Setup of a databased simulation model for the assessment of resilience and risk factors in coastal regions

Aufsetzen eines datenbasierenden Simulationsmodelles zur Beeurteilung von Resilienz und Risikofaktoren in Küstengebieten

Bachelorthesis or higher

Prerequisites:
120 CPs, all basic modules passed and 13 weeks of internship.

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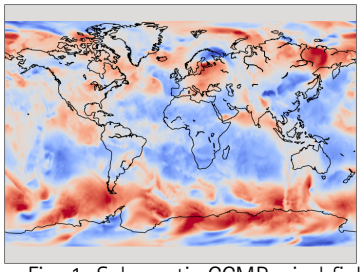

Fig. 1: Schematic CCMP wind field values. (Wentz et. al., 2015)

Despite the ongoing increasing calculation performance of our present technology, the simulation of - and statements about necessary preparatory measures for - natural hazards such as earthquakes, floods, tsunamis, typhoons, droughts are still posing challenging problems. Often it is not easy to define clear model boundaries because these events might even be caused by global interactions between numerous variables and parameters. Furthermore, since the globalization and industrialisation due to constantly growing markets are marching on not only the physical coherences are complex but also the human-made systems such as economic relations, infrastructural dependencies and even cultural arrangements. In Zhang et. al., 2020 a novel systematic framework to connect the relations between wind disasters and resulting economical effects caused by disrupted port operations is presented. A data-driven hybrid wind simulation model to estimate the wind speed given simulated typhoon trajectories was adapted. This physical model is combined with an economic model to estimate the total financial loss of four harbours on the Chinese coast. For this purpose, a critical wind speed threshold has been defined to indicate when ports immediately stop operations. In this project, the hybrid wind field model shall be revisited and validated, based on the data and descriptions provided in [1]. Additionally, considerations alongside the implementation shall be made on how to transfer this model for usage in other regions e.g. Europe. A validation shall be adapted that is using new data and a different background wind information. For this purpose, also a discussion of different models than the ones presented in [2] and [3] should be made. The economic loss for the 4 Chinese harbours shall be revisited and the possibility of collecting similar data for ports in Europe (e.g. Rotterdam, Antwerp and Hamburg) shall be explored. This might give insight on how to enable the usage of the systematic framework also for other regions. Finally, the possibility of another load model shall be discussed. E.g. in the Hamburg harbour port operations usually do not stop given specific wind speed values but rather expected water levels. That opens the question on how it could be possible to add specific water levels as a critical threshold in the model to estimate the number of days of port disruptions cause by not only wind-induced but also water level induced disasters.

Literature (Selection)

[1] *Zhang*, Y., *Wei*, k., *Shen*, Z., *Bai*, X., *Lu*, X., *Soares*, C.G.,2020: Economic impact of typhoon-induced wind disaster on port operations: A case study on ports in China. Int. Jour. of Disaster and Risk Reduction(50) 101719.
[2] *Ueno*, T., 1981. Numerical computations of the storm surges in tosa bay, J. Oceanogr. Soc. Jpn. 37(2) 61-73.
[3] *Wang*, X., 1991. Research and applications of a forecasting model of typhoon surges in China seas, Adv. Water Sci. 2(1) 1-10 (in Chinese).
[4] *Zhang*, Y., *Beer*, M., *Quek*, S.-T., 2015. Long-term performance assesment and design of offshore structures. Computers and Structures 154 101-115.
[5] *Wentz*, F.J., J. *Scott*, R. *Hoffman*, M. *Leidner*, R. *Atlas*, J. *Ardizzone*, 2015: Remote Sensing Systems Cross-Calibrated Multi-Platform (CCMP) 6-hourly ocean vector wind analysis product on 0.25 deg grid, Version 2.0. Remote Sensing Systems, Santa Rosa, CA. Available online at www.remss.com/measurements/ccmp. [Accessed 01.09.2020]
[6] *Luettich*, R., *Westerink*, J., *Scheffner* , N., 1992: ADCIRC: An Advanced Three-Dimensional Circulation Model for Shelves, Coasts, and Estuaries. Report 1. Theory and Methodology of ADCIRC-2DDI and ADCIRC-3DL.

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