)
- Minimal impact of Glen Canyon Dam operations
- Our sediment yields are likely conservative

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