



EU-CIRCLE

A pan-European framework
for strengthening Critical
Infrastructure resilience to
climate change

D1.1 EU-CIRCLE Taxonomy

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Statement

EU-CIRCLE glossary and taxonomy of most common phrases with selected practical illustrations.

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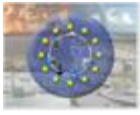


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Executive Summary

This is the EU-CIRCLE project Taxonomy. This Taxonomy is structured as follows:

- Chapter 1: Introduction
- Chapter 2: Glossary structure
- Chapter 3: Critical Infrastructure Terminology
- Chapter 4: Climate Change Terminology
- Chapter 5: Resilience Terminology
- Chapter 6: EU-CIRCLE Taxonomy
- Chapter 7: Bibliography

EU-CIRCLE 's D1.1 has a dual aim :

1. to provide “the common EU-CIRCLE language” where members of the consortium with diverse background have the same understanding of terms and concepts, thus serving as a reference material in all Deliverables
2. provide a taxonomy of the main concepts, elements and definitions that will be used in the project.

The Glossary including the state of the art of the project subject methodology presented in Chapters 3-5 is completed. The EU-CIRCLE Taxonomy presented in Chapter 6 is based upon the classification of terms in accordance with best practices in each sector, as the consortium had to provide with in an effective and simple to use methodology that in a single way covered :

- the plethora of different types of CI
- the large number of climate hazards
- many conspets related to resilience, risk assessment, climate change adaptation, mitigation etc
- terms have been categorised in accordance with best practices and

The detailed definitions of notions presented in Chapter 6 are often given together with short illustrations/interpretations of their meanings and their expected practical usage in the project activity in order to better understanding and to signalize slightly the expected approaches in the project research. Thus, the EU-CIRCLE Taxonomy presented in Chapter 6 is a bit more than a pure taxonomy, what is practically important and justified at this very early stage of the project.

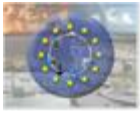


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1 Introduction

To ensure compatibility in the usage and communication of key terms across the work packages of EU-CIRCLE project the common “working terminology” should be fixed at the first steps of the project activity. It is recognized that many of the terms needed for the EU-CIRCLE project are used in different and sometimes conflicting ways across disciplines and approaches. Thus, it is proved important for the purposes of the EU-CIRCLE project that a standard set of definitions should be fixed to support a shared understanding of the foci of the project and be thus applied by all members. Therefore, the definitions should be formulated to reflect the work of EU-CIRCLE programme, however they should also be regarded as “living” definitions, which evolved as the research progressed, with new findings emerging. The preliminary approach to this task is presented in this report.

The first and most important term for the EU-CIRCLE project is the notion of the Critical Infrastructure. To follow the European Commission approach, the Critical Infrastructure (CI) is an asset or system which is essential for the maintenance of vital societal functions. The damage to a critical infrastructure, its destruction or disruption by natural disasters, terrorism, criminal activity or malicious behaviour, may have a significant negative impact for the security of the EU and the well-being of its citizens.

Reducing the vulnerabilities of critical infrastructure and increasing their resilience is one of the major objectives of the EU. An adequate level of protection must be ensured and the detrimental effects of disruptions on the society and citizens must be limited as far as possible.

The European Programme for Critical Infrastructure Protection (EPCIP) sets the overall framework for activities aimed at improving the protection of critical infrastructure in Europe - across all EU States and in all relevant sectors of economic activity. The threats to which the programme aims to respond are not only confined to terrorism, but also include criminal activities, natural disasters and other causes of accidents. In short, it seeks to provide an all-hazards cross-sectorial approach. The EPCIP is supported by regular exchanges of information between EU States in the frame of the CIP Contact Points meetings.

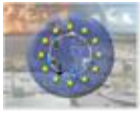
A key pillar of this programme is the 2008 Directive on European Critical Infrastructures. It establishes a procedure for identifying and designating European Critical Infrastructures (ECI) and a common approach for assessing the need to improve their protection. The Directive has a sectorial scope, applying only to the energy and transport sectors. The Directive also requires owners/operators of designated ECI to prepare Operator Security Plans (advanced business continuity plans) and nominate Security Liaison Officers (linking the owner/operator with the national authority responsible for critical infrastructure protection).

The critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy. Most commonly associated with the term of critical infrastructure are facilities for:

- electricity generation, transmission and distribution;
- gas production, transport and distribution;
- oil and oil products production, transport and distribution;
- telecommunication;
- water supply (drinking water, waste water/sewage, stemming of surface water (e.g. dikes and sluices));
- agriculture, food production and distribution;
- heating (e.g. natural gas, fuel oil, district heating);
- public health (hospitals, ambulances);
- transportation systems (fuel supply, railway network, airports, harbours, inland shipping);
- financial services (banking, clearing);
- security services (police, military).

Regional critical infrastructure protection (CIP) programmes in EU, in the EU-CIRCLE partners’ countries and in USA are as follows:

- European Union



The European Programme for Critical Infrastructure Protection (EPCIP) has been laid out in EU Directives by the Commission (e.g., EU COM(2006) 786 final). It has proposed a list of European critical infrastructures based upon inputs by its Member States. The European Commission's "Green Paper " on EPCIP specifies 11 infrastructures as being critical:

1. Energy
2. Information and communication technology (ICT)
3. Water
4. Food
5. Health
6. Financial
7. Public and legal order and safety
8. Civil administration
9. Transportation
10. Chemical and nuclear industry
11. Space and research.

Each designated ECI will have to have an Operator Security Plan (OSP) covering the identification of important assets, a risk analysis based on major threat scenarios and the vulnerability of each asset, and the identification, selection and prioritisation of counter-measures and procedures.

- Croatia

CIP is based on a regulation "National Law on Critical Infrastructure", NN56/2013

http://narodne-novine.nn.hr/clanci/sluzbeni/2013_05_56_1134.html .

Sectors of economy were determined from which the central government bodies identify individual national critical infrastructure, in order to ensure comprehensive action to protect and reduce the negative effects in case of compromising critical infrastructures, due to their importance to the overall functioning of the country and the protection of critical infrastructure at national level (e.g. energy, communication and information technology, transport etc.)

<https://vlada.gov.hr/UserDocsImages//Sjednice/Arhiva//111.%20-%207.pdf>

- Cyprus

In Cyprus protection of critical infrastructure lies with the Minister of Interior and is governed according to Ministerial Decree KDP 15/2012 'On the Identification and Designation of European Critical Infrastructure and Assessment of the Need to improve its Protection Regulations of 2012'. The Ministry of Interior is assisted in the protection of Critical Infrastructure by the Civil Protection Authority. The Civil Protection Authority is responsible, in cooperation with any other relevant Government Departments and Agencies, for the identification and designation of critical infrastructure. The Civil Protection Authority is also responsible for ensuring that operator security plans are in place, and that these plans are adequate.

- France

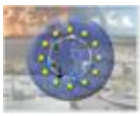
In France, the secretary-general of national defense (SGDN) <http://www.sgdn.gouv.fr/>, a secretary attached to the Prime Minister's Office, bears complete responsibility for organizing CIP.

Furthermore, within the Ministry of Defense, the key organizations responsible for CIP / CIIP are the Central Directorate for Information Systems Security (DCSSI)

http://www.gsit.fr/glossaire/en/Central_Directorate_for_Information_Systems_Security_French_Security_of_Information_Systems_Directorate_DCSSI.htm, the Inter-Ministerial Commission for the Security of Information Systems (CISSI), and the Advisory Office, whereas the Central Office for the Fight Against Hi-Tech Crime plays a leading role within the Ministry of the Interior. [Wenger et al, 2008/2009]

- Germany

The German critical-infrastructure protection programme is coordinated by the Federal Ministry of the Interior. Some of its special agencies like the German Federal Office for Information Security or the Federal Office of Civil Protection and Disaster Assistance BBK deliver the respective content, e.g., about IT systems. The German critical-infrastructure protection programme is coordinated by the Federal Ministry of the Interior. Some of its special agencies like the German Federal Office for Information Security or the Federal Office of Civil Protection and Disaster Assistance BBK deliver the respective content, e.g., about IT systems.



Overall responsibility for, and coordination of, major CIP- and CIIP-related activities rests with the Federal Ministry of the Interior (BMI), together with several of its subordinated agencies, such as the Federal Office for Information Security (BSI) https://www.bsi.bund.de/EN/Home/home_node.html, the Federal Office of Civil Protection and Disaster Assistance (BBK) http://www.bbk.bund.de/EN/Home/home_node.html, the Federal Criminal Police Agency (BKA) <http://www.bka.de>, and the Federal Police (BPOL) http://www.bundespolizei.de/cln_049/DE/Home/home_node.html?nnn=true. For coordination within the ministry and the subordinated agencies, a task force for critical infrastructure protection (AG KRITIS) was established at the BMI in 2002. Strategy development and implementation are also coordinated with other federal ministries, especially the Federal Ministry of Economics and Technology <http://www.bmwi.de/EN/root.html>, the Federal Chancellery http://www.bundestkanzlerin.de/Webs/BKin/DE/Startseite/startseite_node.html, the Federal Ministry of Justice, the Federal Ministry of Foreign Affairs, the Federal Ministry of Defense, and other relevant agencies, such as the Federal Network Agency http://www.bundesnetzagentur.de/cln_1412/EN/General/Bundesnetzagentur/Bundesnetzagentur_node.html. Furthermore, strategic partners from the private sector are consulted. [Wenger et al, 2008/2009]

- Greece

The Greece critical-infrastructure protection programme is coordinated by the KEMEA <http://www.kemea.gr/index.php/en/about-kemea>. KEMEA is supervised by the Minister of Public Order and Citizen Protection and it is a scientific, consulting and research agency, whose purpose is to conduct theoretical and applied research and to perform studies, particularly at the strategic level, on security policies. In 2011, KEMEA was appointed by Presidential Decree No39 (06.05.2011), as the “National Contact Point” for the protection of European Critical infrastructures (ECIs) - “ECIP contact point” – following the implementation of the 2008/114/EC Directive of the European Council of December 8th 2008 “regarding the definition and designation of the European Critical infrastructures and the assessment of the need to improve the protection of such infrastructures”.

- Italy

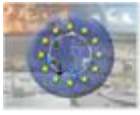
The main Italian government bodies dealing with CIIP are the Ministry of the Interior (Postal and Communications Police) and the Ministry of Innovation and Technologies. The Ministry of Communication is also involved in various activities to improve the security of information and communication networks. In order to improve CIIP at all levels, the public agencies also collaborate closely with the private sector. The most important Public-Private Partnership in the field of CIP is the Association of Italian Experts for Critical Infrastructures (Associazione Italiana Esperti in Infrastrutture Critiche, AIIC) http://www.infrastrutturecritiche.it/aiic/index.php?option=com_content&view=article&id=219&Itemid=125, an expert group of practitioners from both the public and the private sectors. [Wenger et al, 2008/2009]

- Norway

In Norway, the ministry or authority that has responsibility for an area during peacetime or non-crisis times also has responsibility during times of crisis and war. This system also applies to CIIP. The coordinating authority on the civilian side is the Ministry of Justice and Police. The overall authority for ICT security is the Ministry of Government Administration and Reform, which took over this task from the Ministry of Trade and Industry, while the Ministry of Defense is responsible on the military side. The Ministry of Transport and Communications has responsibility for the communication sector in Norway, including all related security issues. The directorates and authorities that are responsible for handling the various aspects of CIIP on behalf of the ministries are answerable to the respective ministries. [Wenger et al, 2008/2009]

- Poland

The Poland critical infrastructure protection programme is coordinated by the Poland’s Government Centre for Security <http://rcb.gov.pl/eng/> and is presented in “Critical Infrastructure Protection in the Polish Crisis Management Framework”, Summer Safety and Reliability Seminars – SSARS 2015, Gdańsk/Sopot, June 21-27th 2015. <http://ssars.am.gdynia.pl>, see (EU-CIRCLE, Dissemination, SSARS 2015) at: <https://eucircle.ipita.demokritos.gr/owncloud/>
The Government Centre for Security established the following 11 critical infrastructures (systems):



1. Energy, fuel and energy resources supply system
2. Communication system
3. Tele-information network system
4. Financial system
5. Food supply system
6. Water supply system
7. Health protection system
8. Transportation System
9. Rescue system
10. System ensuring the continuity of public administration activities
11. System of production, storing and use of chemical and radioactive substances, including pipelines for dangerous substances.

Within the Polish government, two ministries have responsibilities that impinge upon the country's information infrastructures and their protection – the Ministry of Science and Higher Education <http://www.nauka.gov.pl/en/> and the Ministry of the Interior <https://www.msw.gov.pl/en>. As a public-private partnership, the Polish Competence Center for eGov and eEdu strives to provide a platform to bring together the public sector and the IT companies. [Wenger et al, 2008/2009]

- United Kingdom

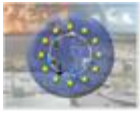
In the UK, the Centre for the Protection of National Infrastructure provides information, personnel and physical security advice to the businesses and organisations which make up the UK's national infrastructure, helping to reduce its vulnerability to terrorism and other threats. See: Category: Disaster preparedness in the United Kingdom. It can call on resources from other government departments and agencies, including MI5, the Communications-Electronics Security Group and other Government departments responsible for national infrastructure sectors.

- United States

The National Infrastructure Protection Plan (NIPP) defines critical infrastructure sector in the US. Presidential Policy Directive 21 (PPD-21), issued in February, 2013 entitled Critical Infrastructure Security and Resilience mandated an update to the NIPP. This revision of the plan established the following 16 critical infrastructure sectors:

1. Chemical
2. Commercial Facilities
3. Communications
4. Critical Manufacturing
5. Dams
6. Defence Industrial Base
7. Emergency Services
8. Energy
9. Financial Services
10. Food and Agriculture
11. Government Facilities
12. Healthcare and Public Health
13. Information Technology
14. Nuclear Reactors, Materials, and Waste
15. Transportation Systems
16. Water and Wastewater Systems.

The above presented approaches to Critical Infrastructures analysis and protection are strictly convergent with the approach of the EU-CIRCLE project to the European Critical Infrastructures resilience to climate change and are taken into account in preparing in Chapters 3-5 the terminology state of the art in the form of the Glossary. The Glossary is composed of all recognized by EU-CIRCLE project participants terms and definitions concerned with the methodology including the notions and the contexts of the Critical



Infrastructure and its Safety, the Climate Change and the Resilience used in other previous and current projects and in available literature as well.

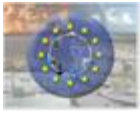
The spectrum of the terms concerned with those three main notions of the EU-CIRCLE project in the form of the state of the art is sufficiently wide and exhaustive in depth. Lot of terms included in the Glossary are defined in different and sometimes conflicting ways across disciplines and approaches. Some of them are simply incorrect. The **main fault** in defining some of the terms in the Glossary is **mixing the meaning of the defined notion with the values of its parameters it is characterized by**.

Having in mind this terminology state of the art and considering its imperfection and faults, the preliminary EU-CIRCLE Taxonomy is proposed in Chapter 6.

The main principles in preparation of this preliminary taxonomy, at the first steps of the EU-CIRCLE project activity, are:

- To differ between the notion and the values of the parameters it is defined by;
- To illustrate shortly the notion and its parameters with their future use in the project in order to better understanding the proposed terms by all project participants;
- To use the defined notions' order consistent with the subsequent steps of the project activity instead of alphabetical order, and leaving the latter arrangement to the last steps of project activity.

The report is completed with the Bibliography including the names of projects and the literature devoted to the problems convergent with the subject of the EU-CIRCLE project.



2 Glossary Structure

The Glossary is composed of three chapters concerned with the notions that can be met in the project:

- Chapter 3. Critical Infrastructure Terminology,
- Chapter 4. Climate Change Terminology,
- Chapter 5. Resilience Terminology,

each of them organised in several sections.

In the Glossary each chapter, the first section is including the definitions of General Terms typical for the subject defined by the main notion the chapter is concerned with. The subsequent sections of each chapter are concerned with and include definitions of detailed notions used in the “sectorial” subjects appropriate for the subject defined by the main notion the chapter is concerned with.

The terms, together with their definitions, in the Glossary all sections are listed in the alphabetical order.

The Glossary is completed with:

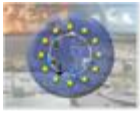
- Chapter 6. EU-CIRCLE Taxonomy,

organized in 14 sections.

The first section includes definition of General Terms that are concerned with the project general subjects formulated in its Title and Summary and in its Workpackages and are going to be used in the project. The remaining, subsequent sections contain definitions of more detailed notions that are going to be used in the project activity. Those detailed definitions are often given together with short illustrations of their meanings and their expected practical usage in the project activity. To the better coincidence, better understanding and better use of the project notions, in the first general section and in the remaining detailed sections as well, the included in them notions together with their definitions and their illustrations are arranged according to the subsequent steps of the project activity instead of the alphabetical order. The alphabetical arrangement of the EU-CIRCLE project terminology will be prepared just before the end of the project activity in one of its final reports.

The proposed preliminary EU-CIRCLE Taxonomy is based on the following key tasks of the future project research activity:

- To understand the behaviour of critical infrastructure dependencies over time; what involves the modification of infrastructure inside and outside dependences as its operation is changing [Lauge et al, 2015], including changing its structure and its components and subsystems safety parameters [Blokus-Roszkowska, Kołowrocki, 2015], [Kołowrocki, 2015], [Kołowrocki, Soszyńska-Budny, 2011],
- To use the information collected in the survey to group critical infrastructures into clusters/networks according to their dependence and/or influence in order to identify their common characteristics [Lague et al, 2015],
- To involve developing a dynamic system model [Lauge et al, 2015], including critical infrastructure ageing/degradation in time [Kołowrocki, 2015], [Kołowrocki, Soszyńska-Budny, 2011] for expressing and simulating [Kołowrocki et al, 2015 b, c, e] critical infrastructure dependence and influence; what enables operators to examine a variety of hypothetical scenarios, focusing on the temporal aspects of critical infrastructure and the consequent effects and provide deep insides into the behaviour of the complex system/network of critical infrastructures, contributing to the design and implementation of robust critical infrastructure protection, strengthening and recovery strategies.



3 Critical Infrastructure Terminology

3.1 General Terms

Contact point. Central body of state administration which carries out communication activities on behalf of the state towards the competent authorities of the European Union and other states in order to exchange information on critical infrastructures and implement activities determined in their protection and ensuring their continuous operation. [Croatian Law on critical infrastructures]

Crisis. A breakdown of familiar symbolic frameworks that legitimises the pre-existing socio-political order. [Boin, 2007], [Hart, 1993]

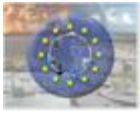
Crisis (emergency situations). Any occurrence that can massively endanger lives and health of people, their property and the environment, in war and in peace. [Bozic, 2014]

Crisis management. Crisis management is the process by which an organisation deals with a major event that threatens to harm the organisation, its stakeholders, or the general public. [Klaver et al, 2011]

Critical facilities are the primary physical structures, technical facilities and systems which are socially, economically or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency. Comment: Critical facilities are elements of the infrastructure that support essential services in a society. They include such things as transport systems, air and sea ports, electricity, water and communications systems, hospitals and health clinics, and centres for fire, police and public administration services. [UNISDR, 2009]

Critical infrastructure.

1. Systems and mutually bound functional objects contained therein, including constructions, facilities, installations and services of key importance for the security of the state and its citizens, as well as serving to ensure efficient functioning of public administration authorities, institutions and enterprises. [PGCS, 2007]
2. An asset, system or part thereof located in member states that is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact on a member state as a result of the failure to maintain those functions. [ECD, 2008],[Hammerli, Renda, 2010]
3. Critical infrastructures are those physical and information technology facilities, networks, services and assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of citizens or the effective functioning of governments in European Union (EU) countries. [EUR-Lex]
4. the assets, systems, and networks, whether physical or virtual, so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof. [U.S Department of Homeland Security].
5. Service, facility or a group of services or facilities, the loss of which will have severe adverse effects on the physical, social, economic or environmental well-being or safety of the community. [Emergency Management Australia, 2003], [Theoharidou et al, 2009]
6. Activities, networks, services and goods of tangible and information technologies, whose failure or destruction would significantly impact the health and safety of citizens or the efficient functioning of state administration. [Croatian Law on private security]
7. Physical facilities, supply chains, information technologies and communication networks which, if destroyed, degraded or rendered unavailable for an extended period, would significantly impact on



- the social or economic wellbeing of the nation or affect ability to conduct national defence and ensure national security. [Australian Government, 2010]
8. Those facilities, systems, or functions, whose incapacity or destruction would cause a debilitating impact on national security, governance, economy and social well-being of a nation. [Muktesh]
 9. Critical infrastructure, also referred to as nationally significant infrastructure, can be broadly defined as the systems, assets, facilities and networks that provide essential services and are necessary for the national security, economic security, prosperity, and health and safety of their respective nations. [Critical Five]
 10. Facilities, systems, sites and networks necessary for the functioning of the country and the delivery of essential services upon which daily life depends. [UK Centre for the Protection of National Infrastructure, 2011]
 11. Systems, networks and facilities of national importance, whose disruption or interruption of goods or service delivery could have serious consequences for national security, human health and life, assets and the environment, security and economic stability and the continuous functioning of the government. [Croatian Law on critical infrastructures]
 12. The National Strategy also adopts the definition of “critical infrastructure” in P.L. 107-56, and provides the following list of specific infrastructure sectors (and its assets) falling under that definition: information technology, telecommunications, chemical and petroleum-chemical, transportation systems, emergency services (includes first responder services), postal and shipping services, agriculture and food (include preparation, delivery and retail), public health and welfare, drinking water/water treatment, energy (both generation as well as transmission), banking and finance, national monuments and icons, defence industrial base, key industry / technology sites, large gathering sites (schools, public buildings), critical manufacturing. [INFRACRITICAL]
 13. Infrastructure which is considered vital or indispensable to society, the economy, public health or the environment, and where the failure or destruction would have large impact. This would include emergency services such as hospitals, communications, electricity sub-stations, water treatment works, transport infrastructure and reservoirs. [DEFRA, 2010]

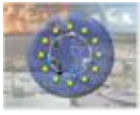
Critical Infrastructure community. Critical infrastructure owners and operators, both public and private; departments and agencies; regional entities; governments; and other organizations from the private and non-profit sectors with a role in securing and strengthening the resilience of the Nation’s critical infrastructure and/or promoting practices and ideas for doing so. [US Homeland Security, 2013]

Critical infrastructure owners and operators. Those entities responsible for day-to-day operation and investment of a particular critical infrastructure entity. [US Homeland Security, 2013]

Critical infrastructure risk management framework. A planning and decision-making framework that outlines the process for setting goals and objectives, identifying infrastructure, assessing risks, implementing risk management activities, and measuring effectiveness to inform continuous improvement in critical infrastructure security and resilience. [2013 NIPP]

Critical infrastructure security. The end goal of security is to use physical, personnel and/or cyber defence measures to reduce both the risk to critical infrastructure and the risk of loss due to a disruption in essential services by minimizing the vulnerability of critical infrastructure assets, systems and networks. [Critical Five]

Critical national infrastructure. The UK’s national infrastructure is defined as “those facilities, systems, sites and networks necessary for the functioning of the country and the delivery of the essential services upon which daily life in the UK depends”. The sectors that are considered to deliver essential services are, communications, energy , finance , food, government, emergency services, health, transport and water. The critical elements of national infrastructure where the loss or compromise of which would have a major



impact on the availability or integrity of essential services leading to severe economic or social consequences or to loss of life in the UK would make up the critical national infrastructure”. [CPNI, 2010]

Criticality. (1) Level of contribution of an infrastructure to society in maintaining a minimum level of national and international law and order, public safety, economy, public health and environment, or (2) Impact level to citizens or to the government from the loss or disruption of the infrastructure. [Palmer, Sheno, 2009], [Theoharidou et al, 2009]

Criticality analysis. Process of assessing the criticality level of an infrastructure. It is a special-purpose, society-centric risk analysis process that attempts to protect infrastructures that are vital to society. Criticality analysis mainly considers the societal impacts instead of the organizational impacts. The scope of the analysis is extended to cover interdependent infrastructures and, thus, possible threats and vulnerabilities. Criticality analysis is performed on large-scale CIs that provide services to large numbers of users/citizens and, thus, it usually involves higher impact scales. [Palmer C, Sheno, 2009], [Theoharidou et al, 2009]

Cross-sectoral criteria. They denote the set of general criteria used to assess risk for individual systems and networks of critical infrastructures in all sectors. [Croatian Law on critical infrastructures]

Dependency. The one-directional reliance of an asset, system, network, or collection thereof—within or across sectors—on an input, interaction, or other requirement from other sources in order to function properly. [US Homeland Security, 2013]

Dependency of CI. A dependency is a linkage or connection between two infrastructures, through which the state of one infrastructure influences or is correlated to the state of the other. [Croatian Methodology for the operational risk analysis of critical infrastructure], [Klaver et al, 2011], [Rinaldi, et al, 2001]

Dependent critical infrastructures. A dependent infrastructure is one that relies on another infrastructure (but not vice versa). [Hammerli, Renda, 2010]

Destruction. A condition when the ability of a critical infrastructure to provide its customers an expected upon level of products and services is negated. Typically a permanent condition. An infrastructure is considered destroyed when its level of performance is zero. [US President’s Commission on Critical Infrastructure Protection, 1997]

Emergencies. Unforeseen but predictable, narrow scope incidents that regularly occur. [Boin, 2007], [Perry, Lindell, 2006]

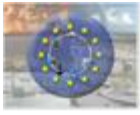
Emergency services. A critical infrastructure characterized by medical, police, fire, and rescue systems and personnel that are called upon when an individual or community is responding to emergencies. These services are typically provided at the local level (county or metropolitan area). [US President’s Commission on Critical Infrastructure Protection, 1997]

European critical infrastructure. Denotes critical infrastructure that is of interest to at least two Member States, or one Member State, and is located on the territory of another Member State.

European Critical Infrastructure (ECI). Critical infrastructure located in Member States the disruption or destruction of which would have a significant impact on at least two Member States. The significance of the impact shall be assessed in terms of cross-cutting criteria. This includes effects resulting from cross-sector dependencies on other types of infrastructure. [EU. Council Directive, 2008]

Failure with the same cause. Simultaneous disruption in the operation of two or more critical infrastructures with the same cause of the disruption. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Geographic dependent. A local environmental event affects components across multiple infrastructures due to physical proximity. [Rinaldi et al, 2001]



Geographical dependence of critical infrastructures. Two critical infrastructures are geographically interdependent if an event in their environment leads to a change in the status of both critical infrastructures. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Geographic interdependencies. Infrastructures are geographically interdependent if a local environmental event can create state changes in all of them. A geographic interdependency occurs when elements of multiple infrastructures are in close spatial proximity. Given this proximity, events such as an explosion or fire could create correlated disturbances or changes in these geographically interdependent infrastructures. Such correlated changes are not due to physical or cyber connections between infrastructures; rather, they arise from the influence the event exerts on all the infrastructures simultaneously. [Rinaldi et al, 2001]

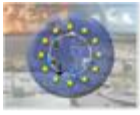
Growing failure. Disruption in one critical infrastructure which aggravates an unrelated disruption in another critical infrastructure. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Independent critical infrastructures. An independent infrastructure is one that in principle is isolated from the risks associated with other infrastructures. [Hammerli, Renda, 2010]

Infrastructure.

1. The framework of interdependent networks and systems comprising identifiable industries, institutions (including people and procedures), and distribution capabilities that provide a reliable flow of products and services essential to the defence and economic security, the smooth functioning of governments at all levels, and society as a whole. [Moteff, 2003], [Moteff, Parfomak, 2004], [Murray, Grubestic, 2007], [Rinaldi et al, 2001], [US Homeland Security, 2013], [US President's Commission on Critical Infrastructure Protection, 1997], [US President's Commission on Critical Infrastructure Protection, 1998]
2. The manmade physical systems, assets, projects, and structures, publicly and/or privately owned, that are used by or provide benefit to the public. Examples of infrastructure include utilities, bridges, levees, drinking water systems, electrical systems, communications systems, dams, sewage systems and roads. [Slandail terminology]
3. The underlying foundation or basic framework (as of a system or organization). [Merriam Webster's Collegiate Dictionary], [Rinaldi, 2001]
4. Network of independent, mostly privately-owned, man-made systems and processes that function collaboratively and synergistically to produce and distribute a continuous flow of essential goods and services. [Rinaldi, 2001], [US President's Commission on Critical Infrastructure Protection, 1997]
5. Basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons. [AHDEL, 2000], [Moteff, Parfomak, 2004]
6. The basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of an organisation, city or nation. [Climate Change 2007: Synthesis Report]
7. Infrastructure is central in achieving the goal of digital inclusion, enabling universal, sustainable, ubiquitous and affordable access to ICTs by all, taking into account relevant solutions already in place in developing countries and countries with economies in transition, to provide sustainable connectivity and access to remote and marginalized areas at national and regional levels. [WSIS]

Inside dependencies. Dependencies within an infrastructure (system) itself i.e. relationship between components and subsystems in a system causing degradation of other components and subsystems and in a consequence causing degradation of a system. [Utne, 2011]



Intent. Demonstrating a deliberate series of actions with the objective of debilitating defence or economic security by destroying or incapacitating a critical infrastructure. [US President's Commission on Critical Infrastructure Protection, 1997]

Interdependency

1. is a relationship in which each member is mutually dependent on the others. [Rinaldi et al, 2001]
2. Bidirectional connection between two critical infrastructures, whereby the state of one critical infrastructure influences or is in correlation with the state of the other critical infrastructure, i. e. two infrastructures are interdependent when one depends on the other. [Croatian Methodology for the operational risk analysis of critical infrastructure], [Rinaldi et al, 2001]
3. Relationship between critical infrastructures, both unidirectional and bidirectional, not specifying the “causal direction” of the dependency. [Utne, 2011]
4. Mutually reliant relationship between entities (objects, individuals, or groups); the degree of interdependency does not need to be equal in both directions. [US Homeland Security, 2013]
5. A bidirectional relationship between two infrastructures through which the state of each infrastructure influences or is correlated to the state of the other. More generally, two infrastructures are interdependent when each is dependent on the other. [Rinaldi et al, 2001]

Logical interdependence of critical infrastructures. Two critical infrastructures are logically interdependent when the state of one depends on the state of the other through a mechanism which is not physical, cyber or geographical connection. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Logic interdependencies. All interdependencies between infrastructures that cannot be classified as physical, cyber or geographic; are called logic interdependencies. These links are dependent on a specific context. Two infrastructures are logically interdependent if the state of each depends on the state of the other via a mechanism that is not a physical, cyber, or geographic connection. [Rinaldi et al, 2001]

Mutually dependent critical infrastructures. Mutually dependent infrastructures depend on each other, with a successful attack to either resulting in damage to both. [Hammerli, Renda, 2010]

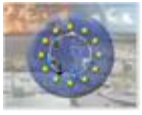
Operational characteristics of critical infrastructures. Indicators of the reaction or the behaviour of critical infrastructures under adverse effects. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Outside dependencies. Dependencies coming from the infrastructure environment (external factors) and relationship between infrastructures. Including degradation of infrastructure's state caused by outside this infrastructure changes e.g. climate changes, changes of infrastructure's functionality, location, government and human decisions (regulations, economic, public policy), also degradation of one infrastructure's state affected or correlated according to the state degradation of other infrastructures (including “loops”). [Rinaldi et al, 2001], [Utne, 2011]

Owners/operators of ECIs. Entities responsible for investments in, and/or day-to-day operation of, a particular asset, system or part there of designated as an ECI. [EU. Council Directive, 2008]

Owner/manager of critical infrastructure. Legal entities responsible for managing critical infrastructure. [Croatian Law on critical infrastructures]

Physical dependence of critical infrastructures. Critical infrastructures are physically dependent when the functioning of one CI depends on the functioning of another, i. e. when the actual results of one critical infrastructure depend on or use the actual results of another critical infrastructure. [Croatian Methodology for the operational risk analysis of critical infrastructure]



Physical dependent. A physical reliance on material flow from one infrastructure to another. [Rinaldi et al, 2001]

Physical interdependencies. Two infrastructures are physically interdependent if the state of each is dependent on the material output(s) of the other. a physical interdependency arises from a physical linkage between the inputs and outputs of two agents: a commodity produced or modified by one infrastructure (an output) is required by another infrastructure for it to operate (an input). For example, a rail network and a coal-fired electrical generation plant are physically interdependent, given that each supplies commodities that the other requires to function properly. The railroad provides coal for fuel and delivers large repair and replacement parts to the electrical generator, while electricity generated by the plant powers the signals, switches, and control centres of the railroad—and in the case of electrified rail, directly powers the locomotives. [Rinaldi, 2001]

Physical security. Actions taken for the purpose of restricting and limiting unauthorized access, specifically, reducing the probability that a threat will succeed in exploiting critical infrastructure vulnerabilities including protection against direct physical attacks, e.g., through use of conventional or unconventional weapons. [US President's Commission on Critical Infrastructure Protection, 1997]

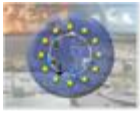
Prevention is an outright avoidance of adverse impacts of hazards and related disasters. Comment: Prevention (i.e. disaster prevention) expresses the concept and intention to completely avoid potential adverse impacts through action taken in advance. Examples include dams or embankments that eliminate flood risks, land-use regulations that do not permit any settlement in high risk zones, and seismic engineering designs that ensure the survival and function of a critical building in any likely earthquake. Very often the complete avoidance of losses is not feasible and the task transforms to that of mitigation. Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably in casual use. [SWD(2013) 134 final]

Protection of critical infrastructure. Indicates activities whose objective is to ensure functionality, continuous operation and delivery of critical infrastructure services/goods, as well as to prevent threats to critical infrastructure. [Croatian Law on critical infrastructures]

Safety. The monitoring and reduction of the risk of personnel casualties (injuries and deaths) to some acceptable level. [Slandail terminology]

Safety of infrastructures. The safety, the operation and the serviceability of large infrastructure under wind actions has recently become a topical matter. For example, harbours are generally very exposed to high wind velocities. This can give rise to great risks for structures in the sites, ships and ferries approaching or docking in port, empty containers piled and, most of all, health hazard for workers, who need to work in safety conditions also in windy days, or stop working in extreme windy days. On the other hand, frequent stops of working of port areas can produce large loss of money. Thus, the definition of operating strategies to identify the real risk conditions is an essential tool for planning the work in safety conditions. As for railways lines, wind conditions the maximum admissible velocity of high-speed trains, with effects on the entire railway network. Moreover, in some situations, strong winds might be responsible for accidents as train overturning and derailment. The medium and short-term forecast of wind intensity and direction is therefore a very important tool for the safety an operation planning of large infrastructures. On the one hand, thanks to the in situ monitoring of the wind velocity and the increasing availability of historical databases of wind records it is possible to provide the probabilistic assessment and a probabilistic-based forecast of the wind where the instrumentation is located. On the other hand, large scale numerical simulations provide a full characterization of the wind climate on large areas, and allow for correlate wind intensity and direction at different locations. Thanks to a complex transfer chain the local wind measurements and forecast can be transformed into simulated wind speeds at the infrastructure location, providing an efficient tool to guarantee the operation safety. [WINDYN]

Safety plan from owner/manager of critical infrastructure. Indicates a plan that ensures confidentiality, integrity and availability of the organizational, human, material, information-communication and other



solutions, as well as permanent and graded security measures necessary for the continuous functioning of critical infrastructure. [Croatian Law on critical infrastructures]

Sector. A logical collection of assets, systems, or networks that provide a common function to the economy, government, or society. [US Homeland Security, 2013]

Sectoral criteria. They denote a set of specific criteria based on which the risk for systems and networks of critical infrastructures in a particular sector is assessed. [Croatian Law on critical infrastructures]

Secure/Security.

1. Reducing the risk to critical infrastructure by physical means or defensive cyber measures to intrusions, attacks, or the effects of natural or manmade disasters. [US Homeland Security, 2013]
2. All aspects related to defining, achieving, and maintaining data confidentiality, integrity, availability, accountability, authenticity, and reliability. [ENISA]
3. The monitoring and reduction of the risk of human-induced events that adversely affect people or property (intrusion of unauthorized personnel, theft, sabotage, assault, etc.), to some acceptable level. [Slandail terminology]

Security coordinator for critical infrastructure. Person acting on the issues related to the protection of critical infrastructure between the owners/operators and the central bodies of state administration competent for individual critical infrastructure sectors. [Croatian Law on critical infrastructures]

Security event. Recognizable case of the state of the system which indicates a potential breach of security policy or the protection failure or previously unknown circumstances which may be important for security. [Nad et al, 2014]

Sensitive critical infrastructure protection related information. Facts about a critical infrastructure, which if disclosed could be used to plan and act with a view to causing disruption or destruction of critical infrastructure installations. [OJEU, 2008]

Sensitive systems. Systems ensuring health, safety, security or economic well-being of citizens or the effective functioning of governments [COM/2004/0702 final]

Stationary return levels, assume no change to the frequency of extremes over time. [Klein, 2009]

Stationary return levels/periods. The stationary return level/period of a given event is defined as the average time elapsing between two successive realizations of the event itself or alternatively the return level is the value expected to be exceeded on average, once every return period, or with probability $1/(\text{return period})$ in any given year. [Vezzoli et al, 2012]

Stationary return period is the average waiting time between the occurrences of extremes of a fixed size. [Klein, 2009]

System-of-systems. The term system-of-systems refers to an emergent class of systems that are built from components which are large-scale systems in their own right. A system is considered a 'system of systems' when:

- (1) Its components fulfil valid purposes in their own right and continue to operate to fulfil those purposes if disassembled from the overall system, and
- (2) the component systems are managed (at least in part) for their own purposes rather than the purposes of the whole. [Maier, 2009]

Terrorism. Premeditated threat or act of violence against non-combatant persons, property, and environmental or economic targets to induce fear, intimidate, coerce, or affect a government, the civilian population, or any segment thereof, in furtherance of political, social, ideological, or religious objectives. [US Homeland Security, 2013]



Terrorism. Use of violence with the intention of bringing to political changes and creating a general feeling of anxiety and fear. [Dobranovic, 2006]

Terrorist act. Act or threat intended to advance a political, ideological or religious cause by coercing or intimidating an government or the public, by causing serious harm to people or property, endangering life, creating a serious risk to the health and safety of the public, or seriously disrupting trade, critical infrastructure or electronic systems. [Australian National Counter-Terrorism Committee, 2011]

3.2 Energy

Centralised generation providing main and ancillary services. Large scale power generation linked to the high voltage transmission network. [EU. European Commission Directorate, 2009]

Critical electricity services to ICT Sector. Banks, ICT providers etc. [EU. European Commission Directorate, 2009]

Critical electricity services to other energy sectors. Power generators requiring electricity to start generating. [EU. European Commission Directorate, 2009]

Distribution (electricity sector). Passage through Grid Transformers and Substations into and from Distribution Systems. [EU. European Commission Directorate, 2009]

Distribution (gas sector). Dedicated pipelines to power plants and major industrial users general industrial and commercial customers domestic users. [EU. European Commission Directorate, 2009]

Distribution grids (low-voltage). Radial networks that carry the electric power from the higher voltage levels to the final users. The number of levels in a distribution grid depends upon the density and magnitude of demand and the terrain. [Holmgren, 2007]

Electrical power systems. A critical infrastructure characterized by generation stations, transmission and distribution networks that create and supply electricity to end-users so that end-users achieve and maintain nominal functionality, including the transportation and storage of fuel essential to that system. [US President's Commission on Critical Infrastructure Protection, 1997]

Embedded and intermittent generation. Small scale power generation linked to the lower voltage distribution network. [EU. European Commission Directorate, 2009]

Emissions tax. Levy imposed by a government on each unit of *CO₂-equivalent emissions* by a *source* subject to the tax. Since virtually all of the carbon in fossil *fuels* is ultimately emitted as *carbon dioxide*, a levy on the carbon content of fossil fuels a *carbon tax* is equivalent to an emissions tax for emissions caused by fossil-fuel combustion. An *energy tax* a levy on the energy content of fuels reduces demand for energy and so reduces carbon dioxide emissions from fossil-fuel use. An *ecotax* is designated for the purpose of influencing human behavior (specifically economic behavior) to follow an ecologically benign path. International emissions/carbon/energy tax is a tax imposed on specified sources in participating countries by an international agency. The revenue is distributed or used as specified by participating countries or the international agency. [Climate Change 2001: Synthesis Report]

Energy. The amount of work or heat delivered. Energy is classified in a variety of types and becomes useful to human ends when it flows from one place to another or is converted from one type into another.

Energy balance. Averaged over the globe and over longer time periods, the energy budget of the *climate system* must be in balance. Because the climate system derives all its energy from the Sun, this balance implies that, globally, the amount of incoming *solar radiation* must on average be equal to the sum of the outgoing reflected solar radiation and the outgoing *infrared radiation* emitted by the climate system. A perturbation of this global radiation balance, be it human-induced or natural, is called *radiative forcing*. [Climate Change 2001: Synthesis Report]

Energy conversion. See *energy transformation*. [Climate Change 2001: Synthesis Report]



Energy efficiency. Ratio of energy output of a conversion process or of a system to its energy input. [Climate Change 2001: Synthesis Report]

Energy infrastructure. The total system of generation, transport, distribution, trade, supply and consumption of energy. This means not only the physical network (e.g. power plants, gas pipes, heat delivery stations), but also the social (economic and institutional) network that manages and controls the physical system. Together, these networks form a socio-technical infrastructure system. It is a complex system; the technological, economic, and institutional domains are strongly interdependent. [Houwing et al, 2007]

Energy intensity. Energy intensity is the ratio of energy consumption to economic or physical output. At the national level, energy intensity is the ratio of total domestic *primary energy* consumption or *final energy* consumption to *Gross Domestic Product* or physical output. [Climate Change 2001: Synthesis Report]

Energy service. The application of useful energy to tasks desired by the consumer such as transportation, a warm room, or light. [Climate Change 2001: Synthesis Report]

Energy tax. See *emissions tax*. [Climate Change 2001: Synthesis Report]

Energy trading. Systems used to trade energy commodities. [EU. European Commission Directorate, 2009]

Energy transformation. The change from one form of energy, such as the energy embodied in *fossil fuels*, to another, such as electricity. [Climate Change 2001: Synthesis Report]

Fuel purchase and supply. Coal, gas, oil, uranium, renewable and onsite storage capacity. [EU. European Commission Directorate, 2009]

Gas and oil production, storage and transportation. A critical infrastructure characterized by the production and holding facilities for natural gas, crude and refined petroleum, and petroleum-derived fuels, the refining and processing facilities for these fuels and the pipelines, ships, trucks, and rail systems that transport these commodities from their source to systems that are dependent upon gas and oil in one of their useful forms. [US President's Commission on Critical Infrastructure Protection, 1997]

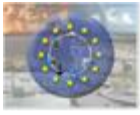
Primary energy (also referred to as energy sources) is the energy embodied in natural resources (e.g., coal, crude oil, natural gas, uranium) that has not undergone any anthropogenic conversion. It is transformed into secondary energy by cleaning (natural gas), refining (oil in oil products) or by conversion into electricity or heat. When the secondary energy is delivered at the end-use facilities it is called final energy (e.g., electricity at the wall outlet), where it becomes **usable energy** (e.g., light). Daily, the sun supplies large quantities of energy as rainfall, winds, radiation, etc. Some share is stored in biomass or rivers that can be harvested by men. Some share is directly usable such as daylight, ventilation or ambient heat.

Renewable energy is obtained from the continuing or repetitive currents of energy occurring in the natural environment and includes non-carbon technologies such as solar energy, hydropower, wind, tide and waves and geothermal heat, as well as carbon-neutral technologies such as biomass. **Embodied energy** is the energy used to produce a material substance (such as processed metals or building materials), taking into account energy used at the manufacturing facility (zero order), energy used in producing the materials that are used in the manufacturing facility (first order), and so on. [Climate Change 2007: Synthesis Report]

Sub transmission grids (regional grids). Radial or locally meshed networks connected to the transmission grid via in-feed points. Smaller generating plants (e.g. wind power stations and gas turbines), and large users are connected to these grids. [Holmgren, 2007]

Transmission. Passage through sub-stations. Additional within country and between country interconnectors. [EU. European Commission Directorate, 2009]

Transmission grids (high-voltage). Meshed networks, connecting large generating stations (e.g. hydro power and nuclear power), sub transmission grids, and very large users. Transmission grids enable power



trading with other countries and facilitate the optimization of generation within a country. [Holmgren, 2007]

3.3 Transport

Asset. An asset is any person, facility, material, information, or activity that has a positive value to the Transportation Systems Sector. The asset may have value to an adversary, as well as an owner, although the nature and magnitude of those values may differ. Assets may be categorized in many ways, including people, information, equipment, facilities, and activities or operations. [US Homeland Security, 2007]

Capsizing/listing. A casualty where the ship no longer floats in the right-side-up mode due to: negative initial stability (negative metacentric height), or transversal shift of the centre of gravity, or the impact of external forces (capsizing when the ship is tipped over until disabled; listing when the ship has a permanent heel or angle of loll).

Casualty events. Unwanted events in which there was some kind of energy release with impact on people and/or ship including its equipment and its cargo or environment. They are classified in. [EMSA]

Collision. A casualty caused by ships striking or being struck by another ship, regardless of whether the ships are underway, anchored or moored. This type of casualty event does not include ships striking underwater wrecks. The collision can be with other ship or with multiple ships or ship not underway.

Contact. A casualty caused by ships striking or being struck by an external object. The objects can be: floating object (cargo, ice, other or unknown), or fixed object, but not the sea bottom, or flying object.

Damage to equipment. A damage to equipment, system or the ship not covered by any of the other casualty type.

Emergency search and rescue facilities. Facilities equipped to respond to maritime emergencies. [US-DHS]

Equipment failure. A system module (subsystem) or component that does not function as intended due to some sort of breakdown. Loss of function may also be the result of operating outside the specified performance criteria (eg. overload, overcapacity). [EMSA]

External agent or ship. This group should apply to external influences; for example, lack of, or inadequate, support from other ships, agents or infrastructure. [EMSA]

Fire/explosion. An uncontrolled ignition of flammable chemicals and other materials on board of a ship (fire is the uncontrolled process of combustion characterised by heat or smoke or flame or any combination of these, explosion is an uncontrolled release of energy which causes a pressure discontinuity or blast wave).

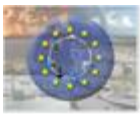
Flag state. The State whose flag a ship is entitled to fly. [EMSA]

Flooding/foundering. A casualty event when the ship is taking water on board (foundering will be considered when the vessel has sunk; foundering should only be regarded as the first casualty event if we do not know the details of the flooding which caused the vessel to founder, in the chain of events foundering can be the last casualty event in this case there is the need to add accidental events; flooding refers to a casualty when a vessel takes water on board and can be: progressive if the water flow is gradual, massive if the water flow is extensive).

Grounding/stranding. A moving navigating ship, either under command, under power, or not under command, drifting, striking the sea bottom, shore or underwater wrecks.

Hull failure. A failure affecting the general structural strength of the ship.

Inland waters. Natural waterways (e.g. rivers, lakes, bayous, estuaries) capable of carrying marine traffic. [US-DHS]



Loss of control. A total or temporary loss of the ability to operate or manoeuvre the ship, failure of electric power, or to contain on board cargo or other substances: loss of electrical power is the loss of the electrical supply to the ship or facility (loss of propulsion power is the loss of propulsion because of machinery failure; loss of directional control is the loss of the ability to steer the ship; loss of containment is an accidental spill or damage or loss of cargo or other substances carried on board a ship).

Marine bulk terminal. Large terminal located on a waterway. Generally receives and distributes its petroleum via pipeline, barge, or marine tanker from either domestic or import suppliers. [US-DHS]

Marine casualty. An event, or a sequence of events, that has resulted in any of the following which has occurred directly in connection with the operations of a ship: 1) the death of, or serious injury to, a person, 2) the loss of a person from a ship, 3) the loss, presumed loss or abandonment of a ship, 4) material damage to a ship, 5) the stranding or disabling of a ship, or the involvement of a ship in a collision, 6) material damage to marine infrastructure external to a ship, that could, seriously endanger the safety of the ship, another ship or an individual or 7) severe damage to the environment, or the potential for severe damage to the environment, brought about by the damage of a ship or ships. [EMSA]

Marine incident. An event, or sequence of events, other than a marine casualty, which has occurred directly in connection with the operations of a ship that endangered, or, if not corrected, would endanger the safety of the ship, its occupants or any other person or the environment. [EMSA]

Marine safety investigation. An investigation or inquiry into a marine casualty or marine incident, conducted with the objective of preventing marine casualties and marine incidents in the future. The investigation includes the collection and analysis of evidence, the identification of causal factors and the making of safety recommendations as necessary. [EMSA]

Maritime transport. Maritime transport is the shipment of goods (cargo) and people by sea and other waterways. Port operations are a necessary tool to enable maritime trade between trading partners. To ensure smooth port operations and to avoid congestion in the harbour it is inevitable to permanently upgrade the ports physical infrastructure, invest in human capital, fostering connectivity of the port and upgrade the port operations to prevailing standards. Hence, port operations can be defined as all policies, reforms and regulations that influence the infrastructure and operations of port facilities including shipping services. [GFP]

Material damage. (In relation to a marine casualty) is a damage that significantly affects the structural integrity, performance or operational characteristics of marine infrastructure or a ship, and requires major repair or replacement of a major component or components; or destruction of the marine infrastructure or ship. [EMSA]

Mega-node. The single point at which multiple modes intersect. In transportation systems, a mega-node is a place of potential failure or bottleneck, with the potential for wide-ranging disruptions and losses. [US Homeland Security, 2007]

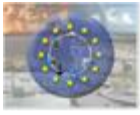
Missing. A casualty to a ship whose fate is undetermined with no information having been received on the loss and whereabouts after a reasonable period of time. [EMSA]

Mode. A specific form or variety of something. In the context of transportation, there are six modes: aviation, maritime, mass transit, highway, freight rail, and pipeline. [US Homeland Security, 2007]

Port handling hazardous chemicals. Port facilities of mooring, docking, loading, and unloading marine vessels with hazardous chemicals. [US-DHS]

Ports. Facilities designed to dock, load, and unload marine vessels. [US-DHS]

Port. Harbour with piers or docks. Left side of a ship when facing forward. Opening in a ship's side for handling freight. [Glossary of Shipping Terms, 2008]



Port. This term is used both for the harbour area where ships are docked and for the agency (port authority), which administers use of public wharves and port properties. [AAPA]

Port home. Port from which a cruise ship loads passengers and begins its itinerary, and to which it returns to disembark passengers upon conclusion of voyage. Sometimes referred to as "embarkation port" and "turn around port." [AAPA]

Port of call. Port where a ship discharges or receives traffic. [Glossary of Shipping Terms, 2008]

Port of entry. Port where cargo is unloaded and enters a country. [Glossary of Shipping Terms, 2008]

Port of exit. Place where cargo is loaded and leaves a country. [Glossary of Shipping Terms, 2008]

Port of refuge. Port, not on a ship's itinerary, which the ship calls at due to some unforeseen hazard at sea and where the ship may undergo repairs, refuel, or rescue cargo. [Brodie, Sullivan, 1997]

Port of registry. Place where a ship is registered with the authorities, thereby establishing its nationality. [Brodie, Sullivan, 1997]

Port-of-call. Port at which cruise ship makes a stop along its itinerary. Calls may range from five to 24 hours. Sometimes referred to as "transit port" and "destination port." [AAPA]

Serious casualty. A casualty to ships which do not qualify as very serious casualties and which involve a fire, explosion, collision, grounding, contact, heavy weather damage, ice damage, hull cracking, or suspected hull defect, etc., resulting in: immobilization of main engines, extensive accommodation damage, severe structural damage, such as penetration of the hull under water, etc., rendering the ship unfit to proceed (the ship is in a condition, which does not correspond substantially with the applicable conventions, presenting a danger to the ship and the persons on board or an unreasonable threat of harm to the marine environment), or pollution (regardless of quantity), and/or a breakdown necessitating towage or shore assistance. [IMO MSC-MEPC.3/Circ.3]

Severe pollution. A case of pollution which, as evaluated by the coastal State(s) affected or the flag Administration, as appropriate, produces a major deleterious effect upon the environment, or which would have produced such an effect without preventive action. [IMO MSC-MEPC.3/Circ.3]

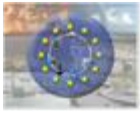
Ship. A sailing vessel having three or more square-rigged masts. [Glossary of Shipping Terms, 2008]

Transshipment port. A port where cargo is transferred from one carrier to another or from one vessel of a carrier to another vessel of the same carrier without the cargo leaving the port. [Brodie, Sullivan, 1997]

Very serious marine casualty. A marine casualty involving the total loss of the ship or a death or severe damage to the environment. [IMO MSC-MEPC.3/Circ.3]

Vessel types [US-DHS]:

- **Container ship.** A vessel specially designed to transport containerized cargo. [US-DHS]
- **Dry bulk cargo ship.** A vessel specially designed to transport dry bulk cargo (e.g. ore, grain). [US-DHS]
- **General cargo ship.** Includes general cargo, tween-deck, multipurpose, heavy lift, and other vessels. [US-DHS]
- **Gas carrier ship.** A vessel specially designed to transport gases. [US-DHS]
- **Passenger ferrie.** A vessel specially designed to carry passengers. [US-DHS]
- **Roll on/ Roll of ship (Ro/Ro ship).** A vessel specially designed to transport vehicles and to load and unload them under their own power. [US-DHS]
- **Supply boat.** Includes offshore supply, inshore workboat, Police/Fire boat. [US-DHS]



- **Tank ship.** A vessel specially designed to transport liquid cargo. [US-DHS]

Transportation. Conveyance of passengers or goods. There are six modes of transportation: aviation, maritime, mass transit, highway, freight rail, and pipeline. [US Homeland Security, 2007]

Transportation Infrastructure. Physical distribution systems critical to supporting the national security and economic well-being of this nation, including the national airspace systems, airlines, and aircraft, and airports; roads and highways, trucking and personal vehicles; ports and waterways and the vessels operating thereon; mass transit, both rail and bus; pipelines, including natural gas, petroleum, and other hazardous materials; freight and long haul passenger rail; and delivery services. [Moteff, 2003], [US President's Commission on Critical Infrastructure Protection, 1997]

Transportation security Incident. A security incident resulting in a significant loss of life, environmental damage, transportation system disruption, or economic disruption in a particular area. [US Homeland Security, 2007]

Tug and towboat. Includes harbour tugs, line-haul towboats, offshore tugs. [US-DHS]

Waterways. Navigable waterways capable of carrying marine traffic. [US-DHS]

3.4 Water

Aquifer. A geologic formation(s) that is water bearing. A geological formation or structure that stores and/or transmits water, such as to wells and springs. Use of the term is usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for people's uses. [USGS]

Aquifer (confined). Soil or rock below the land surface that is saturated with water. There are layers of impermeable material both above and below it and it is under pressure so that when the aquifer is penetrated by a well, the water will rise above the top of the aquifer. [USGS]

Aquifer (unconfined). An aquifer whose upper water surface (water table) is at atmospheric pressure, and thus is able to rise and fall. [USGS]

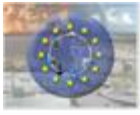
Artesian water. Groundwater that is under pressure when tapped by a well and is able to rise above the level at which it is first encountered. It may or may not flow out at ground level. The pressure in such an aquifer commonly is called artesian pressure, and the formation containing artesian water is an artesian aquifer or confined aquifer. [USGS]

Asset. In flood defence, any man-made or natural feature – such as a raised defence, retaining structure, channel, pumping station or culvert – that performs a flood defence or land drainage function. [EAWFD, 2010]

Asset management. Systematic and coordinated activities through which an organisation manages its assets and asset systems for the purpose of achieving its strategic aims This includes the performance of the assets and the associated risks and expenditures throughout their lifecycles, and carries an implication that the management is undertaken in an optimal and sustainable manner. Assessment The process of understanding the state, structural competence or performance of an existing asset or asset system in order to inform the planning of future interventions. [EAFDG, 2010]

Asset, infrastructure. An infrastructure asset is any long-lived resource that is operated as a system or network, such as a sewer collection and water supply system. [UFM, 2011]

Base. A substance that has a pH of more than 7, which is neutral. A base has less free hydrogen ions (H+) than hydroxyl ions (OH-). [USGS]



Base flow. Sustained flow of a stream in the absence of direct runoff. It includes natural and human-induced stream flows. Natural base flow is sustained largely by ground-water discharges. [USGS]

Bedrock. The solid rock beneath the soil and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material. [USGS]

Critical element. A system element, the failure of which will lead to the failure of the system. [FLOODsite, 2009]

Element. A component part of a system. [FLOODsite, 2009]

Embankment. An artificial, usually earthen, structure, constructed to prevent or control flooding, or for various other purposes including carrying roads and railways. [EAFDG, 2010]

Embankment. A raised structure (as of earth or gravel) used especially to hold back water. [EAWFD, 2010]

Flood embankment, floodbank. Embankment, usually earthen, built to prevent or control the extent of flooding. [EAFDG, 2010]

Floodwalls. Barriers made of concrete or masonry, a kind of flood proofing measures. [FMMEP, 2007]

Flowing well/spring. A well or spring that taps groundwater under pressure so that water rises without pumping. If the water rises above the surface, it is known as a flowing well. [USGS]

Frozen ground. Soil or rock in which part or all of the pore water is frozen. Perennially frozen ground is called permafrost. Ground that freezes and thaws annually is called seasonally frozen ground. [IPCC, 2012a]

Glacier. A huge mass of ice, formed on land by the compaction and recrystallization of snow, that moves very slowly downslope or outward due to its own weight. [USGS]

Greywater. Wastewater from clothes washing machines, showers, bathtubs, hand washing, lavatories and sinks. [USGS]

Groundwater. (1) water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust. [USGS]

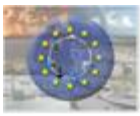
- **Groundwater (confined).** Groundwater under pressure significantly greater than atmospheric, with its upper limit the bottom of a bed with hydraulic conductivity distinctly lower than that of the material in which the confined water occurs. [USGS]
- **Groundwater (unconfined).** Water in an aquifer that has a water table that is exposed to the atmosphere. [USGS]

Ground-water recharge. Inflow of water to a ground-water reservoir from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge. Also, the volume of water added by this process. [USGS]

Hydrologic cycle. The cyclic transfer of water vapour from the Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans. [USGS]

Hydrological cycle (also referred to as water cycle). The cycle in which water evaporates from the oceans and the land surface, is carried over the Earth in atmospheric circulation as water vapour, condenses to form clouds, precipitates again as rain or snow, is intercepted by trees and vegetation, provides runoff on the land surface, infiltrates into soils, recharges groundwater, and/or discharges into streams and flows out into the oceans, and ultimately evaporates again from the oceans or land surface. The various systems involved in the hydrological cycle are usually referred to as hydrological systems. [IPCC, 2012a]

Permafrost. Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least 2 consecutive years. [IPCC, 2012a]



Return flow. (1) That part of a diverted flow that is not consumptively used and returned to its original source or another body of water. (2) (Irrigation) Drainage water from irrigated farmlands that re-enters the water system to be used further downstream. [USGS]

Standard of protection.

1. In flood risk management, the annual probability of the design flood level being reached or exceeded. From the receptor's viewpoint, the definition is different, being the annual probability of a flood overtopping or breaching a flood defence asset and causing harm to the receptor. [EAFDG, 2010]
2. The design event or standard to which a building, asset or area is protected against flooding, generally expressed as an annual exceedance probability. [PPS25, 2009]

Standard of service

1. is the measured performance of a defined performance indicator. [FLOODsite, 2009]
2. The performance of an asset at a specific point in time. [EAFDG, 2010]

Sustainable drainage. Sustainable Drainage Systems: an approach to surface water management that combines a sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques. [FMMEP, 2007]

Sustainable drainage systems.

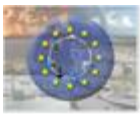
1. A sequence of management practices and control structures, often referred to as SUDS, designed to drain water in a more sustainable manner than some conventional techniques. Typically these are used to attenuate run-off from development sites. [PPS25, 2009]
2. Sustainable drainage systems: a sequence of management practices and control measures designed to mimic natural drainage processes by allowing rainfall to infiltrate and by attenuating and conveying surface water runoff slowly compared to conventional drainage. SuDS can operate at different levels; ideally in a hierarchy of source control, local control and regional control, and can be used in both rural and urban areas. [DEFRA, 2010]
3. Surface water drainage systems which seek to mimic the way that natural features of the landscape soak up rain or allow rain to soak away and reduce the impact of development on the sewerage system. Examples of manmade SuDS include permeable paving, retention basins, reed beds, ponds, wetlands and swales (i.e. shallow channels to carry water from one part of a SuDS management system to the next), green roofs and water butts. Trade effluent – Untreated, non-domestic sewage from commercial premises. [WBG, 2013]

Sustainable flood risk management involves: (1) ensuring quality of life by reducing flood damages but being prepared for floods (2) mitigating the impact of risk management measures on ecological systems at a variety of spatial and temporal scales (3) the wise use of resources in providing, maintaining and operating infrastructure and risk management measures (4) maintaining appropriate economic activity (agricultural, industrial, commercial, residential) on the flood plain. [FLOODsite, 2009]

Sustainable flood risk management strategy. An approach which (1) aims to be effective in the long term, and (2) can be combined ('integrated') with other international, national and regional activities (transport, environment, conservation etc.) (See IRMA-SPONGE Glossary Appendix 2). [FLOODsite, 2009]

System. An assembly of elements, and the interconnections between them, constituting a whole and generally characterised by its behaviour. Applied also for social and human systems. [FLOODsite, 2009]

System asset management plan. Long-term investment plan for a flood defence system that identifies the investment needed and the benefits provided. [EAFDG, 2010]



Systems approach. An approach to flood management that looks at the complete flooding system or defence system insofar as it can be affected by, or may have an impact on, any intervention [EAFDG, 2010]

Water quality. A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. [USGS]

Water Supply Systems. A critical infrastructure characterized by the sources of water, reservoirs and holding facilities, aqueducts and other transport systems, the filtration, cleaning and treatment systems, the pipelines, the cooling systems and other delivery mechanisms that provide for domestic and industrial applications, including systems for dealing with water runoff, waste water, and firefighting. [US President's Commission on Critical Infrastructure Protection, 1997]

Water table. The top of the water surface in the saturated part of an aquifer. [USGS]

Water use. Water that is used for a specific purpose, such as for domestic use, irrigation, or industrial processing. Water use pertains to human's interaction with and influence on the hydrologic cycle, and includes elements, such as water withdrawal from surface- and ground-water sources, water delivery to homes and businesses, consumptive use of water, water released from wastewater-treatment plants, water returned to the environment, and instream uses, such as using water to produce hydroelectric power. [USGS]

3.5 Information and Telecommunication Infrastructure

Access. The ability to enter a secured area and, in the case of accessing a computer, to read, write, modify, or use any of the computer's system resources. [Sadowsky et al, 2003]

Access authorization. Permission granted to users, programs, or workstations. [Sadowsky et al, 2003]

Access control. A set of procedures performed by hardware, software, and administrators to monitor access, identify users requesting access, record access attempts, and grant or deny access. Security policies should be supported by access control, which assist in the prevention of unauthorized use of any of a company's system resources either externally (by an intruder) or internally (by an employee who should not have access). [Sadowsky et al, 2003]

Access control. Means to ensure that access to assets is authorized and restricted based on business and security requirements. [ISO/IEC 27000, 2013]

Accountability. Ensuring that activities on supported systems can be traced to an individual who is held responsible for the integrity of the data. [Sadowsky et al, 2003]

Application security. CI applications are often not built for being exposed to public internet and its users, and were only accessible by trained personal. [Paudel et al, 2013]

Asset. Anything that has value to the organization, its business operations and their continuity, including Information resources that support the organization's mission. [ENISA]

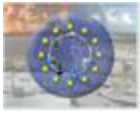
Assurance. A level of confidence that the information system architecture mediates and enforces the organization's security policy. [Sadowsky et al, 2003]

Attack. An assault on system security from an intelligent threat; a deliberate attempt to evade security services and violate the security policy of a system. [Sadowsky et al, 2003]

Authentic signature. A signature, particularly a digital signature, that can be trusted because it can be verified. [Sadowsky et al, 2003]

Authenticate. In networking, to verify the identity of a user, device, or any other system entity. [Sadowsky et al, 2003]

Authentication. Provision of assurance that a claimed characteristic of an entity is correct. [ISO/IEC 27000, 2013]



Authentication. The process of establishing the legitimacy of a node or user before allowing access to requested information. During the process, the user enters a name or account number (identification) and password (authentication). [Sadowsky et al, 2003]

Authenticity. Property that an entity is what it is claims to be. [ISO/IEC 27000, 2013]

Authorization. Granting officially approved access rights to a user, process, or program in accordance with a company's security policy. Usually authorization is completed after the user is authenticated. The user may then be authorized for various levels of access or activity. [Sadowsky et al, 2003]

Availability. The portion of time a system can be use for productive work. [Sadowsky et al, 2003]

Backup. The process of copying computer files to some other location either on the computer, or on storage devices that may be separated from the computer. Backups allow you to recover data in the event that the originals are no longer available, for reasons ranging from accidental deletion to physical damage, theft, or other loss. [Sadowsky et al, 2003]

Cloud Integrity Security. Regular basis of data backup and storing outside Cloud is done to be safe from dataloss incident. The CI metadata is important for billing and provision of basic needs but it also allows to identify the behavioral patterns. This critical information could be misused, so it needs to be secured. [Paudel et al, 2013]

Computer crime. Any form of illegal act involving electronic information and computer equipment. [Sadowsky et al, 2003]

Computer fraud. A computer crime that an intruder commits to obtain money or something of value from a company (or individual). Often, all traces of the crime are covered up. Computer fraud typically involves modification, destruction, theft, or disclosure of data. [Sadowsky et al, 2003]

Confidentiality. Ensuring that sensitive data is limited to specific individuals (external and internal) or groups within an organization. The confidentiality of the information is based on the degree to which an organization must protect its information – for example, registered, proprietary, or non-proprietary. [Sadowsky et al, 2003]

Conflict-of-interest escalation. A preset procedure for escalating a security incident if any members of the security are suspect. [Sadowsky et al, 2003]

Contingency plan. A security plan to ensure that mission-critical computer resources are available to a company in the event of a disaster (such as an earthquake or flood). It includes emergency response actions, backup operations, and post-disaster recovery. [Sadowsky et al, 2003]

Control. A protective action that a company takes to reduce its risk of exposure. [Sadowsky et al, 2003]

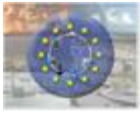
Control systems. Computer-based systems used within many infrastructure and industries to monitor and control sensitive processes and physical functions. These systems typically collect measurement and operational data from the field, process and display the information, and relay control commands to local or remote equipment or human-machine interfaces (operators). [US Homeland Security, 2013]

Cracker. Someone who tries to break the security of, and gain access to, someone else's system without being invited. (See also hacker). [Sadowsky et al, 2003]

Critical information infrastructure. The computer resource, the incapacitation or destruction of which, shall have debilitating impact on national security, economy, public health or safety. [Muktesh,]

Critical Infrastructure Information (CII). Information that is not customarily in the public domain and is related to the security of critical infrastructure or protected systems. CII consists of records and information concerning any of the following:

- Actual, potential, or threatened interference with, attack on, compromise of, or incapacitation of critical infrastructure or protected systems by either physical or computer-based attack or other



similar conduct (including the misuse of or unauthorized access to all types of communications and data transmission systems) that violates law; harms the interstate commerce of the states; or threatens public health or safety.

- The ability of any critical infrastructure or protected system to resist such interference, compromise, or incapacitation, including any planned or past assessment, projection, or estimate of the vulnerability of critical infrastructure or a protected system, including security testing, risk evaluation, risk management planning, or risk audit.
- Any planned or past operational problem or solution regarding critical infrastructure or protected systems, including repair, recovery, insurance, or continuity, to the extent that it is related to such interference, compromise, or incapacitation. [US Homeland Security, 2013]

Cyber dependent. A reliance on information transfer between infrastructure. [Rinaldi et al, 2001]

Cyber interdependencies. An infrastructure has a cyber interdependency if its state depends on information transmitted through the information infrastructure. [Rinaldi et al, 2001]

Cyber system. Any combination of facilities, equipment, personnel, procedures, and communications integrated to provide cyber services; examples include business systems, control systems, and access control systems. [US Homeland Security, 2013]

Cyber terrorism. Causing denial of service, illegal access, introducing a virus in any of the critical information infrastructure of the country with the intent to threaten the unity, integrity, security or sovereignty of state or strike terror in the people or any section of the people; or gaining illegal access to data or database that is restricted for reasons of the security of state or friendly relations with foreign states. [Muktesh,]

Cybersecurity. The prevention of damage to, unauthorized use of, or exploitation of, and, if needed, the restoration of electronic information and communications systems and the information contained therein to ensure confidentiality, integrity, and availability; includes protection and restoration, when needed, of information networks and wireline, wireless, satellite, public safety answering points, and 112 or similar communications systems and control systems. [US Homeland Security, 2013]

Cybersecurity. The prevention of damage to, unauthorized use of, or exploitation of, and, if needed, the restoration of electronic information and communications systems and the information contained therein to ensure confidentiality, integrity and availability. [2013 NIPP]

Data availability. The fact that data is accessible and services are operational. [ENISA]

Data Confidentiality. The protection of communications or stored data against interception and reading by unauthorized persons. [ENISA]

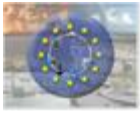
Data integrity. The confirmation that data which has been sent, received, or stored are complete and unchanged. [ENISA]

Data storage security. Correctness and availability of data in the Cloud must be guaranteed. This is of fundamental importance when considering a case where the Cloud is used in a CI context e.g. for storing metering data of a utility network. [Paudel et al, 2013]

Data transmission security. Historically CI components were used in isolated setups and using the Cloud requires additional caution regarding secure transmission as unsecured transmissions allow eavesdropping or alteration of data. [Paudel et al, 2013]

Definition of scope. Process for the establishment of global parameters for the performance of Risk Management within an organization. Within the definition of scope for Risk Management internal and external factors have to be taken into account. [ENISA]

Escalation. The procedure of reporting (and passing responsibility for resolving) a security breach to a higher level of command. See also, "Internal escalation," "External escalation," and "Conflict-of-interest escalation." [Sadowsky et al, 2003]



External escalation. The process of reporting a security breach to an individual or group outside the department, division, or company in which it occurred. Once a problem is escalated, responsibility for resolving that problem is either accepted or shared with the party to whom the problem is escalated. [Sadowsky et al, 2003]

External threat. Arise from outside of the organization by individuals, hackers, organizations, terrorists, foreign Government agents, non-state actors and pose risk like Crippling CII, Espionage, Cyber/Electronic warfare, Cyber Terrorism etc. [Muktesh,]

Fault tolerance. A design method that ensures continued systems operation in the event of individual failures by providing redundant systems elements. [Sadowsky et al, 2003]

Function. Service, process, capability, or operation performed by an asset, system, network, or organization. [US Homeland Security, 2013]

Gap analysis. A comparison that identifies the difference between the actual and the expected / specified system status. [ENISA]

Hacker. Someone with an interest in computers who enjoys experimenting with them. The term has also come to mean a person with malicious intentions who gathers information on computer security flaws and breaks into computers without the system owner's permission, although the term cracker is more appropriate for an exclusively negative connotation. (See also Cracker). [Sadowsky et al, 2003]

Hacking. In general, writing code for computers. In a security context, the term often is used to mean exploiting system vulnerabilities to gain unauthorized access. [Sadowsky et al, 2003]

Identification. Recognizing users on a company's system by using unique names. [Sadowsky et al, 2003]

Incident-response procedures. Formal, written procedures that detail the steps to be taken in the event of a major security problem, such as a break-in. Developing detailed incident-response procedures before the occurrence of a problem is a hallmark of a well-designed security system. [Sadowsky et al, 2003]

Information and communications. A critical infrastructure characterized by computing and telecommunications equipment, software, processes, and people that support:

- the processing, storage, and transmission of data and information,
- the processes and people that convert data into information and information into knowledge, and
- the data and information themselves. [US President's Commission on Critical Infrastructure Protection, 1997]

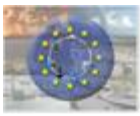
Information communication technology. Electronic information-processing technologies such as computers and the Internet, as well as fixed-line telecommunications, mobile phones and other wireless communications, networks, broadband, and various specialised application devices ranging from barcode scanners and Braille readers to global positioning systems (GPS). [EU. European Commission Directorate, 2009]

Information dependence of critical infrastructures. An infrastructure is information dependent if its state depends on the information transmitted through the information infrastructure. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Information of "cyber" security. Actions taken for the purpose of reducing system risk, specifically, reducing the probability that a threat will succeed in exploiting critical infrastructure vulnerabilities using electronic, RF, or computer-based means. [US President's Commission on Critical Infrastructure Protection, 1997]

Insider attack. An attack originating from inside a protected network. [Sadowsky et al, 2003]

Internal escalation. The process of reporting a security breach to a higher level of command within the department, division, or company in which the breach occurred. [Sadowsky et al, 2003]



Internal threat. One or more individuals with the access and/or inside knowledge of a company, organization, or enterprise that would allow them to exploit the vulnerabilities of that entity's security, systems, services, products, or facilities with the intent to cause harm. [Muktesh,]

Intruder. An entity that gains or attempts to gain access to a system or system resources without having authorization to do so. [Sadowsky et al, 2003]

Intrusion detection. A security service that monitors and analyzes system events for the purpose of finding, and providing real-time or near real-time warning of, attempts to access system resources in an unauthorized manner. [Sadowsky et al, 2003]

Intrusion detection system. A system dedicated to the detection of break-ins or break in attempts either manually via software expert systems that operate on logs or other information available on the network. [Sadowsky et al, 2003]

Network. A group of components that share information or interact with each other to perform a function. [US Homeland Security, 2013]

Password cracker. A software program containing whole dictionaries that tries to match user passwords. [Sadowsky et al, 2003]

Password sniffing. Passive wiretapping, usually on a local area network, to gain knowledge of passwords. [Sadowsky et al, 2003]

Penetration. Successful, repeatable, unauthorized access to a protected system resource. [Sadowsky et al, 2003]

Penetration test. A system test, often part of system certification, in which evaluators attempt to circumvent the security features of the system and penetrate various layers of systems resources. [Sadowsky et al, 2003]

Perimeter-based security. The technique of securing a network by controlling access to all entry and exit points of the network. [Sadowsky et al, 2003]

Permissions. The authorized actions a subject can perform with an object (i.e. read, write, modify, or delete). [Sadowsky et al, 2003]

Policy. Organizational level rules governing acceptable use of computing resources, security practices, and operational procedures. [Sadowsky et al, 2003]

Privacy. The protection of a company's data from being read by unauthorized parties. Safe guards such as encryption can provide a level of assurance that the integrity of the data is protected from exposure. [Sadowsky et al, 2003]

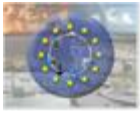
Protected critical infrastructure information. All critical infrastructure information that has been properly submitted and validated pursuant to the Critical Infrastructure Information Act and implementing directive. [US Homeland Security, 2013]

Protocols. Agreed-upon methods of communications used by computers. [Sadowsky et al, 2003]

Reliability. The probability that a system will adequately accomplish its tasks for a specific period of time, under the expected operating conditions. [Sadowsky et al, 2003]

Risk. The probability that a particular vulnerability of a system will be exploited, either intentionally or accidentally. [Sadowsky et al, 2003]

Risk analysis. The analysis of an organization's information resources, existing controls and computer system vulnerabilities. It establishes a potential level of damage in dollars and/or other assets and identifies controls that need improvement. [Sadowsky et al, 2003]



Scalability. The ability to expand a computing solution to support large numbers of users without having an impact on performance. [Sadowsky et al, 2003]

Security audit. An independent professional security review that tests and examines a company's compliance with existing controls, the results of which enable an auditor to recommend necessary changes in security controls, policies, and procedures. [Sadowsky et al, 2003]

Security procedures. A set of detailed instructions, configurations, and recommendations to implement a company's security policy. [Sadowsky et al, 2003]

Security related to third-party. Third Party establishes connection between two parties and provides end-to-end security services. All critical transactions between the two parties are reviewed by the Third Party. Thus, Third party requires security on confidentiality, client and server authentication, certificate based authorization and creation of security domain. [Paudel et al, 2013]

Social engineering. An attack based on deceiving users or administrators at the target site. Social engineering attacks are typically carried out by telephoning users or operators and pretending to be an authorized user to attempt to gain access to systems illicitly. [Sadowsky et al, 2003]

System. Any combination of facilities, equipment, personnel, procedures, and communications integrated for a specific purpose. [US Homeland Security, 2013]

Telecommunications. Any transmission, emission, or reception of signs, signals, writing, images, and sounds or intelligence of any nature by wire, radio, optical, or other electromagnetic systems. [US Department of Energy, 1999]

Threat. Any item that has the potential to compromise the integrity, confidentiality, and availability of data. [Sadowsky et al, 2003]

User identification. User identification is the process by which a user identifies himself to the system as a valid user. This is not the same as authentication, which is the process of establishing that the user is who he says he is and has a right to use that system. [Sadowsky et al, 2003]

Validation. Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled. [ISO/IEC 27000, 2013]

Verification. Confirmation, through the provision of objective evidence, that specified requirements have been fulfilled. [ISO/IEC 27000, 2013]

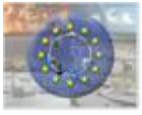
Vulnerability. A flaw or weakness in a system's design, implementation, or operation that can be exploited by an intruder to violate the system's security policy. [Sadowsky et al, 2003]

3.6 Chemical Industry

Chemical weapon. As defined by the Chemical Weapons Convention (CWC), a chemical weapon is, together or separately: (a) toxic chemicals and their precursors, except where intended for purposes not prohibited under the CWC, as long as the types and quantities are consistent with such purposes; (b) munitions and devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals specified in subparagraph (a), which would be released as a result of the employment of such munitions and devices; and (c) any equipment specifically designed for use directly in connection with the employment of munitions and devices specified in subparagraph (b). [US Homeland Security, 2010]

Chemical weapon precursor. Any chemical reactant that can be used in any stage in the production, by whatever method, of a chemical weapon, including any key component of a binary or multi-component chemical system. [US Homeland Security, 2010]

Gas and oil production storage and transportation infrastructure. The production and holding facilities for natural gas, crude and refined petroleum, and petroleum-derived fuels, the refining and processing facilities for these fuels and the pipelines, ships, trucks, and rail systems that transport these commodities



from their source to systems that are dependent upon gas and oil in one of their useful forms. [Moteff, 2003], [US President's Commission on Critical Infrastructure Protection, 1997]

3.7 Buildings and Structures

Building code.

1. A set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage. Building codes can include both technical and functional standards. They should incorporate the lessons of international experience and should be tailored to national and local circumstances. A systematic regime of enforcement is a critical supporting requirement for effective implementation of building codes. [Slandail terminology]
2. is a set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage. [EU-ADAPT]

Critical facilities. The primary physical structures, technical facilities and systems which are socially, economically or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency. [ISDR Terminology of disaster risk reduction].

Geological hazard. Geological condition or occurrence that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. [Dickson, 2012]

Geospatial interdependency. A relationship that exists entirely because of the proximity of components. For example: flooding or a fire may affect all the assets located in one building or area. [Dudenhoeffer, 2006]

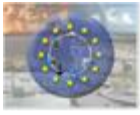
Landslide.

1. A mass of material that has moved downhill by gravity, often assisted by water when the material is saturated. The movement of soil, rock, or debris down a slope can occur rapidly, or may involve slow, gradual failure. [IPCC, 2012a]
2. In general, all varieties of slope movement, under the influence of gravity. More strictly it refers to down-slope movement of rock and/or earth masses along one or several slide surfaces. [Slandail terminology]

Land-use planning. The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses. Land-use planning is an important contributor to sustainable development. It involves studies and mapping; analysis of economic, environmental and hazard data; formulation of alternative land-use decisions; and design of long-range plans for different geographical and administrative scales. Land-use planning can help to mitigate disasters and reduce risks by discouraging settlements and construction of key installations in hazard-prone areas, including consideration of service routes for transport, power, water, sewage and other critical facilities. [Slandail terminology]

Mass movement. Mass movement in the context of mountainous phenomena refers to different types of mass transport processes including landslides, avalanches, rock fall, or debris flows. [IPCC, 2012a]

Mudflow. The down-slope transfer of fine earth material mixed with water. [Slandail terminology]



Retrofitting. Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards. [ISDR Terminology of disaster risk reduction]

Underground building. A building for which 50% or more of the Actual Cash Value (ACV), including machinery and equipment that are part of the building, is below ground. [FEMA, 2014]

3.8 Safety of Critical Infrastructures

Antiterrorism. Programs and activities, defensive in nature, used to reduce the vulnerability and attractiveness of people and property as targets of terrorism. [US Department of Energy, 1999]

Critical infrastructure security. The end goal of security is to use physical, personnel and/or cyber defence measures to reduce both the risk to critical infrastructure and the risk of loss due to a disruption in essential services by minimizing the vulnerability of critical infrastructure assets, systems and networks. [Critical Five]

Owner/Manager of critical infrastructure. Legal entities responsible for managing critical infrastructure. [Croatian Law on critical infrastructures]

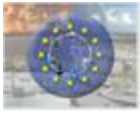
Physical security. Actions taken for the purpose of restricting and limiting unauthorized access, specifically, reducing the probability that a threat will succeed in exploiting critical infrastructure vulnerabilities including protection against direct physical attacks, e.g., through use of conventional or unconventional weapons. [US President's Commission on Critical Infrastructure Protection, 1997]

Prevention is an outright avoidance of adverse impacts of hazards and related disasters. Comment: Prevention (i.e. disaster prevention) expresses the concept and intention to completely avoid potential adverse impacts through action taken in advance. Examples include dams or embankments that eliminate flood risks, land-use regulations that do not permit any settlement in high risk zones, and seismic engineering designs that ensure the survival and function of a critical building in any likely earthquake. Very often the complete avoidance of losses is not feasible and the task transforms to that of mitigation. Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably in casual use. [SWD(2013) 134 final]

Protection of critical infrastructure. Indicates activities whose objective is to ensure functionality, continuous operation and delivery of critical infrastructure services/goods, as well as to prevent threats to critical infrastructure. [Croatian Law on critical infrastructures]

Safety. The monitoring and reduction of the risk of personnel casualties (injuries and deaths) to some acceptable level. [Slandail terminology]

Safety of infrastructures. The safety, the operation and the serviceability of large infrastructure under wind actions has recently become a topical matter. For example, harbours are generally very exposed to high wind velocities. This can give rise to great risks for structures in the sites, ships and ferries approaching or docking in port, empty containers piled and, most of all, health hazard for workers, who need to work in safety conditions also in windy days, or stop working in extreme windy days. On the other hand, frequent stops of working of port areas can produce large loss of money. Thus, the definition of operating strategies to identify the real risk conditions is an essential tool for planning the work in safety conditions. As for railways lines, wind conditions the maximum admissible velocity of high-speed trains, with effects on the entire railway network. Moreover, in some situations, strong winds might be responsible for accidents as train overturning and derailment. The medium and short-term forecast of wind intensity and direction is therefore a very important tool for the safety an operation planning of large infrastructures. On the one hand, thanks to the in situ monitoring of the wind velocity and the increasing availability of historical databases of wind records it is possible to provide the probabilistic assessment and a probabilistic-based forecast of the wind where the instrumentation is located. On the other hand, large scale numerical simulations provide a full characterization of the wind climate on large areas, and allow for correlate wind intensity and direction at different locations. Thanks to a complex transfer chain the local wind



measurements and forecast can be transformed into simulated wind speeds at the infrastructure location, providing an efficient tool to guarantee the operation safety. [WINDYN]

Safety plan from owner/manager of critical infrastructure. Indicates a plan that ensures confidentiality, integrity and availability of the organizational, human, material, information-communication and other solutions, as well as permanent and graded security measures necessary for the continuous functioning of critical infrastructure. [Croatian Law on critical infrastructures]

Secure/Security. Reducing the risk to critical infrastructure by physical means or defensive cyber measures to intrusions, attacks, or the effects of natural or manmade disasters. [US Homeland Security, 2013]

Security. All aspects related to defining, achieving, and maintaining data confidentiality, integrity, availability, accountability, authenticity, and reliability. [ENISA]

Security. The monitoring and reduction of the risk of human-induced events that adversely affect people or property (intrusion of unauthorized personnel, theft, sabotage, assault, etc.), to some acceptable level. [Slandail terminology]

Security event. Recognizable case of the state of the system which indicates a potential breach of security policy or the protection failure or previously unknown circumstances which may be important for security. [Nad et al, 2014]

Terrorism. Premeditated threat or act of violence against non-combatant persons, property, and environmental or economic targets to induce fear, intimidate, coerce, or affect a government, the civilian population, or any segment thereof, in furtherance of political, social, ideological, or religious objectives. [US Homeland Security, 2013]

Terrorism. Use of violence with the intention of bringing to political changes and creating a general feeling of anxiety and fear. [Dobranovic, 2006]

Terrorist act. Act or threat intended to advance a political, ideological or religious cause by coercing or intimidating an government or the public, by causing serious harm to people or property, endangering life, creating a serious risk to the health and safety of the public, or seriously disrupting trade, critical infrastructure or electronic systems. [Australian National Counter-Terrorism Committee, 2011]



4 Climate Change Terminology

4.1 General Terms

Albedo. The fraction of solar radiation reflected by a surface or object, often expressed as a percentage. Snow-covered surfaces have a high albedo, the surface albedo of soils ranges from high to low, and vegetation-covered surfaces and oceans have a low albedo. The Earth's planetary albedo varies mainly through varying cloudiness, snow, ice, leaf area, and land cover changes. [IPCC, 2012a]

Anthropogenic. Resulting from or produced by human beings. [IPCC, 2012a]

Anthropogenic emissions. Emissions of greenhouse gases, greenhouse gas precursors, and aerosols associated with human activities. These activities include the burning of fossil fuels, deforestation, land use changes, livestock, fertilization, etc., that result in a net increase in emissions. [IPCC, 2012a]

Atmosphere. The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium, and radiatively active greenhouse gases such as carbon dioxide (0.035% volume mixing ratio) and ozone. In addition, the atmosphere contains the greenhouse gas water vapour, whose amounts are highly variable but typically around 1% volume mixing ratio. The atmosphere also contains clouds and aerosols. [IPCC, 2012a]

Average absolute sea level change, refers to the height of the ocean surface above the centre of the earth, without regard to whether nearby land is rising or falling (US EPA, <http://www.epa.gov/climatechange/science/indicators/oceans/sea-level.html>).

Carbon cycle. The term used to describe the flow of carbon (in various forms, e.g., as carbon dioxide) through the atmosphere, ocean, terrestrial biosphere, and lithosphere. [IPCC, 2012a]

Carbon dioxide (CO₂). A naturally occurring gas fixed by photosynthesis into organic matter. A product of fossil fuel combustion and biomass burning, it is also emitted from land use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured, thus having a Global Warming Potential of 1. [IPCC, 2012a]

Change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. [IPCC, 2012a], [IPCC, 2012b]

Change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. [UNFCCC]

Climate.

1. Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. [IPCC, 2012a]
2. Long-term weather. The World Meteorological Society defines "long" as taking 30 years or longer. "Climate" refers to the long-term average (trend) and also to the size of the variations around the trend (climate variability). Modern views consider not only the long-term state of the atmosphere, but also those of the hydrosphere, cryosphere and biosphere. [CLIMATE RISK ANALYSIS]



3. in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO). [EU-ADAPT], [SWD(2013) 134 final]
4. in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. In various chapters in this report different averaging periods, such as a period of 20 years, are also used. [IPCC, 2012b] [IPCC, 2014]
5. The average of weather over at least a 30-year period. Note that the climate taken over different periods of time (30 years, 1000 years) may be different. The old saying is climate is what we expect and weather is what we get. [NOAA]

Climate (change) scenario

1. is plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships and assumptions of radiative forcing, typically constructed for explicit use as input to climate change impact models. A 'climate change scenario' is the difference between a climate scenario and the current climate. [EU-ADAPT]
2. A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate. [IPCC, 2012b]

Climate archive. Contains information about past climate changes. [CLIMATE RISK ANALYSIS]

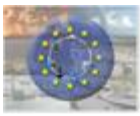
Climate and Climate change. Climate usually refers to a region's long-term weather patterns. This is measured by such statistics as average temperatures, average precipitation (i.e. the amount of annual rainfall, snow etc.), maximum and minimum temperatures throughout the seasons, sunshine hours, humidity, the frequency of extreme weather i.e. the frequency of droughts, and so on. Climate change refers to changes in these statistics over years, decades, or even centuries. [Met Office and National Research Council, 2012]

Climate change.

1. A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. [Dickson et al, 2012], [IPCC, 2012a], [Slandail terminology]
2. A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. [Dickson et al, 2012], [Slandail terminology], [Article 1, UNFCCC]
3. Changes of the mean state and/or changes of the variability of climate variables. Causes of climatic changes are natural as well as human. [CLIMATE RISK ANALYSIS],



4. Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines ‘climate change’ as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods’. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis].
5. refers to any change in climate over time, whether due to natural variability or as a result of human activity. [EU-ADAPT]
6. The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: “a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use”.
7. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods”. [ISDR Terminology of disaster risk reduction]
8. refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods’. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. [IPCC, 2014]
9. refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer. [US EPA].
10. A non-random change in climate that is measured over several decades or longer. The change may be due to natural or human-induced causes. [NOAA]
11. is a large-scale, long-term shift in the planet's weather patterns or average temperatures. [UK Met Office]
12. is a change in the pattern of weather, and related changes in oceans, land surfaces and ice sheets, occurring over time scales of decades or longer. It is a change in the statistical properties of the climate system that persists for several decades or longer—usually at least 30 years. These statistical properties include averages, variability and extremes. Climate change may be due to natural processes, such as changes in the Sun’s radiation, volcanoes or internal variability in the climate system, or due to human influences such as changes in the composition of the atmosphere or land use. (Australian Academy of Sciences, <https://www.science.org.au/publications/scienceofclimatechange-q-and-a-2015/what>)
13. refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or



external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. [IPCC, 2014]

14. Transition from one climatic condition to another, over a specified geographical region, due to various and/or fluctuations of the atmospheric circulation at time scales from decades to centuries. [DELFI Vocabulary of forest fire terms, 1999]
15. Persistent and systematic changes in the typical weather patterns, but it is different from climate variability which is associated with short-term fluctuations in climate. Whereas climatic variations include Southern Oscillations and influences from volcanic eruptions, climate change is associated with long-term changes in the Earth's energy balance due, for example, to changes in atmospheric composition. Involves changes in both physical processes such as energy flow and in climate statistics. In statistical terms, the climate is described in terms of a pdf, and a change in a pdf is by definition a climate change. Global warming is a climate change, but climate change does not necessarily entail global warming. [CGU]

Climate Change Scenario. A coherent and internally-consistent description of the change in climate by a certain time in the future, using a specific modelling technique and under specific assumptions about the growth of greenhouse gas and other emissions and about other factors that may influence climate in the future [UKCIP, 2003 – see ref. in Levina and Tirpak, 2006]

Climate feedback. An interaction mechanism between processes in the climate system is called a climate feedback when the result of an initial process triggers changes in a second process that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it. [IPCC, 2012a], [SREX, 2012]

Climate model.

1. A numerical representation of the climate system that is based on the physical, chemical, and biological properties of its components, their interactions, and feedback processes, and that accounts for all or some of its known properties. The climate system can be represented by models of varying complexity, that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical, or biological processes are explicitly represented, or the level at which empirical parameterizations are involved. Coupled Atmosphere-Ocean Global Climate Models (AOGCMs), also referred to as Atmosphere-Ocean General Circulation Models, provide a representation of the climate system that is near the most comprehensive end of the spectrum currently available. There is an evolution toward more complex models with interactive chemistry and biology. Climate models are applied as a research tool to study and simulate the climate, and for operational purposes, including monthly, seasonal, and inter-annual climate predictions. [IPCC, 2012a], [IPCC, 2012b] [IPCC, 2014]
2. **(Global Climate Models or General Circulation Models (GCMs)).** Lines of computer codes used to solve a set of mathematical equations describing the laws of physics relevant to the atmospheric and oceanic circulation, the distribution of heat and the interaction between electromagnetic radiation and atmospheric gases. Climate models constitute our theoretical knowledge of the climate system, describing interconnections between processes. The models include a description of cloud processes, land-surface characteristics and the chemical composition of the atmosphere. They consist of different modules describing the atmosphere, oceans, sea-ice/snow and the land surface, and represent the world in terms of boxes stacked next to and on top of each other. The values for temperature, motion and mass are solved in each of these boxes, based on well-known physical laws. [EUPORIAS]
3. A quantitative way of representing the interactions of the atmosphere, oceans, land surface, and ice. Models can range from relatively simple to quite comprehensive [US EPA].



4. Mathematical model for quantitatively describing, simulating, and analysing the interactions between the atmosphere and underlying surface (e.g., ocean, land, and ice). [NOAA]

Climate prediction. A climate prediction or climate forecast is the result of an attempt to produce an estimate of the actual evolution of the climate in the future, e.g., at seasonal, inter-annual or long-term time scales. See also climate projection and climate (change) scenario. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]

Climate projection.

1. The calculated response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based on simulations by climate models. Climate projections are distinguished from climate predictions, in that the former critically depend on the emissions/concentration/radiative forcing scenario used, and therefore on highly uncertain assumptions of future socio-economic and technological development. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis].
2. A projection of the response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/concentration/radiative-forcing scenario used, which are based on assumptions concerning, e.g., future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty. [IPCC, 2012a], [IPCC, 2012b], [SREX, 2012]
3. is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized. [IPCC, 2014]
4. is usually a statement about the likelihood that something will happen several decades to centuries in the future if certain influential conditions develop. In contrast to a prediction, a projection specifically allows for significant changes in the set of boundary conditions, such as an increase in greenhouse gases, which might influence the future climate. As a result, what emerge are conditional expectations (if this happens, then that is what is expected). For projections extending well out into the future, scenarios are developed of what could happen given various assumptions and judgments. [WMO]

Climate scenario. A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate. [IPCC, 2012a], [SREX, 2012]

Climate model simulations. Results from computations of climate models, often where the atmospheric greenhouse-gas concentrations, incoming solar energy, land-surface changes and/or volcanic eruptions have been specified. The mathematical equations embedded in a climate model are solved using approximations, and there are different numerical schemes for solving continuous equations in terms of discrete numbers. Sometimes, the solutions of the mathematical equations are extremely sensitive, and small differences, such as rounding errors, can lead to different outcomes after a few days (the 'butterfly effect'). Many of the mathematical equations are highly non-linear, and the circulation has a chaotic character, which is seen both in climate models and in the real world. Many of the real meteorological and



climatological phenomena are reproduced in the climate models: the Hadley cell, westerlies, the NAO, cyclones, the jet stream, ocean currents, Southern Oscillations.

Climate stationarity refers to the stationarity of extremes of climate and weather i.e. that the frequencies and intensities of extremes observed in the past adequately represent those that will occur in the future. Engineering practices and standards are typically based on assumed climate stationarity. [ASCE, 2015]

Climate system.

1. The climate system is the highly complex system consisting of five major components: the atmosphere, the oceans, the cryosphere, the land surface, the biosphere, and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forcing such as volcanic eruptions, solar variations, and anthropogenic forcing such as the changing composition of the atmosphere and land use change. [IPCC, 2012a]
2. is defined by the dynamics and interactions of five major components: atmosphere, hydrosphere, cryosphere, land surface, and biosphere. Climate system dynamics are driven by both internal and external forcing, such as volcanic eruptions, solar variations, or human-induced modifications to the planetary radiative balance, for instance via anthropogenic emissions of greenhouse gases and/or land-use changes. [EU-ADAPT]
3. The five physical components (atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere) that are responsible for the climate and its variations. [US EPA]
4. The system consisting of the atmosphere (gases), hydrosphere (water), lithosphere (solid rocky part of the Earth), and biosphere (living) that determine the Earth's climate. [NOAA]

Climate variability.

1. Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate at all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also Climate change. [IPCC, 2012a], [IPCC, 2012b] [IPCC, 2014], [EU-ADAPT]
2. Variations in the mean state and other statistics (such as standard deviations or statistics of extremes) of the climate on all time and space scales beyond that of individual weather events. Natural variations in climate over time are caused by internal processes of the climate system, such as El Niño, as well as changes in external influences, such as volcanic activity and variations in the output of the sun. [US EPA]

Cold days/cold nights. Days where maximum temperature, or nights where minimum temperature, falls below the 10th percentile, where the respective temperature distributions are generally defined with respect to the 1961-1990 reference period. [SREX-ANNEXS], [IPCC, 2012b]

Cold waves/spells. Extremely cold days or a succession of frost days with minimum temperatures below 0°C). [Diaz et al, 2008]

Detection and attribution. Detection of change is defined as the process of demonstrating that climate or a system affected by climate has changed in some defined statistical sense, without providing a reason for that change. An identified change is detected in observations if its likelihood of occurrence by chance due to internal variability alone is determined to be small, for example, <10%. Attribution is defined as the process of evaluating the relative contributions of multiple causal factors to a change or event with an assignment of statistical confidence (...). [IPCC, 2014]

Downscaling.

1. Downscaling is a method that derives local- to regional-scale (up to 100 km) information from



2. A generic term for inferring local quantities on the basis of large-scale conditions. Local climate conditions are part of a larger picture, such as the climate pattern of the surrounding region. Furthermore, the character of the local climate is strongly dependent on local geographical parameters. Climate models are known to have a minimum scale at which they give well located and accurate information, known as the minimum skilful scale, which is typically larger than the grid-box sizes. Hence, local climate information cannot be inferred directly from climate models, but can be inferred indirectly through downscaling, where the information about the dependency on the large-scale situation and the local geography is utilised. Downscaling is the process of linking local conditions to their large-scale environment. The reason for downscaling is that the global climate models are not designed to provide accurate details of local climates, partly due to their coarse representation of the world, typically a 100 km by 100 km mesh grid, and partly due to how the models compute the results, using simplified ways of describing the surface, clouds, etc. All climate models have a minimum skilful scale that is greater than their resolution (~8 by ~8 grid boxes). The rationale behind downscaling is that climate anomalies do not vary rapidly in space, and that the local climate can be expressed mathematically as a function of both geography and the large-scale conditions. [CGU]

Dynamic global vegetation model (DGVM). Models that simulate vegetation development and dynamics through space and time, as driven by climate and other environmental changes. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis].

Ensemble.

1. A group of parallel model simulations used for climate projections. Variation of the results across the ensemble members gives an estimate of uncertainty. Ensembles made with the same model but different initial conditions only characterize the uncertainty associated with internal climate variability, whereas multi-model ensembles including simulations by several models also include the impact of model differences. Perturbed parameter ensembles, in which model parameters are varied in a systematic manner, aim to produce a more objective estimate of modelling uncertainty than is possible with traditional multi-model ensembles. [IPCC, 2012a]
2. Used to describe a set of climate model simulations. In some cases, one climate model may be used to make many different simulations and hence provide an ensemble from one model. Alternatively, many different models may provide simulations for the same situation (e.g. the corresponding emission scenario) to construct multi-model ensembles. The ensembles can be used to provide an ad hoc description of uncertainties and a crude picture of conditional probabilities, although it is important to recognise that ensembles are samples of opportunity and cannot alone provide proper probability estimates. Furthermore, it is important to realise that the mean of all ensemble members (ensemble mean) brings out the common traits, such as trends, but provides a description with underestimated variance. Usually, the models describe non-linear and chaotic behaviour, where the internal variations, spontaneous variations due to past conditions rather than external influences such as ENSO and NAO, are uncorrelated amongst the members. [CGU]

Environment. Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation. [ISO/IEC 14001, 2004], [ISO/IEC 26000, 2010]

Environmental aspect. Element of an organization's activities or products or services that can interact with the environment. [ISO/IEC 14001, 2004]

Essential climate variable. It is a physical, chemical, or biological variable or a group of linked variables that critically contributes to the characterization of Earth's climate. ECV datasets provide the empirical evidence needed to understand and predict the evolution of climate (AMA). The development of ECVs allows observational datasets to be traceable to quality standards, be readily interpretable and freely available, and cover sufficiently long periods: for example, the 30 years traditionally used for calculating climate normal. [Blunden et al, 2015], [Bojinski et al, 2014]



Essential climate variables. They are climate indicators that have been defined by the Global Climate Observing System used by the UNFCCC and the IPCC to support their work (WMO). ECVs can be divided into those that are considered ‘fully monitored’ or ‘partially monitored’. [Blunden et al, 2015],[Bojinski et al, 2014].

Forecast. Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area. In meteorology a forecast refers to a future condition, whereas a warning refers to a potentially dangerous future condition. [Slandail terminology]

Forecast. Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area. [ISDR Terminology of disaster risk reduction]

Fully monitored essential climate variables. They are those which are observed and analysed across much of the world, with a sufficiently long-term dataset that has peer-reviewed documentation. [Blunden et al, 2015], [Bojinski et al, 2014]

The following are considered as fully monitored ECVs:

- **Atmospheric surface:** air temperature, precipitation, air pressure, water vapour, wind speed and direction.
- **Atmospheric upper air:** earth radiation budget, temperature, water vapour, wind speed and direction.
- **Atmospheric composition:** carbon dioxide, methane, other long-lived greenhouse gases (including nitrous oxide, chlorofluorocarbons, hydro-chlorofluorocarbons, hydrofluorocarbons), sulphur hexafluoride, and perfluorocarbons), ozone and aerosol.
- **Ocean surface:** sea-surface temperature, sea-surface salinity, sea level, sea ice, surface current, ocean colour, phytoplankton.
- **Ocean subsurface:** temperature, salinity.
- **Terrestrial:** snow cover, albedo. [Blunden et al, 2015], [Bojinski et al, 2014]

GCM. See climate model. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]

Global surface temperature. The global surface temperature is an estimate of the global mean surface air temperature. However, for changes over time, only anomalies, as departures from a climatology, are used, most commonly based on the area-weighted global average of the sea surface temperature anomaly and land surface air temperature anomaly. [IPCC, 2012a]

Human induced climate change. Human activities can influence climate by changing concentrations of CO₂ and other greenhouse gases in the atmosphere, altering the concentrations of aerosols e.g. and altering the reflectivity of Earth’s surface by changing land cover e.g. deforestation. [Australian Academy of Sciences, 2015]

Integrated assessment. An interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines so that all relevant aspects of a complex societal issue can be evaluated and considered for the benefit of decision-making. [Climate Change 2007: Synthesis Report]

Land surface air temperature. The air temperature as measured in well-ventilated screens over land at 1.5 to 2 m above the ground. [IPCC, 2012a]

Land use and land use change. Land use refers to the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have radiative forcing and/or other impacts on climate, locally or globally. [IPCC, 2012a]



Mean low water (MLW). Lowest average level water reaches on an outgoing tide. [AAPA]

Mean sea level. Sea level measured by a tide gauge with respect to the land upon which it is situated. Mean sea level is normally defined as the average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides. [IPCC, 2012a]

Mean sea level. The surface level of the ocean at a particular point averaged over an extended period of time such as a month or year. Mean sea level is often used as a national datum to which heights on land are referred. [IPCC, 2013]

Meteorological Information. Characteristics of the atmosphere (e.g., wind direction, wind speed, temperature, and precipitation) used to determine how the material will be transported through the atmosphere to the receptors, and how rapidly the receptors will be affected. [US Department of Energy, 1999]

Mitigation.

1. The action of reducing the severity, seriousness, or painfulness of the effects of incidents when they occur. [Klaver et al, 2011]
2. An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]
3. Planned and orderly efforts to prevent hazards that are preventable and lessen the impact of those that are not. Mitigation activities can act in three ways to prevent or reduce effects of potential hazards. First, they can act on the hazard to eliminate it or to reduce the frequency and intensity of its occurrence. Second, they can change the way a hazard interacts with people and their support systems. Third, they can alter the way people live and the systems they create. [Slandail terminology]
4. is the lessening or limitation of the adverse impacts of hazards and related disasters. [ISDR Terminology of disaster risk reduction]
5. Capabilities necessary to reduce loss of life and property by lessening the impact of disasters. [Source: PPD-8, 2011]
6. is the lessening or limitation of the adverse impacts of hazards and related disasters. Comment: The adverse impacts of hazards often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures encompass engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness. It should be noted that in climate change policy, “mitigation” is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change. [UNISDR]
7. Policies and action to reduce potential negative consequences of malfunctions in system’s functionality in order not to generate damages or destructions of the sensitive systems objects or even to prevent transitions of sensitive systems into crisis situations.
8. A human intervention to reduce the sources or enhance the sinks of greenhouse gases. [IPCC, 2013]
9. refers to efforts to reduce or prevent emission of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour. It can be as complex as a plan for a new city, or as simple as improvements to a cook stove design. Efforts underway around the world range from high-tech subway systems to bicycling paths and walkways. Protecting natural carbon



sinks like forests and oceans, or creating new sinks through silviculture or green agriculture are also elements of mitigation. [UNEP]

10. A human intervention to reduce the sources or enhance the sinks of greenhouse gases. [IPCC, 2012a], [IPCC, 2012b]

Mitigation (of disaster risk and disaster).

1. The lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability. [IPCC, 2012b]
2. A human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs). This report also assesses human interventions to reduce the sources of other substances which may contribute directly or indirectly to limiting climate change, including, for example, the reduction of particulate matter emissions that can directly alter the radiation balance (e.g., black carbon) or measures that control emissions of carbon monoxide, nitrogen oxides, Volatile Organic Compounds and other pollutants that can alter the concentration of tropospheric ozone which has an indirect effect on the climate. [IPCC, 2014]
3. Refers to efforts to reduce or prevent emission of greenhouse gasses. Mitigation can mean using new Technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour. [UNEP]
4. Natural variability of the climate system, in particular on seasonal and longer time scales, predominantly occurs with preferred spatial patterns and time scales, through the dynamical characteristics of the atmospheric circulation and through interactions with the land and ocean surfaces. Such patterns are often called regimes, modes, or teleconnections. Examples are the North Atlantic Oscillation (NAO), the Pacific-North American pattern (PNA), the El Niño-Southern Oscillation (ENSO), the Northern Annular Mode (NAM; previously called the Arctic Oscillation, AO), and the Southern Annular Mode (SAM; previously called the Antarctic Oscillation, AAO). [IPCC, 2012a]

Monitoring. The process of measuring certain environmental parameters on a real-time basis for spatial and time variations. For example, air monitoring may be conducted with direct-reading instruments to indicate relative changes in air contaminant concentrations at various times. [US Department of Energy, 1999]

Non-structural measures. Any measure not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education. [ISDR Terminology of disaster risk reduction]

North Atlantic Oscillation. A recurring spatial pattern of mean sea-level pressure (MSLP) characterised by low MSLP over Iceland and high over the Azores/Lisbon. The NAO expresses climate variability associated with variations in the large-scale temperature and precipitation pattern over Northern Europe. [CGU]

Parameterization. In climate models, this term refers to the technique of representing processes that cannot be explicitly resolved at the spatial or temporal resolution of the model (sub-grid scale processes) by relationships between model-resolved larger-scale flow and the area- or time-averaged effect of such sub-grid scale processes. [IPCC, 2012a]

Partially monitored ECVs. ECVs that are considered “partially monitored”, meeting some but not all of the requirements related to observations, datasets and peer documentation, include:

- **Atmospheric upper air:** cloud properties.
- **Atmospheric composition:** aerosols and their precursors [In particular nitrogen dioxide (NO₂), sulphur dioxide (SO₂), formaldehyde (HCHO) and carbon monoxide (CO)].
- **Ocean surface:** carbon dioxide, ocean acidity.
- **Ocean subsurface:** current, carbon.



- **Terrestrial:** soil moisture, permafrost, glaciers and ice caps, river discharge, groundwater, ice sheets, fraction of absorbed photo-synthetically - active radiation, biomass, fire disturbance. [Blunden et al, 2015], [Bojinski et al, 2014].

Predictability.

1. The extent to which future states of a system may be predicted based on knowledge of current and past states of the system. [IPCC, 2012a]
2. The extent to which future states of a system may be predicted based on knowledge of current and past states of the system. Because knowledge of the climate system's past and current states is generally imperfect, as are the models that utilize this knowledge to produce a climate prediction, and because the climate system is inherently nonlinear and chaotic, predictability of the climate system is inherently limited. Even with arbitrarily accurate models and observations, there may still be limits to the predictability of such a nonlinear system [AMS, 2013].

Probability density function (PDF). A probability density function is a function that indicates the relative chances of occurrence of different outcomes of a variable. The function integrates to unity over the domain for which it is defined and has the property that the integral over a sub-domain equals the probability that the outcome of the variable lies within that sub-domain. For example, the probability that a temperature anomaly defined in a particular way is greater than zero is obtained from its PDF by integrating the PDF over all possible temperature anomalies greater than zero. Probability density functions that describe two or more variables simultaneously are similarly defined. [IPCC, 2012a]

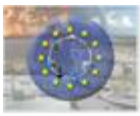
Projection.

1. A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasize that projections involve assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized, and are therefore subject to substantial uncertainty. See also Climate projection. [IPCC, 2012a]
2. The potential evolution of a quality or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasise that projections involve assumptions – concerning, for example, future socio-economic and technological developments, that may or may not be realised – and are therefore subject to substantial uncertainty. [Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability]
3. A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized. [IPCC, 2014]

Proxy climate indicator. A proxy climate indicator is a local record that is interpreted, using physical and biophysical principles, to represent some combination of climate-related variations back in time. Climate-related data derived in this way are referred to as proxy data. Examples of proxies include pollen analysis, tree ring records, characteristics of corals, and various data derived from ice cores. The term 'proxy' can also be used to refer to indirect estimates of present-day conditions, for example, in the absence of observations. [IPCC, 2012a]

Rainfall. The amount of precipitation of any type, primarily liquid. It is usually the amount that is measured by a rain gauge. [Slandail terminology]

RCP. The Representative Concentration Pathways (RCP) are based on selected scenarios from four modelling teams/models working on integrated assessment modelling, climate modelling, and modelling and analysis of impacts. The RCPs are not new, fully integrated scenarios (i.e., they are not a complete package of socioeconomic, emissions, and climate projections). They are consistent sets of projections of



only the components of radiative forcing (the change in the balance between incoming and outgoing radiation to the atmosphere caused primarily by changes in atmospheric composition) that are meant to serve as input for climate modelling. Conceptually, the process begins with pathways of radiative forcing, not detailed socioeconomic narratives or scenarios. Central to the process is the concept that any single radiative forcing pathway can result from a diverse range of socioeconomic and technological development scenarios [WMO, Emission Scenarios]

Overview of Representative Concentration Pathways (RCPs): [WMO, Emission Scenarios]

RCP 8.5 - Rising radiative forcing pathway leading to 8.5 W/m² in 2100

RCP 6 - Stabilization without overshoot pathway to 6 W/m² at stabilization after 2100

RCP 4.5 - Stabilization without overshoot pathway to 4.5 W/m² at stabilization after 2100

RCP 3-PD2- Peak in radiative forcing at ~ 3 W/m² before 2100 and decline

RCM. Regional climate model. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]

Reanalysis.

1. Reanalyses are atmospheric and oceanic analyses of temperature, wind, current, and other meteorological and oceanographic quantities, created by processing past meteorological and oceanographic data using fixed state-of-the-art weather forecasting models and data assimilation techniques. Using fixed data assimilation avoids effects from the changing analysis system that occur in operational analyses. Although continuity is improved, global reanalyses still suffer from changing coverage and biases in the observing systems. [IPCC, 2012a]
2. The results of an atmospheric model that has used observational data to guide (constrain) it to the actual atmospheric state. Often, reanalyses use advanced methods for determining the model state known as data assimilation, and use all available data – surface observations, satellite retrievals, and data from aircraft, buoys, radiosondes and ships. The reanalyses provide the best picture we have of the present state of the atmosphere. [CGU]

Regional climate models. Climate models designed for a specific region, with much in common with global climate models. Some main differences include lateral boundaries imposed on the results at the edge of the region described. The RCMs are nested into global climate model results, taking the results from the global climate models (GCMs) as boundary values. They may also differ in the way they represent cloud processes, exchanges of heat and mass at the surface, atmospheric composition, solar energy and volcanism. Furthermore, RCMs tend to include a more detailed description of orography, with higher mountains, and therefore provide a different description of the surface winds and orthographically forced precipitation to that of the GCM results in which it is embedded. The RCM results tend to contain systematic errors (biases), partly due to the simplified view of the world (parameterisation schemes, lack of coupling between the lower surface and the atmosphere, etc.), minimum skilful scale, the minimum scale at which global-scale models can be expected to give good local scale prediction and the fact that the RCM results do not directly correspond to observations (the former are volume averages whereas the latter are typically point measurements). Furthermore, RCM results are prone to biases in the GCM result in which they are nested. [CGU]

Return value analysis. A method for estimating the average recurrence time between events (return period) or the magnitude of an event (return value). [CGU]

Scenario. A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a 'narrative storyline'. [Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability]

Spatial and temporal scales. Climate may vary on a large range of spatial and temporal scales. Spatial scales may range from local (less than 100 000 km²), through regional (100 000 to 10 million km²) to



continental (10 to 100 million km²). Temporal scales may range from seasonal to geological (up to hundreds of millions of years). [IPCC, 2013]

Structural measures. Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard- resistance and resilience in structures or systems. [ISDR Terminology of disaster risk reduction]

Structural mitigation measures. Measure taken to protect people and property, that counteracts the flood event in order to reduce the hazard or to influence the course or probability of occurrence of the event. Often used as synonym for active protection measures. [FMMEP, 2007]

Sustainable development. Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. [IPCC, 2012a]

The rest of ECVs. Remaining ECVs that are desired for the future include:

- **Atmospheric surface:** surface radiation budget.
- **Ocean surface:** sea state.
- **Ocean subsurface:** nutrients, ocean tracers, ocean acidity, oxygen.
- **Terrestrial:** water use, land cover (including vegetation type), lakes, leaf area index, soil carbon. [Blunden et al, 2015], [Bojinski et al, 2014].

Warm days/warm nights. Days where maximum temperature, or nights where minimum temperature, exceeds the 90th percentile, where the respective temperature distributions are generally defined with respect to the 1961-1990 reference period. [IPCCS, 2012]

Weather. Describes the state of the atmosphere. The major weather variables are temperature and precipitation. [CLIMATE RISK ANALYSIS]. "Weather" refers to the short-term average (trend) and also to the size of the variations around the trend (weather variability). [CLIMATE RISK ANALYSIS]. "Short-term" means usually variations taking place over a period of 30 years or less. [CLIMATE RISK ANALYSIS]

4.2 Climate Hazards – Extreme Weather Events

Abrupt climate change.

1. The nonlinearity of the climate system may lead to abrupt climate change, sometimes called rapid climate change, abrupt events, or even surprises. The term abrupt often refers to time scales faster than the typical time scale of the responsible forcing. However, not all abrupt climate changes need be externally forced. Some changes may be truly unexpected, resulting from a strong, rapidly changing forcing of a nonlinear system. [IPCC, 2012a]
2. The nonlinearity of the climate system may lead to abrupt climate change, sometimes called rapid climate change, abrupt events or even surprises. The term abrupt often refers to time scales faster than the typical time scale of the responsible forcing. However, not all abrupt climate changes need be externally forced. Some possible abrupt events that have been proposed include a dramatic reorganisation of the thermohaline circulation, rapid deglaciation and massive melting of permafrost or increases in soil respiration leading to fast changes in the carbon cycle. Others may be truly unexpected, resulting from a strong, rapidly changing forcing of a nonlinear system. [SWD(2013) 134 final]

Climate extreme (extreme weather or climate event). An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season). [IPCC, 2014]

**Climate risk.**

1. Denotes the result of the interaction of physically defined hazards with the properties of the exposed systems—that is, their sensitivity or social vulnerability. Risk can also be considered as combining an event, its likelihood, and its consequences—that is, risk equals the probability of climate hazard multiplied by a given system's vulnerability. Climate risk management, on the other hand, implies climate-sensitive decision making in dealing with climate variability and change, and promotes sustainable development by reducing vulnerabilities associated with climate risk. [Dickson, 2012]
2. Risk that variables in the climate/weather system reach values that affect human life adversely. This relates to extreme values of the climate or weather variables: high wind speed (storm), high river water stages (flood), low water stages (drought), and so forth. [CLIMATE RISK ANALYSIS]. This general, "anthropocentric" definition can, of course, be adapted to satisfy the needs of specific groups: companies interested more in economic values, a home owner wishing to protect his or her home against flood risk, or conservationists wishing for an ecosystem to survive without species losses. The crucial point is that when climate changes, climate risk can change. Acquiring knowledge about climate risks is the first step toward managing it, reducing it, or living with it. This knowledge is acquired by means of climate risk analysis. [CLIMATE RISK ANALYSIS]

Climate risk analysis. In risk analysis of climate or weather data, the objective is to quantify the climate risk. Climate risk analysis includes data selection and generation, adaptation of risk analysis methods and the interpretation of the results. Climate risk analysis is the initial step in managing the risk, and in making decisions in what can be a challenging situation. [CLIMATE RISK ANALYSIS]

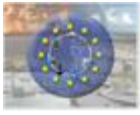
Climate sensitivity.

1. The equilibrium temperature rise that would occur for a doubling of CO₂ concentration above pre-industrial levels. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]
2. In IPCC reports, equilibrium climate sensitivity refers to the equilibrium change in the annual mean global surface temperature following a doubling of the atmospheric equivalent carbon dioxide concentration. Due to computational constraints, the equilibrium climate sensitivity in a climate model is usually estimated by running an atmospheric general circulation model coupled to a mixed-layer ocean model, because equilibrium climate sensitivity is largely determined by atmospheric processes. Efficient models can be run to equilibrium with a dynamic ocean. The effective climate sensitivity is a related measure that circumvents the requirement of equilibrium. It is evaluated from model output for evolving non-equilibrium conditions. It is a measure of the strengths of the climate feedbacks at a particular time and may vary with forcing history and climate state. The climate sensitivity parameter (units: °C (W m⁻²)⁻¹) refers to the equilibrium change in the annual mean global surface temperature following a unit change in radiative forcing. The transient climate response is the change in the global surface temperature, averaged over a 20-year period, centred at the time of atmospheric carbon dioxide doubling, that is, at year 70 in a 1 % yr⁻¹ compound carbon dioxide increase experiment with a global coupled climate model. It is a measure of the strength and rapidity of the surface temperature response to greenhouse gas forcing. [EU-ADAPT]

Climate threshold. A critical limit within the climate system that induces a non-linear response to a given forcing. See also Abrupt climate change. [IPCC, 2012a], [IPCC, 2012b], [SREX, 2012]

Desertification is the persistent degradation of dry land ecosystems by human activities — including unsustainable farming, mining, overgrazing and clear-cutting of land — and by climate change. Desertification occurs when:

- the tree and plant cover that binds the soil is removed. It occurs when trees and bushes are stripped away for fuelwood and timber, or to clear land for cultivation.



- animals eat away grasses and erode topsoil with their hooves.
- intensive farming depletes the nutrients in the soil.

Wind and water erosion aggravate the damage, carrying away topsoil and leaving behind a highly infertile mix of dust and sand. It is the combination of these factors that transforms degraded land into desert. [UN, <http://www.un.org/en/events/desertificationday/background.shtml>]

Drought.

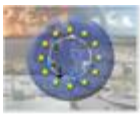
1. A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture drought, also termed agricultural drought), and during the runoff and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a meteorological drought. A mega-drought is a very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more. [IPCC, 2012a], [IPCC, 2012b]
2. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some “normal” or average amount) and the duration of the dry period. Simple definitions relate actual precipitation departures to average amounts on monthly, seasonal, or annual timescales. However, meteorological drought also depends on other quantities such as evaporation that depend on variables such as temperature. [Stephenson, 2008]
3. The phenomenon that exists when precipitation is significantly below normal recorded levels, causing serious hydrological imbalances that often adversely affect land resources and production systems. [Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability]
4. The primary cause of any drought is a lack of rainfall. Drought is different from other hazards in that it develops slowly, sometimes over years, and its onset can be masked by a number of factors. Drought can be devastating: water supplies dry up, crops fail to grow, animals die and malnutrition and ill health become widespread. [WMO, NATURAL HAZARDS]
5. A temporary dry period, in contrast to the permanent aridity in arid areas. While there is no universal definition, drought is often classified into the following three types:
 - meteorological drought: defined as prolonged abnormal deficit of precipitation
 - agricultural drought: also soil-moisture drought – a precipitation shortage during the growing season that affects agriculture or ecosystem functions;
 - hydrological drought: below-normal stream flow, lake and groundwater levels.

Integrated approaches define droughts not only as a lack of rain but more generally as an excess of demand (potential evapotranspiration and runoff) over supply (precipitation), which is a first-order approximation for the drying of the land surface. There is a wide variety of different drought indices, which, depending on their use, differ in combining information on precipitation, evapotranspiration, runoff, temperature and soil moisture. Depending on the type of drought considered, conclusions regarding regional trends may differ. [CGU]

Dust storm. When winds are strong and other (near-) surface atmospheric conditions (such as turbulence level, stability, soil moisture) are favourable, large amounts of sand and dust can be lifted from bare, dry soils into the atmosphere. Every year about 1.5 Giga tons (Gt) of sand and dust are emitted from deserts into the atmosphere (the flux is estimated to be between 1.0 and 2.15 Gt per year). [WMO, https://www.wmo.int/pages/prog/arep/wwrp/new/SDS_WAS_background.html]

Early warning system.

1. The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to



prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. [IPCC, 2012a]

2. can be defined as a set of capacities needed to generate and disseminate timely and meaningful warning information of the possible extreme events or disasters (e.g. floods, drought, fire, earthquake and tsunamis) that threatens people's lives. The purpose of this information is to enable individuals, communities and organizations threatened to prepare and act appropriately and in sufficient time to reduce the possibility of harm, loss or risk. [WMO, 2010]

El Niño-Southern oscillation phenomenon. A complex interaction of the tropical Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world, often with significant impacts over many months, such as altered marine habitats, rainfall changes, floods, droughts, and changes in storm patterns. [ISDR Terminology of disaster risk reduction]

Emissions scenario.

1. A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse gases, aerosols), based on a coherent and internally consistent set of assumptions about driving forces (such as technological change, demographic and socioeconomic development) and their key relationships. Concentration scenarios, derived from emissions scenarios, are used as input to a climate model to compute climate projections. [IPCC, 2012a]
2. describe future releases into the atmosphere of greenhouse gases, aerosols, and other pollutants and, along with information on land use and land cover, provide inputs to climate models. They are based on assumptions about driving forces such as patterns of economic and population growth, technology development, and other factors. Levels of future emissions are highly uncertain, and so scenarios provide alternative images of how the future might unfold. They provide an appropriate tool with which to analyse how driving forces may influence future emission outcomes and to assess the associated uncertainties. They assist in climate change analysis, including climate modelling and the assessment of impacts, adaptation, and mitigation. The possibility that any single emissions path will occur as described in scenarios is highly uncertain. [WMO, Emission scenarios]

Environmental impact. Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects. [ISO/IEC 14001, 2004]

Extratropical cyclone. A large-scale (of order 1000 km) storm in the middle or high latitudes having low central pressure and fronts with strong horizontal gradients in temperature and humidity. A major cause of extreme wind speeds and heavy precipitation especially in wintertime. [IPCC, 2014]

Extreme (weather and climate) events comprise a facet of climate variability under stable or changing climate conditions. They are defined as the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends ('tails') of the range of observed values of the variable. [SREX Ch1]

Extreme coastal high water (also referred to as extreme sea level). Extreme coastal high water depends on average sea level, tides, and regional weather systems. Extreme coastal high water events are usually defined in terms of the higher percentiles (e.g., 90th to 99.9th) of a distribution of hourly values of observed sea level at a station for a given reference period. [IPCC, 2012a], [SREX, 2012]

Extreme cold. What constitutes extreme cold and its effects can vary across different areas of the country. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Whenever temperatures drop decidedly below normal and as wind speed increases, heat can leave your body more rapidly. These weather-related conditions may lead to serious health problems. Extreme cold is a dangerous situation that can bring on health emergencies in susceptible people, such as



those without shelter or who are stranded, or who live in a home that is poorly insulated or without heat. [Slandail terminology]

Extreme heat. Conditions of extreme heat are defined as summertime temperatures that are substantially hotter and/or more humid than average for location at that time of year. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Extremely dry and hot conditions can provoke dust storms and low visibility. Droughts occur when a long period passes without substantial rainfall. A heat wave combined with a drought is a very dangerous situation. [Slandail terminology]

Extreme events are events that have extreme values of certain important meteorological variables. Damage is often caused by extreme values of certain meteorological variables, such as large amounts of precipitation (e.g., floods), high wind speeds (e.g., cyclones), high temperatures (e.g., heat waves), etc. Extreme is generally defined as either taking maximum values or exceedance above pre-existing high thresholds. Such events are generally rare; for example, extreme wind speeds exceeding the 100-year return value, which have a probability of only 0.01 of occurring in any particular year. Extreme events have attributes such as: rate (probability per unit time) of occurrence, magnitude (intensity), temporal duration and timing, spatial scale (footprint), multivariate dependencies. [Stephenson, 2008]

Extreme weather is when a weather event is significantly different from the average or usual weather pattern. This may take place over one day or a period of time. [Global Issues Resources]

Extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of the observed probability density function. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. Single extreme events cannot be simply and directly attributed to anthropogenic climate change, as there is always a finite chance the event in question might have occurred naturally. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g. drought or heavy rainfall over a season). [EU-ADAPT], [IPCC, 2014]

Fog. Extremely low visibility has major impacts on various sectors such as aviation and road transport. [Diaz et al, 2008]

Frozen ground. Soil or rock in which part or all of the pore water is frozen. Perennially frozen ground is called permafrost. Ground that freezes and thaws annually is called seasonally frozen ground.

Geological hazard. Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Geological hazards include internal earth processes, such as earthquakes, volcanic activity and emissions, and related geophysical processes such as mass movements, landslides, rockslides, surface collapses, and debris or mud flows. Hydro-meteorological factors are important contributors to some of these processes. Tsunamis are difficult to categorize; although they are triggered by undersea earthquakes and other geological events, they are essentially an oceanic process that is manifested as a coastal water-related hazard. [Slandail terminology]

Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of radiative forcing caused by anthropogenic emissions.

Greenhouse effect. Greenhouse gases effectively absorb thermal infrared radiation, emitted by the Earth's surface, by the atmosphere itself due to the same gases, and by clouds. Atmospheric radiation is emitted to all sides, including downward to the Earth's surface. Thus, greenhouse gases trap heat within the surface-troposphere system. This is called the greenhouse effect. Thermal infrared radiation in the troposphere is strongly coupled to the temperature of the atmosphere at the altitude at which it is emitted. In the troposphere, the temperature generally decreases with height. Effectively, infrared radiation emitted to space originates from an altitude with a temperature of, on average, -19°C, in balance with the net



incoming solar radiation, whereas the Earth's surface is kept at a much higher temperature of, on average, 14°C. An increase in the concentration of greenhouse gases leads to an increased infrared opacity of the atmosphere and therefore to an effective radiation into space from a higher altitude at a lower temperature. This causes a radiative forcing that leads to an enhancement of the greenhouse effect, the so-called enhanced greenhouse effect. [IPCC, 2012a]

Greenhouse gas. Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, which absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), and ozone (O₃) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Besides CO₂, N₂O, and CH₄, the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride (SF₆), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). [IPCC, 2012a]

Gust. A rapid increase in the strength of the wind relative to the mean strength at the time [Singh, 2004]

Hail. Solid precipitation in the form of balls or pieces of ice (hailstones) with diameters ranging from 5 to 50 mm or even more. [Singh, 2004]

Hazard.

1. A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. The hazards of concern to disaster risk reduction as stated in footnote 3 of the Hyogo Framework are "... hazards of natural origin and related environmental and technological hazards and risks." Such hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological, and technological sources, sometimes acting in combination. In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis. [Slandail terminology]
2. The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. [UNSIRD], [IPCC, 2012b]
3. is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Comment: [...] In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis. [UNISDR]
4. The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts. [IPCC, 2014]
5. is a situation (physical event, phenomenon or human activity) with the potential to result in harm A hazard does not necessarily lead to harm – it can be managed. [EAFDG, 2010]
6. A physical event, phenomenon or human activity with the potential to result in harm. A hazard does not necessarily lead to harm. [FLOODsite, 2009]

Heat wave.



1. 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. [International Meteorological Vocabulary, WMO - No. 182]
2. Persistent hot conditions (extreme temperatures) often associated with drought and high pressure blocking. Typically, a heat wave is declared once it has been hotter than a particular temperature for a number of days, though there is no universal definition. The threshold temperature should be defined according to the impact of interest and the local adaptation level. [CGU]
3. A period of abnormally hot weather. Heat waves and warm spells have various and in some cases overlapping definitions. [IPCC, 2012b], [IPCC, 2012a]
4. Periods of exceptionally warm temperatures can have profound impacts on human health and agriculture. Duration is a key component determining the impact. [Diaz et al, 2008]
5. Heat waves are most deadly in mid-latitude regions, where they concentrate extremes of temperature and humidity over a period of a few days in the warmer months. The oppressive air mass in an urban environment can result in many deaths, especially among the very young, the elderly and the infirm. In 2003, much of Western Europe was affected by heat waves during the summer months. In France, Italy, The Netherlands, Portugal, Spain and the United Kingdom, they caused some 40 000 deaths. Extremely cold spells cause hypothermia and aggravate circulatory and respiratory diseases. [WMO, NATURAL HAZARDS]
6. can be defined as a period of abnormally and uncomfortably hot weather. [IPCC 5th Assessment Report, WG 1 Glossary]
7. The World Meteorological Organization's definition of a heatwave is "when the daily maximum temperature of more than five consecutive days exceeds the average maximum temperature by 5 °C, the normal period being 1961-1990".
8. A heatwave is an extended period of hot weather relative to the expected conditions of the area at that time of year. [UK Met Office]

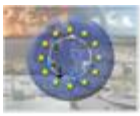
Hurricanes. Name given to a warm core tropical cyclone with maximum surface wind of 118 km•h⁻¹ (64 knots, 74 mph) or greater (hurricane force wind) in the North Atlantic, the Caribbean and the Gulf of Mexico, and in the Eastern North Pacific Ocean.

(2) A tropical cyclone with hurricane force winds in the South Pacific and South-East Indian Ocean. [International Meteorological Vocabulary, WMO - No. 182]

Hydrological drought occurs when there is a deficit in the supply of surface and subsurface water (Drought: Past Problems and Future Scenarios). It occurs due to precipitation deficits over a prolonged period that affect surface or subsurface water supply, thus reducing streamflow, groundwater, reservoir, and lake levels. [Heim, 2002]

Hydrometeorological hazard.

1. Process or phenomenon of atmospheric, hydrological or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Hydro-meteorological hazards include tropical cyclones (also known as typhoons and hurricanes), thunderstorms, hailstorms, tornados, blizzards, heavy snowfall, avalanches, coastal storm surges, floods including flash floods, drought, heatwaves and cold spells. Hydrometeorological conditions also can be a factor in other hazards such as landslides, wild land fires, locust plagues, epidemics, and in the transport and dispersal of toxic substances and volcanic eruption material. [Slandail terminology]
2. is process or phenomenon of atmospheric, hydrological or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. [UNISDR], [ISDR Terminology of disaster risk



reduction]. Comment: Hydro-meteorological hazards include tropical cyclones (also known as typhoons and hurricanes), thunderstorms, hailstorms, tornados, blizzards, heavy snowfall, avalanches, coastal storm surges, floods including flash floods, drought, heat waves and cold spells. Hydro-meteorological conditions also can be a factor in other hazards such as landslides, wild land fires, locust plagues, epidemics, and in the transport and dispersal of toxic substances and volcanic eruption material. [UNISDR]

Ionization. The process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, or nuclear radiations are possible causes of ionization. [US Department of Energy, 1999]

Mega drought is a long-drawn out and pervasive drought, lasting much longer than normal, usually a decade or more. [IPCC, 2013]

Meteorological drought occurs when there is a significant negative deviation from mean precipitation (Drought: Past Problems and Future Scenarios) i.e. when there are atmospheric conditions resulting in the absence or reduction of precipitation. [Heim, 2002]

Multi-hazard assessments (Hazard) determine the likelihood of occurrence of different hazards either occurring at the same time or shortly following each other, because they are dependent from one another or because they are caused by the same triggering event or hazard, or merely threatening the same elements at risk(vulnerable/ exposed elements) without chronological coincidence. [SEC(2010)1626]

Natural hazard (Hazard).

1. The source of harm or difficulty created by a meteorological, environmental, or geological phenomenon or combination of phenomena. It can occur without warning. [DHS 2010]
2. Natural hazards are severe and extreme weather and climate events that occur naturally in all parts of the world, although some regions are more vulnerable to certain hazards than others. Natural hazards become natural disasters when people's lives and livelihoods are destroyed. Human and material losses caused by natural disasters are a major obstacle to sustainable development. By issuing accurate forecasts and warnings in a form that is readily understood and by educating people how to prepare against such hazards, before they become disasters, lives and property can be protected. [WMO, Natural Hazards].

Prevention of pollution. Use of processes, practices, techniques, materials, products, services or energy to avoid, reduce or control (separately or in combination) the creation, emission or discharge of any type of pollutant or waste, in order to reduce adverse environmental impacts. [ISO/IEC 14001, 2004]

Preventive action. Action to eliminate the cause of a potential nonconformity. [ISO/IEC 14001, 2004]

Relative and absolute sea level trends. The two types of sea level data (relative and absolute) complement each other, and each is useful for different purposes. Relative sea level trends show how sea level change and vertical land movement together are likely to affect coastal lands and infrastructure, while absolute sea level trends provide a more comprehensive picture of the volume of water in the world's oceans, how the volume of water is changing, and how these changes relate to other observed or predicted changes in global systems (e.g., increasing ocean heat content and melting polar ice caps). [US EPA, Technical Documentation: Sea Level, 2015]

Relative sea level change is how the height of the ocean rises or falls relative to the land at a particular location. [US EPA, <http://www.epa.gov/climatechange/science/indicators/oceans/sea-level.html>)]

Sea-level rise. An increase in the mean level of the ocean. Eustatic sea-level rise is a change in global average sea level brought about by an increase in the volume of the world ocean. Relative sea-level rise occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence. In areas subject to rapid land-level uplift, relative sea level can fall. [Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability]



Significant wave height. The average height of the highest one-third of the wave heights (trough to peak) from sea and swell occurring in a particular time period.

Socio-economic drought. A combination of meteorological, hydrological and agricultural drought leading to undesirable social and economic impacts. [IPCC, 2013]

Socio-natural hazard. The phenomenon of increased occurrence of certain geophysical and hydro-meteorological hazard events, such as landslides, flooding, land subsidence and drought, that arise from the interaction of natural hazards with overexploited or degraded land and environmental resources. This term is used for the circumstances where human activity is increasing the occurrence of certain hazards beyond their natural probabilities. Evidence points to a growing disaster burden from such hazards. Socio-natural hazards can be reduced and avoided through wise management of land and environmental resources. [Slandail terminology]

Soil moisture or agricultural drought. An agricultural drought arises due to a deficit in soil moisture, driven by meteorological and hydrological drought, that reduces the supply of moisture for vegetation (Drought: Past Problems and Future Scenarios). Agricultural drought relates to moisture deficits in the topmost 1 metre or so of soil (the root zone) that affect crops. [IPCC, 2007]

SRES. The storylines and associated population, GDP and emissions scenarios associated with the Special Report on Emissions Scenarios (SRES) (Nakićenović et al., 2000), and the resulting climate change and sea-level rise scenarios. Four families of socio-economic scenario (A1, A2, B1 and B2) represent different world futures in two distinct dimensions: a focus on economic versus environmental concerns, and global versus regional development patterns. [Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability]

Storm. High wind speed, above some defined threshold. [CLIMATE RISK ANALYSIS]

Storm surge. The temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). The storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place. [IPCC], [IPCC, 2013]

Storm tide is the water level rise during a storm due to the combination of storm surge and the astronomical tide e.g. A 15 ft. storm surge on top of a high tide that is 2 ft. above mean sea level produces a 17 ft. storm tide. [NOAA, Introduction to Storm Surge]

Storm tracks. Regions with a high frequency of storms. The storms tend to have a preference for the north-eastern part of the North Atlantic, but are affected by the NAO. [CGU]

Storms. 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). [International Meteorological Vocabulary, WMO - No. 182]

Thermal expansion. In connection with sea level, this refers to the increase in volume (and decrease in density) that results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence an increase in sea level. [IPCC, 2013]

Weather and climate extremes are defined as rare events within the statistical reference distribution of particular weather elements at a particular place [WMO, 2009]

4.3 Flood

AMAX is series of data giving the largest value of river flow (or level) in each year of record [EAFDG, 2010]

Annual average damages. The average flood damages that are predicted to occur annually, and could include damages to people, property and the environment. [DEFRA, 2010]



Annual exceedance probability is the estimated probability of a flood of given magnitude occurring or being exceeded in any year. Expressed as, for example, 1 in 100 chance or 1 per cent. [PPS25, 2009]

Annual exceedance probability. The chance of a flood of a given size (or larger) occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m³/s has an AEP of 5%, it means that there is a 5% chance (i.e. a 1 in 20 chance) of a peak discharge of 500 m³/s (or larger) occurring in any one year. [ESA, 2015]

Annual exceedance probability. Probability of exceeding a specified flow or level in any year (inverse of the return period for an annual maximum series). [EAFDG, 2010]

Attenuation. The reduction in the peak discharge of a flood which may occur as the flood passes downriver, including the effects of any flood storage ponds and reservoirs. [EAFDG, 2010]

Attenuation. Reduction of peak flow and increased duration of a flow event. [PPS25, 2009]

Average annual damage. Depending on its size (or severity), each flood will cause a different amount of flood damage. The average annual damage is the average damage in dollars per year that would occur in a designated area (e.g. the Innisfail area) from flooding over a very long period of time. In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there will be major flood damage (caused by large, rare flood events). Estimation of the average annual damage provides a basis for comparing the effectiveness of different floodplain management measures (i.e. the reduction in the annual average damage). [ESA, 2015]

Average recurrence interval. The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge as great as (or greater than) the 20yr ARI design flood will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. (see also annual exceedance probability). [ESA, 2015]

Base flood. The flood having a 1% chance of being equalled or exceeded in any given year. [floodsmart.gov]

Base flow. Sustained flow of a stream in the absence of direct runoff. It includes natural and human-induced stream flows. Natural base flow is sustained largely by ground-water discharges. [USGS, 2015]

Base flow. That part of the flow in a watercourse that emerges from groundwater storage. [EAFDG, 2010]

Benefit-cost ratio. A ratio of the present benefits and costs of an option. A BCR of >1 indicates benefits are greater than costs Biodiversity Action Plan Each Local Biodiversity Action Plan works on the basis of partnership to identify local priorities and to determine the contribution they can make to the delivery of the national Species and Habitat Action Plan targets. [DEFRA, 2010]

Catchment. The catchment at a particular point is the area of land that drains to that point. [ESA, 2015]

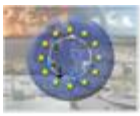
Catchment. An area that serves a river with rainwater. Every part of land where the rainfall drains to a single watercourse is in the same catchment. Charges scheme – Tariffs setting out retail and wholesale charges that incumbent water companies charge their customers. [WBG, 2013]

Catchment. The area drained, either naturally or with artificial assistance, by a watercourse, including all drainage channels, tributaries, floodplains, estuaries and areas of water storage. [PPS15, 2006]

Catchment flood management plan. A strategic planning tool through which the Environment Agency works with other key decision-makers within a river catchment to identify and agree policies for sustainable flood risk management. [DEFRA, 2010]

Catchment, catchment area. The land (and its area) which drains (normally naturally) to a given point on a river, drainage system or other body of water. [EAFDG, 2010], [EAWFD, 2010]

Coastal floods. Inundation of land areas adjacent to the coast by any type of waters and any cause. [SMARTeST, 2011]



Coastal inundation is the flooding of normally dry, low-lying coastal land, primarily caused by severe weather events along the coasts, estuaries, and adjoining rivers. [NOAA, <http://www.stormsurge.noaa.gov/>]

Combined sewer overflow. Combined sewer overflow is the discharge of untreated wastewater from a sewer system that carries both sewage and storm water (a combined sewerage system) during a rainfall event. The increased flow caused by the storm water runoff exceeds the sewerage system's capacity and the sewage is allowed to overflow into streams and rivers through CSO outfalls. [DEFRA, 2010]

Coping capacity. The means by which people or organisations use available resources and abilities to face adverse consequences that could lead to a disaster. [FLOODsite, 2009]

Cost benefit analysis. The process of assesses the relationship between the cost of an undertaking and value of the resulting benefit. [SMARTeST, 2011]

Cost effectiveness analysis. A technique which seeks to identify the least cost option for meeting a particular objective. It enables prioritisation between options, but ultimately does not assess whether an option is economically worthwhile (cost benefit analysis would be employed to do this). [EAWFD, 2010]

Cost-benefit analysis. Analysis which quantifies in monetary terms the costs and benefits of a proposed scheme, including items which the market does not provide a readily available monetary value. Sometimes referred to as Benefit-Cost Analysis. [DEFRA, 2010]

Damage. A description of the value of social, economic and ecological impacts (harm) caused by a flood [FMMEP, 2007]

Design criteria. A set of standards agreed by the developer, planners and regulators that the proposed system should satisfy. [Balmforth et al, 2006 via Spekkers], [SMARTeST, 2011]

Design discharge. See Design standard and Design flood [FLOODsite, 2009]

Design event.

1. Hypothetical event defined as the basis for the design of structures and/or activities to mitigate / eliminate the event's potential for injury or damage. [FMMEP, 2007]
2. A historic or notional flood event of a given annual flood probability, against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed. [PPS25, 2009]

Design flood.

1. Magnitude of the flood adopted for the design of the whole or part of a flood defence system, usually defined in relation to the severity of the flood in terms of its return period. [EAFDG, 2010]
2. A hypothetical flood representing a specific likelihood of occurrence (for example the 100 year or 1% probability flood). The design flood may comprise two or more single source dominated floods. Development Existing or proposed works that may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings. [ESA, 2015]

Design flood level. The maximum estimated water level during the design event. [PPS25, 2009]

Design standard. A performance indicator that is specific to the engineering of a particular defence to meet a particular objective under a given loading condition. Note: the design standard will vary with load, for example there may be different performance requirements under different loading conditions. [FLOODsite, 2009]

Design system. Two or more defences acting to achieve common goals (e.g. maintaining flood protection to a floodplain area/ community). [FLOODsite, 2009]

Deterministic. A method of process of calculation that adopts precise single values (without random variation) for the input variables, and gives a single defined result. [EAFDG, 2010]



Deterministic process/method. A method or process that adopts precise, single-values for all variables and input values, giving a single value output. [FLOODsite, 2009]

Digital elevation model. A model of the elevation of the ground surface and includes building, vegetations etc. [DEFRA, 2010]

Digital terrain model. A model of the terrain of the earth's surface ('bare earth') Discounting A method used to convert future benefits or costs to present values, using the discount rate. [DEFRA, 2010]

Direct, tangible damage. Direct damages are those where the loss is due to direct contact with flood water, such as damage to buildings and their contents. These are tangible when they can be easily specified in monetary terms. [FLOODsite, 2009]

Discharge. The volume of water that passes through a channel cross section in unit time, normally expressed at cubic metres per second (m³ /s) in fluvial design (often more simply referred to as 'flow') [EAFDG, 2010]

Discharge. The rate of flow of water measured in terms of volume over time (i.e. the amount of water moving past a point). Discharge and flow are interchangeable. [ESA, 2015]

Discharge (stream, river) as measured by volume per unit of time. [FLOODsite, 2009]

Drainage. Assessment a statement of the drainage issues relevant to a development proposal and the measures to provide the appropriate standard of drainage. The detail of the assessment will be proportionate to the nature of the proposal. (It may also be called a Drainage Impact Assessment. [PPS15, 2006]

Drainage basin. Land area where precipitation runs off into streams, rivers, lakes, and reservoirs. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large drainage basins, like the area that drains into the Mississippi river contain thousands of smaller drainage basins. Also called a "watershed." [USGS, 2015]

Dredging. Underwater excavation, usually including removal of the excavated material. [EAFDG, 2010]

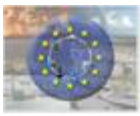
Economic analysis. Economic analysis aims for the comparison, with money as the index, of those costs and benefits to the wider economy that can be reasonably quantified, including all social costs and benefits of a project. [FMMEP, 2007]

Effective warning time. The available time that a community has from receiving a flood warning to when the flood reaches them. [ESA, 2015]

Erosion.

1. Process by which particles are removed by the action of wind, flowing water or waves (opposite is accretion). [EAFDG, 2010]
2. The collapse, undermining or subsidence of land along the shore of a lake or other body of water. Erosion is a covered peril if it is caused by waves or currents of water exceeding their cyclical levels which result in flooding. [FEMA, 2014]
3. The process in which a material is worn away by a stream of liquid (water) or air, often due to the presence of abrasive particles in the stream. [USGS, 2015]
4. is the process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, winds and underground water.

Expectation. Expectation, or 'expected value' of a variable, refers to the mean value the variable takes. For example, in a 100 year period, a 1 in 100 year event is expected to be equalled or exceeded once. This can be defined mathematically (Appendix 1). [FLOODsite, 2009]



Expected annual frequency. Expected number of occurrences per year (reciprocal of the return period of a given event). [FLOODsite, 2009]

Expected loss. Extend of damage to be expected for an event or a given period of time on basis of a particular / given scenario. (BUWAL, Risiko Analyse, 1999). [FMMEP, 2007]

Exceedance flood risk assessment. A study to assess the risk of a site or area being affected by exceedance flow, and to assess the impact that any changes made to a site or area will have on the exceedance flood risk. [PPS25, 2009]

Exceedance flows. Excess flow that appears on the surface once the capacity of the underground drainage system is exceeded. [DEFRA, 2010]

Exposure. Quantification of the receptors that may be influenced by a hazard (flood), for example, number of people and their demographics, number and type of properties etc. [FLOODsite, 2009]

Extrapolation. The inference of unknown data from known data, for instance future data from past data, by analysing trends and making assumptions. [FLOODsite, 2009]

Extreme event. An event (within the context of flood risk) is an occurrence of one or more variables that may lead to flooding. These variables include heavy rainfall, river discharges and storm surges and are often described as 'sources' of flood risk or flood hazards and can also be referred to as 'loads' on natural or man-made structures. [FLOODsite, 2009]

Extreme precipitation. Expresses large precipitation amounts or intensities, or long-duration dry spells. Even though droughts can be considered as extreme precipitation events, we address here mainly events of increased precipitation intensity. By definition, it rarely occurs in the prevalent climate. The potential damaging effects are implied by the rare occurrence as neither nature nor society are prepared for the conditions. Usually one relates the degree of extremeness to the expected return period of incidents estimated from regular observations. [CGU]

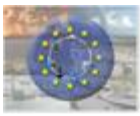
Failure. Inability to achieve a defined performance threshold (response given loading). "Catastrophic" failure describes the situation where the consequences are immediate and severe, whereas "prognostic" failure describes the situation where the consequences only grow to a significant level when additional loading has been applied and/or time has elapsed. [FLOODsite, 2009]

Failure mechanism, failure mode. One of any number of ways in which an asset may fail to meet a particular performance requirement, target or threshold Fascine mattress Bundles of brushwood bound together to form a mat to protect the bed or bank of a channel against erosion The mattress is often floated into position and weighted down with stones. [EAFDG, 2010]

Failure mode. Description of one of any number of ways in which a defence or system may fail to meet a particular performance indicator. [FLOODsite, 2009]

Flash flood.

1. A flash flood is a flood that occurs in a short period of time after a high intensity rainfall event or a sudden massive snow melt. A sudden increase in the level and velocity of the water body is often characteristic of these events. Rising water levels in the river network can reach its peak within minutes to a few hours of the onset of the flood event, leaving an extremely short time for warning. They are localised phenomena that occur in watersheds with maximum response times of a few hours. Therefore, the majority of flash floods occur in streams and small river basins that have a catchment area of a few hundred square kilometres or less. [FLOODsite, 2009]
2. A flood that crests in a short period of time and is often characterized by high velocity flow—often the result of heavy rainfall in a localized area. & A rapid and extreme flow of high water into a normally dry area, or a rapid rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam).



However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters. [Slandail terminology]

3. A flood that occurs within a few hours (usually less than six) of heavy or excessive rainfall, dam or levee failure or water released from an ice jam. [US National Oceanic and Atmospheric Administration]
4. Flash floods occur when excessive water fills normally dry creeks or river beds along with currently flowing creeks and rivers, causing rapid rises of water in a short amount of time. They can happen with little or no warning. [<http://www.nssl.noaa.gov/education/svrwx101/floods>]

Flash flood guidance. A methodology for issuing flood warnings developed in the US which relies on rainfall forecasts and past rainfall to determine catchment condition and does not require runoff modelling. It is not “Guidance” in the meaning of a physical document of accepted good practice on a particular topic. [FLOODsite, 2009]

Flash flood warning. Issued to inform the public, emergency management, and other cooperating agencies that flash flooding is in progress, imminent, or highly likely. [US National Oceanic and Atmospheric Administration]

Flash flood watch. Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent. [US National Oceanic and Atmospheric Administration]

Flood.

1. Relatively high river or creek flows, which overtop the natural or artificial banks, and inundate floodplains and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences. [ESA, 2015]
2. temporary covering of land by water outside its normal confines. [FLOODsite, 2009]
3. An overflow of water onto lands that are used or usable by man and not normally covered by water. Floods have two essential characteristics: the inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean. [USGS, 2015], [USGS]
4. The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods. [23, AMS, 2013, IS – ENES], [IPCC, 2012b]
5. (1) A general and temporal condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters, unusual or rapid accumulation or runoff of surface waters, or mudslides/mudflows caused by accumulation of water. (2) Flooding happens during heavy rains, when rivers overflow, when ocean waves come onshore, when snow melts too fast, or when dams or levees break. This is the most common natural-weather event. Flooding may be only few inches of water or it may cover a house to the rooftop. [Slandail terminology]
6. A condition that occurs when water overflows the natural or artificial confines of a stream or river; the water also may accumulate by drainage over low-lying areas. [US National Oceanic and Atmospheric Administration]
7. A rising body of water that leads to its natural or artificial confines to be exceeded. [CLIMATE RISK ANALYSIS].
8. Floods can occur anywhere after heavy rains. All floodplains are vulnerable and heavy storms can cause flash flooding in any part of the world. Flash floods can also occur after a period of drought when heavy rain falls onto very dry, hard ground that the water cannot penetrate. Floods come in



all sorts of forms, from small flash floods to sheets of water covering huge areas of land. They can be triggered by severe thunderstorms, tornadoes, tropical and extra-tropical cyclones (many of which can be exacerbated by the El Niño phenomenon), monsoons, ice jams or melting snow. In coastal areas, storm surges caused by tropical cyclones, tsunamis or rivers swollen by exceptionally high tides can cause flooding. Dikes can flood when the rivers feeding them carry large amounts of snowmelt. Dam breaks or sudden regulatory operations can also cause catastrophic flooding. Floods threaten human life and property worldwide. [WMO, Natural Hazards]

9. Floods of rivers, lakes, coasts, etc., due to severe weather conditions; for example, river floods caused by intense precipitation over a short period (e.g., flash floods) and persistent/recurrent precipitation over many days (e.g., wintertime floods in northern Europe), river floods caused by rapid snowmelt due to a sudden warm spell, or coastal floods caused by high sea levels due to wind-related storm surges. [Diaz et al, 2008]
10. A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder's property) from one of the following:
 - Overflow of inland or tidal waters
 - Unusual and rapid accumulation or runoff of surface waters from any source
 - Mudflow
 - Collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above [floodsmart.gov], [FEMA, 2014], [FEMA, <https://www.fema.gov/national-flood-insurance-program/definitions#F>]
 - Temporary covering by water of land not normally covered with water. [Pitt, 2008]
 - Extreme situations with an unusually high volume of water present over a given region. There are various forms for flooding – coastal inundation (storm surges), fluvial floods, flash floods, snow-melt floods, etc. [CGU]

Flood (risk management) strategy. An Environment Agency output which provides a detailed assessment of flood risks (from rivers and the sea) at a location or for a whole catchment and the preferred management measures. [DEFRA, 2010]

Flood and coastal defence. The Environment Agency, local authorities and Internal Drainage Boards Operating Authorities with legislative powers to undertake flood and coastal defence works. [PPS25, 2009]

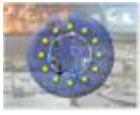
Flood awareness. An appreciation of the likely threats and consequences of flooding and an understanding of any flood warning and evacuation procedures. Communities with a high degree of flood awareness respond to flood warnings promptly and efficiently, greatly reducing the potential for damage and loss of life and limb. Communities with a low degree of flood awareness may not fully appreciate the importance of flood warnings and flood preparedness and consequently suffer greater personal and economic losses. [ESA, 2015]

Flood control (measure). A structural intervention to limit flooding and so an example of a risk management measure. [FLOODsite, 2009]

Flood crest. The highest stage or flow occurring in a flood. [US National Oceanic and Atmospheric Administration]

Flood damage. The tangible and intangible costs of flooding. [ESA, 2015]

Flood defence. Flood defence infrastructure, such as flood walls and embankments, intended to protect an area against flooding to a specified standard of protection. [PPS25, 2009]



Flood defence structure. Structure designed to provide protection against floods. Synonymous to: Flood protection structure, Flood control structure, Flood protection works, Flood control works, Flood mitigation works. FLOWSS Flood forecasting system A system designed to forecast flood levels before they occur. [FLOODsite, 2009]

Flood defence system. A collection of flood defence works for a river catchment and/or estuary and/or coastal region, in which the individual components (or assets) depend on each other for their overall effectiveness. [EAFDG, 2010]

Flood defence works. Works to prevent or alleviate flooding, including works designed to convey and contain water and to resist erosion due to the action of waves and currents. [EAFDG, 2010]

Flood forecasting system. A system designed to forecast flood levels before they occur: [FLOODsite, 2009]

Flood frequency analysis. An analysis of historical flood records to determine estimates of design flood flows. [ESA, 2015]

Flood Hazard.

1. The potential risk to life and limb and potential damage to property resulting from flooding. The degree of flood hazard varies with circumstances across the full range of floods. [ESA, 2015]
2. Flooding that has the potential to result in harm; the description of flood hazard may include the physical characteristics of a flood at a given point; including depth, duration and velocity. Sometimes flood hazard also includes an assessment of the probability of occurrence, but this is excluded from the definition used here. [FLOODsite, 2009]

Flood hazard map.

1. A map which identifies flood risk areas and shows – a) the likely extent (including water level or depth) of possible floods, b) the likely direction and speed of flow of possible floods, and c) whether the probability of each possible flood occurring is low, medium or high. [DEFRA, 2010]
2. A map with the predicted or documented extent of flooding, with or without an indication of the flood probability. [FLOODsite, 2009]

Flood insurance. Specific type of insurance that offers coverage against property loss from flooding, often based on susceptibility of topographical areas to flood risk. [UFM, 2011]

Flood inundation maps. Maps that present the water level and area prone to flooding. In some European countries it is connected with a given return period. As for instance; 10 years floods, 50 years floods, 100 years floods etc. [FMMEP, 2007]

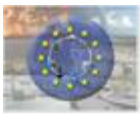
Flood inundation model. Flood inundation models are computer programs that simulate the spread of flood water from rivers, coasts or even urban drainage systems. [FLOODsite, 2009]

Flood level.

1. The height or elevation of floodwaters relative to a datum (typically the Australian Height Datum). Also referred to as "stage". [ESA, 2015]
2. Water level during a flood. [FLOODsite, 2009]

Flood management. Sum of all operational activities to be taken before, during and after an event as well as political and administrative decisions that are aimed at preventing or mitigating a flood event. [FLOODsite, 2009]

Flood management measures. Actions that are taken to reduce either the probability of flooding or the consequences of flooding or some combination of the two. [FLOODsite, 2009]



Flood map. A map produced by the Environment Agency providing an indication of the likelihood of flooding within all areas of England and Wales, assuming there are no flood defences. Only covers river and sea flooding. [PPS25, 2009]

Flood effect mitigation. All measures to reduce the effect of flooding on a building and its occupants including flood avoidance, flood resistance and flood resilience. [PPS25, 2009]

Flood mitigation. Measures taken in order to protect people or property from the damaging effect of water; Synonym cal: Flood damage mitigation, Flood control, Flood protection, Flood defence. [FMMEP, 2007]

Flood mitigation measures. Mitigation measures are planned actions or structures that will be triggered if a certain risk become real and it is treated as a issue that must be resolved. Mitigation plans take into account contingencies and preventive measures as well protective measures that must be put in place to avoid the realisation of the risk. Related to floods mitigation measures are methods of reducing the effects of floods. These methods may be structural solutions (e.g. reservoirs, levees) or non-structural (e.g. land-use planning, early warning systems). [FMMEP, 2007]

Flood mitigation schema. General description of the possible measures to be taken in order to guarantee appropriate flood safety in particular area. [FMMEP, 2007]

Flood operations. The receipt and interpretation of flood information, which can include formal flood warning products and observations of heavy rainfall or stream rises. [Slandail terminology]

Flood peak. Highest water level recorded in the river during a flood. [FLOODsite, 2009]

Flood plain is a part of alluvial plain that would be naturally flooded in the absence of engineered interventions. [FLOODsite, 2009]

Flood proofing. Measures to seal off buildings from floods by constructional changes at or near by the property, a kind of retrofitting measures. [FMMEP, 2007]

Flood protection (measure)to protect a certain area from inundation (using dikes etc). [FLOODsite, 2009]

Flood resilience.

1. The ability to cope with flooding and the ability to recover from flooding. [SMARTeST, 2011]
2. involves designing an infrastructure asset, or adapting an infrastructure asset so that although it comes into contact with floodwater during floods, no permanent damage is caused, structural integrity is maintained and, where operational disruption occurs, normal operation can resume rapidly after a flood has receded. [CLG, 2007]

Flood resilience measures. A plan, or course of action, which provides resilience to flooding. [SMARTeST, 2011]

Flood resilience systems. A set of things working together as parts of a mechanism. [SMARTeST, 2011]

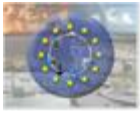
Flood resilience technologies. Technology which provide resilience to flooding, e.g. technologies with the ability to resist flooding and to enable protection to/from flooding. [SMARTeST, 2011]

Flood risk. Product of the probability of flooding occurring and its consequences of happening [Pitt, 2008]

Flood source. The source of the floodwaters. In this study, the Johnstone River catchment is the primary source of floodwaters. [ESA, 2015]

Flood stage.

1. The elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured. [USGS, 2015], [USGS]



2. The stage at which water overflowing the banks of a river, stream or body of water begins to cause damage. [US National Oceanic and Atmospheric Administration]

Flood warning. Issued when there is expected inundation of a normally dry area near a stream, other water course; or unusually severe pounding of water. [US National Oceanic and Atmospheric Administration]

Flood warning codes. The Environment Agency's flood warning system, which consists of codes: Flood Watch; Flood Warning; Severe Flood Warning; and All Clear. [Pitt, 2008]

Flood warning system. A system designed to warn members of the public of the potential of imminent flooding. Typically linked to a flood forecasting system. [FLOODsite, 2009]

Flood zone. A geographical area shown on a Flood Hazard Boundary Map or a Flood Insurance Rate Map that reflects the severity or type of flooding in the area. [floodsmart.gov]

Flood, 100-year. A 100-year flood does not refer to a flood that occurs once every 100 years, but to a flood level with a 1 percent chance of being equalled or exceeded in any given year. [USGS]

Flooding is an overflowing of water onto land that is normally dry. Floods can happen during heavy rains, when ocean waves come on shore, when snow melts too fast, or when dams or levees break. They can occur quickly or over a long period and may last days, weeks, or longer.

[[http://www.nssl.noaa.gov/education/svrwx101/floods /](http://www.nssl.noaa.gov/education/svrwx101/floods/)]

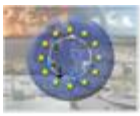
Floodplain.

1. The generally flat areas adjacent to a watercourse or the sea where water flows in time of flood or would flow but for the presence of flood defences. The limits of floodplain are defined by the peak water level of an appropriate return period event. [PPS15, 2006]
2. A strip of relatively flat and normally dry land alongside a stream, river, or lake that is covered by water during a flood. [USGS, 2015], [USGS]
3. Area of land bordering a river which is partly or wholly covered with water during floods. [EAFDG, 2010]
4. Land adjacent to a river or creek that is periodically inundated due to floods. The floodplain includes all land that is susceptible to inundation by the probable maximum flood (PMF) event. [ESA, 2015]
5. Any land area susceptible to being inundated by floodwaters from any source. [FEMA, 2014], [FEMA, <https://www.fema.gov/national-flood-insurance-program/definitions#F>]
6. Part of alluvial plain that would be naturally flooded in the absence of engineered interventions. [FLOODsite, 2009]
7. Area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defences where they exist. [PPS25, 2009]
8. Any land area susceptible to being inundated by floodwaters from any source. [floodsmart.gov]
9. Low-lying area adjacent to a watercourse and prone to flooding [Pitt, 2008]

Floodplain management.

1. The co-ordinated management of activities that occur on the floodplain. [ESA, 2015]
2. The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to, emergency preparedness plans, flood-control works and floodplain management regulations. [FEMA, 2014], [floodsmart.gov]

Floodplain management measures. A range of techniques that are aimed at reducing the impact of flooding. This can involve reduction of: flood damages, disruption and psychological trauma. [ESA, 2015]



Floodplain management plan. A document outlining a range of actions aimed at improving floodplain management. The plan is the principal means of managing the risks associated with the use of the floodplain. A floodplain risk management plan should be developed in accordance with the principles and guidelines contained in the CSIRO (2000). The plan will usually contain both written and diagrammatic information describing how particular areas of the floodplain are to be used and managed to achieve defined objectives. [ESA, 2015]

Floodplain management scheme. A floodplain management scheme comprises a combination of floodplain management measures. In general, one scheme is selected by the floodplain management committee and is incorporated into the plan. [ESA, 2015]

Floodproofing. Any combination of structural and nonstructural additions, changes or adjustments to structures, which reduce or eliminate risk of flood damage to real estate or improved real property, water and sanitation facilities or structures with their contents. [FEMA, 2014]

Floods and water management bill. The proposed Floods and Water Bill was laid in parliament on the 19th November 2009 and will clarify the legislative framework for managing surface water flood risk in England. [DEFRA, 2010]

Floodwall. Wall, of any form of construction, built to prevent or control the extent of flooding Flow control structure See 'control structure' [EAFDG, 2010]

Floodway. The channel of a river or stream and the parts of the floodplain adjoining the channel that are reasonably required to efficiently carry and discharge the flood water or flood flow of a river or stream. [USGS, 2015], [USGS]

Fluvial. Flooding caused by rivers. [PPS25, 2009]

Freeboard.

1. The height of the top of a bank, floodwall or other flood defence structure, above the design water level (normally the water level that would occur disregarding any effects from wave action) Freeboard can be seen as a safety margin that makes allowance for uncertainties. [EAFDG, 2010]
2. A factor of safety usually expressed as a height above the adopted flood level thus determine the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels. [ESA, 2015]
3. An additional amount of height above the Base Flood Elevation used as a factor of safety (e.g., 2 feet above the Base Flood) in determining the level at which a structure's lowest floor must be elevated or floodproofed to be in accordance with state or community floodplain management regulations. [FEMA, 2014]
4. A height added to the predicted level of flood to take account of waves or turbulence and the uncertainty in estimating the probability of flooding. [PPS15, 2006]
5. The difference between the flood defence level and the design flood level. [PPS25, 2009]

Glacial lake outburst flood. Flood associated with outburst of glacial lake. Glacial lake outburst floods are typically a result of cumulative developments and occur (1) only once (e.g., full breach failure of moraine-dammed lakes), (2) for the first time (e.g., new formation and outburst of glacial lakes), and/or (3) repeatedly (e.g., ice-dammed lakes with drainage cycles, or ice fall). [IPCC, 2012a]

Glacier. A mass of land ice that flows downhill under gravity (through internal deformation and/or sliding at the base) and is constrained by internal stress and friction at the base and sides. A glacier is maintained by accumulation of snow at high altitudes, balanced by melting at low altitudes or discharge into the sea. [IPCC, 2012a]

Groundwater



1. is water contained in the interstices of soil and rock, above and below the water table [EAFDG, 2010]
2. Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table. (2) water stored underground in rock crevices and in the pores of geologic materials that make up the earth's crust. [USGS, 2015]
3. Water below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. [PPS15, 2006]

Hard engineering. A collective term for man-made structures – typically involving steel, masonry and concrete – that control or disrupt natural processes (see also ‘soft engineering’). [EAFDG, 2010]

Hazard map. Hazard maps show the extent of flood prone areas considering hydrodynamic impacts on buildings, infrastructure and environment and considering the variability of magnitudes of the expected events. Different zones are designated classifying the intensity of danger related to the probability of occurrences. [FMMEP, 2007]

Hazard mapping. The process of establishing the spatial extents of hazardous phenomena. [FLOODsite, 2009]

Hazard, natural. “Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.” [UNDP, 2004], [UFM, 2011]

Hydraulic. The term given to the study of water flow in rivers, estuaries and coastal systems. [ESA, 2015]

Hydraulic modelling. Hydraulic models are based on calculation techniques, which solve mathematical or physical equations to simulate water systems and make projections relating to water levels, flows and velocities. Hydraulic modelling is the simulation activity. [FMMEP, 2007]

Hydrograph. A graph showing how a river or creek's discharge changes with time. [ESA, 2015]

Hydrologic cycle. The cyclic transfer of water vapor from the earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans. [USGS, 2015]

Hydrology. The term given to the study of the rainfall-runoff process in catchments. [ESA, 2015]

Indirect, tangible damages. Indirect damages are losses that occur due to the interruption of some activity by the flood, e.g. the loss of production due to business interruption in and outside the affected area or traffic disruption. These also include the extra costs of emergency and other actions taken to prevent flood damage and other losses. These are tangible when they can be specified in monetary terms. [FLOODsite, 2009]

Infiltration. Flow of water from the land surface into the subsurface. [USGS, 2015]

Integrated risk management. An approach to risk management that embraces all sources, pathways and receptors of risk and considers combinations of structural and non-structural solutions. [FLOODsite, 2009]

Integrated water resource management. IWRM is a process which promotes the co-ordinated management and development of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. [FLOODsite, 2009]

Intervention. A planned activity designed to effect an improvement in an existing natural or engineered system (particularly with asset management). [EAFDG, 2010]

Inundation. Flooding of land with water. (NB: In certain European languages this can refer to deliberate flooding, to reduce the consequences of flooding on nearby areas, for example. The general definition is preferred here.) [FLOODsite, 2009]



Land drainage. Limiting the effect of flooding by maintaining surface water and land drainage systems. [EAWFD, 2010]

Land use planning. The development of land use strategies to best meet people's current and future needs, according to the land's capabilities. Urban, city, or town planning, deals with design of the built environment from the municipal and metropolitan perspective. Regional planning deals with a still larger environment, at a less detailed level. [FMMEP, 2007]

Landslide. A mass of material that has moved downhill by gravity, often assisted by water when the material is saturated. The movement of soil, rock, or debris down a slope can occur rapidly, or may involve slow, gradual failure. [IPCC, 2012b]

Levee. A natural or manmade earthen barrier along the edge of a stream, lake, or river. Land alongside rivers can be protected from flooding by levees. [USGS, 2015]

LiDAR. Light Detection and Ranging – a technology that employs an airborne scanning laser rangefinder to produce a topographic survey and image of ground features [EAFDG, 2010]

Lifecycle. (1) In flood defence etc, the life of an asset from its construction through to disposal (2) In ecology, the entire life and reproductive cycle of a plant, fish or animal from seed or conception to death [EAFDG, 2010]

Likelihood. A general concept relating to the chance of an event occurring. Likelihood is generally expressed as a probability or a frequency. [FLOODsite, 2009]

Local development. Documents All development plan documents which will form part of the statutory development plan, as well as supplementary planning documents which do not form part of the statutory development plan. [PPS25, 2009]

Main river.

1. Main Rivers are watercourses marked as such on a main river map. Generally main rivers are larger streams or rivers, but can be smaller watercourses. Main Rivers are determined by Defra in England, and the Environment Agency has legal responsibility for them. Making Space for Water MSfW, launched in 2004, outlines the Government strategy for the next 20 years to implement a more holistic approach to managing flood and coastal erosion risks in England. [DEFRA, 2010]
2. A watercourse designated on a statutory map of Main Rivers, maintained by Defra, on which the Environment Agency has permissive powers to construct and maintain flood defences. [PPS25, 2009]
3. A watercourse shown as such on a main river map. All other watercourses are defined as "ordinary watercourses". The Environment Agency has flood risk management responsibility for main rivers in England and Natural Resources Wales has flood risk management responsibility for main rivers in Wales. Ordinary watercourses are the responsibility of Internal Drainage Boards where they are located within internal drainage districts and the responsibility of the Lead Local Flood Authority where they are outside of a drainage district. [WBG, 2013]

Marine flood. The inundation of land areas along the coast by sea waters over and above normal tide actions. [OED and Evelpidou], [SMARTeST, 2011]

Mean annual flood. The arithmetic mean of the series (AMAX) that comprises the maximum flood flows in each water year, defined as QBAR in the Flood estimation handbook The mean annual flood is commonly assumed to be the order of flow with most significance in terms of channel-forming. See also 'median annual flood'. [EAFDG, 2010]

Mean sea level. The sea level halfway between the mean levels of high and low water (OED) [SMARTeST, 2011]



Median annual flood. The flood that has an annual exceedance probability of 50% (return period 2 years), defined as QMED in the Flood estimation handbook. [EAFDG, 2010]

Metadata. Metadata can be described as ‘data about data’. For example, it can contain information about when data was created, who created it, or when it was last updated. [DEFRA, 2010]

Multi-criteria analysis. MCA is a tool to assist decision-making where there are a number of different factors to consider. Each factor is scored and weighted to weigh up the benefits of different intervention options. [DEFRA, 2010]

Municipal master plan. A spatial plan at a municipal level. [FMMEP, 2007]

Municipal water system. A water system that has at least five service connections or which regularly serves 25 individuals for 60 days; also called a public water system. [USGS, 2015]

Natural variability. Uncertainties that stem from the assumed inherent randomness and basic unpredictability in the natural world and are characterised by the variability in known or observable populations. [FLOODsite, 2009]

Net present value. The discounted value of a range of costs and benefits. NPV is used to describe the difference between the present value of costs and benefits in future years. [DEFRA, 2010]

Network infrastructure authorisation. Under the draft Water Bill, the network infrastructure authorisation would have enabled new entrants to own and operate their own infrastructure, which is connected to an incumbent water company’s network. This was removed from the Bill following pre-legislative scrutiny. [WBG, 2013]

Non-structural responses. Responses to urban flood risk that do not involve fixed or permanent facilities and their positive contribution to the reduction of flood risk is most likely through influencing behaviour, usually through government regulation, persuasion, and or economic instruments. [FMMEP, 2007]

Numerical hydraulic modelling. Calculation / simulation of the flow behaviour of a stream based on different parameters. [FMMEP, 2007]

Ordinary watercourse. An ordinary watercourse is any other river, stream, ditch, cut, sluice, dyke or non-public sewer which is not a Main River. The local authority or Internal Drainage Board have powers for such watercourses. [DEFRA, 2010]

Ordinary watercourse. All rivers, streams, ditches, drains, cuts, dykes, sluices, sewers (other than public sewer) and passages through which water flows which do not form part of a Main River. Local authorities and, where relevant, Internal Drainage Boards have similar permissive powers on ordinary watercourses, as the Environment Agency has on Main Rivers. [PPS25, 2009]

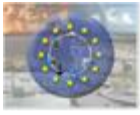
Outcome measures. Outcome Measures are a method to judge different schemes against one another to allow the best mix of schemes to be approved. [DEFRA, 2010]

Outfall

1. is a structure through which water is discharged into a channel or other body of water. [EAFDG, 2010]
2. The place where a sewer, drain, or stream discharges; the outlet or structure through which reclaimed water or treated effluent is finally discharged to a receiving water body. [USGS, 2015]

Overtopping. The passage of water over a component such as a flood-bank or seawall, due to high water levels or wave action Overtopping does not necessarily represent ‘failure’ of a flood defence to perform its function. [EAFDG, 2010]

Pathway.



1. Route that enables a hazard to propagate from a 'source' to a 'receptor', as in the 'source–pathway–receptor' concept. A pathway must exist in order for a hazard to be realised. Pathways can be constrained in order to mitigate the risks. [EAFDG, 2010]
2. Route that a hazard takes to reach Receptors. A pathway must exist for a Hazard to be realised. [FLOODsite, 2009]

Peak flood level, flow or velocity. The maximum flood level, flow or velocity occurring during a flood event. [ESA, 2015]

Peak flow. The maximum instantaneous discharge of a stream or river at a given location. It usually occurs at or near the time of maximum stage. [USGS, 2015]

Peaks-over-threshold, POT series. Series of data giving all the events when the river flow (or level) exceeds a specified threshold. [EAFDG, 2010]

Perception. The way in which something (Free technology/systems), understood or interpreted. [OED], [SMARTeST, 2011]

Performance. The creation or achievement of something that can be valued against some stated initial aim or objective, and also the degree to which a process succeeds when evaluated against some stated aim or objective. [EAFDG, 2010]

Performance. The degree to which a process or activity succeeds when evaluated against some stated aim or objective. [FLOODsite, 2009]

Performance indicator. The well-articulated and measurable objectives of a particular project or policy. These may be detailed engineering performance indicators, such as acceptable wave overtopping rates, rock stability, or conveyance capacity or more generic indicators such as public satisfaction. [FLOODsite, 2009]

Permeability. The ability of a material to allow the passage of a liquid, such as water through rocks. Permeable materials, such as gravel and sand, allow water to move quickly through them, whereas impermeable material, such as clay, don't allow water to flow freely. [USGS, 2015]

Photogrammetry. The technology used to obtain reliable measurements, maps, digital elevation models, and other GIS data primarily from aerial photography. probable maximum flood (PMF) An extreme flood deemed to be the maximum flood likely to occur. [ESA, 2015]

Pitt review. An independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England. [DEFRA, 2010]

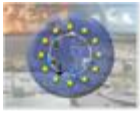
Planning policy statements. These set out the Government's national policies on different aspects of planning. The policies in these statements apply throughout England and focus on procedural policy and the process of preparing local development documents. PPS25 sets out policy to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding and direct development away from areas at highest risk. [DEFRA, 2010]

Pluvial. Surface flooding caused by rain. [PPS25, 2009]

Pluvial flooding. 'Pluvial' flooding (or surface runoff flooding) is caused by rainfall and is that flooding which occurs due to water ponding on or flowing over the surface before it reaches a drain or watercourse. [DEFRA, 2010]

Pluvial flooding. Rainfall-generated overland flow ponding on the urban surface because it overwhelms urban underground sewerage/drainage systems and surface watercourses by its high intensity or is for some reasons unable to enter drainage system or water courses. [ten Veldhuis 2010], [SMARTeST, 2011]

Point-source pollution. Water pollution coming from a single point, such as a sewage-outflow pipe. [USGS, 2015]



Policy. The entire written contract between the insured and the insurer. It includes: The printed policy form; The application and declarations page; Any endorsement(s) that may be issued; and Any renewal certificate indicating that coverage has been instituted for a new policy and new policy term. Only 1 dwelling, specifically described by the prospective policyholder in the application, may be insured under a policy. [FEMA, 2014]

Post-flood mitigation. Measures and instruments after flood events to remedy flood damages and to avoid further damages. [FLOODsite, 2009]

Precautionary principle. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. [PPS25, 2009]

Precipitation. Rain, snow, hail, sleet, dew, and frost. [USGS, 2015]

Preparedness. The ability to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations. [FLOODsite, 2009]

Preparedness strategy. Within the context of flood risk management a preparedness strategy aims at ensuring effective responses to the impact of hazards, including timely and effective early warnings and the evacuation of people and property from threatened locations. [FLOODsite, 2009]

Previously-developed land (often referred to as brownfield land). Land which is or was occupied by a permanent structure, including the cartilage of the developed land and any associated fixed surface infrastructure. [PPS3 annex B], [PPS25, 2009]

Pre-flood mitigation. Measures and instruments in advance to a flood event to provide prevention (reducing flood hazards and flood risks by e.g. planning) and preparedness (enhancing organisational coping capacities). [FLOODsite, 2009]

Probation surcharge (Premium). A flat charge that the policyholder must pay on each new or renewal policy issued covering property in a community that the NFIP has placed on probation under the provisions of 44 CFR 59.24. [FEMA, 2014]

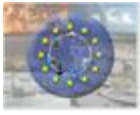
Process model uncertainty. All models are an abstraction of reality and can never be considered true. They are subject to process model uncertainty. Measured data versus modelled data comparisons give an insight into the extent of model uncertainty but do not produce a complete picture. [FLOODsite, 2009]

Progressive failure. Failure where, once a threshold is exceeded, significant (residual) resistance remains enabling the defence to maintain restricted performance. The immediate consequences of failure are not necessarily dramatic but further, progressive, failures may result eventually leading to a complete loss of function. [FLOODsite, 2009]

QMED. Median of the annual maximum flow series – the flow that has an annual exceedance probability of 50% or a return period of two years. [EAFDG, 2010]

Receptor.

1. The entity (such as a person, property or habitat) that may be harmed by an event at a source that reaches it via a pathway, as in the 'source–pathway–receptor' concept The vulnerability of a receptor can be reduced by increasing its resilience. [EAFDG, 2010]
2. Receptor refers to the entity that may be harmed (a person, property, habitat etc.). For example, in the event of heavy rainfall (the source) flood water may propagate across the flood plain (the pathway) and inundate housing (the receptor) that may suffer material damage (the harm or consequence). The vulnerability of a receptor can be modified by increasing its resilience to flooding. [FLOODsite, 2009]



Regression Lowering the bed of a watercourse by erosion (the opposite of ‘accretion’). [EAFDG, 2010]

Return period.

1. Average interval of time between events that equal or exceed a particular magnitude The use of the term ‘return period’ to express the probability of a flood is now often discouraged, as it can lead to confusion in the minds of the public. ‘Annual exceedance probability’ (AEP) is now the generally preferred means of expressing probability, 1% AEP being equivalent to a return period of 100 years. [EAFDG, 2010]
2. The expected (mean) time (usually in years) between the exceedence of a particular extreme threshold. Return period is traditionally used to express the frequency of occurrence of an event, although it is often misunderstood as being a probability of occurrence. [FLOODsite, 2009]
3. The long-term average period between events of a given magnitude which have the same annual exceedance probability of occurring. Residual risk The risk which remains after all risk avoidance, reduction and mitigation measures have been implemented. [PPS25, 2009]
4. An estimate of the average time interval between occurrences of an event (e.g., flood or extreme rainfall) of (or below/above) a defined size or intensity.[IPCC, 2013]

River. A natural stream of water of considerable volume, larger than a brook or creek. [USGS, 2015]

River basin management plan.

1. Describes the main issues to be addressed under the Water Framework Directive for each river basin district and highlights some key actions proposed for dealing with them The annexes to the document give more detail on the conditions in the river basin district, the actions proposed and the mechanisms that can be used to implement these actions. [EAFDG, 2010]
2. A management plan for all river basins required by the Water Framework Directive. These documents will establish a strategic plan for the long-term management of the River Basin District, set out objectives for waterbodies and, in broad terms, what measures are planned to meet these objectives, and act as the main reporting mechanism to the European Commission. [DEFRA, 2010]

Runoff

1. that part of the precipitation, snow melt, or irrigation water that appears in uncontrolled surface streams, rivers, drains or sewers. Runoff may be classified according to speed of appearance after rainfall or melting snow as direct runoff or base runoff, and according to source as surface runoff, storm interflow, or ground-water runoff. (2) the total discharge described in (1), above, during a specified period of time. (3) also defined as the depth to which a drainage area would be covered if all of the runoff for a given period of time were uniformly distributed over it. [USGS, 2015]
2. Overland flow produced by rainfall. [EAFDG, 2010]
3. The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek. [ESA, 2015]
4. The flow of water from an area caused by rainfall. [PPS25, 2009]
5. That proportion of rainfall which is not absorbed into the ground and finds its way into watercourses, eventually flowing to the sea. [PPS15, 2006]

Runup. The upper level reached by a wave on a structure, relative to the still water level. [EAFDG, 2010]

Scenario. A plausible description of a situation, based on a coherent and internally consistent set of assumptions. Scenarios are neither predictions nor forecasts. The results of scenarios (unlike forecasts) depend on the boundary conditions of the scenario. [FLOODsite, 2009]



Scour. Erosion of the bed or banks of a watercourse by the action of moving water, typically associated with the presence of a feature such as bridge pier or abutment that constricts the flow. [EAFDG, 2010]

Sea level rise. An increase of the relative mean sea level (Esteban). [SMARTeST, 2011]

Sea water floods/flooding. Inundation of land areas adjacent to the coast solely by sea waters over and above the level normally wetted by sea water (Toumazis/NL). [SMARTeST, 2011]

Sensitivity. Refers to either: the resilience of a particular receptor to a given hazard. For example, frequent sea water flooding may have considerably greater impact on a fresh water habitat, than a brackish lagoon; or: the change in a result or conclusion arising from a specific perturbation in input values or assumptions. [FLOODsite, 2009]

Sensitivity analysis. The identification at the beginning of the appraisal of those parameters which critically affect the choice between the identified alternative courses of action. [FLOODsite, 2009]

Sewer. A system of underground pipes that collect and deliver wastewater to treatment facilities or streams. [USGS, 2015]

Soft engineering. The use of ecological and geomorphological principles and practices (for example to reduce erosion and stabilise channel banks), while enhancing habitat, improving aesthetics and reducing capital costs. [EAFDG, 2010]

Source. The origin of a hazard (for example, heavy rainfall, strong winds, surge etc). [FLOODsite, 2009]

Source–pathway–recept or concept. How a hazard propagates from its source, via a pathway, to a receptor. For example, in the event of heavy rainfall (the source) floodwater may escape from a river and propagate across the floodplain (both elements of the pathway) to inundate a housing development (the receptor) that may suffer material damage. [EAFDG, 2010]

Spatial planning. Public policy and actions intended to influence the distribution of activities in space and the linkages between them. It will operate at EU, national and local levels and embraces land use planning and regional policy. [FLOODsite, 2009]

Stakeholder. An individual or group with an interest in, or having an influence over, the success of a proposed project or other course of action. [EAFDG, 2010]

Stakeholders. Parties/persons with a direct interest (stake) in an issue also Stakeowners. [FLOODsite, 2009]

Statistic. A measurement of a variable of interest which is subject to random variation. [FLOODsite, 2009]

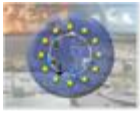
Statistical inference uncertainty. Formal quantification of the uncertainty of estimating the population from a sample. The uncertainty is related to the extent of data and variability of the data that make up the sample. [FLOODsite, 2009]

Statistical model uncertainty. Uncertainty associated with the fitting of a statistical model. The statistical model is usually assumed to be correct. However, if two different models fit a set of data equally well but have different extrapolations/interpolations then this assumption is not valid and there is statistical model uncertainty. [FLOODsite, 2009]

Storm sewer. A sewer that carries only surface runoff, street wash, and snow melt from the land. In a separate sewer system, storm sewers are completely separate from those that carry domestic and commercial wastewater (sanitary sewers). [USGS, 2015]

Storm surge. The increase in sea level caused by the combined effects of low atmospheric pressure, wind and a high tide. [PPS15, 2006]

Strategic environmental assessment directive. European Community Directive (2001/42/EC) on the assessment of the effects of certain plans and programmes on the environment. [PPS25, 2009]



Strategic environmental assessment. A long-term (usually 50 years or more) documented plan for river or coastal management, including all necessary work to meet defined flood and coastal defence objectives for the target area SEA is a legally enforced assessment procedure required by the European Council Directive 2001/42/EC (known as the SEA Directive). An SEA takes place in advance of an environmental impact assessment (EIA) and the findings are used to inform the EIA process. It is usually more detailed and covers a smaller area than a catchment flood management plan (CFMP). [EAFDG, 2010]

Strategic flood risk assessment. SFRA provides information on areas at risk from all sources of flooding. The SFRA should form the basis for flood risk management decisions, and provides the basis from which to apply the Sequential Test and Exception Test (as defined in PPS25) in the development allocation and development control process. [see paragraph E5 to E7 of PPS25 and paragraphs 3.39 to 3.79 of the PPS25 Practice Guide], [DEFRA, 2010]

Stream.

1. Body of water moving under the influence of gravity, to lower levels, in a well-defined natural channel. [AMS, 2013]
2. A general term for a body of flowing water; natural water course containing water at least part of the year. In hydrology, it is generally applied to the water flowing in a natural channel as distinct from a canal. [USGS, 2015]

Streamflow. The water discharge that occurs in a natural channel. A more general term than runoff, streamflow may be applied to discharge whether or not it is affected by diversion or regulation. [USGS, 2015]

Surcharge, surcharged. Flow conditions in an enclosed water conduit (pipe or culvert) in which the water pressure is higher than atmospheric, resulting in water levels at the inlet, outlet or access shafts higher than the soffit level of the conduit (in contrast to 'free surface flow'). [EAFDG, 2010]

Surcharging. A flow of water in a culvert or pipe which is above the design flow. [PPS15, 2006]

Surface water is water that is on the earth's surface, such as in a stream, river, lake, or reservoir. [USGS, 2015]

Surface water flooding. In this context, surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall. [DEFRA, 2010]

Susceptibility.

1. The propensity of a particular receptor to experience harm. [FLOODsite, 2009]
2. Likelihood to be influenced or harmed by a particular thing. [OED], [SMARTeST, 2011]
3. The concept of development that meets the needs of the present without compromising the ability of future generations to meet their own needs. [EAFDG, 2010]

Sustainability appraisal. An integral part of the plan-making process which seeks to appraise the economic, social and environmental effects of a plan in order to inform decision-making that aligns with sustainable development principles. [PPS25, 2009]

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs [FLOODsite, 2009]

Types of floods [Pitt, 2008]

- **Groundwater flooding.** Occurs when water levels in the ground rise above the natural surface. Low-lying areas underlain by permeable strata are particularly susceptible.
- **Flash flooding.** A rapid increase in water levels, leading to flooding, occurs when excessive rain falls over a short period of time.



- **Fluvial flooding or River flooding.** Occurs when water levels in a channel overwhelm the capacity of the channel.
- **Pluvial flooding or Surface water/runoff flooding.** Occurs when the level of rainfall overwhelms the capacity of the drainage system to cope.
- **Coastal flooding.** Occurs when coastal defences are unable to contain the normal predicted high tides that can cause flooding, usually when a high tide combines with a storm surge (created by high winds or a deep depression).

Wastewater. Water that has been used in homes, industries, and businesses that is not for reuse unless it is treated. [USGS, 2015]

Water framework directive. A European Community Directive (2000/60/EC) of the European Parliament and Council designed to integrate the way water bodies are managed across Europe. It requires all inland and coastal waters to reach “good status” by 2015 through a catchment-based system of River Basin Management Plans, incorporating a programme of measures to improve the status of all natural water bodies. [DEFRA, 2010]

Water management. Water management refers to various activities, which aims for an optimal use and distribution of surface and subsurface water, the rationing of drinking water abstraction and distribution and an effective wastewater treatment. Besides the study, planning, monitoring, and application of quantitative and qualitative control and development techniques for long-term and multiple use of the diverse forms of water resources, also the flood protection counts to the tasks of water management. [FMMEP, 2007]

Watercourse.

1. Defined natural or man-made channel for the conveyance of drainage flows and floods by gravity. [EAFDG, 2010]
2. A river, stream, canal, ditch, drain, cut, culvert, dyke, sluice, valve, overland carrier, millrace or layde. Water mains and sewers are not included in this definition. [PPS15, 2006]
3. Any river, stream, ditch, drain, cut culvert, dyke, sluice, sewer and passage through which water flows, except a public sewer. [WBG, 2013]

Watershed.

1. In usual British English usage, the boundary between catchments In American usage (including in the expression ‘watershed management’) it is a synonym for ‘catchment’. [EAFDG, 2010]
2. See catchment area. [UFM, 2011]
3. The land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds, like the Mississippi river basin contain thousands of smaller watersheds. [USGS, 2015]

4.4 Forest Fires

Acceptable damages. Damage which does not seriously impair the flow of economic and social benefits from the wildlands. [DELFI Vocabulary of forest fire terms, 1999]

Acceptable fire risk. The potential fire loss that a community is willing to accept rather than provide resources to reduce such a loss. [DELFI Vocabulary of forest fire terms, 1999]

Anchor point. An advantageous location, usually a barrier to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the chance of being flanked (or outflanked) by the fire while the line is being constructed. [Pennsylvania Bureau of Forestry Fire Crew, 2007]



Backfire. A fire set along the inner edge of a fireline to consume the fuel in the path of a wildfire and/or change the direction or force of the fire's convection column. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Barrier. Any obstruction to the spread of fire. Typically an area or strip devoid of combustible fuel. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Burn out. Setting fire inside a control line to consume fuel between the edge of the fire and the control line. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Burned area. An area over which a fire has run. [DELFI Vocabulary of forest fire terms, 1999]

Burning index. Relative measure of fire-control difficulty; doubling the index means twice the effort may be needed to control the fire (e.g., wind shift, heavier fuel load, etc). [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Burning period. The part of each 24-hour period when fires spread most rapidly; typically from 10:00 AM to sundown. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Catastrophic fire. A fire which has significant negative impacts on the health and productivity of ecosystems and other human values. [DELFI Vocabulary of forest fire terms, 1999]

Closed area. An area in which specified activities or entry are temporarily restricted to reduce risk of human-caused fires. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Closure. Legal restriction, but not necessarily elimination, of specified activities such as smoking, camping, or entry that might cause fires in a given area. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Cold trailing. A method of controlling a partly dead fire edge by carefully inspecting and feeling with the hand for heat to detect any fire, digging out every live spot, and trenching any live edge. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Complex. Two or more individual incidents located in the same general area which are assigned to a single incident commander or unified command. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Extended attack. Situation in which a fire cannot be controlled by initial attack resources within a reasonable period of time. Committing additional resources within 24 hours after commencing suppression action will usually control the fire. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Extreme weather. Unusual or uncommon occurrence. [DELFI Vocabulary of forest fire terms, 1999]

Fire damage. The detrimental effects of fire including the unfavourable effects of fire caused changes in the resource base on the attainment of goal. [DELFI Vocabulary of forest fire terms, 1999]

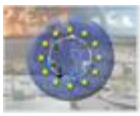
Fire danger. A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and impact. Fire danger is often expressed as an index. [European Forest Fire Networks, 2012]

Fire danger. The resultant of both constant and variable danger factors affecting the inception, spread, and difficulty of control of fires and the damage they cause. [DELFI Vocabulary of forest fire terms, 1999]

Fire environment. The surrounding conditions, influences, and modifying forces of topography, fuel, and weather that determine fire behaviour, fire effects and impact. [European Forest Fire Networks, 2012]

Fire hazard. A measure of the fire danger contributed by fuels available for burning. [DELFI Vocabulary of forest fire terms, 1999]

Fire management plan. A statement of fire Policy and prescribed actions for a specific area. [DELFI Vocabulary of forest fire terms, 1999]



Fire prediction system. A method or tool used to forecast future behaviour of a fire. Fire prediction systems are an important tool that can be used to maintain safety. [European Forest Fire Networks, 2012]

Fire regime. Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects as well, in a given area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval. [ALPFFIRS glossary, 2012]

Fire risk. The probability of a wildfire occurring and its potential impact on a particular location at a particular time. Wildfire risk is calculated using the following equation: Fire risk = probability of occurrence x potential impact. [European Forest Fire Networks, 2012]

Fire spread model. Set of mathematical equations used to predict the advance of a fire front for a given fuelbed and topographical and meteorological conditions. [DELFI Vocabulary of forest fire terms, 1999]

Fire storm. Violent convection caused by a large continuous area of intense fire. [European Forest Fire Networks, 2012]

Fire weather.

1. Weather conditions that affect fire vulnerability, fire behavior and suppression. [Pennsylvania Bureau of Forestry Fire Crew, 2007]
2. Weather conditions that influence fire ignition, behaviour and suppression. [National Wildfire Coordinating Group, 2014]

Fire weather forecast. A weather prediction specially prepared for use in fire control management. [DELFI Vocabulary of forest fire terms, 1999]

Fire weather index. A numerical rating in the Canadian fire danger rating system, based on meteorological measurements of fire intensity in a standard fuel type. [DELFI Vocabulary of forest fire terms, 1999]

Fire weather index.

1. Elements enabling to evaluate hazards according to forest fire weather parameters. [ALPFFIRS glossary, 2012]
2. A numerical rating in the Canadian fire danger rating system, based on meteorological measurements of fire intensity in a standard fuel type. (The standard fuel type is representative of jack pine and lodge pole pine.) The FWI is comprised of three fuel moisture codes, covering classes of forest fuel of different drying rates, and two indices that represent rate of spread and the amount of available fuel. [National Wildfire Coordinating Group, 2014]

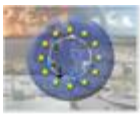
Fire whirl. Spinning vortex column of ascending hot air and gases rising from a fire and carrying aloft smoke, debris, and flame. [European Forest Fire Networks, 2012]

Fire wind. The inflow of air close to a fire caused by the action of convection. Fire winds influence fire spread. [European Forest Fire Networks, 2012]

Firebreak. A natural or constructed barrier used to stop or check fires that may occur, or to provide a control line from which to work. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Fireline. The part of a control line that is scraped or dug to mineral soil. Also called fire trail. More generally, working a fire is called being "on the fire line." May also refer to a "wet line" where water has been used to create a burn boundary in light fuels such as grass. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Firemodel. Computer program which with specified information (fuel, weather, topography) predicts an hourly rate of spread from a point of origin. [National Wildfire Coordinating Group, 2014]



Firestorm. Extreme fire behaviour indicated by widespread in-drafts and a tall column of smoke and flame, where added air increases fire intensity, creating runaway fire growth. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Forest fire.

1. Variously defined for legal purposes (e.g., the State of California Public Resources Code: uncontrolled fire on lands covered wholly or in part by timber, brush, grass, grain, or other flammable vegetation). Types of fires are ground, surface, and crown. [National Wildfire Coordinating Group, 2014]
2. Forest fire means a fire burning uncontrolled on lands covered wholly or in part by timber, brush, grass, grain, or other flammable vegetation. It is the most common hazard in forests. Forest fires pose a threat not only to the forest wealth but also to the entire regime to fauna and flora seriously disturbing the bio-diversity and the ecology and environment of a region. Forest fire is a disaster that causes imbalances in nature and endangers biodiversity by reducing faunal and floral wealth. Forest fires may be caused due to natural or manmade reasons. [USLegal]
3. Fires in forest or brush grasslands that cover extensive areas and usually do extensive damage. They may start by natural causes such as volcanic eruptions or lighting, or they may be caused by arsonists or careless smokers, by those burning wood or by clearing a forest area. [United Nations]

Ground fire. Fire that consumes the organic material beneath the surface litter ground, such as peat fire. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Head of a fire. The most rapidly spreading portion of a fire's perimeter, usually to the leeward or up slope. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Hot spot. A particularly active part of a fire. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Hygrometry. Humidity of the air, that is to say the quantity of water present in its gas form in humid air. It does not take into account the water present in its liquid or solid form. [ALPFFIRS glossary, 2012]

Mega fire. A wildfire demonstrating abnormally extreme fire behaviour. Mega fires will usually represent a significant challenge to suppression agencies because they are very resource intensive to suppress and can pose a significant risk to the safety of suppression personnel. [European Forest Fire Networks, 2012]

Mesoclimate. The climate of small areas of the earth's surface which may not be representative of the general climate of the district. [DELFI Vocabulary of forest fire terms, 1999]

Meteorological factors. Set of meteorological parameters that affect fire danger. [DELFI Vocabulary of forest fire terms, 1999]

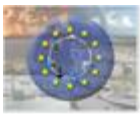
Microclimate. A climate of small area, especially insofar as this differs significantly from the general climate of the region. [DELFI Vocabulary of forest fire terms, 1999]

Peak fire season. The period of the fire season during which fires are expected to ignite most readily, to burn with greater intensity and to result in a High level of damage . [DELFI Vocabulary of forest fire terms, 1999]

Precipitation. Any product of the condensation of atmospheric water vapor that falls under gravity. The main forms of precipitation include rain, snow, sleet, hail. [ALPFFIRS glossary, 2012]

Radiant Heat Flux. The amount of heat flowing through a given area in a given time, usually expressed as calories/square centimetre/second. [National Wildfire Coordinating Group, 2014]

Resilience. The ability of a system to return to its original status after applying stress. [DELFI Vocabulary of forest fire terms, 1999]



Safety zone. An area cleared of flammable material used for escape in the event the line is outflanked or in case a spot fire causes fuels outside the control line to render the line unsafe. In firing operations, crews progress so as to maintain a safety zone close at hand allowing the fuels inside the control line to be consumed before going ahead. Safety zones may also be constructed as integral parts of fuel breaks; they are greatly enlarged areas which can be used with relative safety by fire fighters and their equipment in the event of blow up in the vicinity. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Sunshine period. Time during which an area is exposed to the sun. [ALPFFIRS glossary, 2012]

Surface fire. Fire that burns loose debris on the surface, which include dead branches, leaves, and low vegetation. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Temperature. A physical property of matter that quantitatively expresses the common notions of hot and cold. [ALPFFIRS glossary, 2012]

Wind. Horizontal movement of air caused by differences in pressures. Movement of an atmosphere. [ALPFFIRS glossary, 2012]

Wind effect. Relative variation of the fire behaviour induced by atmospheric wind. [DELFI Vocabulary of forest fire terms, 1999]

Wind model. Physical and mathematical model to predict wind velocity and direction at arbitrary locations given a set of discrete measurements or estimated of wind velocity and direction at know locations. [DELFI Vocabulary of forest fire terms, 1999]

Wind profile. Variation of wind velocity with height above a given ground reference level. [DELFI Vocabulary of forest fire terms, 1999]

Wildfire. An unplanned fire. A generic term which includes grass fires, forest fires and scrub fires. [Slandail terminology]

Wildfire. A fire occurring on wild land that is not meeting management objectives and thus requires a suppression response. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

Wildland. An area in which development is essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered. [Pennsylvania Bureau of Forestry Fire Crew, 2007]

4.5 Adaptation

Adaptation

1. in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity. [Smit, Wandel, 2006]
2. (in climate change literature) is defined as “adjustments in a system’s behaviour and characteristics that enhance its ability to cope with external stress”. [Brooks, 2003]
3. The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.
 - Incremental adaptation: Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale.
 - Transformational adaptation: Adaptation that changes the fundamental attributes of a system in response to climate and its effects. [IPCC, 2014]



4. The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. [Dickson, 2012], [ISDR Terminology of disaster risk reduction]
5. adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. This definition addresses the concerns of climate change and is sourced from the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). The broader concept of adaptation also applies to non-climatic factors such as soil erosion or surface subsidence. Adaptation can occur in autonomous fashion, for example through market changes, or as a result of intentional adaptation policies and plans. Many disaster risk reduction measures can directly contribute to better adaptation. [Slandail terminology]
6. is adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation. [EU-ADAPT]
7. Adjustment or preparation of natural or human systems to a new or changing environment which moderates harm or exploits beneficial opportunities. [US EPA]
8. means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, or taking advantage of opportunities that may arise. [EUC-CA]
9. Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change. For example, flood walls should be built and in numerous cases it is probably advisable to move human settlements out of flood plains and other low-lying areas..." [Levina, Tirpak, 2006]
10. is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented. [UNDP, 2005], [Levina, Tirpak, 2006]
11. process or outcome of a process that leads to a reduction in harm or risk of harm, or realisation of benefits associated with climate variability and climate change. [UKCIP, 2003], [Levina, Tirpak, 2006]
12. In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate. [IPCC, 2012a], [IPCC, 2012b], [SREX]
13. The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. [IPCC, 2014]
14. Initiatives and measures to reduce the vulnerability or increase the resilience of natural and human systems to actual or expected climate change impacts. Various types of adaptation exist, for example, anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dikes, retreating from coastal areas subject to flooding from sea level rise or introducing alternative temperature-appropriate or drought-adapted crops for conventional ones. [Verbruggen et al, 2011]
15. is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation.



There are different ways in which adaptation can be framed; an inventory has been made by the Dutch Climate Changes Spatial Planning research programme. [SWD(2013) 134 final]

16. Strategies to meet future challenges, involving changing practices or construction of new and more resilient infrastructure. The objective is to reduce vulnerability. Adaptation has a local or regional focus as opposed to removing the cause of the problems. Adaptation deals with coping with consequences rather than solving underlying problems (mitigation). [CGU]

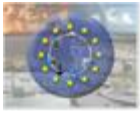
Adaptation assessment. The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility. [IPCC, 2012a], [IPCC, 2012b]

Adaptation benefits. The avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]

Adaptation costs. Costs of planning, preparing for, facilitating, and implementing *adaptation* measures, including transition costs. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]

Adaptive capacity

1. may be described as the ability or capacity of a system to modify or change its characteristics or behaviour so as to cope better with existing or anticipated external stresses. [Brooks, 2003]
2. The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities. [IPCC, 2012a], [IPCC, 2012b]
3. (in relation to climate change impacts) is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. [EU-ADAPT]
4. is the property of a system to adjust its characteristics or behaviour, in order to expand its coping range under existing climate variability, or future climate conditions. The expression of adaptive capacity as actions that lead to adaptation can serve to enhance a system's coping capacity and increase its coping range thereby reducing its vulnerability to climate hazards. The adaptive capacity inherent in a system represents the set of resources available for adaptation, as well as the ability or capacity of that system to use these resources effectively in the pursuit of adaptation. It is possible to differentiate between adaptive potential, a theoretical upper boundary of responses based on global expertise and anticipated developments within the planning horizon of the assessment, and adaptive capacity that is constrained by existing information, technology and resources of the system under consideration. [UNDP, 2005], [Levina, Tirpak, 2006]
5. The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. [IPCC, 2014]
6. (in relation to climate change impacts) describes the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. Adaptive capacity can be framed in many different ways; an inventory has been made by the Dutch Climate Changes Spatial Planning research programme. [SWD(2013) 134 final]
7. The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities. [SREX]



Anticipatory adaptation. Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]

Autonomous adaptation. Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]

Coping

1. is the “ability of people, organizations, and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters” (UNISDR, 2009d). Overall, coping focuses on the moment, constraint, and survival. [SREX Ch1]
2. The use of available skills, resources, and opportunities to address, manage, and overcome adverse conditions, with the aim of achieving basic functioning in the short to medium term. [IPCC, 2012b]

Maladaptation. Action or investment that enhances vulnerability to climate change impacts rather than reducing them. E.g. in the face of rising sea-levels it would be maladaptive to build new key infrastructure on a shallow coastline (UKCIP). [SWD(2013) 134 final]

Maladaptive actions (Maladaptation). Actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future. [IPCC, 2014]

Measures. Adaptation measures are technologies, processes, and activities directed at enhancing our capacity to adapt (building adaptive capacity) and at minimising, adjusting to and taking advantage of the consequences of climatic change (delivering adaptation).

Planned adaptation. Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state. [IPCC, Climate Change 2007: Working Group I: The Physical Science Basis]



5 Resilience Terminology

5.1 General Terms

Capability. The ability of a suitably organized, trained, and equipped entity to access, penetrate, or alter government or privately owned information or communications systems and/or to disrupt, deny, or destroy all or part of a critical infrastructure. [US President's Commission on Critical Infrastructure Protection, 1997]

CI Resilience. The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions. [SREX FD]

Combat. Activity of two or more entities taken in consideration of each other to achieve differing objectives. The military analogue of commercial competition. [US President's Commission on Critical Infrastructure Protection, 1997]

Community resilience is the capability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change. [Shaw, 2014]

Joint probability.

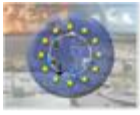
1. Joint probability analysis gives the probability of two or more conditions which affect risk occurring at the same time. For example, high river levels can impede sewer outfalls. [DEFRA, 2010]
2. The probability of specific values of one or more variables occurring simultaneously. For example, extreme water levels in estuaries may occur at times of high river flow, times of high sea level or times when both river flow and sea level are above average levels. When assessing the likelihood of occurrence of high estuarine water levels it is therefore necessary to consider the joint probability of high river flows and high sea levels. [FLOODsite, 2009]

Knowledge uncertainty is the uncertainty due to lack of knowledge of all the causes and effects in a physical or social system. For example, a numerical model of wave transformation may not include an accurate mathematical description of all the relevant physical processes. Wave breaking aspects may be parameterised to compensate for the lack of knowledge regarding the physics. The model is thus subject to a form of knowledge uncertainty. Various forms of knowledge uncertainty exist, including: [FLOODsite, 2009]

Likelihood.

1. The chance of something happening (also described as the probability or frequency of an event occurring). [DECS 07/5007, 2014], [ISO/IEC 31000, 2009]
2. is described as an occurrence, an outcome or a result, where this can be estimated probabilistically. [SWD(2013) 134 final]
3. A probabilistic estimate of the occurrence of a single event or of an outcome, for example, a climate parameter, observed trend, or projected change lying in a given range. Likelihood may be based on statistical or modelling analyses, elicitation of expert views, or other quantitative analyses. [IPCC, 2012b]
4. The chance of a specific outcome occurring, where this might be estimated probabilistically. (...) [IPCC, 2014]

Likely. Will probably occur in most circumstances. In probability terms this may mean that it has between a 50% to 75% probability of occurring. Alternatively this may mean that the event may occur at least once in a year. [DECS 07/5007, 2014]



Probabilistic method. Method in which the variability of input values and the sensitivity of the results are taken into account to give results in the form of a range of probabilities for different outcomes. [FLOODsite, 2009]

Probabilistic reliability methods. These methods attempt to define the proximity of a structure to fail through assessment of a response function. They are categorised as Level III, II or I, based on the degree of complexity and the simplifying assumptions made (Level III being the most complex). [FLOODsite, 2009]

Probability.

1. Extent to which an event is likely to occur. [ENISA]
2. A statistical measure of the likely frequency or occurrence of flooding. [ESA, 2015]
3. A measure of our strength of belief that an event will occur. For events that occur repeatedly the probability of an event is estimated from the relative frequency of occurrence of that event, out of all possible events. In all cases the event in question has to be precisely defined, so, for example, for events that occur through time reference has to be made to the time period, for example, annual exceedance probability. Probability can be expressed as a fraction, % or decimal. For example the probability of obtaining a six with a shake of four dice is $1/6$, 16.7% or 0.167. [FLOODsite, 2009]

Probability density function (distribution). Function which describes the probability of different values across the whole range of a variable (for example flood damage, extreme loads, particular storm conditions etc). [FLOODsite, 2009]

Rare. May occur in exceptional circumstances. In probability terms, may mean that it has less than a 5% probability of occurring. Alternatively this may mean that the event may occur once in 15 or more years. [DECS 07/5007, 2014]

Reliability

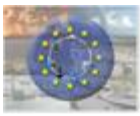
1. is the degree of performance according to imposed standards or expectations. [Verbruggen et al, 2011]
2. Complement of the failure probability [www.inrisk.ubc.ca]
3. The probability that a flood defence asset will not fail during a given period of time Conventionally understood as the performance of flood or coastal defences as described by process-based models. In the context of a risk assessment that definition is extended to the probability that the flood or coastal defence does not fail (the complement of the probability of failure), where failure is defined using a limit-state function with conventional process based models representing the strength and loading models. [EAFDG, 2010]
4. The ability to be reliable. Reliable: constantly good quality or performance, trustworthy. [NL + OED], [SMARTeST, 2011]

Reliability analysis. Address risk by providing the probability that a consequence measure exceed a specific threshold. [www.inrisk.ubc.ca]

Residual flood probability. An estimate of the chance of flooding taking place, taking account of the protection afforded by defences [FLOODsite, 2009]

Residual life The residual life of a defence is the time to when the defence is no longer able to achieve minimum acceptable values of defined performance indicators (see below) in terms of its serviceability function or structural strength. [FLOODsite, 2009]

Resilience



1. is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. [EU-ADAPT]
2. The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions. [Dickson et al, 2012], [IPCC, 2012a], [Klaver et al, 2011]
3. The need for systems to have the capacity to be flexible and adaptable to changing conditions, both foreseeable and unexpected, and to be able to recover rapidly from disruption. [Critical Five]
4. The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions; includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents. [US Homeland Security, 2013]
5. The ability of systems, infrastructures, government, business and citizenry to absorb and/or quickly recover from an adverse event or series of events caused by attack or natural disaster, which may cause harm, destruction or loss of national significance and to restore minimum essential operations and reduce the consequences of its degradation or failure regardless of its cause. Resilience is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures. This includes: 1) immediate efforts to coordinate, execute and plan to restore operations and services for various reasons and 2) immediate evaluation of an incident to identify lessons learned, post incident reporting and development of initiatives to mitigate the effects of future incidents. [Slandail terminology]
6. in the context of critical infrastructure, can be defined as the ability of an asset, or system of assets, to continue to provide essential services when threatened by an unusual event (such as an extreme flood, terrorist attack or flu epidemic), as well as its speed of recovery and ability to return to normal operation after the threat has receded. [McBain et al, 2010]
7. Physical resilience of risk elements (buildings, equipment, facilities) is an important factor in determining whether those elements will be damaged in case of an accident and have effects on relevant systems and processes, networks and objects. [Croatian Methodology for the operational risk analysis of critical infrastructure]
8. The ability of a system, community or society to recover from the effects of a hazard in a timely and efficient manner, including restoration of its essential basic structures and functions. The **resilience** implicates that a system can adapt and regain a new stable position (recover or return quickly to the state ensuring proper functioning of a system) after perturbations and can be measured as the probability that a system will return to a state better than the critical state in fixed time interval $< 0, t$), $t > 0$, (in the period of time not threatening further damage to this or other infrastructures). [Disaster resilient infrastructure]
9. The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions. [IPCC, 2012a], [IPCC, 2012b]
10. The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation. [IPCC, 2014]
11. A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment. [US EPA]



12. is amount of change a system can undergo without changing state. [IPCC, 2001 - see ref. in Levina and Tirpak, 2006]
13. is a tendency to maintain integrity when subject to disturbance. [UNDP, 2005], [Levina, Tirpak, 2006]
14. The ability of a system to recover from the effect of an extreme load that may have caused harm. [UKCIP, 2003], [Levina, Tirpak, 2006]
15. capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures [UN/ISDR, 2004],[Levina, Tirpak, 2006]
16. The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions; includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents. [Source: PPD-21, 2013], [2013 NIPP]
17. The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions. [IPCC, 2012b]
18. In asset management, the ability of an asset or asset system to resist the damaging effect of extreme loading Resilience measures can, for example, help to achieve design standards beyond the standard of protection. [EAFDG, 2010]
19. The ability of a system/community/society/defence to react to and recover from the damaging effect of realised hazards. [FLOODsite, 2009]
20. Constructing the building in such a way that although flood water may enter the building, its impact is minimised, structural integrity is maintained and repair, drying & cleaning are facilitated. [PPS25, 2009]
21. Measure of the cost and time of recovery [www.inrisk.ubc.ca]

Resilience measures. Resilience measures are designed to reduce the impact of water that enters property and businesses, and could include measures such as raising electrical appliances [DEFRA, 2010]

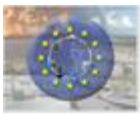
Resistance.

1. The ability of a system to remain unchanged by external events. [FLOODsite, 2009]
2. Constructing a building in such a way as to prevent flood water entering the building or damaging its fabric. This has the same meaning as flood proof. [PPS25, 2009]

Resistance measures. Resistance measures are designed to keep flood water out of properties and businesses, and could include flood guards for example. [DEFRA, 2010]

Retrofitting. Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards. [Dickson et al, 2012]

Robustness. The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to the effects of a hazard in efficient manner, including through the preservation of its essential basic structures and functions. Then **robustness** signifies that a system will retain its system structure (function) intact (remains unchanged or nearly unchanged), when exposed to perturbations and can be measured as the probability that a system will not go into the critical state or worse in time shorter than assumed level T, due to some external factors. [Disaster resilient infrastructure].



Social resilience. The capacity of a community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures. [FLOODsite, 2009]

Social vulnerability. This can be defined as the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard. (cf vulnerability below) [SMARTeST, 2011]

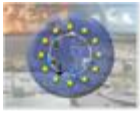
Structural measures. Any physical construction to reduce or avoid the impacts of hazards, or application of engineering techniques to achieve hazard resistance and resilience in structures or systems. [Dickson et al, 2012]

Structural measures. Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard-resistance and resilience in structures or systems. [UNISDR, 2009]

Unlikely. Not likely to occur. In probability terms this may mean that it has between 5% to 25% probability of occurring. Alternatively this may mean that the event may occur once in a period of 5 to 15 years. [DECS 07/5007, 2014]

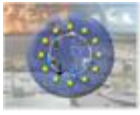
Vulnerability.

1. A physical feature or operational attribute that renders an entity open to exploitation or susceptible to a given hazard. [US Homeland Security, 2013]
2. The existence of a weakness, design, or implementation error that can lead to an unexpected, undesirable event compromising the security of the computer system, network, application, or protocol involved. [ENISA]
3. The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard. [Dickson et al, 2012], [Klaver et al, 2011]
4. The propensity or predisposition to be adversely affected. [IPCC, 2012a]
5. Weakness of an asset or a group of assets that can be used by one or more threats. [Croatian Law on critical infrastructures]
6. Weakness that can be exploited to gain access to a given asset. [Moteff, 2005], [Roper, 1999]
7. Essential properties of the system, parts of the system, assets, community and the environment which make them susceptible to adverse effects of a hazard. [Croatian Methodology for the operational risk analysis of critical infrastructure]
8. The extent to which a community, structure, service, or geographic area is likely to be damaged or disrupted by the impact of a particular disaster hazard, on account of their nature, construction, and proximity to hazardous terrain or a disaster-prone area. For engineering purposes, vulnerability is a mathematical function defined as the degree of loss to a given element at risk, or set of such elements, expected to result from the impact of a disaster hazard of a given magnitude. It is specific to a particular type of structure, and expressed on a scale of 0 (no damage) to 1 (total damage). For more general socio-economic purposes and macro-level analyses, vulnerability is a less-strictly-defined concept. It incorporates considerations of both the intrinsic value of the elements concerned and their functional value in contributing to communal well-being in general and to emergency response and post-disaster recovery in particular. In many cases, it is necessary (and sufficient) to settle for a qualitative classification in terms of “high”, “medium”, and “low”; or explicit statements concerning the disruption likely to be suffered. The characteristics and



circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. [Slandail terminology]

9. A feature of a system (infrastructure) (or a system property) that makes it easily influenced or attacked (especially by some external factors coming from the infrastructure environment or other infrastructures changes). **Vulnerability** in terms of reliability can be measured as the probability that a system will come to the critical state or worse in time shorter than assumed level T , due to some external factors, causing large negative effects that influence on other sensitive systems (consequences above a fixed level). Similar approach has been presented in [Disaster resilient infrastructure], where the vulnerability of an infrastructure system is defined as the probability of at least one disturbance with negative societal consequence Q larger than some large (critical) value q , during a given period time T .
10. Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. [Climate Change 2007: Synthesis Report]
11. is defined as the propensity or predisposition to be adversely affected. Such predisposition constitutes an internal characteristic of the affected element. In the field of disaster risk, this includes the characteristics of a person or group and their situation that influences their capacity to anticipate, cope with, resist, and recover from the adverse effects of physical events (Wisner et al, 2004). It is a result of diverse historical, social, economic, political, cultural, institutional, natural resource, and environmental conditions and processes. [SREX Ch1]
12. The propensity or predisposition to be adversely affected. [IPCC, 2012a], [IPCC, 2012b]
13. The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. [IPCC, 2014]
14. The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed; its sensitivity; and its adaptive capacity. [US EPA]
15. Refers to the magnitude of harm that would result from a particular hazardous event. The concept recognises, for example, that different sub-types of a receptor may differ in their sensitivity to a particular level of hazard. Therefore climate vulnerability defines the extent to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. It depends not only on a system's sensitivity but also on its adaptive capacity. Hence arctic alpine flora or the elderly may be more vulnerable to climate change than other components of our flora or population. [UKCIP, 2003], [Levina, Tirpak, 2006]
16. A physical feature or operational attribute that renders an entity open to exploitation or susceptible to a given hazard. (Source: DHS Lexicon, 2010) [NIPP 2013]
17. Characteristic of a system that describes its potential to be harmed. This can be considered as a combination of susceptibility and value. [FLOODsite, 2009]
18. Measure of the direct consequences of failure. [www.inrisk.ubc.ca]
19. The sensitivity to a hazard. According to the SREX report, vulnerability describes a set of conditions of people that derive from their historical and prevailing cultural, social, environmental, political, and economic contexts. In this sense, vulnerable groups are at risk not only because they are exposed to a hazard but also as a result of marginality, everyday patterns of social interaction and organisation, or access to resources. [CGU]



Vulnerability Analysis. Vulnerability of critical infrastructures, their parts or risk elements is crucial for determining the extent to which a sector, infrastructure or its part has been affected and the damage incurred (the greater vulnerability, the greater are the effects and consequences of adverse events to products and services). [Croatian Methodology for the operational risk analysis of critical infrastructure]

5.2 Disasters

Accident. An unplanned event that results in harm to people, damage to property or loss to process. [IAPA]

Barrier. The various “layers of protection” afforded facility and site personnel, the general public and the environment by the design and operational controls of each facility. [US Department of Energy, 1999]

Barrier challenged. A barrier should be considered “threatened” or “challenged” if the events in progress may result in a barrier failure. [US Department of Energy, 1999]

Barrier failure. A barrier is considered to have failed when it no longer provides the protection to facility and site personnel, the general public, and the environment afforded by design or operational controls. Failure of a barrier can usually be recognized by the readings or output from plant instruments such as valve position indicators, failed fuel monitors, pressure sensors, or stack effluent monitors. [US Department of Energy, 1999]

Cascade failure. A disruption of one infrastructure that causes a disruption in another infrastructure. [Croatian Methodology for the operational risk analysis of critical infrastructure]

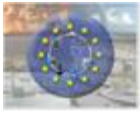
Cascading is a form of general dynamic that may multiply the effects of a combination of different hazards, such as an earthquake that produces a breakdown in infrastructure, whose failure contaminates water and causes disease to spread, which disrupts the local economy. The interdependent nature of many infrastructure systems significantly increases the potential for cascading effects that could spread from one kind of infrastructure to another. [Pescaroli et al, 2015]

Cascading effects are the dynamics present in disasters, in which the impact of a physical event or the development of an initial technological or human failure generates a sequence of events in human subsystems that result in physical, social or economic disruption. Thus, an initial impact can trigger other phenomena that lead to consequences with significant magnitudes. Cascading effects are complex and multi-dimensional and evolve constantly over time. They are associated more with the magnitude of vulnerability than with that of hazards. Low-level hazards can generate broad chain effects if vulnerabilities are widespread in the system or not addressed properly in sub-systems. For these reasons, it is possible to isolate the elements of the chain and see them as individual (subsystem) disasters in their own right. In particular, cascading effects can interact with the secondary or intangible effects of disasters. [Pescaroli et al, 2015]

Catastrophic disaster. The term implies an event or incident, which produces severe and widespread damages of such a magnitude as to result in the requirement for significant resources from outside the affected area to provide the necessary response. It results in large numbers of deaths and injuries; causes extensive damage or destruction of facilities that provide and sustain human needs; produces an overwhelming demand on state and local response resources and mechanisms; causes a severe long-term effect on general economic activity; and severely affects state, local, and private sector capabilities to begin and sustain response activities. [US Department of Energy, 1999]

Condition. Any as-found state, whether or not resulting from an event, that may have adverse safety, health, quality assurance, security, operational or environmental implications. A condition is usually programmatic in nature; for example, an error in analysis or calculation; an anomaly associated with design or performance; or an item indicating a weakness in the management process are all conditions. [US Department of Energy, 1999]

Damage. An injury or harm impairing the function or condition of a person or thing. [Slandail terminology]



Disaster. A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. [Dickson, 2012], [Klaver et al, 2011], [Slandail terminology]

Disaster. Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery. [IPCC, 2012a], [SREX Ch1]

Disaster management. Social processes for designing, implementing, and evaluating strategies, policies, and measures that promote and improve disaster preparedness, response, and recovery practices at different organizational and societal levels. [IPCC, 2012a]

Disaster operations. Disaster Operations are activities undertaken by Local and State government agencies to provide direct assistance to and in the protection of the general public immediately before, during and an immediate aftermath of a disaster event. [Slandail terminology]

Disasters. A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Comment: Disasters are often described as a result of the combination of: the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, social and economic disruption and environmental degradation. [EU-ADAPT]

Hazard. The potential of any machine, equipment, process, material (including biological and chemical) or physical factor that may cause harm to people, or damage to property or the environment. [IAPA]

Hazard is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. [ISDR Terminology of disaster risk reduction].

Incident. An unwanted event which, in different circumstances, could have resulted in harm to people, damage to property or loss to a process. [IAPA]

Incident. An event that is controlled before it leads to accident. [Kristainsen]

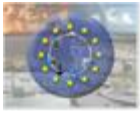
Landslides/mudslides. A mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated; the rapid movement of a mass of soil, rock or debris down a slope. [IPCC, 2007]

Natural disaster.

1. A physical capability with the ability to destroy or incapacitate critical infrastructures. Natural disasters differ from threats due to the absence of intent. [US President's Commission on Critical Infrastructure Protection, 1997]
2. Violent, sudden and destructive change in the environment without cause from human activity, due to phenomena such as floods, earthquakes, fire and hurricanes. [Slandail terminology]

Natural hazard. Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. [ISDR Terminology of disaster risk reduction].

Prevention. Actions taken to avoid an incident or to intervene to stop an incident from occurring. Prevention involves actions taken to protect lives and property. It involves applying intelligence and other information to a range of activities that may include such countermeasures as deterrence operations;



heightened inspections; improved surveillance and security operations; investigations to determine the full nature and source of the threat; immunizations, isolation, or quarantine; public health and agricultural surveillance and testing processes; and, as appropriate, specific law enforcement operations aimed at deterring, preempting, interdicting, or disrupting illegal activity and apprehending potential perpetrators and bringing them to justice. [Slandail terminology]

Protection. Protection includes such actions and measures needed to ensure protective reactions which do not unnecessarily interfere with citizen's freedoms and liberties. [Slandail terminology]

Rescue. The safe removal of persons or animals from actual or threatened danger of physical harm. [US President's Commission on Critical Infrastructure Protection, 1997]

Socio-natural hazard. The phenomenon of increased occurrence of certain geophysical and hydro-meteorological hazard events, such as landslides, flooding, land subsidence and drought, that arise from the interaction of natural hazards with overexploited or degraded land and environmental resources. [ISDR Terminology of disaster risk reduction]

Warning. A warning prompts people to take immediate actions that save lives, reduce injuries and protect property. Natural and manmade hazards create disasters when they kill and injure people, destroy and damage property, and cause further economic and emotional problems by instilling a sense of unease and uncertainty into society. Such losses can and have been reduced when people receive an alert of what is likely to happen soon, or notification of what is happening and advice about what to do in response to the hazard. With such knowledge, people can take appropriate action to get out of harm's way, to reduce losses, to reduce uncertainty, and to speed recovery. Thus a warning must provide the information and motivation for people to take informed action. [Slandail terminology]

5.3 Risk

Acceptable risk. The level of residual risk that has been determined to be a reasonable level of potential loss/disruption for a specific system. [ENISA]

Acceptable risk is the level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. [ISDR Terminology of disaster risk reduction]

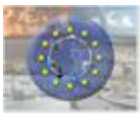
Acceptable risk. The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. In engineering terms, acceptable risk is also used to assess and define the structural and non-structural measures that are needed in order to reduce possible harm to people, property, services and systems to a chosen tolerated level, according to codes or "accepted practice" which are based on known probabilities of hazards and other factors. [Slandail terminology]

All hazards. The term "all hazards" means a threat or an incident, natural or manmade, that warrants action to protect life, property, the environment, and public health or safety, and to minimize disruptions of government, social, or economic activities. It includes natural disasters, cyber incidents, industrial accidents, pandemics, acts of terrorism, sabotage, and destructive criminal activity targeting critical infrastructure. [US Homeland Security, 2013]

Almost certain. Expected to occur in most circumstances. In probability terms this may mean that it has greater than 75% probability of occurring. Alternatively this may mean that the event may occur multiple times in a year. [DECS 07/5007, 2014]

Asset.

1. Person, structure, facility, information, material, or process that has value. [US Homeland Security, 2013]



2. An asset is an item, thing or entity that has potential or actual value to an organization. [ISO 55000]

Asset management.

1. Coordinated activity of an organization to realize value from asset. [ISO 55000]
2. Systematic and coordinated activities and practises through which an organization optimally and sustainable manage manages its assets and asset systems, their associated performance, risks and expenditures over their life cycle. [PAS 55-1:2008]

Cause. Element which alone or in combination has the intrinsic potential to give rise to risk. A risk source can be tangible or intangible. [DECS 07/5007, 2014]

Control. An existing mechanism, process, procedure or action which can be verified, which seeks to reduce the likelihood and/or consequence of a risk. Controls include any process, policy, device, practice, or other actions which modify risk. [DECS 07/5007, 2014]

Corrective disaster risk management. Management activities that address and seek to correct or reduce disaster risks which are already present. This concept aims to distinguish between the risks that are already present, and which need to be managed and reduced now, and the prospective risks that may develop in future if risk reduction policies are not put in place. [Slandail terminology]

Corrective disaster risk management. Management activities that address and seek to correct or reduce disaster risks which are already present. [ISDR Terminology of disaster risk reduction]

Critical infrastructure risk management framework. A planning and decision-making framework that outlines the process for setting goals and objectives, identifying infrastructure, assessing risks, implementing risk management activities, and measuring effectiveness to inform continuous improvement in critical infrastructure security and resilience. [US Homeland Security, 2013]

Critical parts or items. The parts of machinery, equipment, materials, structures or other areas that are more likely than other components to result in a major problem or loss when worn, damaged, abused, misused, or improperly applied. [IAPA]

Criticality analysis. Procedure for identifying processes and/or sub-processes, or systems and/or subsystems, whose disruptions or destruction would have far-reaching consequences for the operation of critical infrastructures. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Current risk rating. The estimated level of risk taking into consideration the existing controls in place. [DECS 07/5007, 2014]

Danger zone. An area or location where the probability of injury is high (for example, in the vicinity of saw blades). [IAPA]

Disaster management. Social processes for designing, implementing, and evaluating strategies, policies, and measures that promote and improve disaster preparedness, response, and recovery practices at different organizational and societal levels. [IPCC, 2012b], [IPCC, 2014]

Disaster preparedness measures, including early warning and the development of contingency or emergency plans, may be considered a component of, and a bridge between, disaster risk reduction and disaster management. Preparedness accepts the existence of residual, unmitigated risk, and attempts to aid society in eliminating certain of the adverse effects that could be experienced once a physical event(s) occurs (for example, by the evacuation of persons and livestock from exposed and vulnerable circumstances). [SREX Ch1]

Disaster risk.



1. The potential disaster losses, in lives, health status, livelihoods, assets, and services, which could occur to a particular community or a society over some specified future time period. [Dickson e., 2012], [ISDR Terminology of disaster risk reduction]
2. The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery. [IPCC, 2012a]
3. is defined for the purposes of this study as the likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery. Disaster risk derives from a combination of physical hazards and the vulnerabilities of exposed elements and will signify the potential for severe interruption of the normal functioning of the affected society once it materializes as disaster. [SREX Ch1]
4. The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery. [IPCC, 2012a], [IPCC, 2012b]
5. The likelihood within a specific time period of disaster. [IPCC, 2014]

Disaster risk management.

1. Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development. [IPCC, 2012a], [IPCC, 2014]
2. The systematic use of administrative directives, organizations, and operational skills and capacities to implement strategies, policies, and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. [Dickson et al, 2012]
3. The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. [EU-ADAPT], [ISDR Terminology of disaster risk reduction]
4. Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, resilience, and sustainable development. [IPCC, 2012a], [IPCC, 2012b]

Disaster risk reduction.

1. Denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience. [IPCC, 2012a]
2. The practice of reducing disaster risks through systematic efforts to analyze and manage the causes of disasters, including through reduced exposure to hazards, lessened vulnerability of people and



property, wise management of land and the environment, and improved preparedness for adverse events. [Dickson et al, 2012]

3. is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. [EU-ADAPT], [ISDR Terminology of disaster risk reduction]
4. Denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience. [IPCC, 2012b]

Disaster risk reduction plan. A document prepared by an authority, sector, organization, or enterprise that sets out goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives. [Dickson et al, 2012], [ISDR Terminology of disaster risk reduction]

Early warning system. The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. [ISDR Terminology of disaster risk reduction]

Emission scenario is a plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g. greenhouse gases, aerosols), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships. Concentration scenarios, derived from emission scenarios, are used as input to a climate model to compute climate projections. In IPCC (1992) a set of emission scenarios was presented which were used as a basis for the climate projections in IPCC (1996). These emission scenarios are referred to as the IS92 scenarios. In the IPCC Special Report on Emission Scenarios (Nakienovi and Swart, 2000) new emission scenarios, the so-called SRES scenarios, were published, some of which were used, among others, as a basis for the climate projections presented in TAR-IPCC (2001) and 4AR-IPCC (2007). [SWD(2013) 134 final]

Environmental risk. The probability of exceedance of the time needed by the ecosystem to recover from the damage. [Skanata,]

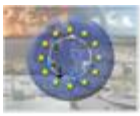
Establishing the context. Defining the external and internal parameters to be taken into account when managing risk, and setting the scope and risk criteria for the risk management policy. [DECS 07/5007, 2014], [ISO/IEC 31000, 2009]

Exposure

1. refers to the presence (location) of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by physical events and which, thereby, are subject to potential future harm, loss, or damage. [SREX Ch1]
2. The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected. [IPCC, 2014]

Extensive risk. The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity, often of a highly localized nature, which can lead to debilitating cumulative disaster impacts. [ISDR Terminology of disaster risk reduction]

External context. External environment in which the organization seeks to achieve its objectives. [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]



Extreme risk. This risk requires immediate action and is the responsibility of the CE or the Executive for their attention. [DECS 07/5007, 2014]

Extreme scenarios. Those scenarios used in vulnerability assessments and/or radiological and toxicological sabotage assessments, should provide the analyst with an upper bound on the severity of potential consequences Hazard. A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to a facility or to the environment (without regard for the likelihood or credibility of accident scenarios or consequence mitigation). [US Department of Energy, 1999]

Hazard classes. Non-nuclear facilities will be categorized as high, moderate, or low hazards based on the following:

- High - hazards with a potential for onsite and offsite impacts to large numbers of persons or for major impacts to the environment,
- Moderate - hazards which present considerable potential onsite impacts to people or the environment, but at most only minor offsite impacts, and
- Low - hazards which present minor onsite and negligible offsite impacts to people and the environment. [US Department of Energy, 1999]

High risk. This risk requires action as a priority and responsibility is assigned to the Director level for their attention. [DECS 07/5007, 2014]

Infrastructure assurance. Preparatory and reactive risk management actions intended to increase confidence that a critical infrastructure's performance level will continue to meet customer expectations despite incurring threat inflicted damage. For instance, incident mitigation, incident response, and service restoration. [US President's Commission on Critical Infrastructure Protection, 1997]

Inherent risk rating. The level of risk without taking into account existing systems and procedures to control or manage the risk (raw risk). [DECS 07/5007, 2014]

Intensive risk. The risk associated with the exposure of large concentrations of people and economic activities to intense hazard events, which can lead to potentially catastrophic disaster impacts involving high mortality and asset loss. Intensive risk is mainly a characteristic of large cities or densely populated areas that are not only exposed to intense hazards such as strong earthquakes, active volcanoes, heavy floods, tsunamis, or major storms but also have high levels of vulnerability to these hazards. [Slandail terminology]

Intensive risk. The risk associated with the exposure of large concentrations of people and economic activities to intense hazard events, which can lead to potentially catastrophic disaster impacts involving high mortality and asset loss. [ISDR Terminology of disaster risk reduction]

Internal context. Internal environment in which the organization seeks to achieve its objectives. [ISO/IEC 31000, 2009]

Level of risk. Magnitude of a risk or combination of risks, expressed in terms of the combination of consequences and their likelihood. [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]

Local disaster risk management. The process in which local actors (citizens, communities, government, non-profit organizations, institutions, and businesses) engage in and have ownership of the identification, analysis, evaluation, monitoring, and treatment of disaster risk and disasters, through measures that reduce or anticipate hazard, exposure, or vulnerability; transfer risk; improve disaster response and recovery; and promote an overall increase in capacities. LDRM normally requires coordination with and support from external actors at the regional, national, or international levels. Community-based disaster risk management is a subset of LDRM where community members and organizations are in the centre of decision making. [IPCC, 2012a], [IPCC, 2012b]



Low regrets policy. A policy that would generate net social and/or economic benefits under current climate and a range of future climate change scenarios. [IPCC, 2014]

Low risk. This risk requires a routine response and responsibility is assigned to a nominated officer for their attention. [DECS 07/5007, 2014]

Measure. A plan or course of action intended to mitigate a risk. [Klaver et al, 2011]

Mitigation. Limitation of any negative consequence of a particular event. [ENISA]

Moderate risk. This risk requires action to be scheduled and monitored and responsibility is assigned to the Business Unit Manager for their attention. [DECS 07/5007, 2014]

Monitor. To check, supervise, observe critically or record the progress of an activity, action or system on a regular basis in order to identify change. [DECS 07/5007, 2014]

Monitor and review. A process for measuring the efficiency and effectiveness of the organization's Risk Management processes is the establishment of an ongoing monitor and review process. This process makes sure that the specified management action plans remain relevant and updated. This process also implements control activities including re-evaluation of the scope and compliance with decisions. [ENISA]

Monitoring. The systematic measurement of health hazards to which workers are exposed. There are two types of measurements that can be taken: biological (worker) and environmental (workplace air) [IAPA]

Natural threat. Natural process or occurrence which may cause death, injury or illness of people, property damage, loss of goods and services, financial loss, interruption of social and economic activities or environmental damage. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Nonstructural measures. Any measure not involving physical construction that uses knowledge, practice, or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training, and education. [Dickson et al., 2012], [UNISDR, 2009]

Operational risk. Operational risks relate to the day-to-day delivery of activities, operational business plans and objectives. Operational risks typically have a short term focus. Operational risks may have the ability to impact strategic and other operational risks. [DECS 07/5007, 2014]

Possible. Might occur at some time. In probability terms this may mean that it has between 25% to 50% probability of occurring. Alternatively this may mean that the event may occur once in a period of 2 to 5 years. [DECS 07/5007, 2014]

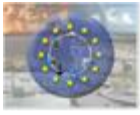
Prediction. A statement of the expected time, place and magnitude of a future event. [Slandail terminology]

Preparedness defines the knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions. [UNISDR]

Prevention.

1. The outright avoidance of adverse impacts of hazards and related disasters. [ISDR Terminology of disaster risk reduction]
2. Those capabilities necessary to avoid, prevent, or stop a threatened or actual act of terrorism [NIPP]
3. The systematic application of recognized principles to reduce incidents, accidents, or the accident potential of a system or organization. [IAPA]

Project Risk. Project risks relate to the achievement and delivery of the project objectives and outcomes. The majority of project risks are short term in nature and exist for the term of the project, whilst some will



be ongoing and re-classified at the end of the project. Projects can be defined as temporary, with the aim of delivering outcomes within a specified timeframe. [DECS 07/5007, 2014]

Projection. The potential evolution of a quality or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasise that projections involve assumptions — concerning, for example, future socio-economic and technological developments, that may or may not be realised — and are therefore subject to substantial uncertainty. [SWD(2013) 134 final]

Prospective disaster risk management.

1. Management activities that address and seek to avoid the development of new or increased disaster risks. This concept focuses on addressing risks that may develop in future if risk reduction policies are not put in place, rather than on the risks that are already present and which can be managed and reduced now. [Slandail terminology]
2. Management activities that address and seek to avoid the development of new or increased disaster risks. [ISDR Terminology of disaster risk reduction]

Public awareness.

1. The extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards. [ISDR Terminology of disaster risk reduction]
2. is the extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards. [UNISDR]Comment: Public awareness is a key factor in effective disaster risk reduction. Its development is pursued, for example, through the development and dissemination of information through media and educational channels, the establishment of information centres, networks, and community or participation actions, and advocacy by senior public officials and community leaders.

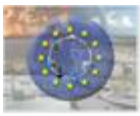
Residual risk.

1. Risk remaining after risk treatment. [ENISA], [ISO/IEC 31000, 2009]
2. The risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained. [ISDR Terminology of disaster risk reduction] , [Slandail terminology], [UNISDR, 2009]
3. The risk that remains after risk management and mitigation measures have been implemented. May include, for example, damage predicted to continue to occur during flood events of greater severity than the 100 to 1 annual probability event. [FLOODsite, 2009]

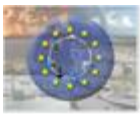
Residual risk rating. The remaining level of risk after all treatment plans have been implemented. [DECS 07/5007, 2014]

Risk.

1. The potential that a given threat will exploit vulnerabilities of an asset or group of assets and thereby cause harm to the organization. [ENISA]
2. The combination of the probability of an event and its negative consequences. [Dickson, 2012]
3. Quantified, objectified, compared or identified hazards. [Bozic, 2015]
4. The combination of the probability of an incident releasing radioactive and/or hazardous materials and the consequences of the release on the public and the environment which, taken over all events relating to system operation, provides a meaningful picture of the adverse impact of the operation. [US Department of Energy, 1999]



5. Risk is a combination of the consequences of an event (hazard) and the associated likelihood/probability of its occurrence. [Klaver et al, 2011]
6. Relationship between the consequence of an event and the possibility/probability of its occurrence. [Croatian Methodology for the operational risk analysis of critical infrastructure]
7. Effect of uncertainty on objectives. [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]
8. potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences. [US Homeland Security, 2013]
9. Risk is the effect of uncertainty on objectives. It is measured in terms of consequences and likelihood. It is any condition or circumstance which may impact on the achievement of objectives and/or have a significant impact on the day-to-day operations. [DECS 07/5007, 2014]
10. The combination of the probability of an event and its negative consequences. [ISDR Terminology of disaster risk reduction] , [UNISDR]
11. Probability (number between 0 and 1) that event with adverse effects occurs. [CLIMATE RISK ANALYSIS]
12. Other definitions exist, but this one has the highest relevance for the practitioner. [CLIMATE RISK ANALYSIS]
13. is a combination of the consequences of an event (hazard) and the associated likelihood/probability of its occurrence. [ISO 31 010]
14. The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. In this report, the term risk is often used to refer to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental services) and infrastructure. [IPCC, 2014]
15. In flood risk management risk is defined as the probability of a flood occurring x consequence of the flood. [DEFRA, 2010]
16. can be considered as having two components: (1) the probability that an event will occur (2) the consequence to receptors associated with that event Risk = probability ´ consequence [EAFDG, 2010]
17. is a function of probability, exposure and vulnerability. Often, in practice, exposure is incorporated in the assessment of consequences, therefore risk can be considered as having two components — the probability that an event will occur and the impact (or consequence) associated with that event. Often this is abbreviated as Risk = Probability multiplied by consequence. [FLOODsite, 2009]
18. Expected consequences associated with a given activity. Considering an activity with only one event with potential consequences risk R is thus the probability that this event will occur P multiplied with the consequences given the event occurs C.
19. Probability of an event multiplied by its impact [www.inrisk.ubc.ca]
20. **(climate-related).** Is the result of interaction of physically defined hazards with the properties of the exposed systems – i.e., their sensitivity or (social) vulnerability. Risk can also be considered as the combination of an event, its likelihood, and its consequences – i.e., risk equals the probability of climate hazard multiplied by a given system’s vulnerability. [UNDP, 2005], [Levina, Tirpak, 2006]



Risk acceptability. The level of risk which the society is consciously willing to accept, with regard to social, political and economic cost-benefit analysis. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Risk acceptability criteria. Specified properties according to which risk acceptability is assessed or decided upon. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Risk acceptance.

1. Informed decision to take a particular risk. [DECS 07/5007, 2014], [ISO/IEC 27000, 2013]
2. The potential that a given threat will exploit vulnerabilities of an asset or group of assets and thereby cause harm to the organization. Risk acceptance depends on risk criteria defined within the process Definition of Scope. [ENISA]
3. Risk acceptance describes the willingness to tolerate a risk, whereby the acceptable risk refers to the level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. [FMMEP, 2007]

Risk analysis.

1. A methodology to objectively determine risk by analysing and combining probabilities and consequences. [FLOODsite, 2009]
2. Process to comprehend the nature of risk and to determine the level of risk. [DECS 07/5007, 2014], [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009], [ISO 31010]
3. Systematic use of information to identify sources and to estimate the risk. [ENISA]
4. Consideration of relevant threat scenarios, in order to assess the vulnerability and the potential impact of disruption or destruction of critical infrastructure. [Croatian Law on critical infrastructures], [EU. Council Directive, 2008], [OJEU, 2008]
5. In a narrow sense, statistical sub-discipline that estimates the risk, using mathematical models and data. In a wider sense, risk analysis includes the identification of potential sources of risk and a strategy of how to obtain accurate information (data) about these sources [CLIMATE RISK ANALYSIS]

Risk appetite. Amount and type of risk that an organisation is willing to pursue or retain. [DECS 07/5007, 2014]

Risk assessment.

1. Overall process of risk identification, risk analysis and risk evaluation. [DECS 07/5007, 2014], [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]
2. A scientific and technologically based process consisting of three steps, risk identification, risk analysis and risk evaluation. [ENISA]
3. A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating conditions of vulnerability that together might harm exposed people, property, services, livelihoods, and the environment on which they depend. [Dickson, 2012],
4. Comprises understanding, evaluating and interpreting the perceptions of risk and societal tolerances of risk to inform decisions and actions in the flood risk management process. [FLOODsite, 2009]
5. A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend. [ISDR Terminology of disaster risk reduction]



6. is the overall process of risk identification, risk analysis, and risk evaluation. [ISO 31010]
7. The qualitative and/or quantitative scientific estimation of risks. [IPCC, 2014]

Risk attitude. Organization's approach to assess and eventually pursue, retain, take or turn away from risk. [ISO/IEC 31000, 2009]

Risk avoidance.

1. Decision not to become involved in, or action to withdraw from, a risk situation. [ENISA]
- 2.
3. Informed decision not to be involved in, or to withdraw from, an activity in order not to be exposed to a particular risk. Risk avoidance may increase the significance of other risks or may lead to the loss of opportunities for gain. [DECS 07/5007, 2014]

Risk categories. The categories used by the organisation to group similar opportunities or risks for the purposes of reporting and assigning responsibility. [DECS 07/5007, 2014]

Risk communication (in context). Any intentional exchange of information on environmental and/or health risks between interested parties. [FLOODsite, 2009]

Risk control. Actions implementing risk management decisions. [ENISA]

Risk criteria.

1. Terms of reference by which the significance or risk is assessed. Risk criteria can include associated cost and benefits, legal and statutory requirements, socio-economic aspects, the concerns of stakeholders, priorities and other inputs to the assessment. [ENISA]
2. Terms of reference against which the significance of a risk is evaluated. [DECS 07/5007, 2014], [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009], [ISO 31010]
3. Reference values according to which risk significance is assessed. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Risk description. Structured statement of risk usually containing four elements: sources, events, causes and consequences. [DECS 07/5007, 2014]

Risk elements. Material and immaterial property that may be damaged or destroyed, which could have consequences for the operation of infrastructure or the functioning of systems and subsystems of the infrastructure. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Risk estimation. Process used to assign values to the probability and consequences of a risk. [ENISA]

Risk evaluation.

1. Process of comparing the estimated risk against given risk criteria to determine the significance of risk. [ENISA]
2. is the process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable. [ISO 31010]
3. Process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable. [Croatian Methodology for the operational risk analysis of critical infrastructure], [DECS 07/5007, 2014], [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]

Risk financing. Provision of funds to meet the cost of implementing risk treatment and related costs. [ENISA]

Risk identification.



1. Process to find, list and characterize elements of risk. [ENISA], [ISO/IEC 31000, 2009]
2. Process of finding, recognizing and describing risks. [Croatian Methodology for the operational risk analysis of critical infrastructure], [ISO/IEC 27000, 2013], [ISO 31010]
3. A systematic process applied to the organisation's objectives and activities to identify possible risk sources and causes and potential consequences or impacts should a risk occur. [DECS 07/5007, 2014]

Risk management.

1. The process, distinct from risk assessment, of weighing policy alternatives in consultation with interested parties, considering risk assessment and other legitimate factors, and selecting appropriate prevention and control options. [ENISA]
2. The systematic practice of managing uncertainty to minimize potential harm and loss. [Dickson et al, 2012]
3. Risk management refers to a coordinated set of activities and methods that is used to direct an organisation and to control the many risks that can affect its ability to achieve objectives. [Klaver et al, 2011]
4. Coordinated activities to direct and control an organisation with regard to risk. [DECS 07/5007, 2014], [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]
5. The systematic approach and practice of managing uncertainty to minimize potential harm and loss. Risk management comprises risk assessment and analysis, and the implementation of strategies and specific actions to control, reduce and transfer risks. It is widely practiced by organizations to minimise risk in investment decisions and to address operational risks such as those of business disruption, production failure, environmental damage, social impacts and damage from fire and natural hazards. Risk management is a core issue for sectors such as water supply, energy and agriculture whose production is directly affected by extremes of weather and climate. [UNISDR]
6. The complete process of risk analysis, risk assessment, options appraisal and implementation of risk management measures. [FLOODsite, 2009]
7. The systematic approach and practice of managing uncertainty to minimize potential harm and loss. [ISDR Terminology of disaster risk reduction]
8. Plans, actions, or policies to reduce the likelihood and/or consequences of risks or to respond to consequences. [IPCC, 2014]

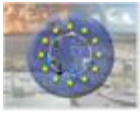
Risk management framework. Set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management throughout the organization. [ISO/IEC 31000, 2009]

Risk management measure. An action that is taken to reduce either the probability of flooding or the consequences of flooding or some combination of the two. [FLOODsite, 2009]

Risk management plan. Scheme within the risk management framework specifying the approach, the management components and resources to be applied to the management of risk. [ISO/IEC 31000, 2009]

Risk management process. The systematic application of management policies, procedures and practices to the activities of communicating, consulting, establishing the context, and identifying, analysing, evaluating, treating, monitoring and reviewing risk. [DECS 07/5007, 2014], [ISO/IEC 31000, 2009]

Risk map is a map that portrays levels of risk across a geographical area. Such maps can focus on one risk only or include different types of risks. [SEC(2010)1626]



Risk mapping. The process of establishing the spatial extent of risk (combining information on probability and consequences). Risk mapping requires combining maps of hazards and vulnerabilities. The results of these analyses are usually presented in the form of maps that show the magnitude and nature of the risk. [FLOODsite, 2009]

Risk matrix. Tool for ranking and displaying risks by defining ranges for consequence and likelihood. [DECS 07/5007, 2014], [Nad et al, 2014]

Risk optimization. Process, related to a risk to minimize the negative and to maximize the positive consequences and their respective probabilities. Risk optimization depends upon risk criteria, including costs and legal requirements. [ENISA]

Risk owner. Person with the accountability and authority to manage risk. [DECS 07/5007, 2014]

Risk perception.

1. Way in which a stakeholder views a risk, based on a set of values or concerns. Risk perception depends on the stakeholder's needs, issues and knowledge. Risk perception can differ from objective data. [ENISA]
2. Risk perception is the view of risk held by a person or group and reflects cultural and personal values, as well as experience. [FLOODsite, 2009]
3. The subjective judgment that people make about the characteristics and severity of a risk. [IPCC, 2014]

Risk profile. The change in performance, and significance of the resulting consequences, under a range of loading conditions. In particular the sensitivity to extreme loads and degree of uncertainty about future performance. [FLOODsite, 2009]

Risk rating. The combination of the consequence and likelihood. The Risk Rating is assessed as either low, moderate, high or extreme. [DECS 07/5007, 2014]

Risk reduction. Actions taken to lessen the probability, negative consequences or both, associated with a risk. [ENISA]

Risk reduction. The reduction of the likelihood of harm, by either reduction in the probability of a flood occurring or a reduction in the exposure or vulnerability of the receptors. [FLOODsite, 2009]

Risk register.

1. A formal record of all the anticipated risks that could have an adverse impact on a project. The register should evaluate the likelihood (probability) of each risk and describe the consequences of it happening. The risk register should assign responsibility for management of the risk with an indication of whether the risk is accepted, or what steps should be taken to reduce or eliminate the risk or to mitigate its consequences. [EAFDG, 2010]
2. An auditable record of the project risks, their consequences and significance, and proposed mitigation and management measures. [FLOODsite, 2009]

Risk retention. Acceptance of the burden of loss, or benefit of gain, from a particular risk. Risk retention includes the acceptance of risks that have not been identified. Risk retention does not include treatments involving insurance, or transfer by other means. [ENISA]

Risk scenario.

1. Situational representation of one or more types of risks which cause significant consequences, and which have been selected in order to conduct a more detailed assessment for a specific type of risk. [Croatian Methodology for the operational risk analysis of critical infrastructure]



2. is a representation of one single-risk or multi-risk situation leading to significant impacts, selected for the purpose of assessing in more detail a particular type of risk for which it is representative, or constitutes an informative example or illustration. [SEC(2010)1626]

Risk sharing. Form of risk treatment involving the agreed distribution of risk with other parties. Legal or regulatory requirements can limit, prohibit or mandate risk sharing. Risk sharing can be carried out through insurance or other forms of contract. [DECS 07/5007, 2014]

Risk significance (in context). The separate consideration of the magnitude of consequences and the frequency of occurrence. [FLOODsite, 2009]

Risk tolerance. An organisations or stakeholders readiness to bear the risk after risk treatment in order to achieve its objectives. [DECS 07/5007, 2014]

Risk transfer.

1. Sharing with another party the burden of loss or benefit of gain, for a risk. [ENISA]
2. The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise, or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party. [Dickson e., 2012], [IPCC, 2012a], [SREX Ch1]
3. The practice of formally or informally shifting the risk of financial consequences for particular negative events from one party to another. [IPCC, 2014].

Risk treatment.

1. Process of selection and implementation of measures to modify risk. Risk treatment measures can include avoiding, optimizing, transferring or retaining risk. [ENISA]
2. Process to modify risk. [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]

Risk-informed decision making. The determination of a course of action predicated on the assessment of risk, the expected impact of that course of action on that risk, and other relevant factors. [US Homeland Security, 2013]

Social risk. Relationship between frequency and the number of people suffering from a specified level of harm in a given population from the realization of specified hazardous. [Skanata D.,]

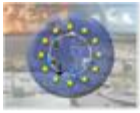
Stakeholder. Any individual, group or organization that can affect, be affected by, or perceive itself to be affected by, a risk. [ENISA]

Standards. Set of rules or codes mandating or defining product performance (e.g., grades, dimensions, characteristics, test methods and rules for use). [Verbruggen et al, 2011]

Strategic risk. A strategic risk has the ability to impact on the achievement /delivery of the Department's strategic objectives/directions. Strategic Risks relate to the highest level of objective, which typically have a long term focus and are linked to the Strategic Plan. [DECS 07/5007, 2014]

Technical-technological threat. Threat arising from technological and industrial conditions, procedures, infrastructure failure or specific human activities, which may cause death, injury or illness, property damage, loss of goods and services, interruption of social and economic activities or environmental damage. [Croatian Methodology for the operational risk analysis of critical infrastructure]

Technological hazard. A range of hazards emanating from the manufacture, transportation, and use of such substances as radioactive materials, chemicals, explosives, flammables, agricultural pesticides, herbicides and disease agents; oil spills on land, coastal waters or inland water systems; and debris from space. [US Department of Energy, 1999]

**Threat.**

1. A natural or manmade occurrence, individual, entity, or action that has or indicates the potential to harm life, information, operations, the environment, and/or property. [US Homeland Security, 2013]
2. Potential cause of an unwanted incident, which may result in harm to a system or organization. [ISO/IEC 27000, 2013], [Nad et al, 2014]
3. Any indication, circumstance or event with the potential to cause loss or damage to an asset. [Moteff, 2005], [Roper, 1999]
4. Any circumstance or event with the potential to adversely impact an asset through unauthorized access, destruction, disclosure, modification of data, and/or denial of service. [ENISA]
5. Occurrence, human activity, substance or state that may cause death, injury or illness, property damage, environmental damage, disruption or interruption of social or economic functions. [Croatian Methodology for the operational risk analysis of critical infrastructure]
6. Potential cause of an unwanted incident, which may result in harm to individuals, a system or organization, the environment or the community. [Slandail terminology]

Threshold is a level of magnitude of a system process at which sudden or rapid change occurs. A point or level at which new properties emerge in an ecological, economic or other system, invalidating predictions based on mathematical relationships that apply at lower levels. [SWD(2013) 134 final]

Treatment. Additional mechanisms, processes, procedures or actions to be implemented, which seek to reduce the current likelihood and/or consequence and reach the Residual Risk Rating. [DECS 07/5007, 2014]

5.4 Impacts

Accident. A deviation from normal operations or activities associated with a hazard, which has the potential to result in an emergency. [US Department of Energy, 1999]

Aggregate impacts. Total impacts summed up across sectors and/or regions. The aggregation of impacts requires knowledge of (or assumptions about) the relative importance of impacts in different sectors and regions. Measures of aggregate impacts include, for example, the total number of people affected, change in net primary productivity, number of systems undergoing change, or total economic costs. [Climate Change 2007: Synthesis Report]

Carcinogen. A chemical, physical or biological agent that can cause cancer in humans or animals. [IAPA]

Chemical agent. A chemical substance that affects the body, a part of the body, or any of its functions. The effects may be beneficial or harmful. [IAPA]

Chronic effect. A change that occurs in the body over a relatively long time (weeks, months, years) following repeated exposure or a single over-exposure to a substance. [IAPA]

Combustible. Capable of catching fire and burning, usually a material that has a flash point above 37.8°C. [IAPA]

Consequence.

1. The result or effect of the release of hazardous materials into the environment. Specifically, the "consequences" of concern are human health effects. [US Department of Energy, 1999]
2. Outcome of an event. [ENISA], [Nad et al, 2014]
3. Outcome of an event affecting objectives. [ISO/IEC 31000, 2009]



4. The effect of an event, incident, or occurrence, including the number of deaths, injuries, and other human health impacts along with economic impacts both direct and indirect and other negative outcomes to society. [Source: Adapted from DHS Lexicon, 2010], [US Homeland Security, 2013], [2013 NIPP], [NIPP]
5. The outcome or impact of an event affecting objectives. It can be expressed either qualitatively or quantitatively, being a loss, disadvantage or gain. There may be a range of possible outcomes associated with an event. [DECS 07/5007, 2014]

Consequence assessment. The process used to evaluate the impacts of a release of radioactive or other hazardous materials. The assessment of consequences is the evaluation and interpretation of all available information concerning an actual or potential release of hazardous materials to the environment for the purpose of estimating personnel exposure/dose. [US Department of Energy, 1999]

Consequence management. Planning, preparedness, and response activities for addressing the consequences of a terrorism incident. These activities include measures to: alleviate damage, loss, hardship, or suffering caused by the incident; protect public health and safety; restore essential Government services; and provide emergency assistance to those affected. [US Department of Energy, 1999]

Contaminant. An unwanted material (for example, radioactive, biological or chemical) that is likely to harm the quality of the working environment. The most common workplace contaminants are chemicals that may be present in the form of dusts, fumes, gases or vapours. [IAPA]

Corrosive. A substance that will burn the skin or eyes on contact. [IAPA]

Critical injury. The serious injury that is life-threatening or produces unconsciousness or results in a substantial loss of blood or involves the fracture of a leg or arm (but not a finger or toe) or involves the amputation of a leg, arm, hand or foot (but not a finger or toe) or consists of burns to a major portion of the body or causes the loss of sight in an eye. [IAPA]

Criticality accident. The release of energy as a result of accidentally producing a self-sustaining or divergent fission chain reaction (also called "Nuclear Criticality Accident."). [US Department of Energy, 1999]

Customer. Organization or individual member of the general public purchasing property, products or services for commercial, private or public purposes. [ISO/IEC 26000, 2010]

Decomposition. The breakdown of a material or substance (by heat, chemical reaction, rotting or other process) into parts or elements. [IAPA]

Detection of impacts of climate change. For a natural, human, or managed system, identification of a change from a specified baseline. The baseline characterizes behaviour in the absence of climate change and may be stationary or non-stationary (e.g., due to land use change). [IPCC, 2014]

Due diligence. Comprehensive, proactive process to identify the actual and potential negative social, environmental and economic impacts of an organization's decisions and activities over the entire life cycle of a project or organizational activity, with the aim of avoiding and mitigating negative impacts. [ISO/IEC 26000, 2010]

Dust. Fine particles of a solid that can remain suspended in air. The particle size of a dust is larger than that of a fume. Dusts are produced by mechanical action, such as grinding. Some dusts may be harmful to an employee's health. [IAPA]

Economic and environmental impacts are the sum of the costs of cure or healthcare, cost of immediate or longer-term emergency measures, costs of restoration of buildings, public transport systems and infrastructure, property, cultural heritage, etc., costs of environmental restoration and other environmental costs (or environmental damage), costs of disruption of economic activity, value of insurance pay-outs,



indirect costs on the economy, indirect social costs, and other direct and indirect costs, as relevant. [SEC(2010)1626]

Environmental impact assessment. Process by which the environmental consequences of a proposed project or programme are evaluated, undertaken as an integral part of planning and decision- making processes with a view to limiting or reducing the adverse impacts of the project or programme. [ISDR Terminology of disaster risk reduction]

Environmental impact assessment is process by which the environmental consequences of a proposed project or programme are evaluated, undertaken as an integral part of planning and decision-making processes with a view to limiting or reducing the adverse impacts of the project or programme. [UNISDR]

Evaluation. The process of validation or identification of weaknesses and/or findings in emergency management programs. [US Department of Energy, 1999]

Evaporation. The process by which a liquid, without reaching its boiling point, changes into a vapour and mixes with the air. [IAPA]

Event. Any real-time occurrence or significant deviation from planned or expected behaviour that could endanger or adversely affect people, property, or the environment. [US Department of Energy, 1999]

Explosive. A substance, mixture or compound that is capable of producing an explosion. [IAPA]

Exposure. People, property, systems, or other elements present in hazard zones and subject to potential losses. [Dickson et al, 2012]

Exposure values. The airborne concentrations of a biological, chemical, or physical agent to which it is believed nearly all workers may be exposed without experiencing any harmful effects. [IAPA]

Exposure Values. The concentrations of a biological, chemical, or physical agent to which it is believed nearly all workers may be exposed without experiencing any harmful effects. [IAPA]

Flammable. Capable of easily catching fire and of burning, usually a material that has a flash point below 37.8°C. [IAPA]

Flash Point. The lowest temperature at which a liquid will give off enough vapours to form a mixture that will burn if ignited. The lower the flash point, the higher the risk of fire. [IAPA]

Hazardous material. Any substance that may produce adverse health and/or safety effects to people or the environment. [IAPA]

Human error. This term is used today to include not just workers' errors, but engineering deficiencies and lack of adequate organizational controls which together account for the majority of accidents. [IAPA]

Human impacts are defined as the quantitative measurement of the following factors: number of deaths, number of severely injured or ill people, and number of permanently displaced people. [SEC(2010)1626]

Ignition source. A source of energy, such as heat, flame, sparks or static electricity, that is capable of causing a fuel mixture to burn. [IAPA]

Impact.

1. The result of an unwanted incident. [ENISA]
2. Effects on natural and human systems. In this report, the term 'impacts' is used to refer to the effects on natural and human systems of physical events, of disasters, and of climate change. [IPCC, 2012a]
3. The effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts:



- Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation. [Climate Change 2007: Synthesis Report].
 - Residual impacts: the impacts of climate change that would occur after adaptation [Climate Change 2007: Synthesis Report]
4. Effects on natural and human systems. In this report, the term ‘impacts’ is used to refer to the effects on natural and human systems of physical events, of disasters, and of climate change. [IPCC, 2012b]
 5. Effects on natural and human systems. In this report, the term impacts are used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts and sea level rise, are a subset of impacts called physical impacts. [IPCC, 2014]
 6. The effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts:
 - **Potential impacts.** All impacts that may occur given a projected change in climate, without considering adaptation.
 - **Residual impacts.** The impacts of climate change that would occur after adaptation. [IPCC, 2007]

Impact analysis. The identification of critical business processes, and the potential damage or loss that may be caused to the organization resulting from a disruption to those processes. Business impact analysis identifies:

- the form the loss or damage will take
- how that degree of damage or loss is likely to escalate with time following an incident
- the minimum staffing, facilities and services needed to enable business processes to continue to operate at a minimum acceptable level
- the time for full recovery of the business processes. [ENISA]

Impact assessment. The practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems. [Climate Change 2007: Synthesis Report]

Incident.

1. An event that has been assessed as having an actual or potentially adverse effect on the security or performance of a system. [ENISA]
2. Any deviation from normal operations or activities which has the potential to result in an emergency. [US Department of Energy, 1999]
3. Realisation of a risk. [Klaver et al, 2011]
4. An occurrence, caused by either human action or natural phenomenon, that may cause harm and require action, which can include major disasters, emergencies, terrorist attacks, terrorist threats, wild and urban fires, floods, hazardous materials spills, nuclear accidents, aircraft accidents, earthquakes, hurricanes, tornadoes, tropical storms, war-related disasters, public health and medical emergencies, cyber attacks, cyber failure/accident, and other occurrences requiring an emergency response. [US Homeland Security, 2013]

Incompatible. A term used to describe materials that could cause dangerous reactions if they come in direct contact with one another. [IAPA]

Inhalation. The breathing in of an airborne gas, vapour, fume, mist or dust. [IAPA]



Initiating event. An unplanned occurrence caused by human or natural phenomena provided to the incident or accident

Irritant. A substance which, in sufficient quantities, can inflame or irritate the eyes, skin or respiratory system (lungs, etc.). Symptoms include pain and reddening. [IAPA]

Market impacts. Impacts that are linked to market transactions and directly affect gross domestic product (GDP, a country's national accounts) — for example, changes in the supply and price of agricultural goods. [Climate Change 2007: Synthesis Report]

Melting point. The temperature at which a solid changes to a liquid. For mixtures, a range of temperatures may be given. [IAPA]

Mutagen. An agent that causes sudden and permanent changes in one or more hereditary features, generally by modifying one or more genes (changes to genetic material). The changes may or may not be passed on to offspring. [IAPA]

Non-market impacts. Impacts that affect ecosystems or human welfare, but that are not directly linked to market transactions — for example, an increased risk of premature death. [Climate Change 2007: Synthesis Report]

Oxidizing agent. A substance that gives up oxygen easily (this oxygen can fuel a fire) or reduces the hydrogen in other compounds. Some examples of oxidizing agents are peroxides, chlorates, perchlorates, nitrates and permanganates. Oxidation and reduction reactions always occur at the same time. [IAPA]

Physical impacts of disasters include casualties (deaths and injuries), losses of structures, animals, and crops and property damage (households, infrastructure etc.). The physical impacts of a disaster are usually the most obvious, easily measured, and first reported by the news media.

Political/social impacts are usually rated on a semi-quantitative scale and may include categories such as public outrage and anxiety²¹, encroachment of the territory, infringement of the international position, violation of the democratic system, and social psychological impact²², impact on public order and safety, political implications, psychological implications, and damage to cultural assets²³, and other factors considered important which cannot be measured in single units, such as certain environmental damage. [SEC(2010)1626]

Priority. Sequence in which an incident or problem needs to be resolved, based on impact and urgency. [ENISA]

Procedure. A written description of a course of action to be taken to perform a given task. [ENISA]

Process. An organized set of activities which uses resources to transform inputs to outputs. [ENISA]

Radiation. The energy transmitted by waves through space or some medium. There are two types of radiation: ionizing (for example, X-Rays or radiation from a radioactive device), and non-ionizing radiation (for example, infra-red radiation, ultra-violet radiation). [IAPA]

Reactivity. The capability of a substance to undergo a chemical reaction with the release of energy. Unwanted effects include: pressure build-up, temperature increase, and formation of harmful by-products. These effects may occur because of the reactivity of a substance to heat, an ignition source, or direct contact with other chemicals in use or in storage. [IAPA]

Reducing agent. A substance that accepts oxygen or gives up hydrogen during a chemical reaction. Oxidation and reduction always occur at the same time. [IAPA]

Sensitizer. A substance which on first exposure causes little or no reaction in humans or test animals. However, on repeated exposure, it may cause a marked response not necessarily limited to the contact site. [IAPA]



Social impacts, include psychosocial, demographic (e.g. displacement of populations), economic (financial cost of physical damage), and political impacts, can develop over a long period of time and can be difficult to assess when they occur.

Social responsibility. Responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behaviour. [ISO/IEC 26000, 2010]

Synergistic effects. The health effects of two or more substances or agents that are greater than the sum of their separate effects. [IAPA]

Teratogen. An agent that causes birth defects by harming the unborn child. [IAPA]

Threat. Natural or man-made occurrence, individual, entity, or action that has or indicates the potential to harm life, information, operations, the environment, and/or property. [DHS 2010]

Threshold limit value. A threshold limit value refers to the airborne concentration of a substance to which it is believed that nearly all workers may be repeatedly exposed day after day (for 8 hours per day) without harmful effect. Because of individual susceptibility, however, a small percentage of workers may experience discomfort from substances in concentrations at or below the threshold limit. A smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by the development of an occupational illness. [IAPA]

Toxic substance. Any substance that can cause acute or chronic effects to a person or is suspected to cause disease or injury under certain conditions. [IAPA]

Unstable. The tendency of a material to break down or to undergo other unwanted chemical changes during normal handling or storage. [IAPA]

Vapour. The form that a gas or liquid takes when it evaporates into the air. [IAPA]

5.5 Economy

Banking and finance. A critical infrastructure characterized by entities, such as retail and commercial organizations, investment institutions, exchange boards, trading houses, and reserve systems, and associated operational organizations, government operations, and support activities, that are involved in all manner of monetary transactions, including its storage for saving purposes, its investment for income purposes, its exchange for payment purposes, and its disbursement in the form of loans and other financial instruments. [US President's Commission on Critical Infrastructure Protection, 1997]

Competition. Activity of two or more entities taken in consideration of each other to achieve differing objectives. The commercial analogue of military combat. [US President's Commission on Critical Infrastructure Protection, 1997]

Cost-benefit analysis. Monetary measurement of all negative and positive impacts associated with a given action. Costs and benefits are compared in terms of their difference and/or ratio as an indicator of how a given investment or other policy effort pays off seen from the society's point of view. [SWD(2013) 134 final]

Debilitated. A condition of defence or economic security characterized by ineffectualness. [Moteff J., 2003], [US President's Commission on Critical Infrastructure Protection, 1997]

Economic risk. The probability of exceedance as a function of the economic damage. [Skanata,]

Economic security (also Global economic competitiveness). The confidence that the nation's goods and services can successfully compete in global markets while maintaining or boosting real incomes of its citizens. [Moteff, 2003], [US President's Commission on Critical Infrastructure Protection, 1997]

Insurance/reinsurance. A family of financial instruments for sharing and transferring risk among a pool of at-risk households, businesses, and/or governments. See Risk transfer. [IPCC, 2012a]



Land-use planning. The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses.

Risk transfer. The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise or state authority will obtain resources from the other party after a disaster occurs, in exchange for on-going or compensatory social or financial benefits provided to that other party.

Socio-economic scenarios. Scenarios concerning future conditions in terms of population, gross domestic product and other socio-economic factors relevant to understanding the implications of climate change. [SWD(2013) 134 final]

5.6 Response

Area sampling. Collection and analysis of representative samples of air/water in general work areas in order to determine the concentrations of any contaminants that are present. [IAPA]

Biological monitoring. The use of medical tests (for example, blood, urine, exhaled air) to determine whether a person has been or is being exposed to a substance. [IAPA]

Capacity.

1. The combination of all the strengths, attributes, and resources available to an individual, community, society, or organization, which can be used to achieve established goals. [IPCC, 2012a]
2. The combination of all the strengths, attributes, and resources available within a community, society, or organization to achieve agreed goals. [Dickson et al, 2012]

Category of emergency. One of three types of emergencies: Operational, Energy, and Continuity of Government Causal Analysis. A review of an activity to determine the root cause, to identify less than adequate contributing systemic factors, and to prevent further concerns. [US Department of Energy, 1999]

Contingency plan. A plan for emergency response, backup operations, and post-disaster recovery in a system, as part of a security program, to ensure availability of critical system resources and facilitate continuity of operations in a crisis. [ENISA]

Contingency planning. A management process that analyses specific potential events or emerging situations that might threaten society or the environment and establishes arrangements in advance to enable timely, effective and appropriate responses to such events and situations. [ISDR Terminology of disaster risk reduction]

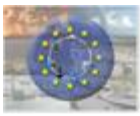
Coping capacity. The ability of people, organizations, and systems, using available skills and resources, to face and manage adverse conditions, emergencies, or disasters. [Dickson et al, 2012], [ISDR Terminology of disaster risk reduction]

Crisis management. Planning, preventive, and response activities for addressing the causes of a terrorist incident; these activities include proactive measures for: prevention; crisis mitigation, operational response; and, criminal prosecution. [US Department of Energy, 1999]

Critical facilities. The primary physical structures, technical facilities, and systems that are socially, economically, or operationally essential to the functioning of a society or community, both in routine circumstances and in emergencies. [Dickson et al, 2012]

Disaster recovery. The process of restoring a system to full operation after an interruption in service, including equipment repair / replacement, file recovery / restoration. [ENISA]

Early warning system.



1. The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. [Slandail terminology]
2. The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. [UNISDR, 2009]
3. The set of capacities for generating and disseminating timely and meaningful warnings to enable individuals, communities, and organizations threatened by a hazard to prepare and act appropriately and quickly enough to reduce the possibility of harm or loss. [Dickson, 2012]

Emergency. An emergency is the most serious event and consists of any unwanted operational, civil, natural-phenomenon, or security occurrence that could endanger or adversely affect people, property, or the environment. [US Department of Energy, 1999]

Emergency management.

1. The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps. [ISDR Terminology of disaster risk reduction]
2. Assets providing mitigation, prevention, preparedness (including planning training, and exercising), response (including coordination, resource acquisition, and resource prioritization), recovery efforts, and public information before, during, and after disasters and catastrophic events [US-DHS]

Emergency plan. Detailed procedures for responding to an emergency, such as a fire or explosion, a chemical spill, or an uncontrolled release of energy. An emergency plan is necessary to keep order, and minimize the effects of the disaster. [IAPA]

Emergency services. The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.[ISDR Terminology of disaster risk reduction]

Evacuation. A protective action that calls for the controlled relocation of personnel from a hazardous or potentially hazardous area. [US Department of Energy, 1999]

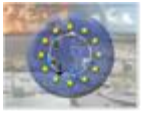
First aid. The immediate care given to a person who is injured or who suddenly becomes ill. It can range from disinfecting a cut and applying a bandage to helping someone who is choking or having a heart attack. [IAPA]

Incapacitation. An abnormal condition when the level of products and services a critical infrastructure provides its customers is reduced. While typically a temporary condition, an infrastructure is considered incapacitated when the duration of reduced performance causes a debilitating impact. [US President's Commission on Critical Infrastructure Protection, 1997]

Partnership. A relationship between two or more entities wherein each accepts responsibility to contribute a specified, but not necessarily equal, level of effort to the achievement of a common goal. The public and private sector contributing their relative strengths to protect and assure the continued operation of critical infrastructures. [US President's Commission on Critical Infrastructure Protection, 1997]

Personal protective equipment. Any device worn by a worker to protect against hazards. Some examples are: respirators, gloves, ear plugs, hard hats, safety goggles and safety shoes. [IAPA]

Preparedness. Preparedness is a continuous cycle of planning, organising, training, equipping, exercising, evaluation and improvement activities to ensure effective coordination and the enhancement of



capabilities to prevent, protect against, respond to, recover from, and mitigate the effects of all hazards. [Klaver et al, 2011]

Preparedness. The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions. [ISDR Terminology of disaster risk reduction]

Protection.

1. Those capabilities necessary to secure the homeland against acts of terrorism and manmade or natural disasters. [US Homeland Security, 2013]
2. All activities aimed at ensuring the functionality, continuity and integrity of critical infrastructures in order to deter, mitigate and neutralise a threat, risk or vulnerability. [EU Council Directive, 2008]

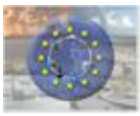
Recovery.

1. The development, coordination, and execution of service- and site-restoration plans for impacted communities and the reconstitution of government operations and services through individual, private-sector, non-governmental, and public assistance programs that: identify needs and define resources; provide housing and promote restoration; address long-term care and treatment of affected persons; implement additional measures for community restoration; incorporate mitigation measures and techniques, as feasible; evaluate the incident to identify lessons learned; and develop initiatives to mitigate the effects of future incidents. [Slandail terminology]
2. Those capabilities necessary to assist communities affected by an incident to recover effectively, including, but not limited to, rebuilding infrastructure systems; providing adequate interim and long-term housing for survivors; restoring health, social, and community services; promoting economic development; and restoring natural and cultural resources. [US Homeland Security, 2013]
3. The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors. [ISDR Terminology of disaster risk reduction]
4. Those capabilities necessary to assist communities affected by an incident to recover effectively, including, but not limited to, rebuilding infrastructure systems; providing adequate interim and long-term housing for survivors; restoring health, social, and community services; promoting economic development; and restoring natural and cultural resources. [Source: PPD-8, 2011], [2013 NIPP]

Recovery procedures. Procedures that include dissemination of information to federal, state, tribal, and local organizations regarding the emergency and possible relaxation of public protective actions; planning for decontamination actions; establishment of a recovery organization; development of reporting requirements; and establishment of criteria for resumption of normal operations. [US Department of Energy, 1999]

Recovery organization. Organization responsible for coordinating all recovery activities. Responsibilities include, but are not limited to, prioritization of activities; protection of worker and general public health and safety; dissemination of information; coordination of site and offsite activities; collection of data and assessment of long-term effects associated with the release of hazardous materials; formulation and implementation of long-term protective actions for the affected areas; and providing assistance as requested to state and local agencies in formulation of long-term protective actions for affected offsite areas. [US Department of Energy, 1999]

Response.



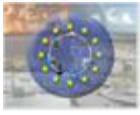
1. **Activities to address the immediate and short-term effects of an emergency or disaster. Response includes immediate actions to save lives, protect property, and meet basic human needs. [US Department of Energy, 1999]**
2. Activities that address the short-term, direct effects of an incident. Response includes immediate actions to save lives, protect property, and meet basic human needs. Response also includes the execution of EOPs and of incident mitigation activities designed to limit loss of life, personal injury, property damage, and other unfavourable outcomes. As indicated by the situation, response activities include: applying intelligence and other information to lessen the effects or consequences of an incident; increasing security operations; continuing investigations into the nature and source of the threat; conducting ongoing public health and agricultural surveillance and testing processes; performing immunizations, isolation, or quarantine; and conducting specific law enforcement operations aimed at preempting, interdicting, or disrupting illegal activity, and apprehending actual perpetrators and bringing them to justice. [Slandail terminology]
3. Capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred. [US Homeland Security, 2013]
4. Response is a human action which attempts to prevent, eliminate, compensate, reduce or adapt to negative consequences (impacts) of climate change. A response can be targeted at any part of the chain between driving forces and impacts. There are planned as well as autonomous responses. [HABIT-CHANGE]
5. Reaction (policies and action) during or immediately after a disaster in order to reduce its impacts, to ensure functioning of basic systems (infrastructures) and to prevent transitions of the sensitive systems into crisis situations.
6. is the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.
7. Capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred. [Source: PPD-8, 2011][NIPP 2013], [NIPP], [US Homeland Security, 2013]
8. is the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduces health impacts, ensure public safety and meet the basic subsistence needs of the people affected. Comment: Disaster response is predominantly focused on immediate and short-term needs and is sometimes called “disaster relief”. The division between this response stage and the subsequent recovery stage is not clear-cut. Some response actions, such as the supply of temporary housing and water supplies, may extend well into the recovery stage. [UNISDR]

Response termination. In general, response activities are terminated when the situation has been stabilized. At this point, potential threats to workers, the public, the environment, and national security have been characterized, conditions no longer meet established emergency categorization criteria, and it appears unlikely that conditions will deteriorate. In coordination with response organizations, the emergency is then declared terminated and activities focus on recovery. [US Department of Energy, 1999]

Retrofitting. Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards. [Slandail terminology]

Return period. An estimate of the average time interval between occurrences of an event (e.g., flood or extreme rainfall) of (or below/above) a defined size or intensity. [IPCC, 2012a]

Return value. The highest (or, alternatively, lowest) value of a given variable, on average occurring once in a given period of time (e.g., in 10 years). [IPCC, 2013]



Search and rescue stations. Facilities housing search and rescue response personnel and their equipment. This station are intended to provide immediate response capability. [US-DHS]

5.7 Business Continuity

Business continuity.

1. Business Continuity (BC) is defined as the capability of the organization to continue delivery of products or services at acceptable predefined levels following a disruptive incident. [ISO 22301:2012], [ISO/IEC 22301, 2012]
2. Capability to continue to deliver products and services at acceptable predefined levels after disruptive incidents have occurred. [ISO 22301]
3. Activities performed by an organization to ensure that during and after a disaster the organization's essential functions are maintained uninterrupted, or are resumed with minimal disruption. [US Homeland Security, 2013]
4. Activities performed by an organization to ensure that during and after a disaster the organization's essential functions are maintained uninterrupted, or are resumed with minimal disruption. [2013 NIPP]

Business continuity management.

1. Business Continuity Management (BCM) is defined as a holistic management process that identifies potential threats to an organization and the impacts to business operations those threats, if realized, might cause, and which provides a framework for building organizational resilience with the capability of an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities. [ISO 22301, 2012], [ISO/IEC 22301, 2012]
2. A management process that helps to manage the risks to the smooth running of an organisation or delivery of a service, ensuring that it can operate to the extent required in the event of a disruption. [Pitt, 2008]

Business continuity management system. Part of the overall management system that establishes, implements, operates, monitors, reviews, maintains and improves business continuity. [ISO/IEC 22301, 2012]

Business continuity plan.

1. A documented set of procedures and information intended to deliver continuity of critical functions in the event of a disruption [Pitt, 2008].
2. is an essential part of any organisation's response planning. It sets out how the business will operate following an incident and how it expects to return to 'business as usual' in the quickest possible time afterwards. [CPNI]
3. Documented procedures that guide organizations to respond, recover, resume, and restore to a pre-defined level of 1operation following disruption. [ISO/IEC 22301, 2012]
4. Documented procedures used by organizations to respond to disruptive incidents, to guide recovery efforts, to resume prioritized activities, and to restore operations to acceptable predefined levels. Business continuity plans usually identify the services, activities, and resources needed to ensure that prioritized business activities and functions can continue whenever disruptions occur. [ISO 22301]
5. is designed to avoid or mitigate risks; to reduce the impact of a crisis (i.e., disaster condition); and to reduce the time to restore conditions to a state of "business as usual." There is no single recommended plan for business continuity; instead, every organization needs to develop a comprehensive BCP based on its unique situation. A BCP should also be dynamic, evolving as the



business environment changes and its dependency on advanced technology changes. The business continuity planning process should address three interdependent objectives [Cerullo, 2004]:

- 1) Identify major risks of business interruption.
- 2) Develop a plan to mitigate or reduce the impact of the identified risk.
- 3) Train employees and test the plan to ensure that it is effective.

Business continuity programme. Ongoing management and governance process supported by top management and appropriately resourced to implement and maintain business continuity management. [ISO/IEC 22301, 2012]

Business impact analysis. Process of analysing activities and the effect that a business disruption might have upon them. [ISO/IEC 22301, 2012]

Decision criteria. Thresholds, targets, or patterns used to determine the need for action or further investigation, or to describe the level of confidence in a given result. [ISO/IEC 27000, 2013]

Early warning system is the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. [UNISDR]

Effectiveness. Extent to which planned activities are realized and planned results achieved. [ISO/IEC 27000, 2013]

Indicator. Measure that provides an estimate or evaluation of specified attributes derived from an analytical model with respect to defined information needs. [ISO/IEC 27000, 2013]

Management of critical infrastructure. Ensuring conditions for the operation and continuous activity of critical infrastructure.[Croatian Law on critical infrastructures]

Maximum acceptable outage. Time it would take for adverse impacts, which might arise as a result of not providing a product/service or performing an activity, to become unacceptable. [ISO/IEC 22301, 2012]

Maximum tolerable period of disruption. Time it would take for adverse impacts, which might arise as a result of not providing a product/service or performing an activity, to become unacceptable. [ISO/IEC 22301, 2012]

Minimum business continuity objective. Minimum level of services and/or products that is acceptable to the organization to achieve its business objectives during a disruption. [ISO/IEC 22301, 2012]

Prioritized activities. Activities to which priority must be given following an incident in order to mitigate impacts. [ISO/IEC 22301, 2012]

Recovery point objective. Point to which information used by an activity must be restored to enable the activity to operate on resumption. [ISO/IEC 22301, 2012]

Recovery time objective. Period of time following an incident within which

- product or service must be resumed, or
- activity must be resumed, or
- resources must be recovered. [ISO/IEC 22301, 2012]

Requirement. Need or expectation that is stated, generally implied or obligatory. [ISO/IEC 22301, 2012]

Resources. All assets, people, skills, information, technology (including plant and equipment), premises, and supplies and information (whether electronic or not) that an organization has to have available to use, when needed, in order to operate and meet its objective. [ISO/IEC 22301, 2012]

The process of developing a ‘plan’ for business continuity and specific disaster recovery involves (Savage, 2002, p255):

- the development of business risk and impact analysis;



- documenting activities prior to an event;
- identifying and authorising detailed activities for the disaster recovery phase;
- identifying and authorising detailed activities for managing the business recovery phase;
- testing and auditing the business recovery phase;
- training staff in the business recovery process; and
- implementing a process for keeping the plan up to date.

Work environment. Set of conditions under which work is performed. [ISO/IEC 22301, 2012]

5.8 Risk communication

Awareness (of risk) The awareness of risk means for an individual to realise and to accept to be vulnerable to a major danger associated with a hazard. [Marchand], [SMARTeST, 2011]

Classification level. A designation assigned to specific elements of information based on the potential damage to national security if disclosed to unauthorized persons. The three classification levels in descending order of potential damage are Top Secret, Secret, and Confidential. [US Department of Energy, 1999]

Communication and consultation. Continual and iterative processes that an organization conducts to provide, share or obtain information and to engage in dialogue with stakeholders regarding the management of risk. [ISO/IEC 27000, 2013], [ISO/IEC 31000, 2009]

Competence. Ability to apply knowledge and skills to achieve intended results. [ISO/IEC 27000, 2013]

Confidence. The validity of a finding based on the type, amount, quality and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and on the degree of agreement. In this report, confidence is expressed qualitatively (...). [IPCC, 2014]

Confidentiality. Property that information is not made available or disclosed to unauthorized individuals, entities, or processes. [ISO/IEC 27000, 2013]

Defensive communication strategy. Indicates partial reporting within and outside the business organization, suppressing and even denial of crisis. This strategy is also called the policy of concealing and suppression. [Metzinger et al, 2014]

Emergency services are the set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations. Comment: Emergency services include agencies such as civil protection authorities, police, fire, ambulance, paramedic and emergency medicine services, Red Cross and Red Crescent societies, and specialized emergency units of electricity, transportation, communications and other related services organizations. [UNISDR]

Hazard awareness. Flood hazard awareness describes the notion, the understanding of dangers that can emerge from a flood. Thus it is essential for self-protection, as it implies hazard-adapted behaviour. It is also seen as precondition for flood protection measures and their endurance or sustainability. Hazard awareness normally evolves from experience of the adverse effects, consequential to a hazard . [FMMEP, 2007]

Information security. Preservation of confidentiality, integrity and availability of information. [ISO/IEC 27000, 2013]

Information security continuity. Processes and procedures for ensuring continued information security operations. [ISO/IEC 27000, 2013]

Material safety data sheet. A form that contains detailed information about the possible health and safety hazards of a product and how to safely store, use and handle the product. [IAPA]

Offensive communication strategy. Means complete, sincere and timely information of the public thus preventing rumours, avoiding insecurity and loss of confidence. [Metzinger et al, 2014]



Partnership. Close cooperation between parties having common interests in achieving a shared vision. [NIPP 2013]

Protocols. Ground rules or rules of conduct. [US Department of Energy, 1999]

Public confidence. Trust bestowed by citizens based on demonstrations and expectations of: (1) Their government's ability to provide for their common defence and economic security and behave consistent with the interests of society; and (2) Their critical infrastructures' ability to provide products and services at expected levels and to behave consistent with their customers' best interests. [US President's Commission on Critical Infrastructure Protection, 1997]

Qualification. The combination of an individual's physical attributes and technical, academic, and practical knowledge and skills developed through training, education, and on-the-job performance. [US Department of Energy, 1999]

Qualification standard. The explicit performance requirements for minimum proficiency in technical, academic, and site-specific knowledge and practical skills used in determining satisfactory completion of training programs. [US Department of Energy, 1999]

Risk communication.

- 1) Risk communication is any purposeful exchange of information about risks between interested parties. Risk communication is a dialogue – an interactive process of information exchange – among the Site Team and the community that discusses the nature of risk and other concerns. This dialogue should be a genuine and sincere conversation that aims to identify mutual solutions and respond to public concerns. [EPA]
- 2) A process to exchange or share information about risk between the decision-maker and other stakeholders. The information can relate to the existence, nature, form, probability, severity, acceptability, treatment or other aspects of risk. [ENISA]

Risk-informed decision making. The determination of a course of action predicated on the assessment of risk, the expected impact of that course of action on that risk, and other relevant factors. [2013 NIPP]

Sensitive critical infrastructure protection related information. Facts about a critical infrastructure, which if disclosed could be used to plan and act with a view to causing disruption or destruction of critical infrastructure installations. [EU. Council Directive, 2008]

Sensitive data of CI. Data on critical infrastructure that have been labelled as classified information in accordance with special regulations. [Croatian Law on critical infrastructures]

Sensitivity. Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise). [Climate Change 2007: Synthesis Report]

Stakeholder engagement. Process through which the stakeholders have power to influence the outcome of the decision. Critically, the extent and nature of the power given to the stakeholders varies between different forms of stakeholder engagement. [FLOODsite, 2009]

Standard (Standing) operating procedure. A procedure prepared for operation of a facility or performance of a task on a routine basis. [US Department of Energy, 1999]

Trusted information communication entity. Autonomous organization supporting information exchange within an information sharing community. [ISO/IEC 27000, 2013]

Uncertainty.

- 1) An expression of the degree to which a value or relationship is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. Uncertainty may



originate from many sources, such as quantifiable errors in the data, ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures, for example, a range of values calculated by various models, or by qualitative statements, for example, reflecting the judgment of a team of experts. [IPCC, 2012b]

- 2) A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts) (...). [IPCC, 2014]
- 3) Lack of precision that is due to (i) natural variability and (ii) knowledge uncertainty. Uncertainty arises principally from lack of knowledge or of our ability to measure or to calculate, which give rise to potential differences between the assessment of some factor and its 'true' value. [EAFDG, 2010]
- 4) A general concept that reflects our lack of sureness about someone or something, ranging from just short of complete sureness to an almost complete lack of conviction about an outcome. [FLOODsite, 2009]
- 5) An expression of the degree to which a value (e.g. the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. [SWD(2013) 134 final]
- 6) Means lack of precision or that the exact value for a given time is not predictable, but it does not usually imply lack of knowledge. Often, the future state of a process may not be predictable, such as a roll with dice, but the probability of finding it in a certain state may be well known (the probability of rolling a six is 1/6, and flipping tails with a coin is 1/2). In climate science, the dice may be loaded, and we may refer to uncertainties even with perfect knowledge of the odds. Uncertainties can be modelled statistically in terms of pdfs, extreme value theory and stochastic time series models. [CGU]

Uncertainty analysis. Uncertainty analysis is the process of assessing the extent of uncertainty in model results or predictions, in order to communicate their fitness as a basis for decision-making. [FLOODsite, 2009]



6 EU-CIRCLE Taxonomy

6.1 General Terms

Project Title and Summary – General Terms

Critical Infrastructure. A complex system in its operating environment that significant features are inside-system dependencies and outside-system dependencies, that in the case of its degradation have significant destructive influence on the health, safety and security, economics and social conditions of large human communities and territory areas.

Climate. Dynamic interactions of several components including atmosphere, hydrosphere, cryosphere, land surface and biosphere.

Climate change. Any changes in climate over time, either due to natural variability or as a result of human activity.

CI resilience to climate change. CI capacity being able to absorb and to recover from hazardous events appearing as a result of climate change.

CI strengthening to climate change. Increasing CI capacity through its components and subsystems parameters improving and its operating environment parameters modification to achieve its characteristics stronger what allows its functioning in its operating environment to be able to absorb and to recover from hazardous events appearing as a result of climate change.

CI natural disaster resilience. CI capacity being able to absorb and to recover from hazardous events appearing as a result of natural disaster impacts.

CI adaptation to climate change. Modification CI structure its components and subsystems parameters and its operating environment parameters to achieve its characteristics that allows its functioning in its operating environment changed by climate change.

CI adaptation to climate change. The process of critical infrastructures adjustment to climate change in response to actual or expected climatic stimuli or their effects. This involves the initiatives, which moderate harm or exploit beneficial opportunities, to reduce the vulnerability of critical infrastructures to climate change or increase resilience of critical infrastructures to expected climate change impacts.

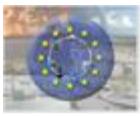
CI natural disaster impacts risk. The possibility of occurrence over the specified time period and area of dangerous alterations in the CI normal functioning due to hazardous events coming out as a result of natural disaster impacts and interacting with CI, leading to its and its operating environment degradation.

CI natural disaster vulnerability. CI feature that makes it easily influenced by some external factors and hazards coming from its operating environment dangerous changes forced by natural disaster impacts.

CI natural disaster impacts reduction. Efforts and actions to reduce effects of potential hazards coming from natural disaster influence on CI by the reduction of their occurrence frequency and intensity, changing their interactions with people and their support systems.

CI natural disaster impacts mitigation. Efforts and actions to prevent and reduce effects of potential hazards coming from natural disaster influence on CI by their elimination or reduction of their occurrence frequency and intensity, changing their interactions with people and their support systems and making alters the way people live and the systems they create.

European infrastructure. The network of interconnected and interdependent infrastructures located in EU member states that function collaboratively in order to ensure a continuous production flow of essentials, goods and services.



Climate related hazard. A natural physical event coming out from climate change that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources.

CI resilience to natural hazards. CI capacity being able to absorb and to recover from natural hazards.

CI preparedness to climate change. CI ability to ensure effective response to the impact of climate change related hazards, including CI operating organizational reactions to the issuance of timely and effective early warnings.

Interconnected critical infrastructures. Critical infrastructures in mutually direct and indirect connections between themselves.

Interdependent critical infrastructures. Critical infrastructures in mutually dependant relationships between themselves interacting at various levels of their complexity.

CI network. A set of interconnected and interdependent critical infrastructures interacting directly and indirectly at various levels of their complexity and operating activity.

CI network cascading effects. Degrading effects occurring within an infrastructure and between infrastructures in their operating environment, including situations in which one infrastructure causes degradation of another ones, which again causes additional degradation in other infrastructures and in their operating environment.

WP1 – General Terms

Project Operational Environment. Project operational context including detailed methodological framework for assessing the impact of climate change to European Critical Infrastructures (ECI).

WP2 – General Terms

Climate related hazards. Natural phenomena coming out from climate change that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources.

Climate hazards. Natural phenomena coming out from climate change that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources.

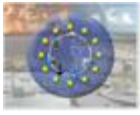
Climate hazards metadata annotation. Collection and annotation in a consistent from all sources of climate related hazards data including processing and sharing of data files, metadata conventions, outcomes of EU projects and identifying and assessing existing related standards and data protocols in literature.

WP3 – General Terms

CI interconnections. Critical infrastructures in mutually direct and indirect connections between themselves.

CI interdependence. Critical infrastructures in mutually dependant relationships between themselves interacting at various levels of their complexity.

CI network. A set of interconnected and interdependent critical infrastructures interacting directly and indirectly at various levels of their complexity and operating activity.



CI network cascading effect. Degrading effects occurring within an infrastructure and between infrastructures in their operating environment, including situations in which one infrastructure causes degradation of another ones, which again causes additional degradation in other infrastructures and in their operating environment.

CI impact model for climate hazards. The joining model of CI operation process including impacts of climate-weather change hazards on changing the operation parameters of its operation process and the model of CI safety including impacts of climate-weather change hazards on changing its safety structure and its components' safety parameters.

Holistic CI risk assessment model related to climate hazards. Comprehensive safety and risk assessment model for interconnected and interdependent CI and CI networks based on an innovative approach to joint consideration of CI variable in time operation processes including operation environment hazards and climate-weather change impacts and CI multistate ageing safety models.

Risk model metadata. Collection and annotation in a consistent form of all sources of climate related hazards data having influence on CI and CI networks safety and risk and necessary for identification of the unknown parameters of the **holistic CI risk assessment model related to climate hazards.**

Risk model metadata. Information on the risk model and on collection of data used in the model. Typically, two types of metadata are most crucial: structural metadata (technical metadata needed to correctly interpret the stored essence) and preservation metadata (metadata for assessing the fixity, integrity, authenticity and quality of the object, as well as a documentation of the preservation actions applied).

WP4 – General Terms

CI resilience to climate change model. A framework joining prevention options to minimize CI exposure to hazards, methods of CI protection, methods reducing potential impacts to enhance contingency planning and business continuity and methods of adaptation and mitigation of consequences related to climate hazards.

CI resilience to climate change indicators. An indicative list of indicators and measures of CI resilience to climate change together with their definitions.

CI adaptation to climate change model. General procedures of CI adaptation to climate change and their detailed modifications for the regional stakeholders to assure the optimal use of the developed in the project tools.

CI resilience prioritization module. Prevention methods based on ordering the importance of potential hazards and threats to minimize their impacts on CI.

CI climate change related business continuity. CI operational activities ensuring that during and after a natural disaster coming out from climate change the CI essential functions are maintained uninterrupted or resumed with minimal disruption.

CI climate change related business continuity model. Methods to maximize CI business continuity while minimizing its service disruptions, methods of preparation of business continuity plans considering climate hazards, methods of identifying CI critical components and their functionalities, methods of creating redundancies and substitutes to continue CI operating and methods of recovery management after CI operation severely affected. Creating a common set of practical procedures based on those all methods.

CI resilience model metadata. Collection and annotation in a consistent form of all sources of climate related hazards data having influence on CI and CI networks safety and risk and necessary for identification of the unknown parameters of the **CI resilience to climate change model.**



WP5 – General Terms

Climate Infrastructure Resilience Platform (CIRP). User friendly environment to enable easy analysis, design and modelling scenarios setup for any kind of climate hazards and CI through functional flow diagrams authoring and intelligent mechanism of individual model selection and orchestration. The validated CIRP will:

- Assess potential impacts of climate hazards,
- Provide monitoring through new resilience indicators,
- Support cost-efficient adaptation measures.

The CIRP tool will allow users to define and thoroughly examine their individual infrastructure's resilience in their own unique manner, setting respective priorities and assessment of the final product.

WP6 – General Terms

Project issues validation. Conducting 5 Case Studies and their results evaluation. Modification and improvement of the project results.

Case study. An experiment/exercise investigating critical infrastructure resilience to climate hazards.

WP7 – General Terms

Simulating Interconnected Critical Infrastructures (SimICI). An unique virtual environment for assessing the resilience of infrastructures to climatic pressures that will facilitate EU-CIRCLE project dissemination and exploitation potential and will be open for effective contribution to CIRP.

Network of interconnected critical infrastructures. A set of mutually directly and indirectly interconnected and interdependent critical infrastructures interacting at various levels of their complexity and operating activity.

WP8 – General Terms

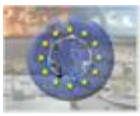
Integrated Critical Infrastructure Resilience to Climate Change System. The package of guidebooks including the integrated main practical tools created by the participants of the EU-CIRCLE project with the procedures of their usage.

Integrated Critical Infrastructure Resilience to Climate Change Training System. The package of training courses based on the package of guidebooks.

Integrated European Critical Infrastructures Resilience to Climate Change Support System. An integrated in a standardized way holistic critical infrastructures resilience model of existing modelling tools and data open and accessible to all parties interested in the infrastructure resilience business complemented with an interactive web-based portal.

WP9 – General Terms

Societal awareness of climate change impacts. An appreciation of the likely threats and consequences of climate change and an understanding of any climate change impacts warning and evacuation procedures.



Public awareness. The extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards.

Societal implications coming from climate change. Effects of climate change that affect society i.e. that affect sectors of society such as water resources, food production, energy use and supply, transportation and commerce, recreation or even national security.

Other – General Terms

Critical infrastructure identification. Procedure leading to designate systems belonging to critical infrastructure.

Critical infrastructure threat. Occurrence of an unwanted circumstance or event, that may cause damage, functioning disruption or service interruption to critical infrastructures.

Critical infrastructure threats' identification. Procedure leading to designate circumstances or events, that in case of their occurrence may cause damage, functioning disruption or service interruption to critical infrastructures.

Critical infrastructure threats' catalogue. Codified (pointing general groups and more detailed categories within them) listing of potential threats to critical infrastructures.

Critical infrastructure threats' diagnostic/detection. Application of tools allowing to indicate and to detect increase of the level of threats to critical infrastructures.

Critical infrastructure protection. Actions to prevent a threat from attempting to or succeeding at damage, functioning disruption or service interruption to critical infrastructure.

6.2 Critical Infrastructure Definition

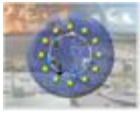
European (Regional) critical infrastructure. The network of interconnected and interdependent critical infrastructures located in EU member states that function collaboratively in order to ensure a continuous production flow of essentials, goods and services.

Country's critical Infrastructure. A complex system and assets located in the country which is essential (vital) for the national security, governance, public health and safety, economy and public confidence of this country.

Critical Infrastructure. A complex system in its operating environment that significant features are inside-system dependencies and outside-system dependencies, that in the case of its degradation have significant destructive influence on the health, safety and security, economics and social conditions of large human communities and territory areas.

Complex system is defined as a set or group of interacting, interrelated or interdependent elements or parts, that are organized and integrated to form a collective unity or an unified whole, to achieve a common objective.

This definition lays emphasis on the interactions between the parts of a system and the external environment to perform a specific task or function in the context of an operational environment. This focus on interactions is to take a view on the expected or unexpected demands (inputs) that will be placed on the system and see whether necessary and sufficient resources are available to process the demands. These might take form of stresses. These stresses can be either expected, as part of normal operations, or unexpected, as part of unforeseen acts or conditions that produce beyond-normal (i.e., abnormal) conditions and behaviours. This definition of a system, therefore, includes not only the product or the process but also the influences that the surrounding environment (including human interactions) may have on the product's or process's safety performance.



System operating environment. Surroundings in which a system operates, including air, water, land, natural resources, flora, fauna, humans and their interrelations.

System operating environment hazard. An event that may cause the system damage and/or change its operation activity in the way unsafe for the system and its operating environment. For instance: another ship activity in the ship operating environment that can result in an accident with serious consequences for the ship and its operating environment, terrorist attack changing the system operation process in an unsafe way.

System inside dependencies. Dependencies within a system itself i.e. relationship between components and subsystems in a system causing state changes of other components and subsystems and in a consequence resulting in changes of the system state.

System outside dependencies. Dependencies coming from the system operating environment (external factors), including changes of the system state caused by outside this system conditions e.g. climate changes, changes of its functionality, location, other objects, government and human decisions (regulations, economic, public policy).

6.3 Critical Infrastructure Safety (without climate-weather change influence)

Safety engineering. The process following a system safety program plan. Preliminary hazard analyses, functional hazard assessments and system safety assessments are to produce evidence based on documentation that will drive safety systems which are certifiable and will hold up in litigation. The primary focus of any system safety plan, hazard analysis and safety assessment is to implement a comprehensive process to systematically predict or identify the operational behaviour of any safety-critical failure condition or fault condition or human error that could lead to a hazard and potential mishap. This is used to influence requirements to drive control strategies and safety attributes in the form of safety design features or safety devices to prevent, eliminate and control (mitigation) safety risk. Modern system safety is comprehensive and is risk based, requirements based, functional based and criteria based with goal structured objectives to yield engineering evidence to verify safety functionality is deterministic and acceptable risk in the intended operating environment. Systems of systems, such as a modern military aircraft or fighting ship with multiple parts and systems with multiple integration, sensor fusion, networking and interoperable systems will require much partnering and coordination with multiple suppliers and vendors responsible for ensuring safety is a vital attribute planned in the overall system.

System safety. The ability of the system such that during fulfilling its operational objective it does not affect destructively on itself and other objects in its operating environment and does not degrade its natural operating environment.

Complex system. A multistate ageing system composed of interacting components and subsystems related to its operation process having significant influence on its safety through changing its structure and its components' safety parameters in the different operation states.

Multistate ageing system. To define the multistate system with degrading components, we assume that:

- n is the number of the system components,
- $E_i, i = 1, 2, \dots, n$, are components of a system,
- all components and a system under consideration have the safety state set $\{0, 1, \dots, z\}$, $z \geq 1$,
- the reliability states are ordered, the safety state 0 is the worst and the safety state z is the best,
- $T_i(u)$, $i = 1, 2, \dots, n$, are independent random variables representing the lifetimes of components E_i in the safety state subset $\{u, u+1, \dots, z\}$, while they were in the safety state z at the moment $t = 0$,
- $T(u)$ is a random variable representing the lifetime of a system in the safety state subset $\{u, u+1, \dots, z\}$ while it was in the safety state z at the moment $t = 0$,
- the system states degrades with time t ,
- $s_i(t)$ is a component E_i safety state at the moment t , $t \in (-\infty, \infty)$, given that it was in the safety state z at the moment $t = 0$,

- $s(t)$ is a system S safety state at the moment t , $t \in [0, \infty)$, given that it was in the safety state z at the moment $t = 0$.

The above assumptions mean that the safety states of the system with degrading components may be changed in time only from better to worse. The way in which the components and the system safety states change is illustrated in Figure 1.

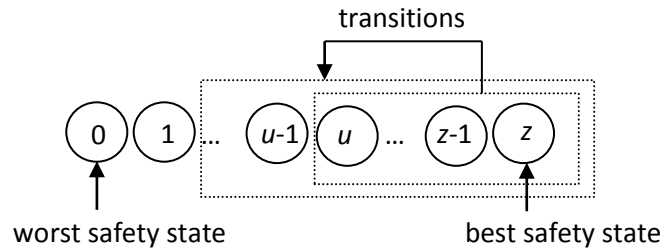


Figure 1. Illustration of a system and components safety states changing

The exemplary realizations of the four-state system safety states changing process $s(t)$ and the realizations $t(1)$, $t(2)$, $t(3)$ of this system lifetimes $T(1)$, $T(2)$ and $T(3)$ in the safety state subsets $\{1,2,3\}$, $\{2,3\}$ and $\{3\}$ are presented in Figure 2.

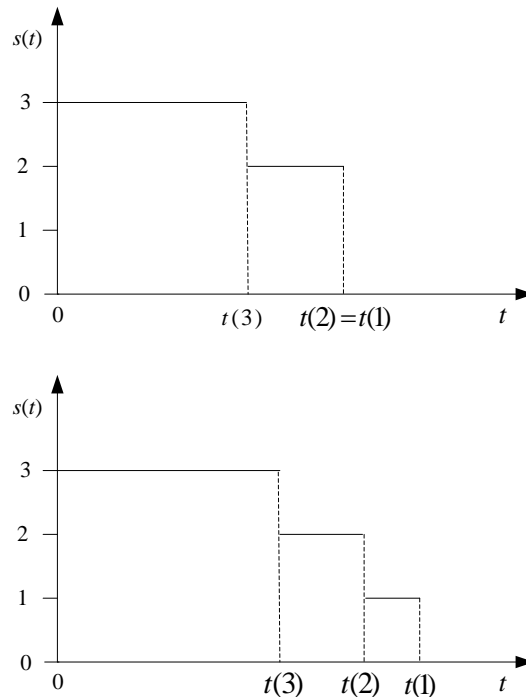


Figure 2. The exemplary realizations of the four-state system safety states changing process $s(t)$ and its lifetimes $T(1)$, $T(2)$ and $T(3)$ in the reliability state subsets $\{1,2,3\}$, $\{2,3\}$ and $\{3\}$

Multistate system critical safety state. The system safety state to exceed which is dangerous for the system and its operating environment.

Multistate system safety. The ability of the system to achieve its operational objective in the safety state subset not worse than the system critical safety state.

Multistate system safety function. A vector

$$S(t, \cdot) = [S(t, 0), S(t, 1), \dots, S(t, z)], \quad t \in [0, \infty),$$

where

$$S(t, u) = P(s(t) \geq u \mid s(0) = z) = P(T(u) > t), \quad t \in [0, \infty), \quad u = 0, 1, \dots, z,$$

is the probability that the multistate system is in the safety state subset $\{u, u+1, \dots, z\}$, at the moment t , $t \in \langle 0, \infty \rangle$, while it was in the safety state z at the moment $t = 0$, is called the safety function of this system.

Multistate system safety function coordinate. The safety functions $S(t, u)$, $t \in \langle 0, \infty \rangle$, $u = 0, 1, \dots, z$, are called the coordinates of the multistate system safety function $S(t, \cdot)$.

Consequently, the relationship between the distribution function $F(t, u)$ of the multistate system lifetime $T(u)$ in the safety state subset $\{u, u+1, \dots, z\}$ and the coordinate $S(t, u)$ of its safety function is given by

$$F(t, u) = P(T(u) \leq t) = 1 - P(T(u) > t) = 1 - S(t, u), \quad t \in \langle 0, \infty \rangle, \quad u = 0, 1, \dots, z.$$

Under above Definition, we have

$$S(t, 0) = 1 \text{ and } S(t, 0) \geq S(t, 1) \geq \dots \geq S(t, z), \quad t \in \langle 0, \infty \rangle,$$

The exemplary graph of a four-state ($z = 3$) system safety function

$$S(t, \cdot) = [1, S(t, 1), S(t, 2), S(t, 3)], \quad t \in \langle 0, \infty \rangle,$$

is shown in Figure 3.

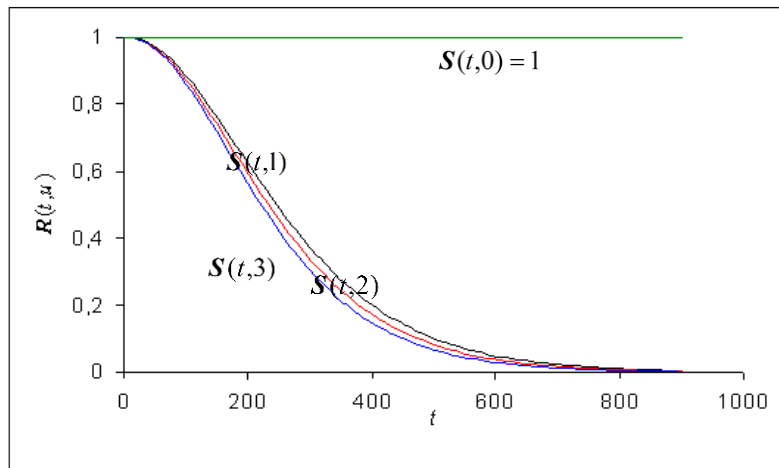


Figure 3. The graph of a four-state system safety function $S(t, \cdot)$ coordinates

Multistate system risk function. A probability

$$r(t) = P(s(t) < r \mid s(0) = z) = P(T(r) \leq t), \quad t \in \langle 0, \infty \rangle,$$

that the system is in the subset of safety states worse than the critical safety state r , $r \in \{1, \dots, z\}$ while it was in the safety state z at the moment $t = 0$ is called a risk function of the multi-state system.

Under this definition, we have

$$r(t) = 1 - P(s(t) \geq r \mid s(0) = z) = 1 - S(t, r), \quad t \in \langle 0, \infty \rangle,$$

and if τ is the moment when the system risk exceeds a permitted level δ , then

$$\tau = r^{-1}(\delta),$$

where $r^{-1}(t)$, if it exists, is the inverse function of the system risk function $r(t)$.

The illustration of the system risk function and the moment when the system risk exceeds a permitted level is given in Figure 4.

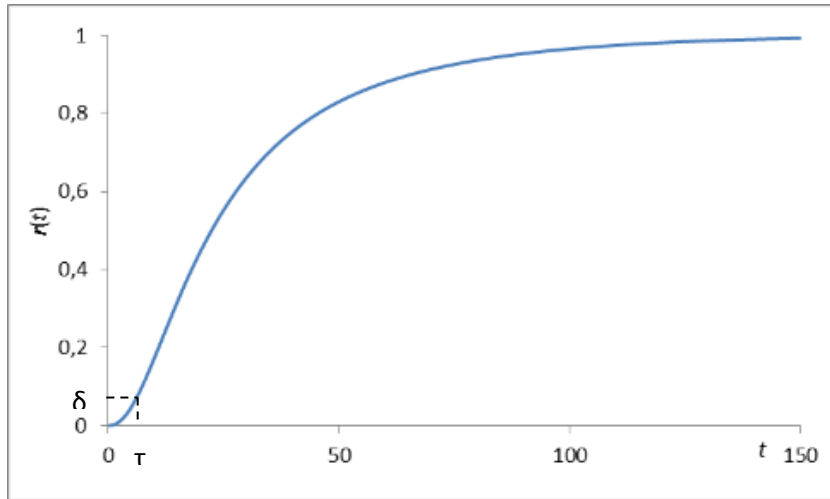


Figure 4. The graph of a four-state system risk function $r(t)$

Multistate component safety function. A vector

$$S_i(t, \cdot) = [S_i(t, 0), S_i(t, 1), \dots, S_i(t, z)], \quad t \in (-\infty, \infty), \quad i = 1, 2, \dots, n,$$

where

$$S_i(t, u) = P(s_i(t) \geq u \mid s_i(0) = z) = P(T_i(u) > t), \quad t \in (-\infty, \infty), \quad u = 0, 1, \dots, z,$$

is the probability that the multistate component E_i is in the safety state subset $\{u, u+1, \dots, z\}$, at the moment t , $t \in (-\infty, \infty)$, while it was in the safety state z at the moment $t = 0$, is called the safety function of this component.

The safety functions $S_i(t, u)$, $t \in (-\infty, \infty)$, $u = 0, 1, \dots, z$, are called the coordinates of the multistate component E_i , $i = 1, 2, \dots, n$, safety function $S_i(t, \cdot)$. Thus, the relationship between the distribution function $F_i(t, u)$ of the multistate component E_i , $i = 1, 2, \dots, n$, lifetime $T_i(u)$ in the safety state subset $\{u, u+1, \dots, z\}$, and the coordinate $S_i(t, u)$ of its safety function is given by

$$F_i(t, u) = P(T_i(u) \leq t) = 1 - P(T_i(u) > t) = 1 - S_i(t, u), \quad t \in (-\infty, \infty), \quad u = 0, 1, \dots, z.$$

Multistate system safety structure. The multistate system safety structure is a function determining the relationship between that system lifetime $T(u)$ in the safety state subset $\{u, u+1, \dots, z\}$, and its components' lifetimes $T_i(u)$ in the safety state subset $\{u, u+1, \dots, z\}$.

Basic multistate system safety structures. After introducing the notion of the multistate safety analysis, it is possible to define basic multi-state safety structures, for instance that defined below.

Multistate series system. A multistate system is called series if its lifetime $T(u)$ in the safety state subset $\{u, u+1, \dots, z\}$ is given by

$$T(u) = \min_{1 \leq i \leq n} \{T_i(u)\}, \quad u = 1, 2, \dots, z.$$

The number n is called the system structure shape parameter.

The above definition means that a multi-state series system is in the safety state subset $\{u, u+1, \dots, z\}$ if and only if all its n components are in this subset of safety states. That meaning is very close to the definition of a two-state series system considered in a classical reliability analysis that is not failed if all its components are not failed. This fact can justify the safety structure scheme for a multistate series system presented in Figure 5.



Figure 5. The scheme of a series system safety structure

Multistate parallel system. A multistate system is called parallel if its lifetime $T(u)$ in the safety state subset

$\{u, u+1, \dots, z\}$ is given by

$$T(u) = \max_{1 \leq i \leq n} \{T_i(u)\}, \quad u = 1, 2, \dots, z.$$

The number n is called the system structure shape parameter.

The above definition means that a multistate parallel system is in the safety state subset $\{u, u+1, \dots, z\}$ if and only if at least one of its n components is in this subset of safety states. That meaning is very close to the definition of a two-state parallel system considered in a classical reliability analysis that is not failed if at least one of its components is not failed. This fact can justify the safety structure scheme for a multistate parallel system presented in Figure 6.

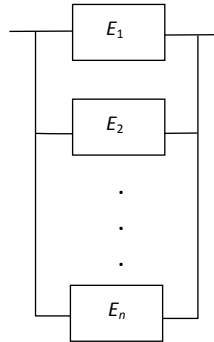


Figure 6. The scheme of a parallel system safety structure

Multistate “ m out of n ” system. A multistate system is called an “ m out of n ” system if its lifetime $T(u)$ in the safety state subset $\{u, u+1, \dots, z\}$ is given by

$$T(u) = T_{(n-m+1)}(u), \quad m = 1, 2, \dots, n, \quad u = 1, 2, \dots, z,$$

where $T_{(n-m+1)}(u)$ is the $n-m+1$ th order statistic in the sequence of the system component lifetimes $T_1(u), T_2(u), \dots, T_n(u)$, $u = 1, 2, \dots, z$.

The numbers m and n are called the system structure shape parameters.

The above definition means that the multistate “ m out of n ” system is in the safety state subset $\{u, u+1, \dots, z\}$ if and only if at least m out of its n components are in this safety state subset and it is a multistate parallel system if $m = 1$ and it is a multistate series system if $m = n$. The safely structure scheme of an “ m out of n ” multistate system, justified in an analogous way as in the case of a multistate series system and a multistate parallel system, is given in Figure 7, where $i_1, i_2, \dots, i_n \in \{1, 2, \dots, n\}$ and $i_a \neq i_b$ for $a \neq b$.

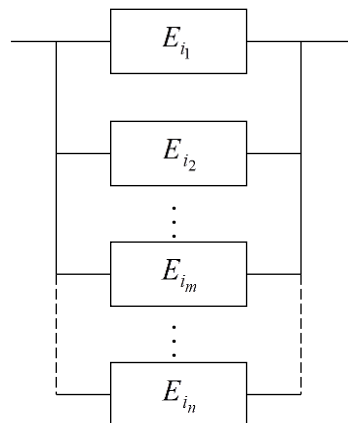


Figure 7. The scheme of an “ m out of n ” system safety structure



System operation process. System activity organized by its operator that can interact with its operating environment.

System operation state. A system activity state determined by its particular organizational activity and its operating environment conditions.

System operation process model. To model the system operation process, we assume that the system during its operation process is taking $v, v \in N$, different operation states z_1, z_2, \dots, z_v . Further, we define the system operation process $Z(t)$ on the time interval $t \in (0, \infty)$, with discrete operation states from the set $\{z_1, z_2, \dots, z_v\}$.

System operation process parameters. The system operation process may be described by:

- the **number of operation states** $v, v \in N$,
- the **initial probabilities** $p_b(0) = P(Z(0) = z_b)$, $b = 1, 2, \dots, v$, of the system operation process $Z(t)$ staying at the operation states z_b at the moment $t = 0$;
- the **probabilities of transitions** p_{bl} , $b, l = 1, 2, \dots, v$, $b \neq l$, of the system operation process $Z(t)$ between the operation states z_b and z_l ;
- the **conditional distribution functions** $H_{bl}(t) = P(\theta_{bl} < t)$, $b, l = 1, 2, \dots, v$, $b \neq l$, of the system operation process $Z(t)$ conditional sojourn times θ_{bl} at the operation states z_b when its next operation state is z_l , $b, l = 1, 2, \dots, v$, $b \neq l$;

System operation process model unknown parameters identification. Application of the methods of identification of the system operation process. They are the methods and procedures for estimating the unknown basic parameters of the system operation process models and identifying the distributions of the conditional system operation processes sojourn times at the operation states. The formulae estimating the probabilities of the system operation process staying at the operation states at the initial moment, the probabilities of the system operation process transitions between the operation states and the parameters of the distributions suitable and typical for the description of the system operation process conditional sojourn times at the operation states can be applied as well. The selected distributions of the system operation process conditional sojourn times at the operation states can be tested for their choice validity. The procedure of statistical data sets uniformity analysis can be proposed to be applied to the empirical conditional sojourn times at the operation states coming from different realizations of the same system operation process. [Kołowrocki, Soszyńska-Budny, 2011]

System operation process prediction. Finding the characteristics of the system operation process like ones listed below and other.

System operation process characteristics. The system operation process may be characterized by:

- the **unconditional distribution functions** $H_b(t) = P(\theta_b < t)$ of the sojourn times θ_b , $b = 1, 2, \dots, v$, of the system operation process $Z(t)$ at the operation states z_b , $b = 1, 2, \dots, v$;
- the **limit transient probabilities** p_b of the probabilities $p_b(t) = P(Z(t) = z_b)$, $t \in (0, \infty)$, of the system operation process $Z(t)$ staying at the particular operation states z_b , $b = 1, 2, \dots, v$.

Complex system safety. The ability of the system to achieve its operational objective in the safety state subset not worse than the system critical safety state at each of its operation states.

Complex system safety function. To define the complex system safety, we assume that the changes of the system operation process $Z(t)$ states have an influence on the system multistate components safety and the system safety structure. This fact has an influence on the shape of the system safety function as well. Therefore, we introduce the following defined below notions.



System conditional safety function of the multistate system while the system is at the operation state z_b , $b = 1, 2, \dots, \nu$, is defined by the vector

$$[S(t, \cdot)]^{(b)} = [1, [S(t, 1)]^{(b)}, \dots, [S(t, z)]^{(b)}],$$

where

$$[S(t, u)]^{(b)} = P(T^{(b)}(u) > t \mid Z(t) = z_b) \text{ for } t \in (-\infty, \infty), u = 0, 1, \dots, z, b = 1, 2, \dots, \nu.$$

The coordinate $[S(t, u)]^{(b)}$ of the system conditional safety function is the conditional probability that the system lifetime $T^{(b)}(u)$ in the safety state subset $\{u, u+1, \dots, z\}$ is greater than t , while the process $Z(t)$ is at the operation state z_b . Thus, the system conditional safety function depends on the system structure at the particular operation states.

System component conditional safety function of the multistate system while the system is at the operation state z_b , $b = 1, 2, \dots, \nu$, is defined by the vector

$$[S_i(t, \cdot)]^{(b)} = [[1, [S_i(t, 1)]^{(b)}, \dots, [S_i(t, z)]^{(b)}], t \in (-\infty, \infty), i = 1, 2, \dots, n,$$

where

$$[S_i(t, u)]^{(b)} = P(T_i(u) \geq t \mid Z(t) = z_b > t), t \in (-\infty, \infty), u = 0, 1, \dots, z, b = 1, 2, \dots, \nu.$$

The coordinate $[S_i(t, u)]^{(b)}$ of the component conditional safety function is the conditional probability that the component lifetime $T_i(u)$ in the safety state subset $\{u, u+1, \dots, z\}$ is greater than t , while the process $Z(t)$ is at the operation state z_b . Thus, the component conditional safety function form depends on the system particular operation states.

Consequently, we mark by $T(u)$ the system unconditional lifetime in the safety states subset $\{u, u+1, \dots, z\}$, $u = 0, 1, \dots, z$, and we define the

System unconditional safety function by the vector

$$S(t, \cdot) = [1, S(t, 1), \dots, S(t, z)],$$

where

$$S(t, u) = P(T(u) > t), t \in (-\infty, \infty), \text{ for } u = 0, 1, \dots, z.$$

The coordinate $S(t, u)$ of the system unconditional safety function is the probability that the system lifetime $T(u)$ in the safety state subset $\{u, u+1, \dots, z\}$ is greater than t . In the case when the system operation time θ , is large enough, the system unconditional safety function coordinates are given by

$$S(t, u) \cong \sum_{b=1}^{\nu} p_b [S(t, u)]^{(b)} \text{ for } t \geq 0, u = 0, 1, \dots, z.$$

where $[S(t, u)]^{(b)}$, $u = 0, 1, \dots, z$, $b = 1, 2, \dots, \nu$, are the coordinates of the system conditional safety functions and p_b , $b = 1, 2, \dots, \nu$, are the system operation process limit transient probabilities.

Complex system risk function. If $s(t)$ is the system safety state at the moment t , $t \in (-\infty, \infty)$ and r , $r \in \{1, 2, \dots, z\}$, is the system critical safety state, then the system risk function

$$r(t) = P(s(t) < r \mid s(0) = z) = P(T(r) \leq t), t \in (-\infty, \infty),$$

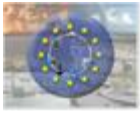
defined as the probability that the system is in the subset of safety states worse than the critical state r , $r \in \{1, \dots, z\}$ while it was in the state z at the moment $t = 0$ is given by

$$r(t) = 1 - S(t, r), t \in (-\infty, \infty),$$

where $S(t, r)$ is the coordinate of the system unconditional safety function for $u = r$ and if τ is the moment when the system risk function exceeds a permitted level δ , then

$$\tau = r^{-1}(\delta).$$

Complex system inside dependencies. Internal dependencies and interactions within a system itself i.e. relationship between components and subsystems in a complex system causing safety state changes of its other components and subsystems and in a consequence resulting in changes of the system safety state.



Complex system outside dependencies. External dependencies and interactions coming from the complex system operating environment, including changes of the complex system structure and its components' safety parameters in different operation states and resulting in the complex system safety state changing caused by outside this system operational conditions related to changes of its functionality, location and other objects activity.

Critical infrastructure integrated safety model. Modelling complex system operation process including its outside dependencies and operating environment hazards. Modelling complex system safety including inside dependencies between its components and subsystems. Constructing integrated critical infrastructure safety model composed of a complex system operation process model and its safety model including its inside and outside dependences and operating environment hazards.

Critical infrastructure integrated safety model unknown parameters identification. Methods of identification of unknown parameters of the critical infrastructure safety general model.

The methods of identification of the operation processes of a critical infrastructure can be applied. They are the methods and procedures for estimating the unknown basic parameters of the critical infrastructure operation process models and identifying the distributions of the conditional critical infrastructure operation processes sojourn times at the operation states. The formulae estimating the probabilities of the critical infrastructure operation process staying at the operation states at the initial moment, the probabilities of the critical infrastructure operation process transitions between the operation states and the parameters of the distributions suitable and typical for the description of the critical infrastructure operation process conditional sojourn times at the operation states can be applied as well. The selected distributions of the critical infrastructure operation process conditional sojourn times at the operation states can be tested for their choice validity. The procedure of statistical data sets uniformity analysis can be proposed to be applied to the empirical conditional sojourn times at the operation states coming from different realizations of the same critical infrastructure operation process. The procedures and formulae estimating the unknown parameters of the critical infrastructure components' safety models on the basis of statistical data coming from the components safety states changing processes can be applied. The method of estimating the unknown intensities of departures from the safety state subsets of the multistate critical infrastructure components having different exponential safety functions at various critical infrastructure operation states can be proposed to be applied as well. This method can be applied to the statistical data collected at different kinds of the empirical experiments, including the cases of small number of realizations and non-completed investigations. Statistical testing can be applied to verifying the hypotheses concerned with the exponential forms of the multistate safety functions of the particular components of the critical infrastructures at the variable operations conditions. In the case of lack of data coming from the components safety states changing processes, the simplified method of estimating the unknown intensities of departures from the safety state subsets based on the expert opinions can be applied [Kołowrocki, Soszyńska-Budny, 2011].

Critical infrastructure safety prediction. Creating the main achievement of this task, the basis for the formulation and development of the new solutions concerned with the prediction of the safety of complex critical infrastructure related to its operation processes and its inside and outside interactions and hazards. Using analytical and Monte Carlo simulation methods in critical infrastructure safety prediction and introducing new methods of investigation of the complex critical infrastructure related to its inside dependences and outside dependencies and hazards.

Short-term critical infrastructure safety prediction. Critical infrastructure safety prognosis for its nearest future time activity in the fixed its operating environment.

Short-term critical infrastructure safety prediction method. Critical infrastructure safety prognosis using Monte Carlo simulation technique based on the **initial probabilities** of the system operation process $Z(t)$ staying at the operation states, the **probabilities of transitions** of the system operation process $Z(t)$ between the operation states and the **conditional distribution functions** of the system operation process $Z(t)$ conditional sojourn times at the operation states and on the **system components' conditional safety**

**functions.**

Long-term critical infrastructure safety prediction. Critical infrastructure safety prognosis for its far time activity in the fixed its operating environment.

Long-term critical infrastructure safety prediction method. Critical infrastructure safety prognosis using analytical methods based on the **probabilities of transitions** of the system operation process $Z(t)$ between the operation states, the **conditional distribution functions** of the system operation process $Z(t)$ conditional sojourn times at the operation states, the **unconditional distribution functions** of the system operation process $Z(t)$ unconditional sojourn times and the **limit transient probabilities** of the system operation process $Z(t)$ at the particular operation states and on the **system conditional safety functions**.

Critical infrastructure safety optimization. The method of the optimization of the critical infrastructure operation process and safety determining the optimal values of limit transient probabilities at the system operation states that maximize the critical infrastructure lifetime in the safety state subset not worse than the safety critical state and/or minimize the critical infrastructure operation process cost.

Critical infrastructure network. A set of interconnected and interdependent critical infrastructures interacting directly and indirectly at various levels of their complexity and operating activity.

Cascading effect in critical infrastructure network. Degrading effects occurring within an infrastructure and between infrastructures in their operating environment, including situations in which one infrastructure causes degradation of another ones, which again causes additional degradation in other infrastructures and in their operating environment.

6.4 Climate-Weather Change Process

Climate. Dynamic interactions of several components including atmosphere, hydrosphere, cryosphere, land surface and biosphere.

Weather. Short-term dynamically changing states of the atmosphere characterised by the values of several parameters including temperature, pressure, humidity and direction and force of wind.

Climate change refers to any change in climate over time, either due to natural variability or as a result of human activity.

Extreme Weather Event. Meteorological conditions that are dangerous and happen at a particular place and time and can generate severe hazards.

Hazard caused by weather change. An event associated with extreme weather that may cause the loss of life or severe injury, property damage, social and economic disruption or environmental degradation. For instance: a dangerous chemical realise into the sea water as a result of ship accident cause by severe storm.

Severe storm. The sea water state characterised by the high increase in sea level caused by the combined effects of low atmospheric pressure, strong wind and a high tide.

Climate-weather change process. The process of the climate-weather states changing considered in time for a fixed area.

Climate-weather state. To define the climate-weather state in the fixed area, we distinguish a parameters that describe the climate-weather state in this area and mark the values they can take by w_1, w_2, \dots, w_a . Further, we assume that the possible values of the i -th parameter $w_i, i=1,2,\dots,a$, can belong to the interval $\langle b_i, d_i \rangle, i=1,2,\dots,a$. We divide each of the intervals $\langle b_i, d_i \rangle, i=1,2,\dots,a$, into $n_i, n_i \in \mathbb{N}$, dicjoint subintervals $\langle b_{i1}, d_{i1} \rangle, \langle b_{i2}, d_{i2} \rangle, \dots, \langle b_{in_i}, d_{in_i} \rangle$ such that

$$\langle b_{i1}, d_{i1} \rangle \cup \langle b_{i2}, d_{i2} \rangle \cup \dots \cup \langle b_{in_i}, d_{in_i} \rangle = \langle b_i, d_i \rangle, b_{ij_i} = d_{ij_i+1_i}, j_i = 1, 2, \dots, n_i - 1, i = 1, 2, \dots, a.$$

Thus, the vector (w_1, w_2, \dots, w_a) describing the climate-weather state can take values from the set of the a dimmensional space points of the Cartesian product

$$< b_1, d_1) \times < b_2, d_2) \times \dots \times < b_a, d_a)$$

that is composed of the a dimensional space domains of the form

$$< b_{1j_1}, d_{1j_1}) \times < b_{2j_2}, d_{2j_2}) \times \dots \times < b_{aj_a}, d_{aj_a}), \text{ where } j_i \in \{1, 2, \dots, n_i\}, i = 1, 2, \dots, a.$$

The domains of the above form are called the climate-weather states of the climate-weather change process and numerated from 1 until the value $w = n_1 \cdot n_2 \cdot \dots \cdot n_a$ and mark by c_1, c_2, \dots, c_w .

The interpretation of the states of the climate-weather change process in the case $a = 2$ is given in Figure 28. In this case, we have $w = n_1 \cdot n_2$ climate-weather states of the climate-weather change process represented in Figure 28 by the squares marked by c_1, c_2, \dots, c_w .

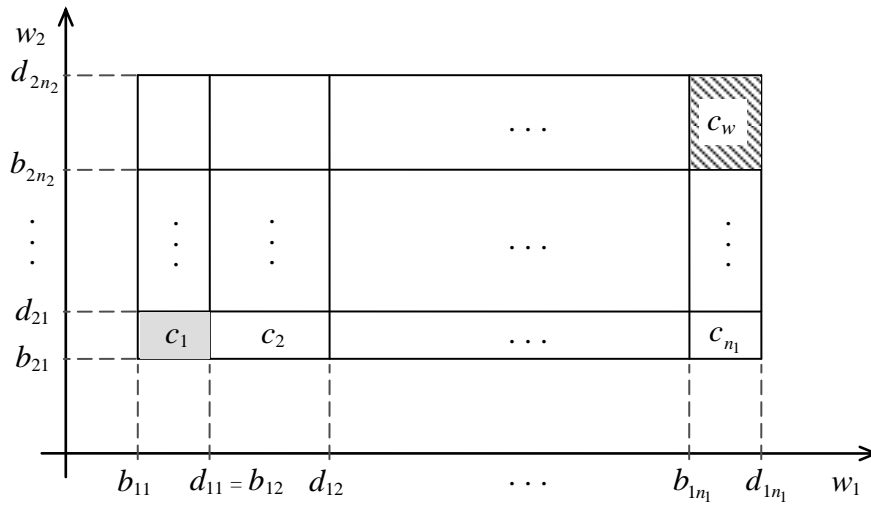


Figure 28. Interpretation of the climate-weather change process two dimensional climate-weather states

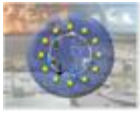
Climate-weather change process model. To model the climate-weather change process for the critical infrastructure operating area we assume that the climate-weather in this area is taking $w, w \in N$, different climate-weather states c_1, c_2, \dots, c_w . Further, we define the climate-weather change process $C(t)$, $t \in (0, +\infty)$, with discrete operation states from the set $\{c_1, c_2, \dots, c_w\}$.

Climate-weather change process parameters. The system operation process may be described by:

- **number of climate-weather states** $w, w \in N$;
- **initial probabilities** $q_b(0) = P(C(0) = c_b)$, $b = 1, 2, \dots, w$, of the climate-weather change process $C(t)$ staying at particular climate-weather states c_b at the moment $t = 0$;
- **probabilities of transitions** q_{bl} , $b, l = 1, 2, \dots, w$, $b \neq l$, of the climate-weather change process $C(t)$ from the climate-weather states c_b to c_l ;
- **conditional distribution functions** $C_{bl}(t) = P(C_{bl} < t)$, $b, l = 1, 2, \dots, w$, $b \neq l$, of the conditional sojourn times C_{bl} at the climate-weather states c_b when its next operation state is c_l , $b, l = 1, 2, \dots, w$, $b \neq l$;

Climate-weather change process identification. The statistical identification of the unknown parameters of the process of climate-weather change, i.e. estimating the probabilities of this process of staying at the states at the initial moment, the probabilities of this process transitions between its states and the parameters and forms of the distributions fixed for the description of this process conditional sojourn times at their states can be performed in the similar way to that presented in [Kořowrocki, Soszyńska-Budny, 2011].

Climate-weather change prediction. Finding the characteristics of the process of climate-weather change like ones listed below and other.



Climate-weather change process characteristics. The climate-weather change process may be characterized by:

- **unconditional distribution functions** $C_b(t) = P(C_b < t)$ of the sojourn times C_b , $b = 1, 2, \dots, w$, of the climate-weather change process $C(t)$ at the climate-weather states c_b , $b = 1, 2, \dots, w$;
- **limit transient probabilities** q_b , of the climate-weather change process $C(t)$ staying at particular climate-weather states $q_b(t) = P(C(t) = c_b)$, $t \in \langle 0, +\infty \rangle$, $b = 1, 2, \dots, w$.

Short-term climate-weather change prediction. Climate-weather change prognosis for the nearest future time in the fixed area/environment.

Short-term climate-weather change prediction method. Climate-weather change prognosis using Monte Carlo simulation technique based on the **initial probabilities** of the climate-weather change process $C(t)$ staying at the climate-weather states, the **probabilities of transitions** of the climate-weather change process $C(t)$ between the climate-weather states and the **conditional distribution functions** of the climate-weather change process $C(t)$ conditional sojourn times at the climate-weather states.

Long-term climate-weather change prediction. Climate-weather change prognosis for the far future time in the fixed area/environment.

Long-term climate-weather change prediction method. Climate-weather change prognosis using analytical methods based on the **probabilities of transitions** of the climate-weather change process $C(t)$ between the climate-weather states, the **conditional distribution functions** of the climate-weather change process $C(t)$ conditional sojourn times at the climate-weather states, the **unconditional distribution functions** of the climate-weather change process $C(t)$ unconditional sojourn times at the climate-weather states and the **limit transient probabilities** of the climate-weather change process $C(t)$ at the particular climate-weather states.

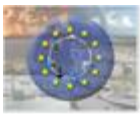
6.5 Critical Infrastructure Safety Related to Climate-Weather Change Modelling, Identification, Prediction and Optimization

Critical infrastructure operation process general model related to climate weather change. The critical infrastructure operation process joint model related to operating environment hazards and climate-weather change extreme events linking the critical infrastructure operation process model and the climate-weather change process model.

Critical infrastructure integrated safety model related to climate-weather change. Modelling the critical infrastructure operation process according to the critical infrastructure operation process general model related to climate-weather change process. Modelling the critical infrastructure inside dependencies between its components and subsystems according to the critical infrastructure safety general model. Construction of the **integrated critical infrastructure safety model** including the above two models of critical infrastructure operation process general model and safety general model.

Critical infrastructure integrated safety model related to climate-weather change unknown parameters identification. The methods and procedures for estimating the unknown parameters of the **integrated critical infrastructure safety model related to climate-weather change** similar to the methods of identification of unknown parameters of the **critical infrastructure integrated safety model unknown parameters identification**, considering additionally the impacts of the climate-weather change on the applied statistical data and on the evaluations of the unknown parameters of the critical infrastructure operation process model and its safety model and applying selected methods and procedures from [Kołowrocki, Soszyńska-Budny, 2011].

Critical infrastructure integrated safety model unknown parameters identification. Application of the methods of identification of unknown parameters of the critical infrastructure safety general model.



The methods of identification of the operation processes of a critical infrastructure can be applied. They are the methods and procedures for estimating the unknown basic parameters of the critical infrastructure operation process models and identifying the distributions of the conditional critical infrastructure operation processes sojourn times at the operation states. The formulae estimating the probabilities of the critical infrastructure operation process staying at the operation states at the initial moment, the probabilities of the critical infrastructure operation process transitions between the operation states and the parameters of the distributions suitable and typical for the description of the critical infrastructure operation process conditional sojourn times at the operation states can be applied as well. The selected distributions of the critical infrastructure operation process conditional sojourn times at the operation states can be tested for their choice validity. The procedure of statistical data sets uniformity analysis can be proposed to be applied to the empirical conditional sojourn times at the operation states coming from different realizations of the same critical infrastructure operation process.

The procedures and formulae estimating the unknown parameters of the critical infrastructure components' safety models on the basis of statistical data coming from the components safety states changing processes can be applied. The method of estimating the unknown intensities of departures from the safety state subsets of the multistate critical infrastructure components having different exponential safety functions at various critical infrastructure operation states can be proposed to be applied as well. This method can be applied to the statistical data collected at different kinds of the empirical experiments, including the cases of small number of realizations and non-completed investigations. Statistical testing can be applied to verifying the hypotheses concerned with the exponential forms of the multistate safety functions of the particular components of the critical infrastructures at the variable operations conditions. In the case of lack of data coming from the components safety states changing processes, the simplified method of estimating the unknown intensities of departures from the safety state subsets based on the expert opinions can be applied [Kołowrocki, Soszyńska-Budny, 2011].

Critical infrastructure safety related to climate-weather change prediction. Prediction of the safety of the critical infrastructures based on the **integrated critical infrastructure safety model related to climate-weather change**. Using analytical and Monte Carlo simulation methods, respectively in long-term and short-term critical infrastructure safety prediction.

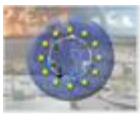
Short-term critical infrastructure safety related to climate-weather prediction. Critical infrastructure safety related to climate-weather change prognosis for its nearest future time activity in the fixed its operating environment.

Short-time critical infrastructure safety prediction method. Critical infrastructure safety prognosis using Monte Carlo simulation technique based on the **initial probabilities** of the system operation process $Z(t)$ staying at the operation states, the **probabilities of transitions** of the system operation process $Z(t)$ between the operation states and the **conditional distribution functions** of the system operation process $Z(t)$ conditional sojourn times at the operation states and on the **system components' conditional safety functions** related to climate-weather change.

Long-term critical infrastructure safety prediction. Critical infrastructure safety related to climate-weather change prognosis for its far time activity in the fixed its operating environment.

Long-term critical infrastructure safety prediction method. Critical infrastructure safety prognosis using analytical methods based on the **probabilities of transitions** of the system operation process $Z(t)$ between the operation states, the **conditional distribution functions** of the system operation process $Z(t)$ conditional sojourn times at the operation states, the **unconditional distribution functions** of the system operation process $Z(t)$ unconditional sojourn times and the **limit transient probabilities** of the system operation process $Z(t)$ at the particular operation states and on the **system conditional safety functions** related to climate-weather change.

Critical infrastructure safety related to climate-weather change optimization. Application of methods based on the results of the **integrated critical infrastructure safety model related to climate-weather**



change linking modelling of the critical infrastructure operation processes with a multistate approach to critical infrastructure safety with climate-weather change process influence and the linear programming to the critical infrastructure at the variable operation conditions operation and safety optimization. The method of the optimization of the critical infrastructure operation processes determining the optimal values of limit transient probabilities at the system operation states that maximize the critical infrastructure lifetime in the safety state subsets not worse than a critical safety state and/or minimize the critical infrastructure operation cost can be used.

6.6 Port and Maritime Critical Infrastructures Safety Related to Climate-Weather Change Modelling, Identification, Prediction and Optimization

Port piping transportation system safety related to climate-weather change process modelling, identification, prediction and optimization. Application of methods and procedures of the critical infrastructure safety related to climate-weather change process modelling, identification, prediction and optimization.

Maritime ferry technical system safety related to climate-weather change process modelling, identification, prediction and optimization. Application of methods and procedures of the critical infrastructure safety related to climate-weather change process modelling, identification, prediction and optimization.

Maritime transportation and information network safety related to climate-weather change process modelling, identification, prediction and optimization. Application of methods and procedures of the critical infrastructure safety related to climate-weather change process modelling, identification, prediction and optimization.

6.7 Validation of Project Issues - Case Studies

Case study. An experiment/exercise investigating critical infrastructure resilience to climate hazards.

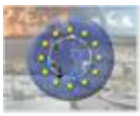
Validation of issues. Case studies outcomes qualitative using questionnaire and quantitative using indicators assessment and proposed and developed tools improvement.

Forest fire and prolonged drought on French/Italian borders. A case study 1 (validation of project issues): Extreme Dryness and forest fires on electricity and transport networks. Simultaneous forest fires ignite in the Bouche du Rhone department near Aix en Provence, and in the Alpes Maritimes Department, at the French/Italian frontier, near a highway (A8) used by thousands of tourists. Due to the important smoke production, visibility is strongly reduced so that highway has to be closed, leading to an important traffic on the secondary road networks. The crossing of the frontier by car being completely impossible, traffic between France and Italy has to be diverted. Tourists are confined on highway rest areas. People, blocked on the roads, have difficulties to breathe because of the smoke and leave their cars, scattering into the nature. Additional accidents are caused because of the panic of people. Due to aerial firefighting, electricity lines have to be cut. Due to the fire smoke, aerial traffic in Nice airport has to be stopped. Numerous dwellings are without electricity and of course without telephones. Other emergency operations are disturbed because of the large delay of alert, major dispersion of means, decrease of available means.

Forest fire. Uncontrolled fire on lands covered wholly or in part by timber, brush, grass, grain, or other flammable vegetation.

Drought. A drought is the absence or marked deficiency of precipitation characterized by abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance.

Prolonged drought (mega-drought). A very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more.



Extreme dryness. A very long time (last for years, usually more than a decade) and deep drought causing exceptional and widespread crop/pasture losses, shortages of water in reservoirs, streams and wells creating water emergencies.

Emergency operation. Emergency services performed according to the fixed rules.

Sea Surge, extreme winds and coastal flooding in Baltic Sea port. A case study 2 (validation of project issues): Scenario 1: Oil Transport in port. The oil piping transportation system is operating at one of the Baltic Oil Terminals that is designated for the reception from ships, the storage and sending by carriages or cars the oil products. It is also designated for receiving from carriages or cars, the storage and loading the tankers with oil products such like petrol and oil. On the basis of the piping system operation and safety statistical data coming from its operators its safety will be modelled, identified and predicted. Further, under the assumption of the possibility of the stress of weather influence on the operation conditions in the form of maritime storm and/or other hard sea conditions existence, the piping system safety will be examined and the results will be compared with the previous results. The piping system safety and operation optimization will be performed and practical suggestions and procedures improving its safety will be worked out.

Scenario 2: Chemical Spill due to extreme sea surges. The sea transport of dangerous chemicals is pretty safe at normal environmental conditions. However, the transported goods may be swept overboard as a result of bad weather and hard sea conditions. The released chemicals may create the threat for the crew and the ship as well as pollute the seawater and the coast. The Baltic Sea and nearby ecosystems are vulnerable to pollution and contamination as a result of sea accident during the dangerous goods transportation. Today, one major accident at the Baltic Sea happens every year approximately. There are more than 50,000 ships entering and leaving the Baltic Sea every year and about 2,000 vessels are at the Baltic Sea at any given moment. This huge traffic across the Baltic Sea will be observed. On the basis of the statistical data coming from reports of chemical accidents at sea, the risk of dangerous chemicals accidents at sea and their dangerous consequences will be modelled, identified and predicted. Further, under the assumption of the stress of weather influence on the operation conditions in the form of maritime storm and/or other hard sea conditions existence, the risk of chemical spills at sea will be examined and the results will be compared with the previous results. The risk of chemical spills at sea the environment degradation optimization will be performed and practical suggestions and procedures decreasing the risk of the environment degradation will be worked out.

Sea surge. The state of sea waters at a particular locality characterized by the increased height of the sea due to extreme meteorological conditions like low atmospheric pressure and strong wind.

Extreme wind is a wind which is strong enough to be dangerous for people, or cause significant damage to buildings and property, usually faster than 100 km/h (>118 km/h = 12 Beaufort scale, hurricane). Extreme wind can cause:

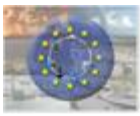
- destruction of buildings, including roofing being blown off, broken windows, and other flying debris
- large scale forest damage and fallen trees or branches falling onto power-lines
- high-sided vehicles and outdoor equipment being blown over
- very tall buildings, suspension bridges and transmission lines can suffer structural failures.

Coastal flooding. An overflow of sea water onto the coastal that are not normally covered by water.

Maritime storm. An elevation of sea level caused by a combination of change in atmospheric pressure, currents, waves and the topography of the coastal shelf.

Storm surge. The increase in sea level caused by the combined effects of low atmospheric pressure, strong wind and a high tide.

Severe storm. An atmospheric disturbance state involving significant perturbations of the prevailing pressure and wind fields.



Storm surge. An elevation of sea level caused by a combination of change in atmospheric pressure, currents, waves and the topography of the coastal shelf.

Maritime accident. An event concerned with the objects operating in maritime environment that causes changing those objects and this environment safety into the state that is dangerous for them.

Risk of maritime accident. The possibility of maritime accident in the fixed maritime area and time interval.

Sea environment threat. Appearing and changing in time phenomenon that is hazardous for the sea environment caused by the objects operating and interacting in this environment.

Chemical spill is defined as the uncontrolled release of a hazardous or harmful chemical substance, either as a solid, liquid or a gas.

Sea pollution. Sea environment pollution caused by hazardous phenomena resulting from the activity of objects operating and interacting in this environment.

Sea pollution vulnerability. Sea environment feature that makes it easily influenced by various pollutions coming from different kinds of objects activity at this environment.

Sea environment degradation. Appearing and changing in time the sea environment state that is hazardous for the sea environment caused by the environment threats appearing and existing in this environment.

Risk of maritime environment degradation. The possibility of environment degradation in the fixed maritime area and time interval.

Flooding in United Kingdom. A case study 3 (validation of project issues): Coastal Flooding (surface water, highway, sewer and watercourse flooding) across Torbay, UK Lead Partner: UNEXE and Torbay Council Torbay is located in South Devon (UK) and covers an area of approximately 62 km². The area has suffered from flooding over many years from a number of different sources, including surface water run-off, highway flooding, sewer flooding, main river and ordinary watercourse flooding during intense rainfall events. In addition the coastal areas of Torbay suffer coastal flooding due to overtopping of the sea defences during high tides that coincide with easterly winds. It should be noted that the surface water, highway, sewer, main river and watercourse flooding is exacerbated in the low lying areas around the coast of Torquay, Paignton and Brixham during high tidal cycles when the capacity of the surface water outfalls discharging to coastal waters is impeded. In addition to the property flooding, during all of these flood events numerous roads have flooded to some extent, with some of the roads having to be closed to traffic until the flood water has subsided. The main coast road linking Torquay to Paignton and Brixham has to be closed on a regular basis due to overtopping of the sea wall during high tides that coincide with easterly wind conditions. These closures result in long traffic diversions and delays. In addition, as a result of surface water flooding from watercourses and main rivers during intense rainfall events the main inland route linking Torquay, Paignton and Brixham has also been closed for periods resulting in no major roads being available between the towns until flooding has subsided. During the last major flooding event, which occurred on 24th October 1999, over 200 properties across all three towns were affected by flooding. Approximately 50% of these properties were commercial properties including shops, restaurants, hotels, bars and a cinema. In addition to the property flooding both the major roads linking Torquay to Paignton and Brixham were closed for a significant period making travel within the Bay extremely difficult and affecting emergency response. Obviously climate change can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability. Wetter winters and more of this rain falling in wet spells will increase river and watercourse flooding. More intense rainfall causes more surface run-off, increasing localised flooding and erosion. In turn this will increase pressure on drains, sewers and water quality. Rising sea levels, as a result of climate change, will increase local flood risk both in coastal regions from increased risk of overtopping of the sea wall and inland from main rivers and watercourses due to the interaction with drains, sewers and smaller watercourses. As sea level is predicted to rise by over 1m in Torbay over



the next 100 years the frequency and impact of overtopping of the sea defences will increase resulting in more infrastructure and properties being affected by flooding.

Coastal flooding. Inundation of normally dry, low-lying coastal land, primarily caused by severe weather events along the coasts, estuaries, and adjoining rivers.

Highway flooding. Inundation of normally dry surfaces caused by exceeding the capacity of the highway drainage system, usually caused by accumulation or run-off of surface water. A further cause of highway flooding is as a result of blockages to gully gratings from fallen leaves or debris, not allowing run-off of surface water to enter gullies and hence flooding occurs. In addition, flooding of the highway can occur as a result of other forms of flooding including coastal flooding, sewer flooding and watercourse flooding.

Sewer flooding. A general and temporary condition of partial or complete inundation of normally dry areas from overflow of a sewer, usually caused by accumulation or runoff of surface waters. Occurs when water levels in pipes overwhelm the capacity of a sewer.

Watercourse flooding. Inundation of normally dry land surface caused by exceeding the capacity of a watercourse, that is identified as any river, stream, ditch, drain, cut culvert, dyke, sluice, sewer and passage through which water flows, except a public sewer.

Tidal cycle. A cycle of the periodic rise and fall of sea level as a result of the gravitational influences of the moon and sun. The result is that most locations experience two high tides and two low tides (known as "semi-diurnal" tides) every 24 hours and 50 minutes. Diurnal tides (one high tide and one low tide) are also quite common.

High tide. The state of tide that refers to high water. The larger than average tides usually occur one to three days after a new or full moon. The stronger the wind, the greater its effect on both the height of the tide and the strength and speed of its flow. When the wind has been blowing in the same direction as the tide for some time, it increases the height of the tide by building up the volume of water flowing in that direction.

Rainfall intensity. The intensity of rain is its rate of fall. "Very light" means that the scattered drops do not completely wet a surface. "Light" means it is greater than a trace and up to 2.5 mm an hour. "Moderate" means the rate of fall is between 2.6 mm to 7.5 mm per hour. "Heavy" means 7 mm per hour or more. [http://climate.weather.gc.ca/glossary_e.html]

Intense rainfall. A rain characterized by a rainfall rate greater than or equal to 50 mm/h.

Heavy rainfall. Rainfall greater than or equal to 50 mm in past 24 hours.

Overtopping. The passage of water over a component such as a flood-bank or seawall, due to high water levels or wave action.

Traffic diversion. The alternative route taken by traffic following the temporary closure of a road due to flooding or a road traffic accident.

Flood risk. The possibility of an overflow of water onto lands that are used or usable by man and not normally covered by water.

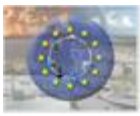
Wetter winter. Winter that has more rain than usual winter.

Surface run-off. The overland flow, that occurs when excess water, from rain, snowmelt, or other sources flow over the land, when soil is infiltrated to full capacity.

Wet spell. Prolonged periods of rainfall.

Pressure on drain. The stress of flows within the drainage system.

Climate change in case of cyclone, storm surges, flood, salinity and tsunami disaster in Bangladesh. A case study 4 (validation of project issues): International Event. Bangladesh is highly vulnerable to climate



induced hazards and disasters and its coastal part are mostly threatened for the impacts of climate change in case of cyclone, storm surges, flood, salinity and tsunami disaster. Even last twenty years the coastal peoples have suffered due to super cyclone SIDR and AILA devastations. Last two decades a lots of disaster coping interventions have been provided to the community to achieve resiliency in this areas. So really it will be a field laboratory for the research of Disaster Resilience and Climate Change: Science and innovation for adaptation to climate change: from assessing costs, risks and opportunities to demonstration of options and practices.

Cyclone. An atmospheric disturbance state involving significant perturbations of the prevailing pressure and wind fields on scale of 2000-3000 km across.

Cyclone. A large area of low atmospheric pressure, characterized by inward-spiraling wind often called a 'low' or a 'depression'.

Hurricanes, cyclones and typhoons are tropical cyclones with maximum sustained wind speed exceeding 119 km/h near their centers. "Hurricane", "cyclone" and "typhoon" are different terms for the same weather phenomenon which is accompanied by torrential rain and maximum sustained wind speeds (near centre) exceeding 119 kilometers per hour.

Tropical cyclone. 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.

Subtropical cyclone. A non-frontal low pressure system that has characteristics of both tropical and extratropical cyclones. The most common type is an upper-level cold low with circulation extending to the surface layer and maximum sustained winds generally occurring at a radius of about 100 miles or more from the centre. In comparison to tropical cyclones, such systems have a relatively broad zone of maximum winds that is located farther from the centre, and typically have a less symmetric wind field and distribution of convection. A second type of subtropical cyclone is a mesoscale low originating in or near a frontolyzing zone of horizontal wind shear, with radius of maximum sustained winds generally less 30 miles. The entire circulation may initially have a diameter of less than 100 miles. These generally short-lived systems may be either cold core or warm core.

Extratropical cyclone. A large-scale of order 1000 km storm in the middle or high latitudes having low central pressure and fronts with strong horizontal gradients in temperature and humidity. A major cause of extreme wind speeds and heavy precipitation especially in wintertime.

Storm surge. The increase in sea level caused by the combined effects of low atmospheric pressure, strong wind and a high tide.

Flood. An overflow of water onto lands that are not normally covered by water. Floods have two essential characteristics: the inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean.

Salinity. The content of salts in soil or water.

Tsunami. The ocean waves generated by sudden displacements in the sea floor (most commonly caused by earthquakes in marine and coastal region), landslides, or volcanic activity. In the deep ocean, the tsunami wave may only be a few inches high. The tsunami wave may come gently ashore or may increase in height to become a fast moving wall of turbulent water several meters high.

Rapid Winter Flooding (melting ice, narrow mountain streams, flooding) around Dresden. A case study 5 (validation of project issues): Dresden is the largest city in the Eastern part of Germany, Saxony, near the Czech border. It is crossed by the large river Elbe (its width is around 110m in Dresden) which comes from the Czech Republic and flows through Magdeburg and Hamburg into the North Sea. The region between Dresden and the Czech border, but also in the near surroundings in the Eastern and South-Western directions, is quite hilly with mountains up to ca. 1200 m. In the recent past (especially notable are the big flooding in 2002 and 2013) there has been quite some flooding caused by intense and long rain which led



to floods of the Elbe. However, there is another threat which is happening more often and hence causing more damage because of the currently ongoing climate changes. In the mountains are lots of small mountain streams which are really small on a normal day (a typical one has a width of 1.5m and a depth of 0.5m). But in cases of heavy rains these small streams rapidly grow quite large (1-2h is not uncommon), especially compared to their normal size (sometimes they grow to their hundredfold size in respect of the amount of water they carry). This causes a lot of damage, especially as prediction and short-term prevention mechanisms are not really possible because of the small timescale. The damages caused by such events are quite local and often not related to the flooding of big rivers. In these regions there are often roads going through valley which are vital in a sense that if they are not available any more, quite long bypasses have to be taken. Additionally railways, especially railway bridges, are often affected as well. These two aspects show the impacts on the transport network.

Winter flooding. Flood that occur in winter. May be caused by ice jams on the rivers, rapid snow melting, or by storm winds that push water level up on one side of the sea.

Flooding short-time prevention. Action that could be taken in a short time to limit consequences of flood (e.g. sandbags, portable water pumps, strengthen of levees).

Intense rain. A rain characterized by a rainfall rate greater than or equal to 50 mm/h.

Heavy rain. Rainfall greater than or equal to 50 mm in past 24 hours.

6.8 Comparison of Results of Critical Infrastructure Safety Modelling, Identification, Prediction and Optimization without and with Climate-Weather Change Influence

The contents:

Climate-weather change impacts on critical infrastructure safety – Results comparison.

Short-term climate-weather change impacts on critical infrastructure safety - Results comparison.

Long-term climate-weather change impacts on critical infrastructure safety - Results comparison.

New notions. Eventual new notions will be defined.

6.9 Critical Infrastructure Resilience to Climate-Weather Change

Resilience. The sufficient ability of an object to continue its operational objective in the conditions including harmful impacts and the ability to mitigate and/or to neutralize those harmful impacts.

Critical infrastructure resilience. The ability of a critical infrastructure to continue providing its essential services when threatened by a harmful event as well as its speed of recovery and ability to return to normal operation after the threat has receded.

Critical infrastructure resilience to climate change. The ability of a critical infrastructure to continue providing its essential services when it is exposed to threats associated with coming out from the climate change harmful events as well as its speed of recovery and ability to return to normal operation after those threats has receded.

Optimization of critical infrastructure accident consequences (with climate-weather change influence).

Applications of procedures and methods addressed to critical infrastructure accident losses minimization.

Mitigation of critical infrastructure accident consequences (with climate-weather change influence).

Policies and actions to reduce the consequences of hazards caused by climate change extreme events.

Critical infrastructure robustness (in climate change context). The inherent strength or the ability of infrastructure to withstand external demands coming from climate change without degradation or loss of functionality.

Critical infrastructure redundancy (in climate change context). The properties of a critical infrastructure that allow for use alternate options, choices, and substitutions under stress, in order to satisfy functional



requirements in threat situations of disruption, degradation, or loss of functionality coming from climate change.

Critical infrastructure resourcefulness (in climate change context). The ability of a critical infrastructure to identify problems, establish priorities, and mobilize needed resources and services when threatened by harmful events coming from the climate change.

Critical infrastructure redundancy (in climate change context). The speed with which disruptions coming from climate change can be overcome, in order to contain losses and avoid future disruption, and with which safety, functionality and stability of critical infrastructure can be restored.

Critical infrastructure vulnerability. The possibility of a critical infrastructure coming to the safety state subset worse than a critical safety state in time shorter than its fixed value, due to some external factors, causing negative effects on itself, other objects and its operating environment.

6.10 Strengthening of Critical Infrastructure Resilience to Climate-Weather Change

Strengthening critical infrastructure resilience. Efforts, like policies, procedures and actions, taken to prolong the proper and effective functioning of a critical infrastructure and providing its essential services when it is exposed to threats.

Strengthening critical infrastructure resilience to climate change. Increasing CI capacity through its components and subsystems parameters improving and its operating environment parameters modification to achieve its characteristics stronger what allow its functioning in its operating environment to be able to absorb and to recover from hazardous events appearing as a result of climate change.

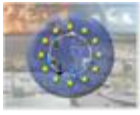
6.11 Integration of EU-CIRCLE Project Achievements

Integrated Critical Infrastructure Safety System – ICISS. The guidebook including the integrated main practical tools created by the participants of the EU-CIRCLE project with the procedure of its usage in the form of detailed and clear scheme-algorithm.

Critical Infrastructure Safety Training System – CISTS. The package of at least the following, based on the e-learning concept, Training Courses (TC):

- TC 1. A general methodology on critical infrastructure safety aspects,
- TC 2. Safety of complex systems and processes,
- TC 3. Safety of multistate system with dependent components,
- TC 4. Modeling critical infrastructure operation process,
- TC 5. Modeling critical infrastructure safety,
- TC 6. Identification of critical infrastructure operation process,
- TC 7. Testing uniformity of statistical data coming from the critical infrastructure operation process,
- TC 8. Analysis and estimation of critical event parameters,
- TC 9. Identification of critical infrastructure components safety,
- TC 10. Prediction of critical infrastructure operation process,
- TC 11. Prediction of critical infrastructures safety,
- TC 12. Optimization of critical infrastructures operation and safety,
- TC 13. Modelling critical infrastructure accident consequences,
- TC 14. Optimization of critical infrastructure accident consequences,
- TC 15. Risk analysis of chemical spills at sea,
- TC 16. Strengthening critical infrastructure resilience to climate change,
- TC 17. Critical Infrastructure Safety Training System.

Integrated Critical Infrastructure Resilience to Climate Change System. The package of guidebooks including the integrated main practical tools created by the participants of the EU-CIRCLE project with the procedures of their usage.



Integrated Critical Infrastructure Resilience to Climate Change Training System. The package of training courses based on the package of guidebooks.

Integrated European Critical Infrastructures Resilience to Climate Change Support System. An integrated in a standardized way holistic critical infrastructures resilience model of existing modelling tools and data open and accessible to all parties interested in the infrastructure resilience business complemented with an interactive web-based portal.

Climate Infrastructure Resilience Platform (CIRP). User friendly environment to enable easy analysis, design and modelling scenarios setup for any kind of climate hazards and CI through functional flow diagrams authoring and intelligent mechanism of individual model selection and orchestration, allowing users to define and thoroughly examine their individual infrastructure's resilience in their own unique manner, setting respective priorities and assessment of the final product.

Simulating Interconnected Critical Infrastructures (SimICI). An unique virtual environment for assessing the resilience of infrastructures to climatic pressures that will facilitate EU-CIRCLE project dissemination and exploitation potential and will be open for effective contribution to CIRP.



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