Country Level

Dimension	Sub-dimension	Indicator	Type	Source	Effect	Rationale
Social	Population	Projected population change	Sensitivity	Eurostat	(+)	Highly dense population areas tend to be more vulnerable due to an increase of both the population exposed to hazards and their sensitivity. "Additionally, the heavy dependence on complex high-tech, and in some cases deteriorating, infrastructure networks increase the susceptibility not only of the cities themselves but also for the wider hinterland and entire economies" (Garschagen & Romero-Lankao, 2013). Higher population tend to lead to a higher consumption for resources and an overall environment degradation which results in a higher vulnerability.
Social	Population (Social Participation)	Children at-risk-of-poverty	Sensitivity	Eurostat	(+)	Children represent a sensitive section of the population in case of disasters since are vulnerable to death, injury and illness (Peek,2008). In addition, disasters negatively affect the population and are able to increase the poverty. If children are both exposed to disasters and poverty, they will be more vulnerable in terms of financial resources and/or social exclusion should be considered. This can further have an influence on political structures. For these reasons, a higher proportion of children at risk of poverty makes communities more vulnerable to disasters in general.
Social	Population (Social Participation)	Disabled people with need for assistance	Sensitivity	Eurostat	(+)	"Disabled people are amongst the most vulnerable groups in relation to natural hazards, because of additional vulnerabilities that accompany poverty" (Abbot & Porter, 2013). When a disaster occurs, disable people are put at risk more than other groups of people and additional factors which threaten their safety may arise. A higher proportion of disable people with need for assistance affect the sensitivity of the communities and consequently their vulnerability.
Social	Population (Social Participation)	Long-term care (health) expenditure	Adapt. Capacity	Eurostat	(-)	A higher expenditure for long-term care identifies the capability of a country to take care of people who need medical assistance. Thus, it is related to the economic welfare of a community: higher expenses are related to a lower vulnerability. The indicator is related to the expenses dedicated to health functions, excluding capital investment.
Social	Dependency	Change in Age-dependency	Sensitivity	Eurostat	(+)	Social dependency highlights groups of people who are not able/have limited capabilities to protect themselves during disasters (due to resources, knowledge, experience - Kabir et al., 2019). The change in Age-dependency ration means that a higher proportion of potentially state-dependent/family dependent people there are, the lower the response capacity is in case of disaster (Stuart et al., 2012; We et al., 2020).
Social	Health	Self-reported unmet need for medical care	Sensitivity	Eurostat	(+)	This indicator explains the vulnerability of people that are unable to afford medical needs. People who are not able to afford/receive medical care are often the ones belonging to the poorest segment of the population. In case of disasters, minorities and low-income households are the ones who experience more unmet needs if compared to other population's segments (Flores et al., 2020) and the inability to receive medical care increase their vulnerability.
Social	Health	Perceived Good Health	Sensitivity	Eurostat	(-)	People who are/perceive good health are more likely to be prepared to disasters being less vulnerable to this kind of events (Eisenman et al. 2009). A perceived good health makes people more self-sufficient and well-being in general is a common measure of the social vulnerability (Naumann et al. 2019).
Economic	Financial resources	Gross National Saving	Adapt. Capacity	WBG	(-)	Despite the fact that GDP is a more common vulnerability indicator, Gross National Saving is indicative of funds available for domestic and foreign investment, therefore the higher it is the higher is the availability of resources that help to recover in case of a disaster. Several studies point out how the economic aspect is fundamental in determining the vulnerability of country/community.
Economic	Financial resources	GDP per capita	Adapt. Capacity	Eurostat	(-)	GDP is a measure of the wealth of the population and it is one of the most common economic vulnerability indicators. A higher wealth allows both to better resist to disaster and proceed through a faster recovery. "GDP and its components are also unavoidable for measuring the economic dimension of VR" (Vulnerability and Resilience - Bates et al., 2014).
Economic	Inequality	Income Inequality	Sensitivity	Eurostat	(+)	The Gini-coefficient describes the inequality of incomes in a country. The greater the gap between low and high salaries is, the more people are vulnerable, provided that inequalities weaken the community and make it less capable to recover after a disaster.

Economic	Environmental (Cultural Heritage)	Cultural heritage	Sensitivity	Unesco	(+)	The indicator is a mix of structural, economic and social aspects. Buildings included in the list of Unesco Heritage Sites are usually more vulnerable to extreme events due to their age and the way they are built; moreover "historic urban areas are vulnerable not only to impending disasters but also during emergency and post disaster recovery phases" (Jigyasu, 2016). Consequently, if a site is heavily damaged, it will have a high cost of re-construction. In addition, heritage sites are landmarks and their lost has a social impact on the communities, given that " cultural heritage is an economic, political, and emotional capital in which, nation states [...] invest" (Labadi, 2021).
Political	Government	Governmental efficiency	Adapt. Capacity	WGI	(-)	Governmental efficiency is a key measure for calculating the efficiency on national level before, during and after a hazard strikes. Overall, "The more effective government, the higher the response capacity" (Swart et al., 2012) and the measure is often linked to the political stability.
Political	Political situation	Political Stability	Sensitivity	WGI	(-)	Often linked to the governmental efficiency the political stability affects the capacity of a country to take immediate and effective responses in case of disaster. Within studies focused on the overall vulnerability, political stability is one of the variables that capture the political dimension of vulnerability and resilience (Bates et al., 2014).
Political	Government (Strategy)	National Adaptation Strategies	Adapt. Capacity	ClimateAdapt	(-)	National Adaptation Strategies and Plans (NAS and NAP) are part of the European adaptation strategy to become more resilient to disasters and climate change in particular. They are often linked to the efficiency of the governments and their response capacity; in addition, there is a specific literature which analyses the impact of adaptation policies, such as Adhikari & Taylor, 2012 and Biesbroek, 2010. Here the indicator is a proxy of the vulnerability meaning that countries that implemented more adaptation strategies/plans are going to be less vulnerable.
Environment	Environmental (Policy)	Environmental protection expenditure	Adapt. Capacity	Eurostat	(-)	It is acknowledged that the environment protection plays a role in the Disaster Risk Reduction subject. The Environmental Protection Expenditure Accounts (EPEA) indicator "describe, in a way consistent with the European System of Accounts (ESA), transactions related to prevention, reduction and elimination of pollution and of any other degradation of the environment" (EUROSTAT, 2023 - env_ac_epite1). The higher is the expenditure (in % of GDP) the more the country become resilient.
Environment	Environmental (Policy)	Production, value added and exports in the environmental goods and services sector	Adapt. Capacity	Eurostat	(-)	"The environmental goods and services sector (EGSS) accounts report on the economic sector that generates environmental products, i.e. goods and services produced for environmental protection or resource management. Products for environmental protection prevent, reduce and eliminate pollution or any other degradation of the environment. They include measures undertaken to restore degraded habitats and ecosystems. Products for resource management safeguard the stock of natural resources against depletion. EGSS accounts provide data on output and exports of environmental goods and services and on the value added of and employment in the environmental goods and services sector" (EUROSTAT, 2023 - env_egs). The indicator is linked to the protection expenditure and higher values are related to countries that are able to increase the quality of the environment and consequently their resilience.
Environment	Ecosystems	Common farmland bird index	Sensitivity	Eurostat	(-)	Birds are high in the food chain; hence they can be considered as a good indicator for the overall state of health of ecosystems and biodiversity. The farmland bird indicator acts as a proxy to assess the biodiversity status of agricultural environments across Europe. A high level of biodiversity is related to a more resilient environment, since the diversification of the ecological niches guarantees the subsistence of the main environmental processes.
Environment	Ecosystems	Natural areas (CLC)	Sensitivity	CORINE	(-)	The indicator provides the proportion of areas classified as natural areas by Corine. The rationale is similar to the Natura 2000 network; Natura 2000 is composed by special protection areas (SPA) and proposed sites of Community importance (pSCI) that are subsequently designated under the Habitats Directive as special areas of conservation (SAC). In general, protected areas identify ecosystems with a high ecological value which should include a high level of biodiversity as well. Therefore, a well-diversified environment is less vulnerable. Since the Natura 2000 network does not cover the whole Europe, natural areas of Corine are used to have better coverage and to include also natural areas that are not under the European Directive. In this case, countries that have a high % share of natural areas have a less vulnerable environment.
Environment	Ecosystems	Environmental Performance Index	Sensitivity	SEDAC	(-)	The EPI utilizes a proximity-to-target methodology focused on a core set of environmental outcomes linked to policy goals. Overall EPI rankings indicate which countries are best addressing the environmental challenges that every nation faces.

NUTS2 Level

Dimension	Sub-dimension	Indicator	Type	Source	Effect	Rationale
Social	Health	Life expectancy	Sensitivity	Eurostat	(-)	Life Expectancy (LE) is related to the social development in general and a higher expectation is often linked to better socio-economic conditions. It "relates to the total achievement of social development, and at the same time, high LE can be a good complementary indicator of low disaster risk" (Egawa et al., 2018).
Social	Health / Access	Hospital beds per 100'000 population	Adapt. Capacity	Eurostat	(-)	The rate of hospital beds for 100,000 inhabitants is a measure of both the reactive adaptation in case of extreme events and the coping capacity of the community (Swart et al., 2012). Within the context of this framework, this number is also considered a proxy of hospitals' accessibility. A higher number decrease the vulnerability of an area since it is able to provide a faster response to the people in need of medical assistance in case of disasters.
Social	Access (Social Participation)	Participation in Social Networks	Adapt. Capacity	Eurostat	(-)	Participation in social network is increasingly getting importance in the context of DRM, by involving more people in strategic planning in mitigation and recovery (Mauroner & Heudorfer, 2016). The monitoring of Social Media is then an essential factor in terms of disaster response since it is "becoming a key platform for information dispersion during disasters" (Dargin et al., 2021). Hence, a higher participation will reduce the vulnerability of the population.
Social	Access (Social Participation)	Information (Frequency of internet access: once a week (including every day))	Adapt. Capacity	Eurostat	(-)	The access to information technologies such as internet improves the resilience of the communities, provided that the speed of new information and communication channels helped reducing the number of disaster-induced fatalities over the last decades (Toya & Skidmore, 2015). Even though this is not sufficient by itself, it is proved that the access to internet can reduce the vulnerability of the communities to disasters.
Social	Access (Social Participation)	People at risk of poverty or social exclusion	Sensitivity	Eurostat	(+)	Poverty and marginalization relate to vulnerability in terms of coping capacity and stress. As stated by Adger (1999) "Poverty is an important aspect of vulnerability because of its direct association with access to resources which affects both baseline vulnerability and coping from the impacts of extreme events". If poverty is spread within a community, it means that the availability of resources is scares and this will affect both the coping and adaptive capacity of the community itself.
Social	Population (Education)	Primary and lower secondary education (levels 1 and 2)	Sensitivity	Eurostat	(+)	Education is a common indicator of social vulnerability in case of disaster, since it is related to the ability to understand information related to emergency plans or warnings to avoid dangerous situations (Frigerio & De Amicis, 2016). A lower level of education is often related to a reduction of the resilience as highlighted on studies at national level such as Frigerio & De Amicis (2016) and Marzi et al. (2019).
Social	Population (Education)	People with tertiary education (levels 5-8)	Adapt. Capacity	Eurostat	(-)	A higher level of education increases the adaptive capacity of the community (Gupta et al. 2020). Tertiary education (or high levels of education) are broadly used as a proxy for social vulnerability, meaning that the higher is the proportion of highly educated population the lower is the resilience of the community.
Economic	Financial resources	Severe material deprivation rate	Sensitivity	Eurostat	(+)	"Deprivation and vulnerability are distinct but related concepts, although sometimes used interchangeably in the development literature" (Busumtwi-Sam, 2008). People who experience material deprivation are more vulnerable to disasters, due to the scarcity of resources they have. The scarcity affects their coping capability as well as the recovery. A higher severe material deprivation leads to a more vulnerable community.
Economic	Financial resources	Household income	Adapt. Capacity	Eurostat	(-)	The household income is calculated as the balance of primary household income calculated in Purchasing Power Standards (PPS). This anticipates the effect of commuting on regional differences and is calculated in context with the country. Economic status is a widely recognized determinant for vulnerability and response capacity (Timmerman et al., 2015), therefore areas with low income are more affected by disastrous events.

Economic	Access	Motorways	Adapt. Capacity	Eurostat	(-)	Length of motorways within an area is used as a proxy to determine accessibility and describe the connectivity and remoteness of places. In this specific context a higher length is related to a better connectivity; in addition, a higher length of available motorways is also related to a better resilience, since in case of disaster it can e related to a higher number of alternative routes. Within the DDR context accessibility and infrastructures provide escaping routes and rapid aid (Tan et al., 2020).
Economic	Access	Railways	Adapt. Capacity	Eurostat	(-)	Like motorways, length of railways within an area is used as a proxy to determine accessibility and describe the connectivity and remoteness of places. In this specific context a higher length is related to a better connectivity; in addition, a higher length of available railways is also related to better resilience, since in case of disaster it can be related to a higher number of alternative routes.
Economic	Inequality (Employment)	Employment rate	Adapt. Capacity	Eurostat	(-)	Employment/unemployment rate is a common indicator related to the economic aspect of communities and households used to assess the availability of financial resources and consequently to the ability of recovering from disastrous events (Begg et al., 2021; Carter et al., 2018). Additionally, the indicator is also informative in terms of inequality and exclusion (Bates et al., 2014).
Political	Government	Regional Quality of Government index	Sensitivity	QoG	(-)	The European Quality of Government Index. (EQI) The EQI data contains information on sub-national governance in Europe from three rounds of a large, pan-European survey on citizen perceptions and experiences with public services. Both micro and sub-national data are provided (https://www.gu.se/en/quality-government/qog-data). From a conceptual point of view, the regional quality of government covers aspects such as political stability and governmental efficiency that have their own indicators at country level. Of course, a higher quality of government tends to reduce the vulnerability of the communities due to a more efficient planning and response capability in case of disaster.
Environment	Environmental	Proportion of artificial surfaces	Sensitivity	CORINE	(+)	Artificial surfaces tend to affect in a negative way the coping capacity of the communities, due to ecosystems degradation. A wide extend of artificial surfaces increases the effects of heatwaves, flood events and the superficial run-off of windstorms and heavy rains, leading to a lower resilience against climate-related hazards (Munang et al., 2013).
Environment	Environmental	Proportion of agricultural areas	Sensitivity	CORINE	(+)	If agricultural areas a widely extent across an area, they can lead to a higher vulnerability due to ecosystems simplification and degradation. An expansion of agricultural lands often relates to deforestation and soil erosion, as well as to a loss of biodiversity due to a cultivation of a single crop (Vijith et al., 2018). This led to a higher sensitivity of this kind of lands in case of disastrous events and consequently a lower coping capacity.
Environment	Environmental	Proportion of forest and seminatural areas	Sensitivity	CORINE	(-)	A wide extent of natural areas allows to increase the coping capacity in case of natural events and increase the resilience against climate-related hazards. Recent studies highlight how ecosystem management should be considered among the most effective measures to mitigate disaster risk, since well-developed natural ecosystems protect communities from floods, heat/cold waves, soil erosion and landslides.

NUTS3 Level

Dimension	Sub-dimension	Indicator	Type	Source	Effect	Rationale
Social	Population	Population density	Sensitivity	Eurostat	(+)	Population density is a common indicator of vulnerability since it is usually related to a lack of quality housing and social services network (Kabir et al., 2019). In addition, denser regions are usually considered more exposed to climate related hazards (Carter et al., 2018 and Glwadys et al., 2010) and also more complex to be evacuated (Kontokosta & Malik, 2018).

Social	Population	Net migration	Sensitivity	Eurostat	(+)	This indicator shows the yearly percentage change of population at NUTS3 level. In the context of the vulnerability framework developed within the Rish Data Hub, Net migration from the previous year indicates the tendency of (inter-)national immigration and therefore, the amount of people living in the NUTS 3 less than 1 year. People living in a place less than one year can have a higher vulnerability which can be reasoned by less local knowledge for disaster risk, preparedness and response or due to language issues. Hence, we link a higher vulnerability to higher values of migration. In literature, there is still debate if migration increase or not the vulnerability as highlighted by Carter et al. (2018), however it seems related to the point of view of the study. Raileanu-Szeles & Tache (2016) approach the topic from a socio-economic perspective concluding that migration in southern Europe has positive effects on incomes and inequality; on the other hand, Zhang et al. (2021) found that migrants appear more vulnerable for reasons in line with the approach we currently set.
Social	Access	Average distance to healthcare facilities	Sensitivity	JRC	(+)	Accessibility (or remoteness) can be interpreted both in terms of coping and adaptive capacity. Distance-decay accessibility (travel time and distance) to emergency services such as hospitals, fire & rescue stations has been considered also in previous studies. The indicator is calculated as the average road distance per person to the nearest healthcare facility, in kilometers.
Social	Access	Access to Local Services	Adapt. capacity	JRC	(+)	Access to health, education services and other assets plays a crucial role in reducing inequalities and climate resilient pathways
Social	Dependency	Young dependency	Sensitivity	Eurostat	(+)	Like the Change in age-dependency indicator, the Young dependency provide an estimate of the people below 20 years old. Together with elders, children are a sensitive category, usually vulnerable to disastrous events. Youngest groups are not able to protect themselves in those situations due to lack of resources, experience and knowledge (Kabir et al., 2019; Timmermans et al., 2015; Swart et al., 2012).
Social	Dependency	Old dependency	Sensitivity	Eurostat	(+)	Like the Change in age-dependency indicator, the Old dependency provide an estimate of the people over 65 years old within the community. On average, older people are more sensitive to health-related impacts of natural events, in addition they are also mobile and less able to avoid and cope with stressors from extreme events (Kabir et al., 2019; Timmermans et al., 2015; Swart et al., 2012).
Economic	Financial resources	NUTS3 GDP per capita vs country average	Adapt. Capacity	Eurostat	(-)	Like GDP per capita at country level, this indicator is a measure of the wealth of the population. In this case the it is calculated against the country average to reflect better the local variability of the population's wealth within a country.
Economic	Financial resources	Gross Value Added (at basic prices - per capita)	Adapt. Capacity	Eurostat	(-)	"Gross Value Added (GVA) is defined as output value at basic prices less intermediate consumption valued at purchasers' prices. GVA is calculated before consumption of fixed capital" (Carter et al., 2018). The indicator is a measure of the resources an area has and it is a good indicator of the adaptive capacity; as a matter of fact, a city that has a below-average GVA may not be able to address DRM measures resulting more susceptible to disastrous events.
Economic	Technology	Power plants per 100'000 inhabitants	Adapt. Capacity	WRI	(-)	The indicator provides the number of power plants per 100'000 inhabitants at NUTS3 level. The idea is that a higher rate lead to a higher resilience due to the redundancy of the system which is able to better cope with failures in case an event damages one or more plants in an area. As a matter of fact, redundancy is a consolidated practice that has been widely adopted for decades by utilities as a reliability measure for critical situations (Mishra et al., 2020).
Economic	Technology	Patent applications to the EPO	Adapt. Capacity	Eurostat	(-)	This indicator shows the number of patent applications to the European Patent Office (EPO) per 1,000 inhabitants in the NUTS3 units. The number of patents per year is used as a proxy indicator reflecting the ability of the system to innovate and invest in new technological solutions. It will help the system to increase its adaptive capacity in relation to climate change and perturbing events in general (Carter et al., 2018; Hu et al., 2018; Miao & Popp, 2014).

Environment	Environmental	Proportion of green urban areas against other artificial surfaces	Sensitivity	CORINE	(-)	Schinasi et al. (2022) and Moura et al. (2020) highlight how well integrated green areas in a urban environment are often related to a healthier community; on the other hand, areas deprived of green spaces are usually related to the most degraded urban areas. Therefore, a high presence of green areas within the urban environment is linked to the less vulnerable communities (high availability of financial resources, less inequality, etc.). Additionally, green spaces help to cope with extreme events such as floods, heatwaves, windstorms, by cooling the artificial surfaces and mitigating the superficial run-off of the water. The indicator is mainly focused on urban areas and their development in "green cities".
Environment	Environmental	Land take intensity	Sensitivity	CORINE	(+)	The land take intensity considers the change of agricultural, forest and semi-natural land taken for urban and other artificial developments. The indicator highlights how urban and artificial surfaces has a negative impact on the environment making more vulnerable areas with a high level of urbanisation. It is estimated by starting from CORINE data and following the methodology provided by the EAA.

Country / NUTS2 / NUTS3

Dimension	Sub-dimension	Indicator	Type	Source	Effect	Rationale
Physical	Population	Rate of fatalities caused by disasters[1] (25 year moving average per capita)		JRC	(+)	The fatalities' rate is a proxy for the physical vulnerability of people to the hazards. Thus, the indicator describes the relationship between the exposure to a hazard and the impact. It is analyzed in terms of effects on population, that are people killed by the considered hazard (Formetta & Feyen, 2019).
Physical	Economic	Economic losses caused by disasters as percentage of GDP (25 year moving average)		JRC	(+)	The % of GDP impacted by a hazard measure the relationship between the exposed assets and the impact in terms of economic losses. As proposed by Formetta & Feyen (2019) the GDP is used as a measure of the wealth of the population and the indicator is developed following the same methodology

[1] The total amount of losses (fatalities or economic damage) for all hazards is considered. Selection of individual hazards is not currently foreseen for the dashboards, but potentially could be implemented on the RDH main platform. The hazards for which disaster loss data has been collected and used for these indicators are: **Coastal flood, Cold wave, Drought, Earthquake, Wildfire, River flood, Flash flood, Heat wave, Landslide, Tsunami, Volcano, Windstorm.**

Link to the data sources for the indicators:

- **Eurostat:** https://ec.europa.eu/eurostat/web/main/data/database
- **WBG (World Bank Group):** https://data.worldbank.org/indicator/NY.GNS.ICTR.ZS
- **UNESCO:** https://whc.unesco.org/en/syndication
- **WGI (World Governance Indicators – World Bank):** https://www.worldbank.org/en/publication/worldwide-governance-indicators
- **CORINE Land Cover:** https://land.copernicus.eu/en/products/corine-land-cover
- **SEDAC (Socioeconomic Data and Applications Center):** https://sedac.ciesin.columbia.edu/data/set/epi-environmental-performance-index-2022
- **QoG (Quality of Government Institute, University of Gothenburg):** https://www.qu.se/en/quality-government/qog-data/data-downloads/european-quality-of-government-index
- **Rural Observatory:** https://observatory.rural-vision.europa.eu/trends?lng=en&ctx=ROBS&is=Default&ts=ROBS&cl=rural
- **Urban Data Platform:** https://urban.jrc.ec.europa.eu/rel2018/#/en/
- **WRI (World Resources Institute):** https://datasets.wri.org/dataset/globalpowerplantdatabase

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