Climate change impacts on solar power systems

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INTRODUCTION

The number of solar energy systems in Hungary has increased significantly in the past few years, but it should be considered that the impacts of climate change can negatively affect energy production, transmission and supply systems in several ways, generating severe financial damage and supply disruptions. Our research is focusing on the climate impact assessment of solar energy buildings and power plants with special focus on operational and safety aspects in the area of Hungary. Necessary to assess how the elements of solar energy systems are affected by the impacts of climate change and how to prepare for the operational risks of these systems.

METHODS

We investigated the role, significance and the historical occurrence of extreme weather events and their near-mid- and long-term projected changes in the future for solar power systems. The changes of relevant meteorological events due to climate change and their impact on solar energy systems evaluated for Hungary based on data from CNRM-CM5/RCA4 and EC-EARTH/RACMO22 regional climate model simulations, driven by RCP4.5 and RCP8.5 scenarios (Jacob et al., 2014). The possible failures of PV systems and the temporal progression of PV module failures and degradation have been identified. We analyzed solar module failures associated with extreme weather events and identify, detect and understand module failures that result directly or indirectly from external environmental stresses, mainly weather, or changes in such stresses. The sensitive elements of PV systems were explored as well as the apadtive capacity options in order to know, how the elements of solar energy systems are affected by the impacts of climate change and how to prepare for the operational risks of these systems.

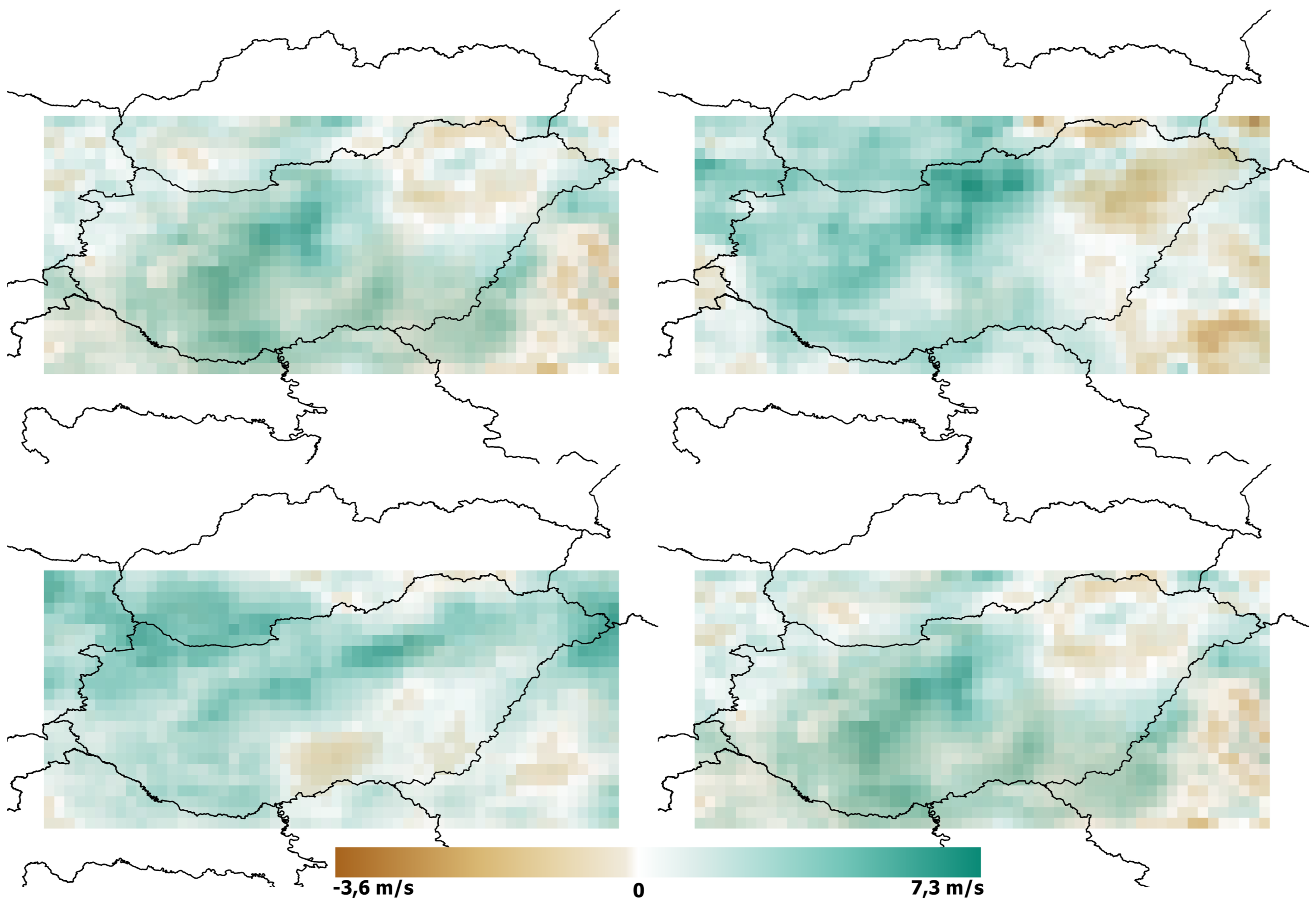

Figure 1: Multi-year changes in daily maximum near-surface wind speed of gust in 2031-2050, based on CNRM-CM5/RCA4 (left) and EC-EARTH/RACMO22 (right) simulations. Scenario: RCP4.5 (top), RCP8.5 (bottom). Reference period: 1991-2010.

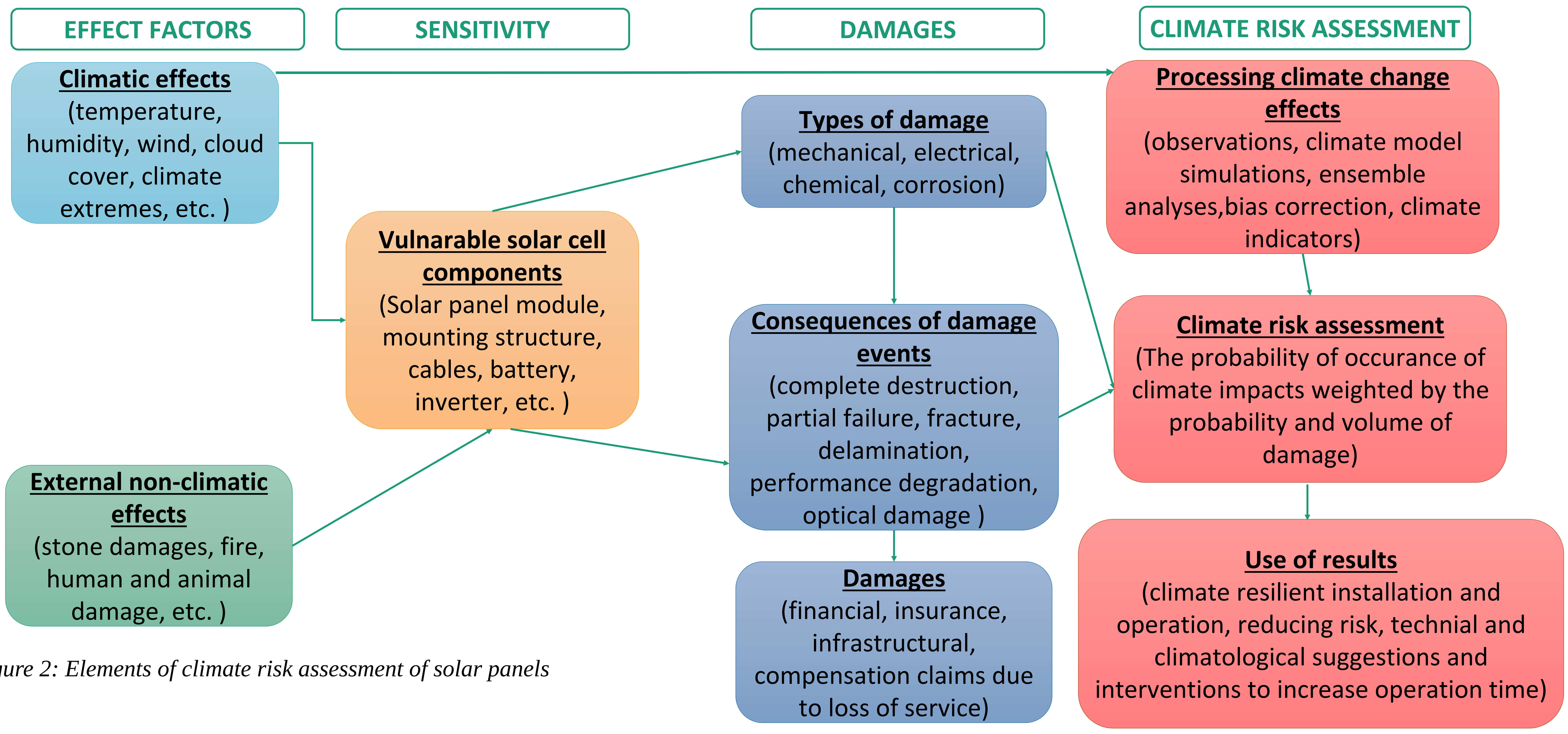

Figure 2: Elements of climate risk assessment of solar panels

PRINCIPAL FINDINGS

Solar power systems are particularly vulnerable to weather extremes: changes in air temperatures, increasing frequency and duration of summer hot periods and heat waves have a negative impact on the efficiency of solar panels. Changes in precipitation and relative humidity, can increase moisture infiltration into the panels, which can contribute to structural failure. In Hungary, climate change will increase the number and intensity of extreme weather events, with thunderstorms, extreme wind gusts and hail which can damaging solar systems. Increasing wind speed and wind gust contribute the higher risk of mechanical failures, resulting in line breaks and temporary outages. In the climatological risk assessment, the different technical sensitivity factors are organized as elements of a risk matrix, and combined with the probability of the expected climatological impacts.

CONCLUSIONS

The results of our research contribute to the long-term safe operation of solar energy systems and provide key information for the planning process of solar parks. It is almost impossible to prepare solar parks, that have already been completed and are in operation, against an extreme weather event with subsequent investment. Even if it were technically feasible, the additional investment costs would be such that the return on investment would be significantly reduced. Therefore, these climate risk assessments should be used at the initial stage of projects and investment developments.

Reference: Jacob et al. EURO-CORDEX (2014): new high-resolution climate change projections for European impact research Regional Environmental Changes. Vol. 14, Issue 2, pp. 563-578., https://doi.org/10.1007/s10113-013-0499-2

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