Kiribati National Coastal Policy - 2016

Building Coastal Resilience and Security

Promote and safeguard the natural protective shorelines of Kiribati to reduce coastal vulnerability and ensure long term coastal security for the people of Kiribati.
Origin of the Kiribati National Coastal Policy

KIRIBATI ADAPTATION PROGRAM PHASE III (KAP III)

Preparation of a National Coastal Policy and Management Framework

This work was implemented under the Kiribati Adaptation Project Phase III (Office of the President) and sponsored by the Ministry of Environment, Lands and Agricultural Development, Environment and Conservation Division.

The key stakeholder Government Ministries and Authorities involved in the review and formulation of this document were the Kiribati Adaptation Project Phase III (KAP III); Office of the President (OB); Ministry of Environment, Lands and Agricultural Development (MELAD); Ministry of Fisheries and Marine Resource Development (MFMRD); Ministry of Public Works and Utilities (MPWU). These key Ministries and Divisions also comprise the Foreshore Management Committee (FMC) which come together as a multi-disciplinary team to assess issues of coastal management and coastal development.

Numerous informal discussions and communications in respect to this work were undertaken and three main formal milestone review and feedback sessions were also completed; Inception Report, Rapid Baseline Situation Assessment and the review of the draft version of this policy. This final document reflects the findings and review feedback and comments received in respect to these preceding reports and stakeholder meetings.

The final draft was accepted by the stakeholder group and recommended for Cabinet approval on the XX XXXXX, 2016.

This document, its preceding reports and presentations developed for stakeholder engagement were written and compiled by

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Introduction

Every part of the natural, built or human environment in Kiribati is coastal; our climate, the land we live on, the water in our wells and the soils which sustain our crops and forests, indeed all of the resources we use, are formed, sustained or influenced by past and ongoing coastal processes.

Kiribati is an atoll nation and developing a coastal policy requires a different approach to accepted or conventional coastal policy. Conventional coastal policy usually defines the coastal zone as a distinct environmental zone between deep water areas and true terrestrial environment. Under these circumstances coastal policy is defined by geographical boundaries and then seeks to address a complete and complex range of ecological, human development and resource use needs within that zone.

On atolls every part of the human environment from the submerged reefs and lagoons through to the tallest coconut palms or buildings is part of the coastal zone. It is important at the outset to make this distinction because Kiribati has already undertaken significant work to develop policy, management and planning guidelines in respect to many ecological, development and resource sectors.

This coastal policy recognises an important gap in existing resource management regimes; the foreshore or shoreline system. By concentrating on shorelines it provides an important opportunity to fill this strategic gap at a time when the importance of shoreline security is becoming an urgent priority. Focusing on shoreline systems also avoids duplicating existing policy and management frameworks which cover a broad range of other aspects of coastal development or resources; e.g. coastal fisheries, agriculture, land use planning, etc.

Like all policy this work will aim to manage human use of the foreshore environment and resources. It also considers the need for a new strategic approach to the long term challenges of sea level rise and climate change. Foreshores are at the front line of such impacts and achieving long term shoreline security will require a significant shift in conventional efforts.

This policy seeks to protect and maintain natural shoreline processes where this measure may provide a reasonable expectation of coastal security. Such approaches are envisaged as mostly targeting the outer islands of Kiribati, where shoreline systems are intact.

On Kiribati’s disturbed urban shorelines, namely and most urgently on the nation’s capital South Tarawa. Severe issues of population pressure, unplanned development, unrestricted resource use and ad hoc shoreline engineering warrant a new approach. This situation threatens imminent widespread exposure to marine hazards and urgent measures are required if we are to avoid significant human suffering and damage to property and infrastructure.
Kiribati’s Natural Shores

Shores are the meeting point between land and sea, they include the intertidal zone or the area between the lowest tide and the highest tide and include the reach of storm waves.

Three main shoreline environments;

The ocean-side shores; these are usually higher (often associated with the highest land on the island) because they have been built by the greatest wave energy. They often have hard reef platforms in front of them which dry at low tide and beyond the hard platform are living reef edges which break up wave energy before it reaches the beach. Ocean-side beaches are usually comprised of rubble and gravel where wave energy is greatest but can also be sandy where the reef platform is wide and reduces wave energy. They often have rocky outcrops (beach rock) which form solid hard barriers to waves and results in a stable shoreline position.

The lagoon-side shores; these shores are usually lower than the ocean side but higher than land in the middle of the islands. This is because wave energy in the lagoon is usually less than on the ocean side of the island. These shores are usually sandy or muddy and

where sheltered often have fringing mangroves and ironwood (te ngia) stands. On many islands lagoon shores have wide muddy reef flats in front of them which dry at low tide and gradually dip below sea level into the lagoon basin. These flats often have seagrass and are alive with burrowing organisms and have always been a rich source of shell fish and other food.

Intertidal channels; these are channels between the ocean and the lagoon which fill and empty on every tide. Such channels provide a unique environment in Kiribati, they often have strong currents and can be rich with transiting marine life, a feature which has made them a popular location for settlement. These channels form a crucial link between ocean and lagoon flushing lagoon waters and carrying sand and gravel from the oceanside reefs (where the greatest volumes of sand are produced) to the lagoon side shores. In terms of shoreline processes and the supply of sand, intertidal channels are often extremely important. It follows that when human development priorities lead to causeways being built, long term shoreline instability follows. The lagoon shore in particular often becomes erosive when this sediment supply is blocked by causeways.
Living Reef Mediated Shores

All of Kiribati’s shores are reef mediated shores, meaning they are protected by living reefs and are also built from once living reef material. These shores also require uninterrupted physical processes (wind, waves and currents) to maintain water conditions which coral reefs require for growth and to transport reef debris (sediment) to and from the beach.

Change in any part of this system will result in changes in the way sediment (sand, gravel and rubble) is produced, and/or moves to our shores. Such changes can be natural (e.g. storms or seasonal) or man made (such as beach mining) and all such changes lead to shoreline instability.

When deep ocean waves meet the island the living reef crest controls the way wave energy can pass over the reef edge and travel to the beach. This crest is usually a reddish colour when exposed at low tide as it is covered in a living blanket of red algae. This algae binds the reef edge together and can gradually grow upwards if broken by waves or if sea levels change.

Wind, waves and currents transport sediment which breaks away from reef edge. Different seasons (e.g. El Nino / La Nina) can change wind and wave conditions and in turn this may increase or reduce the way sand arrives on our beaches. Storms may also rapidly change our shores, sometimes by removing sand or gravel and sometimes they deposit large amounts of new material. Many islands likely started their existence from a deposit of coral rubble from a storm.

Our living reef mediated shores are maintained by this mixture of biological, chemical and physical processes and they all continually change through time. If the reef crest remains healthy; and corals and other organisms continue to grow and supply sand, gravel and rubble; and wind / wave conditions remain advantageous, our beaches and islands will continue to build and be more resilient to ocean waves.

When sand arrives on a beach it does not remain stationary. Tides and waves wash it along the beach similar to a moving conveyor belt; sand arrives on the beach from the reef and is then continuously transported along the beach. This process (long-shore transport) can speed up, slow down and sometimes even reverse during storms or seasonal change. This continually changes the shape of our soft beaches.

When beach sand is mined or alternatively if seawalls, channels or causeways trap sand and prevent it moving along the beach, the natural pattern of beach building will change. Locations “downstream” will be starved of sand causing erosion.

In Kiribati everybody is dependant on functional shores for protection. In the case of shoreline processes, negative actions, even by a single landowner can impact the wellbeing of many others living downstream. The connectivity between beaches is a fundamental concept in coastal management. Like water resources, shorelines must be managed as a common community good or environmental service; individual negative actions of a few can not be allowed to impact the livelihoods or wellbeing of the entire community.
Shores are at the front line of exposure to marine hazards such as storms and wave impacts. However, shores are also formed from these very same processes. Kiribati’s shores if undisturbed can naturally build and protect from marine flooding and erosion and where shoreline systems are intact and undisturbed by direct human impacts, they are still providing good protection from marine hazards. Whereas where shores are degraded through human intervention, communities are becoming exposed to coastal hazards and their resilience to climate change is reduced.

In the greater majority of Kiribati’s outer islands excellent functional natural shoreline systems persist and these shores continue to provide good protection. However, today over half the population of Kiribati lives in conditions of imminent coastal vulnerability on the national capital. South Tarawa has no undisturbed shores left and many are so damaged they are no longer able to give adequate protection from expected marine hazards such as high spring tides.

The stark difference between urban South Tarawa and rural outer island foreshore conditions is the result of direct human use and impacts, including; rapidly expanding and unplanned settlement patterns, unrestricted beach mining, uncontrolled shoreline engineering and of great concern is the level of chronic ongoing mining of the oceanside shoreline and berm systems including beach rock platforms. These are the last line of defence and should never be disturbed.

It is important to recognise the origins of such threats since direct human impacts can be reduced and controlled through community awareness and well-designed and enforced management regimes.

Kiribati’s reefs, shores and islands are also directly threatened by climate change and sea level rise. Even though measurable impacts are difficult to isolate at this time. It is for example known that Kiribati’s reefs are being impacted by regional sea surface temperature increases. Ongoing increases in temperatures resulted in the third ever recorded global coral bleaching event (2015 / 2016) and reefs in Kiribati have been impacted. Ocean acidification is also occurring and whilst its effects on Kiribati’s reefs are not well understood they are expected to also be negative.

Local and global measured sea level rise also continues and projections show a minimum increase in the vicinity of 0.7m expected by the year 2100. It is also important to note that eventual heights beyond 2100 will almost certainly be greater but it is impossible at this time to predict a final future sea level peak.

The extent to which Kiribati’s shores can maintain their natural resilience in the face of such changes is unknown. However, we can confidently say that the relatively pristine shores of the outer islands are better placed to show some level of resilience. Whereas on South Tarawa its deeply degraded shorelines no longer provide adequate protection and we can not expect any level of future natural resilience in the face of sea level rise on South Tarawa.
Urban Coastal Security

Coastal systems in South Tarawa have become dangerously degraded and an urgent shift in approach and thinking in respect to South Tarawa’s coastal resources, systems and management is required. A business as usual approach to coastal management in South Tarawa will, within easily foreseeable timeframes (within the next 10 years), result in significant human suffering and property and infrastructure damage through marine flooding.

Rural Coastal Resilience

Rural locations still largely have healthy, functional shoreline systems. However, active support and implementation of existing appropriate coastal strategies and policy is needed. These are designed to promote and protect natural resilience in shoreline systems. Existing precautionary management concepts are appropriate in Kiribati’s rural outer islands but adequate technical capacity to implement and support local council decision making and planning is absent.

There is now a large contrast between the needs of our rural settlements and urban locations, namely South Tarawa, and different policy approaches must be developed. Much of the pre-existing coastal management guidance and policy material available remains entirely appropriate for the management of outer island shores. This is because there is still excellent opportunity to provide better support for decision making and planning on the outer islands and to support local councils to preserve the natural integrity of their shoreline systems to retain their protective function. However, at this time there is neither the resources or technical capacity to provide such support. Government authorities tend to concentrate efforts in South Tarawa where coastal hazards are continually threatening infrastructure, property and livelihoods. These reactionary, piece-meal measures are being implemented to attempt to stabilise shoreline position but are seldom subject to technical assessment, design or adequate construction standards and in the face of long term climate change and sea level rise none can provide long term coastal security. Existing coastal policy which seeks management objectives to preserve the natural integrity of the shoreline system, whilst sound on the outer islands, is no longer an achievable objective in South Tarawa. South Tarawa shores are in such a state of degradation that damage is now irreversible, we must implement strategies of remedial action and rehabilitation urgently. Seeking to reinstate natural shoreline processes in South Tarawa as the policy response is simply dangerous, as it will not address the growing issues of marine hazard exposure.

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Irrespective of it’s intent or quality, at this time it is not possible to implement effective coastal policy in Kiribati. A large number of coastal guidelines, advisory documents and policy relevant material already exists to support improved coastal management in Kiribati. However, due to the fundamental gap in technical capacity and resources to implement such strategies little progress has been made.

The success or otherwise of this policy is likewise conditional on the capacity and resources available to deliver in this sector. A wide range of coastal expertise and sustained level of support will be required to successfully implement earlier and new recommendations made here. Currently what little capacity exists is spread between several Government Ministries (Environment, Lands and Agriculture; Fisheries and Marine Resources Development and Public Works and Utilities), all are overwhelmed by the magnitude and complexity of the issues at hand and none has the capacity or resources to take a lead role in this Sector.

Decision making regarding shoreline development is currently coordinated via an ad hoc group (the Foreshore Management Committee, FMC) which meets on a needs basis. It is comprised from various stakeholder Ministries who juggle commitments. The FMC has no dedicated coastal expertise and it understandable that under these conditions there is little evidence that dedicated coastal technical analysis, design or empirical criteria are the mainstay of coastal development decisions at present.

There can be no mistaking the importance of shoreline integrity to development and community wellbeing in an atoll nation. Add to this the threat of sea level rise and the absence of any single unit or division with technical expertise and resources to deliver sound coastal management become an urgent strategic gap. Without a dedicated coastal group or unit with the technical capacity to assess and develop appropriate solutions to coastal issues or more broadly implement coastal policy and technical guidelines, it is simply unrealistic to expect any tangible improvement in coastal security.

**Development work in South Tarawa including that of international partners presupposes coastal security. The stark reality today is that this is increasingly not the case and large segments of the South Tarawa community now lives in conditions of imminent vulnerability to coastal hazards. Without any dedicated, resourced national technical capacity, this urgent issue simply grows rapidly worse year by year and to a large extent is unrecognised as the single largest strategic gap in development planning, environmental management and vulnerability reduction today.**
The Challenges - Aggregate Mining

Beach Mining

Beach aggregates especially rounded beach gravel from ocean side beaches has been a traditional source of flooring for local houses and maneaba for millennia, covered with local mats it provides a clean, comfortable and dry living environment. On the outer-islands levels of aggregate mining for such uses, continues but is intermittent and mostly sustainable, causing little or no lasting damage to beach systems.

On urban South Tarawa such traditional uses remain important but the main demand for aggregate today is the production of concrete. Concrete is durable and cheap and in Tarawa’s urban environment housing and urban infrastructure is now heavily reliant on concrete. On average some 85% of concrete’s volume is aggregate, usually sand and gravel bonded with cement powder. Rapid population increase, development and aspirational changes in South Tarawa has meant that demand for concrete building materials and therefor aggregate has vastly outstripped any ability for South Tarawa’s beaches to provide such volumes sustainably.

In 2007, SOPAC estimated some 70,000 m$^3$ of beach aggregate was mined from Tarawa’s beaches annually and such rates were considered “disastrous” by SOPAC coastal scientists. Earlier SOPAC studies dating back to the 1980’s similarly warned that beach mining was unsustainable. In 2016 uncontrolled beach mining continues and is now at catastrophic proportions. Practically every beach on South Tarawa is regularly mined for sand at a household and commercial level and this activity continues mostly unlicensed, uncontrolled and unmonitored. Gravel is a rarer and more valuable resource and areas such as Temaiku’s ocean side coast and increasingly the entire southern ocean side coast of South Tarawa have been unsustainably stripped of gravel resources. Many of these coasts are now erosive and damaged beyond any natural ability for repair. As a direct result many communities along the South Tarawa land mass now face unprecedented exposure to marine wave over topping and flooding threat. At this time beach mining is the single biggest threat to South Tarawa shores.

In 2007 it was recognised that without a viable and affordable alternative, beach mining was impossible to control. In response, the Atinimarawa Company was developed and became operational in 2015. In 2016 beach mining remains widespread and uncontrolled. Current beach mining activity and aspirations for coastal security on South Tarawa are mutually exclusive, these can not coexist. Assuming coastal security is the priority, a moratorium on beach mining must be urgently implemented and use of the sustainably harvested aggregates from Atinimarawa adopted.
Seawalls and reclamation

Sea wall construction for reclamation, protection or causeways has a pre-European history across the Gilbert’s Group of Kiribati. Many village settlements on the outer islands incorporate modest sections of seawall and nearly all have locally constructed causeways linking islets.

On the outer islands traditional builders generally have a good understanding of where their techniques can be successfully deployed and many outer island walls are successful in their intent, even if environmentally poorly advised. This is less true of causeways which often suffer failures during heavy weather. The extension of traditional seawall techniques to exposed passage environments is more a symptom of the proliferation of vehicular transport, than high confidence such techniques were ever appropriate in all environments.

On South Tarawa weak institutions, socio-economic stress and competition for living space has led to the proliferation of poorly advised seawalls. Seawall building and associated reclamation are prescribed activities and are subject to planning, design and environmental approval. However, as with beach mining, there is little capacity or resources to undertake such assessment, monitoring or enforcement and many coastal protection efforts are unauthorised and reflect ad hoc, reactionary measures implemented without adequate design, budget or materials.

The resultant ad hoc protective measures which are built, which often incorporate reclamation to accommodate more development, has led to an untenable situation on South Tarawa. Substandard coastal protection structures proliferate and encourage more near shore development, when these ad hoc structures inevitably fail, ever increasing infrastructure and individual property damage occurs.

A fundamental tool used globally to control near shore development and assist avoidance of unstable or hazardous coastal areas is zoning and set-back criteria. Set-backs and zones control and may even excluded development from locations where coastal hazards are considered too great. Zoning and set backs offer the fundamental opportunity to keep people and assets out of harms way, rather than allowing development to occur in ill advised locations and starting the chain reaction of requests to engineer protective measures.

Significant opportunity still exists in Kiribati to tailor a system of foreshore zoning to reduce vulnerability and prevent the need for reactionary protective measures. Planning approval process must be led by qualified technical expertise and approval criteria must be based in empirically led decision making. This can assist to prevent inappropriate development in highly vulnerable locations and reduce pressure on Government to respond to requests to protect property from coastal hazards in inappropriate vulnerable areas.
Settlement Patterns

Traditionally village sites were selected on land which provided a safe living environment in respect to water supply, coastal hazards, shoreline access, etc. South Tarawa was no exception, even in the 1980’s few if any people lived in areas such as Temaiku basin or former channels, Bikenkoora, or the low-lying areas of Ambo, Bikenibeu or Teoarereke. Likewise, the original villages of South Tarawa were predominantly located on the lagoon shore and the ocean side shore was far less disturbed. This pattern of safer living environments and village placement is still the norm throughout the outer islands of Gilbert’s Group.

There are exceptions, as differing islands offer different levels of exposure and protection for village sites. Additionally, in some cases even where large tracts of undeveloped safe ground exists, communities still opt to shift into dangerously unstable areas e.g. Tebunginako, Abaiang. However these situations are rare on the outer islands.

Today the major exception is South Tarawa and to a limited extent Kiritimati Island. South Tarawa is the national capital and has grown rapidly and now houses over 50% of the national population. Development commensurate with it’s status has also occurred and Tarawa is now seen as the gateway to opportunities for education and employment, as well as access to better communications, medical facilities, etc. As a result urban drift into South Tarawa has accelerated and when combined with high fertility rates, the limited land resources on South Tarawa force people into ever more crowded and marginal living conditions.

In these conditions, issues like coastal hazards are secondary and often ignored in pursuit of the possibility of a foothold on any available land. Marginal areas such as swamps, highly dynamic shores and areas such as Temaiku (which are reclaimed but have never been filled to a suitable height) are prime targets. These areas may also have ambiguous ownership dynamics since these were not stable land features and previously seen as too marginal for settlement or development.

In some cases Government has invested significantly in such marginal areas providing coastal defences, electrical connections, reticulated water and roads. These factors all serve to enhance the speed at which settlements are forming in very exposed, dangerous locations. Once a large population with infrastructure has been established the Government is then locked into a never ending cycle of reactionary coastal works to try and keep populations safe. Since planning is mostly absent and resources are scarce, these engineering works are usually reactionary and fail.

Climate change and sea level rise can only act to worsen this situation and efforts to control development in such hazardous locations must be prioritised.
Sea Level Rise, Coral Bleaching, Acidification

Sea level rise is the most obvious threat to low-lying islands and shorelines. Sea level rise, combined with other climate change factors such as coral bleaching and acidification will continue to incrementally stress shoreline systems, especially living reef mediated systems like those of Kiribati. As discussed, Kiribati’s living reefs must provide a continual supply of sediment and give protection from waves for shores to remain resilient and islands to remain safe.

To gain a more complete understanding of the implications of climate change the 5th IPCC (Intergovernmental Panel on Climate Change) Assessment Report (2014) is recommended as an important document. Otherwise, in relation to shoreline management there is good evidence that Kiribati’s shores at this time and if protected from direct human impacts have a degree of natural capacity for resilience to sea level rise (see Kench and McLain, 2016; Webb and Kench, 2016; and others). However, rates of sea level rise are accelerating (IPCC, 2014) and studies of historical shoreline resilience in atolls can not be confidently used to understand future stress. We do not know how our shores will respond as sea level rise continues towards 2100 but it is unlikely they can persist unchanged or continue to provide atoll land with adequate protection.

Unprecedented global coral bleaching events are now occurring as a result of global warming (NOAA, 2016). The most recently occurred due the El Nino of 2015 - 2016 and coral reefs in Kiribati are known to have been affected. National observational networks or monitoring is absent so the extent of damage is poorly understood. Nonetheless, such news is of great concern as atoll islands and shores can not persist in their natural state if reef damage becomes too great. The additional issue of ocean acidification is also expected to damage coral reef health and structure. At this time the observed impacts of acidification in the central Pacific is poorly understood but gradual change in ocean chemistry is being measured.

The different islands in Kiribati have differing expected levels of sensitivity. Some islands are more exposed and may become impacted and uninhabitable earlier than others, just as some islands today are already uninhabitable due to lack of fresh water resources or viable soils (Southern Line Islands and parts of Phoenix). Nearly all islands in Kiribati have areas which are already uninhabitable, usually because they are too low-lying and flood prone. Such areas will gradually become more widespread and communities living in exposed conditions or marginal lands will be first to feel climate change and sea level rise impacts.

Reef mediated shoreline systems such as those of Kiribati are dependant on continued reef health and productivity. Not all islands will behave in the same way but the combination of bleaching, acidification and sea level rise means that Kiribati’s atoll islands in their natural state may not sustain safe human habitation over a 75 - 150 year time frame. Improved understanding of variability in islands and plans for long term coastal security must be developed.
The Challenges - Long Term Coastal Security

The future
Key to understanding of how sea level rise and climate change impacts will unfold in Kiribati’s islands is the need to recognise the islands are variable. They will be impacted in different ways and at different rates and some will be naturally more resilient than others.

It is obvious that Banaba Island is some 60m high and has rocky limestone shores, it will thus persist comparatively unchanged for the foreseeable long term future, even if it’s surrounding coral reefs are also diminished through acidification and bleaching. Likewise, the land area of large rubble islands like Kiritimati Island can be expected to show greater resilience to climate change and sea level rise impacts than a smaller, sandy, low-lying islands such as Makin. This being said work in 2014 suggests that the true safe, flood free land area of Kiritimati is far smaller (between 100—200km²) than the figure presently quoted (around 400km²). Caution is required when considering these issues and a more exact understanding of comparative island resilience is an important gap in current knowledge. It would be a useful strategic research area as Kiribati considers future options.

It is important to also emphasize that any discussion of the degree of natural shoreline resilience is only relevant to islands which have intact shoreline systems. South Tarawa does not have a single unaltered shoreline left and many of it’s shores are heavily degraded through direct human impacts. The net affect is that at this time South Tarawa is the most immediately vulnerable island to climate change and sea level rise in Kiribati today. Indeed South Tarawa’s shoreline systems are so disturbed that the community is today not safe from normal expected coastal hazards and storms.

Within South Tarawa a number of areas have already been highlighted as the more vulnerable than others. Areas such a Bikenikoora, Temaiku and other similar low lying areas are quite simply unfit for conventional occupation or development. There can be no expectation it is possible to protect those locations from flooding. It is possible (at great expense) to stabilise the shoreline position of such areas but it is not physically possible to exclude floodwater either marine or fresh. Meaning irrespective of any seawall efforts most of the land will still be subject to flooding and this will only continue to get worse with sea level rise. The best option if such areas are to be used is infilling to raise land height to allow safe development.

Pragmatic discussions must be tackled if Kiribati wishes to plan for national long term coastal security. No island except Banaba can offer long tem security in the face of sea level rise. Kiritimati likely offers a longer time frame but it too will not persist as a habitable island without engineering (and its freshwater and soil resources are very limited). South Tarawa with half the country’s population and the largest investment in infrastructure and development is the most immediately vulnerable location to marine hazards in Kiribati today.
Prioritisation and Options

There are limited options in respect to engineering a solution to sea level rise in an atoll environment. Principally, land building techniques using sand, gravel and rock dredged from the lagoon is the only practical, cost effective way to produce raised, flood free land of sufficient size to accommodate a national population. Such concepts are proven and have been successfully used in the Maldives (Indian Ocean) and on pacific atolls (mainly military installations in United States and Japanese Pacific Territories). A number of Kiribati’s atolls including Tarawa have very good geophysical potential for such work. The technical feasibility of such approaches are proven as are the techniques to incorporate shoreline protective measures to ensure coastal hazards are minimised. Technological answers to subsequent sectorial issues such as high density housing, food supply, energy production or water supply also exist.

The official discussion of providing a safe, sustainable and appropriate living environment in Kiribati for the national population into the future, is only recent and earlier discussions have focused on migration. No pre-existing climate change adaptation policy or plan covering this subject exists to provide guidance. This is likely because it has been locally understood that potentially fortifying some locations with the intention of relocating the national population is not only a technical and logistical challenge, it is fraught with social, cultural and political issues and concerns. This coastal policy can not hope to do justice to such issues but it can point out the need for urgent multi-sectorial discussion to start to address this challenge.

The Government of Kiribati has articulated the need for a secure safe future living environment in Kiribati. Given the time frames and costs involved the reality is prioritisation of location(s) must occur. Irrespective of the complexity of these issues, discussion must be generated, with the aim to develop plans, consensuses and implement work. Time is short given the challenges ahead and failure to address the issue of long term security may result in unplanned forced migration. It is pragmatic to assume that the objectives of reducing present vulnerability in South Tarawa, accommodating growth and development and building long term coastal resilience may initially focus on South Tarawa.

Taken from a paper published in August 2016 (Fasullo et al 2016). There are no new startling results here regarding rates of sea level rise and the most recent data indicates around 3.4mm per year globally. Nonetheless its message is pertinent because it follows hundreds of similar research papers indicating the same thing. There is no ambiguity regarding measured sea level rise. It continues inexorably upwards, it is accelerating and there is now such enormous momentum in the Earth’s climate system that sea level rise will continue beyond a stage where our islands can be expected to remain safe or habitable in their natural state. Kiribati must plan and implement appropriate coastal engineering now if it wishes to remain in these islands.
It remains appropriate to promote natural resilience of shoreline systems in the majority of rural outer islands. The greater number of shorelines in these locations remain functional and resilient at this time. These less-disturbed shores provide the best possible and cost effective protection from marine hazards and erosion.

Much of the existing ecosystems based and precautionary guidance documents (see review in appendix) related to coastal development and management as well as small scale engineering in Kiribati remain appropriate for this purpose.

For these conventional management approaches which protect natural-systems to succeed, improved and sustained support to rural areas is crucial. Presently even though the guidelines exist, delivery and assistance is beyond current resources and capacity. This is a major obstacle to achieving improved outcomes in rural locations and ensuring that the natural resilience of shorelines is preserved.

Even if the capacity to implement precautionary, environmental-systems based coastal management in South Tarawa today existed (which it does not), it would not succeed in reinstating an acceptable level of natural beach protection. The level of disturbance to shoreline systems on South Tarawa is now so far advanced that remedial works and engineering are the only mechanisms to reinstate protection from coastal hazards.

Given the added dimensions of increasing development pressure and long term sea level rise Tarawa must urgently embark on a different trajectory to avoid disaster. A business-as-usual approach to coastal management in South Tarawa would be a dangerous miscalculation. Beach mining, ad hoc engineering and development must be controlled and an urgent prioritisation of remedial adaptation works is required. A larger integrated strategy of long term coastal security for Tarawa which plans and commits to strategic reclamation and engineering is the only way the population can be secured from coastal hazards, now and into the future.
Islands such as Kiritimati present opportunities for a mixed policy approach to coastal security. Areas such as the peri-urban environment of London has become subject to coastal vulnerability issues resulting from unplanned development in the coastal zone. Similar to issues in South Tarawa subsequent reactionary shoreline engineering has followed and results in further disturbance and exposure to coastal hazards. Otherwise, away from London much of Kiritimati remains in natural and very pristine state and its natural shores at this time provide excellent protection.

It follows that a prioritised plan for coastal engineering or retreat is appropriate for highly vulnerable parts of Kiritimati but otherwise other areas of the island can be considered similar to an outer island and the promotion and protection of natural resilience of shoreline systems is appropriate.

A number of outer island village locations similarly require a combination of approaches but their issues of coastal disturbance are usually far smaller scale and less urgent than on South Tarawa or Kiritimati.

A major adaptation option which is mostly no longer possible in South Tarawa is the pragmatic solution of on-island relocation. Weather a village or individual home, the ability to move to nearby safer ground is usually possible on outer islands. There is no better, long lasting or cost effective strategy for rural communities than establishment on safe ground. Nonetheless, communities and individuals will likely need support to arrive at and implement such solutions.
A dedicated Coastal management / Coastal decision making authority is urgently required in Kiribati.

No such capacity or dedicated authority currently exists in Kiribati and the present mechanism for delivery of coastal management or planning is comprised of part time capacity spread between several Ministries and intermittently bolstered via the disparate (and usually single dimensional) inputs of international assistance projects. Such an approach may once have been adequate since functional shoreline systems if left undisturbed do not need “management”, but today coastal vulnerability challenges are of a scale and complexity that either adequate expertise and resources are dedicated to this sector, or Kiribati will not meet the coastal challenges of today or the future.

Coastal management is a complex, multi-faceted technical task area, especially in urban locations. The development and implementation of appropriate coastal zone solutions and plans in Kiribati’s urban locations is no longer a matter for simple precautionary approaches aimed to reduce any impacts. The situation of coastal stress has progressed to such an extent that communities in South Tarawa are now living in dangerously exposed conditions.

The reasons are multifaceted and the solutions multi-sectorial but under the current arrangement these conditions of broad scale coastal degradation in South Tarawa are not recognised and appear gravely underestimated. It follows that damage continues more or less unimpeded and numerous policy relevant coastal advisory guidelines, assessments and reports have been produced but in the absence of a resourced and qualified lead authority to implement such work little has been achieved.

There is a clear sense of the intractable nature of the issues of coastal vulnerability in atolls in the face of sea level rise. Numerous specific reports and papers have been written regarding the scale of the challenge to deliver effective coastal security in these circumstances. In a general sense this is also well recognised by local authorities and international partners working in Kiribati. However, the apparent lack of urgency among all stakeholders in respect to ever worsening conditions of coastal vulnerability in South Tarawa is alarming. Again it seems without the continuity of a dedicated technical authority the true magnitude and urgency of the challenges at hand are being dangerously underestimated.

It can not be shared in starker terms, large areas of South Tarawa’s previously flood free village areas now exist with the very real threat of damage through wave over-wash and marine flooding. South Tarawa’s southern oceanside shore’s natural defensive structure has been gravel damaged by relentless, unsustainable aggregate mining and uncontrolled development. Many previously safe communities and associated property and infrastructure is now at risk. This is not a future issue, it is simply a matter of when the next wave, weather, seasonal and tidal conditions combine and orientate to strike the southern shore and extensive marine flooding will occur. This is not due to climate change or sea level rise, this is due to the absence of adequate technical capacity, resources and management in the shoreline zone.

It is recommended that a stand alone, dedicated Coastal Management and Adaptation Unit be established urgently, potentially under the umbrella of the Office of the President / Kiribati Adaptation Project, given the links to national adaptation planning and the fact that coastal adaptation in an atoll environment is a fundamental prerequisite for national adaptation planning. Placement under KAP / OB also provides an initial mechanism for coordination with existing efforts and resources dedicated to coastal vulnerability, management and policy work. Ultimately, the authority or office must be a sustained resource, its technical capacity and means to address the dire needs in this sector must be commensurate with the scale and complexity of the challenges at hand.
1. Coastal Management and Adaptation Unit

The mandate of the Unit is likely to evolve and shift with time and available resources but would ideally be comprised of a mixture of dedicated local and international expertise undertaking, coordinating and providing an advisory role in all aspects of coastal planning, protection, development, vulnerability assessment, community awareness and engineering. This list is not exhaustive.

Long term coastal adaptation planning has not begun in Kiribati and significant work lays ahead to develop an agreed national strategy which may provide coastal security and a safe living environment for the national population. Likewise, the urgent conditions of vulnerability unfolding in South Tarawa today must be an immediate priority and addressed by a capable, qualified team which is resourced commensurate with the scale of the challenge.

The establishment and sustainability of such a Unit will present challenges and formulating a new Unit especially with the clear need for significant international technical support will likely be beyond current local budgetary ability. Whatever the final arrangements or dynamics of funding it must be clearly understood that a business as usual approach by either international partners or local authorities to the delivery of coastal management will not succeed unless a new approach is resourced and developed.

**Recommended Function of Coastal Unit**

- Coastal assessment, survey and monitoring; including assessment of vulnerability, saline intrusion issues, identification of sustainable beach sand resources, monitoring degraded shores and planning / prioritising response.
- Technical coastal development advisory; assess coastal development applications, support decision making and design in coastal zones
- Implement / design coastal zone plans and setback recommendations; work with Government and local council authorities to implement and use zoning criteria. Support rural outer island coastal development planning and decision making (e.g. aggregate supply causeways, seawalls, etc.).
- Coastal outreach and behaviour change; beach mining is a widespread and major challenge. Community awareness of the problems and alternatives must be made a priority. Likewise communities living in highly vulnerable locations must be made aware of the risks and scope / limitations of solutions.
- Coastal engineering; prioritisation of works, technical support to implementing agencies, quality control and standards.
- Build close association with the Atinimarawa Co.; Ensure optimum uptake of Atinimarawa products as the key to reducing beach mining pressure in South Tarawa. Development on some outer islands is starting to place pressure on shoreline systems, alternative, sustainable resources must be explored.
- Co-ordination of coastal programs and projects; support and technical augmentation of the existing coastal mandates across various Ministries and technical focal point for international coastal management / adaptation programs.
- Development of Long Term Coastal Security Strategy; Adaptation to long term sea level rise and population and development pressure.
- Sustained coordination and implementation of long term coastal security strategy; achieving coastal security in Kiribati will require ongoing, sustained, likely multi-decadal coordination. The scope and complexity of such tasks are beyond the mandate of any single office or authority and will necessarily need to be an agreed whole of Government objective and effort. However, coastal security must be a fundamental component and arguably a pre-requisite of success.
2. Coastal Zoning and Setback Criteria

A fundamental coastal management tool coastal land use zoning and set-back criteria have not been adequately developed or implemented in Kiribati. These tools offer an important opportunity and whilst set-backs may seem a physical impossibility in locations like South Tarawa, they should not be ignored despite the challenges. The key purpose of set-backs is to prevent physical damage or interruption to sensitive beach / berm systems and prevent exposure of property and infrastructure to wave damage or dynamic shoreline features (unstable sands etc).

If zoning and set-back criteria can be successfully developed and introduced it could pay huge dividends in keeping people and property safe and avoiding damage to natural shoreline systems. This means ‘free’ coastal protection from hazards and avoids costly coastal engineering. Controlling the type of development which occurs in highly vulnerable zones is crucial given sea level rise and climate change can only increase the magnitude and frequency of future hazards.

Different approaches will be broadly applicable in different locations. Urban South Tarawa will offer a different scope of opportunity to the rural outer islands, just as villages present different needs to uninhhabited woodland. Issues of customary views over the right to use land will require careful attention, design and consultation. Obvious differences also exist between the Line Group where Government essentially retains ownership of all land and plots are leased and the Gilbert’s Group where customary ownership has been established for millennia. These different circumstances present different levels of opportunity to design and implement zoning and set-back criteria. Most importantly, these factors must be viewed as an opportunity, rather than a set of complex obstacles.

It is recommended that appropriate, location / circumstance specific zoning and set-back criteria be developed and incorporated into the national planning and development approvals process.

**Recommended national set-back and zoning criteria**

- The zone from the foot of the landward berm slope*, the berm crest and the foreshore; should not be subject to any new physical disturbance, building, unnecessary traffic, mining, vegetation clearance or other works. Any coastal development proposals which threaten disturbance in this zone are deemed ‘prescribed developments’ and will be subject to full development approval process. Approval must be subject to assessment by a qualified coastal capacity first. Where appropriate, design criteria must also be assessed by qualified coastal authority.

- Traditional Kiribati post and thatch structures may be built in this zone; so long as they prescribe to the traditional te kiakia or te bwuia design, meaning it is possible to move or rebuild.

* see image above. The berm is the highest part of the foreshore, immediately landward of the beach. It is the last line of defence during high wave events. Disturbance greatly increases the risk of wave over-wash and marine flooding. Building on or disturbing the berm must be avoided.
2. Coastal Zoning and Setback Criteria

- Rubble banks and boulders which occur on the reef flat; can not be disturbed for any purpose other than the building and maintenance of traditional fish traps te maa.

- Additional to mangrove which is already protected, te ngea (Pemphis aciddula Ironwood) will not be destroyed or cleared; however the traditional, subsistence harvest of te ngea timber is permitted in rural areas.

**Zoning criteria in uninhabited and pristine areas**

- No new development, disturbance or building of any kind permitted within the set-back zone; National criteria applies regarding the physical extent of the set-back zone.

- Note some beach / berm systems are comparatively large and wide on islands like Kiritimati. Additionally, wind blown sands and ‘dune’ processes can be an important component of coastal systems on Kiritimati Island. In this case, the set-back zone will extend from the foreshore to the landward edge (change in slope) of the dune system where these exist.

**Flood prone, highly vulnerable locations**

- Develop detailed list identifying such areas in high population density areas; some work of this type already exists on South Tarawa (e.g. KAPII work by Elrick and Kay, 2009). Likewise, growth centres such as the London - Tabwakea corridor also requires improved baseline assessment to ascertain safe and exposed locations. There are also some examples of villages locations on outer islands which are marginal and flood prone.

- Where marginal, highly exposed, unstable and flood prone areas are identified e.g. Bikenikoo-ra, South Tarawa; these should not be subject to any new settlement or other infrastructure works. Development in these zones simply places more people in highly exposed hazard prone situations. No new Government services (electrical connection, communications lines, road access) should be developed.

- Comprehensive reclamation and coastal security plans to render such locations permanently secure must be implemented before further development or settlement; current efforts to simply stabilise shores in such areas will not succeed in preventing flooding. Even if marine waters are excluded, freshwater flooding will still occur. Either floor heights, access ways and services must be raised to a minimum height or more practically he land height of the entire areas should be raised through reclamation to provide a safe living or development environment.

- In urban areas, traditional Kiribati post and thatch structures may be built in this zone; so long as any new buildings prescribe to the traditional te kiakia or te bwuia design, and their floor heights are built above high spring tide. However, communities must be made aware these are marginal lands and are unsafe.

New settlement is rapidly occurring in the former lagoon basin of Temaiku. This is land is flood prone and development must be limited until adequate reclamation of this area can be achieved. If correctly filled the area can provide a safe, flood free land.
3. Control of Beach Mining

**A moratorium on beach mining in all urban areas**

- A complete moratorium on all beach and berm sand, gravel and rock mining in South Tarawa must be urgently declared; numerous scientific and technical reports produced for Government since the early 1980’s have warned that beach mining was causing significant damage to South Tarawa’s shoreline systems. Today beach mining especially mining on the ocean side shore has become the single largest and most immediate threat to coastal security on South Tarawa.

Coastal security in South Tarawa can not be achieved unless all beach mining especially on the ocean side coast is halted; degradation of the beach / berm system is well advanced in many location in South Tarawa and this greatly increases the likelihood of wave over-topping and marine flooding. Atolls become uninhabitable if subject to regular marine flooding, destroying ground water, soils, vegetation, infrastructure and property.

**Technical assessment of remediation measures**

- Urgent prioritisation and emergency remediation measures undertaken along the ocean side coast of South Tarawa; because damage from beach mining has advanced unchecked a number of locations are now in a state of imminent flood threat. Measures to reduce threat in these location are urgently required.

**Institutional and public awareness**

- Implement a sustained, professionally designed and launched media campaign; it is impossible to police or enforce an island wide closure of beach mining since it occurs at any time across every part of South Tarawa. A well designed beach mining campaign will be critical to alert communities of the huge dangers of continuing this practice and allow communities to become self-policing. If the public understand how dangerous this activity has become they will prevent it through internal community means.

The Government and general public are unaware of the dangers of widespread mining; by July 2016 only 19 beach miners were licenced for 2016 (their activity is unmonitored) however the magnitude of coastal damage and obvious signs of widespread mining suggest many hundreds of miners are active daily. This activity ranges from a few buckets of material for domestic landscaping or concrete to large activities where hundreds of bags of material are taken.

Beach sand, gravel and rock is seen as a free resource in Kiribati. This may once have been so on South Tarawa, however today it is a dangerous miscalculation. Beach mining will cost the habitability of large areas of the island if left unchecked. It is crucial for these message to be broadcast to the whole community.

**Support the Atinimarawa Co. safe alternative product**

- Te Atinimarawa Co. is now fully operational and can provide cheap high quality sand, gravel and rock products; village communities require a ‘free’ source of sand and gravel for small scale works around their homes, graves, gardens, etc. This non-commercial volume could be stock piled in convenient locations across South Tarawa. Unprocessed lagoon aggregate is very cheap to supply and if suitable stock pile areas were established across South Tarawa this would allow those who can not afford to purchase aggregate to gain access to a safe product.

- All Government, commercial and individual building projects on South Tarawa must use only lagoon sourced aggregate from te Atinimarawa Co.; otherwise imported aggregates are also permissible where high quality is required, subject to normal customs and quarantine treatment and charges.
3. Control of Beach Mining

- **Design and impose significant penalties for Government, commercial projects or individuals using beach aggregates of any sort;** development application processes must show consideration of volumes and budgets for aggregates and purchase material from Te Atinimarawa Co. Receipts for those volumes of aggregates on site must be available for inspection to inspecting authorities.

**Technical assessment of sand mining areas**

- **Some sand resource areas can be mined sustainably; but no beach gravel resources on South Tarawa have been or can be mined safely.** Sand mining has been undertaken at the Fisheries Channel (Betio Causeway) for many years and it is a relatively environmentally safe resource. It has also gone some way to assisting to keep the channel open for navigation.

- **Beach sand is of high quality for mortar applications;** this is because it is well sorted and of a fine grade. Subject to technically qualified assessment and monitoring, it may remain possible to continue controlled extraction of beach sand at the fisheries causeway.

Likewise, there is potential for significant volumes of sand to be harvested from the reef flats at the western end of Betio. This is likely to be seasonal. This sand volume is large and may be important in beach remediation work since it matches the quality of natural beach sands.

Any such mining must be licenced, technically assessed limits developed (and enforced) and each application reviewed afresh by a technically qualified capacity. The resources in both locations must be monitored and subject to regular technical assessment (minimum twice a year).

Subject to technical monitoring and assessment these resources may be closed due to seasonal or unfavourable conditions.

In the case of the Fisheries channel whilst some practical benefits derive from removal of sand. The accumulated sand on the causeway walls is the best possible protection of those walls from wave impacts. These benefits will need to be managed.

Western Betio reef flats have persistent mobile sand spits (yellow circles). This occurs because dominant easterly winds drive beach sand around the island towards the western point of Betio. From here the sand moves across the reef flats and eventually disappears over the edge of the reef platform into deeper water. Once in deeper waters this sand is unlikely to ever re-join the shoreline system—it is lost from the island. Careful harvesting of such resources (at low tide) is possible and would have negligible environmental impacts or costs. Sand should only be taken from beyond the 150m buffer shown above and the resource may be seasonal. Meaning there maybe times it should be left undisturbed, there are other times it may be safe to harvest.
4. Enhance coastal resilience in outer-islands.

**Implement conventional coastal policy**

- It will remain appropriate to promote *natural resilience* of shoreline systems in the rural outer islands. The majority of shorelines in these locations remain functional and resilient at this time. This is because they are largely undisturbed by direct human impacts. Such shores provide protection from flooding and erosion. Existing environmental policy instruments can still be effectively used in conjunction with the specific coastal management recommendations of this document (*see review of these in the appendix*).

- Outer island requests for assistance in coastal development or protection; as with the complex range of issues in South Tarawa, outer island requests can only be better assessed and appropriate solutions developed if suitably qualified and resourced coastal authority is developed and resourced to enable appropriate response.

Supporting the needs of outer island communities in this sector is vitally important since precautionary management of their shoreline systems will prevent a myriad of future challenges.

**Outer island beach sand and gravel mining**

- Beach aggregate mining for traditional needs; beach gravel mining has been undertaken for millennia in rural outer island settings. The impacts of this are negligible whilst populations remain small and outer island housing remains predominantly local (pole / thatch structures). Under these circumstances continued low level, intermittent extraction associated with local flooring and landscaping needs may continue.

- Aggregate demand is gradually increasing in larger village areas or where concrete houses and larger construction projects are planned, e.g. church, maneaba, school, etc.; to understand the dangers of allowing beach mining to gradually increase due to meet development demand, one only need compare the dire situation in South Tarawa with that of the outer islands today.

Where beach aggregate demand in outer island villages or works sites has changed from traditional use and volumes, to use in concrete production or large public building projects, qualified assessment of the quantities required and identification of a safe location for extraction is recommended. It is envisaged that the proposed coastal unit will be the appropriate avenue to support outer island need in this regard.

**Public awareness on outer islands**

- For implementation of these recommendations to be successful; outer island communities must be convinced that such initiatives are ultimately for their benefit and safety and not simply ‘red-tape’ and an unnecessary burden. Some key messages which must be imparted are;
  - Zoning and set-back criteria are developed to protect human wellbeing and property. They must be shown that shorelines are dynamic and are coming under stress from external and internal factors.
  - Beach aggregate mining can at this time be sustained if it is at traditional levels only. Some larger villages with bigger structures and shoreline infrastructure are already placing too much burden on their shoreline systems. Seeking expert technical assistance on safer methods, locations, etc. will protect communities.
  - Careful explanation of the environmental impacts, costs and maintenance needs of causeways and seawalls needs to be shared. These structures can be a huge community burden if poorly conceived, designed or constructed.
5. Enhance coastal resilience in South Tarawa.

**South Tarawa - General approach**

- In unison with the recommendations made so far in this document, it will remain appropriate to promote the fundamental environmental management principles which seek to protect natural systems and thus the resilience and function of shorelines in South Tarawa; these broad environmental protection and development approval processes and policies already exist, however effective implementation remains a challenge. Where appropriate the proposed coastal authority will be a key mechanism to support existing Government efforts to implement and use such instruments effectively towards improved coastal management.

- The potential for conventional precautionary management methods to provide coastal security are limited; there are no ‘undisturbed’ shorelines left in South Tarawa today and many are in a severely degraded state. However, there remains locations with surprisingly resilient, functional shoreline systems and these should be protected from additional disturbance.

The sandy shores which occur between the western end of Teorereke through to the western point of Betio require greater attention and protection. The continuous beach which stretches on the lagoon coastal from Teorereke to Bairiki wharf is precious. It is consistently accreционary, protects the island and is aesthetically beautiful. It is also one of the last such shores left on South Tarawa today.

**Coastal security in South Tarawa today**

- The proposed set-back and zoning recommendations combined with existing environmental protection instruments may improve but can no longer provide adequate coastal security in South Tarawa; in many locations shores are too disturbed or damaged to recover adequately, engineering is poorly constructed / designed and important infrastructure has been placed in exposed locations.

- Systematic assessment, prioritisation and design of suitable solutions in vulnerable areas is required urgently; implement existing work such as the South Tarawa Coastal Condition Assessment (Beca, 2010) but also develop broader, island wide vulnerability profiles and solutions strategies and perspectives.

- Of high priority is to identify areas where the ocean-side beach berm system has been significantly damaged and lowered through erosion; observations of KAP Coastal Experts (2016) indicates this is now a wide spread phenomena on South Tarawa but it is not empirically quantified. Highly accurate topographic (land height) survey (products such as LIDAR) combined with field survey would be invaluable for such assessments of damage and associated flood risk.
5. Enhance coastal resilience in South Tarawa.

Where possible reinstate beach/berm systems

- Undertake trial measures to reinstate the berm system contingent on the closure of beach mining in South Tarawa; beach mining especially on South Tarawa’s southern ocean-side coast is likely the largest source of stress at this time and is causing the majority of erosion issues. This can be evidenced by consideration of other more pristine locations where similarly orientated shores subject to similar weather patterns are not in such degraded state.

Beach mining produces an imbalance in natural beach budgets, it removes more sand and gravel than is being deposited, so the beach erodes.

It is recommended to experiment with addressing this imbalance with a well planned, designed and sustained beach nourishment program. If the berm system and a functional beach can be reinstated and set-backs honoured, the system may again become self sustaining after the initial soft engineering approaches. If successful there are multiple benefits beyond the simple cost and logistical advantages (short and long term) over hard engineering.

Potential safe beach sand resources have been discussed and Atinimarawa Co. is capable of providing mixed material of courser grade as appropriate. Assessment will be required to estimate the possible volumes required and appropriateness of those potential resources to fulfil this rehabilitation role. Expert coastal science and engineering assistance will be required.

Low lying flood prone areas in South Tarawa

- A comprehensive assessment of low lying and flood prone or exposed areas is required across South Tarawa; a number of low lying, flood prone areas exist, some well understood as marginal (e.g. Bikenikoora, Temaiku Channels, areas of Ambo) others are less well understood (inner island areas of Teoraereke, Antenon, Bikenibeu West and areas of Bikenibeu East).

Such areas have only recently (last 25 yrs) been subject more intensive settlement as they had earlier been rejected as safe land for settlement. In urban South Tarawa competition for space has led to such areas becoming more and more developed. Island wide coverage with accurate topographic data (e.g. LIDAR) would be crucial to accurate assessment of low lying areas.

- Render safe such areas for development before more services are developed or permanent housing established; because these areas are marginal, permanent housing is still less common than informal local buildings. Excellent opportunity still exists to reclaim such areas to a suitable safe land height before re-establishing more permanent settlement and services.

Reclamation using lagoon basin sourced sediment is proven to be effective. Recent programs of such work in Funafuti, Tuvalu to fill flood prone land in their main town centre has been highly successful and was achieved without significant environmental impacts. In many cases the low lying areas in South Tarawa can be filled using identical approaches and technology to provide a cost effective, long term solution in what are currently marginal, unsafe environments where the conditions of hazard will otherwise only continue to get worse and be a growing burden on Government services.
5. Enhance coastal resilience in South Tarawa.

**Reclamation to provide more land space**

- Assess the potential for strategic larger scale reclamation; reclamation using the lagoon basin sediment resource is the most cost effective, pragmatic way to plan for and accommodate South Tarawa’s growing population safely. Statistics show that the national population continues to grow and that increasingly South Tarawa is accommodating the greater proportion of the national population.

People and assets are running out of physical space on South Tarawa and this has a direct impact on institutional ability to manage, among a range of issues, coastal vulnerability. Over crowding forces people and infrastructure into ever more marginal and unsafe locations the provision of more space can provide a safe alternatives. It also increases the likelihood of honouring coastal set-back zones which are of primary importance to reducing exposure to coastal hazards.

- Generate concepts and strategic guidelines for reclamation on South Tarawa; for example, use of established guidance for seawall construction, introduce criteria for minimum finished elevation and ensure account is taken of fill volumes and necessary budget. Obviously fill must be sourced from sustainable sources (e.g. Atinimarawa Co.).

Reclamation is a prescribed activity however there is obvious need for qualified technical appraisal in the approvals process. Presently reclamation is undertaken in an ad hoc, piece meal fashion, usually implemented by individual interests. These undertakings are often left incomplete or unfilled and there is a need to support the intuitional approval or monitoring process and ensure adequate technical consideration of the resultant shoreline impacts. Such support is envisaged as a task area of the proposed coastal unit or authority.

**Seawall construction**

- Support improved decision making in respect to seawall approvals, design and monitoring, adopt and implement the Shoreline Protection Guidelines (Becca 2010) already available; failing, ad hoc seawalls are a ubiquitous feature of South Tarawa shores. There already exists sound, locally tailored and appropriate guidelines to improve decision making and design criteria. These simply need to be adopted and used, if there are shortfalls it is through use that these will be found and can be adjusted.

Otherwise, seawalls are already prescribed activity subject to development application process and approval. The approvals process must be better supported by qualified empirical decision making to determine; if a seawall is the appropriate option, what other solutions may exist and any approval must be contingent on qualified review of the shoreline and possible impacts the wall will generate, as well as the design criteria for the specific conditions / purposes of the wall.

Additionally, approvals for any walls must be contingent on realistic budget estimates and assurance of aggregates source, it is only permissible to source aggregates from sustainable sources. Likewise, seawalls are invariably associated with some degree of reclamation or land filling, any such material must come from sustainable resources.

**Public awareness on South Tarawa**

- South Tarawa communities must be made aware of the urgent issues of coastal vulnerability which are occurring and how these new initiatives are designed to tackle coastal vulnerability problems; see outer islands Public Awareness component for further explanation.

**Kiritimati - General Approach**

- Implement existing coastal management policy and development approvals process and adopt the setback and zoning criteria recommended here; however given the different circumstances of Kiritimati in terms of land ownership, its environment and its current small population there is excellent potential to develop a more detailed and site specific coastal zone management strategy for Kiritimati.

As with other islands the authorities in Kiritimati require assistance in respect to technical support in coastal development approval processes and decision making. It is envisaged that the proposed coastal unit would provide this.

- **Develop a site specific coastal management and zoning plan for Kiritimati Island;** Kiritimati is designated by the Kiribati Government as a potential growth centre envisaged to take pressure off the limited resources in South Tarawa and offer opportunities in relation to its proximity to Hawaii, tourism, etc.

At this time coastal development in Kiritimati is restricted and issues of damage to coastal systems and resulting exposure of homes and infrastructure are mostly isolated to London. It is recommended that comprehensive coastal zoning, development and set-back criteria be developed and implemented for Kiritimati without delay and before development and population expands further.

**Coastal security in London**

- **Undertake a comprehensive assessment of coastal vulnerability issues in London;** London shares many similarities with South Tarawa but the scale is a fraction of the size. Nonetheless, the approaches to its issues of erosion and exposure to coastal hazards will need to follow similar process to South Tarawa in terms of assessment of vulnerabilities, development of solutions and subsequent implementation of works.

The neighbouring development area of Tabwakea has to date been better planned and dwellings in Tabwakea are generally set-back up to 100m from the shoreline. This is an excellent precautionary approach and should be retained.

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Kirimiti island general land use plan as shared by local Government Authorities in Kirimiti 2014.

Pristine areas of Kiritimati

- Protect all other coastal areas from disturbance; Kiritimati has pristine shoreline systems over most of its ocean side coasts. These are in excellent condition and should be protected from disturbance. The majority already fall into the category of “Foreshore Reserve” in the existing Kiritimati Island General Land Use Plan, 2008. It is not however clear what level of protection this affords shoreline areas or what the physical boundaries may be. These also appear to cease beyond Cassidy airport to London.

- Assess aggregate supply and designate safe areas; there is little evidence of beach mining in Kiritimati at this time however the moratorium of beach mining should be National. Technical assistance to designate appropriate quarry areas to supply the local demand is recommended.

Lagoon shore of Kiritimati and low lying areas

- Survey and assessment of the vulnerability to flooding of lagoon shore areas; Kiritimati Island has significantly different lagoon shore systems to those common in the Gilberts Group. These differences come about because of the smaller tidal range (only about 1m) and the extensive and complex interior low lying zones (milkfish ponds) which are only irregularly linked to the marine environment (during El Nino wet seasons when flooding due to rainfall can occur).

The land area of Kiritimati is commonly quoted as over 400km² and areas of Kiritimati also have higher land heights than commonly quoted in the Gilberts Group. These factors alone appear to make Kiritimati seem an attractive location for settlement.

However, vast areas of the lagoon shore environment are very low laying and are seasonally exposed to flooding. Low lagoon side bunds barely 0.5m high were built in many areas during the colonial era and these mark what is often seen as the lagoon shore of Kiritimati today. Casual observation alongside the lagoon shore road may give a deceptive impression that areas landward of the road are flood free, whereas areas lagoonwards are plainly subject to tidal or seasonal flooding. Using satellite images a rough approximation of the true, safe, ‘flood-free’ land area of Kiritimati is likely to be closer to 150km² not 400km².

Given the aspirations for Kiritimati as a new development area, gaining an accurate understanding of land height and flood dynamics will be very important to ensuring safe development and future coastal security.

Lagoon shore conditions near Tabwakea. Note extremely low lying nature of these lagoon shore areas, these environments are extensive on Kiritimati Island and are unsuitable for development.

Encourage improved research and understanding of sea level rise, coral bleaching and acidification in the local Kiribati environment

These three global climate change impacts combine to produce great challenges to atoll islands as habitable environments into the future. Atolls are reliant on healthy surrounding reefs for wave protection and for the sustained supply of sand, gravel and rock to build the island and maintain their shores. The increasing threats from sea surface temperature related bleaching and disturbance of reef structure and productivity from acidification (increasing CO₂ concentrations in sea water) mean that reefs may not continue to provide the same level of wave protection or sand, gravel and rock supply, it is expected that these may diminish over time. The way in which these two factors may progressively impact reef health in Kiribati is poorly researched, monitored or understood, yet understanding these impacts is key to long term adaptation response.

Global sea level rise is better understood and there are significant global efforts underway to better measure rates and provide longer term projections. Plainly this is because the implications of sea level rise are far reaching and touch all coastal regions, not just the tropics or reef dependant communities. Kiribati has 2 longer term sea level measuring gauges (Kirimiti Island and Tarawa). The Kirimiti Island gauge was not originally designed to detect global sea level rise associated with climate change whereas the gauge in Tarawa was specifically designed and maintained with this in mind.

It is recommended that the Govt. of Kiribati request the continuation of the comprehensive sea level gauge reports from the Australian authorities.

The last comprehensive report produced by the Bureau of Meteorology Australia (the authority which maintains the Tarawa sea level gauge) was 2011. At this time the record from 1992 - 2011 showed a average trend of sea level rise of +2.8 mm/year, which is somewhat less than the global average rate for the similar period of +3.2mm / year (IPCC, 2014). The difference with the Tarawa gauge record reflects the short period of time the gauge has been operational rather than a reliable divergence in trend from global rates. Unfortunately, after 2011 BoM Australia no longer produced comprehensive sea level analysis reports so more up to date information is at this time unavailable even though the data is available. Otherwise it can only be assumed that long term sea level rise rates for Kiribati are expected to be close to the global average rate and global average projections are likewise the best guide for our planning needs at this juncture.

**Adopt IPCC RCP8.5 averages as the national agreed standards for sea level rise projections.**

There is currently no national or strategically agreed view of long term sea level rise rates or projections. This is extremely important to producing a common and unified approach to all aspects of adaptation and development planning in Kiribati.

From IPCC WGI 2013; two global sea level projection graphs show the comparative difference between RCP8.5 (about 80cm by 2100) and RCP2.6 (about 40cm by 2100). The implications to coastal security is large, RCP 8.5 would likely result in untenable stress and a different adaptation approach.

The question of which RCP value is “correct” is often mistakenly seen as a question for the physical sciences. RCP values are employed by the IPCC because questions of global socio-economic and governance commitment to emissions reduction are political questions. Put in plain terms, the IPCC RCP scenarios are the best available to represent differing global levels of commitment to green house gas emissions reduction. With technical support, Governments are better placed to decide which emissions future they believe will unfold. Science can assist to explain the ramifications of that emissions commitment.

The IPCC 5th Assessment Report (2014) uses 4 “Representative Concentration Pathways” or RCP scenarios; RCP2.6, RCP4.5, RCP6.0 and RCP8.5. RCP 2.6 represents a very high level of global effort to reduce green house gas emissions, whereas RCP8.5 is at the opposite scale and is a business as usual approach with continued growth in emissions.

Despite 30 years of IPCC work and warnings to the global community to reduce emissions there has been little global traction gained and concentration of CO₂ and other green house gases continue to increase every year.

Given Kiribati’s precarious position in respect to sea level rise, a precautionary approach would suggest Kiribati should adopt RCP8.5 as it’s national view in respect to IPCC projections. This can be reviewed as appropriate (perhaps coinciding with each IPCC cycle or as new compelling data comes to light) but otherwise benefits will accrue in the degree of simplification of adopting a single scenario for projected sea level rise and other climate change impacts.

Kiribati Government adopts a common agreed view in respect to the extent and timeframes of sea level rise and other important climate change impacts; an adaptation strategy will require that Kiribati Government discusses and agrees on some basic common views of the extent and times frames regarding climate change impacts, but particularly sea level rise. A common view will allow all sectors to plan and adapt according to a commonly envisioned future. Presently, misunderstanding of climate change science is common and a range of beliefs can be found among sectors, some even remain unconvinced regarding the reality and level of threat.

Develop a consensus based long term coastal security strategy and urgently begin implementation;

Long term coastal security is the first step which must be achieved to allow the goal of long term habitation of these islands to proceed. Long term refers to adaptation timeframes based on far reaching projections (minimum 200 years) and tackles both the challenges of sea level rise and other known climate changes impacts. It must also seek to accommodate the projected population in a safe, productive living environment.

For too long these issues have been dealt with euphemistically. Either, the blunt realities are discussed and technically feasible adaptation plans are drawn or Kiribati will rapidly loose the opportunity to adapt.