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Research Article

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Forecast of Earthquakes Greater than 6 on the Richter Scale in Japan Using ROR Modeling

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ABSTRACT

Knowing in advance the occurrence of a high intensity earthquake is an event that is predictable with a certain degree of error using the Regressive Objective Regression (ROR) methodology, this allows environmental agencies in charge of people's safety to take measures to avoid further damage to life and buildings. To carry out this work, we had a database of the largest earthquakes that occurred in Japan from March 2011 to 2024, extracted from www.nippon.com. First, we modeled the year, month, day and time in which these phenomena occurred, as well as their magnitude. We could not predict the location since the database we have only shows the name of the place and we do not have the latitude and longitude where it really is. These phenomena occurred, then a short-term forecast was made until the year 2025 of the characteristics of the predicted earthquake. The models explain more than 91% of the variance with small errors, the trend for the month is negative which means that earthquakes are more likely to occur in the first months of the year, the trend for the year is to increase logically, for the day, the hour and the magnitude the trend is not significant, regressive patterns of 1,5,8.9,11,12 and 15 steps back are shown for all variables depending on the variable to be modeled.

Keywords: Forecasting, Earthquakes, Japan, ROR Regression

Introduction

In the last decade, 30 earthquakes with intensity 6 or higher on the country's scale have occurred in Japan, the last one occurred on August 8, 2024.

Since 2012, forecasting of high earthquake intensity has been carried out using mathematical modeling with good results [1], in these works a large number of variables are predicted such as the year, month, day, hour and magnitude of these phenomena, the modeling is carried out in the long term and it is reiterated that only the Civil Defense bodies are in charge of issuing alerts about the appearance of these phenomena. In other works, the earthquakes from 1990 to 2010 and the total number of deaths are modeled, in which it is said that in 2014 there would be an increase in earthquakes at a Global level and that their trend was to increase [2]. Also in 2018, a set of earthquakes at a Global Level included in the period of 2014-08-27 23.22.23 UTC until 2018-08-27 04.47.36 UTC, predicting the latitude and longitude of a total of the last 50 earthquakes, obtaining that the correlation between the real value and the forecast was 0.716 for a model, it was also observed that these phenomena had a tendency to increase in longitude, and it also depended, among other factors, on 2 steps back for a studied model [3,4].

In these works, it is concluded that earthquakes at a Global Level are a regressive event throughout the planet and what happens in one place has an impact on another, not randomly or due to chance, but rather it is a well-determined phenomenon. More recently, Oses R, et al, 2021, made a forecast until the year 2050 of the number of earthquakes of magnitude 5 or more on the Richter scale whose tendency was to increase, showing how it impacts the cycle of 22 years of the solar cycle, highlighting how the ROR methodology can be used for the prediction of cyclones and also earthquakes, as well as for viral and parasitic entities, the 11-year cycle of the sun and its impact is also presented, in these works it was possible to predict for Haiti in the year 2031

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a possible earthquake on July 14 at 9:20 minutes latitude 36.60, length 133, at a depth of 71.14 m, magnitude 6.7 on the Richter scale [5,6].

The objective of our work is to apply the ROR methodology to the earthquakes recorded in Japan with a magnitude greater than 6 on the Richter scale and predict the next events, establish if there is any trend and see which are the main statisticians of the models, with the help of regressive objective regression (ROR) [5-7].

Materials and Methods

To carry out this work, we had a database of the largest earthquakes that occurred in Japan with a magnitude greater than 6 on the Richter scale from March 2011 to 2024 extracted from www.nippon.com. First, the year, month, day and time in which these phenomena occurred, as well as their magnitude, were modeled; then a short-term forecast was made until the year 2025 of the characteristics of the earthquake. predicted.

Results and Discussion

It can be seen in Table 1 that in Japan for the data studied the magnitude of the earthquakes ranges between 5.1 and 9 on the Richter scale with mean values of 6.48 and standard deviation of 0.84, the time of occurrence ranges from 1.25 to 23.32 hours, with a standard deviation of 7.6 hours.

Table 1: Descriptive Statistics

	N	Mínimo	Máximo	Media	Desviación estándar
Dia	33	1	28	13,79	5,628
Mes	33	1	12	4,67	2,654
Año	33	2011	2024	2016,36	4,408
Hora	33	1,25	23,32	13,5452	7,62341
Magnitud	33	5,1	9,0	6,482	,8335
N válido (por lista)	33				

First, the magnitude, time, day, month and year were modeled from the past to the future, the latter is shown in Table 2. The models explain more than 91% of the variance with small errors, the trend (NoC) for the month is negative which means that it is more likely that earthquakes occur in the first months of the year, the trend for the year is to increase logically, for the day, time and magnitude the trend is non-significant, they were obtained for all variables regressive patterns of 1,5,8,9,11,12 and 15 steps back depending on the variable to be modeled.

Table 2: Results of the mathematical model by variable

Variable	Varianza explicada	Error del modelo	F de Fisher	DS	DI	NoC	Sig. F
Magnitud	99.5	0.7	374.9	5.415	5.52	0.02	0.00
Hora	91.2	6.8	34.8	6.045	3.32	0.19	0.00
Dia	99.4	5.8	34.9	26.73	23.23	-0.84	0.00
Mes	95.3	2.3	15.7	11.55	8.07	-0.87	0.00
Año	100	1.8	36634883		0.205	0.102	0.00

Red means not significant and green means significant.

Table 3 shows the model for the day variable, the NoC trend is a non-significant increase and the model depends on the day returned in 12, so we can go 12 days into the future to know the behavior of this variable.

Table 3: Coeficientes (a,b)

Modelo	Coeficientes no estandarizados		Coeficientes estandarizados	t	Sig.
	B	Error estándar	Beta		
DS	26,730	5,252	1,226	5,089	,000
DI	23,234	5,221	1,016	4,450	,000
NoC	,074	,298	,112	,249	,807
Lag12Dia	-,836	,409	-,817	-2,043	,057

a. Dependent variable: Day
b. Linear regression through the origin

Finally, a graph of the forecasts for the day variable, Figure 1.

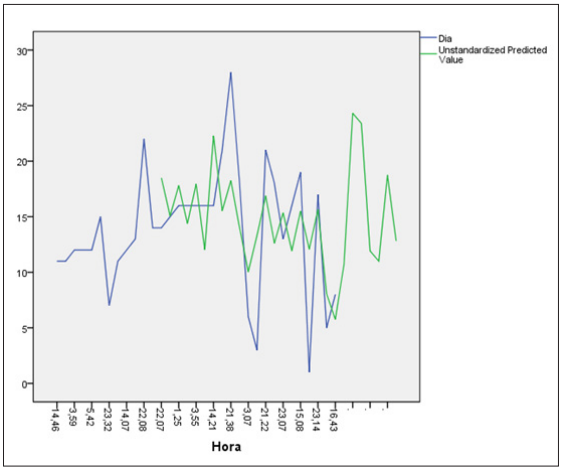

Figure 1: Forecast of the Next Earthquakes to be Recorded in Japan

The expected earthquake of 6.41 that should occur on August 11, 2026 at 4:44 p.m. However, modeling from the future to the past, interesting parameters were obtained since the predicted earthquake should occur with a magnitude of 6.69 on June 10, 2025 at 4:44 p.m.

Conclusions

1. The models explain more than 91% of the variance with small errors, the trend (NoC) for the month is negative, which means that earthquakes are more likely to occur in the first months of the year, the trend for the year is to logically increase, for the day, time and magnitude the trend is non-significant, regressive patterns of 1,5,8,9,11,12 and 15 steps back were obtained for all variables depending on the variable a. model.
2. The expected earthquake of 6.41 that should occur on August 11, 2026 at 4:44 p.m. However, modeling from the future to the past, interesting parameters were obtained since the predicted earthquake should occur with a magnitude of 6.69 on June 10, 2025 at 4:44 p.m.
3. Only civil protection agencies are responsible for giving warnings and taking preventive measures in the event of large-magnitude earthquakes.

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