A reliable and comprehensive characterization of expected seismic ground shaking is essential to improve building codes, particularly for the protection of critical infrastructures and for land use planning. So far, one of the major problems in classical methods for seismic hazard assessment (SHA) consisted in the adequate characterization of the attenuation models, which may be unable to account for the complexity of the medium and of the seismic sources and are often weekly constrained by the available observations. This eventually motivated the development of a Next Generation Attenuation (NGA) approach. Current computational resources and physical knowledge of the seismic waves generation and propagation processes allow nowadays for viable numerical and analytical alternatives to the use of attenuation relations. Accordingly, a scenario-based approach to SHA at different scales and level of detail is proposed, which allows considering a wide range of possible seismic sources as the starting point for deriving scenarios by means of full waveforms modeling. The method does not make use of attenuation relations and permits to carry on parametric analysis and stability tests that may contribute to characterize the related uncertainties, as well as to fill in the unavoidable gaps in available observations. Applications of the proposed method to national scale SHA and microzoning in different regions of the World will be illustrated. The influence of earthquake recurrence on the probability maps of exceeding specific ground motion levels will be addressed as well.