AUGUST 14, 2026

ANALYTICAL ASSESSMENT OF DAMAGE CAUSED BY THE AUGUST 10, 2026 EARTHQUAKE IN COLOMBIA

Catastrophe modeling of losses to buildings and infrastructure.

Ingeniar
Risk Intelligence

ANALYTICAL ASSESSMENT OF DAMAGE CAUSED BY THE AUGUST 10, 2026 EARTHQUAKE IN COLOMBIA

Catastrophe Modeling of Losses to Buildings and Infrastructure

Gabriel Bernal[1]. Omar-Darío Cardona[2], Diana González[3], Sergio Herrera[3]

SUMMARY

The August 10, 2026 earthquake, with a moment magnitude of Mw 7.4 and a focal depth of approximately 100 km, caused significant impacts across western and central Colombia, particularly in the departments of Chocó, Valle del Cauca, Risaralda, Quindío, and Caldas. To quantitatively assess its economic impact, INGENIAR: Risk Intelligence conducted a catastrophe modeling assessment of direct physical losses to buildings and infrastructure using the CAPRA-ROBOT software.[4]

The characterization of the strong ground motion was performed through the simulation of a seismic source consistent with the available information on the event, including its magnitude, depth, focal mechanism, and the concentration of seismic moment release toward the southwestern portion of the rupture. The results reproduce the broad regional extent of the shaking and show significant ground-motion levels even in areas relatively distant from the epicenter. A particularly relevant characteristic of the event was its **prolonged duration**, exceeding 50 to 60 seconds at some locations, associated with the magnitude and extent of the rupture, source depth, wave propagation, and local site effects. This duration is an important factor in interpreting the seismic demand and the observed damage.

The modeled direct physical losses across the five departments analyzed amount to approximately **COP 30 trillion (USD 9.5 billion)**. Of this total, approximately COP 24.5 trillion corresponds to buildings and COP 5.5 trillion to infrastructure. Losses are concentrated primarily in Valle del Cauca, with approximately COP 19.5 trillion, followed by Risaralda, with approximately COP 5.4 trillion. In relative terms, Chocó shows the highest impact on buildings, with losses equivalent to 19% of the exposed value.

The total estimated loss corresponds approximately to a **40-year return period** on Colombia's Probable Maximum Loss (PML) curve. The earthquake therefore represents an event with very significant economic consequences, but not an extreme scenario within the country's seismic risk profile: less frequent events have the potential to produce considerably higher losses. The results constitute an early, model-based estimate of direct economic losses and do not replace detailed inspection, damage assessment, and claims adjustment processes.

[1] CSO INGENIAR CAD/CAE Ltda. Assistant Professor. Universidad Nacional de Colombia – Bogotá Campus.
[2] CEO INGENIAR CAD/CAE Ltda. Full Professor. Universidad Nacional de Colombia – Manizales Campus.
[3] INGENIAR CAD/CAE Ltda Specialist.
[4] https://github.com/ingeniarrisk/CAPRA-ROBOT

1 INTRODUCTION

On August 10, 2026, at 7:34 a.m. local time, a Mw 7.4 earthquake affected western Colombia, with its epicenter located near San José del Palmar, in the department of Chocó, and a focal depth of approximately 100 km. The earthquake was widely felt across the country and caused significant impacts in several cities and municipalities in western and central Colombia, particularly in the departments of Chocó, Valle del Cauca, Risaralda, Quindío, and Caldas. The observed damage includes residential, commercial, and institutional buildings, as well as various infrastructure components, making it one of the most consequential seismic events in Colombia in recent decades.

To quantitatively assess the earthquake's economic impact, INGENIAR: Risk Intelligence conducted a catastrophe modeling-based loss assessment for the five departments identified above. The analysis integrates the AIS 300 seismic hazard model (AIS 300-26 document), the building exposure model developed for E2050 (Cardona et al., 2020), the infrastructure exposure models developed for CDRI (Cardona et al., 2023), and the physical vulnerability functions of the global CDRI-GIRI model. The assessment includes direct losses to buildings and seven infrastructure sectors, providing an integrated view of the economic impact generated by the event. The entire analysis was performed using CAPRA-ROBOT, specifically the *Strong Motion Analyst* module for the characterization of seismic ground motion and *RiskOne* for risk and loss calculations.

The results presented in this report correspond to a modeled estimate of direct, *ground-up*

economic losses, intended to provide an order-of-magnitude assessment of the event's impact. They are not intended to replace the detailed inspection, damage assessment, or claims adjustment processes that will be progressively undertaken following the disaster. The objective is to provide, at an early stage, a consistent technical reference on the magnitude and spatial distribution of losses to help guide response, recovery, and reconstruction efforts, as well as to establish a baseline figure for subsequent analyses of the impact on the insurance and reinsurance sectors. In this way, the assessment provides quantitative evidence to support an understanding of the economic scale of the disaster and to inform decision-making throughout the different stages following the earthquake.

2 MODELLED STRONG GROUND MOTION

The seismic source of the event was located beneath western Colombia, near San José del Palmar, Chocó, at a depth of approximately 96 km, and released a moment magnitude of Mw 7.4. These characteristics identify the event as an intermediate-depth earthquake associated with the internal deformation of the Nazca Plate subducted beneath the South American Plate, within the Wadati–Benioff zone, rather than with the rupture of a shallow crustal fault or directly along the subduction interface. The focal mechanism published by the USGS indicates, for one of the nodal planes, a strike of 226°, a dip of 72°, and a rake of 33°, corresponding to a predominantly strike-slip mechanism. The depth of the source also implies that the rupture did not reach the surface. Preliminary finite-fault source solutions show a spatial distribution of slip at depth, with seismic moment release concentrated in the southwestern portion of the rupture. Taken together, this information, along with the event depth, appears to have significantly influenced the regional propagation of seismic energy and the spatial distribution of the strong ground motion observed.

Although more detailed information on the slip distribution and the extent and geometry of the rupture area is not available, seismic accelerations were simulated based on the available information, supplemented by assumptions derived from the observed characteristics of the event. In this context, the preliminary information published by seismologist Bertrand Delouis (GEOAZUR), obtained through inversion of the displacement field recorded at seismic stations, is particularly relevant. These results suggest a marked concentration of slip toward the southwestern portion of the rupture, in contrast to the northeastern portion, where the contribution appears to have been considerably smaller. Although this information does not constitute a complete finite-fault source model, it provides additional insight into the spatial distribution of rupture, allowing for a more consistent representation of the seismic source and, consequently, an improved simulation of the accelerations performed in this study.

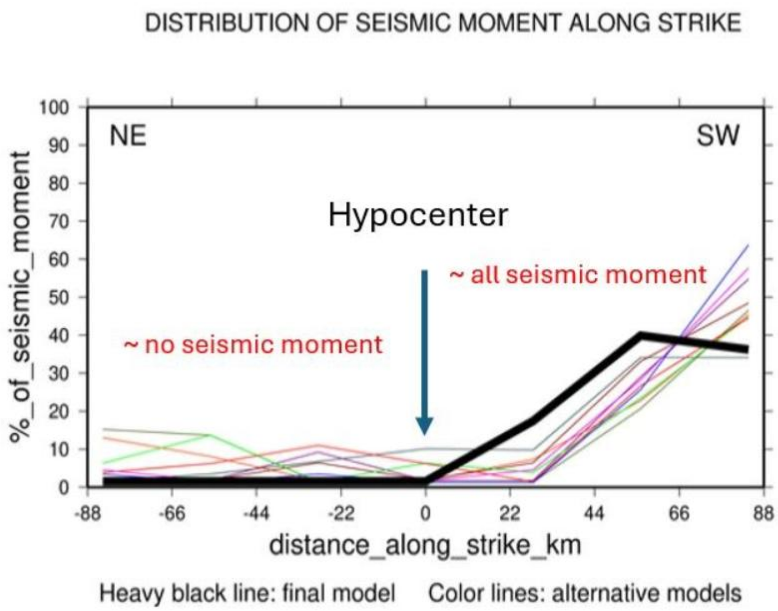

Figure 1. Preliminary result of the spatial distribution of radiated seismic moment along the rupture. Source: Bertrand Delouis[5].

Based on the available information and the elements described above, the main characteristics of the event considered in the modeling were defined. The adopted parameters, including both those derived from published information and the assumptions required to complete the characterization of the seismic source, are summarized in Table 1.

Table 1. Parameters of the modeled rupture

Parameter	**Value**	**Source**
Epicentral coordinates (Lat, Lon – WGS 84)	4.844 - 76.242	*USGS*
Magnitude (Mw)	7.4	*USGS*
Seismic moment (N-m)	1.663 E+20	*USGS*
Depht (Km)	96	*SGC*
Strike (ϕ)	226	*USGS*

[5] Link to the publication: https://lnkd.in/p/eUJePr_Y

Parameter	Value	Source
Dip (δ)	72	*USGS*
Rake (λ)	33	*USGS*
Relative hypocenter location on the fault plane Dip direction	0.5	*Authors*
Relative hypocenter location on the fault plane. Strike direction	0.5	*Authors*
Relative location of the maximum fault slip on the fault plane. Dip direction	0.5	*Authors*
Relative location of the maximum fault slip on the fault plane. Strike direction	0.75	*B. Delouis*
Aspect ratio of the rupture plane	6	*Authors*
Rupture area (Km^2)	2,400	*Authors*
Fault plane size along the strike direction (Km)	120	*Authors*
Fault plane size along the dip direction (Km)	20	*Authors*
Rupture propagation velocity (Km/s)	2.8	*Authors*

Figure 2 presents the simulated distribution of slip within the rupture plane. This distribution is generated randomly, with the concentration of asperities oriented according to the available preliminary observations; therefore, it does not represent a fully developed finite-fault source model. Nevertheless, the resulting distribution is consistent with the available observations and is therefore considered a reasonable approximation for the purposes of the modeling performed.

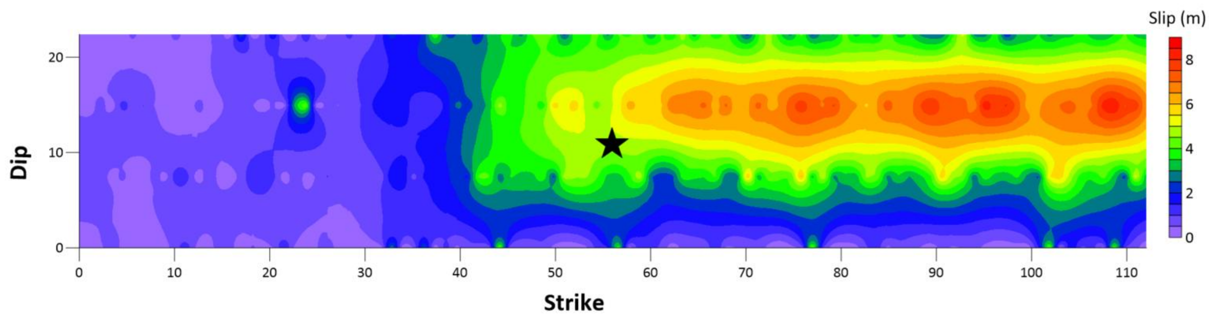

Figure 2. Source model used in the simulation

Figure 3 shows the simulated slip distribution, projected in plan view within the regional context. A clear concentration of slip, and therefore of seismic moment release, can be observed toward the southwestern portion of the rupture, consistent with the preliminary results reported for the event.

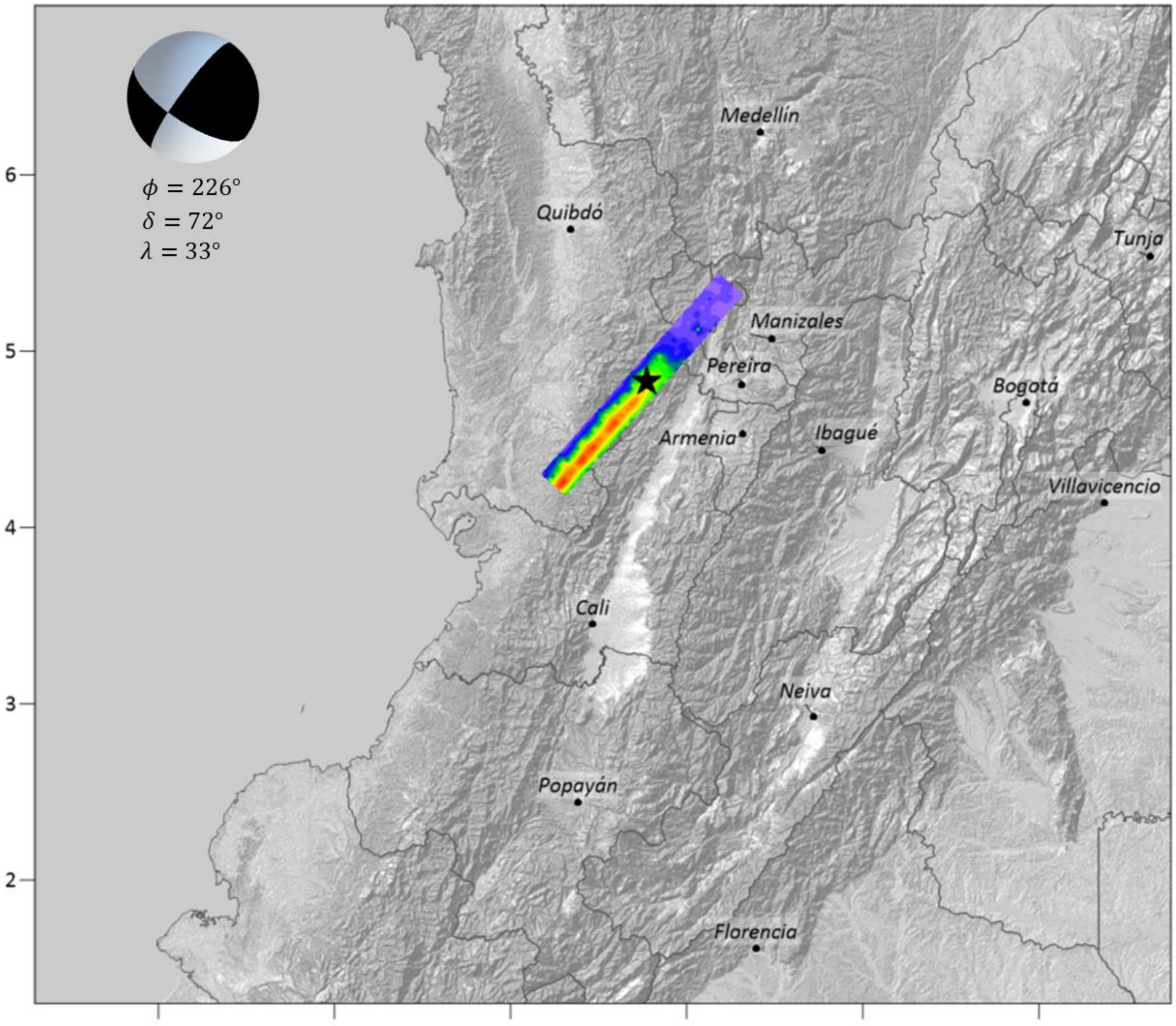

Figure 3. Source model within the regional context of the simulation

Based on this rupture model, surface strong ground-motion accelerations were simulated to characterize the regional distribution of seismic ground motion. The results show significant intensity levels even in areas relatively distant from the epicenter, particularly in sectors located along the Cauca River Valley and the southern coast of Chocó. This behavior suggests that local site conditions, associated with the presence of soil deposits, may have played a particularly relevant role in amplifying the seismic ground motion and, therefore, in explaining the intensity levels recorded in these regions.

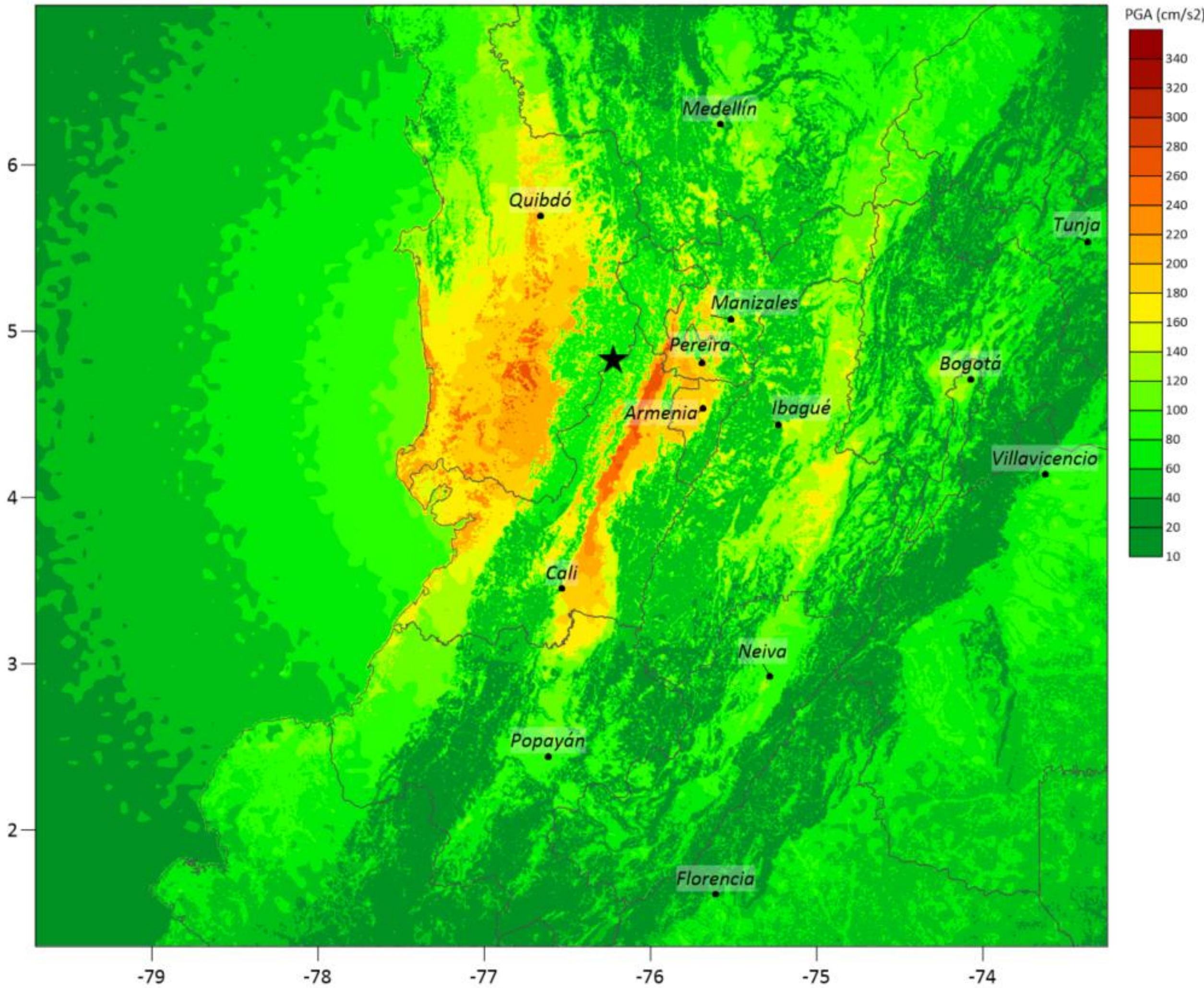

Figure 4. Simulated map of peak ground acceleration

Based on the simulated rupture, ground-motion time histories at firm-rock level are obtained that are consistent with the intensity levels and durations reported and perceived during the earthquake. In this event, the duration of the strong ground motion is a particularly relevant factor for interpreting the observed damage. An earthquake of this magnitude, with a rupture area exceeding 2,000 km^2, may require on the order of 40 seconds to complete the rupture process and release most of the seismic moment, generating ground motion of considerable duration at the source. This is compounded by the propagation of seismic waves through the crust and upper mantle, which is particularly relevant given the event depth of nearly 100 km and contributes to extending the duration of the motion recorded at the surface.

Additionally, local soil conditions, which, as mentioned above, appear to have played a particularly important role during this event, may further increase the duration of the ground motion due to amplification, scattering, and modification of its frequency content. The combination of these effects can explain recorded durations exceeding 50 or 60 seconds at some locations. From the perspective of structural response, this aspect is fundamental: a given level of intensity acting for a few seconds does not represent the same demand as a motion of similar intensity sustained for nearly one minute. Longer duration implies a greater number of response cycles and greater accumulation of inelastic deformations and damage, particularly in structures that enter the nonlinear range. For this reason, the exceptionally long duration of the ground motion may help explain a significant portion of the observed damage to buildings, at least from the perspective of the seismic demand to which they were subjected.

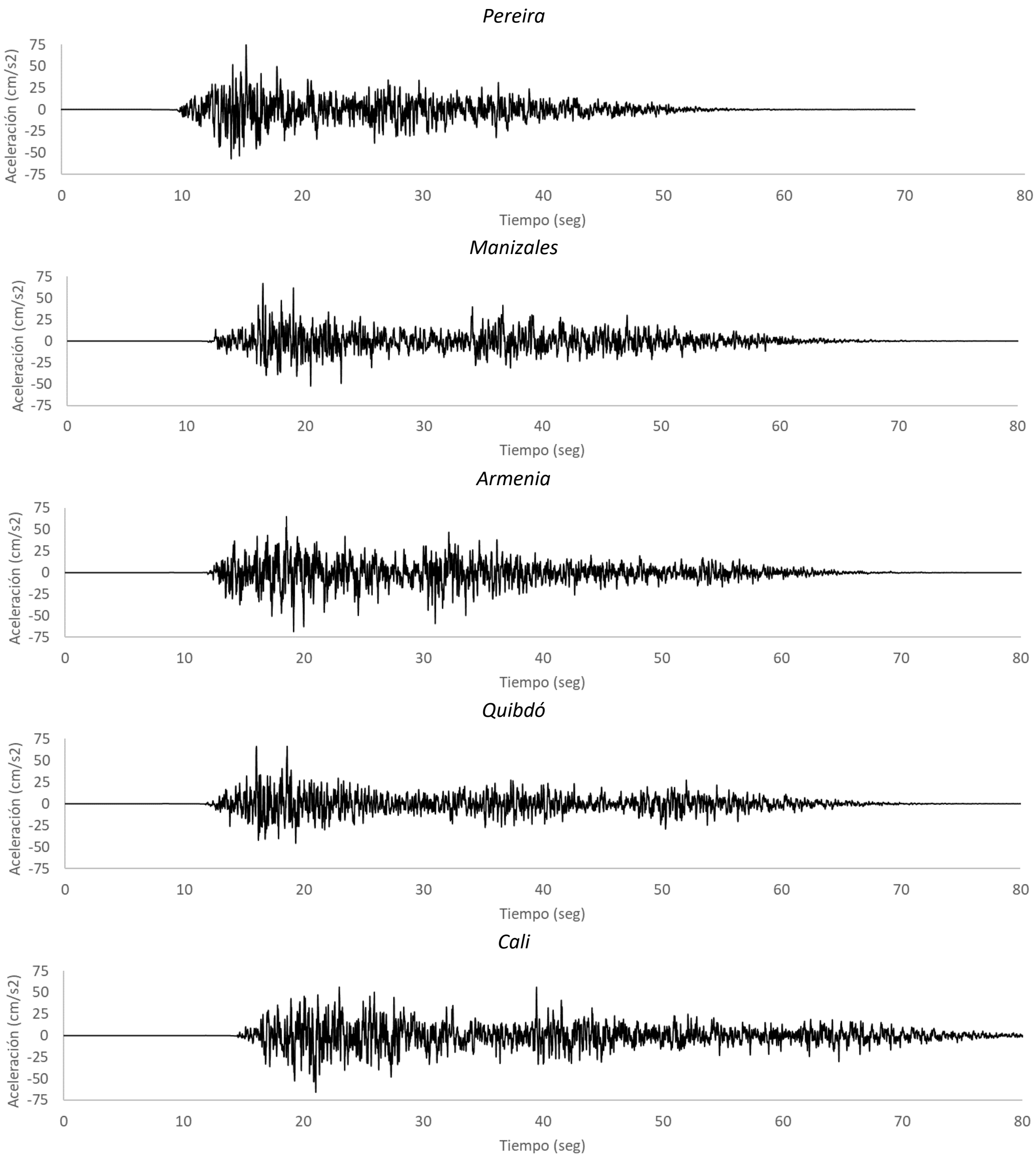

Figure 5. Simulated ground-motion time histories at the firm-rock level in selected affected capital cities

3 EXPOSURE AND VULNERABILITY

To model exposure, two consistent nationwide models were used. The first corresponds to the model developed by INGENIAR for E2050[6], an exposure model of buildings at the cartographic block level covering the entire national territory. Although it was originally designed for climate risk assessments, in this case it was adapted for earthquake loss modeling while maintaining a spatial resolution appropriate for the objectives of the analysis. This model represents the distribution and characterization of residential buildings only.

The second corresponds to the exposure model developed by INGENIAR and UNEP-GRID as part of the CDRI GIRI model[7], which represents the distribution and characterization of elements associated with transportation infrastructure (airports, ports, roads, and railways), public utilities (water treatment plants, water supply and sewerage systems, electricity generation and distribution), and oil and gas production. The total exposed value corresponding to the buildings and infrastructure considered in these models for Colombia is estimated at approximately COP 2,942 trillion. For the five departments considered in this study, the total exposed value amounts to approximately COP 453 trillion, of which approximately 72% corresponds to buildings and 28% to infrastructure.

The E2050 building exposure model consists of a vector model at the cartographic block level, comprising more than 429,486 individual elements distributed across urban and rural areas and covering the entire Colombian territory. Figure 6 presents the geographic distribution of this exposure model. This level of spatial resolution is considered sufficient for the purposes of the assessment presented herein. The exposure model also considers more than 110 combinations of occupancy, structural system, height, and seismic code level used in construction, from which the different building typologies were defined.

The GIRI-CDRI infrastructure exposure model, in turn, represents the exact location of each element or, in the case of linear components such as roads, of each segment considered in the modeling. Based on the characteristics of the exposed elements, more than 50 infrastructure archetypes were also defined for vulnerability modeling.

Physical vulnerability is quantified through vulnerability functions. More than 35 functions were used for buildings, while more than 50 were used for infrastructure, corresponding to the different archetypes considered. Each function establishes a relationship between the hazard level (in this case, ground acceleration at each location) and the expected damage level. In this way, vulnerability is represented through a continuous and quantitative approach that also allows its probabilistic nature to be incorporated.

[6] Colombia's E2050 Long-Term Climate Strategy. Ministry of Environment and Sustainable Development. 2018.
[7] https://giri.unepgrid.ch/sites/default/files/2023-11/2.5-INGENIAR-CDRI-Background-Report-GIRI-Index.

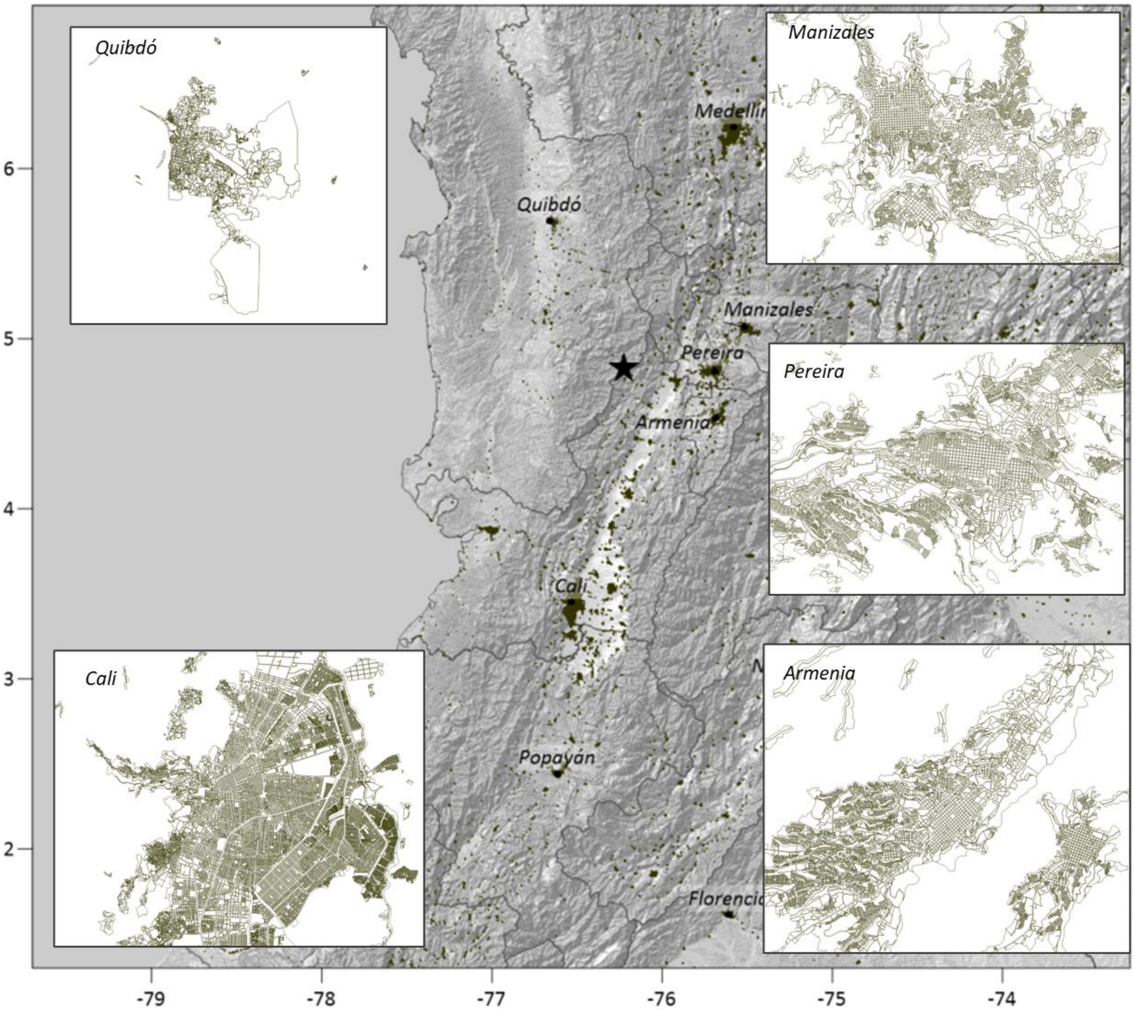

Figure 6. Geographic distribution map of the E2050-adapted building exposure model.

4 MODELLED LOSSES

Based on the modeling performed, the direct physical losses caused by the August 10, 2026 earthquake in Colombia, particularly in the departments of Chocó, Valle del Cauca, Quindío, Risaralda, and Caldas, are estimated at approximately **COP 30 trillion (USD 9.5 billion)**, considering buildings and infrastructure jointly. This level of losses corresponds approximately to a 40-year return period on the Probable Maximum Loss (PML) curve assessed for Colombia, according to the country's risk profile (Cardona et al., 2023).

For the building portfolio, considering only the five departments analyzed, losses are estimated at approximately **COP 24.5 trillion (USD 7.7 billion)**, equivalent to 7.6% of the total exposed value. For the infrastructure portfolio, losses are estimated at approximately **COP 5.5 trillion (USD 1.7 billion)**, corresponding to approximately 4.3% of the total exposed value in the five departments considered.

At the departmental level, losses to buildings and infrastructure are distributed as shown in Table 2.

Table 2. Total losses by department

Department	Buildings		Infrastructure	
	Loss (COP trillions)	*Relative to exposed value*	*Loss (COP trillions)*	*Relative to exposed value*
Caldas	1.65	3.9%	0.61	2.7%
Chocó	0.70	19.0%	0.26	5.6%
Quindío	1.84	7.5%	0.36	5.1%
Risaralda	4.63	9.4%	0.80	5.5%
Valle del Cauca	16.00	7.8%	3.52	4.4%

The distribution of losses by department shows significant differences both in absolute terms and relative to the exposed value. For buildings, the highest losses are estimated in Valle del Cauca, at COP 16 trillion, followed by Risaralda (COP 4.63 trillion), Quindío (COP 1.84 trillion), Caldas (COP 1.65 trillion), and Chocó (COP 0.70 trillion). However, when losses are expressed as a proportion of the exposed value, the distribution changes significantly: Chocó reaches the highest relative loss, at 19%, followed by Risaralda (9.4%), Valle del Cauca (7.8%), Quindío (7.5%), and Caldas (3.9%). This highlights the differences between the concentration of exposed value and the estimated relative impact in each department.

For infrastructure, a similar pattern is observed, although with lower relative loss levels than those estimated for buildings. Valle del Cauca again concentrates the highest absolute loss, at COP 3.52 trillion, followed by Risaralda (COP 0.80 trillion), Caldas (COP 0.61 trillion), Quindío (COP 0.36 trillion), and Chocó (COP 0.26 trillion). Relative to the exposed infrastructure value, the results are more homogeneous across departments: Chocó shows the highest percentage, at 5.6%, followed closely by Risaralda (5.5%) and Quindío (5.1%), while Valle del Cauca reaches 4.4% and Caldas 2.7%. Overall, these results make it possible to distinguish between the departments that concentrate the highest monetary losses and those where the impact represents a larger proportion of the exposed value.

For the infrastructure sectors considered, total losses are presented in Table 3, disaggregated by sector.

Table 3. Infrastructure losses by sector

Sector	Loss (COP trillions)
Ports and airports	663,379
Oil and gas	811
Power	2,341,542
Roads and railways	1,816,031
Water and sanitation	716,748
Telecommunications	7,414

The sectoral distribution of infrastructure losses shows that the largest economic impacts are concentrated in the power and roads and railways sectors, with estimated losses of approximately COP 2.34 trillion and COP 1.82 trillion, respectively. These are followed by the water and sanitation sector, with approximately COP 717 billion, and ports and airports, with approximately COP 663 billion. Estimated losses in telecommunications are considerably lower, on the order of COP 7.4 billion, while losses in the oil and gas sector are estimated at approximately COP 811 million. Overall, the results show that most of the modeled infrastructure losses are concentrated in power and land transportation systems.

Figure 7 presents the spatial distribution at the municipal level of the estimated total losses, considering buildings and infrastructure jointly, for the five departments analyzed, expressed both relative to the exposed value and in absolute economic terms. The relative loss map identifies areas where the impact represents a larger proportion of the total exposed value, with levels exceeding 20% observed in some municipalities in Chocó, Risaralda, and Valle del Cauca. In contrast, the absolute loss map shows a greater concentration of economic losses in areas of Valle del Cauca and Risaralda, particularly in Cali and Pereira.

Loss relative to exposed value (%) *Estimated total loss (COP millions)*

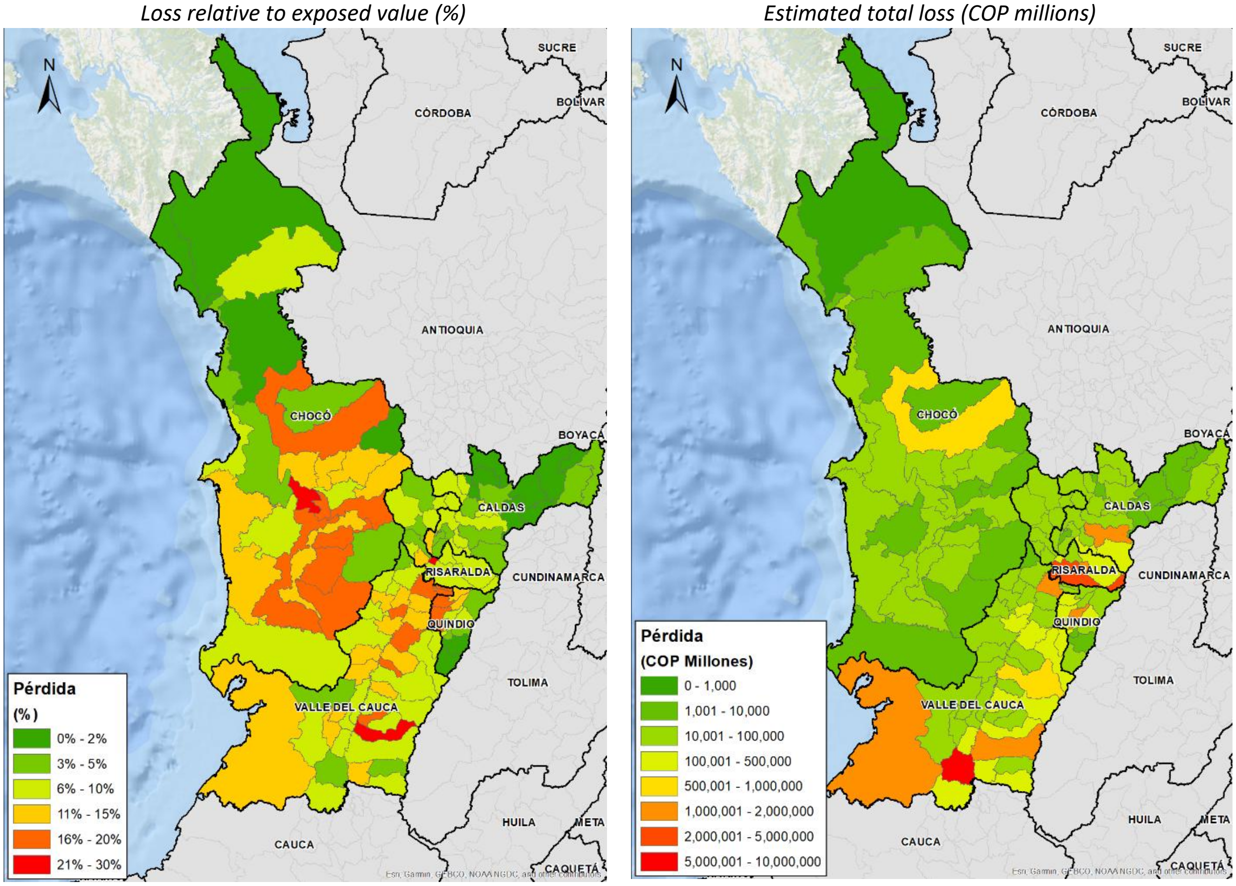

Figure 7. Municipal maps of estimated relative (left) and absolute (right) losses

Figure 8 presents the spatial distribution of the estimated losses in the road network of the five departments analyzed, expressed in millions of pesos per kilometer of road. The results show impacts distributed across a large portion of the network, with the highest loss levels concentrated along several corridors in Valle del Cauca, Risaralda, and Caldas, where segments with values exceeding COP 300 million per kilometer are identified. In Valle del Cauca, an extensive impact on the road network is also observed, particularly along the central corridor of the department, while in Chocó, losses are concentrated along a smaller number of corridors. The segment-level representation makes it possible to spatially identify the sections of the network where the highest modeled losses are concentrated and, therefore, to visualize in greater detail the territorial distribution of the impact on road infrastructure.

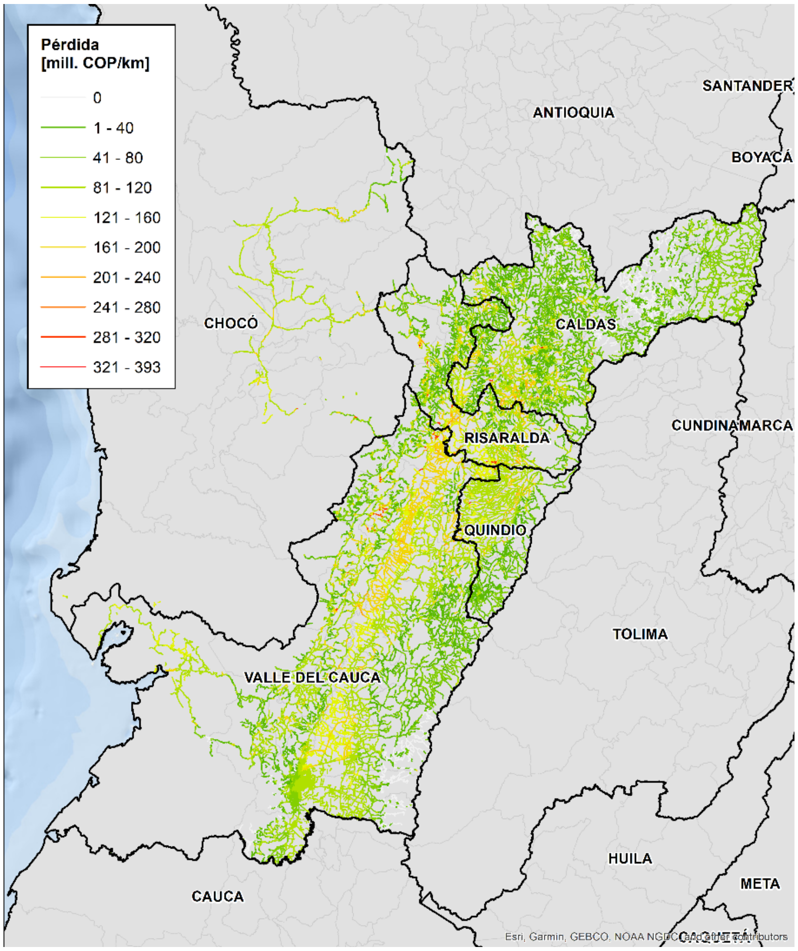

Figure 8. Map of estimated losses in road segments

Finally, the total estimated loss for the event was compared with the most recent seismic risk profile available for Colombia, published by CDRI[8] and calculated by INGENIAR (Cardona et al., 2023), considering buildings and infrastructure jointly. The Probable Maximum Loss (PML) curve is presented in Figure 9. According to this risk profile, the estimated loss for the August 10, 2026 earthquake corresponds approximately to a 40-year return period. This means that a loss level of this magnitude has an approximately 20% probability of exceedance over a 10-year period and a 70% probability of exceedance over a 50-year period, for example. The complete exceedance probability curve for a 40-year return period loss is presented in Figure 9.

[8] https://giri.unepgrid.ch/facts-figures/earthquake

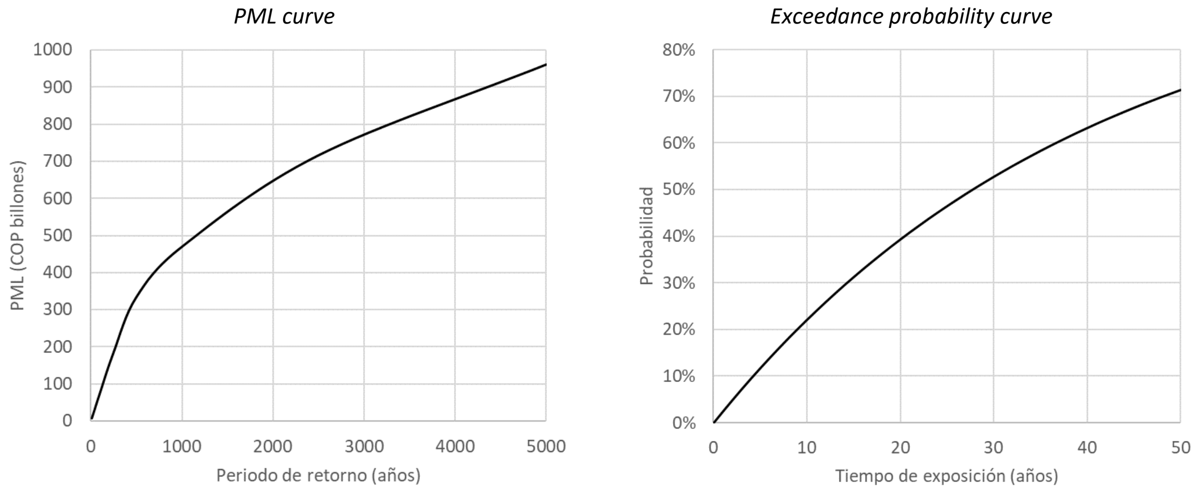

Figure 9 Left: Earthquake PML curve for Colombia. Right: Exceedance probability curve for a PML with a 40-year return period.

These results provide perspective on the magnitude of the event within the country's seismic risk profile. Although the August 10, 2026 earthquake produced very significant economic and social consequences, it is far from representing the most catastrophic event that Colombia could face. Earthquakes may occur in the national territory that, due to their particular characteristics in terms of magnitude, depth, and location, could generate losses considerably greater than those estimated for this event. In this regard, although the losses associated with this event constitute a significant manifestation of the existing seismic risk, they do not represent the upper bound of the socioeconomic consequences that could result from future earthquakes in the country.

5 CONCLUSIONS

The loss assessments presented herein constitute a first technically consistent approximation for understanding the magnitude of the disaster resulting from the earthquake, supporting subsequent investigations, and guiding rehabilitation, reconstruction, and risk reduction processes. The following are some general conclusions derived from this study:

1. An earthquake with broad regional reach and exceptionally long duration. The August 10, 2026 earthquake, with a magnitude of Mw 7.4 and a depth of approximately 100 km, generated significant levels of seismic ground motion over an extensive region of western and central Colombia. Its intermediate depth favored the propagation of seismic energy over large distances, while the magnitude and extent of the rupture produced long-duration ground motions, exceeding 50 or 60 seconds at some locations. Local soil conditions appear to have further contributed to amplifying and prolonging the ground motion in some regions, resulting in particularly demanding seismic loading conditions for structures.

2. The duration of the ground motion is a key factor in interpreting the observed damage. Beyond the peak acceleration values reached, the duration of the strong ground motion means that structures were subjected to a large number of seismic loading cycles. For buildings that reached an inelastic range of behavior, this condition promotes the progressive accumulation of deformations and damage.

Consequently, the severity of the observed effects should not be interpreted solely based on peak intensity levels but also considering the exceptionally long duration of the seismic demand.

3. Direct economic losses reach a considerable magnitude. The modeling performed estimates direct physical losses of approximately **COP 30 trillion (USD 9.5 billion)** to buildings and infrastructure across the five departments analyzed. Of this total, approximately COP 24.5 trillion corresponds to buildings and COP 5.5 trillion to infrastructure, equivalent to 7.6% and 4.3%, respectively, of the exposed value of each portfolio within the assessed area. These results demonstrate the economic magnitude of the disaster and the importance of jointly considering losses to buildings and to the different infrastructure systems.

4. Valle del Cauca accounts for the largest share of economic losses. The results show a marked concentration of absolute losses in Valle del Cauca, with approximately COP 16 trillion in buildings and COP 3.5 trillion in infrastructure, for a total of approximately COP 19.5 trillion. Risaralda follows, with estimated losses of approximately COP 5.4 trillion. This distribution reflects the combination of the levels of seismic ground motion reached and the concentration of exposed value across the different departments analyzed.

5. Chocó presents the highest relative impact on buildings. Although absolute economic losses in Chocó are lower than those estimated for Valle del Cauca, Risaralda, Quindío, and Caldas, their relative impact is particularly significant. Losses to buildings reach approximately 19% of the exposed value, considerably above the other departments analyzed. For infrastructure, the highest relative losses are observed in Chocó (5.6%), Risaralda (5.5%), and Quindío (5.1%). These results show that the absolute magnitude of losses does not necessarily reflect the relative severity of the impact on each territory.

6. The event represents a significant loss but is far from constituting the worst-case seismic scenario for Colombia. The total estimated loss corresponds approximately to a 40-year return period on the Probable Maximum Loss (PML) curve assessed for Colombia. This provides perspective on the event within the national seismic risk profile: it was an earthquake with very significant economic consequences but clearly does not represent the worst event that could impact the country. Colombia's risk profile includes less frequent and potentially much more severe seismic scenarios capable of generating losses considerably greater than those estimated for this earthquake. In this regard, the event also provides a concrete reference for the high level of seismic exposure and vulnerability existing in the country, even in the face of events that are not at the extreme end of its loss distribution.

MODELLING SOFTWARE

The simulations conducted in this study were performed using the *SMA – Strong Motion Analyst* and *RiskOne* software, which are part of the CAPRA ROBOT catastrophe risk modeling platform, and are freely available for download at the following link: https://github.com/ingeniarrisk/CAPRA-ROBOT

REFERENCES

Bernal, G. A. *Strong Motion Analyst (SMA): Computer Program for Processing and Analysis of Seismic Strong-Motion Data*. CAPRA-ROBOT Software Suite. INGENIAR CAD/CAE Ltd.

Bernal, G. A. *RiskOne: High-Performance Computational Engine for Probabilistic Catastrophe Risk Assessment*. CAPRA-ROBOT Software Suite. INGENIAR CAD/CAE Ltd.

Cardona, O. D., Bernal, G. A., Villegas, C. P., Molina, J. F., Herrera, S. A., Marulanda, M. C., Rincón, D. F., Grajales, S., Marulanda, P. M., Gonzalez, D., Maskrey, A. (2023). *Multi-hazard Disaster Risk Model of Infrastructure and Buildings at the Global Level*. Background Report, INGENIAR: Risk Intelligence for the CDRI Flagship Report.

Cardona, O. D., Bernal, G., Pabón, J. D., Escovar, M.A., Rincón, D., Marulanda, M. C., González, D., Villegas, C., Grajales, S., Marulanda, P., Molina, J. F. (2020). *Evaluación del riesgo de línea base. Estudio de Riesgo por Efectos del Cambio Climático y Medidas de Adaptación para la Estrategia a Largo Plazo E2050 de Colombia – Fase 1*. INGENIAR CAD/CAE Ltd.

Comité AIS 300. *Documento AIS 300-26: Modelo de Amenaza Sísmica de Colombia*. Asociación Colombiana de Ingeniería Sísmica – AIS.

Ingeniar Risk Intelligence

www.ingeniar-risk.com