



# Earthquake risk modelling

PRINCIPLES AND CURRENT SITUATION



# Contents

---

Author	3
About	3
List of abbreviations	4
Foreword	4

## Earthquake basics: seismology useful knowledge

---

Magnitude and relationship between magnitude and fault	6
Types of faults	7
Seismic cycle	7
The Gutenberg-Richter law	8

## Earthquake hazard modeling

---

PSHA types of data	10
PSHA methodology	11
PSHA improvements	13
Climate change	13

## California earthquakes

---

California's geological structure	15
The San Andreas fault specificities	18
California earthquake modelling	19
Economic, financial & insurance landscape: how the risk is managed?	20
California earthquake risk in the catbond market	22

---

Conclusion	24
References	25

# Author

**Gwendoline GOUTAIN:** Insurance-Linked Securities analyst - Earthquake specialist - SCOR INVESTMENT PARTNERS

Gwendoline GOUTAIN joined SCOR Investment Partners in 2022 as an ILS analyst. Gwendoline began her career at AXA P&C in 2015 as a CAT Modeler where she was responsible for internal seismic risk modelling and operational exposure monitoring of seismic risk. In 2017, she joined AXA GIE's Group Risk Management team, where she participated in exposure monitoring and entity CAT risk analysis.

Gwendoline holds a Master's degree in Geology and Natural Hazards from the Institut de Physique du Globe de Paris and a Data Analyst certification from Lepont-Berkeley.



# About

## Financing the sustainable development of Societies, together.

SCOR Investment Partners is the asset management company of the SCOR Group, a leading global reinsurer.

With a strong culture focused on asymmetric risk, we offer investment strategies that provide diversification, recurring returns and that focus on mitigating the risk of capital loss. As a responsible asset manager, we offer institutional investors strategies that meet these objectives while actively participating in financing the sustainable development of Societies.

SCOR Investment Partners is authorised by the Autorité des Marchés Financiers (the "AMF", since 2009). We have offices in Paris, London and Zurich,

Since our founding, we have developed recognized and proven expertises in diversifying fixed income strategies: expertises from high yield to corporate loans, infrastructure and real estate debt.

We are a leading player in the Insurance-Linked Securities (ILS) market. This alternative capital market has developed over more than

two decades and provides access to diverse risk portfolios exposed to peak natural perils. Pioneers in the space, we have invested in the ILS market since 2011, where we primarily target natural catastrophe risks.

We work alongside international players to promote sustainable investment as a core concern and are involved in various initiatives. We have been a signatory of the Principles for Responsible Investment (PRI) since 2016 and are members of the working group dedicated to the circular economy. We were also a founding member of – and continue to contribute to – the Coalition for Just Transition initiated by the Institut de la Finance Durable in 2021. As a member of the coalition, we engage with companies, encouraging them to integrate social aspects of the transition into their strategies and highlight best practices within key industries.

In 2023, we joined the ILS ESG Transparency initiative with the objective to further improve ESG transparency in ILS transactions.

*SCOR Investment Partners offers institutional investors access to investment strategies developed for the SCOR Group. SCOR Investment Partners had total assets under management of EUR 19.2 billion (EUR 7.3 billion, excluding SCOR Group investments), including undrawn commitments, as of June 30, 2023.*

[www.scor-ip.com](http://www.scor-ip.com)

## LIST OF ABBREVIATIONS USED IN THIS DOCUMENT

<b>ILS</b>	Insurance-Link Securities
<b>AIR</b>	Applied Insurance Research
<b>CEA</b>	California Earthquake Authority
<b>CGS</b>	California Geological Survey
<b>ETH Zurich</b>	Eidgenössische Technische Hochschule Zürich
<b>ETS</b>	Episodic Tremor and Slip
<b>GDP</b>	Gross Domestic Product
<b>GEM</b>	Global Earthquake Model
<b>GMPE</b>	Ground Motion Prediction Equation
<b>GPS</b>	Global Positioning System
<b>IM</b>	Intensity Measure
<b>ISC</b>	International Seismological Centre
<b>LFE</b>	Low-Frequency Earthquakes
<b>NVT</b>	Non-Volcanic Tremor
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>PCS</b>	Property Claims Services
<b>PGA</b>	Peak Ground Acceleration
<b>PGV</b>	Peak Ground Velocity
<b>PML</b>	Probable Maximum Loss
<b>PSHA</b>	Probabilistic Seismic Hazard Analysis/Assessment
<b>RMS</b>	Risk Management Solutions
<b>SA</b>	Spectral Acceleration
<b>SAF</b>	San Andreas Fault
<b>SCEC</b>	Southern California Earthquake Center
<b>SSE</b>	Slow Slip Event
<b>UCERF</b>	Uniform California Earthquake Rupture Forecast
<b>USGS</b>	United States Geological Survey
<b>VLFE</b>	Very Low-Frequency Earthquakes

# Foreword

Facing rising economic and insured losses caused by natural disasters, the ILS market is increasingly focused on the tropical storm season and its recurring threats and losses. It should not be forgotten, however, that earthquake risk is also a major contributor to the worldwide natural catastrophes landscape.

This is also true in the catbond space where **earthquake accounts for 24% of the total expected loss of the market**. As such, earthquake risk is a key building block of any diversified ILS investment strategy. It is therefore critical to have a good understanding of the nature and science behind the modelling of this peril.

This paper reviews basic principles of seismology, discusses earthquake hazard modelling methodologies and, finally, takes a closer look at the earthquake risk landscape in California from a seismologic, insurance and ILS point of view.



# Conclusion

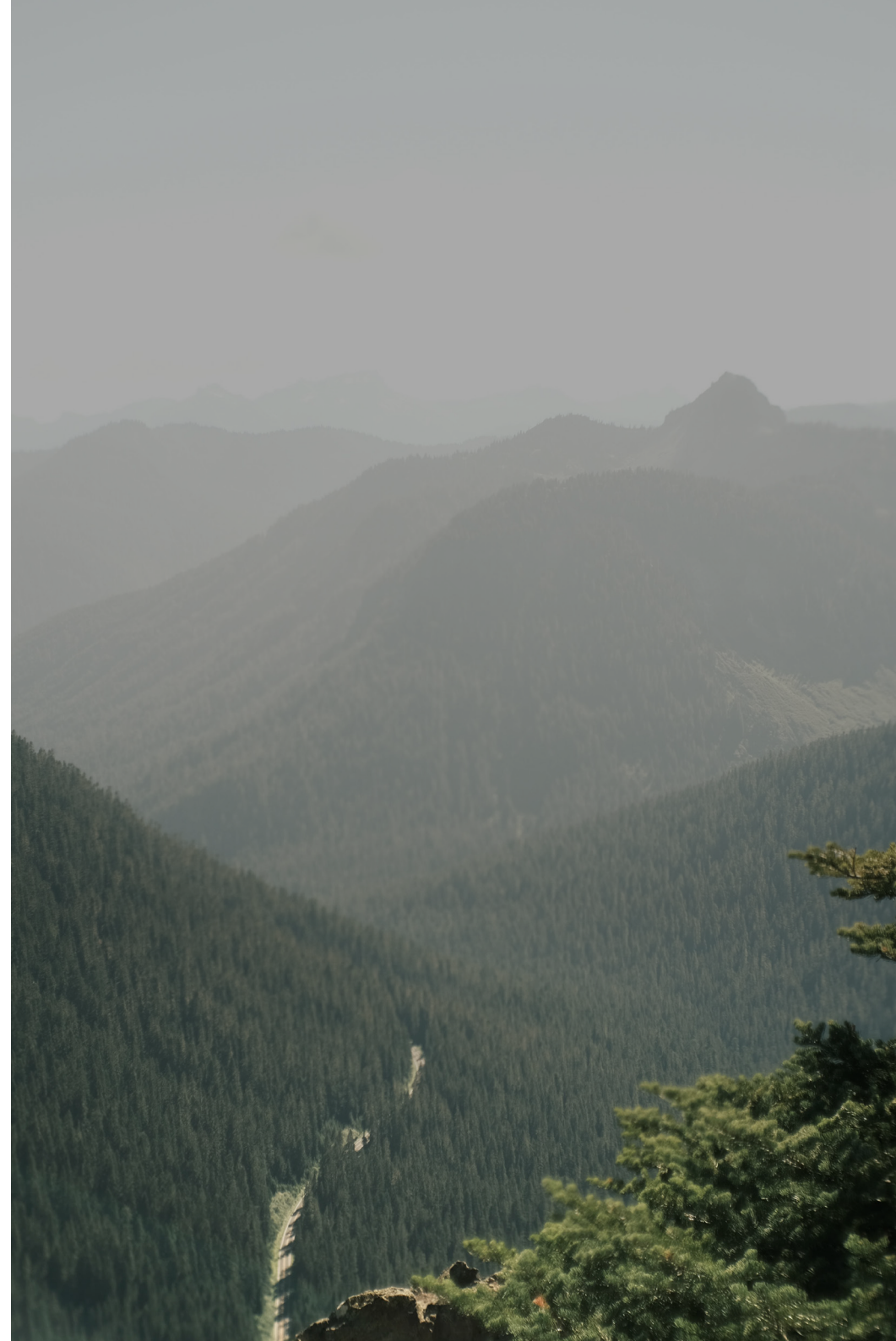
As a diversifying peril from other natural catastrophe perils without a demonstrated material impact from climate change, earthquake risk establishes itself as one of the main building blocks of an efficient and **well diversified ILS investment strategy**.

Given its nature, which is dependent on the accumulation of forces over decades if not centuries, the frequency of powerful earthquakes in a defined region is lower than the other major perils exhibiting an annual peak like strong hurricanes hitting the US coast (as an example, eight major hurricanes have made landfall in the US Gulf of Mexico coast since 2017). This fundamental difference in nature is another reason why it makes sense to combine these perils in a portfolio. It also implies that robust modelling methodologies are critical to taking a view on potential major earthquakes which have not been recorded in modern times.

The understanding of earthquake risk has made tremendous progress in the last decades, and models have witnessed strong improvements such as the integration of the time-dependency, post-seismic stress diffusion principles, and the ability to better model risk at a more local level. This allows ILS managers to measure risk in a more accurate way and to better manage risk concentrations at a detailed geographical level.

However, there will always be a latency between the evolution of scientific knowledge, the development of models, and its integration by commercially available modeling platforms (AIR/Verisk, RMS/Moody's or EQE/Corelogic). In this context, it is crucial to keep a close eye on leading-edge contributors (like, for example, the public-private GEM Foundation) who are constantly gathering new seismic data and developing open-source state-of-the-art software allowing companies, laboratories, and governments to develop their own models.

As ILS managers, such developments make it possible to continuously refine our view of earthquake risk, over and above – and with greater immediacy than – using the latest commercially available models alone. Ultimately, this contributes to making well-informed investment decisions in order to take exposure to earthquake perils in an optimal way.



# SCOR

## — INVESTMENT PARTNERS —

[www.scor-ip.com](http://www.scor-ip.com)

This document is issued by SCOR Investment Partners SE, Societas Europaea, an asset management company with a capital of EUR 15,500,000 Head office: 5, avenue Kléber 75016 Paris – France. SCOR Investment Partners SE is registered with the trade and companies register of Paris (France) under number 510 235 815 and is regulated by the "Autorité des marchés financiers" (AMF) under number GP-09000006.

This document is provided for information purposes only. The information contained herein is subject to change without notice. This document contains information, opinions, assumptions and estimates as well as figures that SCOR Investment Partners SE considers to be well-founded or accurate on the day of publication, given the economic, financial or market context at the time. SCOR Investment Partners SE does not guarantee the accuracy or completeness of such information, opinions and statistical data.

This document should not be construed as an offer, solicitation to buy or sell, or as investment advice. It is not the basis of a contract or commitment of any nature. SCOR Investment Partners SE accepts no liability, direct or indirect, that may result from the use of any information contained herein.

Information in this document is communicated in confidence and must not be copied or reproduced, modified or translated, or distributed without the prior written consent of SCOR Investment Partners SE.

This document is provided without our accurate knowledge of your risk profile and without establishing your status as a qualified investor. Investing in funds involves risks. Past performance is not a reliable indicator of future performance and performance is not constant over time.

Before making any investment decision, you should make sure that the investment vehicle is consistent with your investment goals, risk profile and your legal and regulatory constraints. You must also consider the economic and financial environment. The risks, costs and minimum recommended investment period associated with investing in the investment vehicle are described in the regulatory documentation. Prior to subscription, potential investors must review the Key investor information document (KIID), the Prospectus, the Placement Memorandum or the Regulation or any other equivalent contractual legal document, upon request, and at no cost, from SCOR Investment Partners SE - Client Services Department.