Conclusions

Every year, natural and human-made hazards cause sizeable damage and losses, the exact magnitude of which we do not know. Improving our understanding of the economic impacts of various hazard risks is fundamental for sound and evidence-based disaster risk management. This subchapter has reviewed the state-of-the-art knowledge, methodologies and practice of assessing damage and losses caused to residential building stock, agriculture, and industrial and energy assets.

Hazard risks are stochastic processes, which often are not stationary but respond to environmental changes, including climate change. Hazard manifestations of similar intensity and magnitude may result in different damage and losses, depending on circumstantial factors. The vulnerability and susceptibility to harm are also time-dependent, changing and evolving as our societies transform in demography, wealth, cohesion and use of technology.

Over the past few decades, disaster risk assessment has improved thanks to the advancements in high-performance computing, high-resolution topographic and other spatial data, a new generation of large-scale hazard and disaster loss/impact models, and high-resolution exposure datasets. An accurate spatial representation of exposure features such as residential and industrial facilities and assets, infrastructure, population density and gross domestic product make it possible to improve the estimates and spatial distribution of disaster impacts. Advanced quality and accessibility of Earth observation products, including from the EU's Copernicus programme, have led the way to coherent exposure and vulnerability data at continental and global scales.

Models and methods for assessing the economic damage to physical assets caused by various hazards are similar and rely on some relationship between the intensity of hazards – measured for example as floodwater depth, macro-seismic intensity, wave height or near-surface wind speed – and the vulnerability or fragility of the physical assets that is determined by their material and structural conditions (Huizinga et al., 2017; De Moel and Aerts, 2011). While the parameters of physical fragility are similar across the various hazards, their responses to various hazard intensities are different and need further study. The damage models typically rely on a monotonic function linking hazard intensity to damage in material and financial terms.

Recent analysis of a large empirical dataset of flood losses has revealed that this monotonic form may not always apply, and a beta function with bimodal distributions for different water depths may better explain the observed losses (Wing et al., 2020). Moreover, most damage models and studies fail to account for the functional interdependencies between various buildings, lifelines and transport infrastructure.

Models and methods used to assess the hazards' impacts on crop and livestock production have to deal with more complex and articulated relationships between hazard intensity and impact. The fragility of crops to extreme weather and climate-related events may not be constant over the various phenological phases. The damage revealed at the time of harvest reflects the cumulative impacts of various climate extremes and biological plagues suffered over the whole season, mediated by crop resilience and agronomic risk mitigation. Better computation and storage capacity have made it possible to advance coupled climate models and simulate climate extremes with higher temporal and spatial resolution. Still, some damaging local-scale extreme atmospheric phenomena such as frost and hail cannot be measured or simulated at a resolution that would be necessary for detailed damage assessment.

Assessment of damage and losses to industrial and energy production build upon and combine the approaches to address damage to physical assets, losses due to business interruption and systematic losses caused by the propagation of the initial impacts through a web of interconnected supply and transportation chains. The financial impacts consist of value of capital lost, recovery costs and opportunity costs. These impacts may set off supply and demand shocks that affect regional economies in and beyond the disaster-affected areas. The direct damage to tangible productive assets is equivalent to indirect economic losses caused by disruption of production webs, measured by flows.

The COVID-19 pandemic has taught a lesson about how closely environmental and human health are connected. What we have lived through during the lockdown, and still will, is a mild foretaste of the systemic shocks that climate and global environmental changes may and will cause in the future. Future improvements of risk assessment need to be focused on a better understanding of indirect and spillover economic losses generated by slow-onset hazards, compound risks and cascading risks, as well as losses caused by disruption of social networks, economic flows and ecosystem services. The EU Green Deal and the unprecedented post-COVID-19 recovery package will stimulate immense investments in green technologies and innovation, and lead the way to sustainable development and climate neutrality. Only with sound, evidence-based and multi-hazard risk assessments can we reconcile short-term 'building back better' recovery and medium- to long-term climate-resilient development.