

Useful Definitions and Early Warning Information for Natural Hazards

These basic definitions are presented in order to promote a common understanding on the subject of natural hazards. It is extremely difficult to reach consensus on definitions of different natural hazards and extreme weather events. The definitions proposed within this glossary have been drawn from various sources and developed by the United Kingdom Natural Hazard Partnership through a process of reiteration among the constituent partner agencies including the UK Met Office, British Geological Survey, the National Oceanographic Centre, UK Space Agency, and the Flood Forecasting Centre). Further inputs have been provided by the World Meteorological Organization and the World Health Organization Regional Office for Europe. These definitions provide a reference for further progress on a shared understanding of definitions of natural hazards and extreme weather events.'

Term	Definition	Early Warning Information	
Cyclones (Typhoons/ Hurricanes)	A tropical cyclone is one formed over tropical or sub-tropical waters with organised convection and a definite cyclonic surface wind circulation. WMO nomenclature is as follows:	Prediction of seasonal cyclone activity is now possible using knowledge of sea temperature anomalies (teleconnections).	
		Designated warning centres using observational data and weather models are able to predict tropical cyclones for up to several days ahead.	
	Wind on Beaufort Scale		
	Tropical depression		≤ 7
	Moderate tropical storm		8 & 9
	Severe tropical storm		10 & 11
Hurricane	12		
	Called a tropical cyclone in the Indian Ocean, Cyclone in Arabian Sea or Bay of Bengal, Typhoon in western Pacific and Willy-Willy in western Australia and in most other tropical latitudes a Hurricane. <i>Meteorological Glossary. Lewis, R.P.W 6th Edition.</i>	For non tropical cyclones, alerts are issued 5 days with warnings issued with lead times of 24 hours or more.	
	A non-tropical cyclone is one where atmospheric pressure distribution is such that there is a low central pressure relative to its surroundings. It is characterised on a synoptic chart by a system of closed isobars, generally approximately circular or oval in form, enclosing a central low pressure.		
Heat waves	The World Meteorological Association has not defined the term ‘heatwave’, nor are there any alternative universally accepted definitions. However heat waves are generally understood to be prolonged periods of unusually hot dry or hot humid weather that may have an impact on human and natural systems. In the EuroHEAT project a heat-wave was defined as a period when the maximum apparent temperature* (a measure of relative discomfort due to combined heat and high humidity, developed by RG Steadman in 1979) and minimum temperature are over the 90th percentile of the monthly distribution for at least two days. http://www.euro.who.int/_data/assets/pdf_file/0010/95914/E92474.pdf This definition takes into account local variability in baseline climactic conditions and reflects the finding from a survey of the meteorological services in Europe that	Monthly and seasonal trend to hotter weather is now possible. Warnings issued 2-5 days in advance of a heat wave. A review of heat-health action plans in Europe found that most plans were organised at country-level, with some at regional or local level. In most cases, heat-health warnings were issued by the national meteorological office with public health actions organised and implemented through Ministries or Departments of Health. http://www.euro.who.int/_data/assets/pdf_file/0010/95914/E92474.pdf In England and Wales, a Heat-Health Watch system operates from 1 June to 15 September each year. This comprises four levels of response based upon threshold maximum daytime and minimum	

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	<p>threshold temperatures for a heat wave varied with a north-south and west –east gradient.</p> <p>http://www.euro.who.int/_data/assets/pdf_file/0008/96965/E82629.pdf</p> <p>In the UK, a Heat wave is defined when the daily maximum temperature of more than five consecutive days exceeds the average maximum temperature by 5°C. The normal average period or 1961–1990 corresponds to the UKCP09 baseline period.</p>	<p>night-time temperatures. These thresholds vary by region.</p>
Cold weather	<p>There is no formal definition, but in the UK, this is defined when daily mean temperature of zero or below for a period of four consecutive days. Freezing rain, glazed frost or widespread icy roads are all associated with cold weather.</p>	<p>As with heat waves predicting a trend to cold weather can be achieved at monthly timescales. Freezing rain, glazed frost or widespread icy roads alerts issued 5 days in advance with warnings issued 24 hours ahead.</p>
Snow	<p>Solid precipitation which occurs in a variety of minute ice crystals at temperatures well below 0C but as larger snowflakes at temperatures near 0C.</p> <p><i>Meteorological Glossary. Lewis, R.P.W 6th Edition.</i></p>	<p>Subtle changes in atmospheric conditions can lead to sudden change of weather; snow, ice or rain. For this reason, warning for snow can be difficult. Alerts issued 5 days in advance with warnings issued 24 hours or more ahead. The UK Met Office will issue a national severe weather warning if snow is predicted to fall at a rate of approx 2 cm/hour or more for at least two hours.</p>
Avalanches	<p>Typically avalanches relate to snow or ice. In this context the term defines a process where loosened snow and ice move down hill at high velocities.</p> <p><i>Avalanches can also occur in rock (Rock Avalanches). In Volcanology, Debris Avalanche describes the product of a large scale collapse of a sector of volcanic edifice under water-undersaturated conditions. [Sigurdsson et al, 2000]</i></p>	<p>Very difficult to forecast with little or no warning time given.</p>
Flooding	<p>(1) Overflowing by water of the normal confines of a stream or other body of water, or accumulation of water by drainage over areas which are not normally submerged.</p> <p>(2) Controlled spreading of water for irrigation, etc.</p> <p>http://webworld.unesco.org/water/ihp/db/glossary/glu/EN/GF0469EN.HTM</p>	
River flooding	<p>Occurs when a watercourse cannot cope with the water draining into it from surrounding land. This can happen when heavy rain falls on an already waterlogged catchment.</p> <p>http://www.environment-agency.gov.uk/homeandleisure/floods/31652.aspx</p>	<p>Warnings are issued for river reaches, which may be from a hundred metres to a few kilometres in length. Large river systems may take several/many days for the flood wave to arrive at its lower reaches following a period of excessive rains.</p>
Groundwater flooding	<p>Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise up to the surface causing groundwater flooding.</p> <p>Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive, regional aquifers, such as Chalk or sandstone, or may be localised sands or river gravels in valley bottoms underlain by less permeable rocks. Groundwater flooding takes longer to dissipate because groundwater moves much more slowly than surface water and will take time to flow away underground. <i>UK Groundwater forum</i></p> <p>http://www.groundwateruk.org/FAQ_groundwater_flooding.aspx</p>	<p>The response times are slower compared to other forms of flooding and as such advance warning of more than 5 days are possible.</p>

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Surface water flooding	<p>Pluvial flooding is defined as flooding which results from rainfall-generated overland flow, before the runoff enters any watercourse or sewer. It is usually associated with high intensity rainfall events (typically >30mm/h) but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has low permeability resulting in overland flow and ponding in depressions in the topography. Urban pluvial flooding arises from high intensity 'extreme' rainfall events. In such situations urban underground sewerage/drainage systems and surface watercourses may be completely overwhelmed.</p> <p>OR</p> <p>Flooding caused when intense rainfall cannot drain away quickly enough through drains or rivers – also known as surface-water flooding.</p> <p>NERC FREE programme - http://www.nerc.ac.uk/research/programmes/free/resources/finale-brochure.pdf Press release NERC FREE http://waterworlds.wordpress.com/2008/01/03/13-pluvial-flooding/ http://www.environment-agency.gov.uk/homeandleisure/floods/31652.aspx</p>	<p>Forecasting flooding from surface water is particularly challenging for two reasons. Firstly, as surface water flooding typically occurs a few hours or even minutes after a period of intense rainfall, the lead time for issuing warnings is very short; once the rainfall event is over flooding may have already started. Secondly, as this form of flooding is usually the result of convective rainfall, forecasting the occurrence and location of rainfall events is notoriously difficult.</p>
Coastal flooding	<p>Results from a combination of high tides and stormy conditions. If low pressure coincides with a high tide, a storm tide may happen which can cause serious flooding. http://www.environment-agency.gov.uk/homeandleisure/floods/31652.aspx</p>	<p>The most serious coastal flood events are caused by intense winter depressions and tropical cyclones. Meteorological forecasts of these events are reliable up to 5 days ahead and the remaining uncertainty is well represented by ensemble forecasting systems.</p>
Drought	<p>Droughts are natural events and happen when a period of low rainfall leads to a shortage of water. A different type of drought is the psychological or agricultural drought whereby moisture is in the soil but little is getting to vegetation, either because it is frozen (which can occur in severely cold winters in the UK) or because of very high temperatures which means that the rate of evapotranspiration is exceeding the rate of uptake of water from the plant.</p> <p>Drought Prolonged absence or marked deficiency of precipitation. http://webworld.unesco.org/water/ihp/db/glossary/glu/EN/GF0371EN.HTM</p> <p>Hydrological drought Period of abnormally dry weather sufficiently prolonged to give rise to a shortage of water as evidenced by below normal stream flow and lake levels and/or the depletion of soil moisture and a lowering of groundwater levels. http://webworld.unesco.org/water/ihp/db/glossary/glu/EN/GF0612EN.HTM</p>	<p>Seasonal and monthly water availability trend predictions and associated hydrological induced drought risk are now possible.</p>
Earthquakes	<p>The vibrations of the earth caused by the passage of seismic waves radiating from some source of elastic energy. [Bolt, 1998]. The vibrations often stem from fault lines which are fractures or zones of fractures (zones of weakness) in rock along which the two sides have been displaced relative to each other parallel to the fracture. [Bolt, 1998]. A measure of earthquake size is determined by the Richter scale. Common types of magnitude are: Richter (or Local) magnitude (M_L), Moment magnitude (M_W) and Surface wave (M_S).</p> <p><i>There are more in depth definitions of Magnitude used in seismology literature.</i></p>	<p>There is still no reliable way to predict earthquakes accurately despite many years of research internationally, but statistics and geological knowledge can indicate where large earthquakes are likely and what their effects will be. In the past 20 years or so, with support from Government and industry scientists have developed systems to detect and locate earthquakes and transmit alerts. Near real-time, 24-hour, seismic monitoring and information services are in operation.</p>

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Volcanic eruption	Opening in the crust that allows magma to reach the surface. The eruption can be Plinian, characterised by a high, convective column in which most of the eruptive mass is ejected and results in atmospheric ash dispersal. Or a Bomb, in which a mass of magma more than 64mm in maximum dimension, is largely plastic when it erupts. [Bardintzeff & McBirney, 2000]	There has been an increase in volcano monitoring in recent years. Although there is no universally accepted method of prediction a number of volcanoes that pose significant threat to populations have been studied and risk assessments made. Volcanic ash predictions are available with 2-5 day forecast plumes issued from ICAO designated Volcanic Ash Advisory Centres.
Landslides	<p>A landslide is defined by Cruden (1991) for the Working Party on World Landslide Inventory as <i>a movement of a mass of rock, earth or debris down a slope</i>. There are five kinematically distinct types of landslide identified by Varnes (1978) and Dikau, Brunsden, Schrott and Ibsen (1996):</p> <ul style="list-style-type: none"> a) Falls: A fall starts with the detachment of soil or rock from a steep slope along a surface on which little or no shear displacement takes place. The material then descends largely by falling, bouncing or rolling. b) Topples: A topple is similar to a fall except that it involves the forward rotation, out of the slope, of a mass of soil or rock about a point or axis below the centre of gravity of the displaced mass. c) Slides: A slide is the downslope movement of a soil or rock mass on a distinct slide or shear surface. These can be rotational or translational depending on the geology, structure and hydrogeology. Rotational slides involve a semicircular shear surface. Translational slides usually occur on planar slip surfaces. d) Flows: A flow is a spatially continuous movement in which shear surfaces are short lived, closely spaced and usually not preserved after the event. The distribution of velocities in the displacing mass resembles that in a viscous fluid. e) Spreads: lateral spreading is characterised by the low-angled slopes involved and the unusual form and rate of movement. A spread is an extension of a cohesive soil or rock mass combined with a general subsidence of the fractured mass of cohesive material into softer underlying material. The rupture surface is not a surface of intense shear. Spreads may result from liquefaction or flow (and extrusion) of the softer material. <p>However, Varnes (1978) also presented a sixth mode of movement: Complex Failures. These are failures in which one of the five types of movement is followed by another type (or even types). For such cases the name of the initial type of movement should be followed by an "en dash" and then the next type of movement: e.g. rock fall-debris flow (WP/ WLI, 1990). In reality, almost all landslides involve more than one type of movement either concurrently in different parts of the failure or evolving downslope over time into different failures.</p> <p>Cruden, D.M., 1991. A simple definition of a landslide. <i>Bulletin International Association for Engineering Geology</i>, 43: 27-29.</p>	Very difficult to predict with little or no warning given.

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Tsunami	Tsunamis are caused by underwater earthquakes, landslides (above and below water) and volcanic eruptions. They can cause devastation in low-lying areas when they reach the shore. Major tsunamis are most commonly produced by large (greater than 7 on the Richter scale), shallow-focus (less than 30 km depth) earthquakes associated with rupturing at the boundaries of the Earth's tectonic plates. Occasionally, there are so-called tsunami earthquakes that generate a tsunami greater than expected from standard analysis of their seismic waves.	Once a potentially tsunamigenic earthquake has occurred, automated analysis can generally provide the location, magnitude, and faulting mechanism within minutes. This provides the source term for tsunami modelling which give estimates of the arrival time and wave height at locations in the tsunami's path. Tsunamigenic earthquakes often occur at subduction zones close to ocean-continental boundaries and the nearby coastline may be inundated within minutes giving little time to respond to earthquake alerts. However, the wave directed away from land may take many hours to arrive at distant targets across the oceanic basin giving local and national authorities the opportunity to mobilise and implement emergency plans.
Wildfires	Often referred to as Forest, Moorland, Grass, Heath and Bush fires. Fires can flare up without notice during or following a protracted heat-wave and often triggered by lightning or man made incidents.	Fire requires fuel, oxygen and ignition. In the context of outdoors, the fuel is vegetation - fine, medium and coarse. In order for vegetation to become fuel, it needs to be cured (dried) which is weather related. Dead vegetation is excellent fuel, particularly if it's cured during the warm season. Ideal curing conditions are; no rain, strong winds, low humidity, warm temperatures. These parameters can be predicted days ahead with 24 hour site specific warnings possible once the fire has started.
Space weather	Space weather refers to the variable conditions on the Sun and in the space environment that can influence the performance and reliability of spaceborne and ground based technological systems, as well as endanger life or health. Most space weather occurs because emissions from the Sun influence the space environment around Earth, as well as other planets. A policy statement of the American Meteorological Society (adopted by AMS Council 5 May 2008) Bull. Amer. Meteor. Soc., 89 http://www.ametsoc.org/POLICY/2008spaceweather_amsstatement.html	Disturbances of the ionosphere caused by X-ray emissions from the sun, called radio blackouts, are not predictable taking 8 mins from the sun to hit the earth. A radiation storm, which is a elevated levels of radiation that occur when the numbers of energetic particles increase can take 30mins to 1 day to transit from the sun. A geomagnetic storm, which are disturbances in the earth's magnetosphere brought about by increased solar activity, including solar flares and solar storms resulting in mass ejections of matter (plasma) can take 20 hours to 4 days to transit.