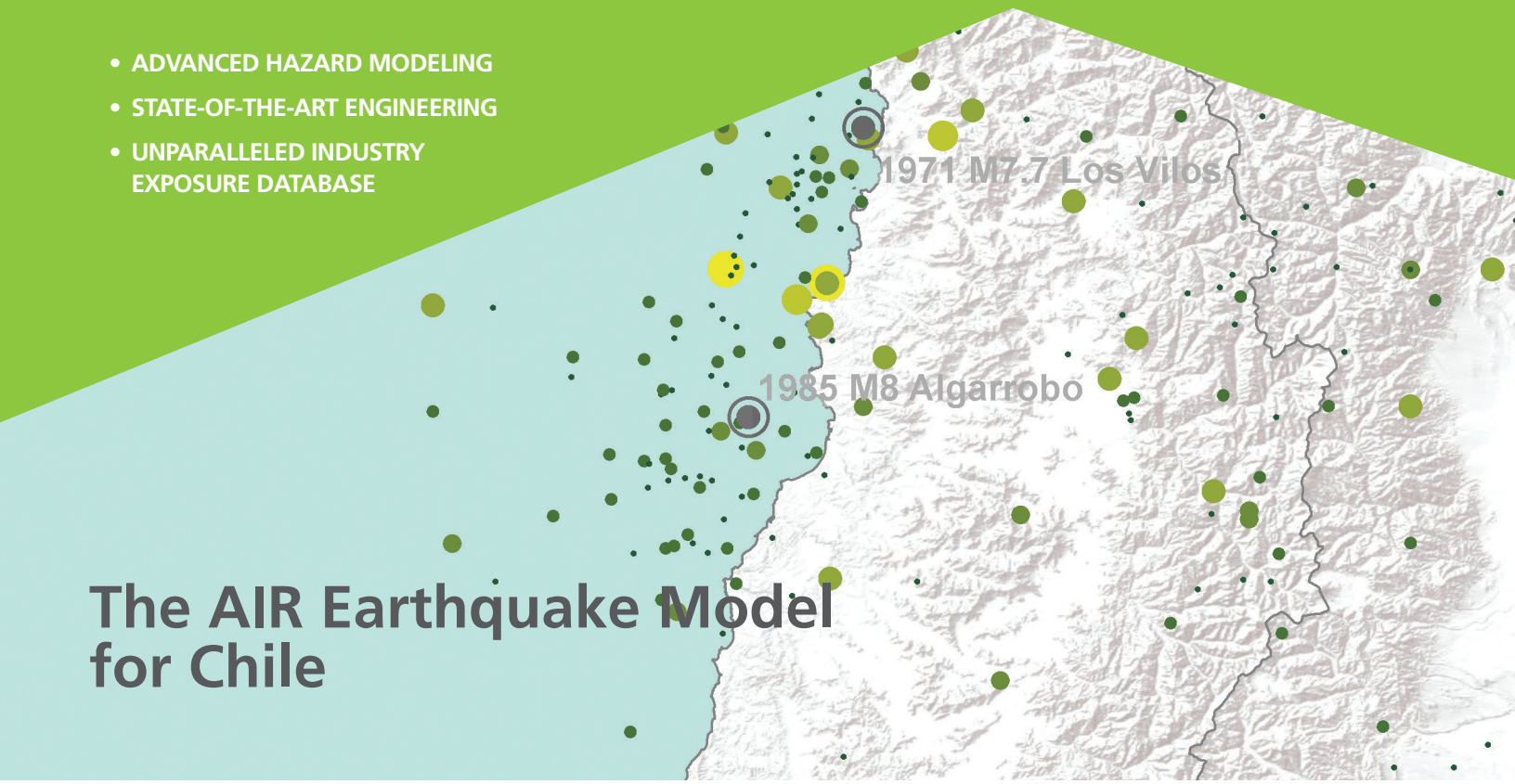
- ADVANCED HAZARD MODELING
- STATE-OF-THE-ART ENGINEERING
- UNPARALLELED INDUSTRY EXPOSURE DATABASE



The AIR Earthquake Model for Chile

ADVANCED HAZARD MODELING	THE ISSUE.	THE SOLUTION.
Comprehensive Data Set to Improve Assessment of Seismic Potential	While Chile has experienced earthquakes for many millions of years, the recorded seismic history is relatively short. Therefore, additional information is needed to improve assessment of seismic hazard.	AIR compiled detailed active fault data, which was used in conjunction with local and regional GPS data, to determine the crustal deformation rate in all of Chile's seismic source zones. This information was used to create a stochastic catalog reflecting the full range of future seismic activity.
Next Generation Ground Motion Prediction Equations (GMPEs) Capture Unique Characteristics of Earthquakes in Chile	In Chile, deep subduction zone earthquakes have resulted in higher levels of observed ground motion than GMPEs alone might predict.	The AIR model appropriately accounts for the higher levels of ground motion associated with subduction zone events by incorporating GMPEs modified to accurately reflect ground motion in Chile.
High Resolution Geological Maps Capture Potential for Soil Amplification and Liquefaction	Soil properties play a critical role in amplifying or de-amplifying seismic waves. They also play a role in liquefaction risk.	The AIR model features three sets of soil maps at varied resolution, including maps at 100-meter resolution, for 20 major cities. The liquefaction module explicitly captures liquefaction risk in these cities.
Stochastic Catalog Reflects Time-Independent and Time-Dependent Earthquake Rupture Probabilities to Provide the Most Robust View of Risk	According to time-dependent views of earthquake risk, the annual probability of an earthquake occurring on a given fault is dependent on when the last earthquake occurred on that fault and how much that fault is accumulating elastic strain (or slip deficit).	The AIR model incorporates both time-dependent and time-independent earthquake rupture probabilities—the former for seismic source zones in Chile with well-known rupture histories, and the latter for source zones where rupture histories are not well known. Through the use of time-dependent earthquake rupture probabilities, the AIR model accounts for the release of stored energy on the Nazca subduction zone by the M8.8 Maule earthquake in 2010, which has reduced seismic risk in Chile.
Probabilistic Tsunami Modeling Capability	Capturing the detailed mechanics of a tsunami from initial formation to dissipation is critical to understanding potential damage and loss.	A numerical model was developed to simulate thousands of stochastic tsunami events, from rupture through the entire inundation period. The model takes into account the effects of friction with the ocean floor on a tsunami's height and forward speed—two major determinants of its damage potential.

AIR WORLDWIDE®

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MODEL AT A GLANCE

MODELED PERILS Ground shaking, tsunami, and liquefaction

CATALOG The model incorporates a 10,000-year catalog of 324,316 simulated earthquakes, 160,562 of which cause loss to industry exposure (2014) of Chile.

HAZARD MODULE Integrates all global, regional, and local catalogs, including: ISC-GEM Global Instrumental Earthquake Catalog, GEM Global Historical Earthquake Catalog, ISC EHB Bulletin, USGS ANSS Comprehensive Catalog, Catálogo de sismicidad from the Red Sismológica Nacional de Colombia (RSNC), the South America CERESIS catalog, the Utsu Catalog of Damaging Earthquakes in the World, and the Global Centroid Moment Tensor Catalog.

VULNERABILITY MODULE Supports 115 occupancy classes and 106 construction classes; accounts for the impact of the evolution of Chile's building codes and other local factors affecting the seismic performance of buildings in Chile. In addition, Touchstone® supports occupancy classes for industrial facilities, including chemical processing, oil refineries, and mining. Occupancy classes for infrastructure such as bridges, pipelines, and tunnels are also supported. Touchstone also supports builder's risk.

HISTORICAL EVENT SET The AIR software systems include a historical event set consisting of 99 historical earthquakes, 32 of which cause loss to the industry exposure (2014) in Chile. The five earthquakes of the historical event set that cause the highest insurable losses in Chile are, in descending order: 1730 Valparaiso, M8.96; 2010 Maule, M8.8; 1906 Valparaiso, M8.57; 1960 Valdivia, M9.6; and 1647 Santiago, M8.13.

Cover image: AIR Worldwide

STATE-OF-THE-ART ENGINEERING	THE ISSUE.	THE SOLUTION.
Damage Estimation Based on Rigorous Engineering Analysis	How buildings respond to earthquakes depends on both the ground motion and the building type. Traditional approaches to damage estimation don't capture these complex interactions.	Complementing local expertise, damage estimation in the AIR model uses state-of-the-art engineering analysis, including results from detailed nonlinear dynamic analysis (NDA) computer models of buildings subjected to actual ground motion records, and findings from post-disaster field surveys.
Comprehensive Set of Damage Functions	Chile's building stock is diverse, and vulnerability varies by construction and occupancy.	The AIR model offers a robust set of damage functions for 115 occupancy classes and 106 construction classes. The supported lines of business are: residential building, residential contents, residential combined, commercial, industrial, commercial/industrial combined, and automobile.
Considers Impact of Local Construction Practices on Building Vulnerability	The seismic performance of buildings in Chile is greatly influenced by local construction practices, with damageability often affected by variations in workmanship, materials, and building code enforcement across the country and over time.	AIR engineers collaborated with local experts to better understand the regional vulnerability of various building types, enabling AIR to develop a model that takes into account these local factors and the evolution of Chile's building codes.

NO ISSUE HERE.

COMPATIBLE WITH NEW CAPITAL REQUIREMENTS

Chile's insurance market is experiencing strong growth. If Chile's Superintendencia de Valores y Seguros moves toward a risk-based capital requirement like those recently established in Peru and Colombia, the AIR Earthquake Model for Chile would allow local insurance companies to tailor their capital reserve in accordance with their portfolio's unique risk profile.

UNPARALLELED INDUSTRY EXPOSURE DATABASE

The industry exposure database (IED) for Chile is constructed at a high resolution (1 km grid), and contains the most recent risk counts and their respective replacement values, along with information about the occupancy and physical characteristics of structures such as construction type and height classification. In addition to the residential, industrial/commercial, and automobile lines of business, the IED features industrial facilities.

ABOUT AIR WORLDWIDE AIR Worldwide (AIR) provides catastrophe risk modeling solutions that make individuals, businesses, and society more resilient. AIR founded the catastrophe modeling industry in 1987, and today models the risk from natural catastrophes and terrorism globally. Insurance, reinsurance, financial, corporate, and government clients rely on AIR's advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk Analytics (Nasdaq:VRSK) business, is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.

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