



## SUVA EARTHQUAKE RISK MANAGEMENT SCENARIO PILOT PROJECT (SERMP)

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### SUMMARY

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At the IDNDR Mid-Term conference in Yokohama, Japan, in May 1994, one of the most positive outcomes of the “Yokohama Strategy and Plan of Action” expressed the need for island nations around the world to better understand the implications of potentially damaging earthquakes and tsunamis on their communities. The Republic of Fiji subsequently took up this challenge. At the 3<sup>rd</sup> Pacific Regional IDNDR Meeting in Suva, Fiji, in September 1994; with support from the WSSI (of IAEE) the “Suva Earthquake Risk Management Scenario Pilot Project” (SERMP) was initiated.

The aim, significance and objectives of SERMP were related to the development of an earthquake and tsunami mitigation strategy to address the elements of awareness and preparedness to mitigate potential effects of these respective hazards as they may impact on the City of Suva. The direction was based on six project components: hazard assessment, vulnerability assessment, disaster mitigation measures, emergency response planning, public awareness and policy support, dissemination of findings. The key elements involved a scenario earthquake and tsunami (actually based on the devastating 14 September 1953 Suva earthquake and tsunami), integrated risk assessments, total involvement of the relevant Fijian agencies, consideration of the indigenous and ethnic populations, practical applications of the results and outcomes and recommendations for the future. The mitigation methodology was developed by CERA involving a multidisciplinary approach with multi-agency cooperation. The project was in total accord with the IDNDR goals and targets for mitigation strategies and the requirements of the Government of Fiji National Disaster Management Office.

The results and outcomes were comprehensive and wide-ranging. Emergency management strategies and disaster plans were developed for potential earthquake and tsunami impacts. A comprehensive “Information Resource” document was prepared in which all available information on seismology, geology, tectonics, built environment, engineering, natural environment, multi-ethnic population, potential damage and results of rigorous analyses of data were delineated. The outcomes were implemented in terms of practical applications in ten avenues of need. These were discussed and presented in the SERMP Sub-Regional Seminar and tested in two earthquake / tsunami exercises, a table-top exercise and field exercise in the industrial suburb of Walu Bay in

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Suva. Considerations are now being given to adopt this SERMP concept for other Pacific Island Countries.

## INTRODUCTION

Earthquakes are the most devastating natural phenomena known to human civilisation. They strike without warning, impact all levels of society and take a toll in human life, personal injury, property damage and the socio-economic fabric. Their consequences affect both the built and natural environments. Some major earthquakes cause associated tsunamis which can further affect coastal precincts and island communities. The Republic of Fiji and, in particular, its capital city of Suva are considered to be so vulnerable. Indeed, recent history attests to this, with the memory of the devastating 14 September 1953 Suva earthquake (Richter Magnitude ML 6.5) and its associated tsunami.

With the world's modern and expanding societies, many recent earthquake and tsunamis are clear testament to the immediate need for earthquake mitigation. This need has been most aptly facilitated during this present decade, 1990 - 2000, by the United Nations International Decade for Natural Disaster Reduction (IDNDR). Herein, the issues of awareness, risk assessment, preparedness and warning for earthquake and tsunami are being addressed. This is the premise for earthquake mitigation measures.

At the IDNDR Mid-Term Conference in Yokohama, Japan, in May 1994, one of the most positive outcomes from the "Yokohama Strategy and Plan of Action" has been the actions taken by the island nations of the world, with particular reference to the Pacific Island Countries (PIC) of the South Pacific. Many national and local agencies, both Government and non-Government, expressed the need to better understand the implications of potentially damaging earthquakes and tsunamis on their communities.

The Republic of Fiji took up this challenge. At the 3rd Pacific Regional IDNDR Meeting held in Suva in September 1994, the premise of earthquake and tsunami mitigation for Fiji was seriously considered. The Government of the Republic of Fiji Ministry for Regional Development and Multi-Ethnic Affairs National Disaster Management Office (NDMO), in cooperation with the UN Department of Humanitarian Affairs South Pacific Programme Office (UNDHA-SPPO), inaugurated this SUVA EARTHQUAKE RISK MANAGEMENT SCENARIO PILOT PROJECT (SERMP) through the UNDHA's South Pacific Disaster Reduction Project (SPDRP). At this meeting, international support was afforded by the International Association for Earthquake Engineering (IAEE) "World Seismic Safety Initiative" (WSSI), an approved IDNDR Demonstration Project. One initial task was to review the devastating 1953 Suva earthquake and tsunami, which was undertaken by Fiji's Department of Mineral Resources and the Centre for Earthquake Research in Australia.

SERMP was undertaken over the period 1995 through 1997. It has been coordinated by the Ministry of Regional Development and Multi-Ethnic Affairs through the National Disaster Management Office (NDMO). UNDHA-SPPO facilitated the project under its SPDRP by providing management support and linkages to regional technical organisations (such as SOPAC, SPC, SPREP), Emergency

Management Australia (EMA) Australian IDNDR Coordination Committee and relevant international geological, seismological and disaster management agencies. This pilot project has involved forty-six (46) Fiji Government agencies, Non-Government Organisations and professional bodies, and international consultancies with the Centre for Earthquake Research in Australia (CERA), Brisbane, Australia and the Institute for Geological and Nuclear Sciences (IGNS) Wellington, New Zealand.

Integral in this project has been the development of an **earthquake mitigation strategy** suitable to the needs of PIC, with the emphasis on a major urban area and its rural environs. As such, the City of Suva, Fiji, was considered to be most appropriate for this initial pilot project. The concept is that of a pilot project to provide necessary and sufficient information resources from which NDMO will be able to implement emergency management procedures to reduce the potential toll and damage from future earthquakes and associated tsunamis that may impact on communities in Fiji. The prime concerns were the vital involvement of relevant Fijian agencies and the consideration of the indigenous and ethnic populations. It must be fully recognized that the aims, significance and objectives of SERMP emphasise that of a **PILOT PROJECT** to strictly address the associated elements of **AWARENESS** and **PREPAREDNESS** to mitigate the earthquake and tsunami hazards. The outcomes are thus required to provide the platform whereby Fiji is able to continue investigations to improve national mitigation strategies - that is, the "way-forward".

The direction for SERMP was stated in terms of six (6) **PROJECT COMPONENTS** (for both the earthquake and associated tsunami hazards relative to The City of Suva) :

1. HAZARD ASSESSMENT
2. VULNERABILITY ASSESSMENT
3. DISASTER MITIGATION MEASURES
4. EMERGENCY RESPONSE PLANNING
5. PUBLIC AWARENESS AND POLICY SUPPORT
6. DISSEMINATION OF FINDINGS.

The **earthquake mitigation methodology** developed in SERMP involves a multidisciplinary approach with multi-agency cooperation to assess the earthquake and associated tsunami risks, in both quantitative and qualitative terms, by consideration of the premise

$$\text{RISK} = \text{HAZARD} \cdot \text{VULNERABILITY}$$

where the hazard assessment involves analyses of the available scientific data and the vulnerability assessment combines the engineering elements in the built and natural environments and the humanities aspects. Assessment of the risk is then an integration of the hazard and vulnerability assessments. The outcomes provide the necessary information resources, in terms of analytical results,

data bases and maps and practical applications therefrom, to proceed with earthquake and tsunami mitigation. These are in total accord with the IDNDR goals and targets for mitigation strategies, and the requirements of Fiji's NDMO.

This multidisciplinary approach involves the disciplines of the earth sciences (seismology, tectonics, geology, geophysics, geotechnical engineering), marine sciences, tsunami, engineering (built environment - buildings, infrastructure, lifelines, critical facilities; codes of practice), geography/natural environment, demography (population), environmental sciences, agriculture, government (national, local), public health, medicine, insurance, economics, sociology, cultural, emergency management, risk management and GIS mapping.

This has been achieved by following the structured and detailed method developed for SERMP. As well as considering all available local (Fiji) data and information (especially for the 14 September 1953 Suva earthquake and tsunami which devastated the City of Suva and surrounding areas), relevant aspects of similar international studies were incorporated. These included results and outputs from the 1989 Loma Prieta (USA), 1989 Newcastle (Australia), 1994 Northridge (USA) and 1995 Kobe (Japan) earthquakes and specific studies on New Zealand cities and the CERA earthquake zonation mapping of Australian cities. The hazard assessment employs essentially a deterministic approach (developed jointly by CERA and IGNS), but incorporates previous deterministic assessments and recent probabilistic studies. This is in accord with the most recent advances in hazard assessment considerations.

The scenario earthquake and associated tsunami selected for SERMP is based on the 1953 Suva event. This has an epicentre at 18.2°S, 178.3°E (off the Navua-Naqara coast of Southeast Viti Levu, approximately 15-20 km southeast of the SERMP area (The City of Suva) and Moment Magnitude Mw 7.0 (equivalent Richter Magnitude ML 7.0). The tsunami was considered to be generated from a source of sediment slumping in submarine canyons in the vicinity of the earthquake epicentre, just WSW of The City of Suva.

The project **outputs (results)** have been delineated in terms of the hazard and vulnerability components (for each of earthquake and tsunami), wherefrom the risks have been assessed. For various elements within each of the six (6) Project Components, a review of the published literature was conducted and a brief summary proposed for this project. In a few of the earth science elements, re-analyses of the data were necessary to provide the required input into SERMP. These included the seismotectonics (with specific note of the 1953 Suva event) for the choice of the scenario earthquake and associated tsunami, structural geology and attenuation of seismic energy with distance for the earthquake hazard assessment map, and tsunami data for the tsunami inundation map.

The **outcomes** of SERMP are comprehensive and wide-ranging and include :

- Review of published literature
- Review of the 1953 Suva earthquake and associated tsunami
- Earthquake hazard assessment

including ground shaking susceptibility map, attenuation relation, potential earthquake hazards and earthquake hazard map (in terms of Modified Mercalli Intensities MM) and commentary

- Earthquake vulnerability assessment
  - including inventories, GIS mapping and the approach to vulnerability assessment
- Earthquake risk assessment
  - in terms of earthquake zonation map, commentary and potential vulnerability levels matrix
- Tsunami risk assessment
  - including hazard and vulnerability assessments and inundation map
- Socio-economic loss estimation
- Practical applications of risk assessments
- Earthquake and associated tsunami exercise "SUVEQ 97"
- Earthquake response planning and management
  - including disaster planning, tsunami warnings, mitigation strategies and risk management
- Dissemination of findings
- Recommendations for the future.

Such outcomes can be implemented in terms of **practical applications** in :

- Earthquake and building codes
- Land-use planning
- Disaster planning
- Emergency management
- Emergency personnel training
- Rescue and response
- Insurance needs
- GIS mapping
- Community education
- Simulated earthquake and tsunami exercises.

SERMP has identified a significant earthquake risk for the City of Suva if a major earthquake were to occur in Southeast Viti Levu. If a tsunami were to be generated from such an earthquake, the potential for further damage and distress is also significant. Note is again made of the 1953 Suva earthquake and tsunami, which provided the "real experience" catalyst and platform for SERMP. Based on the SERMP scenario earthquake (with epicentre 15-25km southeast of Suva and magnitude of 7.0), the levels of earthquake and tsunami risks have been quantified in terms of their respective hazard and vulnerability components. The earthquake hazard assessment determined a maximum damage to both the built and natural environments of Modified Mercalli intensity MM 10 (very severe and considerable damage), with an equivalent maximum peak ground acceleration in the range 0.7 - 1.0g (depending on the geological conditions). Because of both the existing and planned development of Suva, the vulnerability is unquestionably high. The tsunami hazard assessment shows a maximum inundation level between the 2m and 5m elevation contours. The vulnerability relates to water and collateral damage to the environments within these low-lying zones. The highest risk areas for potential earthquake and associated tsunami damage are those around the foreshores of the Suva Peninsula, although it is also significant for earthquake on the interior "rock" (Suva marl or soapstone) areas. The consequences of these risk assessments are thus considered in the context of the City of Suva being all of local, national and international significance.

Two particular practical applications of SERMP are specifically noted, which ensured a comprehensive approach for the fulfilment of SERMP, whereby NDMO will be able to apply many of the results to test emergency procedures in a real (operational) simulation and integrate them into future planning and training requirements :

(a) SERMP Sub-Regional Seminar :

This was held in Suva on 25-26 August 1997 and constituted the dissemination of the preliminary findings of SERMP to the Fijian participants in the project and invited regional delegates from the Pacific Island Countries of Samoa, Tonga, Vanuatu, Solomon Is and Papua New Guinea;

(b) Simulated earthquake and associated tsunami exercise "SUVEQ 97":

This was the first such exercise conducted in Fiji and was composed of three parts :

"WALKTHROUGH" - A training session on 5 August 1997 to brief participants on the aims and significance of such an exercise;

"TABLETOP" - A full-scale, one-day, tabletop exercise on 27 August 1997 simulating the operational procedures on the Day one of an earthquake and associated tsunami impacting the City of Suva, in terms of the NDMO response;

"WALU BAY FIELD EXERCISE" - A full-scale, field exercise for the Walu Bay / Korovou industrial and commercial suburbs of the City of Suva on the morning of 28 August 1997, which included both the NDMO response arrangements and "real" incidents in the field.

A most important aspect in earthquake mitigation is to ensure the provision exists to continually upgrade and refine mitigation strategies. This can only be achieved if further studies are conducted and the most up-to-date information implemented into the existing strategies. SERMP has addressed this issue by providing a series of **RECOMMENDATIONS** based on the outputs of this pilot project. Recommendations are made in reference to many elements of the Project Components. They have been formulated through the cooperative efforts of the participating Fijian agencies and thereby constitute relevant and realistic actions for the future, that is, "the way forward".

This SERMP FINAL REPORT has been prepared as an "**INFORMATION RESOURCE**", in strict accord with the requirements specified in the Consultancy, to provide a comprehensive overview, while still including specific detail in terms of analytical results, practical maps and commentaries. It is divided into six (6) parts :

PART 1 : PROJECT CONCEPT AND CERA CONSULTANCY

PART 2 : REVIEW OF 1953 SUVA EARTHQUAKE AND TSUNAMI

PART 3 : EARTHQUAKE AND ASSOCIATED TSUNAMI RISK ASSESSMENTS

(Project Components 1 and 2)

PART 4 : OUTCOMES OF SERMP

(Project Component 3)

PART 5 : EARTHQUAKE AND TSUNAMI MITIGATION STRATEGIES

(Project Components 4, 5 and 6)

PART 6 : SUMMARY OF RECOMMENDATIONS

with BIBLIOGRAPHY and APPENDICES. Several other Reports congruent with SERMP are attached as ACCOMPANYING DOCUMENTATION, and include the IGNS/CERA Report on the earthquake hazard assessment, IGNS and MRD Reports on the microtremor survey, SERMP Sub-Regional Seminar Notes, Comments from the Fiji Institution of Engineers and the "SUVEQ 97" Exercise Briefing Notes.

The format of this FINAL REPORT has been based upon the stated Project Components of SERMP relative to the specific elements necessary for earthquake risk management. It is delineated in terms of Sections for each major contributing factor with itemised elements considered in the Sub-Sections. This provides a dual-function to all interested parties whereby the Report may be referenced, either as a whole, or with respect to particular sections / sub-sections that are of specific relevance and/or interest to singular Fijian agencies. Where required, necessary inter-agency liaison and cooperation has been identified.

Earthquakes and tsunamis are rare natural events, but when they occur, their consequences are very serious. SERMP represents a major contribution to earthquake mitigation strategies for the Republic of Fiji. The **outcomes** of SERMP have met the stated objectives. They provide a platform on which the Fiji Government can formulate mitigation measures and improve emergency management capabilities for earthquake and tsunami, in accord with the Fiji National Disaster Management Plan (January 1995). This pilot project has established a methodology which the Fiji Government can replicate for other parts of the nation, in both urban and rural areas. Many lessons were learnt. The close cooperative participation and efforts of both UNDHA-SPPO and the many Fijian agencies has been the key to the successful completion of SERMP - a benchmark to future mitigation strategies.

This project for the City of Suva can be used to demonstrate to decision-makers for Pacific Island nations within the entire South Pacific region, the steps and processes to understand the likely damage from earthquakes, and where applicable tsunamis, with the emphasis on **vulnerability to and preparedness of the community** that is considered necessary - that is, the need for and development of earthquake mitigation strategies towards sustainable development into the twenty-first century.