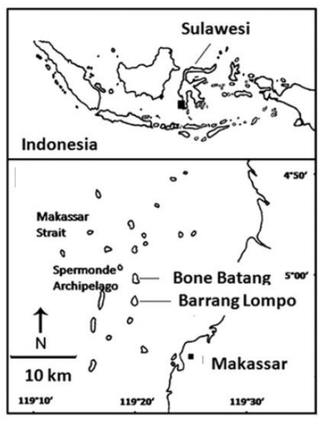
Seagrass meadows on tropical Indo-Pacific reef islands:

How do water motion and water depth relate to seagrass species composition, and are seagrass communities really controlled by shrimp bioturbation?

Dominik Kneer[1], Dody Priosambodo[2], Harald Asmus[1]

[1] Alfred-Wegener-Institute for Polar and Marine Research, Wadden Sea Station Sylt, Germany
[2] Center for Coral Reef Research, Hasanuddin University Makassar, Indonesia



Introduction

Tropical Indo-Pacific seagrass meadows are characterized by high species diversity and mostly mixed vegegation.
The distribution and composition of such mixed meadows is influenced by species-specific reactions to

- **abiotic factors:** emergence during low tides, light attenuation by the water column, siltation, sediment characteristics, hydrodynamics
- **biotic factors:** grazing, bioturbation (e.g. burrowing shrimp), competitive interaction between seagrass species

Seagrass meadows on small coral islands in the Spermonde Archipelago, Indonesia, grow across a wide range of hydrodynamic regimes and water depths.
The sandy carbonate sediments on these islands are a habitat for many species of burrowing shrimps.
-> The islands offer a unique possibility to study the effects of **water motion**, **water depth** and **bioturbation** on seagrasses.

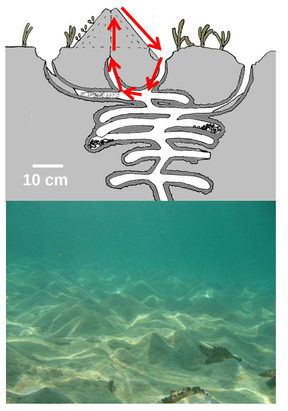
Methods

Seagrass distribution and composition - 19 research sites distributed over two islands

- Shoot density, leaf area index (LAI), biomass, rhizome length and epiphyte biomass of *Halophila ovalis*, *Halodule uninervis*, *Syringodium isoetifolium*, *Cymodocea rotundata*, *Thalassia hemprichii* and *Enhalus acoroides* were determined.
- Water motion, water depth, Sediment parameters (depth, organic content, grain size composition) and the abundance of burrowing shrimp were quantified.
- The dynamics of erosion and recolonization processes were reconstructed by repeatedly obtaining aerial photographs of the research sites using a kite and a tethered blimp.

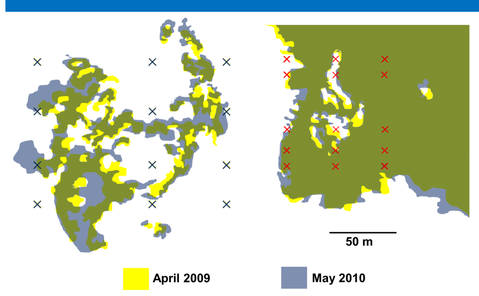
Shrimp exclusion experiment in a seagrass-free subtidal "moonscape"

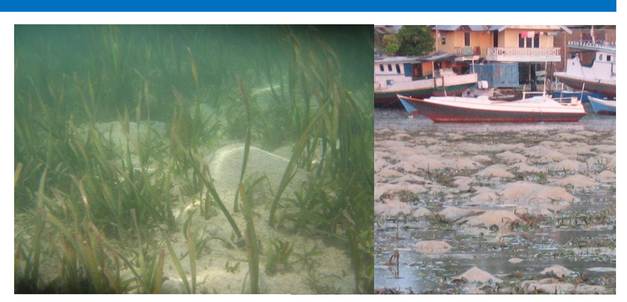
- Shrimp (*Neocallichirus vigilax*) were excluded from 6 experimental plots (3 * 3 m) at different water depths by burying a 1 mm mesh 10 – 15 cm below the surface.
- The survival of transplanted shoots of six seagrass species in exclusion, procedural control and zero treatment plots was monitored over a 27 months period.



Callianassid shrimp such as *Glypturus armatus* (above) and *Neocallichirus vigilax* are **„conveyor-belt deposit feeders"**: sediment is subduced from the surface through funnels, food items like microphytobenthos are separated and the cleaned sediment is rejected through mounds.
„Moonscapes" of mounds and funnels are typical of sandy sedimentary areas exposed to benign water motion.
Both seagrasses and callianassid shrimp are **„ecosystem engineers".** While seagrasses stabilize sediments with their root and rhizome network, callianassid shrimp do exactly the opposite, and their distribution is usually mutually exclusive.

Results

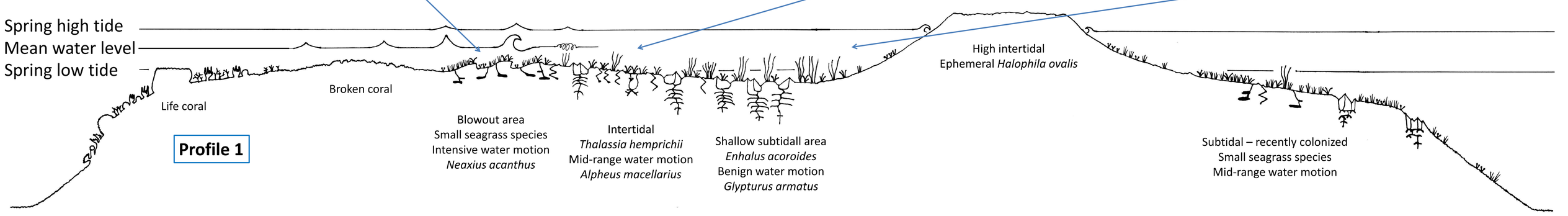


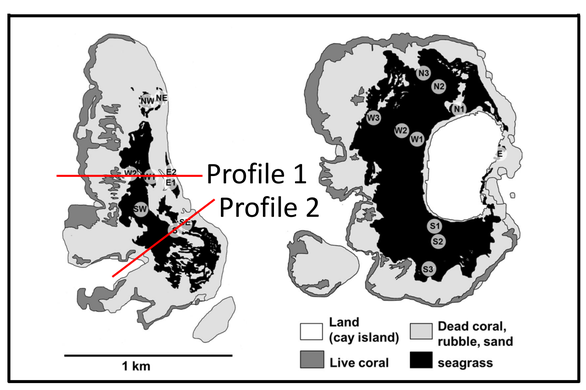


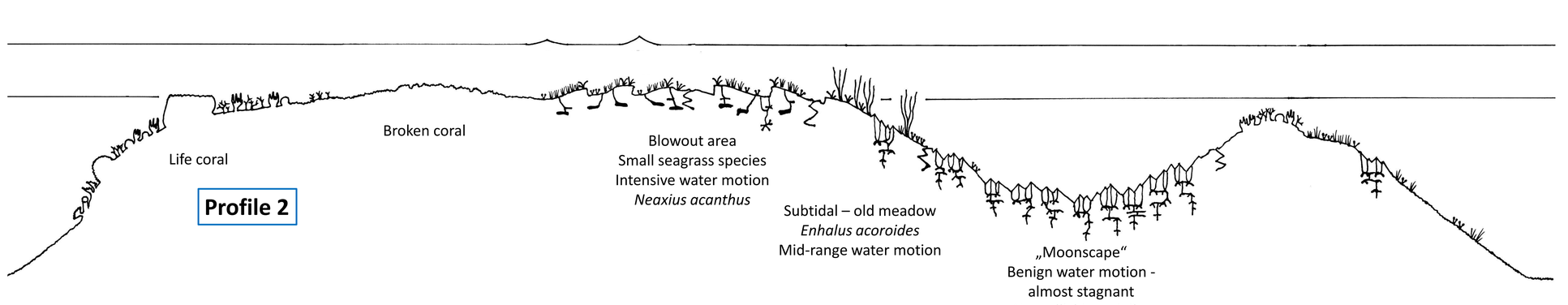
Intensive water motion leads to **„blowouts"** which disrupt successional processes. Meadows are characterized by small species, high shoot densities and an extensive rhizome network. This is the preferred habitat of shrimp which do not shift large amounts of sand and produce stable burrows, like the drift-catching strahlaxiid *Neaxius acanthus*.

Meadows in the **intertidal** mostly experienced **mid-range water motion** and where dominated by *Thalassia hemprichii*. High densities of *Alpheus macellarius*, an important grazer.

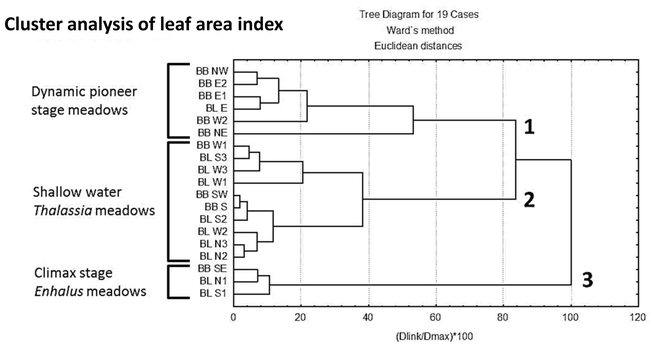
Meadows with **benign water motion** were dominated by *Enhalus acoroides*. Callianassid shrimp (*Glypturus armatus* in the intertidal and *Neocallichirus vigilax* in the subtidal) abundant.



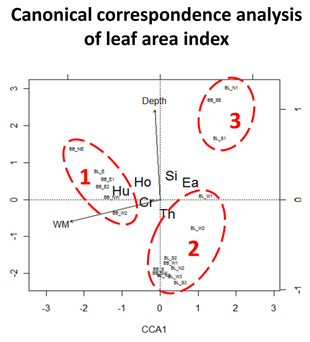


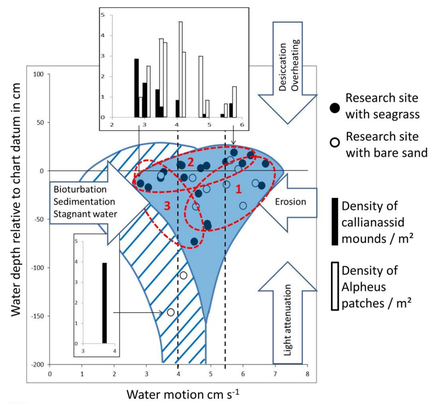


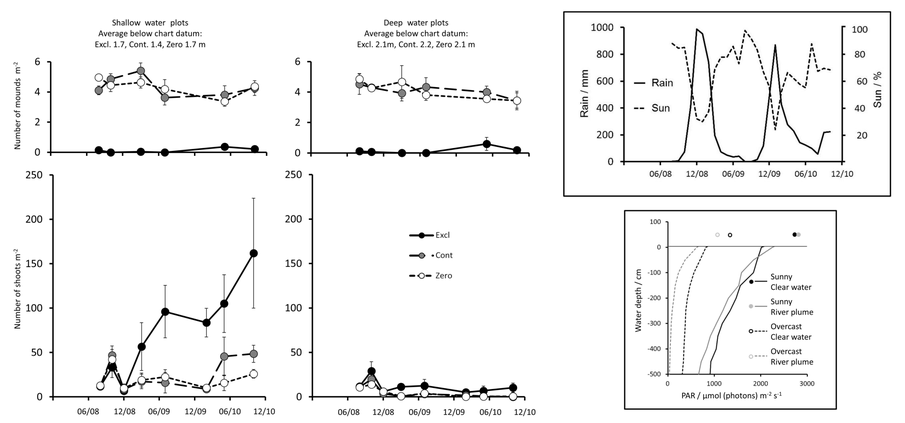
Cluster analysis of leaf area index



Canonical correspondence analysis of leaf area index







In a **cluster analysis**, three distinct species assemblage types were identified. A **canonical correspondence analysis** produced the same three assemblages, and water motion explained more of the variation than water depth.
Sediment characteristics and epiphyte biomass were uniform across all sites and are considered to be dependant variables.

Transplanted seagrass shoots performed best in shrimp exclusion plots, and better in shallow moving water compared to deeper calm water.
The northeast monsoon negatively influenced plant performance.

Conclusions

- Water motion strongly affects seagrass assemblages, directly by promoting sediment instability and indirectly by influencing the abundance of burrowing shrimp.
- Seagrasses and shrimp compete for space at sites with benign water motion.