

# **Government of Kiribati**

## **Kiribati Adaptation Program**

### **Implementation Phase (KAP II)**

**GEF GRANT TF056267**

**Monitoring and Sustaining Coastal Ecosystems: Coastal Monitoring Network  
KAP II Component 2.3.2 IC 22**

### **Workshop Report**



Coastal erosion in a site located west of the Nippon Causeway, Bairiki , Tarawa. Source: Shennan, A. 2007

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## **Executive Summary**

This report has been written to address the Kiribati Adaptation Project Phase II (Implementation Phase) and the Terms of Reference (ToR) for the Monitoring and Sustaining Coastal Ecosystems: Coastal Monitoring Network Consultant (refer to Appendix A). The following key recommendations of the report are as follows:

- Multi-temporal image analysis to be used as the tool to address long term coastal changes as it is reliable and allows continued monitoring efforts. It is also a very powerful interpretative tool that can address different stakeholders both in village and in government bodies.
- KAP approaches SOPAC through MFMRD to secure assistance both in equipment and technical expertise to complete the required accuracy test for the case study islands in order for monitoring to commence.
- Mapinfo software be utilised as the platform for GIS work
- Results of multi-temporal image analyses be centralised on the MFMRD map server to make it readily available to other stakeholders for other uses and ensure development of appropriate coastal management plans.
- Coastal change information to be integrated into the coastal adaptation planning to assist in reducing coastal vulnerability.
- A glossary of coastal related terms in I-Kiribati with translations in English is developed. This would assist in the correct usage of existing local terms and lessen confusion amongst the locals with the creation of new terms.
- Inclusion of coastal into the curriculum is carried out at the beginning of the year to coincide with curriculum review. It is recommended that Mineral Unit work closely with the Kiribati Adaptation Project to ensure that this be done.

## **Summary Description of Project**

### **1. Introduction**

This report has been written as part of an implementation for the Kiribati Adaptation Project Phase II. This is in response to the Terms of Reference (ToR) for the Monitoring and Sustaining Coastal Ecosystems: Coastal Monitoring Network Consultant (Appendix A).

The ToR requested that the following be undertaken:

- i. The design of an extended coastal monitoring system that comprises sites in outer islands and sites that are not heavily urbanized by using multi-temporal image analysis which provides an understanding of how an island has changed overtime.
- ii. Techniques used for monitoring including standard survey and GPS methods;
- iii. Equipment requirements (GPS and survey instruments)
- iv. Data analyses and reporting

The above tasks have been dealt with under separate sections as they are isolated from each other.

### **2. Outcomes of In-country Workshop on Coastal Processes.**

The first task requested involves the following:

- i. The design of an extended coastal monitoring system that comprises sites in outer islands and sites that are not heavily urbanized by using multi-temporal image analysis which provides an understanding of how an island has changed overtime.
- ii. Techniques used for monitoring including standard survey and GPS methods;
- iii. Data analyses and reporting

## **2.1. Objectives**

The main objective of the project was to design an extended a systematic national coastal monitoring system that includes the full spectrum of islands settings (island size, energy exposure and degree of anthropogenic influence). This included establishing analyses and reporting protocols. The main outcome of the workshop is the development of a road map to allow monitoring efforts from different bodies within the Government Ministries to be integrated and this would facilitate a full exchange of data and joint analyses.

Note: Clarification on the amount of funding available was available after the workshop therefore the information contributed by the participants are still included in this report, as a guidance to the Line Ministry on islands to focus on when extending its coastal monitoring efforts. In addition, amendments to the workshop recommendations have been made to take into consideration this funding clarification (see page 19 - 20).

## **2.2. Methodology**

A workshop was held from Tuesday 6<sup>th</sup> to Friday 9<sup>th</sup> November, 2007 to provide invited participants who were middle managers, technical staff of the Government and other related bodies like Tarawa Urban Council with an understanding of the coastal processes, and the importance of coastal data towards coastal management planning and adaptation efforts (Appendix B: Participant List and Appendix C: Workshop Agenda). It was opened by Coordinator for the Kiribati Adaptation Project - Mr Kautuna Kaitara at the Otintaa Hotel and closed by Mr Kaiarake Taburua, Kiribati Adaptation Project Manager at the Maneaba in Biketawa, North Tarawa.

The workshop commenced with a series of simple technical presentations covering the topics: coastal processes, natural effects like ENSO, human induced effects and use of GPS (Appendix D). The workshop was carried out in I-Kiribati language to allow the participants a better understanding and appreciation of the general basis of coastal processes and management.

It was not possible to provide the participants with a hands on to familiarise themselves with the techniques used for monitoring which included standard survey and GPS methods as time was limited. Therefore the discussions concentrated on the results of the resource

material as it was based on the comparison of results obtained from two different tools: beach profiling and multi-temporal image analysis using case studies from Tarawa. Study sites used were from an urban area which had a high degree of human influence (Betio and Bairiki), intermediate area (Bikenibeu and Abatao) and to a comparatively pristine area (Buariki).

The participants were taken through the following topics:

- a) Different data sets involved in multi-temporal image analyses both historical and satellite imagery;
- b) How and where to obtain the data sets;
- c) How to undertake an accuracy test for geo-referenced satellite images involving GPS work;
- d) GPS equipment involved;
- e) Steps involved in multi-temporal image analyses;
- f) Comparison of results obtained from multi-temporal and beach profiling;
- g) Benefits and limitations of both tools to address climate change (Appendix D).

The above information provided the participants with an understanding of the powerfulness of the tool when addressing climate change and how it could be utilised when addressing the public both in Government level and local village level. It also prepared the participants with necessary information to discuss and develop a road map for coastal monitoring (Table 1). It also prompted them to request additional islands to be covered under the Kiribati Adaptation Project (KAP), noting that the islands selected by KAP (i.e. Tarawa and Tamana) did not require a lot of resources, as their images were available and secondly that SOPAC in close collaboration with the Mineral Unit would complete a 63 year coastal change analyses of Tarawa by this year. The participants also developed appropriate strategies as to how the national TA should proceed in the 8 month assignment (Appendix E).

Field visits were taken on both South Tarawa and North Tarawa to provide participants with an appreciation of the actual changes that have or are taking place on the ground. Participants were taken to see the effects of human developments or activities (jetties, reclamations, bunkers, groynes and beach mining) and natural (storms) effects determining

coastal changes in different settings (urban and comparatively pristine areas). Areas where structures acting like groynes blocking longshore sediment transport, causing down drift erosion and updrift accretion were visited i.e. coastline east of the Bairiki jetty, area near St Anne reclamation, and bunkers in Betio.

### **2.3. Resource Materials**

Resource material (power presentations) used in the workshop are attached as Annex D.

### **2.4. Design of Extended Coastal Monitoring System.**

Design of an extended coastal monitoring system is based on several factors like geographical location (spread from North to South Gilbert Islands), different atoll setting (with lagoons, without lagoons table reefs), climate conditions having impacts of ENSO (5 degrees N and S of equator are reported to have effects of cyclones i.e. Butaritari and Makin). Other factors include degree of human impacts (disturbed /undisturbed) and different sizes of islands.

The additional islands selected as case studies are Butaritari, Abemama, and Tabiteuea. Butaritari was selected to represent the northern islands as it was reported to have less effects of Southern Oscillation Index (SOI) noting that it lies close to Makin Island reported to have less effects of SOI (Woodroffe and Morrison, 2001). Another reason is that it has been selected as a site for coral monitoring under the Coral Monitoring Component of KAP.

It is necessary to provide an understanding about carbonate producing organisms responsible for the carbonate production on reef flats on ocean and lagoon sides of the islands and where they originate. An understanding of the carbonate producing organisms and the source is fundamental for the management of these coastal resources. These organisms provide the sediments for the beaches, which are the forefront defence of coral atolls. For coral atolls that are low lying and vulnerable to sea level rise, these sediment that accumulate and deposit on beaches are an invaluable asset. If the sediment production is disrupted then there may be no source of sediment to these islands which would be detrimental. It is therefore important to determine and understand what carbonate

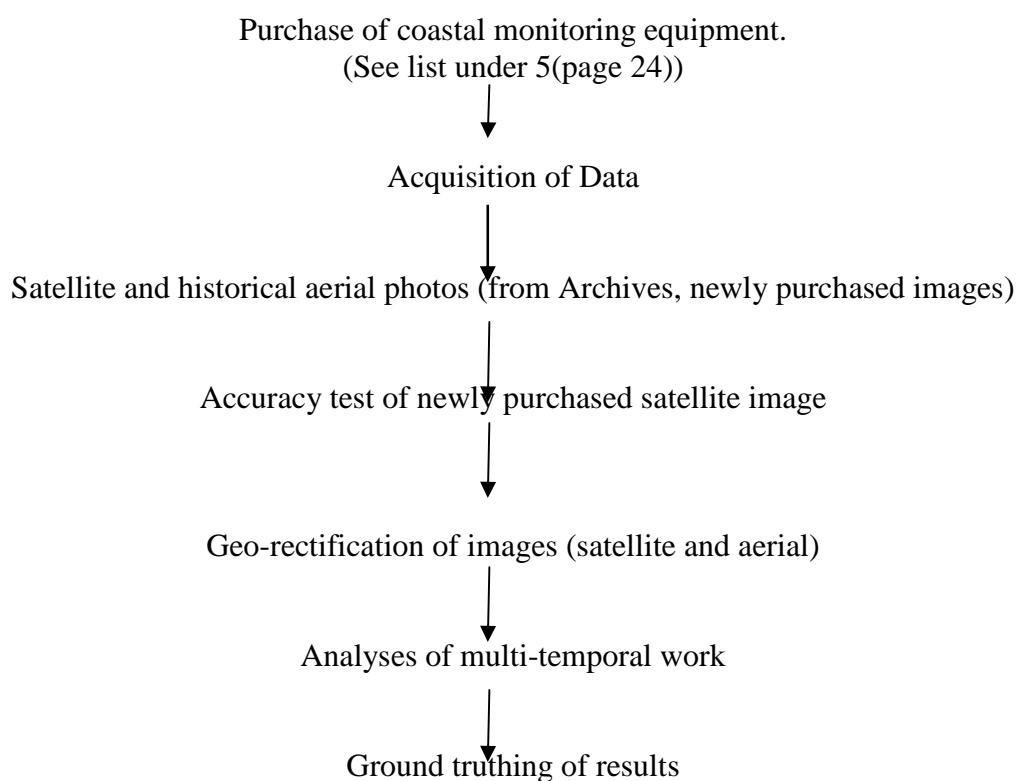
producing organisms are responsible for providing these sediments for these atolls and their origin.

Abemama was chosen to represent the central Gilbert Islands and its island setting. Tabiteuea Island was picked as development efforts are progressing with the near completion of the Hospital in Tabiteuea North. It was considered that there is an urgent need to provide Government with coastal change information so that a land management plan can be developed for the islands which includes setbacks. There is concern that if this is not carried out then the same issues on South Tarawa may occur on these islands.

Aerial photo coverage of Tabiteuea Island is low requiring further search both in-country and overseas in archives. It is recommended that KAP provides the cost for obtaining the satellite images, search cost for aerial photos should they not be in country and cost of retrieval.

## 2.5. Implementation Strategy

Below is a flow diagram for the implementation strategy which is further explained in Table 1.



## 2.6. Discussions

a) Discussions were undertaken as to which ministry should play the leading role in coastal monitoring noting that each ministry invited to the workshop had different responsibilities in regards to the coastal area. This would allow integration of collaborative efforts on coastal monitoring thus reducing duplication of work and most importantly allow a full exchange of data and joint analyses. It was noted that the Mineral Unit under the Ministry of Fisheries and Marine Resources Development has built its capacity in this area. One is currently undergoing training as part of the KAP work and the other is currently undergoing postgraduate training using the same methodology. The unit has also been active in coastal monitoring using beach levelling monitoring tool. It was noted that the Mineral unit under the Ministry of Fisheries and Marine Resources Development should play the leading role in coastal monitoring whilst others play a supportive role.

b) It was considered that a staff within the Mineral Unit responsible for coastal monitoring, who has prior experience on the tool be trained to undertake this eight month assignment with KAP to implement coastal monitoring for the case study island or islands. This would provide capacity building for the unit and ensure that the staff would be able to continue this effort for the remaining islands identified under the Ministries MOP.

c) Participants noted that there was a need to include several other islands noting that the case study islands selected by KAP had available images on hand. For instance:

i) Tamana: has a complete set of images with a Quick bird pan sharpened image, and a set of aerial photos from 1964;

ii) North Tarawa: Biribo and Webb have completed a study using several sites namely Buariki and Abatao and determined the coastal changes over a period of 35 years (1968 – 2003). This report will become available to Kiribati this year to assist with their efforts on coastal management. Another study is to be carried out by SOPAC in close collaboration with the Mineral Unit, MFMRD to cover the whole island of Tarawa for 1943 – 2006, and a 63 year period.

As earlier noted this new list of islands could assist with Kiribati's future monitoring efforts.

d) Satellite images even though were geo-referenced when purchased, were still not accurate, and need to undergo an accuracy test (Wolf and Lomani, 2007). Participants requested that the Mineral unit request that Pacific Applied Geoscience Commission

(SOPAC) to assist in regards with the accuracy test for Tamana Island. In addition the organisation has currently purchased a new set of GPS equipments and with expertise and experience in undertaking accuracy tests, it was recommended that KAP approaches SOPAC through MFMRD to provide the Mineral, Lands and Environment Division with a 2 week training involving collection of data, down loading of data and applying the geometric correction to the Quick bird pan sharpened image. Kiribati will be purchasing a GPS system under the Maritime Boundaries Project which is of priority to the Government. Plans are to submit the proposal and undertake the fieldwork in close collaboration with SOPAC in the latter part of this year. It is therefore considered not appropriate to purchase two expensive equipments for the country.

SOPAC is a regional organisation of which Kiribati is a member, and can continue to provide technical support on this methodology. The organisation aims to build regional and national capacity so that such data from multi-temporal image analyses can assist in advising national Governments in developing their policy in relation to adaptation and mitigation strategies (Eastwood, 2007).

e) A three month contract can be undertaken when all equipment have been received and once assistance from SOPAC for accuracy test of satellite image is secured with KAP. The consultant can complete analyses on Tamana based on information from the Mineral Unit, all images are currently available. Only the 2006 Satellite image needs to have undergo an accuracy test before monitoring can start. If KAP opts to include another island, then the consultant will be required to order the second set of satellite images for the second phase of the contract. The second contract can undertaken once satellite images have been bought.

h) It was noted that compatibility of programs on which the information was to be provided was essential as it reduced time when different stakeholders access the information. As most stakeholders in Kiribati used Mapinfo software for GIS work, and secondly because it was in line with the Forums decision in late 1990's, it was recommended to be used as the GIS platform.

i) To allow stakeholder access, results of the images needed to be centralised and easily accessible. The use of the MFMRD's map server would assist in ensuring that other

stakeholders could access the information which can be used to address land issues, social issues and others.

j) Key players in coastal awareness (Mineral Unit, ECD and MISA) should make every opportunity to ensure that coastal awareness is carried out using multi-temporal imagery results. Examples are through KAP, ECD and MISA workshops.

k) A glossary of coastal related terms in I-Kiribati with translations in English was required to assist with the correct usage of local terms and lessen confusion amongst locals with the creation of new terms. A workshop is to be held with local navigators, old men and Kiribati language teachers as selected participants. Mineral Unit should liaise closely with the Kiribati Adaptation Project for the timing and venue.

l) Kiribati Adaptation Project and the Mineral Unit to ensure the inclusion of the coastal subject into the curriculum which would be reviewed at the beginning of this year.

## **2.7. Questions and comments**

a) Environment representative requested that Environment who plays a supporting role in coastal monitoring to be included under capacity building in areas of; accuracy test of satellite image; image geo-rectification and ground truthing. This will ensure that tool was understood at different ministry levels should there be a need to request support when undertaking fieldwork plus other associated activities of the multi-temporal analysis work.

b) Representative from MISA asked what organisation was responsible for acquiring images. He noted that the images both historical and satellite images required for the work were expensive and would require a certain amount of funds. It was explained that the Pacific Applied Geoscience Commission (SOPAC) was able to assist at the regional level with the purchases of correct images, through RADARSat. Benefits of the arrangement would provide a single license for all Government bodies and Non Governmental bodies in one country for the use of the satellite images.

c) Environment representative mentioned that the Office of Te Beretitenti had requested assistance to the Environment Division in regards to the coastal issues in Government leased areas on South Tarawa. The Environment representative further commented that the Division was not able to assist, and suggested that OB be advised of the draft report by

Biribo and Webb (2008) and how it may assist with the issue. OB to be advised to redirect their issue to the Mineral unit who is responsible for coastal issues as such.

d) MISA suggested that project should be undertaken by Mineral Staff as they have the responsibility and capacity to do it. In recognising their capability he advised that MISA will include them in their future visits to outer islands on coastal erosion issues.

e) MISA representative asked if the project could consider including other outer islands to represent the Gilbert Group noting that North Tarawa and Tamana did not provide true representation. He noted that a current study has completed multi-temporal image analyses for Abatao and Buariki, North Tarawa, therefore there was a possibility to cover some other islands noting the powerfulness of the tool to serve as a base-map for other work such as island profiling? KAP responded advising that there was a possibility to cover some other islands depending on the availability of funding and it was best that the selection based on a certain criteria. Selection of islands was based on geographical location spread from North, Central and South, different island types, as well as climate conditions (impacts of storms, climate), degree of human impacts etc. In addition to the projects limited time frame, selection of islands were also based on the availability of imagery in Kiribati.

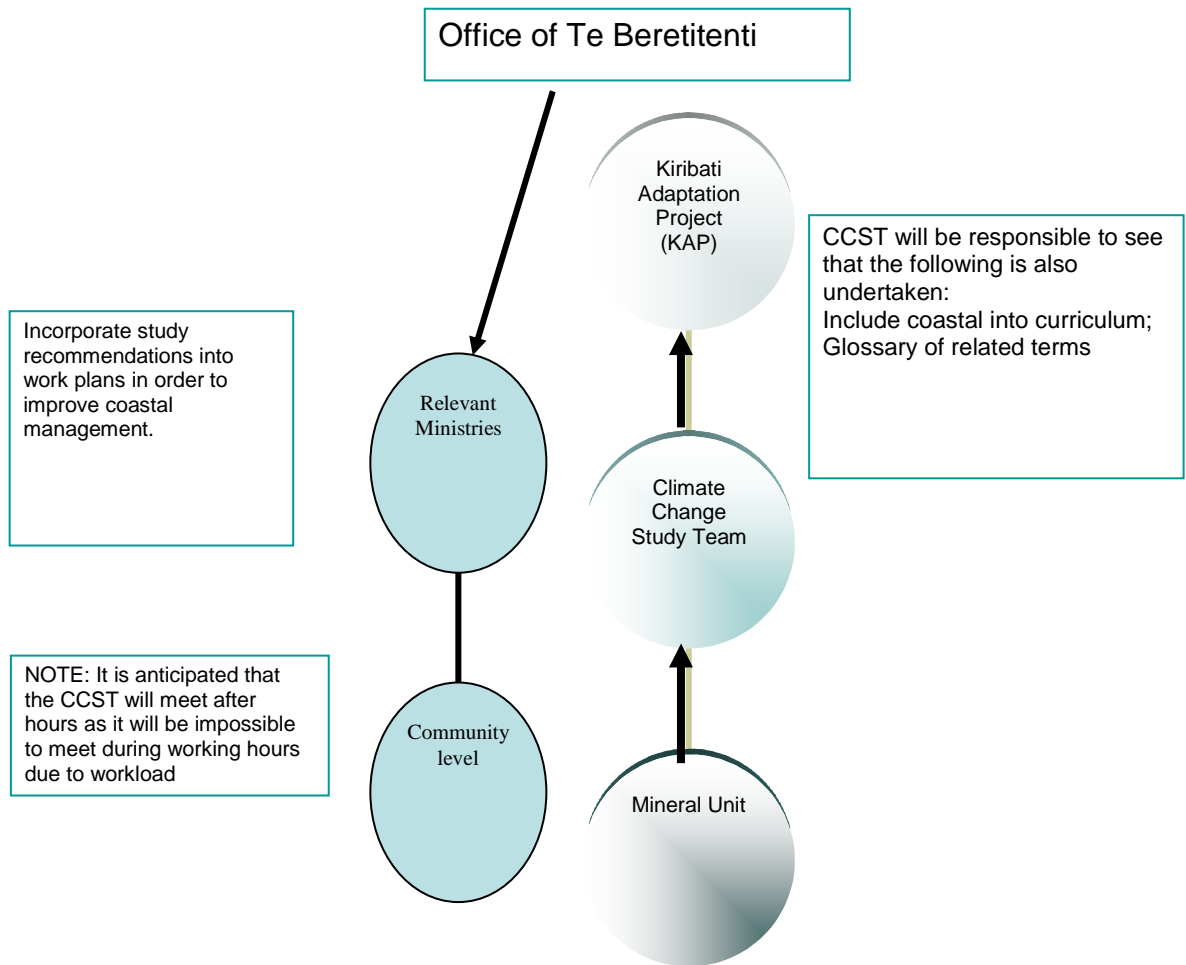
**Table 1: Kiribati Coastal Monitoring Road Map**

| <b>Activity</b>  | <b>Possible Funding</b>   | <b>Responsible</b>  |
|--|---|---|
| Purchase of equipment<br>(scanner, laptop, digital camera,<br>accessories (colour toners) etc) | KAP and MELAD (Second<br>National Communication)  | KAP/Lands and Mineral   |
| Acquisition of data<br>(imagery)<br>(Archives/ Radar Sat/Local Archives)                       | KAP initial and MELAD<br>(Second National<br>Communication)<br>Seek possibility of funding<br>from Kir_EU<br>Ministries concerned                                 | Mineral/SOPAC   |
| Accuracy test of satellite image   | KAP<br>MELAD (Second National<br>Communication Project)<br>Ministries concerned (future)<br>Mineral and related<br>ministries budget<br>Kir_EU (for some islands) | Lands Division/Mineral<br>Unit with short term TA<br>in assistance with<br>acquisition of secondary<br>ground control points<br>and shift of image<br>* |
| Geo-rectification of images  | KAP initially<br>Mineral Unit budget  | Mineral Unit<br>*   |
| Analysis   | KAP initially,<br>Mineral Unit recurrent<br>budget  | Various ministries;<br>SOPAC<br>Capacity building for<br>Mineral Staff on coastal<br>processes analysis   |
| Additional information required  | KAP, other possible projects  | Biological<br>(Fisheries/ECD);<br>Bathymetry, current<br>flow; temperature, wind<br>data, ENSO, sediment<br>analysis                                    |

|   |  |  |
|---|--|--|
| Output GIS based  | KAP initially,<br>Mineral Unit recurrent<br>budget | Mineral Unit<br>Centralise Coastal Data<br>Reports   |
| Policy advice   | KAP initially,<br>Recurrent budget                 | All Ministries having<br>responsibilities on<br>coastal areas: MPWU,<br>MFMRD, MELAD,<br>MISA  |
| Regulations   |  | All responsible<br>ministries with guidance<br>from AG's chambers  |
| Awareness-<br>Presentations;<br>Pamphlets, drama, media (radio), Annual<br>Coastal Awareness week<br><br>Audience to address<br>Use church maneabas for presentations in<br>villages;<br>Schools<br><br>Curriculum – address primary up to<br>secondary level | KAP  | Mineral Unit, ECD,<br>MISA<br>Use any available<br>opportunity provided<br>through KAP, ECD<br>workshops and MISA to<br>promote coastal<br>awareness<br><br>Inclusion under KAP<br>curriculum review |
| Glossary of coastal related terms in I-<br>Kiribati/English (invite local navigators,<br>unimane, Kiribati Language teachers for<br>a workshop)   | KAP  | Mineral Unit, ECD,<br>MISA   |

- Notes \* ECD request inclusion in activities as part of capacity building for division.

**Fig 1. Coastal Monitoring Reporting**



## **2.8. Workshop Recommendations:**

The following recommendations were proposed by the workshop participants:

- a) It was recommended that multi-temporal image tool be utilised to monitor coastal changes as it is considerable reliable providing area changes, rates of changes and assists in identifying possible causes of changes.
- b) It was recommended that the Mineral unit under the Ministry of Fisheries and Marine Resources Development play the leading role in coastal monitoring and to ensure that data is readily available on the MFMRD map server.
- c) Staff responsible for coastal management within the Mineral unit is considered to take up the 8 month attachment and complete work required for multi-temporal image analyses in order to build the units capacity on the usage of the tool. It is recommended that this strategy is also considered for other sectors of which KAP will provide capacity building.
- d) In addition to the case study island the following islands were recommended to be included based on geographical location, different atoll setting, and to be linked with the sites for the coral monitoring. The following islands are Butaritari, Abemama and Tabiteuea. In addition to the ToR of the National Consultant, the following tasks be included purchasing of satellite images and historical aerial photos for Butaritari, Abemama and Tabiteuea and to take wherever possible accuracy tests for the satellite images.
- f) It was recommended that the Mineral Unit provide the delegation representing Kiribati at the Pacific Applied Geoscience Commission Annual Session in Tonga to seek assistance from the organisation in regards to the accuracy test for one case study. As SOPAC is currently purchasing a new set of GPS equipments and with their current expertise and experience in undertaking accuracy tests, it is recommended that they be approached to provide the Mineral, Lands and Environment Division with a 2 week training involving collection of data, down loading of data and applying the geometric correction to the Quick bird pan sharpened image. In addition SOPAC being a regional organisation can continue to provide support to Kiribati when carrying out this methodology.
- m) It was recommended that as Kiribati does not have any capacity in purchasing correctly required images, KAP seeks SOPAC's assistance on this matter through the Ministry of Fisheries and Marine Resources Development.

- n) Noting the above works required to complete the case study sites, it was recommended that the national consultancy be split into two portions to utilise time efficiently. A 2 month contract can be undertaken once all equipment are in place, and once assistance from SOPAC for accuracy test of satellite image is secured with KAP. The consultant will be required to complete analyses for Tamana as the images are readily available, except the 2006 Satellite image which requires to be corrected. The consultant will also be required to order the second set of satellite images required for the second phase of the contract. The second term can be undertaken once satellite images have been bought. Butaritari will be the second case study to be completed by the consultant and the remaining islands is completed by the mineral unit at the end of the contract.
- o) It is recommended that Mapinfo program to allow compatibility noting that it is currently the most used program with Kiribati and as well it is the Forums decision.
- p) It was recommended that the results of the images be centralised and made readily available on MFMRD's map server to allow other stakeholders access to such information that can be used to address land issues, social issues and others.
- q) It was recommended SOPAC be approached for analysis assistance in order to analyse the GIS outputs from the consultancy and the mineral unit, noting that the Mineral Unit does not have the capacity to analyse the results.
- r) It was recommended that results of the studies be incorporated into work plans to improve coastal management.
- s) It was recommended that Mineral unit, ECD and MISA are responsible for coastal awareness and to utilise any opportunity provided through KAP, ECD and MISA workshops to promote coastal awareness.
- t) It was highly recommended that a workshop be held soon to develop a glossary of coastal related terms in I-Kiribati with translations in English. Selected participants are local navigators, old men and Kiribati language teachers. This was to allow correct usage of the local terms and lessen confusion amongst the locals with the creation of new terms.
- u) It is recommended that the Mineral Unit and Kiribati Adaptation Project ensure the inclusion of coastal into the curriculum which is to be reviewed at the beginning of the year.

## Note

As earlier noted, based on clarification of funding, amendments were made to the following recommendations:

d) For the case studies, two options are recommended:

**Option One.** KAP pilot islands, focusing on Tamana island noting that North Tarawa has been completed and that a report is to be received by Kiribati Government this year.

(Note that all costs used are estimates)

| Items   |   | Costs                       |
|---|---|-----------------------------|
| Satellite Accuracy test<br>Three participants: Mineral,<br>Lands and Environment<br>staff | Return ticket to Tamana<br>\$304 return ticket  | \$912.00                    |
|   | One week per diem<br>(\$45 per night per person)  | \$945.00                    |
| Miscellaneous costs   | Fuel for generator to recharge<br>batteries for GPS, batteries for digital<br>camera, etc | \$300.00                    |
| Ground truthing   |   |                             |
|   | Return ticket for Mineral Staff   | \$152.00                    |
|   | Transport cost<br>\$20 per day  | \$20 x 5 days =<br>\$100.00 |
|   | Per diem  | \$315.00                    |
|   | Total Cost  | \$2,724.00                  |

**Option Two.** KAP pilot islands and take on an additional island. Based on available information from the Mineral Unit, only Abemama Island has a complete set of aerial photos for 1969 and an IKONOS satellite image for 2003. The resolution of the image is poor to allow comparisons with the 1969 images therefore it is recommended that a Quick bird pan sharpened image be bought. Noting that the image would need to be purchased and then undergo another accuracy test, it is

considered cost effective if the accuracy test for the images be carried out consecutively. It is therefore recommended that option two should not be considered as it would result in further delay to the coastal monitoring efforts.

| Items   |   | Costs                       |
|---|---|-----------------------------|
| Purchase cost of satellite image  | New collect Pan sharpened image for 366 sqkm - USD \$6,810.00                       | \$ 9900.00                  |
| Satellite Accuracy test<br>Three participants: Mineral, Lands and Environment staff | Return ticket to Tamana<br>\$304 return ticket                                      | \$912.00                    |
|   | One week per diem<br>(\$45 per night per person)                                    | \$945.00                    |
|   | Return ticket to Abemama<br>\$122 return ticket                                     | \$366.00                    |
|   | One week per diem<br>(\$45 per night per person)                                    | \$945.00                    |
| Miscellaneous costs   | Fuel for generator to recharge batteries for GPS, batteries for digital camera, etc | \$600.00                    |
| Ground truthing   |   |                             |
| Tamana  | Return ticket for Mineral Staff   | \$152.00                    |
|   | Transport cost<br>\$20 per day  | \$20 x 5 days =<br>\$100.00 |
|   | Per diem  | \$315.00                    |
| Abemama   | Return ticket for Mineral Staff   | \$122.00                    |
|   | Transport cost<br>\$20 per day  | \$20 x 4 days =<br>\$80.00  |
|   | Per diem for 4 days   | \$180.00                    |
|   |   |                             |
|   | Total Cost  | 14,617.00                   |

Option One will have savings under the budget line for the National Consultant, as it is estimated that three months would be adequate to complete the work. This provides a possible option to support the required services from SOPAC to carry out the two week consultancy on accuracy testing.

n) Noting the above works required to complete the case study sites, the proposed timeframe for the two options be considered for the National Consultant. It was also recommended that the contracts be undertaken once all equipments are in place, and once assistance from SOPAC for an accuracy test is secured with KAP in close consultation with MFMRD:

**Option One**

A three month contract to carry out all the required work for Tamana island, including the ground truthing of results.

**Option Two**

A eight month contract to carry out the required work for both Tamana and Abemama once image of Abemama has been purchased.

### **3. Coastal Monitoring System in Gilbert Islands.**

The second task involves three parts:

- Work with Members of MFMRD to design an extended monitoring system in the Gilbert Islands;
- Work with members of MFMRD to implement the extended monitoring system;
- Oversee the analysis and reporting of the initial monitoring field data.

This section addresses the tasks outlined above and summarised below are the outputs.

#### **3.1 Summary of work involved with Mineral Unit under MFMRD.**

Selected case study islands under the KAP project are Tamana and Tarawa. For the purpose of this exercise with the Mineral Unit, work concentrated on Tarawa as images were available from 1968, 1998 and 2003. Selection of Bairiki and Abatao islets were used to represent disturbed and undisturbed islets respectively. Coastal changes of these islets were determined using multi-temporal image analysis tool.

The tool allowed full coverage of islets or island depending on the availability of images both satellite and aerial photos. It allowed coverage of urban (disturbed) areas as well as comparatively pristine areas. Training assistance was provided to the Mineral Unit to enable them to undertake extended monitoring in the Gilbert Islands and selection of islands were left to be discussed during the workshop as there it was considered that more ideas were required to assist with the selection of islands (refer to 2.4).

#### **3.2 Methodology**

Methodology for the multi-temporal work is based on previous work carried out by Webb (2005, 2006a, 2006b) in Funafuti, Tuvalu and site specific locations in Abaiang and South Tarawa in Kiribati.

Historic aerial photo hard copies scanned at a high resolution available as tiff. were utilised by the Mineral Unit. These were then digitally manipulated or rectified using a

mapping software (ERDAS Imagine 8.4<sup>®</sup>) and the geo-referenced 2003 IKONOS image. As discussed by Biribo and Webb (unpub) rectification of earlier images that have no defined roadways, permanent houses and other structures can be corrected using permanent and persistent natural and man made features for example beach rock, reef features, stone fish traps, isolated coral heads, etc.

This procedure allowed extremely accurate rectification of earlier aerial photos and the limit of accuracy was more related to the comparatively poor resolution of the IKONOS imagery (4m) rather than process error. All completed images from 1968, 1998 were embedded with the geographical projection, Universe Transverse Mercator (UTM) Zone 59 WGS84 which enabled the images to be used in any GIS system. Coastlines were then traced from each year for comparisons of shore line positions using MapInfo<sup>®</sup>. This also allowed comparison of overall islet area over time. The shoreline position was based on the vegetation line, but did not include intertidal vegetation like mangroves as they lie on the intertidal flats.

The procedure involved in geo-referencing was done in steps by geo-rectifying 1998 aerial photographs against the geo-referenced 2003 IKONOS image. Once this was completed it was then used to rectify the 1968 aerial photos. It was noted that this approach may not be optimum due to the possibility of cumulative error, but it was considered best as it allowed clearer interpretation and comparison of features to the older 1968 images. Staff was shown how to undertake quality control of the rectified images before undertaking shoreline digitisation in each different layer. Polygons were used to represent areas and which comparison was undertaken to determine the area changes.

### **3.3 Reporting and Analyses.**

Results of work were presented in a tabular form to provide the area change, rate of change and overall percentage change (Table 2).

Table 2: Area changes for Abatao (comparatively pristine) and Bairiki (urban).

|                                  | Period    | Abatao | Bairiki |
|----------------------------------|-----------|--------|---------|
| Area Ha                          | 1968      | 75.694 |         |
| Area Ha                          | 1998      | 77.172 | 38.634  |
| Area Ha                          | 2003      | 77.683 | 40.043  |
|                                  |           |        |         |
| Area increase Ha                 | 1968-1998 | 1.478  |         |
| Area increase Ha                 | 1998-2003 | 0.511  | 1.409   |
| Overall increase Ha              | 1968-2003 | 1.989  | 1.409   |
|                                  |           |        |         |
| Rate of increase (Ha/yr)         | 1968-1998 | 0.049  |         |
| Rate of Increase (Ha/yr)         | 1998-2003 | 0.102  | 0.282   |
| Overall rate of increase (Ha/yr) | 1968-2003 | 0.151  |         |
|                                  |           |        |         |
| % increase in area               | 1968-1998 | 1.903  |         |
| % increase in area               | 1998-2003 | 0.657  | 3.520   |
| Overall % increase in area       | 1968-2003 | 2.560  |         |
|                                  |           |        |         |

Area change for Bairiki was completed for the two years, 1968 and 1998 whilst for Abatao the years 1968, 1998 and 2003 layers were completed. Analyses of the results was not possible as this requires long term training in coastal processes before one could understand properly why such changes had occurred etc. It is therefore recommended that the following be undertaken:

- a) Results are provided in a tabular format and geo-rectified images in digital format so that stakeholders can utilise the results to assist them with their needs.
- b) Long term training on coastal processes is provided to the Unit to build their capacity in this area so as to assist the Government with its current issues and thus improve coastal management.

This monitoring tool can assist the SOPAC/EU Aggregates Mining project by providing the baseline information of the coastal changes that have taken place prior to the commencement of the project. Continued monitoring efforts can assist in providing an insight as to what coastal changes may have taken place due to the project on the coastal areas of Betio islet.

#### 4. Current status of affairs in respect to coastal monitoring and analyses efforts.

This task involves outlining stakeholders' activities and state of affairs in respect of coastal monitoring and analyses efforts.

| Division/Ministry   | Monitoring   | Analyses  |
|---|--|---|
| Mineral Unit/Ministry of Fisheries and Marine Resources Development | <p>Ms Yeeting responsible for coastal monitoring has been assisting the Mineral Unit in its beach profiling programme. She has been attached to SOPAC to undertake scanning of the available historical aerial photos for Kiribati islands. These digital datasets are currently housed within the Mineral Unit, MFMRD. She has been working closely with SOPAC staff on multi-temporal image analyses. Ms Yeeting has also been part of a national team who assisted SOPAC staff in their recent work to undertake an accuracy test of a Pan sharpened satellite image.</p> <p>The Mineral Unit is currently utilising multi-temporal image analyses to monitor coastal changes in islands of Butaritari, Tamana, Abemama, Marakei and Christmas. It has capacity</p> | <p>The Division currently lacks the capacity to analyse results. Analyses or interpretation of the results is a separate matter requiring a higher level of qualification and experience of understanding the coastal processes in order to analyse and discuss the results correctly, that is not currently available in Kiribati. To address this in the short term, the Unit may require external assistance on the analyses or interpretation of its monitoring results. For the long term, Kiribati may wish to train staff on coastal management in order to provide assistance in these national issues.</p> |

|   |   |  |
|---|---|--|
|   | to undertake this monitoring effort and provide a GIS data to assist with adaptation efforts as well as providing time series of coastal area changes depending on data availability.                               |  |
| Environment Division/Ministry of Environment, Lands and Agriculture | Division is using beach profiling to determine spatial coastal changes when monitoring effect of coastal development. The division has also expressed interest to be involved in the multi-temporal image analysis. | The Division currently lacks the capacity to analyse results. Comments above are also applicable here. |

#### 4.1 Recommendations

3. It is recommended that multi-temporal image analysis is used to address climate change as it provides a longer and reliable data. Another benefit of the tool is that it is visual and very powerful when addressing different levels of the communities and government bodies.
4. As capacity building is provided to the Mineral Unit staff, it is recommended that monitoring of coastal changes be carried out by the Mineral Unit as they have been involved in monitoring of coastal areas and have some hands on experience with the tool. Outputs are to be made available as GIS formats to interested stakeholders. Prior to the release of the outputs the Mineral Unit may wish approach SOPAC to provide a quality check of the obtained results.
5. It is recommended that outputs be made available on GIS using Mapinfo software as most stakeholders use the program. Digital outputs to be made available on the map server so information is centralised on the MFMRD map server. Accessibility to the information would assist in improving national coastal adaptation efforts.
6. Interpretation and use of outputs can be carried out by the different stakeholders as the currently Kiribati lacks such expertise in interpreting the results. Kiribati may seek assistance where available in interpreting the outputs and it is strongly recommended that

the information be integrated into the national development or adaptation planning to reduce coastal vulnerability (Kench, 2005).

7. Kiribati currently lacks capacity in coastal processes therefore there is an urgent need to build local capacity in this area.

## 5. Technical Specifications for Coastal Monitoring Equipment Needs

The task involves the providing advice on the procurement of necessary equipments to support field based monitoring. Total indicative costs for the equipment is AUD\$15,463.00.

### 1. Electronic Equipment

These electronic equipments are available from vendors in Australia, New Zealand or Fiji.

a) Mobile workstation Indicative cost: \$4,800.00

1 x mobile workstation with the following specifications:

- Processor Type and clock speed: Intel Core Duo T7700/2.4 GHZ – with Centrino Pro processor technology capable
- Storage: Hard drives: 120/160 GB
- Optical drives– DVD +/- RW
- Card reader: multi
- Memory- Ram 2 GB
- Networking : Gigabit Ethernet – Wifi Link
- Bluetooth 2.0
- Display: 17" widescreen antiglare
- Max resolution 1900 x 1200 (WUXGA)
- Weight: not more than 3kgs
- Year Warranty and backup service
- 1 x Backpack or Laptop carry bag
- 1 x USB Mouse

b) A3 size colour scanner Indicative cost: \$6,800.00

(1 x A3 Colour scanner and 1 x Transparency adaptor)

1 x A3 scanner with following specifications

- Type: Flatbed scanner
- Colour depth: 48 bit colour
- Gray scale depth: 16 bit(64K grey levels)
- Input type: Colour
- Interface type: Fire wire / USB
- Interface type (2<sup>nd</sup>): Fast SCSI
- Maximum optical resolution: 1600 dpi
- Max supported media size: 305 x 432mm
- Media feeder type: Manual
- Scan mode: Single pass
- Supported media type: film, plain paper, slides, transparencies
  
- Operating System requirements: Microsoft windows 2000, Microsoft Windows XP
- Power device: Power supply to meet 100V -240 V
- Transparency adaptor: Preferred scan area of 409 x 307mm
- Compatibility: PC

c) Multi-media server (Network Attached Storage) Indicative cost: \$1,300.00

1 x Network Attached Storage with following specifications

- LAN interface: Gigabit Ethernet
- Storage Controller: RAID 0, 1, 5,10 JBOD
- Internal Hard drives: 4 having a total capacity of 3.0TB.
  - : Rotational speed: 7200RPM
- USB Interface: standard compliance: Data transfer rates: 480Mbps
- Protocol support: Networking
- Power supply: Internal AC100V-240V 50/60Hz
- Inbuilt cooling system and able to withstand more than +65° C
- Easy maintenance from front;
- Easy setup wizard and management through web interface.

d) USB Flash Disk Indicative cost: \$163.00  
 1 x USB flash disk with - 1GB capacity

e) Digital Camera Indicative cost: \$570.00  
 1 x 7.1 mega pixel digital camera with the following specifications

- 6 x optical zoom,
- 2.5 inch LCD screen
- Charger set with 6 spare rechargeable Alkaline (AA) size batteries
- 1GB SD card,
- USB port,
- Camera carrying case

*Consumables:*

These are available from any office equipment shop in Kiribati, Fiji, Australia or New Zealand

|   |          |
|---|----------|
| 200 x Blank DVD+R D/LIFE+ 4.7GB   | \$180.00 |
| 100 x Blank CD's CD-R 80min 700MB   | \$330.00 |
| 2 x HPM 6 way Power Board Surge Protector   | \$90.00  |
| 2 x Extension Cords - 5m  | \$50.00  |
| 1 x CD-Rom Drive Cleaner  | \$20.00  |
| 4 x cartons A3 paper reams  | \$5.00   |
| Specific needs: Print cartridges for the current printer, HP Color Inkjet CP1700 in the Mineral Unit. | \$45.00  |
| 6 x C4844A HP No. 10 CP1700 Black Ink Cartridge   | \$276.00 |
| 6 x C4836AA HP No. 11 CP1700 Cyan Ink Cartridge   | \$293.00 |
| 6 x C4837AA HP No. 11 CP1700 Magenta Ink Cartridge  | \$293.00 |
| 6 x C4838AA HP No. 11 CP1700 Yellow Ink Cartridge   | \$293.00 |

## References

Eastwood, P. 2007. Asia Pacific Network for Global Change Research RCP Full Proposal: Historical Reconstruction and Mapping of Pacific Island Coasts (PI-CoastMap). 19pp.

Kench, P. 2005. Coastal protection measures report. Kiribati Adaptation Program, Preparation for Phase II project. Government of Kiribati. 76pp.

Wolf, F. and Whippy, L. 2007. Accuracy test of geo-referenced Quick bird image data in Moresby, Papua New Guinea. Pacific Applied Geoscience Commission Technical Report No

Woodroffe, C.D. and Morrison, R.J., 2001. Reef-island accretion and soil development on Makin, Kiribati, Central Pacific. *Catena*, 44: 245-261.

## Appendix A

### **Terms of Reference for Coastal Monitoring**

The objectives of this Technical Assistance are to design and implement a systematic national coastal monitoring system that includes the full spectrum of island settings (island size, energy exposure and degree of anthropogenic influence). The TA will also be responsible for establishing analysis and reporting protocols. Wherever possible, the TA should contribute to enhanced national coordination of various types of monitoring of island systems.

#### **1. Tasks**

It is expected that the TA will:

1. Design and deliver a 1 week training workshop to cover:
  - a. The design of an extended coastal monitoring system that comprises sites in outer islands and sites that are not heavily urbanised.
  - b. Techniques used for monitoring including standard survey and GPS methods.
  - c. Equipment requirements (GPS and survey instruments).
  - d. Data analysis and reporting.
2. Work with members of MFMRD to design an extended monitoring system in the Gilbert Islands.
3. Work with members of MFMRD to implement the extended monitoring system.
4. Oversee the analysis and reporting of the initial monitoring field data.
5. Advise on the procurement of necessary equipment to support field-based monitoring.

These activities will be coordinated with the ecosystems and coral reef benthic monitoring also supported by KAP II (2.3.1) and other relevant coastal monitoring efforts ongoing in Kiribati.

All of these tasks will be undertaken in close consultation with the activities under the SOPAC/EU Aggregates Mining project.

#### **2. Outputs**

- Workshop report covering the issues listed above

- Document describing the design of a monitoring system for the Gilbert islands and implementation strategy
- Procurement advice for equipment
- Final report summarizing the activities and describing the state of affairs with respect to the monitoring and analysis efforts and providing a set of final recommendations to all stakeholders

## Appendix B

**Participant Listing**

| Name                  | Designation                         | Ministry/Division   | Contact address        |
|-----------------------|-------------------------------------|---|------------------------|
| Boata Iabeta          | Lands Surveyor                      | Land Management Division, Ministry of Environment and Lands Development           | kiricgps@tskl.net.ki   |
| Moataake<br>Burentoon | Rural Development Officer           | Ministry of Internal and Social Affairs   | moataake@yahoo.com     |
| Teata Terubea         | Ag Director Rural Planning Division | Ministry of Internal and Social Affairs   |                        |
| Andrew Sheenan        | Senior Lands Planning Officer       | Land Management Division, Ministry of Environment and Lands Development           | Asheenan37@hotmail.com |
| Kabure Yeeting        | Ag Minerals Officer                 | Mineral Unit, Ministry of Fisheries and Marine Resources Development              | kaburey@mfmr.gov.ki    |
| Titeem Auatabu        | Resource Information Officer        | Mineral Unit, Ministry of Fisheries and Marine Resources Development              | titeema@mfmr.gov.ki    |
| Mike Foon             | Ag Environmental Inspector          | Environment Conversation Officer<br>Ministry of Environment and Lands Development | mike.ecd@melad.gov.ki  |
| Putu Tofinga          | Ag Environmental Inspector          | Environment Conversation Officer<br>Ministry of Environment and Lands Development | puta.ecd@melad.gov.ki  |
| Timau Tira            | Chief Councillor                    | Teinainano Urban Council  |                        |



**Thursday 08 November**

- 9.00 am Coastal changes for Bikenibeu, Abatao and Buariki: Comparatively pristine areas.
- 10:00 am Tea Break
- 10.30 am Selection of islands for case studies; design and implementation
- 12.30 Lunch (Video: Enhancing Coastal Resilience in Tarawa).  
Kiribati Coastal Monitoring Protocols.
- 15:00 Tea Break
- Road map for Kiribati Coastal Monitoring

**Friday 09 November**

- 8:00 Fieldtrip to comparatively pristine area (Biketawa, North Tarawa).
- 12.30 Picnic Lunch
- 16:00 Close of workshop.**

## Appendix D      Workshop presentations

## Appendix E.

### **Proposed Schedule for National Coastal Monitoring TA**

The proposed 8 month schedule can be undertaken in two options which is highly dependant on availability of funds:

**Option One:** (Time frame: 3 months) Tamana and North Tarawa KAP pilot areas:

As multi-temporal image analysis for Buariki and Abatao have been completed in another study which will become available to Kiribati this year, it is recommended that this may serve the purpose of this study and efforts to concentrate on completing Tamana. Based on information from the Mineral Unit, MFMRD, 1969 historical aerial photo and 2006 Quick bird pan sharpened image for Tamana are available, providing a 37 year data.

In general schedule will allow one week of fieldwork involving accuracy test for satellite imagery and then ground truthing to take place once digitisation of coastlines has been completed.

1. Search for any aerial photo for Tamana. Scan aerial photos for Tamana (label, catalogue and back up) all available layers
2. Undertake accuracy test of satellite image on Tamana (1 week)
3. Training on downloading of GPS data to correct satellite image (1 week)
4. Geo-rectify all layers available
5. Digitize layers (Determine area changes)
6. Ground truthing of work (Visit Tamana for one week)  
(Seek external assistance for quality control of images and reports)
7. Place on the Map Server (geo-rectified images)
8. Produce report

**Option 2** (8 months). Selection of island based on availability of imagery and flight availability.

Tamana and Abemama Island

Satellite image for Abemama needs to be bought. Upon receipt, accuracy test for the images need to be done consecutively, in order to be cost effective with the hire of the GPS equipments.

1. Order and purchase for Quick bird pan sharpened image for Abemama
2. Search for any other aerial photo for Tamana. Scan aerial photos for Tamana (label, catalogue and back up) all available layers
3. Undertake accuracy test of satellite image on Tamana (1 week)
4. Undertake accuracy test of satellite image on Abemama (1 week)
5. Training on downloading of GPS data to correct satellite image (1 week)
6. Geo-rectify all layers available for Tamana
7. Digitize layers (Determine area changes)

8. Ground truthing of work (Visit Tamana for one week)
9. Place on the Map Server (geo-rectified images)
10. Abemama - Scan aerial photos (label, catalogue and back up) all available layers
11. Geo-rectify all layers available
12. Digitize layers (Determine area changes)
13. Ground truthing of work( Visit Abemama for 4 days)  
(Seek external assistance for quality control of images and reports)
14. Place on the Map Server (geo-rectified images)