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Indian Ocean Disaster: risk reduction for a safer future

Information paper submitted by the delegation of the Federal Republic of Germany entitled "Concept of the the Federal Republic of Germany for the Establishment of a Tsunami Early-Warning System in the Disaster Region of the Indian Ocean"

Note by the Secretariat

The delegation of the Federal Republic of Germany has submitted the attached paper to the secretariat of the Conference with a request that it be circulated as an official document of the Conference. It is reproduced as received.

Concept of the Federal Republic of Germany for the Establishment of a Tsunami Early-Warning System in the Disaster Region of the Indian Ocean

The goal is to implement an effective tsunami early-warning system for the Indian Ocean, which should later be extended to cover the Mediterranean Region and the Atlantic. The tsunami early-warning system is a component part of an Early-Warning-System for the registration of other natural catastrophes including, earthquakes and volcanic eruptions. The system will integrate terrestrial seismologic and geodetic monitoring arrays with marine and satellite-based observation platforms. The necessary R&D work will be organized on two levels. The first level will guarantee rapid and reliable protection, i.e., within 1-3 years, using existing technology. It will be designed to allow easy integration of new technologic advancements, for which a longer-term research program will be implemented in a parallel, second level. All institutions wishing to contribute are called to participate. The initiative will be coordinated by the Helmholtz Association of German Research Centres, represented by the Scientific Executive Board of the GeoForschungsZentrum Potsdam.

The concept is based upon the partnership model suggested by the German Chancellor, Gerhard Schröder and shall focus on the partner countries Indonesia and Sri Lanka, which have a tradition of good scientific-technical cooperation with Germany. Based on the geologic situation of the region, Indonesia, especially, must also be expected to face the most frequent and acute risks from future catastrophic tsunamis because of its direct proximity to the seismically-active Sunda arc. An integral component of the concept is measures of Capacity-Building in the area of Disaster Management for decision makers and experts as well as for the inhabitants of the region.

An extension of coverage beyond the initial focus areas of Indonesia and Sri Lanka can readily be achieved within the German concept, and with the anticipated support of other donor nations for building early-warning capacity in the region, integration with further geophysical and geodetic monitor systems is ensured. Among these are the Global Geodetic Observing System (GGOS), the Global Ocean Observing System (GOOS), and the Global Climate Observing System (GCOS). With the suggestions for a satellite-supported monitoring of the endangered region, solely the objectives of humanitarian aid will be pursued.

The early-warning concept comprises two levels of implementation. The first level will provide a rapid, basic system that employs the existing global earthquake monitoring system of the GeoForschungsZentrums Potsdam (GFZ) at its core. The level 2 work should commence in parallel with the first level but will operate over a longer-term and build on the results and experience gained in level 1.

Level I is designed for 1 - 3 years and comprises the following 4 components:

1. Establishment of a warning system focussed on earthquakes and tsunamis in the Indian Ocean based on existing systems and technology
   - Extension of the GFZ-GEOFON-Network (additional stations, enhanced data transfer rates via satellite, improved accuracy and interpretation methods)
   - Integration with existing and newly-implemented seismologic networks of other donor nations in the region
   - Establishment of a network of marine (buoy-based) pressure and wave gauges in the Indian Ocean
   - Installation of additional coastal tidal gauges linked with GPS
   - Enhancement of the system for monitoring permanent crustal deformation by adding stations and improving the GPS-Network Geodyssea of the GFZ
   - Utilization of existing satellite systems for fast communication in the region (Eumetnet, WMO, Orbcomm)
   - Support of capacity building and know-how transfer in regional and national seismologic centres through training courses

2. Conceptual studies for expanding the system
   - Extension and improvements for monitoring permanent crustal deformation
     - implementing satellite-based radar interferometry with German systems (TerraSAR-X)
     - developing L-Band-radar supported satellite systems
   - Study of an low-orbiting (Micro-) Satellite constellation to improve communication

3. Development of new technologies (e.g., GPS-based sea level measurements using reflectometry/altimetry data from CHAMP)

4. Capacity Building

Level II comprises the construction and operation of a multi-satellite system to be based on the results of conceptual studies in Level I. Such a multi-satellite system is the necessary step toward a globally-operational tsunami warning system. It will require considerable investment and the concept should, within 1-2 years, be discussed and agreed on by European and other international partners. From the German side, the results and experience gained in the 3-part program of level I will be brought in.

Rough Estimates of Required Funds:

Level 1	Component 1:	20 Mio. €
	Component 2:	10 Mio. €
	Component 3:	10 Mio. €
	Component 4:	5 Mio. €

Level 1, Component 1 of the total system:

Establishment of a real-time earthquake monitoring system

Previous work by GFZ

The GFZ already operates a seismologic research network (the GEOFON-Net) in cooperation with several partner institutes, which continuously registers earth seismicity and transfers the data online to Potsdam using a GFZ-developed protocol. The GEOFON network is closely linked with seismologic nets of other countries, and mutual exchanges of data take place on a regular basis.

The forerunner methodology for real-time communication developed at GFZ has now become a standard internationally, including the USA. In addition, GFZ scientists have developed a software package for automated detection and localization of earthquake foci. This software package, together with a real-time seismometry network consisting of GEOFON stations and other compatible stations operated by partner organizations (now well over 100 stations) forms the basis for a prototype global real-time earthquake monitoring system now operating at the GFZ.

Normally, an earthquake can be localized by the system within 2 minutes after seismic waves reach the GEOFON stations in Europe. For the tragic Sumatra earthquake, the seismic waves took an average of 11 minutes to reach European stations. The system issued an automatic (i.e. without input from a seismologist) large earthquake alert by internet at 01:11:40 Universal Time (about 13 minutes after the event at

00:58:41 UT). Simultaneously, email and SMS-alerts were automatically sent to the subscribed user community (various logisitic centres, seismologic institutes, media, insurance agencies, interested public). However, the information sent did not – and principally does not ever – include any prognosis of possible damage.

Stations network

There exist today only a very few high-quality (broadband) seismologic stations in the Indian Ocean region that produce data for public access (Fig. 1). And real-time data are available from only 6 stations, all of which belong to the American IRIS-network

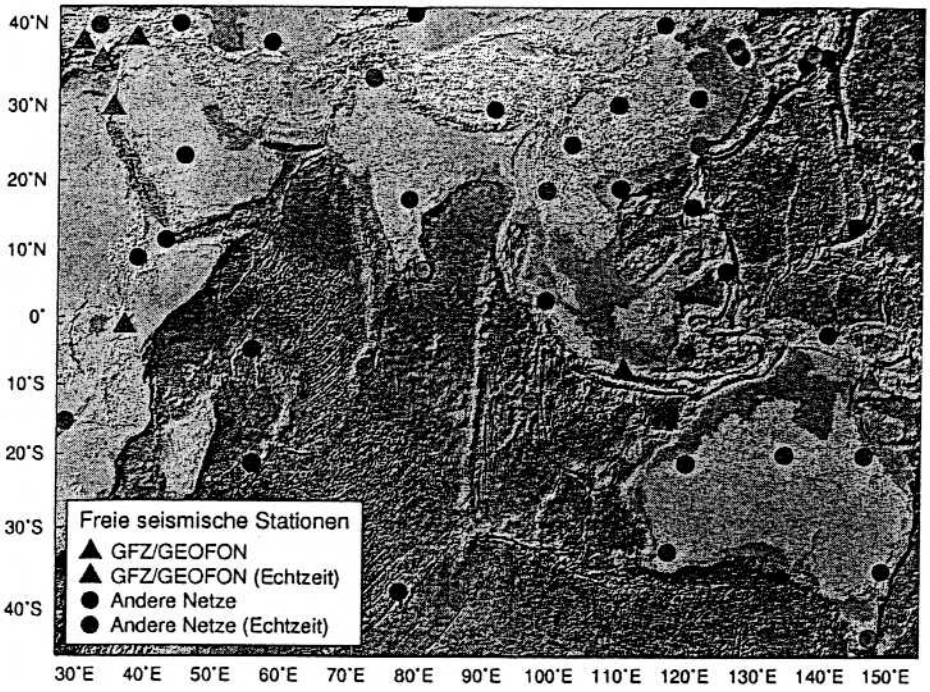

Figure 1: Distribution of existing broadband seismologic stations that produce public-access data in the Indian Ocean region.

In response to this need, the first level of system implementation will install ca. 30 - 40 new GEOFON-compatible stations fitted for real-time satellite communication. In cooperation other donor countries, the total number of public-access stations in the network should be about 250.

Data communication

Because of the only limited range of internet coverage in the Indian Ocean region, there is no alternative to satellite-based communication for data transfer. Therefore, each station must be fitted with a VSAT-terminal and the system must include its own satellite master station that is to be installed at an appropriate computing centre in the region.

Local data processing

Each country in the region should operate and maintain one or, as in Indonesia, perhaps several data processing centres where real-time seismologic data generated by the stations are received and quickly processed to produce earthquake localization and source parameters. The local centres can also serve to coordinate announcement of civil alerts for their respective regions. A crucial point is that all of the local data centres must receive all seismologic data within the whole system. The overall coordination within the system will be run through the GFZ Potsdam.

Cooperation with other donor countries and partnerships

The concept outlined here is modular and flexible and can easily integrate compatible data from outside sources. This will ensure the capability to integrate with seismologic networks established by other donor countries in aid of a full, regional early-warning system. Should a group of donor countries agree to support a joint program towards this aim, the concept proposed here could first be implemented for one or two countries (e.g., Indonesia and Sri Lanka), in line with the partnership model favoured by the German government, and would then organize links and data exchange with systems implemented in the other affected countries.

Partner organisations that should be involved and with which close cooperation with GFZ already exists

In the region:
Meteorological and Geophysical Agency of Indonesia (BMG)
National Geophysical Research Institute (NGRI), India
Institute of Fundamental Studies, Sri Lanka
Bureau of Mines and Resources (BMR), Australia
National Research Council, South Africa

International:
Incorporated Research Institutions for Seismology (IRIS), USA
US Geological Survey (USGS), USA
Institut de Physique du Globe, (I.P.G.P.), France
Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan
ISDR Platform for the Promotion of Early Warning (PPEW), Bonn, Germany
United Nations University, Institute for Environment & Human Security (UNU-EHS), Bonn, Germany

National:
GeoForschungsZentrum Potsdam (GFZ)
Alfred-Wegener-Institut (AWI), Bremerhaven
Deutsches Zentrum für Luft- und Raumfahrt (DLR), Köln
Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover
Leibniz-Institut für Meereswissenschaften Kiel (IfM-Geomar), Kiel
Technische Universität Karlsruhe
Deutsches Komitee für Katastrophenvorsorge (DKKV), Bonn
