NTERNATIONAL GEOSCIENCE PROGRAMME (IGCP)

Annual Report of IGCP Project No. 495

IGCP Project short title: **Quaternary Land-Ocean Interactions**

Duration: **5 years 2004 – 2009**

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1. Web site

The IGCP495 web site can be accessed at the following address:

http://www.geography.dur.ac.uk/research/IGCP_495/index.html

This includes a project description, information of upcoming and past field meetings and conferences as well as a list of project members and their contact details. It is hosted by Durham University and is regularly maintained.

2. Summary of major past achievements of the project

This is the first full report of IGCP495. There are therefore no major past achievements of the project to report.

3. Achievements of the project this year

*3.1 List of countries involved in the project (*indicates the countries active this year):*

Argentina, Australia, Bangladesh*, Belgium*, Brazil*, Canada*, China, Denmark, Ecuador, Estonia, Ethiopia, Fiji, Finland*, France*, Germany*, Greece, India*, Indonesia*, Israel*, Italy*, Jamaica, Japan*, Kenya*, Morocco, New Zealand, Norway, Poland*, Philippines*, Portugal*, Republic of Ireland, Russia, Spain*, Taiwan, The Netherlands*, Turkey, United Kingdom*, United Arab Emirates, Uruguay, United States of America*, and Venezuela.

3.2 General scientific achievements (including societal benefits).

In our original project design we identified a series of milestones, detailed in Table 1 below, against which progress so far in the project can be gauged:

Provisional programme and actual activities

2004

Task	Achievements
Approval of project;	Approval received in March 2004
Announce project approval to all project participants;	Announcement to all project participants 6th April 2005
Announce plans for first international project meeting in Maine/New England.	Announcement of field meeting on June 15th 2005 to all project colleagues
Formation of working groups listed in Attachment 1 and arrange liaison with other international programmes (including existing IGCP projects, INQUA, PAGES, LOICZ etc.);	Working group subject areas confirmed at first international meeting in Maine. Links to other projects have been reviewed and contacts established.

First international meeting in Maine / New England with particular emphasis on driving mechanisms of coastal change (including ocean circulation and climate);	First meeting held in Bar Harbour, Maine, October 14-17th 2005.
First training workshop on data collection. Agree format for manual publication;	The field trip associated with the Bar Harbour conference provided opportunities for reviewing methods of data collection, notably high resolution salt marsh records of sea-level change from the late Holocene. Discussions were held regarding a manual publication.
Establish National working groups and encourage and partial sponsoring of regional meetings (in developed and developing countries);	National working groups have been established in developing and developed countries.
Establish web site and participant address list;	Web site established in April 2005 and updated on a regular basis. It includes details of project, contacts, meetings and meeting reports.
Publication of first annual report.	Short report submitted to UNESCO in December 2004.

2005

Task	**Achievements**
Edited collection of papers in a journal special issue addressing the theme of oceanic forcing, sea level and coastal change over a variety of Quaternary to recent (particular emphasis on the last 1000 years) and future timescales;	This did not occur. It was too soon in the project to warrant a special publication capable of demonstrating real scientific progress. It was agreed to defer this until the second year of the project when more progress had been made.
Publicity of the project objectives, including summaries of current research activities and their relevance to the service of society in a range of international and national magazines that are widely available to communities and learned scientific societies;	Dissemination of IGCP495 activities has occurred primarily via the web and also by National Committees. A press release was issued before the 2005 international meeting.
Second international project meeting in Indonesia with particular emphasis on coastal archaeology and coastal evolution, tsunami impact as well as monsoonal controls on past and future sea-level change and coastal flooding;	The second international meeting was held in Indonesia, September 24th-29th 2005.

Second training workshop on data collection.	Opportunities for discussing a range of techniques of data collection, mostly relating to the identification of palaeotsunami, occurred during the field meeting.
Publication of second annual report. Ongoing update of web based material.	A special publication proposal has been submitted to *Marine Geology*. Fifteen papers are included on the project themes.
Additional tasks completed not previously listed	
A joint INQUA/IGCP495 International conference and field meeting was held in Dunkerque (France), June 28th-June 31st 2005 (see below for full report).	

In our project design, we identified two main aims to the project. They form a logical structure against which to review scientific developments. For reference, in the following, we refer to papers presented at one of the three IGCP495 conferences (Maine, Dunkerque and Indonesia) as: Long, Place (e.g. Maine) Conference year (2004 or 2005).

A. The vertical dimension of sea-level change. Correlating sea level and coastal stratigraphic data with data derived from a variety of terrestrial (including ice core) and marine depositional records.

A.1 Quaternary sea-level change and ice-sheet volume

A key control on vertical changes in sea level are variations in the global volume and distribution of land-based ice. Work here seeks to reconstruct vertical records of relative sea-level change and, where possible, use these data to constrain geophysical models capable of reconstructing former ice sheet volume. Our field-based research is being completed at near-field sites (close to the present ice sheets), intermediate sites (mostly located in the mid-latitudes) and far field sites (in equatorial locations).

- Near-field sites: *Scotland* (Smith et al. 2005, JCR; Fretwell et al. 2005; Shennan et al. 2005), *Sweden* (Miettinen 2004; Miettinen et al. 2005), *Greenland* (Long et al. in press) and *Maine* (Kelly, Maine conference 2004).

- Intermediate-field sites: The *Baltic* (Harfe et al. 2005; Hoffman et al. 2005; Lampe 2005), *Belgium* (Bertrand and Baeteman 2005; Baeteman 2005), the *Netherlands* (Kiden and Johnston, Dunkerque conference 2005); the *Mediterranean* (Morhange and Pirazzoli 2005; Alliota et al. 2005; Pirazzoli et al. in press); *Argentina* (Isla 2004; Bujalesky et al. 2004)

- Far-field sites*: Indo-Pacific* (Woodroffe and Horton 2004), *South America* (Milne et al. 2005); *Bangladesh* (Islam, Indonesia conference 2005).

There is a relatively small number of geophysical modellers that engage with the international sea-level community. They include Dick Peltier (Canada), Kurt Lamebeck (Australia) and Glenn Milne (UK). A scientific highlight arising from collaborative research with these scientists under IGCP495 relates to recent debate regarding the origin and magnitude of meltwater pulse 1a. Two schools of thought exist; one favouring Antarctica as the source of this melwater pulse (e.g. Bassett et al. 2005; Verleven et al. 2005), the other preferring the Arctic (e.g. Peltier 2004; Tarasov and Peltier 2005). Other collaboration between field scientists and modellers under IGCP495 include Milne et al. (2005), who use relative sea-level data from the S. American coast to constrain the global contribution of meltwater during the last 6-7,000 years to c. 1 m. Sivan et al. (2004) use ancient coastal wells from Caesarea, Israel, as indicators of sea-level that are, in turn, used to constrain tectonic and oceanic changes during the last 2000 years. Lastly, Gehrels et al. (2004) reconstruct late Holocene sea-level changes and isostatic crustal motions in Atlantic Canada through a combination of numerical model calculations and high resolution sea-level observations. This important work suggests that sea-level has risen by 1.0 m per 1000 yrs in New Brunswick and 2.5 m per 1000 years in Nova Scotia, as a result of crustal subsidence caused by the combined effects of the Laurentide ice loading and ocean loading of the Scotian shelf. Ocean loading is far more important than previously thought, amounting to up to 40% of the observed changes in sea level in some areas at certain times.

Other work under theme A.1 has sought to determine the link between climate change, ice sheet history and ice sheet dynamics with a particular focus on the so-called 8200 yr event, a short-lived period of climatic cooling associated with the release of meltwater from the North American continent into the North Atlantic. Thus, Tornqvist et al. (2004) use sea-level data from the Mississippi delta plain to constrain the magnitude of RSL rise associated with this event to less than 1.2 m equivalent global sea level. Meanwhile, working on the coast of West Greenland, Long et al. (in press) use RSL data to demonstrate that there was no distinct, regional response of the ice sheet margin to this cooling event.

A.2 Quaternary coastal evolution and fluvial archives of environmental change

This aspect of IGCP495 aims to better understand the linkages between the fluvial and coastal archives of environmental change. There are relatively few researchers operating at this scientific interface, which we identify as a growing area of importance and at an interdisciplinary junction with other UNESCO projects, notably IGCP449 “Global correlation of Late Cenozoic fluvial deposits”. An example of its potential is provided by Kelly et al. (Maine conference 2004), which examined the upstream impacts of glacio-isostatic rebound on fluvial system dynamics including sediment transferral and river incision. A further illustration is given by Wallinga et al. (2004) who explore the roles of climate change, crustal motions and sea-level change in controlling the late Quaternary fluvial record of the Rhine-Meuse. Their analysis neatly shows the importance of considering upstream and downstream controls to obtain a full understanding of the evolution of basin-margin successions. Finally, Baeteman and Heyvaert (2005; Indonesia conference 2005) highlight the significance of fluvial processes in determining the pattern of sediment infilling during the mid and late Holocene in the coastal plain of the Northern Persian Gulf. We expect further scientific progress to be made under this subject area in the coming years of the project.

A.3 Quaternary sea-level and ocean circulation

As part of our project's effort to identify driving mechanisms behind sea-level change and coastal evolution, IGCP495 is looking to promote and encourage research that seeks to test hypotheses regarding the link between changes in ocean circulation and sea-level change. Modelling work suggests that changes in the strength of ocean circulation (e.g. the Gulf Stream) can have an effect on both sea-surface elevation and ocean temperatures. Towards the end of IGCP437 (the predecessor to IGCP495), several authors were beginning to explore the potential link between ocean circulation and sea-level changes (e.g. Van de Plassche et al. 2003). This is a challenging area since it requires past sea-level observations of the highest quality with clearly defined and minimised age and height error terms. The reason for holding the first project field meeting and conference to the Atlantic US seaboard of Maine was to enable us to examine the salt marshes from which some of the recently collected high resolution records of RSL have been derived. Aims A.3 and A.4 are closely linked and papers relating to this work are described in A.4 below.

A.4 Global to local relative sea-level change during the last 1000 years

The importance of quantitative modelling approaches to palaeosea-level reconstruction continues to grow, with the integration of contemporary and fossil micro-organisms (pollen, diatom, foraminifera as well as testate ameobae) via numerical transfer functions setting the pace (e.g. Horton et al., 2004; Horton and Edwards 2005; Horton et al., 2005; Sawai et al., 2004; Roe and Van de Plassche 2005; Patterson et al., 2005; Roe and Patterson in press; Patterson et al., 2005; Edwards et al., 2004a, b).

One thrust of this research is to use the salt-marsh records as archives for stretching the observations derived from tide gauges back in time. This is importance science, since although tide gauge records are often short, they nevertheless provide the only quantifiable means of determining the spatial and temporal trends in sea level during the recent past. Using data from the western Atlantic Ocean, Gehrels et al. (2005) demonstrate that the rate of sea-level rise increased from c. 1.6 mm/yr during the 19th century to 3.2 mm/yr between AD 1900 and AD 1920. Their work suggests that this acceleration corresponds to a rise in global temperatures and may therefore be associated with recent global warming. Gehrels et al. presented unpublished results of comparable research conducted in Iceland at the Indonesia conference in September 2005, arguing that there was evidence from these records for the effects of changes in the temperature of nearshore waters associated with the Gulf Stream. Similar high resolution work is underway by several PhD students under the IGCP495 banner, such as Szkornik et al. (Ho Bugt, Denmark), Marshall et al. (Poole Harbour, UK), Daly and Bell (Newfoundland), Harman et al. (North of Ireland coast) and Woodroffe (Great Barrier reef, Australia).

As noted above, technical development is crucial to this area. This is because the resolution required in terms of dating as well as determining the former position of sea-level is much higher than is normally the case when longer-term (and generally larger magnitude) trends are the primary focus for study. Methodological developments under way during IGCP495 include novel applications of palaeomagnetic dating and the use of bomb spike ^{14}C to salt-marsh sediments (Marshall, Dunqkerque meeting).

Archaeological records have the potential to provide valuable additional controls on sea-level change during the late Holocene, especially where artefacts or structures are well-

dated, have a closely defined height relationship to a former sea level (such as quays or harbours) and have good dating control (via radiocarbon or dendrochronology). We have referred already to the Israeli well date, and a further example of the use of such data is provided by Morhange et al. (Dunkerque conference 2005) where he presented evidence for rapid tectonics associated with volcanic activity from the world-famous site of Pozzuoli (Italy).

B. The lateral dimension of sea-level change. The role of terrestrial and oceanic processes in driving patterns of RSL change and coastal evolution.

B.1 Sediment fingerprinting in the coastal zone

An important challenge for IGCP495 is to develop new techniques to resolve the importance of terrestrial and oceanic processes in controlling coastal stratigraphic sequences, sea-level change and coastal evolution. As noted above, where possible we are looking to explore the opportunities provided by the often rich archaeological record for human activity in coastal areas and coastal catchments.

Some promising progress is being made in the application of a range of geochemical proxies for reconstructing changes in salinity and the source of different sediment fractions under IGCP495. For example, Wilson et al. (2005a, b) report on the potential $\delta^{13}C$ and C/N as coastal palaeonenvironmental indicators in the Mersey Estuary, UK. Using information on the contemporary distribution of these proxies, they successfully apply them to the interpretation of an early Holocene sediment sequence. This approach provides an interesting alternative to the more conventional pollen, diatom and foraminifera, which may be only variably preserved within the sediment record. Elsewhere, a variety of geochemical proxies are used to reonstruct Holocene sedimentary sequences in the Guadiana River estuary in SW Portugal (e.g., Gonzalez-Villa et al. 2003). A very interesting paper presented by Boski (Indonesia conference 2005) described the results of new geochemical analyses aimed at reconstructing the carbon flux from terrestrial to marine sources in three Algarve estuaries (Portugal) over the Holocene.

An important aspect of research under this theme is developing appropriate dating techniques for tackling minerogenic sediments. There is significant progress in this area through the application and development of palaeomagnetics (see A.4 above), Radiumm 226 dating (Hillaire-Marcel, Indonesia conference 2005), and the optical dating of clastic sediments (Mauz and Bungenstock, Dunkerque conference 2005). The latter includes dune deposits of Little Ice Age origin in NW Europe (Orford et al., Dunkerque conference 2005) and evidence for marine-terrestrial sediment recycling of the Southern Cape coastal barriers, South Africa (Bateman et al., Dunkerque conference 2005).

B.2 Human impact on coastal evolution and sea-level change

Humans are major players in past, present and future coastal evolution both directly via the imposition of a wide range of coastal management strategies, and also indirectly by inadvertent changes in sediment supply to the coast. Research under this theme is divided into three sub-headings:

B.2.1 Observations of human impact on coastal evolution

An excellent introduction to this thread of IGCP495 was provided by a keynote paper by Professor David Sanger at the Maine conference (2004), when he reviewed the prehistoric archaeology of the Maine and Gulf of Maine region. His work demonstrated the critical interdependence between people and the coast through time and the potential of archaeological resources as archives of wider environmental change in the coastal zone. He showed, for example, how changes in the frequency of fish and mammalian remains can be used to infer variations in the temperature and salinity of nearshore waters.

Other ongoing research addressing Holocene human-coastal interactions include the work of Heyvaert and Baeteman, who are reconstructing (at a very large spatial scale) the fluvial and marine processes in the Northern Persian Gulf, Iran (Maine conference 2004, Dunkerque conference 2005 and Indonesia conference 2005). They identify the strong role played by land-use practices, moderated by climate changes, in influencing the release of clastic sediment to the coastal system, as well as associated large scale (10^2 km) changes in shoreline position that can result from these processes. Similar, larger scale changes in coastal landscape were reported by Giosan in his review of the Holocene evolution of the Indus Delta (Maine conference 2004) and by Islam in his analysis of the Quaternary sea-level change and the geomorphic evolution of the Teknaf coast in Bangladesh (Indonesian conference 2005). Sivan and Zvieli presented an analysis of the Late Pleistocene-Holocene geological history of the Haifa Bay, Israel, and its impact on human settlement (Dunkerque conference 2005; Sivan et al., 2004; Sivan and Porrit 2004). Lastly, some of the potentially most significant research under this aim is that reported by Marriner et al. (2005) and Marriner and Morhange (2005), who use a combination of geoarchaeological techniques and sea-level records to identify, for the first time, the exact location and chronology of the ancient harbours of Phoenicia's two most important city-states, Tyre and Sidon. Their work highlights the enormous potential of the well-preserved coastal sediments in these Levantine harbours for our understanding of the Phoenician maritime archaeology.

Over more recent timescales (during the last few hundred years), IGCP495 members are addressing a range of human-coastal interactions. For example, Abuodha presented research on the human impact on coastal evolution on the North Kenyan coast (Maine conference 2004), while Fettweis et al. addressed the issue of human impact on the coastal mud plains of Southern North Sea Basin (Dunkerque conference, 2005). Musereau and Regnauld (Dunkerque conference, 2005) reported on their analysis of the artificial coastal dunes between the Loire and Gironde estuaries and role of social and climate factors in their stability.

B2.2.2 Methodological aspects of human / coastal interactions:

Humans are increasingly viewed as significant agents of coastal change over Holocene time periods. The examples above in B2.2.1 illustrate the impact of land-use patterns of coastal sedimentation extend in the Mediterranean well-back into the Bronze Age. Less direct but equally significant impacts of human activity have also been identified in coastal lowlands around the Southern North Sea. Here, peat cutting, wetland drainage and the construction of sea defences are increasingly identified as major disruptors to the natural processes of coastal change. For example, Baeteman (2005), Long et al. (in press, Dunkerque conference, 2005), Brain et al. (Maine conference, 2004), Waller et al. (in press, Indonesia conference, 2005) and Vos (Indonesia conference 2005) argue that peat wastage caused by drainage was instrumental in widespread and dramatic

changes in coastal landscape during the late Holocene throughout many coastal lowlands of NW Europe. They contend that drainage causes wetlands to deteriorate and waste, to lose their mass and physical coherence and to become structurally weakened. Once their surface begins to be lowered by these processes, a positive feedback loop starts whereby local sea level rises and causes further flooding and loading of the former wetland surface by water and sediment. These processes further lower the peat by compaction, causing rapid landscape burial that can amount to 4 m or more in a few centuries. These processes are far more important that the traditionally considered mechanisms of eustatic and isostatic change that are typically measured in mm per year over thousands of years.

B2.2.3 Modelling human-coastal interactions:

A theme that runs through IGCP495 is the desire to link observations with modelling in order to develop predictive capacity and enhance ability to mitigate deleterious changes in the world's coastal zone as a result of natural and anthropogenic processes. Our approach here is to develop quantitative models of sediment and water / nutrient flux to the coastal zone. Examples of the former include Holocene-scale reconstructions of long-shore sediment movement (Jennings, Maine conference 2005) and numerical modelling of long-term sedimentation on the Romanga coastal Po Plain (Farabegoli and Onorevoli, northern Italy, Maine conference 2005). Over shorter timescales, Regnauld (Maine 2004; Indonesia 2005) presented results of 2-d modelling of coastal accumulation under unidirectional forcing and assessed the sensitivity of coastline to sea-level rise in Brittany with implications for coastal management and coastal evolution. The Indonesia meeting provided an opportunity to examine the exchange of nutrients between catchments and the coast, with Susilowati et al. describing steady state nutrient modelling of Jakarta Bay, Leksono reporting on land-use change in Jakarta coastal watershed and coastal impacts, and Rais describing the results of water-quality monitoring in Jakarata.

B.3 The role of earthquakes, tsunami and storms as driving mechanisms of Quaternary RSL change and coastal evolution

Members of IGCP495 are involved in palaeoseismic research in several regions of the world, mostly by providing well-constrained records of former events that can help inform hazard assessment by defining expected coseismic displacement, tsunami risk and run-up, as well as constraining geophysical models of plate boundary characteristics. Much of our focus under this theme during the last 12 months has understandably been directed towards the Indian Ocean tsunami of December 26th 2004, which comprised a dedicated science session at the Indonesia conference in September 2005. This involved a series of papers that addressed the physical and social impacts of the tsunami throughout the Indian ocean, including in Banda Aceh and the Nam Khem Plain, Thailand (Umitsu), the Maldives (Dawson), a review of historical tsunami in Indonesia including the 1883 Karakatoa event (Latief), and the development of a new technique for the reconstruction of past tsunami run-up (Smith). This work will take a central place in the planned special issue of Marine Geology that will arise from this conference.

Away from the Indian Ocean event, research continued by IGCP495 members examining palaeoseismicity elsewhere around the world, including in Scotland (Tooley and Smith 2005; Smith et al., 2005; Smith et al., 2005; Dawson et al., 2004), Newfoundland (Ruffman, Maine conference 2004), the Kuril subduction zone (Japan)

(Sawai et al., 2004), Alaska (Hamilton and Shennan 2005a, b; Hamilton et al., 2005), as well as in the southern and central Antillean island arc (Scheffers et al., 2005) and Bahamas (Kelletat and Scheffers 2004; Kelletat et al., forthcoming). Resolving the geological signature of palaeotsunami versus storms remains a challenge to the community and Tuttle et al. (2004) compare the 1929 Grand Banks tsunami with the deposits of the 1991 Halloween storm in an effort to determine discriminatory criteria.

Research addressing the significance of storm events included a wide-ranging keynote paper presented by Andrew Cooper at the Maine conference that addressed century-scale driving mechanisms and coastal responses from Northern Ireland. His work demonstrated the powerful role of storms in shaping coastal geometry as well as the potential resilience inherent in coastal systems supplied with adequate sediment. Given the concerns that Hurricane Katrina may be representative of wider changes in storm activity associated with global warming, the papers of Pirazolli and Coasta on surge-peak propogation and storms in the Eastern English Channel (Dunkerque conference, 2005 and also Pirazzoli et al. 2004) are particularly timely.

3.3 List of meetings with approximate attendance and number of countries

To date we have held three international project meetings. The first of these was held in Bar Harbour (Maine, USA, October 2004), a field venue chosen specifically for the research conducted along the US East Coast examining the link between climate and sea-level change over the last millennia, as well as longer patterns of Holocene land-ocean interactions. The second field meeting was held jointly with the INQUA Coastal and Marine Processes Commission (Dunkerque, France, July 2005). The third international field meeting was held in Indonesia where the focus of the meeting was on the role of tectonics and anthropogenic influences on the coastline, with a scientific session dedicated to the Indian Ocean tsunami of December 26th 2004, and a field trip to Krakatau and the associated effects of the 1883 eruption and tsunami on coastal communities. Numbers attending and countries represented at each are listed below. Full meeting reports can be viewed on the project web site.

Title of Meeting	**Date**	**Venue**	**No. of delegates**	**No. of Countries represented**
Quaternary Land-Ocean Interactions: Driving Mechanisms & Coastal Responses	14th to 17th October 2004	Bar Harbor, Maine, United States of America	39	11
Late Quaternary Coastal Changes Sea Level, Sedimentary Forcing and Anthropogenic Impacts	28th June to 2nd July 2005	Dunkerque, France	74	12
Quaternary Ocean and Land Interaction: Climatic, Tectonic and Anthropogenic Influence	24th to 30th September 2005	Anyer-Carita, Banten-Sunda Strait area, Indonesia	32	10

IGCP Project No. 495 also contributed to the following meetings:
The Sixth Iberian Quaternary Meeting, Gibraltar, 26th to 28th September 2005.
The Sixth International Conference on Geomorphology, Zaragoza, Spain, September 2005.

3.4 Educational, training or capacity building activities

Previous coastal IGCP projects have placed a significant weight on the promotion of research by younger scientists at the outset of their career. We are continuing this tradition under IGCP495 by encouraging students to attend our meetings to give papers and also to explain their research in the field wherever possible. For example, in Maine, Dunkerque and Indonesia, a total of 23 papers were delivered by postgraduate students.

3.5 Participation of scientists from developing countries

The project provides a particular focus on the support and training of colleagues from developing countries. IGCP495 is co-led by Professor Islam who is based in Bangladesh and is very aware of the issues relating to sea-level change, coastal evolution and climate change and how these may impact on developing countries. He intends to host the 2007 international conference. The project addresses this issue in three ways.

Firstly, we have ensured that the budget allocated from UNESCO is used only to support attendance of colleagues from developing countries to the project meetings (the conferences are self-financing in all other respects). In 2004, delegates from Kenya, Indonesia, Brazil and the Philippines were able to attend the conference directly as a result of UNESCO-funded support. One of these has subsequently embarked on a PhD programme in Australia as a direct result of this conference. At our Indonesian meeting, funds were dedicated to support attendance of local delegates and those from countries affected by the Indian Ocean tsunami. Eleven colleagues were directly supported by UNESCO funds. Secondly, the project uses additional commitments from colleagues in developed countries to provide additional support to enable attendance from poorer countries. In the first two years this has amounted to a 50% increase to the core support provided by UNESCO and was used to support delegates attending the Maine and Indonesia meetings. Thirdly, we stated in our original project design that the project will hold at least two of its project meetings in developing world countries (in fact, it is likely that we will increase this to three). This will reduce costs for delegates attending and also show-case the research in these countries.

The following colleagues have participated in the project by attending the Maine, USA and Indonesian meetings:

1.	Pamela Abuodha	Kenya
2.	Kumaresan Anbarasu	India
3.	Rodolfo José Angulo	Brazil
4.	Lulil Gustiantin	Indonesia
5.	Lina Handayani	Indonesia
6.	Shahid Islam	Bangladesh
7.	Hamza Latief	Indonesia
8.	Bambang Edhi Leksono	Indonesia
9.	Jacob Rais	Indonesia
10.	Tjoek Aziz Soeprapto	Indonesia
11.	S. Susilohadi	Indonesia
12.	Yuliana Susilowait	Indonesia
13.	Igan S. Sutawidjaja	Indonesia
14.	Siti Zulaikah	Indonesia

3.6 List of most important publications

Bibliography (listed by author in alphabetical order with the most recent work listed first)

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Bertrand, S., Baeteman, C. 2005. Sequence mapping of Holocene coastal lowlands: the application of the Streif classification system in the Belgian coastal plain, *Quaternary International*, **133-34**, 151-158.

Betts, N.L., Orford, J.D., White, D., Graham, C.J. 2004. Storminess and surges in the south-western approaches of the eastern North Atlantic: the synoptic climatology of recent extreme coastal storms. *Marine Geology*, **210**, 227-246.

Bujalesky, G., Aliotta, S., Isla, F.I. 2004. Facies del subfondo del Canal Beagle, Tierra del Fuego. *Revista de Asociación Geológica Argentina*, **59**, 29-37.

Buynevich, I.V., FitzGerald, D.M., van Heteren, S. 2004. Sedimentary records of intense storms in Holocene barrier sequences, Maine, USA, *Marine Geology*, **210**, 135-148.

Cavalotto, J.L., Violante, R.A., y Colombo, F. 2005. Evolución y cambios ambientales de la llanura costera de la cabecera del Río de la Plata, *Revista de la Asociación Geológica Argentina* **60**, 353-367.

Dawson, S., Smith, D.E., Jordan, J., Dawson, A.G. 2004. Late Holocene coastal sand movements in the Outer Hebrides, NW Scotland, *Marine Geology*, **210**, 281-306.

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4. Activities planned

4.1 General goals for 2006

- Publication of journal special issue on sea-level changes, tsunami and coastal archaeology, addressing vertical changes in sea-level and human responses, submerged archaeology, ancient and more recent coastal defence work and their impacts of landscape change and coastal processes; ; to be approved by Marine Geology.
- Third international project meeting in Brazil. Emphasis on reconstructing sediment flux from terrestrial to coastal and nearshore depositional environments, as well as ocean – atmosphere forcing of sea-level change;
- Working groups to define publication outputs arising from their work;
- Publication of third annual report. On-going update of web based material.

4.2 Specific meetings and field trips (please indicate participation from developing countries)

Planned meetings in the next 12 months:

First International Tsunami Field Symposium, Captain Don´s Habitat, Bonaire, Netherlands Antilles, 2nd to 4th March 2006

International Conference and Field Trip on: Holocene land-ocean interactions: driving mechanisms and coastal responses, Romney Marsh & Dungeness Foreland, 9th to 12th July 2006.

Third international conference and fieldtrip to Santa Catarina State, Brazil, to be hosted by Brazilian colleagues (September 2006; Klein and Angulo).

As in previous meetings, we will encourage attendance by colleagues from development countries by offering financial support and, in the case of the Brazil meeting, directly by allocation if IGCP495 conference support resources.

5. Project funding requested

We seek continued support at the level received in the second year of this project (US $6000). We will continue to provide additional funds from individual project members to boost this budget and further support attendance at the project meetings by attendees from developing countries.

6. Request for extensions, on-extended-term-status, or intention to propose successor project.

None required at this stage.

7. Financial statement

We have ensured that the budget allocated from UNESCO is used only to support attendance of colleagues from developing countries to the project meetings – see attached appendices.