Impacts of volcanic ash on road transportation

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Kelud 2014 ash (Rudianto/Zuma Press/Corbis)

Importance of the research

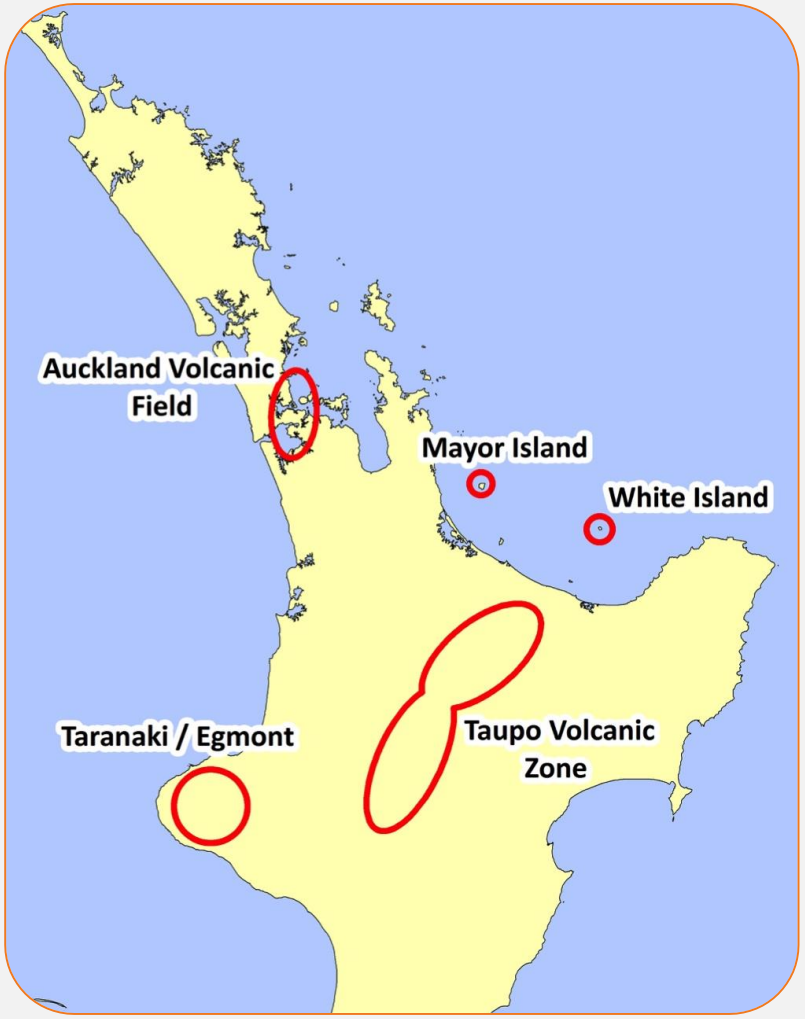
- Functional transport networks critical for society
  - evacuation
  - emergency services
  - recovery
- Ash widely dispersed and disruptive hazard
- Small eruptions capable of widespread disruption for months

Calbuco 2015 ash (AP/Federico Grosso)

Auckland context

- Auckland Volcanic Field (360 km^2)
  - Many volcanic hazards
- Volcanic ash from larger volcanoes >190 km away

Auckland City from Mt. Eden (Daniel Blake)



Why conduct lab studies?

- Frequently occurring impacts:

  1. **Reduced skid resistance**
  2. **Road marking coverage**
  3. **Reduced visibility**

- Quantitative empirical evidence could inform transport management strategies

- Various ash characteristics can be isolated and their effects investigated

1. Skid resistance – ash covered roads

Pendulum Skid Resistance Tester

- Skid Resistance Values (SRVs) calculated
- Comparable to Coefficient of Friction

Tests included:

- Stone Mastic and Porous Asphalt
- Ash types
- Soluble components
- Depths up to 9 mm
- Dry and wet conditions
- Line painted surfaces

1. Skid resistance – key findings

Particularly slippery road surfaces caused by:

- Thin (~1 mm deep) layers of coarse-grained ash
- Thicker (~5 mm) layers of hard, non-vesiculated ash
- Fresh ash containing a high degree of soluble components
- Line-painted surfaces covered by thin layers of ash

<u>Largest change in skid resistance occurs during dry conditions.</u>

1. Skid resistance – recommendations

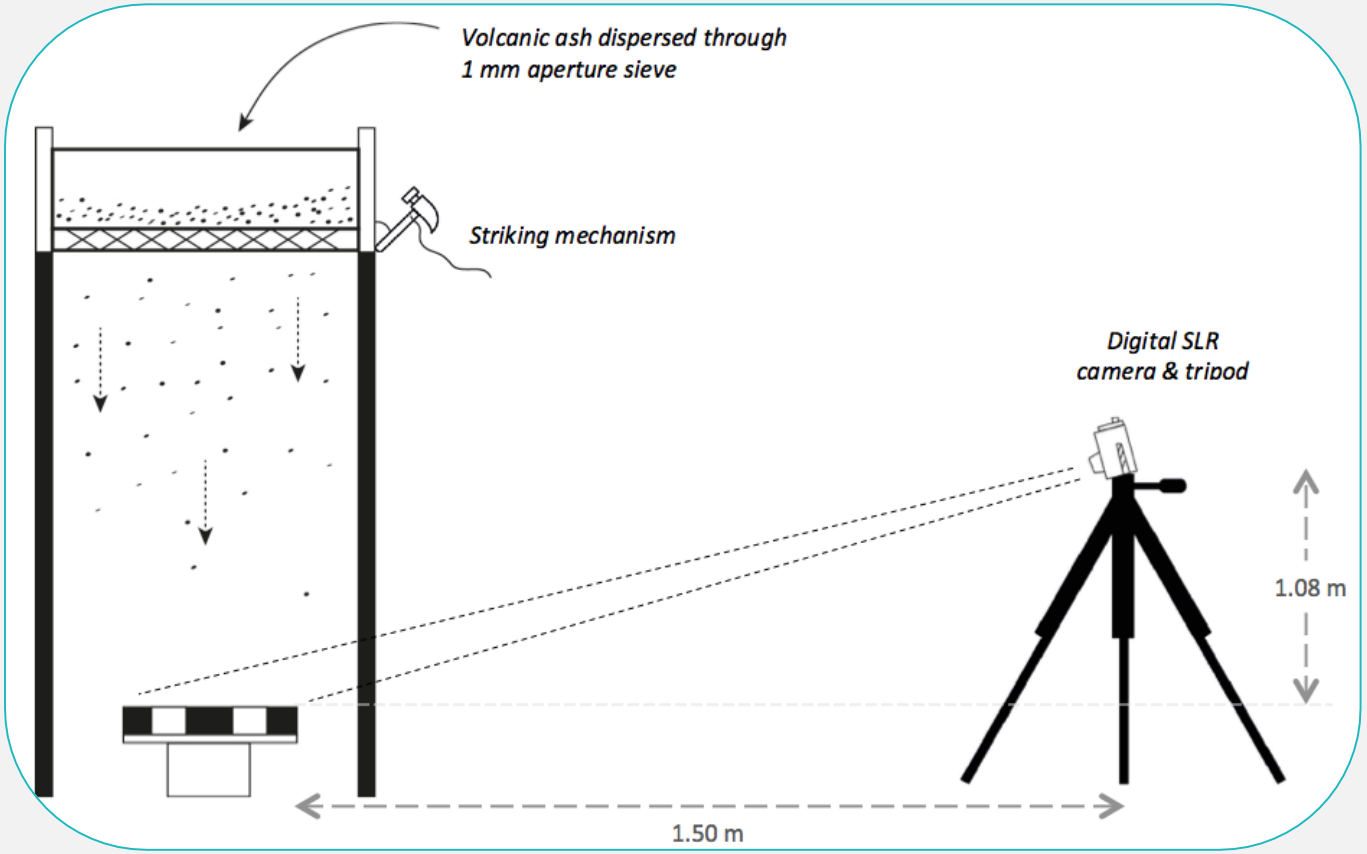
In ≤ 5 mm thick volcanic ash, the following actions can improve road safety:

- Reduce vehicle speed to levels below those for 'typical' wet conditions
- Advise motorists of restrictions promptly
- Take extreme caution on dry surfaces covered by coarse-grained ash
- Be aware that road markings may be hidden and will be especially slippery

<u>Road closures are unlikely to be required based on loss of skid resistance alone</u>

2. Road marking coverage

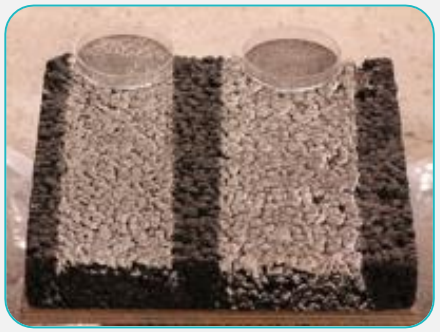
- Line painted asphalt slabs
- Light-coloured rhyolite or dark-coloured basalt applied
- Ash depth and weight recorded
- Images from driver's eye height



2. Road marking coverage

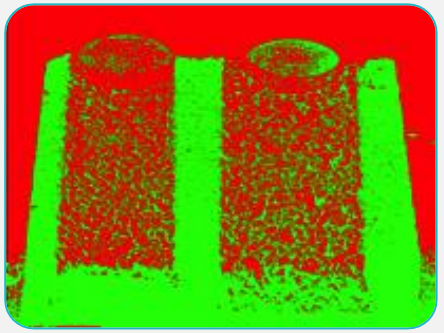
Calculation of visible road markings

1. Photography

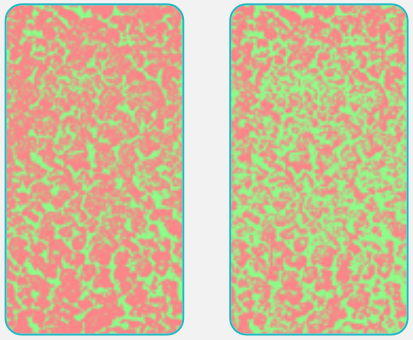


2. Classification

3. Pixel segmentation



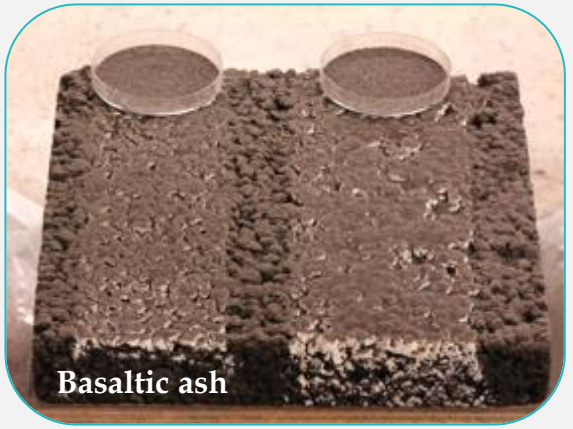
4. Image processing



2. Road marking coverage – key findings

Difficult for drivers to distinguish between markings and asphalt at:

- **0.1 mm** for fine-grained ash (~30 g m^{-2})
- **1.0 mm** for coarse-grained ash (~1000 g m^{-2})



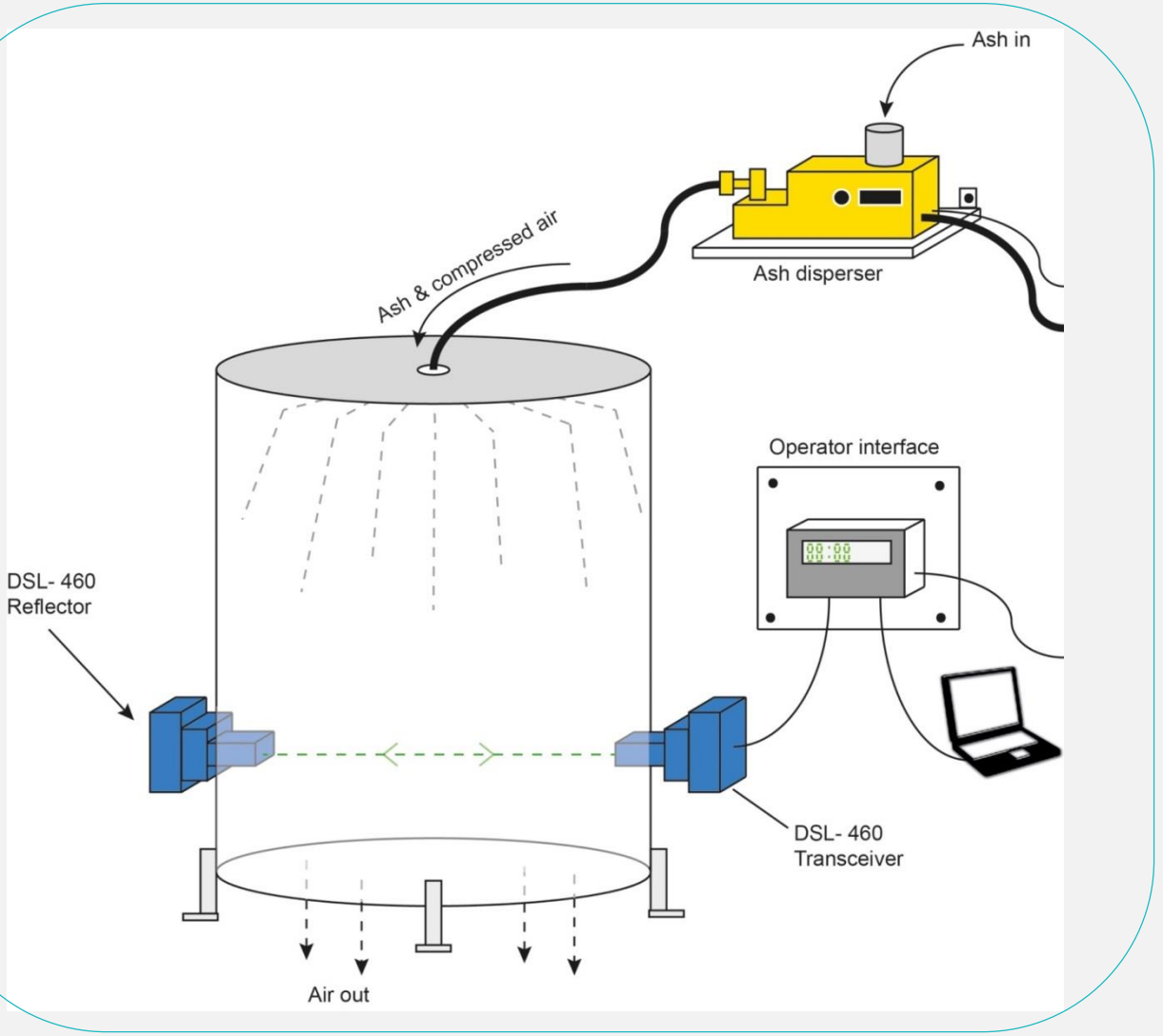
Some variation from ash colour and line paint characteristics

Thresholds useful for road cleaning initiation

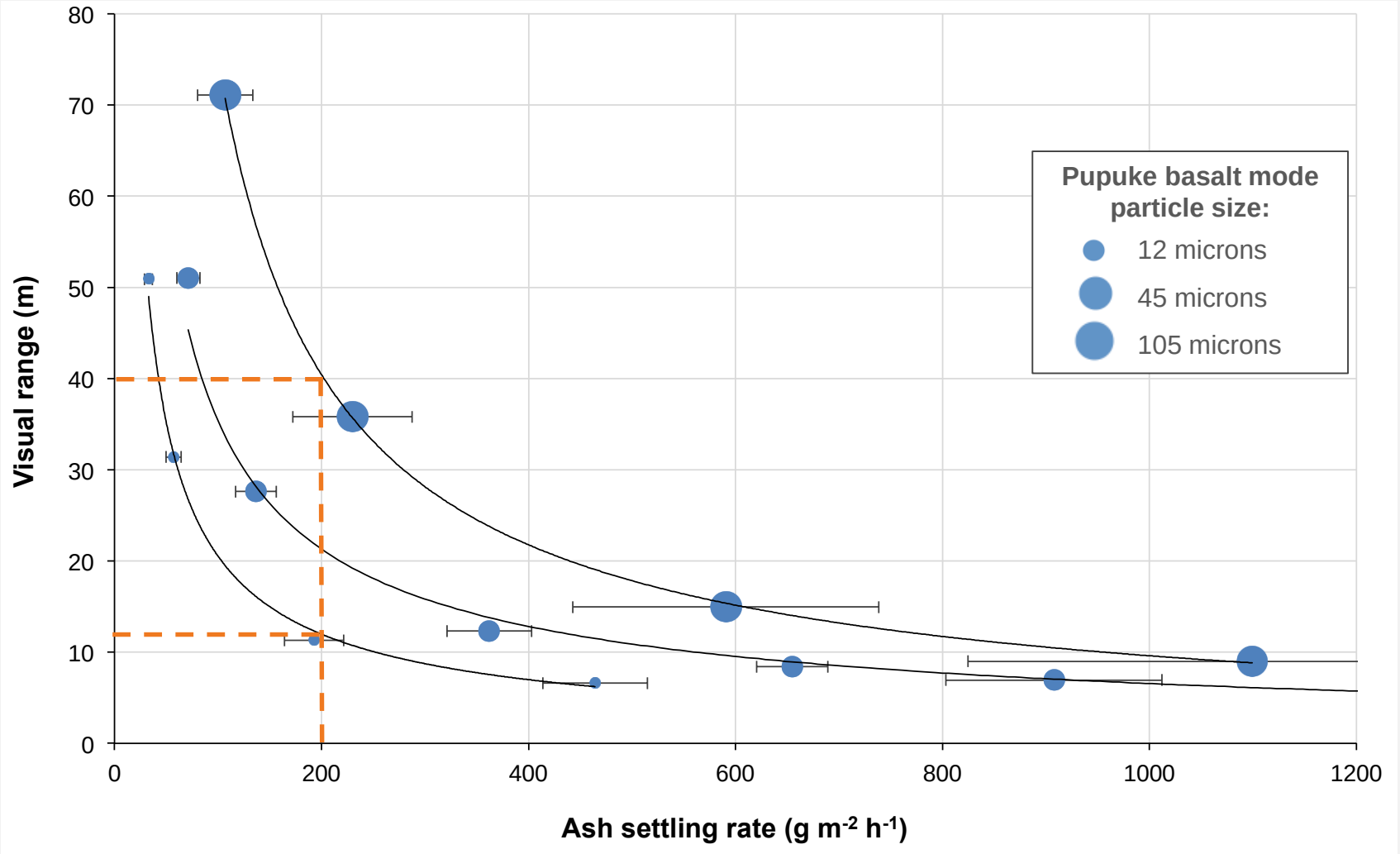
3. Visibility – through airborne ash

- Ash dispersed into container
- Ash falls through high intensity light beam
- Extinction coefficient (b_{ext}) recorded
- Visual range calculated:

$$VR = 3912 / (b_{ext} + 10)$$



3. Visibility – key findings



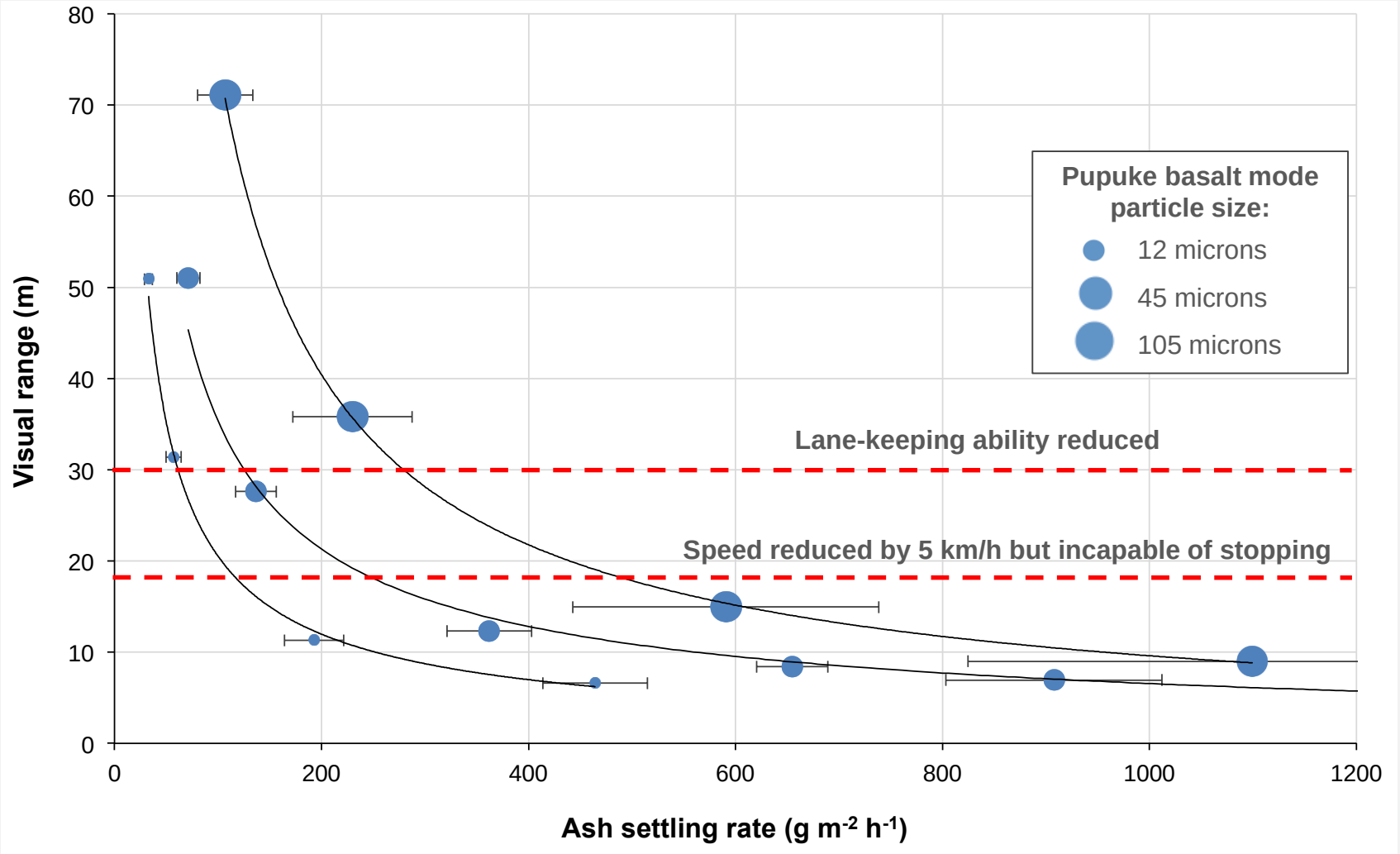
Visibility – key findings

- **2.5 to 100 m** visual range likely for Auckland
- Visual range low for **fine-grained ash**
- Visual range low for **light-coloured** and more **elongated** ash particles

- Results for direct ashfall only
- Consequences for traffic…

Ash in Kagoshima City (Kagoshima City Office, 2015)

3. Visibility – traffic considerations



Brooks et al. (2011)

Summary

Quantification of volcanic ash impacts to surface transport can be achieved through laboratory testing

1. **Skid resistance**
   - Reduced by ~1 mm of ash
   - Unlikely to warrant road closures on its own

2. **Road marking coverage**
   - 0.1 – 1.0 mm ash covers road markings

3. **Visibility**
   - 2.5 – 100 m visual range

Fine ash problematic… distal eruptions

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http://www.theguardian.com/world/2014/feb/14/indonesia-volcano-eruption-evacuations-airport, http://www.washingtonpost.com/world/mount-kelud-erupts-in-indonesia/2014/02/14/de8c2e24-957c-11e3-afce-3e7c922ef31e_gallery.html#item0, http://www.bbc.com/news/world-latin-america-32444840