

**Table 4.5: Proposed measures for Restoration of coral reefs**

No	Recommended Measures
1.	(i) Attract project soecific funding from local & foreign sources, NGOs etc., (ii) Introduce eco-friendly activities having potential for financial gains.
2.	(i) Establish community participatory organizations in the vicinity of coral reefs to monitor the development programmes, ensure sustainability of coral reefs and to help mitigation practices; (ii) Appoint competent committees to review the IEE & EIA
3.	Improve stakeholder awareness on the impacts of unsustainable economic activities related to reefs and non-extractive uses of coral reefs and promote eco friendly activities.
4.	Implementation of river basin management programs and regulate land use practices to reduce sedimentation due to agriculture, mining and other modes of erosion.
5.	Provide adequate training to members of stakeholder groups and line ministries and use them as leaders for implementation of the respective restoration programs and as trainers to train others
6.	(i) Formulate development plans with stakeholder consultations; (ii) Conduct regular monitoring programmes by involving stakeholders trained to be alert about natural phenomena,

## 4.2 Action Plan for Technology 1: Rehabilitation of Sand Dunes

### 4.2.1 Description of the Technology

Natural sand barriers with their vegetation could be used as soft barriers as an adaptation against coastal erosion and inundation due to climate change induced sea level rise. Wherever they have been removed for anthropogenic activities, their rehabilitation need to be done by replanting dune vegetation. Propagation of plants could be done by using seeds or tissue culture techniques.

Facilities to collect seeds of *Pandanus* and other dune plants with economic or medicinal value and to establish nurseries to raise the required number of propagules should be provided at academic or research institutes or at community centres established for this purpose. In areas where dune sand has been removed for anthropogenic activities, such as construction work, replanting could be carried out after beach nourishment to improve the quality of the substratum to speed up the establishment of dune vegetation. In addition to replanting of *Pandanus* spp., other dune plant species should be introduced to the same area or allow natural regeneration over time with the improvement of environmental conditions upon replanting *Pandanus* sp. Terraced plantations should be introduced.

*Pandanus* plantations are widely practiced in Pacific islands and it has been accepted by the local communities due to its economic value. The successful post tsunami rehabilitation programs appear to suffer due to the lack of maintenance in view of inadequate government patronage to promote such projects. If the funding is made available, this project will be a feasible one and would provide opportunities for cottage industries based on *Pandanus* leaves.

Plant species that grow on dune sand are abundant in Sri Lanka and scientifically organised terraced plantations would not only provide protection to the coastal sand dunes against coastal erosion, storm surge, tsunami and other harmful coastal activities, but it will also provide alternative income sources for coastal communities and will improve the aesthety of the sandy beaches. It will also provide nesting sites to turtles and sea birds, which would attract nature lovers and local and foreign tourists. Coastal communities living in the vicinity of sand dunes in the North, North-western, South-eastern and Eastern coastal belts would be the potential beneficiaries of this technology.

It will provide a protection from coastal erosion and also will act as a wind belt in areas where strong winds persist. In addition, *Pandanus* plant and other plants of economic and medicinal value will provide an alternative income source for coastal communities. Improved soil conditions due to rehabilitation would facilitate natural regeneration of plant communities while improving their biodiversity.

#### **4.2.2 Target for Technology Transfer**

The initial target for the technology is 20 ha within a period of 7 years. The activity schedule for rehabilitation of sand dunes is summarised below.

- Identification and demarcation of 10 suitable sites each having approximately 2 ha
- Conduct awareness programs
- Train 100 persons selected from 10 sites
- Establish dune plant nurseries
- Re-planting of dunes and select best sites for maintaining plantations
- Commence establishment of Small and Medium Industries (SMEs) in successful sites
- Select the most suitable sites to re-establish dune vegetation and expand the area up to 50 ha by 3<sup>rd</sup> quarter of the sixth year. The total period involved will be 7 years.

### 4.2.3 Barriers to Technologies diffusion

Ten (10) key barriers comprised of one (01) economic & financial, two (02) policy, legal & regulatory, one (01) network failures, one (01) institutional & organizational capacity, one (01) human skills, one (01) social, cultural & behavioural, one (01) information & awareness and, one (01) technical and one (01) “Other” have been identified.

The list of key barriers and hierarchy classification is given in table 4.6.

**Table 4.6: List of key barriers and hierarchy classification for the technology 1**

<b>Technology Name: Rehabilitation of Sand Dunes</b>			
<b>No.</b>	<b>Key Barriers Identified</b>	<b>Priority Rank (1-5)</b>	<b>Category of Barriers</b>
1.	Inadequate funds for restoration of sand dunes through natural beach nourishment and planting of dune vegetation and to conduct awareness programs	2	Economic and financial
2.	Poor enforcement of coastal zone management regulations	1	Policy, legal & regulatory
3.	Low priority given for funding for environmental protection and R&D under the existing financial policy	3	Policy, legal & regulatory
4.	Inadequate inter agency coordination among relevant government agencies	3	Network failures
5.	Inadequate opportunities for research	5	Institutional & organisational capacity
6.	Inadequate trained personnel / experts to provide knowledge on technologies used	4	Human Skills
7.	Lack of commitment by the coastal communities & industries to protect existing sand dunes and rehabilitation due to difficulty in giving up destructive coastal resources based livelihood activities	5	Social, cultural & behavioural
8.	General lack of awareness on the non extractive uses/importance, role and functions of coastal	2	Information and Awareness

	sand dunes for national development and protection of the environment, at all levels of the society		
9.	Lack of knowledge on technologies adopted for sustainable utilisation of dune vegetation	3	Technical
10.	Negative impacts of extracting sand for construction industries	5	Other barriers

#### 4.2.4 Proposed Action Plans for Rehabilitation of Sand Dunes

The Proposed Action Plan for Rehabilitation of Sand Dunes is provided in table 4.7.

## COASTAL SECTOR

### Action plans for Rehabilitation of Sand Dunes

**Table 4.7: Proposed Action plans for Rehabilitation of sand dunes**

<b>Measure/Action 1:</b> Provide annual funding from the Government, based on suitably justified proposals submitted by relevant line Ministries/Departments and by NGOs & INGOs who are actively involved in adaptation procedures for climate change and on conservation of ecosystems & biodiversity.					
<b>Justification for the action:</b> Inadequate funds for rehabilitation of sand dunes by beach nourishment and planting of dune vegetation and to conduct awareness programs					
Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Provide funding for implementation of sand dune rehabilitation activities.	High	Coast Conservation Department (CCD)	0-7 year	Domestic US \$ 50,000	Availability of funding with effect from end of year 1 to year 7
<b>Measure/Action 2:</b> Conduct awareness programmes to all stakeholders of the coastal regions on existing policies, rules & regulations, socioeconomic importance of sand dune ecosystems and their non-extractive uses					
<b>Justification for the action:</b> General lack of awareness on the socioeconomic importance of sand dunes and its vegetation and the non-extractive uses of sand dune resources at all levels of the society					
Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Conduct awareness workshops					

<b>a)</b> Awareness programmes to all stake holders on socio-economic benefits of sand dune ecosystems and its vegetation and on technologies involved in propagation and maintenance of dune plantations.	V. High	Coast Conservation Department (CCD)	0-2 years	Domestic & International US \$ 21,000	- Improved awareness among all stakeholders on sand dunes within 2 years
<b>b)</b> Awareness workshops to members of the Police department, Navy and Coast Guard on the importance of protecting sand dune ecosystems from illegal and destructive activities.	V. High	Coast Conservation Department (CCD)	0-2. years	Domestic & International US \$ 6,000	- At least 50% reduction of reported sand dune ecosystem destructive activities by the end of 2 years
<b>c)</b> Training workshops on ecotourism to unemployed youth.	High	CCD/ Tourist Board/ Coast Guard	1 to 3 years	Domestic & International US \$ 12,000	- 100- 200 Trained tour guides to be involved in eco-tourism from 2-4 years.
<b>d)</b> Awareness workshops to coastal tourist hotel owners, on conservation & management of sand dunes, establishment of nature trails in dune vegetation.	High	CCD/ Tourist Board/ Tourist hotel owners	1.5-3.0 Years	D & I US \$ 6,000	- Over 60-80% of coastal tourist hotels involve in conservation of sand dunes & establishment of nature trails by end of year 3.
<b>e)</b> Training workshops on identification of suitable dune plants of economic & medicinal importance for replanting, tissue culture techniques to produce propagules.	High	M/Agricultural Development, M/ Indigenous medicine, CCD,	1 to 3 years	US \$ 120,000	- 100- 200 trained persons for identification of suitable dune plants and on tissue culture techniques by 2 to 4 years
<b>f)</b> Awareness/training programmes on use of alternatives for dune sand in construction industry	High	ICTAD & CCD	0.5-1.5 Years	D & I US\$ 6,000	- 25%to 90% reduction in usage of dune sand for construction work (from 2- 7 years)

**Measure/Action 3:** I. Encourage plantations of dune vegetations of economic and medicinal importance; II. Establish SMEs and provision of incentives to trained

persons to establish SMEs; **III.** Conduct feasibility studies for introduction of exotic species of *Pandanus* spp. of economic importance.

**Justification for the action:** General lack of awareness on the non extractive uses/importance role and functions of coastal sand dunes; Lack of knowledge on technologies adopted for sustainable utilisation of dune vegetation

Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Establishment of Tissue culture laboratories & nurseries for propagation of plants for dune re-plantatings & herbal gardens.	High	Universities, Agrarian research institutes,	1-3 years	D & I US \$ 600,000	- Establishment of 2 tissue culture laboratories at research/higher educational institutes by 2 <sup>nd</sup> year. - Establishment of 10 nurseries and 10 Dune plantations/herbal gardens of economic/medicinal importance by 2-4 years
II. Establish SMEs and provision of incentives to trained persons to establish SMEs	High	Indigenous medicine, M/ Industrial Development,	1.5 -4.0 years	D & I \$200,000	- Establishment of 10 dune vegetation related SMEs by 2.5 years.
III. Conduct feasibility studies for introduction of exotic <i>Pandanus</i> spp. of economic importance.	High	Universities/ Agrarian research institute	1.5-2.5 years	D & I US \$ 50,000	- Suitable exotic <i>Pandanus</i> spp of economic importance are identified by the end of 2 years

**Measure/Action 4:** (I) Development of multidisciplinary projects in collaboration with research/academic institutions, identify strategies to develop and improve fruitful collaborations, identify problems within the locations with sand dunes and prepare activity plans to overcome the problems to reach development goals

**Justification for the action:** Inadequate inter agency coordination

Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Preparation of R & D projects/plans in collaboration with government agencies having responsibilities for activities in the coastal areas.	Medium	National Science Foundation (NSF)	Every 3- 5 years	D US \$ 35000 (Funding for projects are not included)	- Approval of funding for at least 3 project proposals once in every 3 years.
II. Conduct regular consultations with relevant institutions for identification of specific and important problems for implementation of collaborative activities related to conservation & sustainable management of dune ecosystems.	Medium	Provincial councils. M/Environment	0-2	D US \$ 24,000	- Development of fruitful collaborations among relevant institutions from 2 years
<b>Measure/Action 5:</b> Train and retain adequate number of staff and prepare a bibliography of available trained personnel					
<b>Justification for the action:</b> Inadequate trained personnel/experts to conduct awareness programmes and to provide knowledge on technologies used for dune rehabilitation and related activities					
Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Allocation of funds for training by line ministries	Medium	- M/Environment - Ministry/Science & Technology - M/Higher education	0-5 Years	D & I 500,000* (*This has not been included in	- 5 to 10 trained personnel in each of the institutions under three line ministries to serve as trainers within 2-5 years .



II. Develop strategies to retain trained Persons (e.g. obligatory service based on bond agreements)	Medium	M/Environment; M/Agricultural dev; M/Higher ed;	No time limits	the initial budget)	- Retention of at least 5 trainers in each of the relevant institutions after 7 years.
III. Preparation of a bibliography of trained persons in relevant fields,	Medium	NSF/ Centre for Agrarian Research policy(CARP)	0-0.1 Years	D US \$ 5,000	- Database & a bibliography of experts and their research out puts prepared after 1 year

**Measure/Action 6:** Form a committed group of catalysts selected from the coastal communities, provide alternative sources of income or employment within the same region to those involved in destructive activities; Government agencies to develop suitable strategies for better understanding and appreciation of NGOs involved in community participatory programmes.

**Justification for the action:** Lack of commitment by the coastal communities and industries to protect existing sand dunes and to rehabilitate disturbed sand dunes due to difficulty in giving up livelihood activities based on destructive coastal activities.

Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Form community based organisations to be involved in sand dune rehabilitation programmes	Medium	Communities within the area/ CCD/NGOs	0-2 Years	D & I US \$ 5,000	- Effective conservation and management of dune ecosystems through community participation after 1.5 years.
II. Provide employment to persons involved in destructive activities (Tourism, SMEs, etc.)	Medium	CCD/M/Environment/NGOs	1 -6 Years	D & I US \$ 150,000	- 50% reduction of dune destructive activities after 3 years and 90% reduction by 7 <sup>th</sup> year
III. Development of community participatory programmes by government institutions in collaboration with NGOs	Medium	CCD/NGOs	0-7 years	D & I US \$ 450,000	- Establishment of at least 10 community participatory socioeconomic programmes by the end of 7 years.

<b>Measure/Action 6:</b> Encourage off-shore sand extraction for building construction; II. Popularise construction technologies, not involving coastal sand					
<b>Justification for the action:</b> Use of dune sand for construction work. Action is to minimize the use of dune sand for construction work.					
Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Encourage extraction of off shore sand for construction purposes	High	NBRO/Land Reclamation & Development Corporation (SLLRDC)	0-3.0 Years	US \$ 5,000 D & I	- 25% reduction of removal of sand from dunes and coastal belt close to sand dunes after 0.5 years and 90% reduction by 7 years.
<b>Measure/Action 9:</b> Build capacity at R & D institutions to handle research related to environmental protection, conservation & management, by incorporating this need in the corporate plan					
<b>Justification for the action:</b> Inadequate opportunities for research activities related to sand dune rehabilitation					
Action /Sub Action	Priority Rank	Responsibility for Implementation	Time Frame	Cost (US\$) & Funding	Indicators
I. Improve infrastructure facilities at R & D institutions and Higher Educational Institutions and develop R&D plans to including required research activities	Medium	- M/Technology & Research - M/Higher Education	0.5-5.0 years	D & I \$ 150,000/ year to each institution	- Required infrastructure facilities available at R & D and Higher Educational Institutions within 5 years.
<b>Total Cost of Technology 1:</b>				<b>US \$ 2.395 million</b>	

V. High = Very High; D – Domestic; I – International; CCD - Coast Conservation Department; ICTAD - Institute of Construction Training and Development; SLLRDC - Land Reclamation & Development Corporation; NSF – National Science Foundation; CARP - Centre for Agrarian Research Policy; NBR0 – National Building Research Organization; NGOs – Non-governmental Organizations.