

INTERNATIONAL 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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Guidelines for Annual Report

(September 2008)

1. Website address(es) related to the project:

<http://www.geography.dur.ac.uk/projects/igcp495>

2. Summary of major past achievements of the project

Five international project conferences and field trips and 11 regional / thematic meetings. Two hundred and fifty project members. Special issue of *Zeitschrift für Geomorphologie, Supplementbände* (2006), *Marine Geology* (2007), *Quaternary Science Reviews* and *Quaternary International* (the latter contain c. 30 papers and should be published in 2009). We continue to have strong links with the INQUA Commission on Coastal and Marine Processes.

3. Achievements of the project this year only

3.1. *List of countries involved in the project (please *indicate the countries active this year: Australia*, Bangladesh*, Belgium*, Brazil*, Canada*, China*, Denmark, Ecuador, Estonia, Ethiopia, Fiji, Finland*, France*, Germany*, Greece*, Hong Kong*, India*, Indonesia*, Ireland*, Israel*, Jamaica*, Japan, Kenya, Malaysia, Morocco, Mozambique, Latvia*, Lithuania*, New Zealand*, Norway, Portugal*, Russia, Singapore, South Korea*, Spain*, Sweden*, Switzerland, Taiwan, Thailand, The Netherlands*, Turkey, Ukraine, United Arab Emirates, United Kingdom*, United States of America*, Venezuela (46, 26*).*

3.2. *General scientific achievements and social benefits*

We summarise achievements and address issues raised in the 2007 Annual Assessment Form.

i) Scientific achievements directly associated with the project: UNESCO feedback from the 2007 Annual Assessment was an item considered in detail by the 2008 Business Meeting of the Fifth International Project Meeting in Portugal. It was agreed that although there is a large amount of work associated with the project, we should highlight to UNESCO five areas in which we are having major international impact to demonstrate explicit deliverables associated with IGCP495: **A) Sea-level “fingerprints”:** Sea-level rise caused by the melting of an ice sheet will not be evenly distributed across the globe. Although the volume of water in the oceans increases if a polar ice sheet melts, simultaneously the strength of the gravity pull from the ice sheet on the oceans falls. The overall result of these processes is that sea-level rise occurs faster in areas a long way from the melting source. In fact, polar ice melt produces the most rapid sea-level rise about halfway towards the equator. This has significant implications for reconstructing past and future sea-level change since sea-level will not change in a uniform manner across the globe – it will have a unique spatial pattern or “fingerprint”. IGCP495 scientists (modelers and field scientists) are leading the world in developing predictions of sea-level fingerprints for future and past sea-level change, thus improving regional scale sea-level rise predictions and also identifying potential sources of recent acceleration in global sea-level rise in the last 1-2 centuries. **B) Late Holocene sea-level changes:** Estimates of ice equivalent sea-level change in the last few thousand years are critical to estimates of future sea-level rise by IPCC, to models of crustal rebound, and to the interpretation of recent space-based observations of ice sheet elevation change. Existing models from the Peltier and Lambeck groups differ in their treatment of this term, favouring different patterns and rates of ice equivalent sea-level change in the last few millennia. IGCP495 scientists are addressing this issue through developing new, high precision reconstructions of sea-level change from a variety of geomorphological, sedimentary and archaeological sources from sites close to and far from the polar ice sheets. They are working closely with the modeling community to resolve existing differences in their models. **C) Transfer functions:** High precision models of vertical sea-level change require well defined reconstructions of former sea level. IGCP495 scientists are responsible for developing new “transfer function” reconstructions of past sea-level that use information regarding the contemporary distribution of plants, animals and sediment types across the intertidal zone to develop a simple mathematical model that can be applied to fossil sequences to develop quantitative reconstructions. The work is able to resolve recent trends in sea-level, linking the past to the observational (tide gauge) period,

as well as quantifying continuous patterns of sea-level change before and after great plate boundary earthquakes. **D) Tsunami and hurricanes:** The IGCP495 Tsunami working group is one of the largest communities of tsunami-related scientists in the world and is leading efforts to develop new approaches to reconstructing tsunami and hurricane hazards around the world. Key achievements under IGCP495 arising from two international workshops in Bonaire (2006) and Italy/Greece (2008) are: the definition of geomorphological criteria for the identification of past tsunami / hurricanes; classifying tsunami-genetic events by source (e.g. volcanic eruption, earthquakes, landslides, meteorological events), and; identifying the location, age and hydrodynamic features of past-tsunami/hurricanes. Our work is contributing to improved planning and management of the human activities in the coastal environment, including the development of early warning systems. **E) Sediment compaction:** Hurricane Katrina provided a devastating reminder of the effect of sediment compaction and associated land-lowering on flood hazard. IGCP495 scientists are at the forefront of efforts to better understand the role of sediment compaction on land surface elevation, since this process is so strongly influenced by the stratigraphy of the coastal plain.

ii) Project communication: We have continued to maintain and expand our website, taking on board comments raised in the 2007 UNESCO assessment by including further field trip guides and abstracts volumes wherever possible. We have also included several review papers of current trends in sea-level research written by IGCP495 scientists. We have been invited to write a short paper for *EoS* in January 2009 summarising the project's activities.

iii) External funding: With a project membership of 250 it is not possible to detail here the additional funding secured as a result of involvement in IGCP495 which runs into many tens of projects. However, UNESCO funding is used to support project meetings and in this respect we secured additional funding support from the following organizations: Portuguese Science Foundation, The Municipalities of Faro, Lagos and Odemira and University of Algarve; Durham University for free secretarial support, web site hosting; the US Geological Survey, National Science Foundation and Pennsylvania State University for support of the AMQUA (2008) meeting including attendance for young scientists. In cash-kind, this is probably c. US \$25,000 towards running the project.

iv) Application of knowledge to contemporary issues of sea-level rise: As explained above, much of the work in IGCP495 is linked to issues of future sea-level change. Key research questions that we are tackling include: trends in sea level during the last few centuries to millennia, mass balance change of the Greenland Ice Sheet, the influence of Holocene sediment / topography in controlling current coastal dynamics and spatially-variable trends in past and future sea-level rise due to gravity changes. We have published a short paper aimed at a more general audience that explains why we need to rethink existing IPCC approaches to future sea-level rise (Gehrels and Long, 2008). Project PI Long is contributing author to "*Sea-Level Rise and Related Climate Scenarios in Impact and Vulnerability Assessment of Coastal Areas: A Note to IPCC DDC*" which draws significantly on IGCP495-research (in review). The next UK IGCP495/INQUA Commission regional meeting will have a specific focus on the relevance of our research to future sea-level change (see 4.2 below).

3.3. List of meetings with approximate attendance and number of countries

Meeting	Date	Venue	Delegates	Countries
American Geophysical Union IGCP495 session on palaeo-tsunami	December 2007	San Francisco	c. 75	Not known
UK Sea Level IGCP495 Conference Annual conference and field trip "Holocene Land-Ocean Interactions: Driving Mechanisms and Coastal Responses"	22 nd – 25 th June 2008	Belfast, Northern Ireland	35	8
American Quaternary Association (AMQUA) "Quaternary Land-Ocean Interactions"	5 th – 7 th June 2008	State College, Pennsylvania, USA	80	6
International Geological Congress CGC-05 "Sea level fluctuations: past, present and future"	6th - 14th August 2008	Oslo	40 (min) 70 (max)	15
IGCP495 2 nd International Tsunami Field Symposium	22 nd – 28 th September	Ostuni and Ionian Islands	54	10

	2008	(Greece)		
IGCP495 Fifth International Meeting and fieldtrip “Quaternary Land-Ocean Interactions: Driving Mechanisms and Coastal Responses”	27 th October – 1 st November 2008	Faro, Portugal	64	18
American Geophysical Union IGCP495 session on Late Holocene sea-level change and climate	14 th – 19 th December 2008	San Francisco, USA	Not known	Not known

3.4. Educational, training or capacity building activities

The Portugal 08 meeting provided an opportunity for training in collection of sea-level data from a variety of depositional environments, including estuarine, back-barrier and salt marsh settings. The 09 Netherlands meeting will include a day’s training geared towards younger scientists in the methods of sediment description. IGCP495 prioritises postgraduate students in its activities and prides itself in providing a supportive environment for early career scientists during oral and poster sessions. Our website provides a source of information on project members, previous meetings, and emerging research projects.

3.5. Participation of scientists from developing countries, and in particular young/ women scientists

IGCP495 is co-led by Prof. Islam (Bangladesh), who is very aware of the issues relating to sea-level change, coastal evolution and climate change and their impact on developing countries. 64 scientists attended the 2008 International Meeting, with 3 scientists from developing countries (each receiving UNESCO funding), 24 women and 11 young scientists who directly participated in IGCP495 activities.

3.6. List of most important publications (by theme identified in 3.2 above):

Sea-level fingerprints:

Milne, G.A. and Mitrovika, J.X. in press. Searching for eustasy in deglacial sea-level histories. *Quaternary Science Reviews*.

Kendell, R.A., Mitrovika, J.X., Milne, G.A., Tornqvist, T.E. and Li, Y.X. 2008. The sea-level fingerprint of the 8.2 ka climate event. *Geology* 36, 423-426.

Late Holocene sea-level change:

Gehrels, W.R., Hayward, B.W., Newnham, R.M. and Southall, K.E. 2008. A 20th century sea-level acceleration in New Zealand. *Geophysical Research Letters* 35, L02717, doi 10.1029/2007GL032632.

Leorri, E., Horton B.P. and Cearreta, A. 2008. Development of a foraminifera-based transfer function in the Basque marshes, N. Spain: implications for sea-level studies in the Bay of Biscay. *Marine Geology*, 251, 60-74.

Transfer functions:

Woodroffe, S.A. in press. Recognising subtidal foraminiferal assemblages: implications for quantitative sea-level reconstructions using a foraminiferal-based transfer function. *Journal of Quaternary Science*.

Tsunami and hurricanes:

Imamura F., Goto K., Ohkubo S. (2008). A numerical model for the transport of a boulder by tsunami. *J. Geophys. Res. - Ocean* 113, C01008, doi:10.1029/2007JC004170.

Mastroruzzi G., Pignatelli C., Sansò P., Selleri G. 2007. Boulder accumulations produced by the 20th February 1743 tsunami along the coast of southeastern Salento (Apulia region, Italy). *Marine Geology*, 242, 191-205.

Woodruff, J.D., Donnelly, J.P., Emanuel, K. and Lane, P. 2008. Assessing sedimentary records of paleohurricane activity using modeled hurricane climatology. *Geochemistry Geophysics Geosystems*, 9, DOI 10.1029/2008GC002043

Sediment compaction:

Tornqvist, T.E., Wallace, D.J., Storms, J.E.A., Wallinga, J., Van Dam, R.L., Blaauw, M., Derksen, M.S., Klerks, C.J.W., Meijneken, C. and Snijders, E.M.A. 2008. Mississippi Delta subsidence primarily caused by compaction of Holocene strata. *Nature Geoscience*, 1, 173-176.

Selected bibliography (2008 dates only) listed by author with the most recent work listed first)

- Angulo, R.J., de Souza, M.C., Assine, M.L., Pessenda, L.C.R., and Disaro, S.T. (2008). Chronostratigraphy and radiocarbon age inversion in the Holocene regressive barrier of Parana, southern Brazil. *Mar. Geol.*, **252**, 111-119.
- Bird, D., Roberts, M.J., and Dominey-Howes, D. (2008). Usage of an early warning and information system Web-site for real-time seismicity in Iceland. *Natural Hazards* **47**, 75-94.
- Boski, T., Camacho, S., Moura, D., Fletcher, W., Wilarnowski, A., Veiga-Pires, C., Correia, V., Loureiro, C., and Santana, P. (2008). Chronology of the sedimentary processes during the postglacial sea level rise in two estuaries of the Algarve coast, Southern Portugal. *Estuarine Coastal and Shelf Science* **77**, 230-244.
- Brooke, B., Ryan, D., Pietsch, T., Olley, J., Douglas, G., Packett, R., Radke, L., and Flood, P. (2008). Influence of climate fluctuations and changes in catchment land use on Late Holocene and modern beach-ridge sedimentation on a tropical macrotidal coast: Keppel Bay, Queensland, Australia. *Mar. Geol.*, **251**, 195-208.
- Brooks, A.J., Bradley, S.L., Edwards, R.J., Milne, G.A., Horton, B., and Shennan, I. (2008). Postglacial relative sea-level observations from Ireland and their role in glacial rebound modelling. *J. Quat. Sci.* **23**, 175-192.
- Caldara, M., Caroli, I., and Simone, O. (2008). Holocene evolution and sea-level changes in the Battaglia basin area (eastern Gargano coast, Apulia, Italy). *Quaternary International* **183**, 102-114.
- Daly, J.F., Belknap, D.F., Kelley, J.T., and Bell, T. (2007). Late Holocene sea-level change around Newfoundland. *Canadian Journal of Earth Sciences* **44**, 1453-1465.
- Fouache, E., Ghilardi, M., Vouvalidis, K., Syrides, G., Styllas, M., Kunesch, S., and Stiros, S. (2008). Contribution on the Holocene reconstruction of Thessaloniki coastal plain, Greece. *J. Coastal. Res.*, **24**, 1161-1173.
- Harris, P.T., Heap, A.D., Marshall, J. F., and McCulloch, M. (2008). A new coral reef province in the Gulf of Carpentaria, Australia: Colonisation, growth and submergence during the early Holocene. *Marine Geology* **251**, 85-97.
- Horton, B.P., Culver, S.J., Hardbattle, M.I.J., Larcombe, P., Milne, G.A., Morigi, C., Whittaker, J.E., and Woodroffe, S.A. (2007). Reconstructing Holocene sea-level change for the central great barrier reef (Australia) using subtidal foraminifera. *Journal of Foraminiferal Research* **37**, 327-343.
- Leorri, E., Horton, B.P., and Cearreta, A. (2008). Development of a foraminifera-based transfer function in the Basque marshes, N. Spain: Implications for sea-level studies in the Bay of Biscay. *Mar. Geol.*, **251**, 60-74.
- Long, A.J., Roberts, D.H., Simpson, M.J.R., Dawson, S., Milne, G.A., and Huybrechts, P. (2008). Late Weichselian relative sea-level changes and ice sheet history in southeast Greenland. *Earth and Planetary Science Letters* **272**, 8-18.
- Marriner, N., Goiran, J.P., and Morhange, C. (2008). Alexander the Great's tomolos at Tyre and Alexandria, eastern Mediterranean. *Geomorphology* **100**, 377-400.
- Marriner, N., Morhange, C., and Saghieh-Beydoun, M. (2008). Geoarchaeology of Beirut's ancient harbour, Phoenicia. *Journal of Archaeological Science* **35**, 2495-2516.
- Massey, A.C., Gehrels, W.R., Charman, D.J., Milne, G.A., Peltier, W.R., Lambeck, K., and Selby, K.A. (2008). Relative sea-level change and postglacial isostatic adjustment along the coast of south Devon, United Kingdom. *J. Quat. Sci.* **23**, 415-433.
- Morales, J.A., Borrego, J., San Miguel, E.G., López-González, N., and Carro, B. (2008). Sedimentary record of recent tsunamis in the Huelva Estuary (southwestern Spain). *Quat. Sci. Rev* **27**, 734-746.
- Nelson, A.R., Sawai, Y., Jennings, A.E., Bradley, L.A., Gerson, L., Sherrod, B.L., Sabeen, J., and Horton, B.P. (2008). Great-earthquake paleogeodesy and tsunamis of the past 2000 years at Alsea Bay, central Oregon coast, USA. *Quat. Sci. Rev* **27**, 747-768.
- Proske, U., Hanebuth, T.J.J., Meggers, H., and Leroy, S.A.G. (2008). Tidal flat sedimentation during the last millennium in the northern area of Tidra Island, Banc d'Arguin, Mauritania. *J. African Earth Sci.*, **50**, 37-48.
- Scheffers, A., Kelletat, D., Scheffers, S.R., Abbott, D.H., and Bryant, E.A. (2008). Chevrons-enigmatic sedimentary coastal features. *Zeitschrift Fur Geomorphologie* **52**, 375-402.
- Scheffers, A., Kelletat, D., Vott, A., May, S.M., and Scheffers, S. (2008). Late Holocene tsunami traces

- on the western and southern coastlines of the Peloponnesus (Greece). *Earth and Plan. Sci. Letters* **269**, 271-279.
- Scicchitano, G., Antonioli, F., Berlinghieri, E.F.C., Dutton, A., and Monaco, C. (2008). Submerged archaeological sites along the Ionian coast of southeastern Sicily (Italy) and implications for the Holocene relative sea-level change. *Quaternary Research* **70**, 26-39.
- Szkornik, K., Gehrels, W.R., and Murray, A.S. (2008). Aeolian sand movement and relative sea-level rise in Ho Bugt, western Denmark, during the 'Little Ice Age'. *Holocene* **18**, 951-965.
- Woodruff, J.D., Donnelly, J.P., Emanuel, K., and Lane, P. (2008). Assessing sedimentary records of paleohurricane activity using modeled hurricane climatology. *Geochemistry Geophysics Geosystems*.
- Zazo, C., Dabrio, C.J., Goy, J.L., Lario, J., Cabero, A., Silva, P.G., Bardaji, T., Mercier, N., Borja, F., and Roquero, E. (2005). The coastal archives of the last 15 ka in the Atlantic-Mediterranean Spanish linkage area: Sea level and climate changes. In "Meeting on the Last 15ka of Environmental Change in Mediterranean Regions." pp. 72-87. Pergamon-Elsevier Science Ltd, Baeza, SPAIN.
- Zazo, C., Mercier, N., Lario, J., Roquero, E., Goy, J.L., Silva, P.G., Cabero, A., Borja, F., Dabrio, C.J., Bardaji, T., Soler, V., Garcia-Blazquez, A., and de Luque, L. (2008). Palaeoenvironmental evolution of the Barbate-Trafalgar coast (Cadiz) during the last similar to 140 ka: Climate, sea-level interactions and tectonics. *Geomorphology* **100**, 212-222.

3.7. Activities involving other IGCP projects, UNESCO, IUGS or others

IGC-OSLO, 2008 – Joint Session with IGCP 495 “Sea level fluctuations: past, present and future” Oslo, Norway, 6th - 14th August 2008. Conveners: Willy Fjeldskaar, Lawrence Cathles, Arto Miettinen.

4. Activities planned

4.1. *General goals:* Deliver comprehensive programme of meetings, complete two special issues, submit proposal for successor project, final project meeting and preparation of a concluding volume.

4.2. *Tentative list of specific meetings and field trips (please list the participating countries):* **IGCP495, Sixth International Conference and Field meeting Quaternary Land-Ocean Interactions**, North Carolina, November 2009, Dr Paul Gayes and Professor David Scott. Expected delegates = 100. **Joint UK IGCP495 Working Group and INQUA Commission on Coastal and Marine Processes, Field trip and Conference Decadal to Millennium-Scale Land-Ocean Interactions in the Geological Record: Blueprints for the 21st century?** Egmond aan Zee, Netherlands, June 2009, Dr Sytze van Heteren and Dr Henk Weerts. **The Third International Tsunami Field Symposium**, Sendai City, Japan, April-May 2009, Dr. Fumihiko Imamura and Dr. Kazuhisa Goto.

5. Project funding requested: We request US\$ 5,000 to support attendance at the two International Project Meetings listed in 4.2 above. Any resource will be used to support the attendance from less developed countries, with preference given to young scientists.

6. Request for extension, on-extended-term-status, or intention to propose successor project: A draft proposal for a new IGCP project to follow from IGCP495 was discussed and approved at the 2008 International Business Meeting and a proposal will be brought to UNESCO in early 2009. The new project is intended to start in 2010 and provide continuity to IGCP495 (project leaders: Dr Adam Switsur (Hong Kong University, China) and Dr Craig Sloss (Queensland University of Technology, Australia)).

7. Financial statement (\$ USD only)

See attached appendix.

8. Attach any information you may consider relevant

Please see our web site for further details of activities: <http://www.geography.dur.ac.uk/projects/igcp495>