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Proposed Conceptual Framework for an International Hailstorm Intensity Scale

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We propose a framework for the development and refinement of an internationally applicable hailstorm intensity scale that supports an objective, categorical characterisation of hailstorm intensity and damage potential. The intent is to develop a scale that is universally applicable across time and space. It should demonstrate utility for assessing historical events through to future projected changes in hailstorm intensity, as well as being applicable internationally for damaging hailstorms, regardless of location of occurrence or regional asset sensitivities.

The scale would need to address the many uncertainties associated with hail damage potential. These can be due to variability in hailstorm and hailstone characteristics (e.g., concurrent winds; hailstone hardness; hailfall density, size distribution and duration) which, in varied combination, may result in similar damage potential. These uncertainties can also stem from differences in asset response to hail impacts. The damage scale would need to allow for differences in the fragility and failure modes of key assets (i.e., agricultural crops, building surfaces and vehicles). Failure modes, for example, can fall on a spectrum encompassing brittle failure – with damage triggered by a peak or maximum kinetic energy (MKE) – while other damage receivers are better characterized by cumulative impact (accumulated kinetic energy, or AKE) and/or ductile failure (i.e., cumulative deformation) modes.

Data and information used to categorise storms should be "physically based" (i.e., tied/linked to event damage potential) but with uncertainties associated with those relationships also taken into account. Such a scale should be effective at easily communicating nuances and variability in the damage potential of hail events while not being unnecessarily complex.

By defining, *a priori,* the intended applications of such a scale, along with key performance indicators (i.e., metrics to determine if it meets intended scope and applications), the potential for successful development is increased. For example, a focus on intensity precludes a need for incorporating spatial extent, because hailstorms of similar intensity may affect vastly different surface areas.

To support development and refinement of this scale, observations from post-storm forensic damage assessments are combined with a literature review of other natural hazard intensity and magnitude scales (e.g., EF-Scale, Mercalli Scale), including previously proposed hail intensity scales (ANELFA, TORRO), as well as other natural hazard risk assessment scales. These will be further supplemented by concurrent observations of hailstone characteristics from field campaigns.