GEN-EX

Metagenomics of Extreme Wave Events

DURATION
15/03/2017 – 15/10/2019

BUDGET
149 979 €

PROJECT DESCRIPTION

Background
With more than 10% of the global population living at elevations of less than 10 m above sea level, extreme wave events, including storm surges and tsunamis, pose significant hazards to coastal communities and infrastructure around the world. The impact of these events will be further accentuated by anthropogenically-driven sea-level rise, emphasizing the need for better understanding of their potential future frequency and size. To develop evidence-based hazard assessments, we rely on records of the past occurrence of extreme wave events. While such understanding may be founded on instrumental and historical data sources, the recurrence interval between the largest extreme wave events may be far in excess of historical documentation. The analysis of geological records presents a complementary approach, with sedimentary and geomorphic archives providing evidence for the occurrence and characteristics of palaeostorms and palaeotsunamis over multi-millennial timescales.

A range of coastal environments, including tidal marshes, coastal lowlands, lakes and uplifted beach ridge systems, may preserve evidence for past extreme wave events through the presence of laterally extensive sand sheets (Fig.1) The scientific community has developed a wide range of techniques to study these deposits, with approaches incorporating sedimentology, macro- and micropalaeontology, geochemistry and geomorphology. Despite this interest, differentiation between the sedimentary evidence for tsunamis and storms remains a major unresolved issue. Both storms surges and tsunamis may be characterised by wave heights and velocities significantly in excess of normal waves. Both storm surge and tsunami deposits may consequently share features resulting from erosion, transport and redeposition of sediment, including erosive basal contacts, rip-up clasts, upward fining sequences, landward thinning and fining, marine or mixed macro- and microfossil assemblages and increased elemental salinity indicators and heavy minerals.

The GEN-EX project seeks to **address the issue of identifying and differentiating between storm surge and tsunami deposits through the application of metagenomic techniques.** Metagenomics, also known as environmental genomics, environmental DNA or eDNA, is the field of biology concerned with extracting DNA directly from the environment. While metagenomics has successfully answered a range of questions concerning the biodiversity of current and ancient flora and fauna, it constitutes a **novel approach** for the extreme wave event community.

Fig. 1: The photo shows layers of light colored sand deposited on a coastal lowland in Thailand resulting from a sequence of tsunamis. The uppermost sand layer relates to the Indian Ocean tsunami of 2004.@RBINS.

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The overall aim of the research project is to **pioneer the use of metagenomic approaches to study extreme wave events in different environments** and establish their potential for a wide range of future sediment-based geoscience and biological questions.

Objectives

1. Quantify the relationship between water depth and the distribution of different species of foraminifera using both classic assemblage methods and metagenomic approaches
2. Assess the potential for identifying key indicator species in extreme wave deposits (tsunami and storm) in two different climate settings based on both assemblage approaches and metagenomic high-throughput sequencing techniques
3. Establish how metagenomic approaches contribute to consistent and reliable differentiation between the sedimentary evidence for storms and tsunamis in coastal settings

Methodology

We will apply the classic tsunami tool kit, including techniques from sedimentology, macro- and micropalaeontology, geomorphology and geochemistry. We will extensively study microfossil assemblages of Foraminifera, single celled protists, which are ideal to distinguish between tsunamis and extreme wave events. Postdepositional modification can lead to poor preservation of Foraminifera, their visible testes might be lost or certain species might be too rare to be identified with classic methods. All of these complications are the reason why the core of this project is the development of metagenomic techniques for identifying foraminiferal biodiversity to study extreme wave and tsunami events. We will first develop a molecular reference database of recent Foraminifera, followed by applying metagenomics to sediments from potential tsunami and extreme storm events, and by comparing the results of Foraminifera diversity from classic and genomic approaches. Finally, the outcomes of all techniques will be integrated into an extended toolbox for the study of extreme wave events.

Nature of the interdisciplinarity

GEN-EX is highly interdisciplinary as it will use state-of-the art molecular techniques including metagenomics and ancient DNA to investigate the geological research question how tsunamis and storms can be distinguished in extreme wave events.

Potential impact of the research on science, society and/or on decision-making

As explained above, GEN-EX will pioneer the application of modern genomic techniques to geological research questions, having a large impact on science in both disciplines Given that extreme wave events pose a significant hazard to coastal communities and infrastructures around the world, the results of GEN-EX will also have a significant impact on society and decision making.

Description of finished products of research (model, scenario, report, workshop, publication, etc…) at short and medium term.

GEN-EX will generate scientific publications, presentations, organize a special conference session and an interdisciplinary workshop, and will provide tailored reports for decision makers.

CONTACT INFORMATION

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LINKS

https://www.researchgate.net/project/GEN-EX-MetaGENomics-of-EXtreme-wave-events