



DHI SOLUTION

## COMPENSATORY MITIGATION FOR CORAL REEF IMPACTS

Minimise and offset unavoidable direct and indirect loss of sensitive coral reef habitats

Coral reef ecosystems are unique and among the most complex and biologically diverse ecosystems on earth. The resources, services and functions they provide are important and beneficial to humans, including coastal protection, diverse job and recreational opportunities, provision of food and raw materials, as well as social and cultural significance. They also contain a vast diversity of flora and fauna that often form the basis for valuable tourism industries.

However, coral reefs around the world continue to decline from exploitation, destructive fishing practices and overfishing, coastal development, pollution, nuisance or invasive species, disease and other anthropogenic damage. The threat level is heightened when combined with climate change and widespread coral bleaching.

When anthropogenic impact to coral reefs cannot be avoided or minimised, for example during land reclamation, compensatory mitigation through a range of active measures such as coral relocation and other restoration efforts are often carried out to offset the direct and indirect loss of these valuable resources.

Very often, such compensatory efforts are only marginally successful, ineffective, poorly implemented and studied, or they may completely fail to accomplish a project's objectives. Such failures can be attributed to inadequate training, knowledge and experience, resulting in costly project delays, further raising concerns and scepticism about the efficacy of such mitigation measures in the face of global declining coral reef status.

Nevertheless, mitigation efforts remain a necessary and viable option. When effectively designed, managed and executed by well trained and experienced personnel, the loss of sensitive coral reef habitats can be minimised. In DHI's experience, barring any unanticipated events such as elevated sea surface temperatures and oil spill, coral relocation survival rates of up to 80% have been documented over the medium-term of three to five years and high-quality functional communities can be re-established that further attract and support healthy populations of other taxa, e.g. reef fishes.



*Direct loss of sensitive coral reef habitats*

*Photo: © <http://lyon.us.com/pacific-island.php>*

### SUMMARY

#### CLIENT

- Infrastructure developers
- Port authorities and operators
- Oil and gas industry
- Consultants and contractors
- Government and environmental authorities

#### CHALLENGE

- Minimising the environmental impact of marine construction works
- Preventing loss of habitat, biodiversity, livelihood, and other ecosystem functions
- Overcoming uncertain outcomes and cost-ineffective solutions

#### SOLUTION

- Coordinated and project specific mitigation strategies, for example coral relocation plans
- Objective methodologies to estimate impacts and implement appropriate compensatory measures
- Long-term monitoring systems to effectively assess the adequacy and outcome of the mitigation efforts
- Further offset any impacts through other innovative mitigation and restoration solutions such as building with nature, e.g. artificial reefs

#### VALUE

- Customised solutions in collaboration with clients
- Reduction in environmental impacts
- Cost-effective design of mitigation efforts
- Environmental compliance
- Strategic environmental planning
- Project approval by environmental authorities

## CORAL RELOCATION

Since 2003, DHI has successfully carried out several compensatory coral relocation projects for large-scale coastal infrastructure developments in Southeast Asia, e.g. land reclamation and port development, where impacts to coral reefs and other coastal habitats were unavoidable.

To meet the needs of our clients in a broad range of industries, DHI has developed a robust and fully customisable coral relocation programme that spans the entire duration of a mitigation project's life-cycle. Furthermore, this is continually improved upon through our on-going research and development while working on a variety of challenging projects throughout the region.

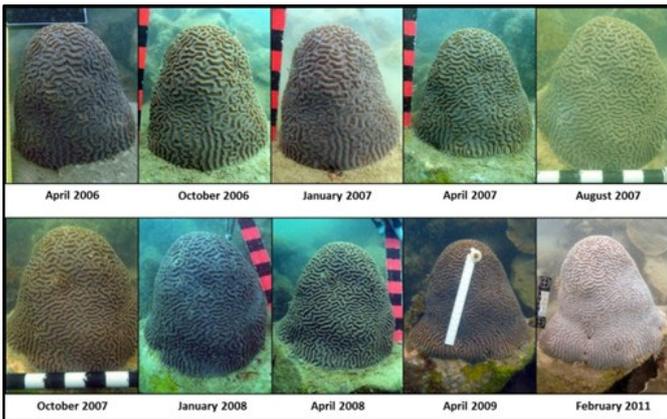


*Coral transplantation in Malaysia*  
Photo: © DHI

## DESIGN, PLANNING AND IMPLEMENTATION

No two coral relocation projects are similar. Very often, specific environmental objectives and project constraints are usually very different even for similar developments. Therefore, due diligence must be taken at the onset of any project to identify and implement specific measures required to achieve the project objectives.

Consequently, the inception phase of any coral relocation effort is critical where particular requirements and targets are identified, designed and planned. This often culminates in the development of a comprehensive action plan that provides a framework for the implementation to follow.



*Long-term monitoring of transplanted corals, Singapore*  
Photo: © DHI

## DHI OFFERS

- Detailed habitat and biodiversity survey of impacted coral reefs
- Assessment and selection of suitable recipient sites
- Formulation of comprehensive coral relocation plan including transplantation targets and other relocation guidance materials
- Harvesting and active transplantation of corals and other benthic reef organisms
- Long-term monitoring of corals and other transplants, including recipient site maintenance and contingency planning
- Technical support for stakeholder consultation and NGO engagement
- Design and implementation of other biodiversity offsets, e.g. coral nursery and artificial reefs
- Design and implementation of other coastal habitat compensatory mitigation measures, e.g. mangroves and seagrass relocation

## REEFS AT RISK IN SOUTH EAST ASIA

The coral reefs of Southeast Asia make up 28% of the global total but are the most extensive and diverse in the world. At the same time, more than 138 million people in the region live within 30km of the coast and heavily depend on the natural resources provided by its coral reefs, e.g. fish and seafood. As a result, the coral reefs of Southeast Asia are also the most threatened in the world.

It is estimated that about 95% are at risk from local threats. Overfishing as well as destructive fishing practices, e.g. blast and poison fishing, has affected almost every reef in the region, and it remains a major enforcement challenge. Although sedimentation and land pollution are considerable, in recent years, coastal development, e.g. land reclamation, has also become a growing concern. With the addition of global warming and ocean acidification, it is projected that by 2050, all of the region's coral reefs will be threatened, most of which at the highest or critical levels.

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## ABOUT DHI

DHI is an independent, international consulting and research organisation headquartered in Denmark and with a global network of offices, agents and representatives, including countries throughout the Asia Pacific, e.g. Singapore, Malaysia, Indonesia and Australia. Our objectives are to advance technological development and knowledge in water environments worldwide.

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