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Exceptional weather and sea level events in changing climate: experiences on providing user-relevant information to support nuclear power plant safety in Finland

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Energy technologies not resulting in direct greenhouse gas emissions include renewable energy sources and nuclear energy. These alternatives to the combustion of fossil fuels each have their advantages and disadvantages and are in various stages of development. In contrast to several other European countries, a significant part of the Finnish energy system will continue to rely on nuclear energy, alongside renewable energy. In 2018, around one-third of electricity was produced with nuclear energy, and its portion of total energy consumption was 17%.

An issue in using nuclear energy is its safety. The overall safety management over the life cycle of a nuclear power plant (NPP) requires, among others, probability estimates of exceptional weather and sea level conditions in the current and future climate. These are needed for the determination of the design basis for new NPP units, for probabilistic risk assessments of new and existing NPPs, and for periodic safety reviews of existing NPPs. Major nuclear accidents are typically low-probability–high-consequence events. Therefore probabilities of occurrence of extremely rare events, unseen in the past 100 years of observations and corresponding to return periods of thousands or even millions of years, are needed. Besides, the ongoing climate change may alter the frequencies and severity of the events in the future. To tackle these challenges, utilization of a spectrum of different sources of information and understanding the behaviour of multivariate events are in demand.

Forecasts of extreme weather and sea level events and conditions may allow the operator of an NPP to take appropriate action, provided that they can be issued in time. However, weather forecasts and warnings issued to the public, or to authorities, are not designed with the needs of nuclear power production in mind. Events to be predicted should be both relevant for the operation of nuclear power production and within the capabilities of the applied forecasting systems.

The Finnish Meteorological Institute has examined extreme weather, climate and sea level events potentially posing risks to NPPs since 2007 within consecutive 4-year national research programmes on NPP safety (Jylhä et al., 2018), currently in SAFIR2022. The phenomena being studied have been selected based on feedback and enquires from the power companies designing and running the Finnish NPPs, and from the nuclear safety authorities defining the safety regulations for the construction and operation of power plants. In this presentation, examples of the research topics, methods and results will be provided.

Jylhä et al. 2018: Recent meteorological and marine studies to support nuclear power plant safety in Finland. Energy, 165 (A), 1102-1118, https://doi.org/10.1016/j.energy.2018.09.033