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Real Option Cost Vulnerability Analysis of Electrical Infrastructure

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Critical infrastructure such as electricity substations are vulnerable to various geo-hazards that arise from climate change. These geo-hazards range from increased vegetation growth to increased temperatures and flood inundation. Of all the identified geo-hazards, coastal flooding has the greatest impact, but to date has had a low probability of occurring. However, in the face of climate change, coastal flooding is likely to occur more often due to extreme water levels being experienced more frequently due to sea-level rise (SLR). Knowing what impact coastal flooding will have now and in the future on critical infrastructure such as electrical substations is important for long-term management. Using a flood inundation model, present day and future flood events have been simulated, from 1 in 1 year events up to 1 in 10,000 year events. The modelling makes an integrated assessment of impact by using sea-level and surge to simulate a storm tide. The geographical area the model covers is part of the Northwest UK coastline with a range of urban and rural areas. The ensemble of flood maps generated allows the identification of critical infrastructure exposed to coastal flooding. Vulnerability has be assessed using an Estimated Annual Damage (EAD) value. Sampling SLR annual probability distributions produces a projected "pathway" for SLR up to 2100. EAD is then calculated using a relationship derived from the flood model. Repeating the sampling process allows a distribution of EAD up to 2100 to be produced. These values are discounted to present day values using an appropriate discount rate. If the cost of building and maintain defences is also removed from this a Net Present Value (NPV) of building the defences can be calculated. This distribution of NPV can be used as part of a cost modelling process involving Real Options, A real option is the right but not obligation to undertake investment decisions. In terms of investment in critical infrastructure resilience this means that a real option can be deferred or exercised depending on the climate future that has been realised. The real option value is defined as the maximum positive NPV value that is found across the range of potential SLR "futures". Real Options add value in that flood defences may not be built when there is real value in doing so. The cost modelling output is in the form of an accessible database that has detailed real option values varying spatially across the model domain (for each critical infrastructure) and temporally up to 2100. The analysis has shown that in 2100, 8.2% of the substations analysed have a greater than a 1 in 2 chance of exercising the real option to build flood defences against coastal flooding. The cost modelling tool and flood maps that have been developed will help stakeholders in deciding where and when to invest in mitigating against coastal flooding.