**Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung**
– Wadden Sea Station Sylt, Germany –

# The effects of ocean acidification, warming and enhanced nutrients on a Wadden Sea community - Examined with Mesocosm experiments

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**Andreas Pansch**

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Erster Gutachter: PD Dr. Harald Asmus

Zweiter Gutachter: Prof. Dr. Martin Wahl

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# Summary

Ocean acidification and global warming are known as two of the most crucial factors impacting marine ecosystems worldwide. While most investigations tested short-term impacts of single environmental drivers (e.g. temperature, salintiy) on single species, studies on the combined effect of multiple drivers on a multi-species assemblage in different seasons, which is much more realistic and relevant, are still scarce. Therefore, an experimental mesocosm facility was built to gain information on community changes under the impacts from multiple drivers. In three consecutive experiments, in spring, summer and autumn 2014, compartments of an intertidal macroalgae-mussel community from the Wadden Sea were incubated for 8 to 11 weeks within a large-scale mesocosm facility (Sylt Benthic Mesocosm). In the experiments four different treatments were applied: Ambient, nutrient enrichment (N; doubled natural summer nutrient concentration), warming in combination with acidification (OAW; ambient + 5°C and 1000ppm), and a combination of all three drivers (OAW+N). To find seasonal effects, we compared the responses of (OAW) to that of the ambient treatment in spring, summer and autumn. Carbon flows within the food web of the enclosed species assemblage were analysed by a holistic, static modelling approach (Ecological Network Analysis, ENA).

The combined effects of ocean warming and acidification decreased the biomass of the main grazers and the macrophyte *Fucus vesiculosus,* while epiphytes massively increased due to an altered top-down control during summer. This creates a bottle neck within the energy flow between the first two trophic levels and let less energy pass to higher trophic levels. Enriched nutrients alone did not affect the system substantially, but especially grazers seem to benefit from enriched nutrient concentrations. The effects of climate change on the investigated Wadden Sea community strongly depends on the investigated season. In spring and autumn, OAW affected less or even promoted the system by increased energy flows between the trophic levels. In summer the opposite was found, with decreased energy flow, hampered top-down control and a reduced trophic efficiency, that could propagate through the whole food web and alter the structure and functioning of the investigated community. The Analysis ENA showed a lower relative ascendancy and the trend to an increasing flow diversity, as the result of a high number of multiple pathways between the system components. Theoretically, the resilience of the system shows a tendency to increase and the capability of withstanding external disturbances under OAW as compared to an unstressed system.