# Review of valuations of volcanic risk. How they apply to the La Palma event

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### Introduction

Coverage of volcanic eruptions by Spain's *Consorcio de Compensación de Seguros (CCS)* dates back to issue of the Spanish Law on recasting the Property and Accident Insurance Catastrophe Compensation Funds into a single "Insurance Compensation Fund" also covering Livestock, Forestry, and Agricultural Insurance [*Ley de 16 de diciembre de 1954 sobre refundición de los Consorcios de Compensación de Riesgos Catastróficos sobre las Cosas y de Accidentes Individuales en un solo "Consorcio de Compensación de Seguros" e integrando en el mismo los Seguros Agrícolas, Forestales y Pecuarios*]. The order of magnitude of the exposed sum insured on the island of La Palma in 2013, 4,876 million euros for property damage and pecuniary losses, 4,464 and 412 million euros, respectively, reported in the AON Benfield study, was consistent with the exposure on the island of La Palma in 2021, 5,316 million euros for property damage and pecuniary losses based on SIR (insurers' extraordinary risk surcharge reporting system) data.

That Law provided that one of the Consorcio's functions would be to serve as a compensation fund for non-personal risk insurance lines

covering losses to insured risks produced by unusual or exceptional causes not covered by ordinary private insurance policies.

The Decree of 13 April 1956 approving the Implementing Regulations for the Law of 16 December 1954 stipulated that the 'extraordinary' risks covered would explicitly cover volcanic eruptions.

There is no record of any losses covered by CCS for this reason until the volcanic eruption on La Palma in September 2021, because the eruption at El Hierro in October 2011 took place under the ocean and did not cause any covered damage, and there is no record of any damage caused by the eruption of the Teneguía Volcano in October 1971.

Even though CCS has not had to face an event of this kind until now, in recent years a series of approximations into the cost that would arise in the event of a possible volcanic eruption event have been performed.

This study compares the three available approximations estimating the cost of damage from volcanic eruptions in Spain covered by the Fund with the projected cost of the current La Palma event based on updated data as of 11 December 2021.

### Valuations of volcanic risk

The three valuations available to the Fund were prepared by:

- Consorcio de Compensación de Seguros.
- The Spanish Geological Survey [Instituto Geológico y Minero de España (IGME)].
- AON Benfield, an external consultant engaged by CCS.

The methodology used and the results obtained by each of these valuations are briefly described below.

### Valuation performed by CCS

# "EXPANDED VALUATION OF THE ECONOMIC IMPACT OF CATASTROPHIC RISKS ON CCS", report from February 2014

The purpose of this study was to estimate the risk to CCS represented by its coverage of catastrophic events in Spain under the exceptional risk insurance scheme in terms of both expected loss rates and potential deviations to that rate and to assign a probability of occurrence.

The records on historical eruptions in the Canary Islands span 16 eruptions over the period from 1430 to 2012 (583 years) affecting La Palma, Tenerife, Lanzarote, and El Hierro.

Island	Year	Eruption	Time span
	1430/1440?	Tacande or Montaña Quemada	?
	1585	Tehuya	19 May-10 Aug
	1646	Martín or Tigalate	2 Oct-21 Dec
La Palma	1677-1678	San Antonio	17 Nov-21 Jan
	1712	El Charco	9 Oct-3 Dec
	1949	San Juan or Nambroque	24 Jun-30 Jul
	1971	Teneguía	26 Oct-18 Nov
	1492	Boca Cangrejo	?
	1704/1705	Siete Fuentes	31 Dec-4-5 Jan
		Fasnia	5-16 Jan
Tenerife		Arafo	2 Feb-27 Mar
	1706	Garachico or Montaña Negra	5 May-13 Jun
	1798	Chahorra or Narices Del Teide	9 Jun-14-15 Sep
	1909	Chinyero	18-27 Nov
	1730-36	Timanfaya	1 Sep-16 Abr
Lanzaroto		Tao or Clérigo Duarte	31-Jul
Lanzarote	1824	Nuevo Del Fuego or Chinero	29 Sep-5 Oct
		Tinguatón or Volcán Nuevo	16-24 Oct
El Hiorro	1793	Lomo Negro	?
Li fileri o	2011-2012	South of La Restinga (offshore)	10 Oct-5 Mar

Table 1. Historical record of volcanic eruptions in the Canary Islands.

Source: "GeoMEP: Loss model by geological hazards. Technical Memory." Spain's Geological Survey (IGME) and CCS - May 2014.

Reliable data on the damage caused by the various events being extremely hard to obtain, a historical simulation was run based solely on one extreme event, i.e., the Timanfaya eruption in 1730, which was assigned a return period of 500 years and an impact equal to the destruction of 50% of the insured property on the island of Lanzarote.

Accordingly, the following assumptions were taken as the basis for this assessment: (i) only one event occurs every 500 years; (ii) the event takes place on the island of Lanzarote; (iii) it destroys 50% of the insured sums exposed on the island; and (iv) the insured sums exposed on the island total 21,000 million euros.

On that basis, it follows that quantification of the risk (Risk = Exposure x Vulnerability x Probability of occurrence) was:

Return period		Exposure	Probability	Vulnerability	INSURED LOSS
	500		100%		
1	year	21,000	0%	50%	21
50	) years	21,000	10%	50%	1,050
100	0 years	21,000	20%	50%	2,100
200	0 years	21,000	40%	50%	4,200
500 years		21,000	100%	50%	10,500

In millions of Euros

Table 2. CCS valuation of volcanic eruption risk in Spain. (Lanzarote scenario).

The assessment results are set forth in the following Table, which compares the relative importance of volcanic eruptions to such other hazards as floods, storms, and earthquakes.

PMLin			
100 years	200 years		
576	1,155		
1,947	2,875		
2,100	4,200		
4,623	8,230		
Loss estimat	e by magnitude		
	327		
	3,428		
	6,167		
	66,532		
	PM 100 years 576 1,947 2,100 4,623 Loss estimat		

Million Euros

(1) Maximum magnitude expected for an inland earthquake in Spain by IGN (National Geographic Institute) hazard study.

Table 3. Probable Maximum Losses (PML) by return period. Source: "Expansion of the loss assessment of catastrophic risks for Consorcio de Compensación de Seguros" - February 2014.

### Valuation by the Spanish Geological Survey (IGME)

# «GeoMEP: ASSESSMENT MODEL FOR LOSSES DUE TO GEOLOGICAL HAZARDS», report on the Canary Islands from May 2014

This assessment of volcanic eruptions was based on the premise of lava flows. A total of 14 scenarios were considered, all on the island of Tenerife.

No reconstruction or repair ratio was used for volcanic risk, because damage was assumed to be total and the cost equal to the assessed value of the properties plus contents in each of the selected scenarios.

Study assumptions: (i) 14 scenarios on the island of Tenerife were selected, all sharing the attribute of being areas with moderate to high vulnerability; (ii) the scenarios ranged from minor to maximum expected damage; (iii) all were considered to have the same probability of occurrence (threat level), not specified, hence there was no association between the loss rate and the return periods; (iv) exposure was restricted to each of the 14 scenarios, so vulnerability was 100% of exposure.

The results of this assessment yielded insured losses of **between 0 and 5,504 million euros, depending on the area** (scenario) concerned:

Scenario	No. of plots	VC2014 x10 <sup>6</sup>	VC+30% * 10 <sup>6</sup> €	Insured loss
c526_20	12,052	6,127.60	7,965.88	5,504.43
c525_19	11,215	4,020.96	5,227.24	3,612.02
c520_17	7,501	1,395.88	1,814.65	1,253.92
c555_25	4,896	873.34	1,135.34	784.52
c829_1	838	581.74	756.26	522.58
c394_1	1,330	562.61	731.39	505.39
c395_3	665	452.90	588.77	406.84
c262_4	1,467	357.41	464.64	321.06
c930_3	294	211.10	274.43	189.63
c295_4b	769	91.93	119.51	82.58
c484_2	50	4.70	6.11	4.22
c494_2	2	0.04	0.05	0.04
c493_8	0	0	0	0
c493_7	0	0	0	0

Table 4. Insured loss by scenario concerned.

Source: "GeoMEP: Loss model by geological hazards. Technical Memory." Spain's Geological Survey (IGME) and CCS - May 2014.

#### Aon Benfield valuation

### «CONSORCIO DE COMPENSACIÓN DE SEGUROS: VALUATION OF CATASTROPHE HAZARDS», report from July 2014

This study suggested that volcanic eruptions were a hazard that had not benefited from commercial modelling and classified it as the most dangerous of all the natural perils covered by CCS in terms of the ratio of losses to the exposed sums insured.

The study used a combined experience-exposure approach.

It was based on the following total exposure to volcanic risk in Spain in 2013:

Las Palmas Province							
	Property damage		Business interruption		Personal injury		
ISLAND	Number	Insured	Number	Insured	Number	Insured	
	of risks	Capital	of risks	Capital	of risks	Capital	
Lanzarote	110,998	12,766,482,741	37,180	1,207,233,594	85,014	4,137,461,352	
Fuerteventura	110,377	15,665,499,331	46,041	1,492,981,611	65 <i>,</i> 383	3,182,059,844	
Gran Canaria	547,593	44,767,831,568	149,624	3,926,765,204	510,684	24,853,968,912	
Total Las Palmas	768,968	73,199,813,640	232,845	6,626,980,409	661,081	32,173,490,108	

Tenerife Province									
	Pro	Property damage		Business interruption		Personal injury			
ISLAND	Number	Insured	Number	Insured	Number	Insured			
	of risks	Capital	of risks	Capital	of risks	Capital			
Tenerife	636,449	60,585,941,900	187,974	5,303,907,404	560,008	27,254,469,344			
La Gomera	14,031	1,249,414,320	3,611	113,542,915	13,198	642,320,264			
La Palma	53,679	4,463,843,209	13,060	412,527,401	53,104	2,584,465,472			
El Hierro	7,613	818,367,849	2,123	81,912,724	6,850	333,375,800			
Total Tenerife	711,772	67,117,567,278	206,768	5,911,890,444	633,160	30,814,630,880			

Volcanic areas in the Iberian Peninsula								
	Property damage		Business interruption		Personal injury			
AREA	Number	Insured	Number	Insured	Number	Insured		
	of risks	Capital	of risks	Capital	of risks	Capital		
Calatrava County (Ciudad Real)	59,064	5,160,129,268	18,847	454,510,826	151,449	7,370,719,932		
La Garrotxa Area (Girona)	3,675	388,733,128	1,379	43,890,844	37,704	1,834,978,272		
Total Peninsula	62,739	5,548,862,396	20,226	498,401,670	189,153	9,205,698,204		

Table 5. Distribution of risks and sums insured across volcanic regions.

Source: "CCS: AON Benfield risk assessment." July 2014.

Accordingly, exposure to property damage and pecuniary losses (exposure of individuals was not contemplated) in Spain as a whole in 2013 came to around 160 billion euros.

Valcanicaroa	Event	Event Considered		Brobability	
Voicanic area	Number	time span	period	Flobability	
La Garrotxa	0	n.d.	n.d.	0.0105%*	
Calatrava County	1	5144	5144	0.0196%	
La Palma	13	6864	528	0.1894%	
El Hierro	7	6804	972	0.1029%	
Tenerife	45	9564	213	0.4705%	
Gran Canaria	11	6609	601	0.1664%	
Fuerteventura	0	n.d.	n.d.	0.0105%*	
Lanzarote	4	1464	366	0.2732%	
Total Canary Islands	80	9564	120	0.8365%	
Total Spain	81	9564	118	0.8469%	

External data taken from the Smithsonian Institution were used to ascertain frequency, as set out below:

\* For the volcanic areas of La Garrotxa and Fuerteventura, being no likely events documented, we apply a probability of at least one event in 9564 years (equal to the longest considered time span).

Table 6. Frequency of events – Volcanic eruptions. Source: "CCS: AON Benfield risk assessment." July 2014.

The Volcanic Explosivity Index (VEI), a scale of from 0 to 8, was used for vulnerability and yielded the following percentage values:

VEL	% of total loss				
VLI	of insured value				
0	0.0001%				
1	0.0010%				
2	0.1000%				
3	1%				
4	10%				
5	100%				
6	100%				
7	100%				
8	100%				

Table 7. Vulnerability according to the VEI. Source: "CCS: AON Benfield risk assessment." July 2014.

The average for Spain was 2 on the VEI scale:

VEI	No. of eruptions Areas			
0	2	El Hierro and Tenerife		
2	11	La Palma, El Hierro, Tenerife and Lanzarote		
3	2	Tenerife and Lanzarote		
4	1	Tenerife		
Total	16	Mean VEI: 2		

Table 8. Mean vulnerability in Spain.

Source: "CCS: AON Benfield risk assessment." July 2014.

The following table sets out the results obtained by this study for all hazards for Spain as a whole by type of damage (property damage, business interruption, and personal injury).

	Earthqual	ke	Windstor	m	Flood		Volcanic Eru	otion
Exposed capital	7,974,058,17	9,180	7,974,058,17	9,180	7,974,058,17	9,180	236,331,665	,948
Mean Standard deviation	71,910,948 731,331,085	0.00% 0.01%	70,100,815 202,736,733	0.00% 0.00%	109,627,127 427,421,490	0.00% 0.01%	46,641,583 1,103,281,317	0.02% 0.47%
Return period		% exposed capital		% exposed capital		% exposed capital		% exposed capital
5	9,275,562	0.00%	68,087,303	0.00%	128,546,281	0.00%	0	0.00%
10	53,116,824	0.00%	182,978,268	0.00%	201,617,771	0.00%	0	0.00%
20	195,002,103	0.00%	355,458,141	0.00%	303,529,695	0.00%	0	0.00%
50	641,902,426	0.01%	628,803,578	0.01%	611,107,516	0.01%	0	0.00%
95	1,252,814,881	0.02%	964,836,692	0.01%	1,125,276,152	0.01%	104,223,843	0.04%
100	1,311,869,579	0.02%	994,717,557	0.01%	1,165,757,216	0.01%	157,510,516	0.07%
200	2,496,963,507	0.03%	1,402,696,992	0.02%	2,021,088,759	0.03%	1,489,866,856	0.63%
250	3,027,385,931	0.04%	1,539,914,196	0.02%	2,357,135,103	0.03%	2,219,142,678	0.94%
475	4,810,431,174	0.06%	1,923,087,202	0.02%	3,634,794,305	0.05%	5,023,983,347	2.13%
500	5,044,117,780	0.06%	1,947,191,570	0.02%	3,703,875,893	0.05%	5,315,809,420	2.25%
950	8,188,780,197	0.10%	2,401,093,774	0.03%	5,385,111,526	0.07%	10,304,841,313	4.36%
1,000	8,650,889,186	0.11%	2,464,527,078	0.03%	5,568,124,451	0.07%	10,788,829,557	4.57%
2,000	15,054,408,779	0.19%	2,800,390,076	0.04%	7,700,777,826	0.10%	18,765,440,608	7.94%
5,000	26,373,529,198	0.33%	3,115,058,120	0.04%	13,045,597,966	0.16%	35,500,223,050	15.02%
10,000	31,429,211,562	0.39%	3,279,614,365	0.04%	16,251,282,348	0.20%	54,975,399,936	23.26%

Table 9. Distribution of Maximum Loss per Event (extraordinary risks).Source: "CCS: AON Benfield risk assessment." July 2014.

This Table describes the weight of each of the main extraordinary risks covered by CCS.

The loss data included personal injury, though as shown by the following Table, personal injuries caused by volcanoes are of limited consequence:

	Property da	mage	<b>Business interr</b>	uption	Personal in	ijury
Exposed capital 151,248,454		13,531,712,6		,647 71,551,49		,928
Mean	41,760,959	0.03%	4,876,019	0.04%	9,528	0.00%
Standard deviation	1,035,519,813	0.68%	265,425,469	1.96%	158,293	0.00%
		% exposed		% exposed		% exposed
Return period		capital		capital		capital
5	0	0.00%	0	0.00%	0	0.00%
10	0	0.00%	0	0.00%	0	0.00%
20	0	0.00%	0	0.00%	0	0.00%
50	0	0.00%	0	0.00%	0	0.00%
95	60,739,667	0.04%	6,437,475	0.05%	15,120	0.00%
100	104,806,000	0.07%	10,154,283	0.08%	26,038	0.00%
200	1,148,976,400	0.76%	117,477,033	0.87%	583,464	0.00%
250	1,741,504,485	1.15%	179,321,569	1.33%	787,607	0.00%
475	4,537,157,890	3.00%	423,671,352	3.13%	1,437,152	0.00%
500	4,705,467,422	3.11%	450,546,192	3.33%	1,481,032	0.00%
950	9,797,380,929	6.48%	908,096,409	6.71%	2,098,101	0.00%
1,000	10,161,855,089	6.72%	930,949,601	6.88%	2,181,700	0.00%
2,000	17,488,680,271	11.56%	1,629,325,680	12.04%	3,061,182	0.00%
5,000	33,776,341,355	22.33%	3,084,309,536	22.79%	4,682,875	0.01%
10,000	50,377,663,865	33.31%	5,013,978,906	37.05%	5,849,317	0.01%

Table 10. Distribution of Maximum Loss per Event (volcanic eruptions). Source: "CCS: AON Benfield risk assessment." July 2014.

## Data for the La Palma eruption in 2021

In this section are shown, separately, exposure data on the Island of La Palma, that is to say, the value of insured property damage and business interruption and, on the other hand, the currently known losses in property damage from the 2021 eruption process.

### Insured value in property damage and business interruption on the island of La Palma

CCS' risk exposure was estimated based on data from the insurers' extraordinary risk surcharge reporting system (abbreviated SIR after the Spanish, "sistema de información de recargos") as of 31 July 2021 and was put at:

- Property damage exposure in the whole Island of La Palma 2021 = 5,124 million euros.
- Business interruption exposure in the whole Island of La Palma 2021 = 192 million euros.
- Property damage plus business interruption exposure in the whole Island of La Palma = 5,124 + 192 = 5,316 million euros.

It includes all categories (residential, business, other property, and motor vehicles) but not individual life and accident cover exposures.

It shows that the order of magnitude of the exposed sum insured on the island of La Palma in 2013, 4,876 million euros for property damage and pecuniary losses, 4,464 and 412 million euros, respectively, reported in the AON Benfield study, was consistent with the exposure on the island of La Palma in 2021, 5,316 million euros for property damage and pecuniary losses based on SIR data.

### Actual loss on insured properties from the 2021 volcanic eruption in La Palma.

The expected loss for CCS from the eruption event of the last quarter of 2021 in La Palma, that at the moment of writing is showing clear signs of being near its end, after the information updated on 11 December 2021, comes to:

ІТЕМ		TOTAL INSURED CAPITAL
Residential and hospitality properties-destroyed	Property damage	136,100,000
	Business interruption	8,166,000
Damaged residential properties-non destroyed	Property damage	10,000,000
	Business interruption	2,400,000
Ousted residences, without significant damage	Property damage	-
	Business interruption	1,500,000
Automobiles		2,000,000
Other individual risks		18,850,000
TOTAL		179,016,000
In Euros		

Luios

Table 11. Projected cost of the volcanic eruption on La Palma.

Property damage and pecuniary losses from risks not affected by lava flows, or business interruption losses from individual risks are not included, therefore the total cost for CCS is expected to be higher than this figure.