Proposal for a new SCOR Working Group
"Tsunamis"

Background and Rationale

The destructive tsunami generated by the 26 December 2004 M_w = 9.3 megathrust earthquake off the coast of Sumatra and Andaman Islands in the Indian Ocean killed more than 226,000 people and left millions more displaced and homeless. Damage is estimated in the billions of dollars. As a result of international tourism, countries far removed from the major disaster areas felt the global reach of the Sumatra tsunami, which triggered the largest international relief effort in history. The highly destructive waves generated by the 1-10 m vertical displacements of the crust elevated our awareness of tsunami hazards to a new level. The extensive damage and loss of life from this event have forever changed our view of tsunamis as relatively infrequent, marginally significant, local consequences of earthquakes. Tsunamis are now considered one of the most dangerous global catastrophes.

To learn from this tragedy, the tsunami research community has responded with an unprecedented effort to collect and interpret the vast amount of tsunami-related data. There is historical evidence of tsunamis in the Pacific Ocean that have traveled across the ocean causing destruction thousands of kilometers from the source. However, the Sumatra tsunami of December 26 was the first global tsunami to occur during the "instrumental era". It provided high-quality tsunami measurements on a worldwide basis. The tsunami was clearly recorded by a large number of tide gauges throughout the worlds' oceans, including those in the North Pacific and North Atlantic. Global tsunami propagation models (cf. Titov et al., 2005) demonstrated that the mid-ocean ridges served as wave-guides to the 2004 event. They efficiently transmitted tsunami energy from the source area to far-field regions of the Pacific and the Atlantic coast of North America. The 2004 Sumatra tsunami is now recognized as the most globally distributed and accurately measured tsunami in recorded history. More than 200 digital records of this tsunami are available and years after the event, tsunami measurements are still being collected and archived.

An unprecedented number of international survey teams working in the impacted coastal areas of the Indian Ocean collected a tremendous amount of data on maximum tsunami wave heights along the coasts (vertical and horizontal tsunami run-ups). The Sumatra tsunami was the first major tsunami that was clearly recorded by satellite altimetry (Topex-Poseidon, Jason and Envisat satellites). Signals from the earthquake and tsunami were also recorded by a wide variety of other geophysical instruments, including GPS, hydrophones, seismometers and infrasound stations. This huge volume of observational data has prompted scientists to revise previously held conceptions regarding tsunami propagation and transformation. It also generated many questions initiated by public interest and incomplete scientific understanding. These data provide us, the scientific community, with a unique opportunity to better understand the physics of tsunami generation, propagation and dissipation. Collection, careful examination and interpretation of these data, requires broad international cooperation and *a SCOR Working Group on Tsunamis could play a key role in this process.*

A question of particular importance is numerical modeling of tsunami waves: their generation, propagation and inundation of the coast. The 2004 Sumatra tsunami was the first tsunami when numerical model simulations of global tsunami propagation could be coupled with global water level records. This has shed light on the evolution of tsunami wave properties during inter-ocean spread. As a consequence, this event has exposed several problems in tsunami modeling. First is the availability of globally accurate and reliable bathymetry and coastal topography (for potentially floodable regions). Second are nonlinear 3-dimensional effects in coastal zones. These remain a serious problem for tsunami modelers and could be effectively considered under the *SCOR Working Group guidance*.

The 2004 Sumatra tsunami strongly affected the coasts of the entire Indian Ocean, killing citizens from more than 60 countries. This resulted in significant scientific and public interest in the problem of tsunami warning and mitigation. Many new scientists and specialists have become involved in this problem. Many countries have begun work on elaboration of their national tsunami warning systems. A *SCOR Working Group on Tsunamis* could provide valuable guidance, assistance and scientific understanding to these individuals and countries.

This working group would be an efficient international team of leading scientists from various geographical regions, representing countries both with a long history of tsunami research (e.g. Japan, USA and Russia) and those that are beginning to work in this area (e.g. Guadeloupe, Thailand and Malaysia). Most of the potential members of the group have a record of successful cooperation, working on joint projects.

The rationale behind the proposal to create the *SCOR Working Group on Tsunamis* is summarized as the following. The devastating tsunami of the 26 December 2004 in the Indian Ocean (and some other catastrophic tsunamis ~~of the~~ in recent time) has peaked the interest of the public, governments and scientists in the problem of tsunamis. There is a vast quantity of data that now exists on major tsunami events of the past two years. This demands and deserves detailed analysis and interpretation to better understand the phenomenon. However, this goal cannot be achieved by a few individuals working in isolation. A well-coordinated international effort to collect, process and interpret the available data will derive significantly more valuable outcomes in a shorter time frame. The international nature of the group will also facilitate the translation of the scientific results to the practical world of warning and mitigation.

As a response to the tragic events, several regional and international organizations and groups have been created or significantly reconstructed. These include the Intergovernmental Coordination Groups on the Pacific and Indian Ocean Tsunami Warning Systems (ICG/PTWS and ICG/IOTWS, respectively) working under the umbrella of the Intergovernmental Oceanographic Commission (IOC/UNESCO). The main purposes of these organizations and groups are *applied research and development*. They are directed to providing effective tsunami warning and mitigation of the catastrophic consequences of tsunami events. The main purpose of the *SCOR Working Group on Tsunami* would be to promote *scientific research*. It would solve specific scientific problems, enhance the scientific knowledge of tsunami physics and provide this scientific information for practical use. This working group would work in close cooperation with IOC, providing scientific background for the IOC applied organizations and projects. This co-operation would be achieved, in part, through the members of the SCOR Working Group,

who are also members of the various Intergovernmental Coordination Groups. Taking into account the scientific and practical importance of the tsunami study, we expect the foundation support of this working group to come from national and international funds.

Terms of Reference

Based on discussions between the prospective members of the SCOR Working Group on Tsunamis, the following three primary themes of the group's activity have been specified:

(1) Analysis of tide gauge tsunami data
(2) Numerical modeling of tsunami waves
(3) Estimation of tsunami risk for the coastal regions

These three themes have high scientific significance and practical importance. The detail regarding each is of these themes is give below.

(1) *Analysis of tide gauge tsunami data*

The working group would collect and to analyze coastal and open ocean tsunami records from all over the World Ocean. The main attention will be paid to the records of the Sumatra tsunami of 26 December 2004 (this tsunami was recorded by approximately 200 tide gauges), but other major tsunami events with well documented records also would be examined carefully (e.g. Chile, 1960; Alaska, 1964; Shikotan, 1994; Peru, 2001; Tonga, 2006). There are four major problems to work on in respect to these data:

- Separation of the source and topography effects in the tsunami records. From this, estimate their relative influence for different sites and the distance from the source distance.
- Reconstruction of the tsunami source.
- Comparison of near-field (near-source) and far-field tsunami record to investigate the evolution of a tsunami with distance.
- Intercomparison of the major tsunamis (e.g. the global 1960 Chile and 2004 Sumatra tsunamis) and examination of the source physics and wave field characteristics of the corresponding tsunamis.

All these problems are of key importance for tsunami understanding and prediction.

(2) *Numerical modeling of tsunami waves (generation, propagation and runup)*

There are three main directions of tsunami modeling:

- Numerical modeling of *historical events.* This is important for better understanding of the physical mechanisms of these events, and to verify the models by comparison with the existing observational data.
- Numerical modeling of the plausible *worst-case scenarios* for future tsunami events to estimate tsunami risk for specific regions of the Worlds Ocean.
- *Real-time* numerical modeling of tsunami propagation in the case of a major earthquake; this is a crucial problem for efficient tsunami warning.

The main purpose of the group is to outline the effective ways to do these three types of modeling. The concrete problems to consider are:

- Collecting and utilizing the accurate bottom bathymetry and coastal topography
- Example modeling studies to support developing Tsunami Warning Systems (in particular, for the Indian Ocean, Caribbean, and Mediterranean).
- Estimation of various tsunami sources (rupture and possible landslide characteristics) for selected study regions (or for some countries); determination of domain dimensions for modeling with respect to sources, vulnerable coastal regions, and buoy locations; and determination of several scenarios for the modeling.
- Determine the best format of the database to develop the outputs of each scenario from modeling so that model results can be used immediately after the tsunami event for decision-making and warning issues.
- Development of numerical tools for computation of wave structure interaction and wave characteristics in inundation zone

Solving these problems may have important practical outcomes.

(3) *Estimation of tsunami risk for the coastal regions*

The problem of long-term tsunami forecast, that is, estimation of tsunami risk for specific geographical regions and local areas, is the problem of the highest priority, especially for the regions where studies have never been provided in the past (e.g. the coasts of the Indian Ocean). There are two main directions of the group activity in the frame of this theme:

- Development of new effective methods to estimate tsunami risk based on the methods of extreme statistics and numerical modeling.
- Estimation of tsunami risk for specific geographical regions first of all for the coasts of the Indian Ocean and Caribbean.

The main scientific product of the Working Group's activity would be a book (collection of scientific papers) summarizing the main scientific results of the group. Also the group will regularly present individual scientific articles in refereed journals.

Working Group meetings

The meetings of the SCOR Working Group on Tsunamis (WGT) are planned to be on an annual basis, that is, three meetings during the four-year period, 2007-2010. Two of these meetings (in 2007 and 2009) will be combined with the IUGG International Tsunami symposiums and two (2008 and 2010) will be independent. The exact places of these meeting will be defined later. One of the main criterions that will be taken into account is the minimizing travel expense for the WGT members.

2007: WGT Meeting 1 Prerugia, Italy (July, 2007**)**

(combined with the 23rd International Tsunami Symposium, XXIV IUGG General Assembly)

2008: WGT Meeting 2

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2010: WGT Meeting 3

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Beyond the SCOR-sponsored meetings, some additional informal Working Group meetings are possible combined with some other tsunami meetings.

Preliminary Time Table

Year	Theme		
	Tsunami analysis	**Numerical modeling**	**Tsunami risk**
2007	- Collecting the tide gauge data from the 2004 Sumatra tsunami and other major tsunami events. - Overview of the 2004 Sumatra tide gauge measurements in the Indian, Pacific and Atlantic oceans.	- Collecting and utilizing the bottom bathymetry and coastal topography. - Example modeling studies for Indian Ocean and Caribbean (to support developing Tsunami Warning Systems)	- Preliminary estimation of tsunami risk for the Indian Ocean (based on historical earthquake and tsunami data). - Preparation of the corresponding paper
	Meeting of the SCOR Tsunami Working Group (23rd IUGG Tsunami Symposium), Perugia, Italy, July 2007		
2008	- Statistical analysis of the 2004 Sumatra tsunami records and other major historical tsunami events. - Parameterization of tsunami events, comparative analysis of	- Development of the tsunami scenario for the Indian Ocean, Mediterranean, and Caribbean. - Numerical modeling of global historical tsunami events.	- Development of new methods to estimate tsunami risk (based on of extreme statistics and numerical modeling) - Preliminary estimation of tsunami risk for the

	wave structure.		Caribbean region..
	Second Meeting of the SCOR Tsunami Working Group Preparation of peer-reviewed papers.		
2009	- Separation of the source and topography effects for the 2004 Sumatra tsunami. Reconstruction of the tsunami source - Intercomparison of near-field and far-field tsunami characteristics	Development of numerical tools for computation of wave structure interaction and wave characteristics in inundation zone	- Estimation of tsunami risk for the Indian Ocean, Mediterranean and Caribbean regions
2010	Preparation of the special volume (paper collection) summarizing the results and findings of the SCOR Tsunami Working Group		
	Final Meeting of the SCOR Tsunami Working Group		

Proposed Members of the Group

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