WMO OMM

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

World Meteorological Organization
Organisation météorologique mondiale
Organización Meteorológica Mundial
Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
世界气象组织

Secrétariat
7 bis, avenue de la Paix – Case postale 2300
CH 1211 Genève 2 – Suisse
Tél.: +41 (0) 22 730 81 11
Fax: +41 (0) 22 730 81 81
wmo@wmo.int – public.wmo.int

5 March 2018

Cataloguing High-Impact Events and Associated Loss and Damage

Submission in the context of the five-year rolling workplan of the Executive Committee activity 1(a) of the strategic workstream (e), on the type and nature of actions to address loss and damage for which finance may be required

Introduction

Most hazard-related loss and damage globally is associated with hydro-meteorological hazards and extreme events. Consequently, systematically tracking losses and damages associated with these events globally is important for major policy frameworks, including the United Nations Framework Convention on Climate Change as well as the United Nations Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction. These frameworks recognize the importance of averting, minimizing and addressing loss and damage associated with hydro-meteorological hazards and the adverse effects of climate change, including extreme weather and slow onset events.

Systematically catalogued data on such events and associated loss and damage is essential for measuring the efficacy of comprehensive risk management approaches, for assessing risks of future loss and damage, for calibrating risk reduction investments, and for designing risk transfer mechanisms. In this regard, the World Meteorological Organization (WMO) has taken steps towards standardizing weather, water, climate, space weather and other related environmental hazard information, and has developed a draft methodology for assigning unique identifiers to such events for use in cataloguing them and linking them to data on associated losses and damage (see annex). Results and recommendations from an initial test phase, currently underway, will be forwarded to the seventieth Session of the WMO Executive Council in June 2018 for further recommendation to the eighteenth session of the World Meteorological Congress (Cg-18) in 2019 as appropriate, full implementation being subject to a decision of the latter.

Related actions for which finance may be required

The type and nature of related actions for which finance may be required include:

- Capacitation and coordination of relevant national, regional and global centres for the preparation and maintenance of event catalogues, including the assignment of unique event identifiers
- Capacitation and coordination of relevant national authorities for using unique event identifiers for linking events and associated loss and damage
- Capacitation of, and coordination with, stakeholders for accessing and using the event catalogues and associated data as an input to comprehensive risk management approaches including, inter alia, risk assessments, design of risk management measures including risk transfer (insurance) schemes, and underpinning research, and
- Further methodological refinement.

Annex: 1

Annex

Unique Identifiers for Cataloguing High-Impact Events and Associated Loss and Damage

Background

At its 17th (Cg-17) session in 2015, the World Meteorological Congress noted the need for systematic characterization and cataloguing of extreme weather and climate events in a form that allows data on losses and damage to be cross-referenced to these phenomena. Towards this end, Cg-17 adopted Resolution 9, through which it decided "to standardize weather, water, climate, space weather and other related environmental hazard information", including the development of identifiers for cataloguing extreme and high-impact weather, water and climate events.

In November 2017, WMO organized an international workshop on cataloguing and managing information on extreme events. The workshop was convened by the WMO Commission for Climatology and the Commission for Basic Systems, co-chaired by the presidents of both commissions, and attended by experts from WMO National Meteorological and Hydrological Services and Regional Climate Centres as well as by representatives from the United Nations International Strategy on Disaster Risk Reduction, the European Commission, and the Centre for Research on the Epidemiology of Disasters. The main output from the workshop was an innovative approach for cataloguing high-impact events which leverages international standards and which is versatile and flexible enough to account for complex relationships among various event types.

In February 2018, the WMO Regional Association VI decided to test the proposed approach for cataloguing high impact events in Europe. The test phase will entail tracking events using a standard typology of high impact event types, assigning a Universal Unique Identifier (UUID) to each as they occur. The UUID will provide a means of systematically linking the events to associated data on loss and damage such as is being routinely collected by relevant national authorities. The test phase will start in 2018 and continue over a sufficient period to deliver results and recommendations relevant for operationalization of the approach to the seventieth Session of the WMO Executive Council in June 2018 and the eighteenth session of the World Meteorological Congress (Cg-18) in 2019.

Cataloguing

The approach centres on identifying events uniquely, while at the same time being able to group together events which are hydro-meteorologically related (figure 1). The UUID, further described below, is an ISO-standard random number generated by a relevant national, regional or global WMO meteorological authority. In addition to the UUID, key attributes contained in a data record for each event include information that define the event, such as event start and end times, spatial extent, and event type. Other attributes provide context such as description, local identifier (e.g. local or regional names of storms), and links to other events (e.g. heavy rain to tropical cyclone) which enables the clustering of events (e.g. events linked to other events) into larger scale (synoptic) phenomena.

Additional information about each event can be stored in a separate database, also associated with the UUID, for storing relevant hydro-meteorological parameters (wind speeds, precipitation amounts, values of hydro-meteorological indexes, etc.). Importantly, authorities responsible for assessing and cataloguing information on loss and damage would be able to use the same UUID to associate this type of non-hydro-meteorological information with the events as well.

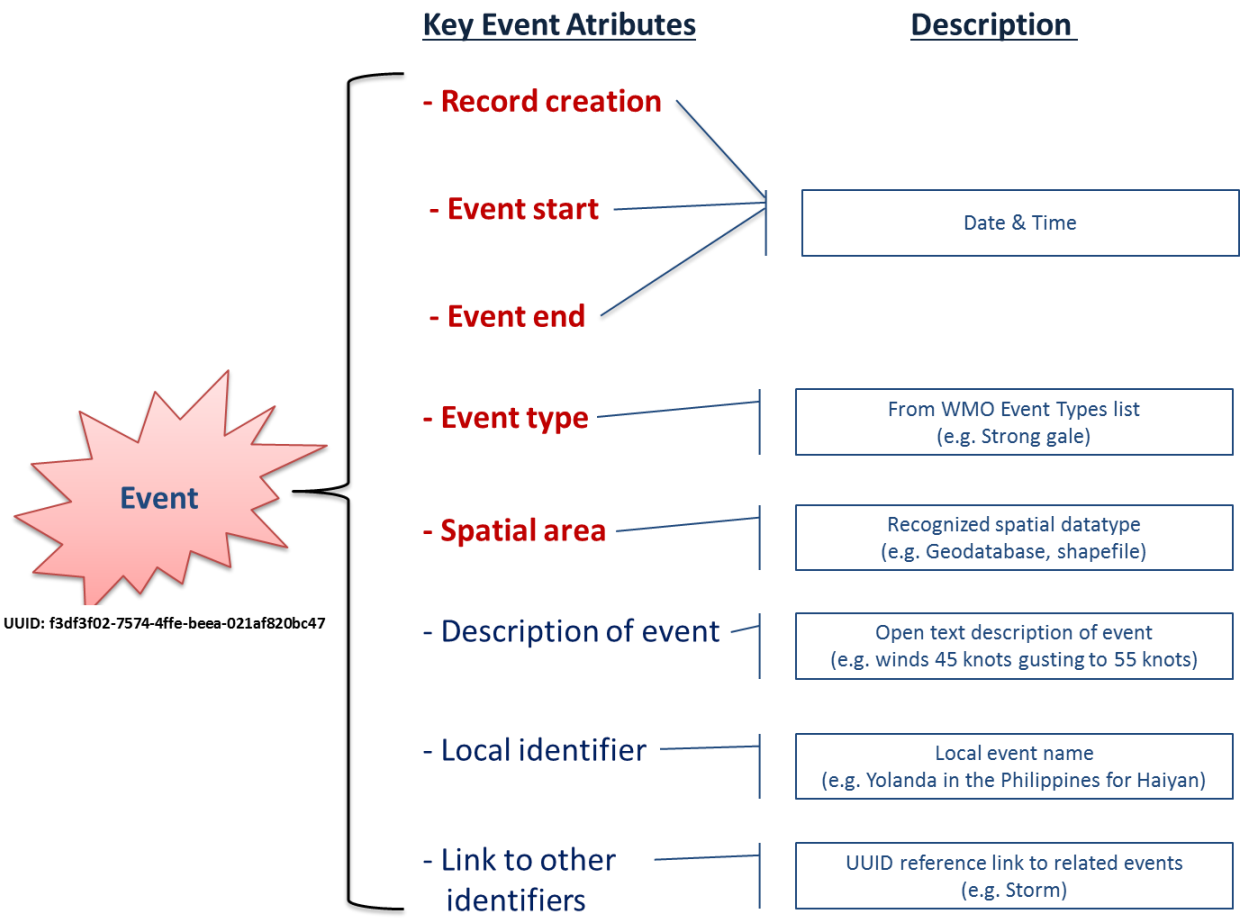

Figure 1: Event record containing UUID and key event attributes (attributes in red are mandatory entries)

The scheme also addresses the issue of events being associated with each other, e.g. a cyclone, leading to heavy rain, strong winds, storm surge flooding and landslides. Each event and sub-event can have its own UUID, yet incorporating the UUIDs of associated events in any given event record allows the entire chain of events to be linked to each other, along with any associated data.

Recording process and analysis

The UUID, record creation date, event start date and type are all entered at the time of event onset. The end date, spatial extent, description, local id, and UUIDs of related events are all entered at or prior to the time of record closure. Post analysis will be conducted for linking events into a hierarchical clustering from synoptic to meso- and local–scales. Quality control in partnership with loss and damage database stakeholders could also be necessary to verify and finalize event information (e.g. spatial area and/or relationships among events cross-referenced in each other's event records).

Event Types

A draft typology which lists types of events associated with impacts has been compiled from authoritative WMO references and resource materials (see below). The typology contains an initial list of event types with which losses and damage are potentially associated will be submitted to Cg-18 for approval after consideration by the WMO Executive Council at its 70th session in June 2018. The typology will be a standard living list that can be amended by

countries and regions through the appropriate WMO governance mechanism, such as the GDPFS. The event typology will be also be referenced to by the WMO Information System, to allow a consistent access to the most updated version.

UUID

A universally unique identifier (UUID) is a 128-bit number used to identify information in computer systems (the term globally unique identifier (GUID) is also used). When generated according to the standard methods, UUIDs are for practical purposes unique, without depending for their uniqueness on a central registration authority or coordination between the parties generating them, unlike most other numbering schemes. While the probability that a UUID will be duplicated is not zero, it is close enough to zero to be negligible. Thus, anyone can create a UUID and use it to identify something with near certainty that the identifier does not duplicate one that has already been, or will be, created to identify something else. Information labelled with UUIDs by independent parties can therefore be later combined into a single database, or transmitted on the same channel, without needing to resolve conflicts between identifiers. Adoption of UUIDs and GUIDs is widespread, with many computing platforms providing support for generating them, and for parsing their textual representation.

Types of Events

I. Weather

Blizzard
A severe snow storm characterized by poor visibility, usually occurring in high-latitude and mountainous regions. *(source: Manual on marine meteorological services (WMO-No. 558, App. 1.2))*

Downburst
Violent and damaging downdraught reaching the surface, associated with a severe thunderstorm. *(source: International Meteorological Vocabulary, WMO-No. 182)*

Dry spell
Period of abnormally dry weather. Use of the term should be confined to conditions less severe than those of a drought. *(source: International Meteorological Vocabulary, WMO-No. 182)*

Extreme precipitation
A marked precipitation event occurring during a period of time (such as hourly or daily) with precipitation exceeding a certain threshold defined for a given location (source: CCl, TT-DEWCE)

Fog
A suspension of very small, usually microscopic water droplets in the air, reducing visibility at the Earth's surface. *(source: Manual on marine meteorological services (WMO-No. 558, App. 1.2) and International Cloud Atlas, Volume I – Manual on the Observation of Clouds and Other Meteors)*

Hoar frost
A deposit of ice on objects generally crystalline in appearance, and produced by the direct "sublimation" of water vapour from the surrounding air. (*source: International Cloud Atlas, Volume I – Manual on the Observation of Clouds and Other Meteors*)

Gale
Wind with a speed between 34 and 40 knots (Beaufort scale wind force 8).
(source: International Meteorological Vocabulary, WMO-No. 182)

Hail
Precipitation of transparent, or partly or completely opaque, particles of ice (hail- stones), which are usually spherical, conical or irregular in form and have a diameter generally between 5 and 50 mm (smaller particles of similar origin may be classified either as small hail or ice

pellets), and fall either separately or agglomerated into irregular lumps. Hail always occurs in the forms of showers and is generally observed during heavy thunderstorms. *(source: Guide to Meteorological Instruments and Methods of Observation, WMO-No. 8)*

Haze
A suspension in the air of extremely small, dry particles invisible to the naked eye and sufficiently numerous to give the air an opalescent appearance. *(source: Manual on marine meteorological services, WMO-No. 558, App. 1.2 and International Cloud Atlas, Volume I – Manual on the Observation of Clouds and Other Meteors)*

Heavy rain
Rain with a rate of accumulation exceeding a specific value, e.g. 7.6 mm h^{-1}.
(source: International Meteorological Vocabulary, WMO-No. 182)

Ice storm
Intense formation of ice on objects by the freezing, on impact, of rain or drizzle.
(source: International Meteorological Vocabulary, WMO-No. 182)

Snowstorm
Meteorological disturbance giving rise to a heavy fall of snow, often accompanied by strong winds. *(source: International Meteorological Vocabulary, WMO-No. 182)*

Squall
Atmospheric phenomenon characterized by a very large variation of wind speed: it begins suddenly, has a duration of the order of minutes and decreases rather suddenly in speed. It is often accompanied by a shower or thunderstorm. *(source: Manual on Codes, International Codes, Volume I.2, WMO-No. 306*

Storm
(1) An atmospheric disturbance involving perturbations of the prevailing pressure and wind fields, on scales ranging from tornadoes (1 km across) to extratropical cyclones (2000-3000 km across).

(2) Wind with a speed between 48 and 55 knots (Beaufort scale wind force 10).
(source: International Meteorological Vocabulary, WMO-No. 182)

Strong gale
Wind with a speed between 41 and 47 knots (Beaufort scale wind force 9).
(source: International Meteorological Vocabulary, WMO-No. 182)

Thunderstorm
One or more sudden electrical discharges, manifested by a flash of light (lightning) and a sharp or rumbling sound (thunder). *(source: Manual on marine meteorological services (WMO-No. 558, App. 1.2) and International Cloud Atlas, Volume I – Manual on the Observation of Clouds and Other Meteors)*

Wet spell
A period of a number of consecutive days on each of which precipitation exceeding a specific minimum amount has occurred. *(source: International Meteorological Vocabulary, WMO-No. 182)*

Cyclone
An area of low pressure, with the lowest pressure at the centre. Commonly referred to as Low. *(source: Hurricane Operational Plan, Tropical Cyclone Programme, Report No. TCP-30, WMO-No.1163)*

The term is also used to refer to tropical cyclones in the Bay of Bengal and the Arabian Sea (*source: Tropical Cyclone Operational Plan for the Bay of Bengal and the Arabian Sea Tropical Cyclone Programme, report No. TCP-21, WMO/TD No.84)*

Depression or Cyclone, low, low-pressure area
Region of the atmosphere in which the pressures are lower than those of the surrounding region at the same level.
(source: International Meteorological Vocabulary, WMO-No. 182)

Tropical cyclone
Cyclone of tropical origin of small diameter (some hundreds of kilometres) with minimum surface pressure in some cases less than 900 hPa, very violent winds and torrential rain; sometimes accompanied by thunderstorms. It usually contains a central region, known as the "eye" of the storm, with a diameter of the order of some tens of kilometres, and with light winds and more or less lightly clouded sky. *(source: Manual on Codes, International Codes, Volume I.2, WMO-No. 306)*
Tropical Cyclone Operational Plan for the Bay of Bengal and the Arabian Sea, Tropical Cyclone Programme, report No. TCP-21, WMO/TD No.84, and Typhoon Committee Operational Manual, Tropical Cyclone Programme, report No. TCP-23, WMO/TD No.196

Alternative definition: A warm-core, non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and closed surface wind circulation about a well-defined centre
(Source: Tropical Cyclone Operational Plan for the South Pacific and South-East Indian Ocean, Tropical Cyclone Programme, report No. TCP-24, WMO-NO 1181; Hurricane Operational Plan for North America, Central America and the Caribbean, Tropical Cyclone Programme, Report No. TCP-30, WMO-No.1163; Typhoon Committee Operational Manual, Tropical Cyclone Programme, report No. TCP-23, WMO/TD No.196; Tropical Cyclone Operational Plan for the South-West Indian Ocean, Tropical Cyclone Programme, report No. TCP-12, WMO-NO 1178; Tropical Cyclone Operational Plan for the South Pacific and South-East Indian Ocean, Tropical Cyclone Programme, report No. TCP-24, WMO-NO 1181)

The term is also used for a storm in the South-West Indian Ocean in which the maximum of the sustained wind speed (10-min mean) [1] is estimated to be in the range of 64 to 89 knots and in the South Pacific and South-East Indian Ocean with the maximum of the sustained wind speed over 33 knots.
(Sources: Tropical Cyclone Operational Plan for the South-West Indian Ocean, Tropical Cyclone Programme, report No. TCP-12, WMO-NO 1178; Tropical Cyclone Operational Plan for the South Pacific and South-East Indian Ocean, Tropical Cyclone Programme, report No. TCP-24, WMO-NO 1181)

Sub-tropical cyclone
A low pressure system, developing over subtropical waters which initially contains few tropical characteristics. With time the subtropical cyclone can become tropical. (Sources: *Tropical Cyclone Operational Plan for the South Pacific and South-East Indian Ocean, Tropical Cyclone Programme, report No. TCP-24, WMO-NO 1181;*

Alternative definition: A non-frontal low-pressure system that has characteristics of both tropical and extratropical cyclones. Like tropical cyclones, they are non-frontal, synoptic-scale cyclones that originate over tropical or subtropical waters, and have a closed surface wind circulation about a well-defined center.
Source: Hurricane Operational Plan for North America, Central America and the Caribbean, Tropical Cyclone Programme, Report No. TCP-30, WMO-No.1163

Subtropical Storm
A subtropical cyclone in which the maximum sustained surface wind is 63 km/h (39 mph) (34 knots) or greater. *(source: RA IV/TD-No. 494 (1995))*

---

[1] For converting the wind speeds of different averaging periods such as 1-min, 2-min, 3-min and 10-min, WMO Tropical Cyclone Programme recommends to follow the guidelines as shown in the Guidelines for converting between various wind averaging periods in tropical cyclone conditions (Harper et al. (2010), Knaff and Harper (2010))

Extra-tropical cyclone
Low-pressure system which develops in latitudes outside the tropics. *(source: International Meteorological Vocabulary, WMO - No. 182)*

Definition used by the tropical cyclone community: A former tropical cyclone that has gone through extra-tropical transition and lost its initial tropical characteristics.
Sources: *Seventh Tropical Cyclone RSMCs/TCWCs, Technical Coordination Meeting, WMO, 2012, appendix VIII; Typhoon Committee Operational Manual, report No. TCP-23* and *Tropical Cyclone Programme, RA-I Operational Plan, Report No. TCP-12, WMO-No.1178*

Hurricane
Name given to a tropical cyclone with maximum average surface wind (one-minute mean [2]) is 119 km/h (74 mph) (64 knots) or greater near the center in the North Atlantic.
(sources: Tropical Cyclone Programme, Hurricane Operational Plan, Report No. TCP-30, WMO-No.1163, International Meteorological Vocabulary, WMO-No. 182)

Typhoon
Name given to a tropical cyclone with maximum sustained winds of 64 knots or more near the centre in the western North Pacific. *(source: International Meteorological Vocabulary, WMO-No. 182)*

Severe tropical storm
A tropical cyclone with the maximum sustained winds of 48 knots (24.5 m/s, 89 km/h) to 63 knots (32.6 m/s, 117 km/h) near the centre. (sources: Typhoon Committee Operational Manual, Tropical Cyclone Programme, report No. TCP-23, WMO/TD No.196; International Meteorological Vocabulary, WMO-No. 182, Tropical Cyclone Operational Plan for the South-West Indian Ocean, Tropical Cyclone Programme, report No. TCP-12, WMO-NO 1178)

Tornado
A severe rotating windstorm of small diameter and great destructive power. It is the most violent natural meteorological phenomenon. With certain frequency they can occur within hurricanes circulation. Although tornadoes occur over land areas in many parts of the world associated with several weather situations, they are relatively frequent in the forward portion of the hurricane periphery. *(source: RA IV/TD-No. 494 (1995))*

Tropical storm A tropical cyclone with the maximum sustained winds of 34 knots (17.2 m/s, 62 km/h) to 47 knots (24.4 m/s, 88 km/h) near the centre. *(sources: Typhoon Committee Operational Manual, report No. TCP-23, International Meteorological Vocabulary, WMO-No. 182)*

Definition used for the Atlantic basin: A well organised tropical cyclone in which the maximum average surface wind (one-minute mean) is in the range 63-118 km/h (39-73 mph) (34-63 knots) inclusive.
(Source: Tropical Cyclone Programme, Hurricane Operational Plan, Report No. TCP-30, WMO-No.1163)

II. Climate

Cold wave
Marked cooling of the air, or the invasion of very cold air, over a large area.
(source: International Meteorological Vocabulary, WMO-No. 182)

---

[2] For converting the wind speeds of different averaging periods such as 1-min, 2-min, 3-min and 10-min, WMO Tropical Cyclone Programme recommends to follow the guidelines as shown in the Guidelines for converting between various wind averaging periods in tropical cyclone conditions (Harper et al. (2010), Knaff and Harper (2010))

Alternative definition: Marked and unusual cold weather characterized by a sharp and significant drop of air temperatures near the surface (maximum, minimum and daily average) over a large area and persisting below certain thresholds for at least two consecutive days during the cold season. The term cold wave is commonly used during the cold season *(source: CCl/TT-DEWCE)*

Heatwave/heat wave
Marked warming of the air, or the invasion of very warm air, over a large area; it usually lasts from a few days to a few weeks. *(source: International Meteorological Vocabulary, WMO-No. 182)*

Alternative definition 1: Periods of unusually hot and dry or hot and humid weather that have a subtle onset and cessation, a duration of at least two to three days and a discernible impact on human activities. *(source: Heatwaves and Health: Guidance on Warning-System Development, WMO-No. 1142)*

- Bio-meteorological Indices: heat index, humidex, net effective temperature, wet-bulb globe temperature, apparent temperature, excess heat index, heat-budget models, standard effective temperature, predicted mean vote, perceived temperature, physiological equivalent temperature, universal thermal climate index
- Holistic approach: health-related assessment of the thermal environment, Heat Stress Index, Excess Heat Index-acclimatization, Excess heat factor

Alternative definition 2: A period of marked unusual hot weather (maximum, minimum and daily average temperature) over a region persisting at least two to three consecutive days during the warm period of the year based on local (station-based) climatological conditions, with thermal conditions recorded above given thresholds *(source: CCl/TT-DEWCE)*

Drought
Conditions that are significantly drier than normal or otherwise limiting moisture availability to a potentially damaging extent. (source: *Handbook of Drought Indicators and Indices, WMO-No. 1173)*

Alternative definition: Prolonged absence or marked deficiency of precipitation. *(source: International Glossary of Hydrology, WMO/UNESCO, WMO-No. 385)*

Hydrological drought
Period of abnormally dry weather sufficiently prolonged to give rise to a shortage of water as evidenced by below normal streamflow and lake levels and/or the depletion of soil moisture and a lowering of groundwater levels. *(source: International Glossary of Hydrology, WMO/UNESCO, 2011 and International Glossary of Hydrology, WMO/UNESCO, WMO-No. 385, 2012 and Technical Regulations, Volume III: Hydrology, WMO-No. 49)*

Meteorological drought
Prolonged absence or marked deficiency of precipitation. *(source: International Glossary of Hydrology, WMO/UNESCO, 2011; Guide to Agricultural Meteorological Practices, WMO-No. 134 and International Glossary of Hydrology, WMO/UNESCO, WMO-No. 385, 2012)*

III. Water

Coastal flood
Storm surges and high winds coinciding with high tides are the most frequent cause of this type of flooding. The surge itself is the result of the raising of sea levels due to low atmospheric pressure. In particular configurations, such as major estuaries or confined sea areas, the piling up of water is amplified by a combination of the shallowing of the seabed and retarding of return flow. Major deltas such as the Mississippi and Ganges are prone to this type of flooding when affected by hurricanes (cyclones). Another sensitive area is the southern North Sea in western Europe as a result of particular tracks of winter depressions. If the surge

takes place near the mouth of a river issuing into the sea, the river flow will be obstructed due to the surge, resulting in severe flooding over and near the coastal areas. Tsunamis resulting from sub-seabed earthquakes are a very specific cause of occasionally severe coastal flooding. *(source: Manual on flood forecasting and warning, WMO-No. 1072)*

Estuarine flood
Estuaries are inlet areas of the coastline where the coastal tide meets a concentrated seaward flow of fresh water in a river. The interaction between the seaward flow of river water and landward flow of saline water during high tides may cause a build-up of water or inland-moving tidal bore. Frequently, the funnel shape characteristic of many estuaries causes an increase in high water levels in the upper, narrowing reaches of the associated river. These types of floods are mostly experienced in deltaic areas of rivers along the coasts, for example the Mouths of the Ganges. They are more frequent and less severe in terms of inundated depth and area than flooding caused by storm surges. *(source: Manual on flood forecasting and warning, WMO-No. 1072)*

Flash flood
Flood of short duration with a relatively high peak discharge in which the time interval between the observable causative event and the flood is less than four to six hours. *(source: Technical Regulations, Volume III: Hydrology, WMO-No. 49)*

Flood
(1) Rise, usually brief, in the water level of a stream or water body to a peak from which the water level recedes at a slower rate.
(2) Relatively high flow as measured by stage height or discharge.
(3) Rising tide. *(source: International Glossary of Hydrology, WMO/UNESCO, WMO-No. 385, 2012)*

Flooding
The effects of a flood as distinct from the flood itself, is defined as: Overflowing by water of the normal confines of a stream or other body of water, or accumulation of water by drainage over areas that are not normally submerged. *(source: Manual on flood forecasting and warning, WMO-No. 1072)*

Fluvial (riverine) flood
Fluvial flooding occurs over a wide range of river and catchment systems. Floods in river valleys occur mostly on flood plains or wash lands as a result of flow exceeding the capacity of the stream channels and spilling over the natural banks or artificial embankments. Flash floods are often more damaging, occurring in narrow, steep and confined valleys, characterized as the name implies by the rapidity of formation following rainfall and high flow velocities. The rapidity makes them particularly dangerous to human life. *(source: Manual on flood forecasting and warning, WMO-No. 1072)*

Ice and debris-jam flood
In areas that experience seasonal melting, if this is rapid ice floes can accumulate in rivers, forming constrictions and damming flows, causing river levels to rise upstream of the ice jam. A sudden release of the "ice jam" can cause a flood wave similar to that caused by a dam break to move downstream. Both meltwater and heavy rainfall in steep areas can cause landslips and debris flows. As these move downstream, major constrictions can build up. When these collapse or are breached, severe flooding can result. Both of these phenomena are very difficult to predict. *(source: Manual on flood forecasting and warning, WMO No. 1072)*

Landslide/Mudslide
A mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated; the rapid movement of a mass of soil, rock or debris down a slope. *(source: IPCC 4th Assessment Report, WG 2 Glossary)*

Mudflow
Flow of water so heavily charged with sediment and debris that the flowing mass is thick and viscous. *(source: International Glossary of Hydrology, WMO/UNESCO, 2011)*

Multiple event flood
These result from heavy rainfall associated with successive weather disturbances following closely after each other. On the largest scale, these include for example floods in the Indo-Gangetic plains and central Indian regions often caused by the passage of a series of low-pressure areas or depressions from the Bay of Bengal, more or less along the same path. Multiple event floods can also affect large basins in mid-latitude areas in winter, when sequences of active depressions occur, for example over Western Europe. *(source: Manual on flood forecasting and warning, WMO No. 1072)*

Seasonal flood
These are floods that occur with general regularity as a result of major seasonal rainfall activity. The areas of the world subject to a monsoonal type climate are typically the areas most affected and critical situations arise when "normal" flooding is replaced by extended or high-runoff floods. Flooding is frequently a basin-wide situation that can last for periods of several weeks. Within active monsoon conditions, a number of individual peak events can occur during a flood season. Seasonal floods can also result from high water levels in lakes in the upper reaches of a river basin, for example Lake Victoria and the River Nile. Another type of seasonal flood can result from wet conditions in an upper portion of a catchment, which experiences a different climate regime from the lower, affected areas. The Nile and Yangtze rivers are good examples. *(source: Manual on flood forecasting and warning, WMO No. 1072)*

Single event flood
This is the most common type of flooding, in which widespread heavy rains lasting several hours to a few days over a drainage basin results in severe floods. Typically, these heavy rains are associated with cyclonic disturbances, mid-latitude depressions and storms, with well-marked synoptic scale frontal systems. *(source: Manual on flood forecasting and warning, WMO No. 1072)*

Snowmelt flood
Significant flood rise in a river caused by the melting of snowpack accumulated during the winter. *(source: International Glossary of Hydrology, WMO/UNESCO, 2011 and International Glossary of Hydrology, WMO/UNESCO, WMO-No. 385, 2012)*

IV. Other related environmental phenomena

Dust storm
Particles of dust energetically lifted by a strong and turbulent wind. Dust storms are usually associated with hot, dry and windy conditions, especially just ahead of vigorous cold fronts that can be cloud free. Dust particles typically have a diameter of less than 0.08 mm and consequently can be lifted to far greater heights than sand. *(source: Aerodrome Reports and Forecasts, A Users' Handbook to the Codes, WMO-No. 782)*

Sand haze
Haze caused by the suspension in the atmosphere of small sand or dust particles, raised from the ground prior to the time of observation by a sandstorm or duststorm.
(source: International Meteorological Vocabulary, WMO-No. 182)

Sand storm
An ensemble of particles of sand energetically lifted by a strong and turbulent wind. The forward portion of the sandstorm may have the appearance of a wide and high wall. The height to which sand is raised will increase with increasing wind speed and instability
(source: Aerodrome Reports and Forecasts, A Users' Handbook to the Codes, WMO-No. 782)

Sand storm/Dust storm
An ensemble of particles of sand energetically lifted to great heights by a strong and turbulent wind. *(source: Manual on marine meteorological services, WMO-No. 558, App. 1.2 and Manual on the Observation of Clouds and other Meteors, WMO-No. 407)*

Acid rain
Rain which in the course of its history has combined with chemical elements or pollutants in the atmosphere and reaches the Earth's surface as a weak acid solution. *(source: International Glossary of Hydrology, WMO/UNESCO, 2011)*

Black carbon
Operationally defined aerosol species based on measurement of light absorption and chemical reactivity and/or thermal stability; consists of soot, charcoal and/or possible light-absorbing refractory organic matter. *(source: IPCC 4th Assessment Report, WG 1 Glossary)*

Meteoterm definition: Operationally defined aerosol species based on measurement of light absorption and chemical reactivity and/or thermal stability. It is sometimes referred to as soot. *(source: IPCC 5th Assessment Report, WG 1 Glossary)*

Brown clouds
Elevated black carbon concentrations in areas with high solar radiation are a major contributor to the so-called brown clouds covering large regions, for instance in Asia. Brown clouds have led to dimming of the Earth's surface, warming of the atmosphere and perturbation of the hydrological cycle, possibly affecting the monsoon. *(source: The carbonaceous aerosol – a remaining challenge, WMO Bulletin, Volume 58(1) – January 2009)*

Pollen pollution episodes
No WMO definition

Polluted air
Air containing dust, smoke, micro-organisms or gases different from those which normally compose it. *(source: International Meteorological Vocabulary, WMO-No. 182)*

V. Marine

Storm surges
disturbance and the level which would have occurred in the absence of the meteorological disturbance. *(source: Technical Regulations, Volume III: Hydrology, WMO No. 49)*

Tsunami
A rapidly moving and often large seawave generated by submarine earthquakes, landslides or volcanic activity. *(source: Manual on marine meteorological services, WMO-No. 558, App. 1.2)*

VI. Space weather

Note: Hazardous space weather situations can result of eruptive solar events consisting of Solar Flares and Erupting Prominences, Coronal Mass Ejections, associated streams of charged particles and high-speed particle streams from Coronal Holes. These eruptions are driving geomagnetic storms, ionospheric storms, and radiation storms in near-Earth space, with hazardous impacts.

Coronal mass ejections
A Coronal Mass Ejection is literally an eruption of a huge volume of the solar outer atmosphere, the Corona, which blows into space billions of tons of plasma. When propagating towards the Earth, CMEs perturb the Earth's magnetic field, causing the strongest magnetic storms. CMEs may take hours to fully erupt from the Sun. A typical travel time for a CME from the Sun to

Earth may range from less than 1 day, to more than 4 days. *(source: Space Weather Effects in Regard to International Air Navigation, ICAO and review of experts)*

Geomagnetic storms
Geomagnetic storms, which are caused primarily by CMEs or by high-speed particle streams interacting with the magnetosphere, are strong temporary disturbances of the Earth's magnetic field. Geomagnetic storms can last several hours. They may cause major damage to power grids through geomagnetically induced currents (GIC). Geomagnetic storms and disturbances are highly variable in space and time.

Different indices are used to describe geomagnetic storm activity. The planetary three-hour range Kp index, provided by the Helmholtz Centre, Potsdam (http://www.gfz-potsdam.de/en/section/earths-magnetic-field/data-products-services/kp-index/) is often used as an approximation for the geomagnetic activity caused by solar particle radiation. Other indices include for instance the A index, Disturbance Storm Time (Dst), the Auroral Electrojet (AE) or the delta-B index. *(source: The potential role of WMO in space weather, WMO/TD-No. 1482 and Space Weather Effects in Regard to International Air Navigation, ICAO and review of experts)*

Ionospheric storms
Turbulence in the F region of the ionosphere, usually due to a sudden burst of radiation from the Sun. *(source: International Meteorological Vocabulary, WMO - No. 182)*

Alternative definition: Geomagnetic storms are often associated with ionospheric storms which are characterized by enhanced electron currents in the ionosphere, turbulence and wave activity in the ionospheric plasma. The clustering of the electrons leads to scintillation and attenuation of radio signals. This is particularly problematic for GNSS signals which can result in positioning errors or loss of signal lock. Like geomagnetic storms, ionospheric storms are highly variable in space and time. *(source: The potential role of WMO in space weather, WMO/TD-No. 1482 and Space Weather Effects in Regard to International Air Navigation, ICAO and review of experts)*

Radio blackout
X-ray and EUV bursts from a solar flare cause an ionization, increasing the number of free electrons, in the atmosphere below 90 km on the sunlit side of the Earth. The enhanced electron density increases the amount of radio energy lost as radio waves pass through this region. During a large flare event the amount of radio energy lost is sufficient to make the return signal from the ionosphere too small to be useful with normal radio receivers. The net effect of this process is the radio blackout – no signal – for HF transmissions. Radio blackouts primarily affect HF (3-30 MHz) although detrimental effects may spill over to VHF (30-300 MHz) and beyond in fading and diminished ability for reception. *(source: The potential role of WMO in space weather, WMO/TD-No. 1482 and Space Weather Effects in Regard to International Air Navigation, ICAO and review of experts)*

Solar energetic particles
A Solar Energetic Particles event (SEP) is a sudden release of particles (protons, electrons and heavy ions) with energy ranging from a few tens of keV to GeV. These events are generally associated with Solar Flares or Coronal Mass Ejections.

High-speed particle streams, in particular electrons, are also emitted by Coronal Holes, which are persistent large-scale features of the solar corona that appear dark in EUV and X-ray images. *(source: The potential role of WMO in space weather, WMO/TD-No. 1482 and Space Weather Effects in Regard to International Air Navigation, ICAO and review of experts)*

Solar flares
Bright eruption from the Sun's chromosphere. Solar flares are classified in terms of the area of chromosphere affected, the duration of the phenomenon, and the width of the Hα line of hydrogen, on a scale ranging from 1- (minor eruption) to 3+ (very large eruption).
(source: International Meteorological Vocabulary, WMO-No. 182)

Solar radiation storm
Solar radiation storms occur when large quantities of charged particles, primarily protons, accelerated by eruptive processes at or near the Sun are reaching the near-Earth environment.

The Earth's magnetic field and atmosphere generally protect from this particle radiation, but that shielding depends on latitude, magnetic field strength and direction. In the Polar Regions the magnetic field lines intersecting the Earth's surface allow the particles to penetrate into the atmosphere. Solar radiation storms thus often take the form of Polar Cap Events (PCA), which occur in limited areas around geomagnetic poles; they may last more than a week.

A factor of criticality of a radiation storm is the energy spectrum of the solar protons. High-energy protons cause single event upsets in spacecraft or aircraft electronics and increase the harmful radiation dose of exposed human beings, e.g. in manned spaceflights or cross-polar aircraft flights. Lower energy protons have a severe impact on the polar ionosphere and affect HF propagation at high latitude. The severity of radiation storms can thus be characterized by the flux of charged particles (typically in 5-minute average) above a given energy threshold such as 10 or 100 MeV. For example the NOAA scale characterizes a radiation storm as extreme when the 5-min flux above 10 MeV exceeds 10^5 particles$\cdot s^{-1}\cdot sr^{-1}\cdot cm^{-2}$. In large magnitude solar eruptions, high-energy events may last only a few hours while low-energy events may last up to one week. *(source: The potential role of WMO in space weather, WMO/TD-No. 1482 and Space Weather Effects in Regard to International Air Navigation, ICAO and review of experts)*
