Title:	**Breakwater coastal defense technology**
Sector	**Coastal Resources**
Sub-Sector	**Coastal Zone Management**
Technology Characteristics	
Introduction	Enormous concrete blocks and natural boulders are sunk offshore to alter wave direction and to filter the energy of waves and tides. These are offshore breakwaters facilitating the breaking of the waves further offshore and therefore reduce their erosive power. This leads to wider beaches, which absorb the reduced wave energy, protecting infrastructure and property behind.
Technology characteristics/Highlights	Massive concrete blocks and natural boulders are sunk offshore to alter wave direction and to filter the energy of waves and tides. The waves break further offshore and therefore reduce their erosive power. This leads to wider beaches, which absorb the reduced wave energy, protecting cliff and settlements behind. The Dolos which was invented by a South African engineer in East London has replaced the use of enormous concrete blocks because the dolos is much more resistant to wave action and requires less concrete to produce a superior result. Breakwater is designed to dissipate the force of incoming waves by allowing water to flow around rather than against it, and to reduce displacement by allowing a random distribution of tetrapods to mutually interlock.
Institutional and Organization requirements	Monitoring of the coastal environment is the responsibility of the Coastal Working Group at the National Environment Agency. Design, construction and management of coastal defense structures are the responsibilities of the Technical Services Department of the Ministry of Works and Infrastructure Development. At the municipality level, Mayoral offices of Banjul and Kanifing are involved.
Operation and maintenance	Breakwater systems have a life span of 25 to 50 years. Given the natural forces to which breakwaters are constantly subjected, maintenance (and eventually replacement) is an ongoing requirement if they are to provide an effective long-term solution.
Endorsement by experts	Experts at the Ministry of Works, Ministry of Environment, Ministry of Tourism, the National Environment Agency, the municipalities and other stakeholder institutions endorsed the installation of breakwaters around the Senegambia coastal stretch under the GOTG/GEF/UNDP LDCF Coastal project.
Adequacy for current climate	Studies have indicated that the breakwater systems are adequate for current climate and for the projected climate in The Gambia if they are constructed to standard and with most appropriate materials.
Scale/size of beneficiary group	The coast is generally a high-energy, dynamic environment with spatial variations occurring over a wide range of temporal scales. Breakwater systems can be designed and constructed for all the coastal zone of The Gambia but being a sandy coast the systems need to be constructed to greater depths and thu becoming more expensive.
Disadvantages	The advantages of breakwater system include waves breaking further offshore so as to reduce erosive power and they also allow the build up of sand. Disadvantages include inadequacy to handle heavy storms and they are difficult to install.
Capital Costs	
Cost to implement adaptation technology	Typical cost estimate is about £1,900 - 2,000 per m. Water depth may increase the cost.
Adaptational: cost to implement adaptation technology compared to "business-as-usual"	Additional cost may be incurred due to increase in the depth as the coastal zone of the Gambia is sandy in nature.
Development Impacts, direct and indirect benefits	
Direct benefits	Reduces the incident wave energy and thus the erosive power of the waves. Produces accretion of sand on

	the beach.
Indirect benefits	
Reduction of vulnerability to climate change impacts	Reduces soil erosion, lost of beach and infrastructure
Economic benefits: employment, growth and investment	Economic activities and infrastructure are protected and continue to grow including employment. Tourism prospers
Social benefits: Income	Employment is generated and income generating activities are conducted providing stakeholders with financial means of meeting health needs and education for their children
Environmental benefits:	The breakwater systems can be used as habitat by many aquatic species. The installation of the system can also destroy existing habitats.
Local context	
Opportunities and Barriers	When constructed well and out of materials which can withstand the force of ongoing wave energy, breakwater systems can be a successful way to control coastal erosion by reducing the incident wave energy on shoreline.
Market potential	Business entities can be engaged in procurement of materials required in the construction and maintenance of breakwater systems.
Status	A feasibility study under the GOTG/GEF/UNDP LDCF NAPA project on the coastal zone has concluded on the viability of the technology in reduction of erosion on the shoreline.
Timeframe	Construction can be fast if all the required materials are available on site. Breakwater systems can survive 25 years or more with regular monitoring and maintenance.
Acceptability to local stakeholders	The installation of breakwater systems is acceptable to stakeholders as the structure protects their property and livelihoods from erosion and floods. However, the structure must be visible and be properly spaced to protect fishing boats during operations.

Images of Offshore Breakwater systems