

Intergovernmental Oceanographic Commission
Reports of Governing and Major Subsidiary Bodies

International Co-ordination Group for the Tsunami Warning System in the Pacific

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* Report translated into French, Spanish and Russian. Annexes in English only.

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1. OPENING AND ARRANGEMENTS OF THE SESSION

1 The Chairman, Mr. R. Hagemeyer, opened the Thirteenth Session of the IOC International Co-ordination Group for the Tsunami Warning System in the Pacific at 10.00 on 10 September 1991.

2 The Group acknowledged the statements given by the Chairman who invited the Session to propose mechanisms and procedures for making the Tsunami Warning System in the Pacific more effective and organized so that it can cope with the increased demands for better and reliable warnings.

3 The Group noted with appreciation the welcoming address presented by Dr. Mario Martinez Garcia, Director of the Centro de Investigacion Cientifica y Educacion Superior (CICESE), the full text of which is given in Annex V to the Summary Report.

4 The Technical Secretary of the Session, Dr. I. Oliounine, Senior Assistant Secretary IOC, on behalf of the Secretary IOC, welcomed the participants and paid tribute to the Government of Mexico and CICESE for hosting the Session and providing the necessary support and facilities. In his statement he emphasized that though tsunamis occur infrequently and there is always a danger for the warning system to become out-dated and ineffective due to people's short memory, Member States in the Pacific should always need to be on alert and to guard against this.

5 He called on the Group to make decisions which may establish a workable strategy to guide the IOC's own direct activities in the tsunami warning system and to enable the IOC to fulfil its role in this field as a joint specialized mechanism for co-ordinating marine research and service activities within the United Nations System.

6 The Chairman of the Group thanked all speakers for their valuable advice, and kind and encouraging words. He invited the Group to express its profound gratitude to all those who have been associated with the development of the Tsunami Warning System and who could not come to the Session because of different reasons. The names of Prof. S. Soloviev, Mr. G. Burton, Mr. W. Rapatz were specially mentioned. He thanked them all for their generous contributions to the success of the ITSU programme.

7 The Chairman then invited the Group to adopt the Provisional Agenda. The Agenda was adopted and is presented in Annex I.

8 The Group accepted the proposal by the Republic of Korea to designate Mr. F. Stephenson (Canada) as Rapporteur for the Session.

9 The Technical Secretary briefly introduced the time schedule, identified changes in the List of Documents and reviewed the documentation (Annex IV).

10 The List of Participants is Annex III.

11 Finally, the Representative of the local organizing committee, Mrs. Elena Enriquez-Silva, informed the participants of the local arrangements.

2. GENERAL REVIEW OF THE INTERSESSIONAL ACTIVITIES

12 The Chairman presented his report on intersessional activities (Document IOC/ITSU-XIII/6) and introduced a supplement to this report prepared by the Senior Assistant Secretary which contained information on the status of implementation of ITSU-XII (Novosibirsk, USSR, 7-10 August 1989) decisions.

13 He specially mentioned his participation at the Twenty-Third Session of the IOC Executive Council (Paris, France, 7-14 March 1990). At this Session particular emphasis was placed on the need for additional funds to support the ITSU work programme for 1990-1991. As a result of these efforts, additional extra-budgetary support was provided for ITSU activities by the Director-General of UNESCO and Secretary IOC. Responding to the instructions of the Sixteenth Assembly of the IOC (Paris, France, 7-21 March 1991) the Chairman visited the UNDP's Headquarters in April 1991 where he had productive discussions with the officers of UNDP who are dealing with the project on the establishment of the Regional Tsunami Warning Centre for South-West Pacific. As a result of the visit, specific action items were formulated which may assist in the implementation of the project. The Chairman also informed the Groups on his participation at the ITSU Officers meeting and at the meetings of ITSU sub-groups of experts dealing with Tsunami disaster mitigation and with real-time seismic data exchange. The findings of these meetings will be discussed under the relevant agenda items.

14 The National Reports were presented by Canada, Chile, France, Japan, Mexico, Republic of Korea, and the USA. Though the representatives of Australia and New Zealand could not come to the Session, their reports were made available to the participants (Document IOC/ITSU-XIII/8). The Group recommended that full texts of all reports be published in one of the coming issues of the Tsunami Newsletter and requested the Director of ITIC to pursue the implementation of this decision.

15 The Representative of Chile provided additional information on national activities, reporting on the efforts taken in the field of Tsunami Public Education and on the recent establishment of a National Commission for IDNDR that includes as a Permanent Advisor, the Tsunami National Focal Point.

16 Dr. George Pararas-Carayannis, Director of the International Tsunami Information Centre (ITIC) presented the ITIC Progress Report for 1989-1991 (Document IOC/ITSU-XIII/7). This report covered a summary of activities and progress made by the Centre during the intersessional period. It summarized significant developments in the Tsunami Warning System in the Pacific and the implementation of resolutions and recommendations of the last session of the ICG/ITSU in which the ITIC was directly involved.

17 The Group accepted the Reports of the Chairman and the Director of ITIC and congratulated them for their efforts in carrying out the programme and ensuring that the views of the Group were brought to the attention of the IOC Governing Bodies.

3. IMPLEMENTATION OF RESOLUTIONS AND RECOMMENDATIONS OF THE TWELFTH SESSION OF THE ICG/ITSU

18 The most important activities recommended by the Twelfth Session of the ICG/ITSU (Novosibirsk, USSR, 7-10 August 1989) which need further follow-up actions were thoroughly discussed.

3.1 CONTRIBUTION OF ICG/ITSU TO THE IDNDR

19 Reduction of tsunami hazards constitutes a major component of IDNDR. Four projects had been specifically developed by the Group to meet IDNDR objectives. The Group considered actions taken during the intersessional period as a contribution to IDNDR.

3.1.1 Tsunami Inundation Modelling Exchange Project (TIME)

20 Dr. Eddie Bernard, Chairman, IUGG/Tsunami Commission, presented the Summary Report of the First Session of an *ad hoc* Joint IUGG/Tsunami Commission - ICG/ITSU Group of Experts which had been established by ITSU-XII to formulate a project on tsunami disaster mitigation as a contribution to the IDNDR (Document IOC/INF-838). The Group of Experts evaluated 19 suggested projects from Japan, USA, and the USSR. Four candidate projects were selected and sent to the international tsunami community for comment. From the four, the tsunami inundation project received the greatest support from the community as having wide potential to mitigate the tsunami hazard and which most fully met the criteria specially developed for selection of the project.

21 Dr. Bernard presented the project proposal (Document IOC/ITSU-XIII/14), reviewed the process used by the Group of Experts to reach a decision on the content of the project and described the budget and possible sources of the project funding.

22 The Senior Assistant Secretary indicated some concern that IOC might have with the present draft of the proposal: the level of financial support requested from IOC almost corresponded to all funds allocated by IOC annually to cover all activities of the IOC tsunami warning programme and the IOC was unlikely to provide funds from the regular budget for certain budget categories (e.g., salaries of the staff of the Centre, purchase of hardware).

23 The Group noted the concern but agreed that these budget categories are essential for the success of the project. The Chairman explained that IOC is seen as a catalyst for this project. Once the project was under way, it was hoped that other groups would become involved and contribute financially. In this regard the Group noted with interest the information provided by Dr. Bernard about the decision of the IUGG Assembly to endorse this project as a part of IDNDR activities.

24 The Group accepted the Summary Report of the Joint Group of Experts, endorsed the project proposal and recommended it for implementation.

25 **The Group welcomed** information on contributions in cash and kind by Japan (Tohoku University), Canada and the USA, and **urged** other Member States to support the project. All Member States present indicated their willingness to participate in the project.

26 **Recommendation ITSU-XIII.1** was adopted.

3.1.2 Interactive Software for Seismic Network Analysis on Personal Computers

27 The implementation of Recommendation ITSU-XII.1 on the urgent need for a rapid determination of seismic parameters for operational implementation of automated predictive evaluation techniques was considered by the Group. In the absence of the Representative of the USSR, the Director ITIC presented this agenda item, described the function of this programme developed by the Computing Center at Novosibirsk (Document IOC/ITSU-XIII/13) and noted that it had originally been included in the Interactive Tsunami Modelling System (ITMS).

28 **The Group commented** upon the usefulness of the programme, noting that it would be of significant value in designing networks for new regional centres. **The Group also expressed** its appreciation to the Computing Center for their efforts in developing this programme.

29 **The Group expressed** its appreciation for the work carried out by the Novosibirsk Computing Centre and recommended that this work should be continued and expanded.

3.1.3 Real-Time Exchange of Seismic Data

30 The Chairman of the *ad hoc* Group of Experts for Real Time Data Exchange, Dr. R. Masse, provided the Group with a summary of the Report of the First Session (Document IOC/INF-848) which took place in Honolulu, Hawaii, USA, 28-30 January 1991.

31 He briefed the Group on the current state of the real-time collection and exchange of seismic data with particular emphasis on North, Central and South America.

32 He also identified efforts in progress in the Pacific basin to further the collection of seismic data in real time using PEACESAT and in near real time via the US GOES Satellite. He concluded with an encouraging statement that within the next few years seismic data should be available in real time or near real-time from all areas of the North, Central and South America.

33 Dr. Masse explained that the many recommendations contained in Annex IV to Document IOC/INF-848, Draft Project Proposal for Pacific Rapid Response System, were not intended to identify actions to be funded by IOC. Rather, they identified actions, which if taken by individual Member States, would make significant contributions to the work of the Group. It was noted that individual Member States already have activities in progress that address a number of the recommendations.

34 During the discussions which followed, it was pointed out that the PEACESAT also had a voice channel which will be made available for the PTWC's use during times when a Pacific wide tsunami warning is in effect. This capability will enable the PTWC personnel to talk directly to all users of the PEACESAT voice channel.

35 **The Group thanked** Dr. Masse for his presentation, adopted the Summary Report, expressed appreciation for the efforts of the *ad hoc* Working Group and adopted Recommendation ITSU-XIII.2.

36 **The Group requested** its Chairman and the Senior Assistant Secretary to include the text of the project as an Annex to the Summary Report, taking into account comments on the first draft from ITSU Member States (see Annex VI).

3.1.4 Tsunami Public Education and Awareness Programme

37 A member of the ICG/ITSU *ad hoc* Working Group for Public Education and Awareness, Mr. Hugo Gorziglia (Chile), reported on the activities of the Working Group and on the implementation of responsibilities which were assigned to this body at the Twelfth Session of the ICG/ITSU. The findings of the Working Group were summarized in Document IOC/ITSU-XIII/12. The main highlights of this document are a general programme for school education and a description of tasks needed to prepare the student and general public programmes. Mr. Gorziglia also introduced an action plan for the development of general education programmes for primary and high schools and for the definition and development of a general public education strategy for 1992-1993.

- 38 **The Group acknowledged with thanks the activities of the *ad hoc* Working Group and especially recognized with thanks the input of Chilean experts to the studies. It was specially noted that the increase of awareness of populations to natural hazards through training and education is one of the main objectives of the International Decade for Natural Disaster Reduction (IDNDR) and is a high priority action in the Master Plan for the Tsunami Warning System in the Pacific. The Group strongly recommended the continuation of the *ad hoc* Working Group with revised terms of reference and a new membership.**
- 39 **The Group considered and agreed on the following plan of activities of the Working Group for 1991-1993 for the development of education programmes and strategy.**
- (i) Development of education programmes for primary and high schools based on the deliberations and agreements achieved at the Thirteenth Session of the ICG/ITSU;
(main product - draft texts, deadline - November 1992)
 - (ii) Definition and development of general public education strategy;
(main product - draft instructions, deadline - November 1992)
 - (iii) Distribution of programmes and strategy to the members of the Working Group, selected experts, Secretariats of IOC and IDNDR for comments and modifications - December 1992;
 - (iv) Meeting ¹ of the Working Group for the revision of drafts taking into account comments received from experts;
(main product - progress report, revised version of programmes and strategy, deadline - beginning of March 1993)
 - (v) Distribution of the Summary Report of the Meeting and revised programmes and strategy to ITSU Member States;
(end of March/beginning of April 1993)
 - (vi) Application of programmes and evaluation of results by Chile;²
(Trial period: March - June 1993)
 - (vii) Submission of programmes, strategy and evaluation results to ITSU-XIV for adoption;
(deadline - August 1993)
- 40 **The Group noted with thanks the kind readiness of Chile to provide support and take responsibility for designing and printing of the draft documents and to cover their editorial expenses.**
- 41 **The Group requested the Secretary IOC to provide necessary financial support for a meeting of an *ad hoc* Working Group and for 3 consultants (2 experts in education and a mass media expert) to develop the texts for the programmes and strategy.**
- 42 **The Group strongly recommended that the experts who will be invited to take responsibility for the development of the programmes and strategy should try to be generic, as far as possible, in order to take into account the experience and knowledge available in this field, not only in Chile but also in other IOC Member States.**
- 43 **The Group decided that because of the shortage of time for the implementation of the project, it would be most advisable that both education experts will be invited from Chile. However, Chile would need to ensure that they should have wide international experience in making educational programmes.**
- 44 **The Group stressed that the programmes and strategy should be drafted in English.**
- 45 **Recommendation ITSU-XIII.3 was adopted.**

¹ Place of the meeting to be identified jointly by the Chairmen, ICG/ITSU and Working Group, in consultation with the Secretary IOC.

² Other ICG/ITSU Member States may be invited to take part in this exercise by the Secretary IOC.

3.2 USAGE OF THE Mm MAGNITUDE TO ESTIMATE THE SEISMIC MOMENT FOR LOCAL AND TELESEISMIC EVENTS AND TSUNAMI RISKS

46 Dr. J. Talandier reported on the implementation of Recommendation ITSU-XII.3 (Document IOC/ITSU-XIII/9 rev.)

47 The studies concerned principally are:

- (i) extension of the concept of the mantle magnitude Mm to the near field (it has been proved theoretically and verified experimentally that mantle magnitude calculation in frequency domain is valid for distance until 1 degree);
- (ii) extension of the concept of Mm mantle magnitude to Love waves (a distance correction Cd and a source correction Cs has been adapted for the Love waves);
- (iii) validity of Mm for the great earthquakes (it has been verified with old records that the Mm magnitude was adequate for the two strongest tsunamigenic earthquakes of the last century - Chile in May 1960 and Alaska in March 1964);
- (iv) systematic and automatic measurements of seismic moment through Mm magnitude;
- (v) automatic system of real-time measurement of seismic moment and estimation of tsunami risk (the system relies on a broad-band long period 3-component seismic station, linked to a personal computer. The algorithm includes automatic detection and location of the epicenter. The seismic moment is used to compute a window of expected tsunami heights. This system is fully operational since 1987 at the Polynesian Tsunami Warning Centre).

48 The Group expressed interest to the achievements described by Dr. Talandier and specially noted that this system needs a minimum of infrastructure, and is less expensive than a network of short period telemetered stations, which also needs to use a long period broad-band seismometer. The Group noted further that this system has been specially designed to equip new tsunamis warning centers. The Group thanked Dr. Talandier for the demonstration of available software and recommended the Chairman and the Secretary IOC to give wide publicity to this system and solicit strongly comments from the field.

49 The Group appreciated the readiness of France to provide support and implement software, hardware and training for Mm determination to Mexico.

3.3 RESULTS OF COMMUNICATION TESTS BETWEEN SELECTED COMMUNICATIONS CENTRES OF THE NORTH PACIFIC - NEEDS AND WAYS FOR IMPROVEMENT

50 The Chairman advised the Group of the actions taken as requested at ITSU-XII, in an attempt to improve communications between the PTWC and the People's Republic of China (PRC) and the Democratic People's Republic of Korea (DPRK). The action began with correspondence between the USSR and the DPRK and was followed by correspondence from the Chairman to the PRC and the DPRK attempting to establish a special communication test. The communications channel used by the PTWC to distribute warnings/watches to the PRC and the DPRK is the WMO Global Telecommunications System (GTS). The routing is to the JMA in Japan, then to Beijing and Khabarovsk, and from both of these points to Pyongyang. The tests indicated that the relay in Japan worked well but the receipt of the test message was not acknowledged by either Beijing or Pyongyang. It was thought that a part of the problem might be due to the fact that receipt in Beijing and Pyongyang was at the Meteorological Agency and not at the agency responsible for the tsunami programme. A special message was transmitted via the GTS to both meteorological agencies requesting them to acknowledge receipt of the message. This was done to test the receipt by the agencies but no response was received.

51 The Chairman indicated his belief that the distribution problem is a local one and thus must be solved by actions within each country. He indicated however, that he will continue his efforts to solve this problem. The Group recommended the Secretary IOC and its Chairman to inform the Member States concerned on the results of communication tests with the request to clarify the situation.

3.4 STATE OF PREPARATION OF DATABASE FORMAT

- 52 The Director of ITIC, Dr. G. Pararas-Carayannis, reported on the current state of preparation of the database and plans for its completion. He stated that one of the principal functions of the International Tsunami Information Centre (ITIC) is to collect and catalogue historical tsunami data. Such data is valuable to the basic understanding of the tsunami phenomenon, its generation, propagation, and terminal characteristics. The historical database is widely used for coastal zone management engineering design criteria and disaster preparedness. The data also serves as a basis for operation analysis of tsunami and is becoming an indispensable tool for the real-time evaluation by the Pacific Tsunami Warning Centre (PTWC) and other Tsunami Warning Centres. The ITIC for the last 25 years has been engaged in historical research of past tsunamis, and has also been documenting recent events. Thus, ITIC has prepared or has helped to prepare catalogues of tsunamis in the Pacific, Hawaii, Alaska, Samoa, Philippines, Indonesia and elsewhere. Furthermore, ITIC began the development of the historical tsunami database in a standardized computer format to permit cross-referencing and retrieval of data in a variety of fields ranging from earthquake epicenter, earthquake magnitude, geophysical region of tsunami impact and bibliographic reference.
- 53 Dr. Pararas-Carayannis described the computerized database format developed by ITIC (and approved by the Group at ITSU-XI) for the purpose of archiving the data and making it readily available. He then explained that 5 files have been developed which can be cross-referenced either by data or event number:
- (i) earthquake file: earthquake parameters;
 - (ii) tsunami file: tsunami parameters of each event;
 - (iii) observations file: descriptive and quantitative information on tsunami observations;
 - (iv) bibliographic file: references documenting each event;
 - (v) more complete bibliographic file gives full reference and descriptive material quotations of each specific event or observation.
- 54 The Group thanked the Director ITIC for his diligent efforts in documenting historical tsunamis and in developing the proper computerized format. The Group noted that although the format has been developed, the historical tsunami data collection was by no means complete and the effort needs to be continued by ITSU Member States on a regional basis, since ITIC does not have enough resources to do this.
- 55 The Group urged the Director ITIC to make the software for this format available upon request and recommended that efforts should be made to use the most updated version of d-Base IV for the tsunami database format.
- 56 The Representative of Chile requested the Director ITIC to provide the database format software to his country.
- 57 The Representative of Mexico advised the Group that they would put the catalogue of Mexican Tsunami published by CICESE in the ITIC standard format if the material was provided to them. The Group thanked Mexico for its offer and requested the Director ITIC to make the necessary data available to Mexico for this purpose.

3.5 USAGE OF PERSONAL COMPUTERS FOR TSUNAMI TRAVEL TIME CALCULATIONS

- 58 The ICG/ITSU at its Twelfth Session requested the Krasnoyarsk Computing Center (USSR) to provide the algorithm and software for the tsunami travel time calculations with the use of personal computers to interested countries and organizations.
- 59 The Director ITIC, Dr. G. Pararas-Carayannis, described the work of the Krasnoyarsk Computing Center in developing the system "Luch" (Document IOC-ITSU-XIII/11). This software gives an opportunity to compute tsunami travel times from designated tsunami sources. The mathematical model solves the appropriate shallow water wave equations and simulates the propagation of tsunami waves over a spherical earth with an ocean of variable depth distribution using a one-degree square grid bathymetry. The model calculates the ray paths of waves (orthogonals) in different directions and provides a plot of isochrones designating the progress of tsunami waves in the time domain. Scientists of the Krasnoyarsk Computing Center have completed an analysis of the results of the model. They show relatively small standard deviations which on the average do not exceed 3% or 2 minutes per hour of wave propagation. The Director ITIC, commented that this is an acceptable error which could be minimized in the future by the use of denser bathymetric grids. The availability of the "Luch" system and its adoption to personal computers make the algorithm and software particularly attractive to potential users.

60 **The Group expressed its appreciation for the work that has been completed in the Soviet Union.**

61 **The Group noted information provided by the Senior Assistant Secretary that the Computing Center is ready to transfer rights for copying software to IOC and make distribution of this software to the Member States of the ICG/ITSU on the basis of a special contract.**

62 **The Group agreed that the IOC should enter into the Special Contract (US\$ 9,500) with the Krasnoyarsk Computing Center. The Group further agreed that each Member State that desired a copy of the "Luch" software should make a necessary contribution to the IOC Trust Fund for this specific purpose.**

4. EXTENSION OF THE SEA-LEVEL NETWORKS IN THE PACIFIC BY USING DATA COLLECTION PLATFORM TECHNOLOGY

63 The Director of PTWC, Mr. M. Blackford, reported that, since IOC/ITSU-XII, the number of data collection platforms (DCPs) available for monitoring sea-level during a tsunami investigation has increased from 32 in 1989 to approximately 80 in 1991. Three US-NOAA affiliated organizations, NOS, NOAA, TOGA Sea-Level Centre at the University of Hawaii and NWS/PTWC, are primarily responsible for the installation and maintenance of these DCPs with additional support provided by national organizations where these DCPs are cited. About half of the DCPs are provided by NOS, while the remainder are provided, about evenly, by TOGA and NWS/PTWC. The NOS data is in an encoded format utilizing nearly the entire ASCII character data set, while TOGA and NWS/PTWC data are in a strictly numeric format. The NOS DCPs report at 3-hour intervals, and TOGA and NWS/PTWC report at either 3-hour or one-hour intervals (about 25 are 1-hour). The TOGA and NWS/PTWC DCPs also have an event-immediate reporting capability. Data packets from all DCPs, except 2 platforms, are transmitted via GOES satellite, to the National Marine Center facilities in Maryland, USA, where they are multiplexed into a data stream that is, in turn, transmitted to the data user community. Since Malakal and Yap are located outside the range of the GOES satellite, their data are first transmitted to Tokyo via the GMS satellite and then re-transmitted to Maryland for integration into the NMC data stream. Using a recently acquired Concurrent/Masscomp 6600 computer, PTWC modified TOGA software and developed additional software to de-multiplex, decode if necessary, and display as much as two and one-half days of sea-level data from all available DCPs, to search the NMC data stream for particular data sets of interest, including not only the sea-level data but also messages containing seismic phase information, and to tabulate daily accounting of DCP transmissions in order to evaluate individual DCP performance.

64 The Representative of France inquired when the equipment provided by his country for a DCP at Niue Island will be installed. The Director PTWC explained that the DCP will be installed as soon as travel and transportation arrangements to Niue Island will be confirmed, hopefully within the next 6 months.

65 The Group took note of the progress made in the extension of the sea-level network in the Pacific and of the plans to site more sea-level DCPs in the Western Pacific when additional satellite facilities will be utilized to cover this area and further noted that the data from these stations are also provided to, and support, GLOSS. The Group expressed its concern that the NOS Next Generation Water Level Measurement System DCPs have only 3-hour reporting intervals and no event-immediate reporting capability.

66 The Group thanked the PTWC for its readiness to provide any marigraphic data obtained during their investigations in their tsunami investigation reports (for smaller events not requiring formal tsunami investigations, any marigraphic data obtained will be provided on request).

67 The Group thanked the Senior Assistant Secretary for his informative briefing on Global Ocean Observing System (GOOS) and agreed that the Group would support GOOS, freely sharing all operational data acquired in the operation of the Tsunami Warning System in the Pacific.

68 The Group was informed that satellite altimeters will be used extensively in GOOS, and that there will probably be a need to calibrate these altimeters using a network of bottom mounted pressure gauges. The Group expressed its hope that the requirements of the tsunami community will be considered in the planning of this network.

5. PROMOTION OF INTERNATIONAL PACIFIC-WIDE CO-OPERATION IN SEISMOLOGY AND TSUNAMI PREPAREDNESS

69 Most of the IOC Member States of the Pacific Region are currently involved in seismological data exchange, but not on a real-time basis. Most of the Member States of the ICG/ITSU are involved to varying degrees in tsunami preparedness activities. Dr. G. Pararas-Carayannis was asked to introduce this item and to bring to the attention of the Group the needs and areas of concern for international seismological co-operation and tsunami preparedness, particularly in the Western Pacific and Southwest Asia regions. He commented that areas exist in this regions where coverage by seismic instrumentation is inadequate or if seismic instrumentation exists, there are no telemetry networks for the real-time or near-real time transmission of data and its co-operative exchange and analysis. Such limitations in the region necessitated UNESCO-ROSTSEA (Regional Office of Science and Technology in South East Asia) to hold an organizational meeting/workshop of experts on the promotion of international co-operation in seismology in the Western Pacific and Southwest Asia in June 1990, at the Philippine Institute of Volcanology and Seismology. The Director, ITIC took part in this meeting.

70 Topics which were under consideration at the meeting included:

- (i) Acquisition of quality seismic data;
- (ii) Development of common data format;
- (iii) Upgrading needs of participating countries' monitoring networks;
- (iv) Identification, characterization, and monitoring of secondary effects of earthquakes;
- (v) Identification of short- to long-term training needs;
- (vi) Formulation of research priorities;
- (vii) Selection of target sites with unique tectonic settings for defining and understanding the dynamism of the Pacific Plate.

71 The Director, ITIC reported that in addition to discussing the above listed problems, appropriate needed steps were outlined and recommendations were made. These were included as Annex 5 in the ITIC Progress Report for 1989-1991 (Document IOC/ITSU-XIII/7). He also reported that as a result of this meeting the Association for Seismological Co-operation in the Western Pacific and Southeast Asia (ASCWP) was formed with the mandate of promoting international co-operation in the region for the exchange of seismic data, the understanding of tectonic processes, and the mitigation of the effects of earthquake and tsunami disasters.

72 Based on this information and after reviewing the mandate and functions of ASCWP, the Group emphasized the need for continuous co-operation with the Association for the support of its objectives and requested the Chairman to establish direct contacts with this organization.

6. IMPLEMENTATION OF THE PROVISION OF THE ITSU MASTER PLAN

73 The Chairman introduced this agenda item by observing that four years had passed since the adoption of the Master Plan. Since the Plan was designed to be a guide to the improvement of the Tsunami Warning System, he believed that it was time to look at what had been accomplished relative to the specific actions identified in Section VI of the Action Plan.

74 The Director, ITIC gave a broad overview of accomplishments. The Group agreed that a more detailed comparison of accomplishments versus proposed actions needed to be made. Realizing that this could not be accomplished at this Session, the Group directed the Chairman, Vice-Chairman and the Director ITIC to prepare such a comparison within one year and distribute the results to all Member States for their study at least a few months in advance of ITSU-XIV.

75 It was the intent of the Group to circulate, as an agenda item at ITSU-XIV, a review of the accomplishments and the considerations of the possibility of updating the Master Plan.

6.1 STATUS OF THE REGIONAL PROJECT ON THE TSUNAMI WARNING SYSTEM IN THE SOUTHWEST PACIFIC

76 The Chairman began the discussion by covering the decisions of the Sixteenth Session of the IOC Assembly (Paris, France, 7-21 March 1991), relative to this agenda item. He described the visit he made to UNDP Headquarters in accordance to the instruction of the Assembly and covered the problems with the proposal which the UNDP identified and what some of the possible solutions might be.

7 The Senior Assistant Secretary advised the Group that the Chairman, after his visit to UNDP Headquarters, had prepared a comprehensive report to the IOC Secretariat and had also provided a detailed action plan designed to move the project forward. The Senior Assistant Secretary reported on the implementation of some of the proposed actions.

8 After an extensive discussion of the problem, their potential solutions, and the actions taken to date, the Group noted that the request for UNDP funding of this project would be strengthened by expressions of strong support for the project from the Member States concerned. The Group, therefore, urged all Member States involved in the implementation of the project to give necessary instruction to their representatives to UNDP to express their countries' support to the project.

9 The Representative of France, Dr. J. Talandier, informed the Group that he was invited to participate at the upcoming Session of SOPAC, to be held in September this year, in Vanuatu. The Group strongly urged Dr. Talandier to bring to the attention of this meeting, concerns expressed by the Group related to the development of the UNDP support of the project of the regional Tsunami Warning Centre for the Southwest Pacific.

10 The Senior Assistant Secretary informed the Group on a Resolution adopted at the International Symposium "Hazards '91" (Perugia, Italy, 4-9 August 1991) in which it recommended *inter alia* that "UNDP will give a high priority to this project (project for the Tsunami Warning System for the Southwest Pacific) and that its implementation will commence by the IOC and Member States concerned in the next few years with necessary financial support from UNDP; recommends further, that UNESCO will bring this project to the consideration of the next Session of the Scientific and Technical Committee for IDNDR in order to adopt it as an international project".

11 The Group also noted that newly formed Association for Seismological Co-operation in the Western Pacific and Southeast Asia (ASCWP) in its resolutions and recommendations endorsed the goals for the development of the proposed Regional Tsunami Warning System in the Southwest Pacific, since the goals of this project complement very well the objectives of the Association for the mitigation of earthquake disasters.

6.2 EXPANSION OF THE ICG/ITSU ACTIVITIES TO OTHER TSUNAMI AREAS OF THE WORLD OCEAN

12 The Group considered the letter (IOC/ITSU-XIII/10) sent by Prof. Stefano Tinti, Co-ordinator of the European Geophysical Society Working Group on Tsunami (EGSWG), to the Chairman ICG/ITSU and Secretary IOC.

13 In his letter, Prof. S. Tinti invited the ICG/ITSU to consider the possibility of establishing stable contacts between ITSU and EGSWG and the extension of the present area of interest of ITSU to other zones of the World Ocean than the Pacific, such as the European Seas and the Atlantic Ocean.

14 After an extensive discussion, the Group noted with interest the request to involve the EGSWG in ITSU activities and agreed that a relationship between the EGSWG and the Group, similar to the Group's relationship to the IUGG Tsunami Commission could be appropriate and desirable.

15 The Group also noted the uniqueness of the ICG/ITSU within the IOC since it is the only technical body concerned with an operational observation and warning system. The Group further noted that it has taken 20 years to achieve the current level of effectiveness, that the current levels of funding from the IOC and from the Member States do not provide the level of funding which is really needed to support all elements of the system, and that it is unlikely that any significant increase in the level of funding will become available in the near future. Considering the foregoing, the Group concluded that an expansion of the area of operational responsibility of the ICG/ITSU was not advisable since that expansion, through the diversion of current resources, will reduce the level of services available to Members of the Group.

16 The Group expressed strong willingness to share with other groups or IOC Member States from other Tsunami prone areas of the World Ocean, the results of the Group's 20 years of experience in operating the TWS. This can include provision of educational materials, operational programmes and data basis, and its experts to act as consultants when requested.

7. SUPPORT TO ITIC

87 The Director ITIC stated that the ITIC operates under a comprehensive and ambitious mandate which is attainable only to the extent that resources are available. Since its establishment in 1965, ITIC has played an important role in the development of the Tsunami Warning System in the Pacific, and in providing the world community with useful information exchange. The role has been considerably enhanced in recent years after launching IDNDR when the Tsunami Programme and natural disaster reduction have become the focus of wide international interest. This is exemplified by the fact that over 220 inquiries for assistance in information and services were received at the ITIC during the intersessional period from 37 different IOC Member countries, organizations and scientists. Such requests are heavily taxing the limited resources of ITIC.

88 The US National Weather Service-Pacific Region supports ITIC with the salaries of the Director and a part-time secretary, and provides space and facilities for the ITIC office and library in Honolulu. Additional support for specific ITIC functions and action items are partially provided by IOC through yearly contracts. The amount of this support has varied from year to year depending on the availability of funding and was increased by a decision of the Director-General of UNESCO to \$28,000 in 1990.

89 In 1991 the support to ITIC comprised of \$18,000 which were spent for various activities in support of TWS. As before, the greatest amount of these funds was taken by the Visiting Experts Programme. The Director ITIC concluded that, to the extent of available resources, ITIC fulfills most of its functions - at least at the minimal level. Any additional responsibilities and the greatly increased number of inquiries for assistance and information have placed great strain on ITIC's present limited resources. An increase in the support by IOC or Member States would improve on ITIC's effectiveness.

90 The Group expressed appreciation to the Secretary IOC for his continuing attention to the ITIC's needs and decided to put the highest priority to the support of ITIC in the programme for 1992-1993.

91 Following this discussion, the Senior Assistant Secretary brought up the subject of the ITIC Associate Directorship and provided the background of the efforts made by the IOC and ICG/ITSU Officers in pursuing IOC Member States to sponsor this important post. He urged the Group to consider nominating a candidate for this post, so that a higher degree of ITIC effectiveness can be achieved. The Group supported the view that the appointment of an Associate Director is of critical importance, particularly if funding is approved for the southwest Pacific Regional Center Project by UNDP and the implementation of the project will commence.

92 The Group thanked the Director ITIC and the Senior Assistant Secretary IOC for their efforts in carrying out the functions of ITIC under such severe financial limitations, and in continuing the search for an ITIC Associate Director and, recommended that IOC should reinstate its level of support to ITIC (to at least the \$28,000 per year level).

93 The Group emphasized that the recommendations of the Twenty-third Session of the IOC Executive Council (EC) for extra-budgetary support of ITIC activities, be taken into consideration.

8. TRAINING, EDUCATION AND MUTUAL ASSISTANCE IN REGARD TO THE ITSU PROGRAMME

8.1 VISITING EXPERTS PROGRAMME

94 The Director, ITIC was invited to inform the Group of the progress made in carrying out the IOC-sponsored and supported Visiting Experts Programme. According to the ITIC information, the Visiting Experts Programme has been very successful and has resulted in the increased effectiveness of the Tsunami Warning System. Dr. Pararas-Carayannis reported that in 1990 two visiting experts (from the Philippines and Chile), completed a 4-week training programme. The training these visiting scientists received was comprehensive, encompassing all operational aspects of the Tsunami Warning System. In addition, the visiting scientists had a thorough introduction to all aspects of the tsunami phenomenon, and worked on specific problems related to tsunami warning in their own countries and on improvements of communications.

95 The ITIC Director reported that a selection of scientists has been made for the October 1991 programme. Scientists from the Republic of Korea and from Colombia have been invited.

96 **The Group thanked the ITIC Director for carrying out effectively this programme.**

97 **The consensus of the Group was that the nomination process of prospective candidates for the ITIC training should be co-ordinated with the national contacts of each ITSU member country.**

8.2 INTERACTIVE TSUNAMI MODELLING SYSTEM (ITMS)

98 In the absence of the Soviet Delegation, the Director ITIC (because of his recent visit to Novosibirsk and discussions with soviet experts from the Novosibirsk Computing Centre who were involved in the developments of ITMS) introduced this item. He presented various components of the ITMS, their functions and the improvements which had been made to earlier versions (Document IOC/ITSU-XIII/15). He explained the directions that future improvements were expected to take and the uses which could be possibly made of the ITMS.

99 The Chairman supplemented this by quoting from a letter which he had sent to Academician Alekseev. In this he expressed admiration for the work of the Computing Centre in the development and continuing refinement of the ITMS. He noted that while the concept of the ITMS and many of its components were new and unique, some of the components were duplications of work being done elsewhere in the tsunami community. The Chairman urged our Soviet colleagues to concentrate on the development and further refinement of those aspects of the ITMS which were really unique.

100 The Director of ITIC emphasized that the ITMS concept is not redundant in any way with the TIME project, as both address different needs of predictive evaluation of tsunamis.

101 **The Group thanked the Director ITIC and the Chairman for the explanations and expressed great appreciation for the work done by the Novosibirsk Computing Centre. The Group noted that further refinement might be desirable before beginning to consider the use of the ITMS as a training tool. The Group urged the Computer Centre to continue their work on the ITMS and to report the progress to ITSU-XIV.**

9. PUBLICATIONS

102 Dr. Pararas-Carayannis, Director ITIC, commented on publications that were completed or are under preparation. In addition to the regular publications of Tsunami Newsletters ITIC completed the Tsunami Glossary, the editing of the Second International Tsunami Workshop Proceedings, a brochure describing the mandate and functions of the Centre, and the draft text of a Children's Book on Tsunamis.

103 **The Group acknowledged with appreciation the work of ITIC in providing these publications and agreed that the comments and corrections related to the Glossary should be provided to the Director ITIC for incorporation into the computer master copy and for the preparation of an errata page. The Group agreed further that a second edition of the Glossary should be published in 3 to 4 years from now in case sufficient changes have been made to the first edition. As for the Children's book on Tsunamis, countries such as Mexico and Chile requested copies of the Children's book text, Chile agreed to use this text in its primary school educational experiment and in its evaluation of the results.**

104 **The Group stressed the importance and need for the publication of the ITIC brochure in other working languages of IOC, namely, Spanish, French and Russian. The Group acknowledged the readiness of Mexico to prepare translation of the text of the brochure in Spanish and of France - in French. The Secretariat IOC was requested to investigate the readiness of the Soviet Union to make a Russian version of the text. The IOC was requested to make the publication of the brochure in all working languages with the assistance of ITIC.**

105 **The Group expressed interest in having a wide distribution of the Catalogue of Tsunamis on the western coast of Mexico, published by CICESE in a limited number of copies, and requested the Secretariat IOC to investigate the WDC-A for Tsunamis interest in carrying out this exercise, taking into account the experience gained by that Centre in the publication of the Catalogue of Tsunami events in Peru and Chile.**

10. ELECTION OF THE CHAIRMAN AND VICE-CHAIRMAN OF THE ICG/ITSU

106 The Senior Assistant Secretary, IOC explained to the participants the election procedures in the IOC Manual by quoting, *inter alia*, the following extract:

"The Chairman and Vice-Chairman of the Technical Committee will serve for two sessions and two intersessional periods and may be re-elected for one additional term of office."

107 The Group expressed its full satisfaction with the work carried out by the present Chairman Mr. R.H. Hagemeyer, and was unanimous in electing him for the next term of office.

108 The Group noted that an ordinary term of service of Prof. S. Soloviev, Vice-Chairman of the ICG/ITSU, has expired, thanked him warmly for his great contribution to the success of the Tsunami Warning System and expressed hope that the Group may rely in the future on his knowledge and experience.

109 The Group elected Mr. Hiroo Uchiike from Japan as a new Vice-Chairman of the Group.

11. PROGRAMME AND BUDGET FOR 1992-1993

110 The Senior Assistant Secretary IOC informed the Group of the decisions of the Sixteenth Session of the IOC Assembly (Paris, 7-21 March 1991) with regard to the programme and budget for 1992-1993. The importance of mobilizing extra-budgetary resources was emphasized to ensure that priority activities be implemented and that re-phasing of these activities be kept to a minimum.

111 The Group expressed its appreciation to the Director General of UNESCO for his decision to provide additional direct support to ITIC and its thanks to the Secretary IOC for his continuous efforts to increase financial support to the activities of the programme.

112 The Group requested its Chairman to look for new and additional sources of funding which are essential to fulfilling the responsibilities and growing tasks assigned by the Member States to the Group.

113 In light of the information and discussion under the previous agenda item, the Group formulated the ITSU work programme for 1992-1993 to be presented to the Twenty-fifth Session of the IOC Executive Council for approval.

114 The Group adopted Recommendation ITSU-XIII.4

12. 1993 ICG/ITSU WORKSHOP

115 The Group noted that the Sessions of the ICG/ITSU are held, if possible, in conjunction with IUGG Symposium and in these instances also include an ICG/ITSU Tsunami Workshop. The workshop provides an avenue for involving representatives from developing countries and scientists in the ITSU programme.

116 In preliminary discussions with the local organizers of the IUG regarding the 1993 events, they have offered to allot only one half day to a Workshop. The Groups believed that at least two days are necessary for a Workshop. It was recommended that if a two day Workshop is not possible, the Chairman should investigate the possibility of having the IOC co-sponsor the IUGG Symposium.

117 The Group supported the Chairman and the Senior Assistant Secretary IOC, in their efforts to secure an arrangement acceptable to the ICG/ITSU.

13. DATE AND PLACE OF THE NEXT SESSION

118 The Representative of Japan informed the Group on a kind agreement of his Government to investigate the possibility of hosting the Fourteenth Session of the Group in August 1993 under the auspices of the Japan Meteorological Agency. He explained that an official invitation will be issued in due course. The Group acknowledged the interest of Japan to host the coming session and requested its Chairman to approach Japanese authorities in order to facilitate the decision.

119 **The Group noted that it would be most desirable to finally identify the place and time of the meeting before the IOC Executive Council planned for March 1992.**

120 **The Group expressed strong appreciation to the kind invitation of the Representative of France to have the Fifteenth Session of the ICG/ITSU in Tahiti, French Polynesia in 1995, and to provide all the necessary facilities for the ICG/ITSU Workshop if the Group decides to have one there. The Group requested its Chairman and the Secretary IOC to take this invitation into account when formulating the programmes and budget of the Group for 1994-1995.**

14. ADOPTION OF THE SUMMARY REPORT AND RECOMMENDATIONS

121 **The Group adopted the Summary Report and Recommendations of the Session (Annex II).**

15. CLOSURE

122 **The Chairman thanked all the delegates, representatives and observers for their constructive and friendly contributions to the discussions which provided the basis for the Summary Report.**

123 **He expressed on behalf of all the Group, his great appreciation to the local organizers for their devotion and hard work. The Chairman closed the Session at 16.00 on 13 September 1991.**

ANNEX I

AGENDA

- 1. OPENING AND ARRANGEMENTS FOR THE SESSION**
- 2. GENERAL REVIEW OF INTERSESSIONAL ACTIVITIES**
- 3. IMPLEMENTATION OF RESOLUTIONS AND RECOMMENDATIONS OF THE TWELFTH SESSION OF THE ICG/ITSU**
 - 3.1 CONTRIBUTION OF ICG/ITSU TO THE IDNDR**
 - 3.1.1 Tsunami Inundation Modelling Exchange Project (TIME)**
 - 3.1.2 Interactive Software for Seismic Network Analysis on Personal Computers**
 - 3.1.3 Real-Time Exchange of Seismic Data**
 - 3.1.4 Tsunami Public Education and Awareness Programme**
 - 3.2 USAGE OF THE M_m MAGNITUDE TO ESTIMATE THE SEISMIC MOMENT FOR LOCAL AND TELESEISMIC EVENTS AND TSUNAMI RISKS**
 - 3.3 RESULTS OF COMMUNICATION TESTS BETWEEN SELECTED COMMUNICATIONS CENTRES OF THE NORTH PACIFIC - NEEDS AND WAYS FOR IMPROVEMENT**
 - 3.4 STATE OF PREPARATION OF DATABASE FORMAT**
 - 3.5 USAGE OF PERSONAL COMPUTERS FOR TSUNAMI TRAVEL TIME CALCULATIONS**
- 4. EXTENSION OF THE SEA-LEVEL NETWORKS IN THE PACIFIC BY USING DATA COLLECTION PLATFORM TECHNOLOGY**
- 5. PROMOTION OF INTERNATIONAL PACIFIC-WIDE CO-OPERATION IN SEISMOLOGY AND TSUNAMI PREPAREDNESS**
- 6. IMPLEMENTATION OF THE PROVISION OF THE ITSU MASTER PLAN**
 - 6.1 STATUS OF THE REGIONAL PROJECT ON THE TSUNAMI WARNING SYSTEM IN THE SOUTHWEST PACIFIC**
 - 6.2 EXPANSION OF THE ICG/ITSU ACTIVITIES TO OTHER TSUNAMI AREAS OF THE WORLD OCEAN**
- 7. SUPPORT TO ITIC**
- 8. TRAINING, EDUCATION AND MUTUAL ASSISTANCE IN REGARD TO THE ITSU PROGRAMME**
 - 8.1 VISITING EXPERTS PROGRAMME**
 - 8.2 INTERACTIVE TSUNAMI MODELLING SYSTEM (ITMS)**

9. PUBLICATIONS
10. ELECTION OF THE CHAIRMAN AND VICE-CHAIRMAN OF THE ICG/ITSU
11. PROGRAMME AND BUDGET FOR 1992-1993
12. 1993 ICG/ITSU WORKSHOP
13. DATE AND PLACE OF THE NEXT SESSION
14. ADOPTION OF THE SUMMARY REPORT AND RECOMMENDATIONS
15. CLOSURE

ANNEX II

LIST OF ADOPTED RECOMMENDATIONS

Recommendation ITSU-XIII.1

TSUNAMI INUNDATION MODELLING EXCHANGE PROJECT (TIME)

The International Co-ordination Group for the Tsunami Warning System in the Pacific,

Recognizing the urgent need of the IOC Member States for tsunami inundation maps to mitigate the tsunami hazard along threatened coastlines,

Taking into account that the project constitutes an important component of the IOC contribution to the International Decade on Natural Disaster Reduction (IDNDR),

Urges IOC Member States at the Twenty-fifth Session of the IOC Executive Council to give high priority to this project and to take all necessary actions to facilitate its implementation;

Recommends that the Secretary IOC allocate the necessary funds in the IOC budget for 1992-1993 in order to take full advantage of the opportunities given by the IDNDR;

Invites IOC Member States to consider financial support for the project using extra-budgetary mechanisms of funding, (e.g., the IOC Trust Fund).

Recommendation ITSU-XIII.2

PACIFIC RAPID RESPONSE SYSTEM

The International Co-ordination Group for the Tsunami Warning System in the Pacific,

Recognizing the urgent need to rapidly disseminate data and information related to tsunamis, with the real-time transmission of seismic data being especially critical,

Taking into account the very productive efforts of the *ad hoc* Group of Experts formed pursuant to the decision of the Twelfth Session of the ICG/ITSU,

Recommends that the *ad hoc* Group of Experts on Real-Time Telemetry, Seismic and Tsunami Data Exchange continue its activities with the Terms of Reference presented in the annex to this Resolution;

Encourages Member States of the IOC to provide the necessary financial support for the implementation of the elements of Phase-II as identified in the project for Pacific Rapid Response system;

Urges the Secretary IOC to secure necessary funds for a meeting of the *ad hoc* Group of Experts during the latter half of 1992 or early 1993, in order to review the progress made in the implementation of the project.

Annex to Recommendation ITSU-XIII.2

TERMS OF REFERENCE OF THE AD HOC GROUP OF EXPERTS

- (i) **Evaluate** the success in achieving the Phase I goals as identified in the Project Plan;
- (ii) **Evaluate** the progress being made toward achieving the Phase II goals of the Project Plan;
- (iii) **Review** the Project Plan considering these evaluations to determine whether any revisions are required;
- (iv) **Report** on these actions to the Fourteenth Session of the ICG/ITSU.

Recommendation ITSU-XIII.3

PROGRAMMES FOR PUBLIC EDUCATION AND AWARENESS

The International Co-ordination Group for the Tsunami Warning System in the Pacific,

Welcoming the progress being achieved by an *ad hoc* Working Group for Public Education and Awareness in 1989-1991,

Recognizing the growing need of developing Member States for education and awareness programmes which may help populations to develop a knowledge and understanding of seismic and tsunami phenomena and to attain a favourable and rational attitude in case of earthquakes and tsunamis,

Acknowledging that the objectives of this project correspond fully to the IDNDR objectives relevant to training and education, and to those of the Master Plan for the Tsunami Warning System in the Pacific,

Recommends that the activities of the Working Group should be continued with the revised Terms of Reference to:

- develop education programmes for primary and high schools;
- define and develop general public education strategy;
- provide advice on the progress of the development of public education and awareness materials to ITSU member States;
- report on the progress to the Fourteenth Session of ICG/ITSU;

Recommends that the Secretary IOC anticipates and secures appropriate funds to support the following minimum activities needed for the successful implementation of the project:

- provision of funds for three consultants to prepare texts for education programmes and strategy;
- provision of support for the meeting of the *ad hoc* Working Group
(envisaged total expenditures - US\$ 10,000-12,000);

Noting an important contribution of Chile to the development of the project,

Recommends Mr. H. Gorziglia (Chile) to become a Chairman of an *ad hoc* Working Group;

Invites the Secretary IOC, in consultation with the Chairman of the *ad hoc* Working Group and the Chairman of the ICG/ITSU, to finalize its new composition taking into account participation of Member States in the preparation of the project proposal.

Recommendation ITSU-XIII.4

PROGRAMME OF WORK AND PRIORITIES FOR 1992 - 1993

The International Co-ordination Group for the Tsunami Warning System in the Pacific,

Being Informed of the IOC Programme and Budget for 1992-1993, adopted by the Sixteenth Session of the IOC Assembly,

Recognizing increased support to the programme provided by the Director-General of UNESCO and the Secretary IOC during the intersessional period,

Being aware of the need to fulfil efficiently and effectively the responsibilities assigned to the Group by IOC Member States and to maintain the momentum of the programmes that contribute to the IDNDR,

Noting that additional resources would be required for sustained satisfactory implementation for all projects proposed by the Thirteenth Session of the Group,

Noting further the need for additional resources which can be acquired through voluntary contributions of Member States to the IOC Trust Fund, secondment of staff and in-kind support,

Urges the Secretary IOC to assign a high budgetary priority to the IOC Tsunami programme and to make additional funds available to meet the demands of the IOC Member States for enhancement of their capabilities to combat tsunami;

Further urges that Member States of the ICG/ITSU increase their efforts to provide adequate funding for the support of the IOC Tsunami Programme;

Adopts the ICG/ITSU work programme for 1992-1993 with the following order of priority:

1. Provision of increased assistance for the continuing activities of the International Tsunami Information Centre
2. Visiting Experts Programme (4-6 trainees)
3. Provision of assistance to Member States for the implementation of the actions of the Master Plan for the Tsunami Warning System in the Pacific
4. Provision of funds for the organization of meetings of the Group and its subsidiary bodies (ITSU-XIV, ITSU Workshop, ITSU Officers Meeting, Meeting of an *ad hoc* Group of Experts for Public Education and Awareness, Meeting of the Working Group for Real-Time Seismic Data) and for hiring consultants to work on texts for education programmes and strategy
5. Implementation of the TIME Project
6. Provision of funds for participation of ITSU Officers/Experts in the meetings of other organizations dealing with tsunami problems, and of the ICG/ITSU Chairman at the Twenty-sixth Session of the IOC Executive Council

7. Co-sponsoring of scientific conferences and symposia of other international bodies related to the programme by providing support for participation of experts from developing countries
8. Provision of living allowance and travel for the Associate Director, ITIC
9. Support for publication of tsunami research and mitigation documents (ITIC brochure in French, Spanish and Russian, Tsunami book for children, errata sheet for the Tsunami Glossary, etc.).

ANNEX III

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ANNEX IV

LIST OF WORKING DOCUMENTS ¹

Document Code	Title
IOC/ITSU-XIII/1	Agenda
IOC/ITSU-XIII/1 Add.	Timetable
IOC/ITSU-XIII/2	Annotated Agenda
IOC/ITSU-XIII/3	Summary Report
IOC/ITSU-XIII/4	List of Documents
IOC/ITSU-XIII/5	List of Participants
IOC/ITSU-XIII/6	Report of the ICG/ITSU Chairman
IOC/ITSU-XIII/6 Suppl.1	Status of Implementation of ITSU-XII: Decisions and Recommendations
IOC/ITSU-XIII/7	International Tsunami Information Centre: Progress Report for 1989-1991
IOC/ITSU-XIII/8	National Reports on Intersessional Activities
IOC/ITSU-XIII/9 rev.	Integrated Automated Device to Estimate the Tsunami Risk (France)
IOC/ITSU-XIII/10	Expansion of ICG/ITSU to the Mediterranean
IOC/ITSU-XIII/11	Description of the "Luch" System
IOC/ITSU-XIII/12	Proposal for a "Tsunami Public Education and Awareness Programme"
IOC/ITSU-XIII/13	Interactive Software for Seismic Network Analysis
IOC/ITSU XIII/14	Tsunami Inundation Modelling Exchange Project
IOC/ITSU-XIII/15	Interactive Tsunami Modelling System on Personal Computers
IOC/ITSU-XIII/16	Historical Earthquake and Tsunami Data Base for Kuril-Kamchatka Region
IOC/ITSU-XIII/Inf.1	Information on Arrangements and Services Available for the Session
IOC/ITSU-XIII/Inf.2	Five-Year Master Plan for the Development of a Regional TWS in the Southwest Pacific

¹ This list is for reference only. No stocks of these documents are maintained, except for the Summary Report

ANNEX V

TEXT OF THE WELCOME SPEECH

by

Dr. Mario Martinez-Garcia
Director-General, CICESE

Honourable members of the podium, representatives of the Member States and international organizations, ladies and gentlemen:

Over the past two decades, most of the coastal areas in the Pacific have experienced a rapid growth in population and industrial harbour facilities. As a result, our vulnerability to tsunamis has enormously increased, threatening not only lives but also property, industry, transportation and communication systems.

Tsunamis pose a unique natural disaster threat. They are capable of major destruction not only in the near source region, but also at distant coastal areas, often in compassing the entire Pacific Basin within a matter of hours.

During the month of April 1965, following a request of the Intergovernmental Oceanographic Commission, a Working Group met in Honolulu, Hawaii, USA to discuss a resolution to establish, on an international basis, a system to provide timely tsunami warnings in the Pacific. Mexico participated in this Working Group and is a member of the System since it was created.

The subduction zone of the Cocos Plate in the Middle America Trench, adjacent to the Pacific Coast of Mexico, is one of the most active seismic zones in the Northern Hemisphere. In the last three centuries, at least 16 seismic events in this zone generated destructive tsunamis with wave heights between 2 and 6 meters, and reaching even 10 meters. Well known are the total destruction of Zihuatanejo in 1925 and Cuyutlan in 1932. Besides that, Mexico is also affected by tsunamis of distant origin generated in the seismic zones around the Pacific Ocean, like the arrival of 1960 Chilean and the 1964 Alaskan Tsunamis to Ensenada.

In a joint effort, the CICESE Research Centre and the local Oceanographic Research Station of the Mexican Navy, both in Ensenada, in co-ordination with the State of Baja California Civil Protection Agency, developed the Baja California regional Tsunami Warning System.

The CICESE and the Mexican Navy presently operate and maintain two tidal stations: Cabo San Lucas and Isla Guadalupe equipped with Handar Data Collecting Platforms and real-time satellite transmitters to the Pacific Tsunami Warning Centre. Since August 1986, CICESE also acts as a Dissemination Agency of the Pacific Tsunami Warning System for Baja California.

The main objective of the Pacific Tsunami Warning System is to provide accurate and reliable tsunami warnings within the shortest possible time-frame in order to protect life and property. Present techniques for tsunami prediction are very limited. It is possible to predict when a tsunami will arrive at a given location, but it is not yet possible to predict the wave height, number of waves, duration of the hazard or forces to be expected. A secondary objective is to adequately inform and educate all persons living within tsunami risk zones, so that they are properly prepared to respond to the warnings when issued.

Rapid telecommunication both for data acquisition and for information dissemination, is the most important factor for the success of the system. During the last few years new operational concepts utilizing updated technology and instrumentation that may represent a very great improvement for the system, have been developed. The advent of computers and satellite communication will drastically increase the responsiveness of the system and greatly enhance the protection of life and property.

The needs of those people potentially impacted by tsunamis are ultimately the most important element to be considered. The development of an educational programme to meet the needs of the responsible authorities and the general public is an important goal to be reached.

Finally, tsunami inundation modelling, a powerful methodology to produce maps for hazard planning and evacuation purposes which may minimize future tsunami impact, should be vigorously developed and its technology transferred to the developing countries in urgent need of it.

All of these topics are present in your Agenda. I have no doubt that with your enthusiasm and willingness, you will achieve the main purpose of the International Co-ordination Group for the Tsunami Warning System in the Pacific to recommend and co-ordinate the most beneficial programmes to those countries whose coastal areas are potentially threatened by tsunamis.

On behalf of the Mexican Government, I welcome you to Ensenada and wish you a successful Thirteenth Session.

Thank you very much.

ANNEX VI

PROJECT ON RAPID SEISMIC RESPONSE

Project: Real-time telemetry of oceanographic and geophysical data necessary for emergency response to tsunamis and strong earthquakes within the Pacific region.

Project Objective: Mitigation of the hazards created by tsunamis and destructive earthquakes within the Pacific region through the real-time telemetry of geophysical data.

Two significant hazards to people and their property have long been recognized to exist in the Pacific region. The first of these is the tsunami. For example, a tsunami can be created by a large earthquake (or volcano eruption) on one side of the Pacific and cause massive destruction to islands in the mid-Pacific and to coastal areas on the other side of the Pacific. The second hazard to man is the earthquake itself. The entire Pacific region is surrounded by the most seismically active zones in the world. Destructive earthquakes are common in these zones, and there is a long history of death and destruction caused by these earthquakes.

Over the last several decades, many countries within or bordering the Pacific region have sought to improve their capability to monitor both earthquake activity and sea-level parameters in an attempt to obtain the data necessary for guiding rescue teams to inland locations of destructive earthquakes or for issuing tsunami warnings. Along with the technical advances made in these years, there has been an equally important advance in the co-operation between countries of the Pacific region. This co-operation is reflected in the activities of member countries to the International Co-ordination Group of the Tsunami Warning System in the Pacific (ICG/ITSU).

Despite the advances of the past several decades, some very significant deficiencies are recognized to still exist in our capability to mitigate the hazards of tsunamis and earthquakes occurring in the Pacific region. For example, the current poor seismic coverage of many areas within and surrounding the Pacific Ocean make it impossible to locate earthquakes with the accuracy necessary for determining if a tsunami has or has not been generated. In some cases, the location determined for the earthquake is so poor that there is also difficulty in ordering evacuation of coastal areas or in directing rescue teams to those remote inland areas which may have suffered damage. Both the quality and timeliness of seismic and sea-level data vary around the Pacific, with major inadequacies in data quality and coverage existing for many areas.

While these deficiencies were hard to correct in past years, the availability of improved sensors, digitizers, computers and communications have now made possible a dramatic improvement in our overall capability to mitigate tsunami and earthquake hazards. Modern data analysis techniques combined with the computer power available today at relatively small cost also makes it possible to process broadband digital seismic data and thereby obtain important information about the earthquake source and depth. This information is critical to the process of evaluating both the potential earthquake damage and the possible generation of a tsunami. If such high quality seismic data are available in real-time, then this type of analysis will furnish new information which can be used to mitigate tsunami and earthquake hazards. Similarly, water level sensors using satellite telemetry could provide important information, both near shore and in the open ocean. The timely issuance of tsunami warnings and the rapid location and evaluation of potential earthquake damage are fundamental to hazard mitigation efforts. Real-time communication of seismic and other geophysical data is a cornerstone to improving our capability to mitigate these and other natural hazards in the Pacific region.

The very nature of the effort required to improve our capability to mitigate these hazards makes this project international in scope and character. Consequently, to be completely successful, this project will require good international co-operation and the active support of all countries in the Pacific region. This project is being proposed then, to co-ordinate the individual efforts of many countries and to provide the necessary technical and financial assistance to those participating countries requiring it. Sponsorship of this international project by the national and international funding agencies will clearly help to ensure its success.

This project will build upon the framework created by many other existing and planned projects. This project is structured to have 3 phases. The first phase is essentially complete and consists of all the systems which have already been deployed and are functioning today to provide useful geophysical data for monitoring earthquake activity and tsunamis. Included in Phase 1 are all of the national and international co-operative arrangements which have been made and are in effect today. Only minor refinements are left to complete Phase 1. These refinements involved transfer of existing technology and improved co-ordination between National tsunami and earthquake centers.

The second phase of this project consists of those efforts currently underway to improve the existing monitoring system. Many of these efforts include the deployment of new high quality broadband seismic stations and the real-time transmission by satellite of seismic and other geophysical data. Additional support for efforts under phase 2 will be extremely important. The second phase will be complete within the next 2 years.

The third phase and the motivating factor for this proposal consists of those actions which must be undertaken to complete the system. These actions may be technical (involving hardware) or political (encouraging co-operation). The activities of Phase 3 of this project are designed to support the objectives of the International Decade of Natural Hazard Reduction. Phase 3 will continue throughout the time period of the Decade. At the end of this time, a complete modern tsunami and earthquake monitoring and data exchange system will be in place throughout the Pacific region to safeguard life and property against these natural hazards.

Each of these phases will now be described in some detail. The technical and co-operative aspects of the project for each phase will be presented.

Phase 1

In 1965, the Intergovernmental Oceanographic Commission (IOC) accepted the offer of the United States to undertake the expansion of its existing Tsunami Warning Center in Honolulu to become the headquarters of the International Tsunami Warning System. The IOC also accepted the offer of other Member States to integrate their existing facilities and communications into this International Warning System. At a meeting in Honolulu in 1965, an agreement was reached and IOC established the International Tsunami Information Center (ITIC) and the International Co-ordination Group of the Tsunami Warning System in the Pacific (ICG/ITSU).

The International Co-ordination Group was established as a subsidiary body of IOC, meeting every 2 years at a Member State to co-ordinate and review the activities of the International Tsunami Warning System (ITWS). Since 1965 and with IOC support, the Tsunami Warning System integrated with other regional tsunami warning systems, to become the nucleus of a truly international network.

Present protective measures involve primarily, the use of the existing Tsunami Warning System employing advanced technological instrumentation for data collection and for warning communications. Countries like France, Japan, the Soviet Union, Canada, and the United States have developed sophisticated warning systems and have accepted the responsibility to share warning information with other countries of the Pacific. Their resources have been integrated into the International Tsunami Warning System.

Twenty-four nations are now members of ICG/ITSU. Several non-member states maintain stations. The System makes use of approximately 31 seismic stations, 53 tidal stations and 101 dissemination points scattered across the Pacific under the varying control of the Member States of ITWS.

The objectives of the ITWS are to detect and locate major earthquakes in the Pacific region, determine whether they have generated tsunami and provide timely and effective information and warnings to the population of the Pacific region in order to minimize the effect of the hazards on life and property.

The ITWS has been a successful international programme and has been able to provide timely warnings to most of its participants. At least 6 hazardous tsunamis have occurred in the last 15 years in the Pacific area resulting in the loss of about 10,000 lives and considerable amount of property. Most of the destructive tsunamis have occurred in inland seas bordering the Pacific Ocean, and occurred without adequate warning to the countries closest to the tsunami origin. Each time the warning came too late to be of usefulness.

During the last few years, new operational concepts, computer methodology and satellite telemetry, have been developed that can improve the performance of ITWS. An important need has been identified for regional tsunami warning systems in regions vulnerable to the tsunami hazard. These regions are mostly in Central and South America, and in the West and Southwest Pacific. Concerted efforts have been initiated to support developing countries in these regions by establishing regional tsunami warning systems, which utilize modern technology, computers and instrumentation, including shore-based seismic and tidal sensors, and real-time telemetry. These efforts, initiated by IOC and ICG/ITSU are consistent with the objectives of the International Decade for Natural Disaster Reduction (IDNDR), and are in support of its principles. A proposal has been submitted to UNDP to support this effort as its contribution to the mitigation of the tsunami and earthquake disasters and other related natural hazards.

An area that holds a great deal of promise in mitigating the earthquake and tsunami hazards as well as supporting other global monitoring programmes, is that of instrumentation that utilizes satellite telemetry for data transmission and disaster warning dissemination. The IOC through its ICG/ITSU is presently co-ordinating the establishment of satellite telemetry in its use of tsunami monitoring and warning. Satellite telemetry for the transmission primarily of water level data was established in the last 2 years. The US geosynchronous satellite GOES has been primarily used for the Pacific Satellite Sea-Level Network for tsunami detection and for short- and long-term sea-level changes in the Pacific, in support of Global Climate Prediction efforts. The Pacific Satellite Sea-Level Network now consists of 68 Data Collection Platforms (DCPs) in the Pacific. This number of DCPs although impressive, does not provide full coverage of the Pacific. Satellite seismic data telemetry, although presently feasible, it is presently in its infancy with only a few sensors which detect only p-wave arrival from short period instruments.

Other countries are presently using their own satellites for selective data collection on a variety of monitoring programmes. The need has been identified to co-ordinate all these independent national efforts under the international umbrella of ICG/ITSU and in support of the principles of IDNDR. Japan, USA, USSR, France and many other countries operate satellite communications and telemetry that can be made compatible and integrated into IDNDR's efforts. These objectives can be accomplished in the manner outlined in Phases 2 and 3 as explained in the following sections of this proposal.

Phase 2

Expansion of the tide-gauge system will continue under Phase 2. However, most of the advances considered for Phase 2 will be in the deployment of new seismic systems and in the greatly increased utilization of satellite communication systems. Specific aspects of Phase 2 will be described by considering activities in individual countries and, in some cases where convenient, in regions around the Pacific.

Antarctica: A high quality borehole seismometer has now been installed in Antarctica by the USGS. Within the next year it is expected that satellite transmission of data using IMMARSAT from this sensor will be available. The data will be received by the NEIC in Golden, Colorado. This station is very important for monitoring the entire South Pacific region.

Status: Funding is available.

South America: Four high quality seismic stations are now being installed in South America by the USGS. They are located in Argentina, Paraguay, Bolivia and Brazil. Installation is scheduled to be completed in 1992. Each station will have the seismometers in a borehole. These stations are part of the Global Telemetered Seismograph Network (GTSN). Data from each station will be transmitted in real-time by satellite to the NEIC.

Status: Funding for these 4 stations is available. However, many more stations are necessary to provide the required accuracy in earthquake location for tsunami warnings.

Middle America: Mexico is currently installing 5 high quality digital seismic stations across Mexico. These stations are the same hardware design as those of the US National Seismograph Network (USNSN). Data from each station will be transmitted in real-time via the Mexican satellite to UNAM in Mexico City. These data will then be immediately retransmitted to the NEIC. Both the National Seismographic Service of Mexico and the NEIC will process data from these stations in real-time. In November 1985, an earthquake occurred in Mexico which caused significant damage to Mexico City. Only telephone circuits were used to transmit seismic data at the time and all of these circuits failed. This provides a clear example of the importance of satellite communications.

Geoscope has now installed one of their broadband seismic stations in Mexico City.

In 1990, the Middle America Seismograph Network (MIDAS) project was created. This project's purpose is to establish a broadband digital seismograph network surrounding the Caribbean and to transmit data from these stations in real-time via satellite to all the participating countries. As part of the MIDAS project, the USA and Mexico together will install a high quality broadband seismic station in Central America (possibly Costa Rica) sometime within the next year. Data from this station will be transmitted in real-time to both UNAP in Mexico City and NEIC in Golden, Colorado, using the Mexican satellite.

Status: These stations are all funded. Many more stations are necessary for adequate coverage of Mexico and Central America.

North America: The USA is currently deploying National Seismographic Network (USNSN). When completed, the network will consist of about 150 stations located in the conterminous US, Alaska, Hawaii and Puerto Rico. Each station will have 3 component broadband seismic sensors and 3 component strong motion sensors. Data will be digitized using 24 bit digitizers. The broadband data will be sampled at 40 samples/second. Signals will be detected using both amplitude and frequency detectors at each station. Long-period data will be transmitted continuously by satellite from each station; broadband data will be transmitted as segmented events. The satellite transmission system being used by the USNS is a KU band system operating with Very Small Aperture (VSAT) dishes at each station. The master satellite station is located at the NEIC and consists of a large satellite dish and associated control electronics for the entire network.

Deployment of the USNSN is scheduled to be completed in 2 to 3 years. Data from the entire USNSN will be processed in real-time at the NEIC.

USNSN satellite dishes will also be placed at about 10 IRIS stations in the USA to transmit these data in real-time to the NEIC.

Canada has begun the development of a National Seismograph Network. This network will be deployed across Canada when completed. The design goals of the Canadian networks are similar to those of the USNSN, although the hardware used is slightly different. Data from each station of the Canadian network will be transmitted in real-time by satellite to Ottawa for analysis.

Data exchange between the Canadian network and the USNSN will occur by satellite from Ottawa and the NEIC in Golden, Colorado. The Canadian network is scheduled to be completed within the next few years.

In Alaska there are a number of projects underway which will improve the existing monitoring capability. These include the deployment of USNSN stations, the establishment of an Alaskan Earthquake Information Center (AEIC) at the University of Alaska in Fairbanks and the deployment of seismic stations for volcano monitoring. The USNSN stations will have satellite telemetry. This telemetry will also be used to transmit data from local networks.

Status: Most of the USNSN and the Canadian networks are now funded.

USSR: The USSR is continuing a major modernization of its tsunami warning system. There is a possibility that the satellite PEACESAT can be used to transmit data between the seismic stations on the eastern coast of the USSR and the PTWC. Stations currently being considered include Yuzhno-Sakhalinsk, Petropavlovsk and Vladivostok. It is very important that reliable real-time data communications be established between the eastern part of the USSR and PTWC, Japan and Alaska (ATWC and AEIC). While the best opportunity to accomplish this communication now appears to be PEACESAT, other possibilities should be investigated. This is particularly true if these objectives cannot be fulfilled using PEACESAT. It is also important that broadband digital seismic stations be installed at a number of locations in the eastern part of the USSR.

Status: Partial funding is available. This funding covers equipment for 3 broadband seismic stations and associated satellite transmission equipment. It also covers some of the upgrade of the USSR tsunami warning system.

Japan: The Japan Meteorological Agency (JMA) currently operates a very technologically sophisticated tsunami warning system in Japan. In some isolated areas, communications could be improved by using satellite telemetry and some such improvements are planned. The JMA is considering real-time data transmission of geophysical data using packet-switched networks. The JMA is also actively engaged in improving tsunami warning capabilities in the Philippines.

- Status:** Efforts underway are funded. Increased use of satellite transmission may require a lengthy approval process.
- South Korea:** A good seismic network now exists in South Korea. Real-time data exchange to international tsunami warning centres need to be implemented.
- Status:** Satellite communication system for data exchange needs to be implemented.
- China:** A network of broadband digital seismograph stations have been installed in China (the CDSN). Access to data from this network would be valuable for hazard mitigation efforts.
- Status:** Satellite communication system for data exchange needs to be implemented.
- Southwest Pacific:** Significant development of a tsunami warning system for this region is required. A detailed plan to accomplish this has been proposed by George Pararas-Carayannis of the International Tsunami Information Center. Real-time communications to whatever systems that are installed in this region will be important.
- Status:** Unfunded as yet.
- Australia:** An excellent network of digital seismic stations exists in Australia. Data from these stations are transmitted via satellite to one processing center. These data can then be accessed through computer channels or through a direct link to the NEIC, which now exists.
- Status:** Seismic network and communications systems exist.
- New Zealand:** A number of seismic stations exist, with some real-time transmission into Wellington. There is, however, no real-time data link to PTWC or other tsunami centres.
- Status:** Communications systems does not exist for real-time data to other countries.
- Pacific Islands:** A joint programme is now underway by PTWC and NEIC to deploy seismic sensors and new DCPs to many islands in the Pacific. This will make possible the acquisition of near real-time seismic data through the GOES satellite system.
- The near future policy of CPPT concerning the tsunami threat in Reudi Polynesia is a direct consequence of its location in the middle of the South Pacific tectonic plate. Although the existence of submarine volcanic activity has been proved in the vicinity of Tahiti and the Austral Islands, the only tsunami risk to take into account comes from the Tonga-Kemadec trench.
- The method used by CPPT to determine in real-time the seismic moment of an earthquake and then to evaluate the tsunami risk, is based on a one-station analysis of mantle Raleigh waves recorded on broadband instruments. The work currently being developed concerns the extension of this method to close field earthquakes and the automatic determination of their main parameters: location, depth, number. Modelling of particular effects such as amplification in shallow water or resonance of bays and harbours is also under way.
- The installation of a broadband seismic station near the Tonga-Kemadec trench (Fiji or Tonga Islands) would provide a significant improvement in warning systems for all events occurring in this area. This installation would be associated with real-time data communications and/or the development of a regional warning center able to process the data.
- Status:** Awaiting delivery of new DCPs. Programme is partially funded. Efforts underway in CPPT which include a new processing system (HP workstations connected by Ethernet) are funded. A broadband seismic station in the Tonga-Kemadec area and satellite communications needs to be implemented.

General Communications: Satellite communications described in this phase result in significant amounts of real-time seismic data being transmitted to a number of earthquake centres such as the NEIC. Because of the real-time communication link between the NEIC and PTWC, these data are sent immediately from the NEIC to PTWC and therefore to all co-operating tsunami warning centres.

Phase 3

Real-Time Data Acquisition The Pacific Rapid Response System

Phase 1 and 2 of this programme have addressed the current and intended projects relating to real-time and near real-time data acquisition of tsunami and seismic data for the Pacific Basin. The completion of Phase 2 within the next 2 years will result in significant technological improvements for some areas of the Pacific and little or no improvements for other areas. As some of these encompass the most active seismic regions of the Pacific, such as Indonesia and the Southwest Pacific, and others encompass the most threatening tsunami source regions, such as Chile-Peru and Kamchatka, Phase 2 projects still leave many deficiencies for the early detection and evaluation of earthquakes and tsunamis. A continuing problem for all areas relates to the loss of communications and therefore meaningful data from the source region due to the effects of the earthquake. Even in those regions where technology will result in significant improvements, the application of these advances will benefit only a limited population of the Pacific.

It is clear that present and ongoing efforts at improved data acquisition will not satisfy the requirements of ICG/ITSU participating nations throughout the Pacific, or even begin to address the earthquake and tsunami threat in many areas of the Pacific. It must be emphasized that a timely and accurate data acquisition effort is fundamental to the success of any disaster mitigation effort. What is required is a geophysical and oceanographic data acquisition system for the entire Pacific Basin, with all data being available continuously in real-time to all participating nations at the local, regional and national levels. Rapid improvements have been made and continue to be made in communication technology. This proposal is intended to access available and emerging communication technology to establish a real-time data network throughout the Pacific Basin.

It is the goal of the Pacific Rapid Response System to provide high quality data for the detection, location and preliminary evaluation of any significant earthquake and tsunami within 10 minutes of origin. The accurate location, focal depth and size of the earthquake can be used by responsible authorities to estimate potential earthquake damage in order to commence immediate rescue and relief efforts at the local, national and international levels. The seismic data also can be used to determine the probability of tsunami generation for the issuance of immediate tsunami warnings and evacuation of coastal areas nearest the source. The continuous availability of sea level data will provide appropriate tsunami warning centres and public authorities with information to confirm and evaluate the generation of a tsunami, and to determine its destructive potential both near-source and far-field.

The project constitutes an achievable goal that can be implemented at reasonably cost to mitigate both the earthquake hazard and the tsunami threat throughout the Pacific. At the same time, the communications technology developed for the Pacific Rapid Response System can be transferred for application to other natural disaster situations.

It is envisioned that multiple modes of data communications technology will be required to provide seismic and tsunami data on a real-time basis to participants throughout the Pacific Basin. This will include satellite data broadcasts over GOES and commercial satellites and linking land based systems using VHF, microwave and telephone lines. National centres will serve as nodes for local and regional data access.

It is requested that funding be provided for the following project components:

1. Completion of Phase 2 projects, particularly for South America, the USSR and the Western and Southwestern Pacific nations.
2. The installation of state-of-the-art seismic broadband instrumentation throughout the Pacific Basin at approximately intervals of 10 degrees of latitude or longitude where needed. Initial efforts should be focussed in the Western and Southwestern Pacific where Phase 2 projects will remain deficient.
3. The development of a real-time data acquisition telemetry system for these seismic installations, capable of surviving a nearby earthquake.

4. The installation of tsunami gauges at strategic intervals in tsunami source regions and at locations throughout the Pacific to rapidly detect and monitor the progress of tsunami propagation across the Pacific.
5. The development of a real-time data acquisition telemetry system for these tsunami gauges, capable of surviving local earthquake or tsunami destruction.
6. The development of a real-time communications network linking national tsunami warning and earthquake information centres. These would initially include PTWC, USGS/NEIC, JMA, CPPT, SHOA, Yuzhno-Sakhalinsk, Petropavlovsk and Vladivostok. This communications system would be independent of local earthquake and tsunami destruction or power losses.
7. Convening of a second meeting within 2 years at the end of Phase 2 to evaluate the success of Phase 1 projects, their deficiencies and re-evaluation of the preceding goals.

Expected Outputs

- rapid availability of geophysical and oceanographic data throughout the Pacific region.
- opportunities for utilizing inexpensive real-time communication circuits will be taken full advantage of by the tsunami and earthquake centres of the countries in the Pacific region.
- very significant steps towards reducing hazards related to earthquakes and tsunamis will be accomplished in the Pacific region during the period of the International Decade for Hazard Reduction.
- Scientific and economic co-operation among countries in the Pacific region will improve.
- the level of preparedness and co-operation of countries in the Pacific region will become a model for other regions of the world.