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Global Seismic Hazard Assessment Program (GSHAP)

Progress Report n.2 – December 1993

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A. Foreword

The Global Seismic Hazard Assessment Program (GSHAP) was launched in 1992 by the International Lithosphere Program (ILP), and endorsed as a spearhead program in the framework of the UN International Decade for Natural Disaster Reduction (UN/IDNDR), with the support of the International Council of Scientific Unions (ICSU).

In order to mitigate the risk associated to the recurrence of earthquakes, the GSHAP promotes a regionally coordinated, homogeneous approach to seismic hazard evaluation; the ultimate benefits will be national assessments of seismic hazards, to be used by national decision makers and engineers for land use planning and improved building design and construction.

The GSHAP was launched with the Technical Planning Meeting, held in June 1992 in Rome, to focus the consensus of the scientific community on the development of a multi-national and multi-disciplinary approach to seismic hazard assessment. The first year of GSHAP was devoted to the program definition and implementation; this preparatory phase culminated with the second meeting of the GSHAP Steering Committee in Ixtapa (Messico) in April 1993, where the program technical procedures and regional structures were approved, and can be considered as concluded as the main elements of the program are now operating. It has taken the whole 1993 to initiate steady activities in all regions and to attain a significant global implementation of the GSHAP.

Reports describing the program concept, planning and implementation were issued in February 1992, June 1992 and November 1992. The final Program Description and the Technical Guidelines were released in July 1993, following the approval of the GSHAP Steering Committee. This document describes the activities of the program since the last Progress Report of November 1992.

The report provides a summary of the GSHAP, as seen by the point of view of the Coordinator. It describes the highlights and setbacks of 1993, the implementation of the UN/IDNDR framework and its implications on the GSHAP, the management structure and the funding status, the activities conducted at global scale (technical guidelines, software development, special projects), the coordination with other UN/IDNDR activities and with programs conducted by IASPEI, ILP and by the engineering community. Also, an overview of the regional activities and the test areas is provided. Finally, the program expectations and challenges for 1994 are discussed.

Appendices include an explanatory list of acronyms used in the report, a map of the Regional Structure and Test Areas, mailing contacts for the Steering Committee and the Regional Centers, the index of the GSHAP Technical Planning Volume and the list of GSHAP publications in 1993.

B. Highlights of 1993

The GSHAP is progressing, on schedule and reasonably along the initial expectations.

During 1993 the main elements of the program were defined and went into operation; the program is now recognized worldwide as one of the most significant contributions of the scientific community

to the Decade. The role of GSHAP as an effort in coordination, comunication and standardization is now established and the needed connections with existing regional and national hazard programs have been made.

The consensus of the seismic hazard community has been obtained on a set of Technical Guidelines that, when fully implemented, will represent a needed improvement in seismological standards and practice and a significant step forward in promoting a multi-disciplinary, multi-national approach to seismic hazard assessment. The implementation of the Technical Guidelines is taking place through the development of Special Projects and dedicated software and the activities conducted at the Regional Centers.

The key element of the GSHAP strategy in 1993 has been the establishment of the Regional Centers to act as focal points for national activities in all continents (Appendix A2). Regional meetings focusing on GSHAP and on regional test areas in seismic hazard assessment have been organized in all continents: Beijing (10/92), Rabat (12/92), Teheran (1/93), Mexico (4/93), Tsukuba (6/93), Potsdam (7/93), Moscow (9/93), Cairo (10/93) and Nairobi (11/93). For example, the GSHAP Regional Meeting in Northern Eurasia (Moscow, 9/93) was attended by 40 representatives of 15 countries, to successfully plan activities along the Alpine-Himalayan seismic belt and in the Caucasus test area.

Regional activities in the GSHAP framework are coordinated in five broad areas:

- **Americas:** regional programs in seismic hazard assessment are well advanced in both continents; the role of GSHAP is to ensure coordination with other regions and to pursue the continuation of the activities in South America;
- **Europe-Mediterranean:** a mosaic of multi-national test areas is being activated by different programs with the coordination of the European Seismological Commission (ESC) and of GSHAP; Spain-Maghreb, the British Channel, the Adriatic plate, the D-A-CH countries, the Eastern Mediterranean, the Caucasus;
- **Central Asia:** the efforts of the GSHAP Regional Centers in Russia, China and Iran strive to maintain open cooperation along the Alpine-Himalayan seismic belt;
- **East-Asia:** GSHAP has taken a significant role in supporting regional initiatives (e.g. the Natural Hazards Mapping program) and succeded in establishing international links in China, Japan, Philippines; a true regional framework is not yet active;
- **Africa:** although the pace of cooperative activities is still trailing behind, a successful GSHAP meeting was held in Nairobi (11/93) and support for a regional program is being identified.

The GSHAP has been invited to the main IDNDR Conferences of 1993:

- the International Forum on Natural Hazards Mapping (Tsukuba, 6/93),
- the Conference on Natural Disasters: Protecting Vulnerable Communities, (London, 10/93),
- the Seminar on Earthquake Hazards in the Eastern Mediterranean Region, (Cairo, 10/93),
- the Conference on Disaster Management in Metropolitan Areas for the 21st Century (Nagoya, 11/93).

About 20 papers have been published on scientific journals and volumes, describing GSHAP and its regional implementation in different areas of the world; several contributions were also published on local journals by the Regional Centers. The GSHAP Technical Planning Volume was published in November 1993, as special issue of *Annali di Geofisica*, and distributed worldwide.

While the program financial support has not been secured in the projected measure, thus hindering progress, several major proposals are pending, to support activities in Northern Europe, the Mediterranean, Africa, the CSI, China, the Philippines and EastAsia, Latin America. A small coordinating fund was available to support start-up activities in several Regional Centers.

The cooperation of the scientific community has been remarkable. The GSHAP is a Decade program proposed and run by scientists; as such its technical content is very high, more so than in the usual international cooperation programs. This long-term effort relies on the active participation of top-level scientists who are willing to devote considerable amount of time and energy on a program driven not only by scientific interest but also and often by an admirable spirit of cooperation.

GSHAP is conducted in close coordination and with the full cooperation of the international scientific organizations (ILP, IASPEI, IUGG, IUGS, ICSU), and in coordination with the international engineering community (UITA/WFEO, IAEE) and other UN/IDNDR programs. A few examples:

- a full session of the 1993 Annual Assembly of the American Seismological Society (Ixtapa, 4/93) was devoted to GSHAP;
- the opening presentation at the 27th IASPEI General Assembly (Wellington, 1/94) will be on GSHAP;
- the description of the session on Seismic Hazard Assessment at the XIX General Assembly of the European Geophysical Society (Grenoble, 4/94) reads: "GSHAP related activities";
- the WMO/STEND program and GSHAP will work together to facilitate technology transfer for disaster reduction.

C. Setbacks of 1993

The implementation of the GSHAP has also shown limitations and setbacks in 1993.

As a general comment, GSHAP has suffered by the lack of clarity which accompanied so far the whole UN/IDNDR, by the lack of a concertated strategy to support the Decade spearhead programs, by the general delay in Government action in support of Decade activities, by the deteriorating conditions of global recession and international relations.

The importance of GSHAP as spearhead program of the Decade lies in providing the best science to mitigate seismic risk in developing countries. The chances of success in implementing an international cooperative effort of this size and in ensuring that the scientific achievements effectively translate into risk mitigation strategies, depend on the active support and participation of the UN cooperation agencies and of the engineering community.

The world of global international cooperation by and large relies on the programs proposed and

supported by the UN cooperation agencies (UNESCO, DHA, UNDP, UNEP); besides some support of UNESCO, GSHAP has failed to generate significant interaction with the UN organizations, and to our knowlegde this is true for the other scientific spearhead programs of the Decade.

The coordination with the engineering community is still not efficient. The multi-disciplinary basis for seismic hazard assessment is becoming so diverse that only a true cooperative spirit among complementary approaches and fields can lead to the full understanding of the earthquake process and hazard. Engineers need to talk to scientists, or the scientific achievements will remain largely academic and the risk mitigation strategies will be based on low-quality inputs.

Finally, in planning GSHAP it was clearly underestimated the fact that the scientific community working in seismic hazard assessment in developing country is usually limited in number, equipment and energies; if often consists of a handful of scientists dealing with all sort of national geological-seismological-geophysical investigations and priorities. Some groups are literally overwhelmed by programs of international cooperation, and there is simply not enough man-power to carry them along; other groups spend precious time in trying to secure funds for their survival. The lack of organized funding in GSHAP means that several Regional Centers will be able to devote only limited time and energies to GSHAP; it is clear that no coordinating effort or global program will replace activities carried out at local, national and regional scale.

D. The UN/IDNDR Framework

As the GSHAP is a program designed and proposed for the UN/IDNDR, its implementation has been influenced by the overall implementation of the UN/IDNDR framework.

The United Nations, recognizing natural disasters as a major threat to human life and development, designed the 1990-2000 period as the International Decade for Natural Disaster Reduction (UN/IDNDR; UN Res. 42/169/1987). The Decade goals are to increase worldwide awareness, foster the prevention and reduce the risks of natural disasters, through the widespread application of modern science and technology. The Decade promotes the enhancement of national activities focused on risk reduction and the implementation of an international framework for efficient transfer and application of science and technology.

While the Decade officially started in 1990, it has taken years for the UN administration to promote efficiently the Decade concept and for many Governments to take any action in the Decade framework. Meanwhile, the overall conditions for the success of the Decade have significantly deteriorated; the global recession and the worsening international relations have reduced the support available for international scientific cooperation.

The Decade was launched as a zero cost program, to be built on existing energies, and the role of the UN agencies in the implementation of the Decade and specifically of the spearhead programs was known to be crucial, both in channeling the support needed for their implementation and in paving the way for the use of the results in developing countries. Any attempt to implement a global international cooperative effort without the active support of the UN agencies is likely to

falter; it is important to understand, in fact, that the relevance of GSHAP and of other Decade spearhead programs lies not in achieving better scientific results, but in the use of these results to mitigate risk in developing countries.

The lack of overall financial support for the Decade spearhead programs is hurting the credibility of the Decade with the scientific community. So far the GSHAP has been conducted as a purely scientific program and to secure funds we are tapping the usual funding channels for international cooperation, therefore competing with existing priorities and creating a dangerous precedent.

The Scientific and Technical Committee (STC) of the UN/IDNDR has endorsed several demonstration projects designed to promote the Decade concept; among these are the spearhead programs for the assessment of global natural hazards (earthquakes, volcanoes, tropical hurricanes, floods) as the first, necessary measure toward the implementation of risk reduction strategies. The spearhead programs range from local, to regional and global applications, from mostly scientific to purely applied efforts, including several proposals of the industry. The different character and lack of coordination among the spearhead programs has made their overall implementation quite difficult.

1994 will be critical for the Decade. The mid-Decade *World Conference on Natural Disaster Reduction*, scheduled in Yokohama on May 23-27, 1994, will bring together political leaders and decision makers from all countries. It is widely hoped that, following the Yokohama Conference, the Decade will start off with renewed impetus.

E. Management Structure

The GSHAP is coordinated at global level but implemented at regional and local scale. The overall operation and administration of the program has been defined through 1993 and is conducted at four levels.

A Steering Committee has been named by ILP and includes directors of national and international seismological associations and leading authorities in seismic hazard assessment. The Steering Committee will serve for the five-years duration of the program, to provide overall guidance and scientific direction to the GSHAP, assist in obtaining support and resources for the program implementation, develop and approve all technical specifications and strategies of the program, oversee the action of the Coordinating and Regional Centers, and represent GSHAP in international organizations and meetings. At present the GSHAP Steering Committee is composed by: H. Gupta (India), Chairman, P. Basham (Canada), Secretary, M. Berry (Canada), ILP Secretary General, E. Engdahl (US), IASPEI Secretary General, N. Ambraseys (UK), D. Ben Sari (Morocco), M. Ghafory-Ashtiany (Iran), A. Giesecke (CERESIS), G. Grandori (Italy), D. Mayer-Rosa (Switzerland), R. McGuire (USA), G. Sobolev (Russia), G. Suarez (Mexico), P. Zhang (China) and D. Giardini (ex officio, GSHAP Coordinator). A representative from Japan is being considered.

A Coordinating Center and a program Coordinator have been established by ILP at the Istituto Nazionale di Geofisica of Rome, to ensure global coordination of the GSHAP implementation, assist in obtaining support and resources for the implementation of the program objectives and regional

structure, represent GSHAP in international organizations and meetings, prepare progress reports and program documents, organize the global publication and dissemination of GSHAP plans and results, coordinate the development of the technical specifications and strategies for the program, and supervise the Special Projects and software development conducted by restricted groups of international experts.

The GSHAP activities are conducted mostly at the regional and national level; it is the responsability of the **Regional Centers** to identify and activate an operative network of national correspondents in all nations in each region, prepare a five-year plan detailing the structure and goals of each Regional Center, organize meetings of national representatives to review existing efforts and schedule regional activities, prepare and submit funding requests to secure support and resources, identify test areas for the implementation of the GSHAP multi-national approach and assemble joint regional geophysical datasets, coordinate the compilation and analysis of regional data bases and catalogues and the assessment of regional seismic hazard, organize the training and educational program, represent GSHAP in regional organizations and meetings, maintain close coordination with the other Regional Centers and the program Coordinator, prepare progress reports, organize the regional publication and dissemination of GSHAP plans and results, and cooperate in devising technical specifications and strategies of the program.

The **national agencies** are the bodies that have the local expertise and will ultimately be responsible for championing the hazard assessment with local and national planning agencies and with the engineering organizations. GSHAP provides a framework for enhanced cooperation in multinational seismic hazard assessment, by building on existing capabilities and assessment efforts at national and regional scalés and by sponsoring the compilation of national and regional data bases to common standards. Special emphasis is placed on obtaining close working relationships with the appropriate national seismological agencies and institutes; on them rests the responsability and merit of transforming the GSHAP framework into a fruitful program.

A Memorandum of Understanding covering duties and task sharing in the program has been signed by the ILP Secretary General, the GSHAP Coordinator, the members of the Steering Committee and the Regional Coordinators.

F. Technical Guidelines

To define the program goals and to develop a common approach to seismic hazard assessment under GSHAP, representatives of 27 countries and of international and regional agencies involved in seismic hazard assessment attended the GSHAP Technical Planning Meeting in Rome (6/92). Leading scientists were asked to prepare a report for the Rome meeting and provide recommendations on the four basic elements of hazard assessment: earthquake catalogues and databases (A. Johnston); seismotectonics and earthquake source zones (R. Muir Wood); strong seismic ground motion (D. Boore and N. Ambraseys); and seismic hazard computation (R. McGuire). In addition, summary presentations were given on scientific developments relevant to seismic hazard assessment: historical earthquakes (M. Stucchi and E. Guidoboni), tectonic stress (M.L. Zoback), active faults (V.

Trifonov and M. Machette) and paleo-seismology (D. Pantosti and B. Yeats).

Working groups were formed at the meeting on each of the four basic elements, chaired by the theme leaders, to assess the recommendations for GSHAP implementation in the wide variety of conditions found around the globe.

Following the meeting, the opinion of relevant commissions of IASPEI and ESC and of selected specialists has been requested, to ensure wide consensus in the definition of the GSHAP Technical Guidelines. In addition, some of the Regional Centers have prepared very detailed plans and specifications for the GSHAP implementation in their area.

In the fall of 1992 the theme leaders were then asked by the GSHAP Steering Committee to consider the results of the Rome working groups, the information provided under these special themes, and their general experience from contacts around the globe, and submit specific recommendations for the preparation of the Technical Guidelines.

The final document, compiling 20 recommendations, has been assembled by P. Basham and D. Giardini, adopted by the GSHAP Steering Committee in April 1993, approved by the IASPEI Executive Committee in June 1993, distributed worldwide in July 1993 and included in the GSHAP Technical Planning Volume in November 1993.

The implementation of these guidelines could have far-reaching effects for the future practice of seismic hazard assessment and is currently taking place though the activation of special projects and at the Regional Centers, as described later in the document.

G. GSHAP Volume

A Volume illustrating the phylosophy and the technical framework for the development of a unified approach to seismic hazard assessment for GSHAP has now been published, containing the revised Program Description, the Technical Guidelines, and the technical reports and the regional overviews of seismic hazard assessment prepared for the Technical Planning Meeting of Rome (6/92).

The GSHAP Technical Planning Volume has been edited by D. Giardini and P. Basham (Appendix A3) and published in November 1993 as a special issue of *Annali di Geofisica* (Vol. 36, n. 3-4, 258 pp). It has been distributed worldwide; copies are available on request.

H. Special Projects

A key element to the GSHAP is the establishment of global standards. The Technical Guidelines identify several areas where the adoption of reference formats and procedures could improve the seismological practice and the seismic hazard assessment at the Regional Centers. In particular they recommend that the initial work in GSHAP be focused on the improvement of the instrumental earthquake catalogues and of the attenuation laws; these activities are routinely conducted in all

regions and can be initiated in the GSHAP framework before full funding is established.

Two global goals were identified and developed as GSHAP Special Projects, to be conducted outside of the Regional Centers activities.

Global Instrumental Earthquake Catalogue.

A reference catalogue and data base of world earthquakes for this century has never been assembled. To this purpose global seismicity data need to be considered in two time-period categories:
1900-1963: early instrumental data; main sources are ISS, BCIS and Gutenberg and Richter (1954);
1964-present: modern instrumental data available from the International Seismological Center (ISC).

The compilation of a global earthquake catalogue pursued by GSHAP requires the adoption of uniform procedures for the determination of earthquake location and size and the adoption of a common format for data cataloguing to merge macroseismic and instrumental parametric data.

This GSHAP goal is timely as the agencies responsible for the seismological practice at global scale (ISC, USGS, IASPEI Commission on Practice) have been considering the adoption of new data formats and new procedures for the determination of earthquake size and location, prompted by the rapid progress in the practice of earthquake recording, in the calibration of global travel-times and in the capability of quantifying the earthquake size.

For the early instrumental era, a two-years Special Project has been undertaken jointly by UNAM and USGS to digitize and merge the ISS and BCIS data bases, recompute hypocenters and assign uniform moment magnitudes using these data and modern techniques, including the newly-adopted travel-time tables.

For the modern instrumental period the ISC has been asked by GSHAP to consider the Technical Guidelines in adopting new procedures consistent with those used by USGS and UNAM for the earlier period and to reevaluate its catalogue from 1964 following these same procedures.

The ISC Governing Council and the IASPEI Commission on Practice will meet in Wellington on January 1994 and will evaluate the GSHAP Technical Guidelines. The USGS has already indicated that it will proceed with the reevaluation of its entire dataset for this century adopting homogeneous procedures and a single size estimator in line with the recommendations of GSHAP.

Attenuation Laws.

The assessment of seismic hazard requires the calibration of the strong ground motion estimation equations, specifying the ground shaking as a function of earthquake size and hypocentral distance. Obtaining realistic estimates of strong ground motions in all regions is a major challenge that must be met if GSHAP is to be a success.

These equations have been developed for only a few regions of the world, due to the lack or the inaccessibility of high-quality data. The Technical Guidelines recommend that, if a region lacks any studies of ground-motion attenuation and source scaling or sufficient ground motion data to obtain new regressions, then studies from other parts of the world must be used.

A GSHAP Special Project has been undertaken by a small team of international experts, headed by D. Boore of USGS, to:

- review the strong ground motions estimation equations in use around the world;
- prepare an inventory of well calibrated, three-components strong motions recordings, with attention paid to the geophysical and geological parameters that might control the rate of attenuation and the scaling of motions with source size;
- calibrate strong ground motions estimation equations for a limited number of tectonic provinces, ranging from Precambrian shield to subduction regions.

I. SOFTWARE

A goal of GSHAP is the worldwide implementation of a common approach dealing in consistent manner with all the elements of seismic hazard assessment, as specified by the Technical Guidelines. This can be facilitated by the adoption at the Regional Centers of a single software package, enforcing data standards and compatibility and allowing easy communication and exchange among participating national and regional centers. The software is intended as a complement to the existing tools available at the different centers, to be used as a way to improve joint analysis of seismic hazard and compatibility of results.

Following the input provided by the GSHAP Technical Guidelines, the software package will contain the following modules:

Catalogue Manipulation. The earthquake catalogues are the fundamental data base for earthquake hazard analysis and deserve the closest scrutiny. This module will provide the capability to perform two major functions: (i) process catalogues of different formats, eliminate duplicates and produce a master catalogue in the recommended format, and (ii) convert all seismic size estimates to moment magnitude, assigning uncertainties to these estimates. Commercial database software are being evaluated for this purpose.

Plotting. This module will enable: (i) plotting of epicenters from the master catalogue on a geographical base of land masses and political boundaries; (ii) the interactive display and analysis of all areal geological and tectonic data bases available in digital form; and (iii) the display of contoured seismic hazard maps and associated uncertainty. GIS software is under evaluation for this purpose.

Recurrence Parameter Estimation. From the master catalogue, and using the geometry of the seismic source zones, this module will quantify the seismic occurrence by magnitude range and year, and estimate rates of activities and b-values for the definition of periods of catalogue completeness.

Hazard Computation. The GSHAP Steering Committee has agreed to select a Cornell-type hazard computation approach as standard reference, complete with uncertainty estimation. The code will calculate hazard for a grid of sites; have the capability of weighting different seismic sources and ground motion equations; and produce a mean hazard result, with uncertainty, in terms

of both probabilities of exceedence for several ground motion amplitudes and specific amplitudes corresponding to selected probabilities. Several Cornell-type codes are available, but only few have the desired features. The possibility of acquiring a commercial package was explored and discarded; at present the feasibility of using a code available at USGS or one under development at GFZ (Potsdam) is under evaluation.

As the primary effort at the Regional Centers should be on evaluating data and making interpretations, not on adapting software for data handling and exchange, the GSHAP software is presently being assembled through original development and use of existing codes as a Special Project by three centers:
(1) the Geological Survey of Canada, where one computer and hazard expert (S. Halchuck) has been made available to GSHAP by the Ontario Hydro-Electric Company and is working on standardizing formats for assembling geophysical databases and on hazard computation modules;
(2) the GFZ of Potsdam (G. Grunthal and C. Bosse) is developing a Software Toolbox for catalogue manipulation and the definition of seismic source zones, which is planned for distribution in the IASPEI Shared Libraries series;
(3) the ILP/JIPE Data Center in Moscow (A. Eliutin) is working on graphic packages and GIS tailored to geophysical and geological datasets.

The three groups have worked in close communication to ensure compatibility, under pressure by the Coordinator, and joint development will take place during the winter of 1994 in Potsdam. It is expected that through the combined efforts of the three groups a preliminary version of the software package will be available in late spring for installation and testing at the Regional Centers.

J. Overview of Regional Activities

This concise summary presents the regional activities in the GSHAP framework in 1993 and the existing structure and cooperative programs relevant for GSHAP in each region. For each of the nine regions in the GSHAP structure we list also the Regional Center and Regional Coordinator. More complete summaries of existing national and regional programs in seismic hazard assessment in each region can be found in the GSHAP Volume.

1. North and Central America — UNAM, Mexico City (G. Suarez)

The practice of regional, coordinated seismic hazard assessment is common in the whole continent, where activities can be considered in five sub-areas: Canada, the US, Mexico, Caribbeans, Central America. Numerous cooperative programs have been conducted throughout the whole region; countries of Central America maintain bilateral cooperation for seismic hazard assessment with Canada, the US, Germany, Norway, Israel.

Of particular relevance is the project launched in 1990 by the Geophysics Commission of the Instituto Panamericano de Geografia y Historia (IPGH), with the support of the International Development Research Centre of Canada. This five-years effort has goals and structure very similar to those of GSHAP, and relies on five principal organizations for the completion of the project:

UNAM for Mexico, CEPREDENAC for Central America, the University of the West Indies for the Caribbean region, CERESIS for South America and the IPGH.

This if the case where there is little need for a direct GSHAP involvement, other than to ensure the coordination and the compatibility of the procedures and standards used with the programs active in other continents. UNAM has been chosen as a key institution in both the IPGH and GSHAP programs, providing efficient link.

UNAM and USGS have joined efforts in undertaking one of the GSHAP Special Projects, to produce a new instrumental catalogue for this century from the original ISS and BCIS data.

A GSHAP meeting was organized by UNAM in Ixtapa (4/93) in occasion of the Annual Assembly of the Seismological Society of America.

The test area for North America is the whole Central America south of Mexico, expected to be completed by 1995 as one of the sub-areas of the IPGH program.

2. South America — CERESIS (A. Giesecke)

This is the only continent of the world where an efficient regional framework for cooperation in seismology and geophysics has been active for a long time: CERESIS was created by UNESCO and Peru in 1966, and was extended to include most countries of South America in 1971.

During the 1981-1986 period CERESIS carried out the Earthquake Mitigation Project in the Andean Region (SISRA), financed by the US Agency for International Development under USGS leadership. Now CERESIS is the contact agency for the IPGH program, and is expected to expand the data bases and results obtained during the SISRA program by including the data of the last ten years, and publish a new map of seismic hazard for the whole South America in 1994.

Here again the regional framework is operating and well tested, although difficulties in securing support and equipment always exist. The role of GSHAP will be to work with CERESIS after the end of the IPGH program in 1994, in coordination with the other regions. A proposal in this sense has been submitted to the Commission of the European Communities (CEC).

CERESIS has requested that the GSHAP test area be designated to include the whole South America, as continuation of the IPGH program.

A Regional Seismological Assembly for South America is beeing organized jointly by IASPEI, ILP and UNESCO for August 1994 in Brasilia.

3. Northern-Central Europe — GFZ, Potsdam (G. Grunthal)

With the active support of the ESC, the implementation of GSHAP is rapidly progressing.

The GFZ of Potsdam is completing the compilation of a seismic catalogue for the whole region to GSHAP standards and leads a key role in the establishment of GSHAP test areas in the British Channel, the Adriatic plate and the D-A-CH countries.

GFZ has been the partner of several GSHAP proposals submitted to the CEC to support bilateral activities in the Andean countries, the CIS, and China, and is actively pursuing the development of software for distribution to the other Regional Centers. In addition, GFZ is actively cooperating

in the GSHAP implementation in the Mediterranean basin.

A meeting of the Northern European region and of the European Expert Group was convened in Potsdam in July 1993, with the participation of 16 experts from 10 countries. Meetings planned for next year include a School on Seismic Hazard sponsored by the European Science Foundation in Granada (5/94), a meeting for the Adriatic plate test area scheduled on June 1994 in Trieste, and the Assembly of the ESC in Athens (9/94).

4. Mediterranean — CNCPRST, Rabat (D. Ben Sari)

The Mediterranean has a strong tradition of cooperative activities in seismic hazard assessment; important programs are active in the Ibero-Maghreb region, the Arab countries, Italy and the Alpine region, the Balcans, Greece, Turkey and the Middle East. The ESC plays a major role in coordinating the activities of the whole area.

Keeping with the Decade goal of technology transfer, the Regional Center for the whole Mediterranean has been established in Morocco. The CNR of Morocco has been a leader in all the Arab programs and in the Ibero-Maghreb cooperation; it has recently launched a IDNDR program for "Geology, Geodynamics, Earth Structures and Seismic Hazard Studies in Northern Africa". In addition, the CNR has played a significant role in the UNDRO (now DHA) program for Seismic Hazard Mitigation in the Mediterranean, a Decade program concluded in 1991.

The coordination of the numerous programs active in the Mediterranean has not yet been accomplished, as the action of the Rabat Center has not been adequately supported. Now the Government of Morocco has applied to enter the Open Partial Agreement on Natural Disasters of the European Council; this should allow the CNR to be named as Center for Seismic Hazard Assessment for the European Council and receive significant funding and support for the next years.

Two GSHAP test areas have been identified in the Gibraltar Strait and in the Adriatic plate, extending from the Alps to Northern Greece; this second area will be run under the coordination of Italian institutions; a proposal has been submitted to the CEC.

The recent improvement in the political conditions in the Middle East may have important implications also for seismic hazard assessment. A Seminar on Earthquake Hazards in the Eastern Mediterranean Region was organized in Cairo (10/93) by USGS and UNESCO, and brought together scientists from the whole region, from Yemen to Turkey including Israel; GSHAP was present. While precise plans for future initiatives have not been drawn yet, it appears that the area could be considered as a joint test area for GSHAP between the Mediterranean and Middle East GSHAP regions.

Meetings planned for next year include the School on Seismic Hazard sponsored by the European Science Foundation in Granada (5/94), a meeting for the Adriatic plate test area scheduled on June 1994 in Trieste, and the Assembly of the ESC in Athens (9/94).

5. Continental Africa — University of Nairobi (I. Nyambok)

The Regional Center has been established by the University of Nairobi on the grounds of the Kenya National Academy of Science and has prepared a five-years plans for GSHAP activities in

the region, including the activation of the test area designed in the Eastern Rift.

Due to the lack of support, activities in this region are still progressing slowly. The high point of 1993 was the regional GSHAP meeting held in Nairobi (11/93); 20 participants from countries of the Rift region, South Africa and the UK convened to discuss the activation of the test area and the program implementation.

The International Commission for Earth Sciences in Africa has been active in promoting regional cooperation and has planned a regional meeting in Nigeria in the late 1994; GSHAP will hold a special session.

GSHAP is trying to secure the commitment of scientists and institutions which have traditionally worked in the area. The UK and the South African Republic have manifested interest in pursuing the cooperation; in addition, official links have been established with the regional program seismic data collection run by Norwegian and Swedish institutions.

6. Middle East

IIEES, Tehran (M. Ghafory Ashtiany)

The region under the coordination of the IIEES includes countries as diverse as those of the Arab peninsula, the Middle East and Israel, Turkey and the Caucasus, the southern CSI republics, Iran and Iraq. Here the implementation of a complete regional framework is a difficult task.

IIEES has initiated work on producing a regional seismic catalogue and activated bilateral cooperation with several countries of the region.

A first GSHAP Regional meeting was held in Teheran in January 1993; a second meeting was planned for October 1993, but it has been postponed pending the results of the Seminar on Earthquake Hazards in the Eastern Mediterranean Region organized in Cairo (10/93) by USGS and UNESCO.

A test area has been designed in the Western Iran-Caucasus area, jointly with the Northern Eurasia region. It appears also that the Middle-East area along the Dead Sea fault, which should be coordinated in the future by USGS and UNESCO, could be considered as a joint test area for GSHAP between the Mediterranean and Middle East GSHAP regions.

7. Northern Eurasia

JIPE, Moscow (V. Strakhov)

This continental craton is characterized by the highest concentration of seismicity along its Southern and Eastern borders, and exemplifies the need for cooperation among neighboring countries and regions.

The former USSR had launched a five-year plan in 1991 for the reclassification of the territory, with the participation of 30 institutions from all the Republics. The program included five inter-coordinated projects on partially overlapping regions: Eastern Europe platform, Middle Asia and Kazakhstan, Central Siberia, North-Eastern Siberia and Northern Siberia. This network of sub-regions and scientists is now the basis for the activation of GSHAP. In addition, the cooperation with neighboring institutions in China, Mongolia, Iran, Turkey and Fennoscandia has been strengthened.

Under the coordination of the JIPE of Moscow, a seismic catalogue and geophysical data base

has been assembled to GSHAP standards, including also the neighboring territories. A software package for data organization and mapping is being developed.

A very successful Regional GSHAP Meeting was held near Moscow (9/93), with the participation of 40 scientists from 15 countries to plan activities and test areas; the first such area has been established in the Causasus jointly with the Middle East region, and will be the focus of 1994 activities, while two more areas are being developed in Central Asia and on the Chinese border.

This region poses today serious organizational problems as comunications, transports and overall technical capabilities are rapidly deteriorating. A proposal to support activities along the Alpine-Himalayan belt has been submitted by GSHAP to the CEC.

8. Central-Southern Asia — SSB, Beijing (P. Zhang)

This vast region has areas of extreme seismic hazard; here national programs in seismic hazard assessment have strong traditions but the presence of natural and political borders has prevented in the past the implementation of an efficient regional framework.

The SSB has undertaken a course of open cooperation, also in the GSHAP framework, bearing important results. For the first time, Russia and China are compiling a joint seismic data base and catalogue, covering a large area of the worl. SSB is leading the initiative for the establishment of a new Asian Seismological Commission and will be one of the key partners in the Natural Hazards Mapping project promoted by the Geological Survey of Japan, in representation of GSHAP.

The test area designed in the China-Burma-India region is already well under way, as a joint seismic catalogue is being assembled, and a regional GSHAP meeting, covering also the test area, is scheduled for June 1994. A second test area is being planned jointly with the Northern Eurasia region.

9. East Asia-Oceania — PHIVOLCS (R. Punongbayan)

The longest belt of active seismicity of the globe, running from Kamchatka to New Zealand, displays common tectonic characters; strong national programs are active in all the seismic countries, although a unified regional program for hazard assessment and mitigation has not yet been developed.

The GSHAP Regional Center has been established in the Philippines. Given the importance of the national and international programs conducted by Japanese institutions, the GSHAP has also attempted to gain the support and participation of Japanese organizations in the program. So far the Geological Survey of Japan and the Earthquake Research Institute of Tokyo have pledged their support.

With the International Forum held in Tsukuba (7/93), the Geological Survey of Japan has launched a program for Natural Hazards Mapping in East Asia, as part of the IDNDR activities. The area covered by this program includes part of the GSHAP Regions 8 and 9; it was decided in Tsukuba that the GSHAP will be responsible for the seismic hazard mapping for the program, and that the GSHAP Regional Centers of Beijing and Manila will take turn in chairing an ad-hoc committee named by the Geological Survey.

Other recent initiatives in regional cooperation include plans made for the creation of a new Asian Seismological Commission and a Meeting on Seismic Hazard in East Asia scheduled in Hanoi in January 1994.

The Wellington IASPEI Assembly (1/94) will provide the chance to review the implementation of GSHAP in the East Asia-Oceania region, the participation in the Natural Hazards Mapping program and in other regional initiatives, and the possibility of naming a representative of Japan in the GSHAP Steering Committee.

K. Funding Status

The GSHAP has yet to attain the level of funds needed for its global implementation.

As explained above, the UN administration has failed to create efficient ways to channel funds available for international cooperation toward the Decade spearhead programs. Under these conditions, the GSHAP has been forced to seek the usual funding channels in competition with existing programs and priorities. In these days of scarse international funds, this process is expected to be slow, uncertain and uneven.

A major effort, however, has been undertaken to secure funds to the Regional Centers, as it was made clear from the start that additional funds should be made available to support regional GSHAP activities.

We are following a regionalized strategy also in seeking funding support, with a scheme usually based on four steps:

- funding and development agencies are identified which can be interested in sponsoring activities in a test area or Regional Center;
- where needed, contacts are established by the Coordinating Center to introduce the GSHAP framework and explore possibilities;
- detailed proposals to sponsor activities in a region or in a test area are submitted by the Regional Centers, with the participation, if needed, of the Coordinating Center;
- international agencies (ICSU, UNESCO, ILP, UN/IDNDR) provide support where appropriate.

Many initiatives in this framework are already under way, as detailed in the regional overview, and specific proposals to support regional activities and test areas have been submitted to potential funding agencies. Our espectation is that this effort will pay off in 1994, allowing a significant step forward in the program implementation.

The role of the Coordinating Center has been to elicit the support of the CEC for bilateral cooperation in the Balcans, CSI, Philippines, China and Andean countries, and to promote the activation of similar channels in other regions.

In addition, a fund of 32,000 US$ was made available to the Coordinating Center in 1993 through

the contribution of ILP, ICSU, UN/IDNDR, IASPEI and ING; it has been used as seed fund to support regional activities.

L. Coordination with UN/IDNDR activities

Among the spearhead programs endorsed by the UN/IDNDR STC, several bear direct relevance to the GSHAP implementation. However, the spearhead programs have not been officially coordinated in a concertated strategy by the Decade; each program is conducted in autonomous fashion and the possible links have often not been exploited.

GSHAP maintains close links with the program proposed by IASPEI on "Minimizing Earthquake Vulnerability" and with initiatives of the engineering community, as it will be detailed later in the document.

In addition, upon request by the WMO, GSHAP is evaluating the feasibility of joining the WMO demonstration program for the Decade for the establishment of a System for Technology Exchange for Natural Disasters (STEND). The network of GSHAP Regional Centers could provide a valuable link with seismology and solid Earth geophysics, particularly in developing countries, and complement STEND with useful operational technology for the collection and analysis of seismological data and for seismic hazard assessment; in turn STEND would be able to disseminate the technology available at the Regional Centers through its network. It is expected that the cooperation between STEND and GSHAP will initiate within 1994.

M. Coordination with ILP programs

ILP is conducting three projects under its *Theme II on Contemporary Dynamics and Deep Processes*:

- the World Stress Map, directed by M.L. Zoback,
- the World Map of Active Faults, directed by V. Trifonov and M. Michette,
- Paleoseismicity of the Late Holocene, directed by B. Yeats.

These programs were initiated to improve understanding of the earthquake process and to provide a firmer basis for the assessment of seismic hazards to modern standards; they have been endorsed in the Decade framework. The link with GSHAP is obvious, and these programs were directly involved in the definition of the GSHAP goals and structure, as it is reflected in the GSHAP Technical Guidelines and Technical Planning Volume.

The integration among these programs is not conducted following imposed criteria; scientists working on tectonic stress, active faults and paleo-seismology also take part in the definition of the geodynamic framework and of the source zones for seismic hazard assessment.

N. Coordination with IASPEI

The International Association of Seismology and Physics of the Earth's Interior (IASPEI) is the prime scientific association dealing with seismic hazard assessment, although several aspects more related to geological and geodynamic analysis are covered directly by IUGS and ILP.

IASPEI has been instrumental in supporting the ILP's GSHAP since its debut in 1992; in several occasions IASPEI and GSHAP activities have been conducted jointly. The IASPEI Secretary General, E. Engdahl, sits on the GSHAP Steering Committee, and the GSHAP Technical Guidelines were submitted to the IASPEI Executive Committee (6/93) before circulation.

While ILP activates specific, time-limited programs like GSHAP, IASPEI maintains a structure of Commissions and Working Groups that meet routinely every two years to evaluate the developments in each field and promote cooperation. Several IASPEI Commissions have a relevant interest in GSHAP: the Commission on Practice, the Commission on Earthquake Hazard and Prediction, the Sub-Commission on Earthquake Hazard, the Sub-Commission on Strong Motions, the Committee for Developing Countries, the Commission for the IDNDR.

A IASPEI Proposal for a five-year program on "Minimizing Earthquake Vulnerability" has been endorsed by the Decade, and will focus on education, training and research.

The 27th IASPEI General Assembly (Wellington, 1/94) will provide the first official occasion for the IASPEI Commission structure to evaluate the GSHAP status. To ensure that the work conducted under GSHAP is integrated with the IASPEI activities, the Chairmen of the relevant IASPEI Commissions will attend an ad-hoc GSHAP meeting scheduled in Wellington; conversely, the GSHAP Coordinator and Secretary will take part in the working meetings of the IASPEI Commissions. It is expected that the possible links between the ILP's GSHAP and the IASPEI's "Minimizing Earthquake Vulnerability" will be explored, leading to joint initiatives in the near future.

In addition, the European Seismological Commission, itself a IASPEI Commission, held its bi-annual meeting in Prague (9/92) and resolved to form a European Group of Experts for the implementation of GSHAP, which already met in Potsdam (7/93); a further meeting and a GSHAP scientific session are scheduled in occasion of the 1994 ESC bi-annual meeting in Athens (9/94).

O. Coordination with engineering programs

The assessment of seismic hazard is the first step in the implementation of strategies for seismic risk mitigation and is commonly carried out through the multi-disciplinary cooperation of engineers, seismologists and geologists; the need exists to maintain close contacts within and among the different groups and disciplines involved in various aspects of seismic hazard assessment, to make sure that the natural links among the different sciences are exploited and the advancements, often substantial, in various fields can be merged in a unified approach to seismic hazard assessment.

This obvious consideration is far from being applied in the common practice of seismic hazard and

risk assessment around the world, and unfortunately this lack of coordination also exists in the Decade activities.

It is of paramount importance for GSHAP that the scientific achievements and the technology transfer obtained in the next years find adequate utilisation in risk mitigation strategies, or we will fail the Decade driving goal.

GSHAP has attempted since its debut to establish official links with the main engineering bodies: the Union of International Technical Associations and World Federation of Engineering Organizations (UITA/WFEO), and the unaffiliated IAEE. In fact, three renown representatives of the engineering seismology community sit in the GSHAP Steering Committee and have been very active: N. Ambraseys, R. McGuire and G. Grandori, former IAEE President.

After the initial lack of interest or open criticism, progress is being made in linking the GSHAP with the World Seismic Safety Initiative (WSSI), undertaken by the IAEE as a Decade activity but not yet endorsed as a spearhead program. The GSHAP provides the natural input for WSSI and our request to the IAEE has been to assume an active role in the definition of GSHAP, to ensure that the potential links are fully developed.

The 10th Conference of the European Earthquake Engineers (Vienna, 8/94) will provide the occasion to compare the state of the art, to combine the different approaches to seismic hazard assessment and to find common ground for future cooperative initiatives; to this purpose a joint session is being arranged.

P. Publications and Meetings

The GSHAP is publicized through the distribution of program documentation, the publication of specialized articles on scientific journals, the participation to meetings and conferences and the regional activities.

In 1993 the Program Document, Progress Reports, Technical Guidelines and GSHAP Volume have been distributed worldwide. In addition, a GSHAP description has been included in the Annual Reports of ILP, IASPEI and ICSU, and on the IASPEI/IDNDR Newsletter (N.2).

Several articles describing the program and its technical approach have been published since November 1992 on scientific journals; the list given (Appendix A4) includes only those publications submitted under the Coordinator's name. Several more have been published by Regional Coordinators on local journals.

In addition to the meetings organized as part of the activities of the Regional Centers, GSHAP has been invited to provide the seismic hazard input at IDNDR conferences in 1993:

- the *International Forum on Natural Hazards Mapping*, Tsukuba (Japan, 6/93);
- the Conference on *Natural Disasters: Protecting Vulnerable Communities*, London (10/93);
- the *Seminar on Earthquake Hazards in the Eastern Mediterranean Region*, Cairo (10/93);
- the Conference on *Disaster management in metropolitan areas for the 21st century*, Nagoya

(Japan, 11/93).

Presentations on GSHAP have been given at scientific meetings and institutions around the globe. Among these, a session on GSHAP has been chaired by D. Giardini and P. Basham at the Annual Assembly of the American Seismological Society, Ixtapa (Messico, 4/93).

Q. Mailing List

A wide mailing list for distribution of GSHAP material has been assembled, including now more than 400 entries: the national correspondents of ILP and IASPEI, officers of ILP, IUGG, IUGS and IASPEI, the focal points of National IDNDR Committees, the participants to the GSHAP Technical Planning Meeting of Roma, the members of the UN/IDNDR STC and of the ICSU IDNDR Committee, national correspondents identified by the GSHAP Regional Centers, senior officers in the UN organizations (UNESCO, UNDP, UN/IDNDR), representatives of the engineering comunity and of the industry, representatives of funding agencies, other interested scientists.

The GSHAP Volume has also been mailed to the distribution list of Annali di Geofisica, including more than 1200 addresses worldwide.

R. 1994

The core of the activities in the GSHAP framework for 1994 and the following years will be conducted chiefly at the Regional Centers. The progress in the implementation of GSHAP will therefore depend on the overall level of funding and on the willingness of the Regional Centers to devote energies and resources to this program. A detailed report of regional activities and plans is being assembled, based on the individual reports submitted by the Regional Centers, and will be circulated when complete.

Here the priorities and the challenges of the GSHAP for 1994 are presented as seen from the point of view of the Coordinator.

GSHAP Regional Meetings. These working meetings where national experts meet to plan regional cooperation and test areas will remain a priority also for next year; definite plans have been made for meetings in Wellington (1/94), Granada (5/94), Beijing (6/94), Brasilia (8/94), Athens (9/94), Nigeria (late 94), Caucasus. Several of these will be held in conjunction with other scientific assemblies.

Test Areas. Significant developments are expected in several of the multi-national test areas planned for GSHAP: South America, Gibraltar Strait, Adriatic plate, Eastern Mediterranean, Caucasus, China-Burma-India. Progress in other areas is also possible, and tied to the level of support attained in 1994.

Comunications. The successful implementation of the GSHAP is tied to the ability to comunicate easily across the world. A GSHAP priority of 1994 is to improve the comunication capability of the Coordinating and Regional Centers.

Funding. We will continue the policy of seeking regional funding for regional activities, aiming to some breakthrough within 1994 for at least three regions. It is hoped also that the mid-Decade World Conference of Yokohama (4/94) will shed some light on the global financing for the spearhead Decade programs.

Coordination with the engineering programs. We will strive to establish operative links between GSHAP and the programs of the engineering associations (UITA/WFEO, IAEE). In particular we expect that the preparatory work for the 10th Assembly of the European Earthquake Engineers (Vienna, 8/94) will allow GSHAP to be efficiently linked to the WSSI.

Coordination with UN/IDNDR activities. The GSHAP and the WMO 'STEND programs will join their efforts to improve technology transfer for natural disaster in developing countries.

Coordination with IASPEI. The 27th IASPEI General Assembly will provide the chance to link the work of the IASPEI Commissions and of the IASPEI Decade program "Minimizing Earthquake Vulnerability" with GSHAP.

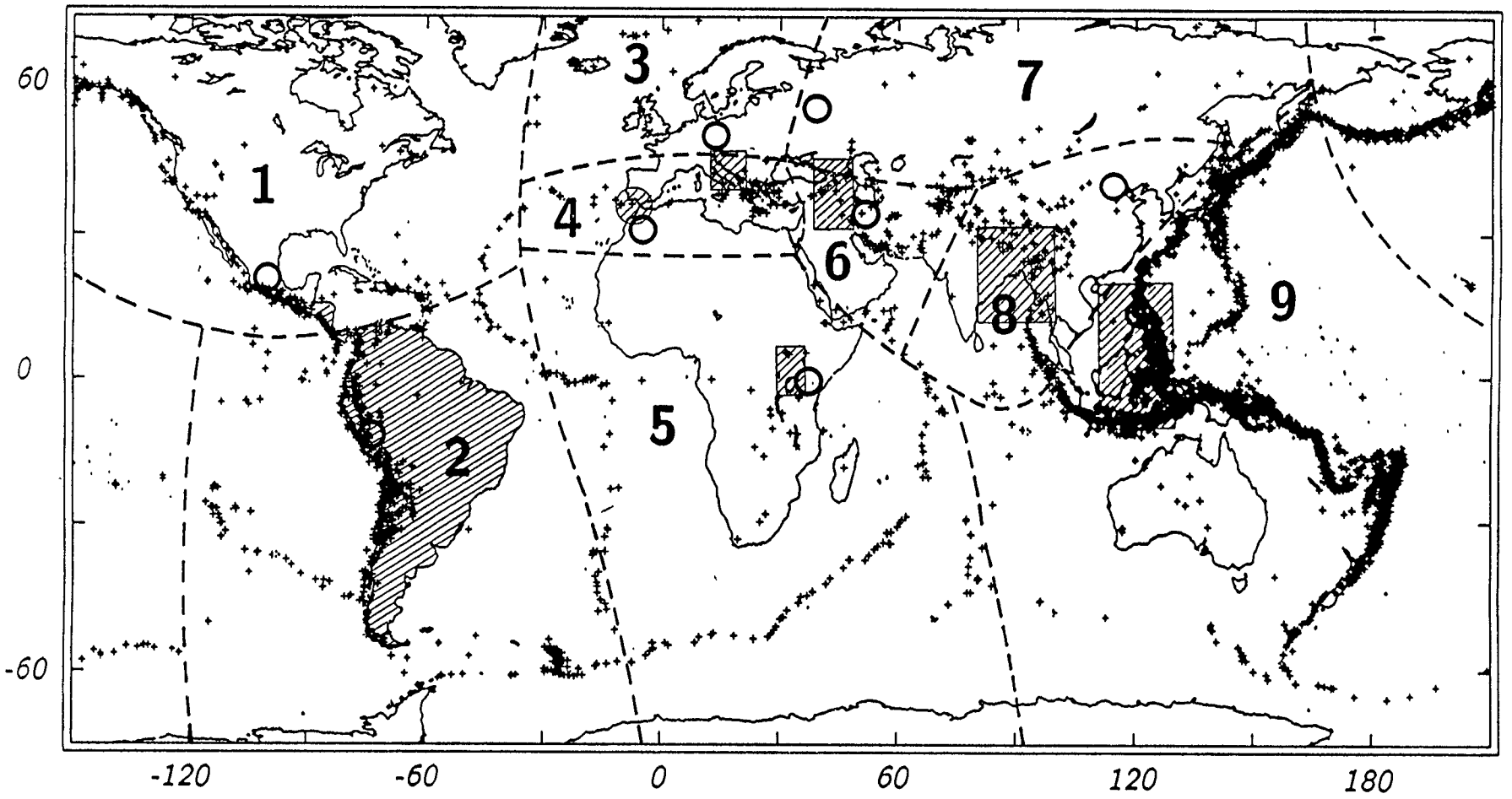
Special Projects and Software. We expect to complete testing and distribution of the GSHAP software to the Regional Centers within 1994. We also expect to see significant progress in the Special Projects for the improvement of seismological standards; these projects should near conclusion by 1995.

Report prepared on December 15, 1993, by Domenico Giardini, GSHAP Coordinator

List of Acronyms

CERESIS - Regional Center for Seismology for South America
CNCPRST - Centre National de Coordination ed de Planification de la Recherche Scientifique et Technique, Rabat
DHA - Department of Humanitarian Affairs, UN
ESC - European Seismological Commission
GIS - Geographycal Information System
GSHAP - Global Seismic Hazard Assessment Program
GFZ - GeoForshungs Zentrum, Potsdam
IAEE - International Association of Earthquake Engineers
IASPEI - International Association of Seismology and Physics of the Earth's Interior
ICSU - International Council of Scientific Unions, UN
IIEES - International Institute for Earthquake Engineering and Seismology, Teheran
ILP - International Lithosphere Program
ING - Istituto Nazionale di Geofisica, Rome, It
IPGH - Instituto Panamericano de Geografia y Historia
ISC - International Seismological Centre, UK
ISS - International Seismic Service
IUGG - International Union of Geophysics and Geodesy
IUGS - International Union of Geological Sciences
JIPE - Joint Institute of Physics of the Earth, Russian Academy of Sciences
PHIVOLCS - Philippines Institute of Volcanology and Seismology, Manila
SISRA - Earthquake Mitigation Program in the Andean Region
SSB - State Seismological Bureau, Beijing
STC - Scientific and Technical Committee, UN/IDNDR
STEND - System for Technology Exchange for Natural Disasters
UITA - Union of International Technical Associations
UNAM - Universitad Nacional Autonoma de Mexico, Mexico City
UN/IDNDR - United Nations International Decade for Natural Disaster Reduction
UNDP - United Nations Development Program
UNEP - United Nationas Environment Program
UNESCO - United Nations Educational, Scientific and Cultural Organization
USGS - United States Geological Survey
WFEO - World Federation of Engineering Organizations
WMO - World Metereological Organization
WSSI - World Seismic Safety Initiative

GSHAP Regional Structure



○ GSHAP Regional Centers

Test Areas

GSHAP Technical Planning Volume

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