Sea Level Change
From Minutes to Millenia

IGCP Project 639 Newsletter • N° 1 • November 2017

Editorial

Dear All,

Welcome to the first newsletter of IGCP Project 639 "Sea-level change from Minutes to Millennia". Future newsletters will be released once to twice a year and highlight ongoing research within our community, and some of those who are undertaking this work. We hope you enjoy this insight into the work of the project and will offer contributions to the newsletter in the future. Our thanks go to Jerome Goslin who is organizing the newsletter for the project.

As always, you can find up to date details on the project at our website, including our annual reports to IGCP, a reference list of project contributions, and information on past and future meetings. As a reminder, please continue to acknowledge IGCP Project 639 in your publications that form contributions to the project.

We have enjoyed meeting many of you in Oman and South Africa, and we hope to have the opportunity to discuss the project with many more of you at our next annual meeting in Italy in September 2018 or at sessions sponsored by IGCP at international and regional meetings.

Regards,

Simon, Gösta, Fengling, and Alar.

Contents

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Project outline

Sea-level changes over timescales from minutes to millennia are of great concern to coastal communities. Long-term changes in sea level due to the solid earths response to glaciation and tectonics are the background rate upon which the hazard from anthropogenic sea-level change and extreme inundation from tsunamis and storms must be superimposed. Short-term measurements from instrumental and historical records provide short glimpses at the hazard posed by sea-level change over varying temporal scales but must be placed within the long-term context that only geological and archaeological records provide.

This project will provide a platform for the development of integrated records of sea-level change and coastal hazards obtained from instrumental, historical, archaeological, and geological records. This project will place a particular focus on integrating disparate records in growth regions for science, namely in Africa, South America, and the Middle East. This project will result in a coastal hazard toolkit that can be applied by those most at risk from future coastal inundation.

Meeting reports

IGCP Project 639 has held two annual meetings so far. The first in Oman in November 2016 saw over 50 participants come together in Muscat, Oman, and at field sites along the Oman coast, for a six-day meeting. The meeting was comprised of workshops, oral and poster sessions, and a field trip to explore records of coastal hazards in the Middle East. Organized by project co-leader Gösta Hoffmann, the meeting attracted researchers primarily focused on hazards interested in earthquake and tsunami hazards, but there was a healthy cadre of researchers working on longer-term sea-level changes.

The workshop was split into two parts. The morning session was focused on emerging techniques in our field, with demonstrations of Ground Penetrating Radar (GPR), Real-Time Kinematic GPS (RTK-GPS) and Terrestrial Laser Scanning (TLS). All attendees participated in the workshop, including over 15 Omani undergraduate students. The afternoon focused on academic aspects related to research including the integration of data and models and the use of different proxies to investigate sudden coastal changes. The main scientific sessions included 1.5 days of oral presentations with keynotes by Prof. Ben Horton, Prof. Andrew Cooper, and Dr Tina Dura. These were followed by a half day poster session. Three days of field trips included time for discussion of evidence for tsunami inundation from both boulder deposits and from low energy sedimentary environments, as well as marine notches and terraces related to past relative sea-level highstands.

A detailed meeting reports has been submitted for publication in the journal EPISODES.

The second meeting was held in St Lucia, South Africa and hosted by Andrew Green of the University of KwaZulu-Natal. Over 40 participants were involved in the meeting, which was well balanced between those who had attended the Oman meeting and new attendees. The meeting was a joint meeting between IGCP Project 639, HOLSEA (INQUA CMP1601P) and a new INQUA project "Late Quaternary records of coastal inundation due to earth surface deformation, tsunami, and storms" (CMP1701P) that will run alongside IGCP Project 639. The meeting followed a similar format to Oman, with a day of workshops, two days of scientific sessions, followed by two days of field trips. The morning workshop focused on the HOLSEA project, led by Nicole Khan, with sessions on constructing and analyzing sea-level databases. The afternoon saw presentations on techniques that can be used to study coastal hazards. The scientific sessions were again split into 1.5 days of oral presentations and 0.5 day of posters. Keynotes were given by Dr Matthew Brain, Prof. Joe Kelley, Dr Gloria Lopez and Dr Jessica Pilarczyk. Field trips visited the heavily impacted St Lucia estuary, the beachrock and boulder deposits at Mission Rocks, and shoreline deposits at False Bay ranging from the Cretaceous to the last interglacial.

The next meeting will be held in Italy in September 2018. Specific dates will be announced soon.

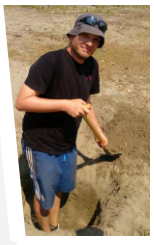
United Nations Educational, Scientific and Cultural Organization

IUGS UNESCO

IUGS Earth Science for the Global Community

Three questions to...

...Early career scientists at the 1st IGCP 639 project meeting in Oman, November 9th -14th 2016.



Martin Seeliger

Post-doc - Insitute of Geography, University of Cologne - Germany

Can you introduce your scientific background and actual research interests in a few words?

Martin Seeliger: *I am working on different palaeogeographical projects mainly based on the Turkish Aegean coast. My research interests comprise Coastal Geomorphology, Geoarchaeology and Sea-level research.*

How do your research align with IGCP 639 objectives? How do you feel being involved in IGCP 639 project strengthen your research plans?

M.S. : *While writing my PhD thesis, dealing with the coastal evolution of the Bay of Elaia (W-Turkey), the question of sea-level changes in this area appeared and creating a robust sea-level curve for my study area became one of the main tasks of my thesis. Based on foraminifera assemblages, I established a new sea-level indicator (together with Anna Pint; University of Cologne and Peter Frenzel; Friedrich-Schiller-University Jena) and used this to build a regional relative sea-level curve. In this context, I took notice of the recently started IGCP 639 project.*

You recently participated to the project meeting in Oman. What did you gain from attending this meeting?

"It was amazing to see the wide range of features usable for sea-level reconstruction presented by the experts of that sites. "

M.S. : *While joining the meeting in Muscat, I was able to discuss the validity of the sea-level indicator I developed with international researchers. This finally ends up in publishing my results (Seelinger et al. , 2017. Foraminifera as markers of Holocene sea-level fluctuations and water depths of ancient harbours - A case study from the Bay of Elaia, W Turkey, Palaeo3, 482, 17–29. Furthermore, it was amazing to take part in the field trip and see the wide range of coastal features usable for sea-level reconstruction presented by the experts of that sites.*

Noelynna Ramos

Assistant professor - National Institute of Geological Sciences, Quezon city - Philippines

Can you introduce your scientific background and actual research interests in a few words?

Noelynna Ramos: *My research activities generally focus on active tectonics, geomorphology, and geological hazards. I have done significant work on the mapping of marine terraces along some coastlines in the Philippines in relation to relative sea level changes, long-term deformation, and seismotectonic processes. My current research projects include geohazards assessment and susceptibility mapping, ground geophysics, and GIS applications in the geosciences.*

How do your research align with IGCP 639 objectives? How do you feel being involved in IGCP 639 project strengthen your research plans?

N.R.:*Most of my scientific work looks into hazards along coastal environments so I have benefited tremendously from participating in the 1st IGCP 639 meeting in Oman. The discussions guided me in refining our scientific methods and strategies in carrying out our research projects in the Philippines.*

You recently participated to the project meeting in Oman. What did you gain from attending this meeting?

"IGCP 639 strengthened my motivation to pursue research activities that are beneficial to many "

N.R.: *IGCP 639 meetings provide very good opportunities for early career researchers and students to learn from experts. I learned a lot from esteemed colleagues and fellow researchers from different parts of the world. My knowledge and understanding of relative sea level changes have developed significantly because of the lectures, training, and discussions we participated in. My participation in the conference activities exposed me to more complex and exciting research questions and strengthened my motivation to pursue research activities that are beneficial to many.*

Susanne Lindauer

Physicist - Curt Engelhorn Center for Archaeometry, Mannheim - Germany

Can you introduce your scientific background and actual research interests in a few words?

Susanne Lindauer: *I´m a physicist specialist of radiocarbon and luminescence dating methods. My interest lies in the species-specific, time-dependent reservoir effect of shells and snails in Arabia and adjacent seas. It is my (late) PhD topic to which I will continue working on after the PhD (which should be finished next year). The shells I´m working on at the moment basically can be found in or near mangrove areas.*

How do your research align with IGCP 639 objectives? How do you feel being involved in IGCP 639 project strengthen your research plans?

S.L. : *My connection to the IGCP 639 project arises from the fact that the reservoir effect changes with changing conditions the shells find in the ocean. A change in sea level means changes in their food resources and in the carbon distribution supplied with the ocean circulation. In Arabia, organic carbon sources that can be used for dating are rather rare. Hence dating foraminifera (used e.g. as hints for tsunami layers) is a helpful tool which might be used instead. As a physicist learning from the geoscientists of the group is amazing and helps me to recognize the settings easier.*

You recently participated to the project meeting in Oman. What did you gain from attending this meeting?

S.L. : *The meeting in Oman was amazing! I was amazed to see how much tsunami research is going on. I was not aware of how to recognize tsunami layers in sediments and what to look for as an indicator. Learning about the research of the colleagues of the IGCP 639 project is a constant source of new ideas. Meeting colleagues from Pakistan and India, as well as Colombia, was great for me as they also have mangrove areas which provide a link to my work. Working in an area not too far from Muscat where the meeting took place I also learned a lot about tectonics which might also provide some clues to the sea level changes in my area and the corresponding changes in reservoir effect. I immediately incorporated these ideas in my publication which I submitted few months ago.*

Drasti Gandhi

Senior Research Fellow - Institute of Seismological Research, Raisan, Gandhinagar - India

Can you introduce your scientific background and actual research interests in a few words?

Drasti Gandhi: *I am a geologist and currently working as senior research fellow at the Institute of Seismological Research, Gandhinagar, India. My research interest is in unraveling the geological evidences of high energy marine event deposits from the Gujarat coastline, India by carrying out geomorphology, sedimentology, geochemistry and OSL chronology. I submitted my thesis last month only on similar topic " Geological evidences of high energy marine events from the western coast of Gujarat, India".*

How do your research align with IGCP 639 objectives? How do you feel being involved in IGCP 639 project strengthen your research plans?

D.G.: *As an early career researcher, the IGCP conference and field trip provided me with a valuable learning experience. I find comments and discussion with the experts enhanced my knowledge. The talks of the experts on integrated records of sea level change and coastal hazards helped me seek and use a variety of tools for my future research in palaeotsunami and palaeostorm research. Their ideas, latest techniques and its implication helped in achieving the objective of my doctoral thesis.*

You participated to the meeting in Oman. What did you gain from attending this meeting?

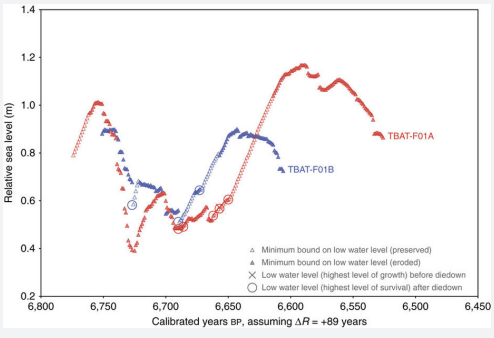
D.G.: *t was a great meeting and an amazing field trip. The three-days fieldwork along the Oman coastline for palaeotsunami deposits enhanced my views for world scenario on palaeotsunami deposits. It was an excellent opportunity to gather together, interact and exchange findings and views during conference sessions, coffee breaks and field trip.*

Publications

Focus on...

Aron J. Meltzner *et al.* (2017), Half-metre sea-level fluctuations on centennial timescales from mid-Holocene corals of Southeast Asia. Nature communications, 8:14387. (see the publication list below for the full reference)

The crucial question of the existence of high-frequency relative sea-level (RSL) oscillations during the Holocene has triggered lively debates in the community in the last decades. Indeed, the implications of such short-lived oscillations are numerous, either on fundamental or societal grounds. In this paper, Meltzner and colleagues tackle this question by studying the history of growth of coral micro-atolls found on the shore of Belitung Island (Indonesia, Sunda shelf, southeast Asia). Microatolls adequately record sea-level changes due to the very limited range of water depth in which they grow. As such, coral growth reflects RSL rise while micro-atoll diedowns (partial mortality event on a coral colony) is seen to sign for a drop in RSL. The corals skeletons wearing annual growth bands, changes in sea-level can precisely be time constrained when combined with radiocarbon dating.



The results of the study of two micro-atolls presented in this paper point toward the same fact: RSL appears to have known to 0.6m fluctuations around 6850 and 6500 years ago. Impressively, this echoes the results previously obtained in southern China (Yu et al. 2009, Quat. Res. 71, 354–360), thus suggesting these RSL fluctuations were at least of regional significance. Meltzner et al. proposes that such variations may be linked to regional to local changes dynamic sea-surface height or steric effect (e.g. linked to climatic phenomena such as Enso, Pacific Decadal oscillation or the Asian Moonsoon) or reflect eustatic changes.

In both cases, the implications of these results are large. If similar oscillations are regional and were to occur in the near-future, it would bear massive impacts on the very densely low-lying populated areas of Asia. If it is the far-field signature of Holocene eustatic changes, it would question the global ice-budget for the Holocene and subsequently impact the representativeness of GIA models.

Janneli Lea A. Soria *et al.* (2017) Typhoon Haiyan overwash sediments from Leyte Gulf coastlines show local spatial variations with hybrid storm and tsunami signatures, Sedimentary Geology 358, 121–138. (see the publication list below for the full reference)

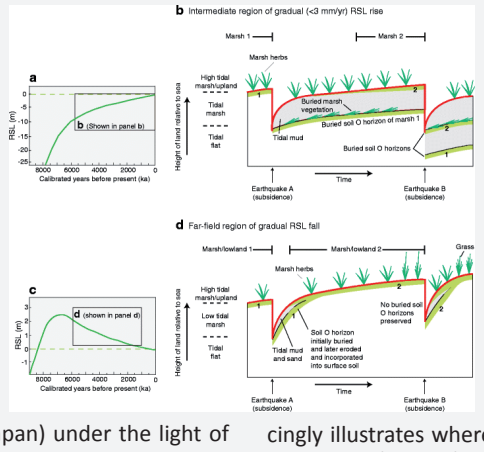
In regions concerned by both tsunamis and cyclogenic activity, distinguishing between storm and tsunami layers within the sedimentary records is often deemed problematic, inducing some uncertainty in the reconstructions of past extreme events. Modern extreme events give the opportunity to better understand the sedimentary characteristics of the deposits left by such extreme events. In this article, Janneli Lea A. Soria and colleagues present the results of the study of the overwash lags left by 2013 typhoon Hayian on the coastal plains of the northwestern shores of Leyte Gulf, Philippines.

Soria et al. sampled Haiyan overwash blankets along crossshore transects. Generally, Haiyan overwash deposits were observed to be composed of two very distinctive units, interpreted to result from different flow regimes. These two units were most likely deposited during different phases of the inundation caused by typhoon Haiyan: the first of these units most likely deposited in suspension under a bore-type flooding while the second was most probably provoked by a traction load of the washover terrace at the vanishing stage of the surge. The deposits left by Haiyan share sedimentary characteristics similar to those observed for storms of comparable strength. Nonetheless, Soria *et al.* observed Haiyan deposits to be thinner and to extent much further inland than the washovers left by equivalent storms. To that extent, Haiyan washovers are very comparable to the deposits left by the 2004 Indian Ocean tsunami. Also, deposits were observed to share sedimentary structures with tsunamis deposits.

These findings demonstrate that *"the maximum inland extent and thickness of sedimentation, by virtue of the local variability, may not necessarily provide conclusive evidence for distinguishing between storm and tsunami deposits."* Here is what to fuel to the debate!

Tina Dura *et al.* (2016) The Role of Holocene Relative Sea-Level Change in Preserving Records of Subduction Zone Earthquakes, Current Climate Change Reports, 2, 86–100. (see the publication list below for the full reference)

Coastal wetlands (intertidal salt-marshes) are widely studied for the purpose of reconstructing past earthquake activity along millennial timescales, as their sedimentary sequences were shown to be able to preserve records of sudden RSL changes associated with earthquake-driven coseismic vertical deformation of the coasts (subsidence or uplift). Yet, the ability of wetlands to have recorded long and complete records of past coseismic changes in RSL, and the preservation potential of these records are heavily dependent on the RSL history of the region. In this article, Dura and colleagues review records of prehistoric earthquakes built from coastal wetlands sedimentary sequences retrieved from subduction zones worldwide (Cascadia, Sunda, Chile, Japan) under the light of RSL changes experienced by these regions.



Where RSL has been continuously rising over the last millennia, the accommodation space provided by such RSL evolution makes that marsh horizons quickly developped over the stratigraphic contact that signed for the coseismic events, thus most likely allowing its adequate burial and subsequent preservation. On the contrary, regions that have experienced by thin marsh sedimentation, which is subsequently prone to post-depositional degradation as they are stranded due to coastal emergence. Studying regions located in the near-, intermediate- and far-field domains of Holocene RSL changes allow the authors to convincingly illustrates where adequate records of past earthquake activity are best to be sought after.

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