EPIBENTHIC ASSEMBLAGES AND CORAL RUBBLES: POSSIBLE EFFECTS OF HUMAN IMPACTS ON CORAL REEFS.

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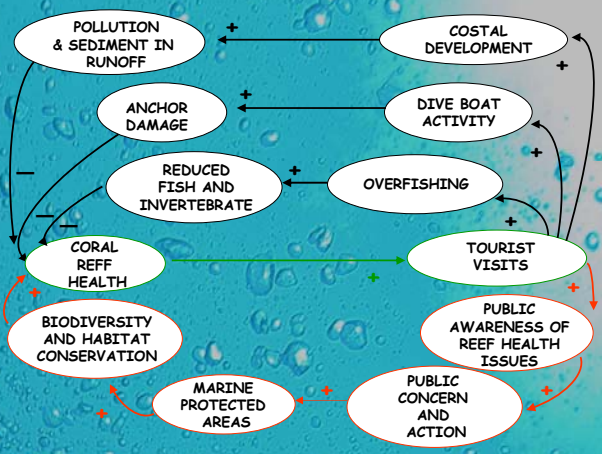
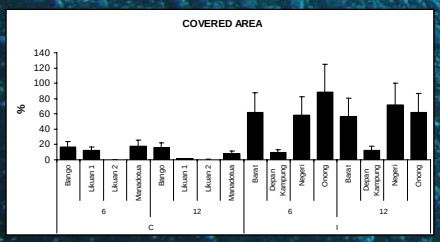
Introduction - Coral reefs have a high ecological value with its most diverse marine habitat and species but also a social and economic ones with million of people depending on it for their supplies (Costanza *et al.*, 1997; Berg *et al.*, 1998). Unfortunately reefs are affected by human disturbances and the degree of degradation is increasing with time worldwide. The major physical disturbances that directly affect coral reefs are summarized in the scheme on the right.

In this study we analysed the epibenthic assemblages structure and coral rubbles features (coverage, grain size and living fraction) as possible indicator of human physical impact in the Bunaken Marine National Park (1°37'N 124°45'E, North Sulawesi, Indonesia).

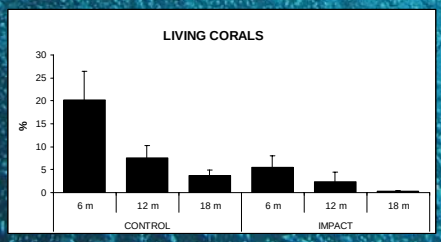


Materials and methods - Impacted and control locations within the Bunaken Marine Park were defined considering the physical disturbance due to the increasing tourism close to the villages, according to the technical report of de Vantier and Turak (2004). Four study sites were randomly chosen in both impacted and control locations. The coral rubbles percentage cover was estimated measuring the size of rubble patches along 6 belt transects (10x1m) at two depths (6-12 m) in each site. Rubble sizes and the living coral fraction were evaluated collecting three replicate samples at three depths (6-12-18 m) in each site. Coral rubbles were divided into 5 size classes using a nested series of sieves (meshes 0.1, 0.5, 1.0, 2.0, 4.0, 8.0 cm) and weighted, while living corals fraction was estimated as relative percentage. Epibenthic assemblages were analysed in term of morphological categories, using a photographic sampling considering eight sites (5 impacts and 3 controls) at 6, 12, 18 metres depth.

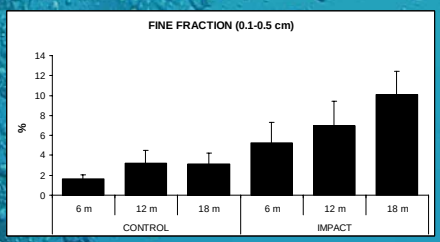
Results



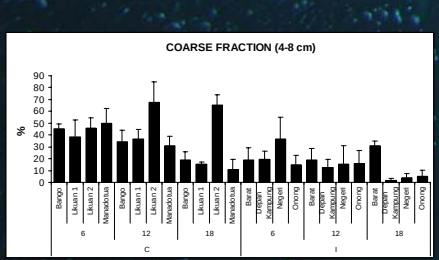
Coral rubbles percent cover was significantly higher in the impacted sites (ANOVA $p<0.05$)



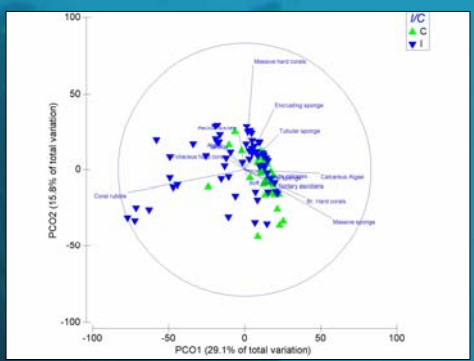
The average percentage of living corals among fragments was significantly higher in the control *vs.* impacted sites (ANOVA $p<0.05$) and decreased with depth ($p<0.01$).



Coral rubbles fine fraction (0.1-0.5 cm) was more abundant in impacted sites (ANOVA $p<0.05$)



Coarse fraction prevailed at the control sites (ANOVA $p<0.05$) and showed differences between sites within controls (ANOVA $p<0.01$), which appeared more heterogeneous than impacts



PCO ordination plot of epibenthic assemblages data and superimposed correlation vectors of the main taxa groups and coral rubbles cover. Coral rubble significantly increased toward impacted sites while calcareous algae, branching hard corals and massive sponges were more abundant in the control sites

Conclusions: In the impacted sites the amount of coral rubbles and the fine fraction are higher than in control ones, probably due to the physical disturbances that led to a major destruction and erosion rate of hard corals. Instead the high quantity of living coral fragments within coral rubbles could be related to recent physical damage. The epibenthic assemblages shift their features from control to impacted sites with a lost of three-dimensional structural complexity with increasing physical disturbances . In the studied area the impact seems mainly due to boats striking and anchoring, which destroy lagoon corals and cause continuous coral rubbles rain towards the slope. In this way, the impact is directly performed on the flat and reef edge but its effect is detectable also along the reef wall, transferring the negative effect of anthropic activities in the deep.

BERG H., OHMAN M.C., TROENG S., LINDEN O. (1998) - Environmental economics of coral reef destruction in Sri Lanka. *Ambio*, **27**: 627-634.
COSTANZA R., DARGE R., DEGROOT R., FARBER S., GRASSO M., HANNON B., LIMBURG K., NAEEM S., ONEILL R.V., PARUELO J., RASKIN R.G., SUTTON P., VANDENBELT M. (1997) - The value of the world's ecosystem services and natural capital. Nature, 387: 253-260.