Technology Fact Sheet for Adaptation

Replanting of Sea Grasses [i]

Replanting of Sea Grasses

22. **Sector**: Coastal

23. Technology characteristics

23.1 Introduction to establishment of seagrass beds by replanting seagrasses:

Sea Grasses are flowering plants belong to four families (Posidoniaceae, Zosteraceae, Hydrocharitaceae & Cymodoceaceae) of the order: Alismatales and Class: Monocotyledons, which grow in marine, fully saline environments. These unusual marine flowering plants are called *seagrasses* because the leaves are long and narrow, are very often green and and often grow in large "meadows". They superficially resemble terrestrial grasslands. They are found submerged within the photic zone, in the shallow and sheltered coasts, because they are photosynthetic organisms. They possess a well developed underground plant parts consists of rhizomes and root system which are extensive and close to each other, helps them to be anchored to sand or mud bottoms in many places (Dawes, 1981).

They undergo pollination while submerged and complete their entire life cycle underwater. Seagrasses form extensive beds or meadows, which can be either monospecific (made up of one species) or multispecific (co-existance of many species) and the tropical seagrass beds belongs to the latter.

(http://en.wikipedia.org/wiki/Seagrass)

Plate 1; Seagrasses found in the sea grass bed in Mannar off Pallimunai. *Hallophila ovalis* (left), *Enhalus acoroides,* (middle) & *Cymodocea rotundata* (right) during a study conducted by Cumaranatunga et al.(2010) (Photographed by P.B.T.P. Kumara)

2.7.2 Importance of sea grass beds to other marine organisms

Seagrass beds are productive ecosystems, and they provide permanent or temporary refuge to many other organisms either during the whole life time or during a certain stage of their life cycles. For example juvenile and adult fish, epiphytic and free-living macroalgae and microalgae, mollusks, bristle worms, and nematodes.Scientific investigations have revealed that despite their low nutritional content, seagrass herbivory is a highly important link in the food chain, with hundreds of species feeding on seagrasses worldwide (e.g. green turtles, dugongs, manatees, fish, sea urchins, crabs, etc). (http://en.wikipedia.org/wiki/Seagrass)

2.7.2 Important services provided by the Sea grasses for ecosystem stability

Seagrasses are sometimes referred to as ecosystem engineers, because they partly create their own habitat: the leaves slow down water-currents increasing sedimentation and the seagrass roots and rhizomes stabilize the seabed (http://en.wikipedia.org/wiki/Seagrass.

Their importance for associated species is mainly due to provision of shelter (through their three-dimensional structure in the water column), and for their extraordinarily high rate of primary production. As a result, seagrasses provide coastal zones with a number of ecosystem goods and ecosystem services, for instance fishing grounds, wave protection, oxygen production and protection against coastal erosion. Seagrass meadows account for 15% of the ocean's total carbon storage. They slowdown the water current, maintaining water clarity by trapping sediments to allow light penetration and providing shade and habitats for small marine species. The ocean currently absorbs 25% of global carbon emissions. Due to the above services provided by the sea grass meadows, they are very useful for forming a protective belt as an adaptation for the coastal erosion that may occur due to sea level rise & also for removal of CO_2.

Disturbances and threats to seagrass beds

Natural disturbances such as grazing, storms, ice-scouring, and desiccation are an inherent part of seagrass ecosystem dynamics. Seagrasses display an extraordinarily high degree of phenotypic plasticity, adapting rapidly to changing environmental conditions. Seagrasses are in global decline, with some 30,000 km^2 (12,000 sq mi) lost during recent decades. The main cause is human disturbance, most notably eutrophication, mechanical destruction of habitat (due to using drag nets for fishing and nchorage of boats), and overfishing. Excessive input of nutrients (nitrogen, phosphorus) is directly toxic to seagrasses, but most importantly, it stimulates the growth of epiphytic and free-floating macro- and micro-algae. This weakens the sunlight, reducing the photosynthesis that nourishes the seagrass and the primary production results. http://en.wikipedia.org/wiki/Seagrass

24. Technology Characteristics/Highlights

Since Sea grass diversity may change with salinity & temperature, species with wide tolerance range for salinity and temperature variations and those which are having a strong root systems that would help to stand high wave action should be selected for this purpose. This technology could be used as a soft defence technology (Figure 1) and also togethher with hard defence technology as

shown in figure 2 & figure 3. Seagrass plots could be propagated in cement tanks with seawater circulation or on the coastal belt where seagrasses are abundant and plots of seagrasses or individual plants could be tranfered to areas where transplanting is needed

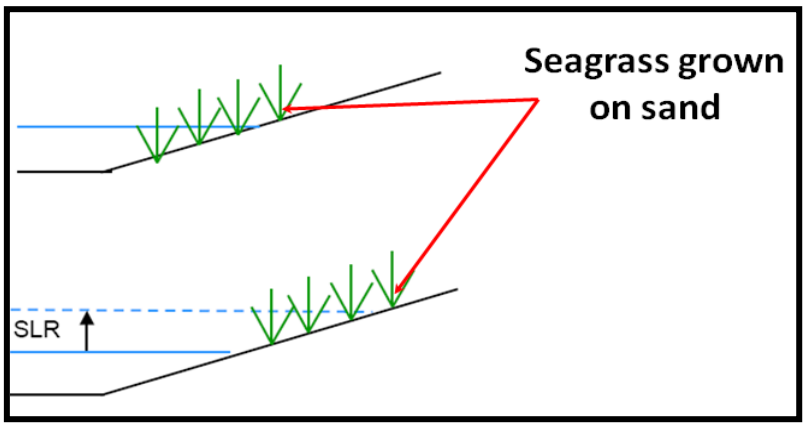

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Figure 1: Where hard defences are not present, sor they will migrate upwards and landwards with SLR (modified from Linham & Nicholls, 2010)

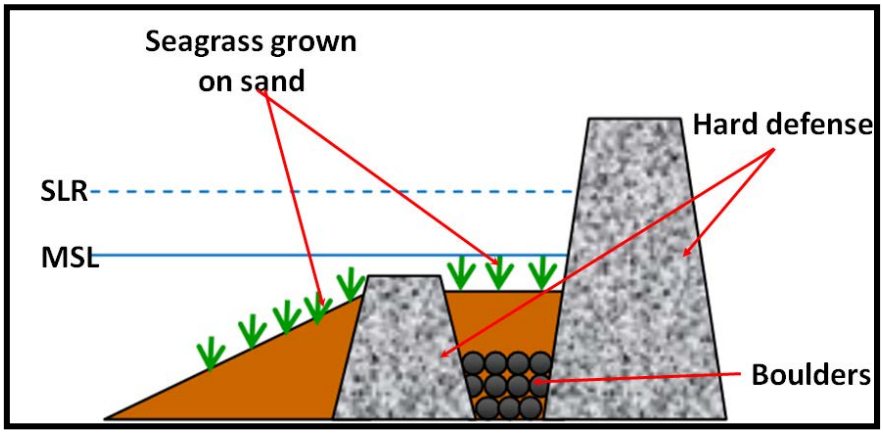

Figure2: establishment of seagrass beds as a soft defense or together with hard defense

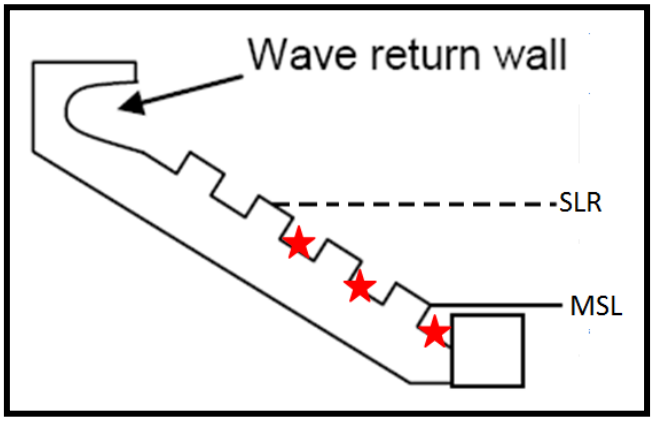

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Figure 3: Modified drawing of a sea wall with a structure that helps the return of the waves could be used as a hard substratum to establish seagrass transplants

(Source: Adopted from *French, 2001).* *- Places suitable to establish seagrass plots. MSL- Mean sea level; SLR- Water level at sea level rise*

2.1 Institutional/ organisational requirements

Facilities for snorkeling and facilities for maintain seagrass nursaries in cement tanks should be provided to academic and research institutions and also to local societies and hoteliers who are involved in conservation and management of sea grass beds and with hotels located in the vicinity of the sites selected within the existing seagrass beds that needs restoration and transplanting of corals.

CCD should take necessary action to implement the necessary programme at experimental basis on selected sites

3 Operations and maintenance

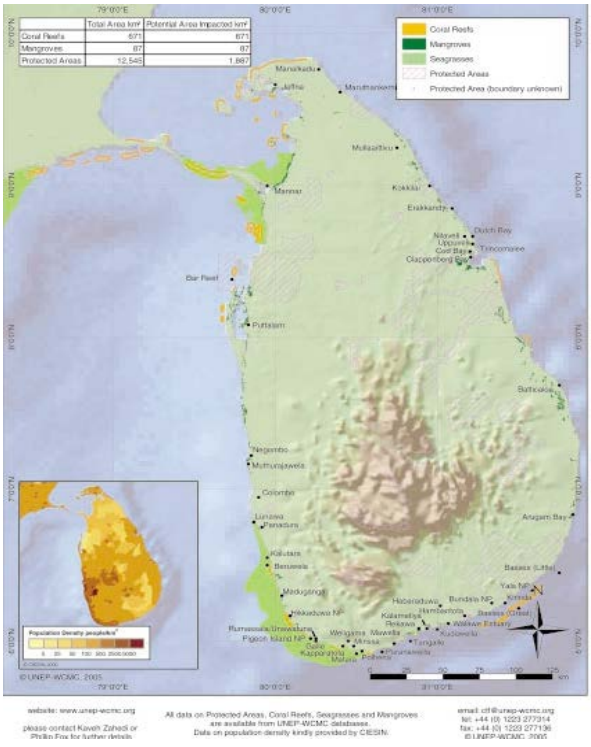
3.1 Endorsement by experts

Seagrass replanting is a technology accepted worldwide for prevention of coastal erosion and for ecosystem restoration

3.2 Adequacy for current climate

Seagrass beds are seen on the coastal belt near Mannar and they were abundant within the shallow coastal waters off Manar in the North Western Province and in the southern & South-western province of Sri Lanka (Plate 3

Figure 4: Map of Sri Lanka indicating the locations of Sri Grass beds.



(http://www.unep.org/tsunami/reports/tsunami_srilanka_layout.pdf)

Seagrasses are continuously subjected to the inflowing and outflowing of the tides, and to avoid being washed away the seagrass has a root system and stems. The roots help in stabilising the seabed against powerful water currents. Ability of sea grass beds for survival after a tsunami was evident within the sea grass beds off Weligama, Sri Lanka (Plate 2).

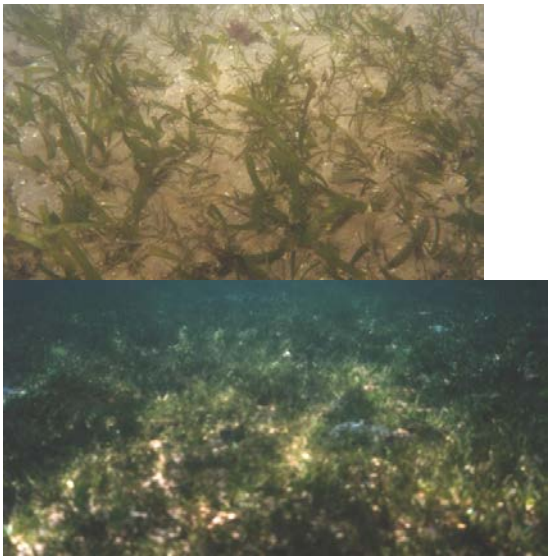


Plate 2: *Sea grass bed in Weligama before tsunami in December 2004 (left) and few days after tsunami (right). (Photographed by P.B.T.P. Kumara)*

3.3 Size of the beneficiary group

Coastal communities living close to the coastal belt, who are having a risk of losing their properties due to coastal erosion as a result of wave action and storm surge and due to coastal inundation as a result of sea level rise. Fisher communities also could be considered as indirect beneficiaries as the seagrass beds provides breeding sites for marine fish and provide refuge to both larval and adult stages. In order to quantify the numbers of beneficiaries detailed surveys should be carried out with respect to the coastal communities associated with coastal belts rich in seagrass beds. Location of the seagrass beds are given in figure 4.

4 Costs

4.1Cost to implement adaptation options

Costs up to the Phase 4 will be given herein because the area to be included for the Phase 5 will be decided on the success of the project up to phase 4

Activity	cost	
	Unit cost (US $)	Total cost (US $)
Field surveys to decide the suitable sites (duration 6 months)		10,000
Training workshops 10 Nos	3,000	30,000

Material for replanting 10 sites of 1 ha (100,000m²)	40	4,000,000
Allowances for persons (10) involved in trasplanting and taking care of the transplants for 1.5 year		40,000
Transport & other miscellaneous costs		6,000
Contingencies		4,286,000/10ha/2 yrs
Total cost	21.43/m²	214,300/ha/yr

4.1 Additional costs to implement adaptation option, compared to "business as usual"

This technology could be coupled with the construction of hard defenses such as sea walls and dykes as shown in Figure 2 and in such occasions cost for hard structures also should be taken in to consideration.

To receive maximum benefits from this technology, sensitivity on the importance of seagrass beds as a ecosystem as a food resource and a shelter for economically important fish resources, etc. should be improved among all stakeholdes living along the coastal belt. Therefore awareness among coastal communities, school children, hoteliers, industrialists, should be improved. Thus there is a need for conducting awareness programmes whenever necessary.

5 Development impacts , indirect benefits

5.1 Economic benefits

- **Employment**

This project will provide employment opportunities to person involved in coastal construction sector, coastal zone management sector, etc.

Persons employed in coral transplanting could be used for this matter.

- **Investment :**
  - Income to fisher communities due to improvement of coastal fish stocks
  - Seagrasses could be used as a fodder for fish bred in captivity for food and ornamental purposes

5.2 Social benefits :

- **Income**

26.1.1.1.1.1 Increase the income of fisher communities due to proper management of seagrass beds which are feeding, breeding and hiding grounds for certain food fish (fin-fish, shellfish, sea cucumber, etc.)

26.1.1.1.1.2 Improvement of economy as the expenditure on repairing the damages caused to their properties due to coastal erosion is reduced.

26.1.1.1.1.3 Socioeconomic status of coastal communities due to reduced risk of coastal inundation and erosion

26.1.1.1.1.4 Increased income to persons involved in coastal resource management.

- **Education**
  - Improvement of awareness on the importance of conservation, management and restoration of seagrass beds
  - Improvement of scientific knowledge on the sensitivity and ecological importance of seagrass beds.
  - Adaptation to natural phenomena by scientifically maneuvering the natural coastal ecosystems
  - Knowledge on the establishment of artificial structures within the coastal belt, with least impacts on sensitive ecosystems
  - Development of new technologies for restoration of seagrass beds and for utilization of seagrasses for other economic activities
  - Engagement in fishery activities without harming seagrass beds
- **Health**
  1. Improved security of coastal dwellings will naturally improve the health condition of coastal communities
  2. Proper management of coastal ecosystems by controlling harmful anthropogenic activities such as pollution, coral mining, illegal fishing, etc., to protect the reefs, will provide the coastal communities a healthy atomosphere
  3. Due to improved income due to proper management of seagrass beds and hence the coastal fish stocks, economy of coastal communities (especially of fisher communities) will improve, resulting them a more prosperous and a healthy life.

5.3 Environmental benefits

- Restoration of seagrass beds through replanting will form a more effective barrier with respect to wave action, inundation, erosion, etc. will stabilize the coastal belt, which will reduce the negative impacts to coast from natural phenomena.
- Provision of shelter for organisms living in association with the sea grass beds will improve the stability ecosystems and also will improve the biodiversity
- Utilisation of CO_2 for photo synthesis by sea grasses will CO_2 concentration in coastal habitats, reducing its impacts on global warming

6 Local context

6.1 Opportunities & Barriers

- **Opportunities**
  - For coastal scientists, coastal engineers and coastal zone managers will get a very good opportunity to use their knowledge and experience to find solutions for global warming and for sustainable management of coastal resources & coastal ecosystems to be adapted for climate change
  - Coastal resource utilisers and those who were involved in destructive activities harmful to coastal ecosystems will get an opportunity to obtain a training to sustainably manage the coastal resources for their own benefit.
  - Academics and researchers will get an opportunity to conduct useful scientific research to reduce the impacts of climate change to coastal ecosystems and communities
  - Sri Lanka will get an opportunity to make possible contributions to find solutions for local regional and global problems that may faced due to climate change.

- **Barriers**
  - Cost incurred on coastal constructions, for planting, training personnel and to provide security to restored seagrass beds and to other associated artificial structures against harmful anthropogenic activities
  - Release of pollutants and nutrients from land based activities and industries.
    Lack of or insufficient political commitment for coastal resource conservation and management.
  - Low inputs by the government on coastal & marine science education, due to ignorance of the importance of marine science education and the cost incurred.
  - Insufficient or lack of motivation and knowledge of the coastal & marine resource utilisers on the importance of sensitive coastal marine ecosystems and their sustainable utilization.
  - Reluctance of older generation of the coastal communities to acquire new knowledge and to accept that certain practices adopted by them for fishing and other socio economic activities could cause serious threats to sensitive coastal ecosystems and their biodiversity.

6.2 Status

Technology for replanting seagrasses have been successfully implemented in other countries and a group of scientists led by Dr. P.B.T.P. Kumara (Dept. of Oceanography & Marine Geology, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna has initiated research related to management of seagrass beds. Such technologies should be adopted in a larger scale at other sites with sea grass beds independently and in combination with hard defense technology

6.3 Time frame

Activity	Year 1 divided to 4 quarters				Year 2 divided to 4 quarters			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Survey for selection of sites	X							
Awareness/training		X						
Preparation of sea-grasses for replanting			X					
Planting/monitoring			X	X				
Sea-grass plots coupled with hard defense structures				X				
Monitoring					X	X		
If successful adoption to a wider area						X	X	
Evaluation of success				X		X		X

6.4 Acceptability to local stake holders:

- Younger generations with secondary & tertiary education have assisted the University staff and undergraduates to conduct research in sea grass beds
- Pilot project should be carried out with thecommunity participation prior to expending the programme to a larger area to find the acceptability.

7 References

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[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment Reports For Climate Change Adaptation – Sir Lanka. You can access the complete report from the TNA project website http://tech-action.org/**