

Research on Prediction and Damage Analysis of Devices of Mass Disruption Based on Optimized Gray Model Algorithm, ARIMA, and Correlation Analysis

Yueyang Liu*, Leyi Song, Chaohao Hu, Zihan Wang, Yanbing Chen

Stony Brook Institute, Anhui University, Hefei, Anhui, 230039

*Corresponding author: 15036663699@163.com

Abstract. Atomic deterrence is a significant capability for safeguarding national sovereignty and ensuring national defense. This article mainly uses Statistical Analysis, Grey correlation Analysis, Optimized Gray prediction model, ARIMA, BP neural network regression, and Spearman correlation coefficient method to study the total and changing number of devices of mass disruption, the number of devices of mass disruption in each country, and to find a balance between the number of atomic devices and destruction of the earth. Unfortunately, this paper get the result that the number of countries with atomic devices will be 15 in the next 100 years. It calls on everyone to protect the earth and the environment in which this paper live.

Keywords: Devices of Mass Disruption; Optimized Gray Model; ARIMA; Correlation Analysis.

1. Introduction

This paper have already realized the terrible power of the atomic devices. However, to rev up the arms race or protect their countries from foreign aggression, more and more countries began to research atomic devices and conduct atomic tests. The US atomic Arsenal, for example, is estimated to hold a stock of about 3,800 payloads. Of these payloads, only 1,800 were deployed, while about 2,000 were retained. In addition, about 1,750 retired payloads are waiting to be dismantled, with a total inventory of about 5,550 nuclear payloads. Of the about 1,800 payloads deployed, 400 are mounted on land-based intercontinental ballistic missiles, and about 1,000 are mounted on submarine-launched ballistic missiles. 300 bomber bases in the United States and 100 tactical bombs in Europe [1]. Russia, whose atomic Arsenal includes about 4,477 payloads. Of this, about 1,588 strategic payloads are deployed in ballistic missile and heavy bomber bases, while about 977 strategic payloads and 1,912 non-strategic payloads are in reserve [2]. At the same time, the “Big Ivan” is the product of the arms race, whose power amounts to dozens or even hundreds of “little boys”. If a large-scale conflict breaks out, the atmospheric soot produced by the explosion of devices of mass disruption can cause enormous damage to the Earth’s climate and greatly limit land and aquatic food production, which is a disaster for all living things on Earth [3]. Therefore, it is essential to build models based on the historical data of devices of mass disruption and complete the mission of safeguarding world peace.

In addition to its devastating direct effects, large-scale conflict is expected to cause global climate disturbances by injecting soot into the upper atmosphere. However, the impact of large-scale conflict on marine wild fishing fisheries remains unexplored, thus using state-of-the-art earth system models and global process-based fisheries models. They also simulated how a rapid growth in fish demand (driven by food shortages) or a decline in fishing capacity (due to infrastructure disruptions) would affect the global catch [4]. The explosion of a (hypothetical) simple atomic device (IND) produces the release of radioactive material in the form of particles and dust in the atmosphere, ultimately polluting the soil. Someone simulated IND explosions in urban areas and identified their human effects. The Excess Relative Risk (ERR) of developing solid cancer was assessed by using the Radiation Effects Research Foundation (RERF) study and hotspot codes [5].

Someone used a national representative of the American survey experiment to verify the public attitude toward civilian and military atomic technology is related to [6]. Someone using the latest

collection of data about CBW pursuit and data found that devices of mass disruption, biological implements, and chemical implements in the pursuit phase are usually complementary.

Some studies have used Monte Carlo techniques to examine the characteristics of the modern NSNW. The results of this study suggest that in recent years, low-equivalent atomic devices such as NSNWS received more attention strategically than strategic ones because of the lower plutonium demand of NSNWS than strategic devices of mass disruption [7]. A combined theory of atomic force structure has been proposed, arguing that countries seek a different set of atomic deterrent capabilities, but also face major resource and organizational constraints. Many factors may help explain the mix of atomic forces that countries ultimately have, including resource availability, experience as a atomic power, bureaucracy, the traditional threat environment, the presence of atomic rivals, and the maintenance of a atomic alliance.

The interpretation of the US military's impact on devices of mass disruption needs to be changed and modernized. Some studies have used Monte Carlo simulation to develop a new method to analyze NSNW effects. This model allows commanders to calculate the expected force strength after the NSNW attack, which will contribute to their operational decision-making capabilities. The Monte Carlo simulation method for analyzing atomic effects provides a new way to interpret variation while providing an analytically interpretable output for the commander as a descriptive statistic for the avoidance probabilities [8].

One recent way of reconstructing the historical impact of aboveground devices of mass disruption testing (ANWT) in places lacking historical data is by measuring ^{129}I in natural archives such as coral cores. However, discussions arising from ^{129}I in corals remain qualitative or semi-quantitative. Someone built a mathematical model that simulated ^{129}I bomb peaks from the Pacific Proving Ground (PPG) test. This work captures quantitative information on the size and timing of the radioactivity and the transport pathway from the ANWT site to the coral location, increasing the application and significance of the $^{129}\text{I} / ^{127}\text{I}$ coral core data [9]. This paper found that a BP neural network model based on the steepest descent method to predict the number of devices of mass disruption states in the next 100 years. Combined with the AHP analytic hierarchical process model, it predicts the countries most likely to have devices of mass disruption in the next 100 years. Then, a linear regression method was used to predict the total number of devices of mass disruption in 2,123. The killing range of devices of mass disruption is also calculated, and the positioning model of devices of mass disruption explosion is established. Finally, a model was built using cellular automata to determine the minimum number of devices of mass disruption needed to destroy the human living environment and to derive the limited range of the number of devices of mass disruption [10].

This paper mainly used the optimized grey model for the prediction. The accuracy of the grey model is first compared with the accuracy of the BP neural network, which proves that the optimized gray model is more suitable in this case and the model is more reasonable and accurate. Then this paper predict the change trend of the global devices of mass disruption total in the next 100 years and 2123 from the time series model. At the same time, this paper predict the number of devices of mass disruption in each country according to the optimized gray prediction model and finally analyze the error between the national devices of mass disruption storage prediction and the global device of mass disruption storage prediction.

2. Model

2.1. The structure of gray models

Based on the concepts of correlation space and smooth discrete function, Gray System Theory defines Gray Derivatives and Gray Differential Equations, and then uses discrete data columns to build dynamic models in the form of differential equations. Gray Model is a model in the form of a differential equation established by using discrete random numbers, which are generated into the generated numbers with significantly weakened randomness and relatively regular, to facilitate the study and description of its change process.

The system characteristic data sequence:

$$x_1^{(0)} = (x_1^{(0)}(1), x_1^{(0)}(2), \dots, x_1^{(0)}(n)), \quad (1)$$

Where $x_i^{(1)}$ is the 1-AGO sequence of $x_i^{(0)}$ ($i=1, 2, \dots, N$), and $z_1^{(1)}$ is the close mean value generating of $x_1^{(1)}$. Then, the GM (1, N) Model is set:

$$x_1^{(0)}(k) + az_1^{(1)}(k) = \sum_{i=2}^N b_i x_i^{(1)}(k), \quad (2)$$

$-a$ is called the system development coefficient, and $b_i x_i^{(1)}(k)$ is called a driving term. b_i is called driving coefficient, and $u = [a, b_2, \dots, b_N]^T$ is the parameter column. Then, this paper accumulated the original data.

This paper use the least square method to calculate \hat{u} .

$$\hat{u} = [a, b_2, \dots, b_N]^T = (B^T B)^{-1} B^T Y. \quad (3)$$

According to the condition, this paper can build the model:

$$\frac{dx_1^{(1)}}{dt} + ax_1^{(1)} = b_2 x_2^{(1)} + b_3 x_3^{(1)} + \dots + b_N x_N^{(1)}. \quad (4)$$

Then this paper can substitute $x_1^{(0)}(k) + az_1^{(1)}(k) = b_2 x_2^{(1)} + b_3 x_3^{(1)} + \dots + b_N x_N^{(1)}(k)$.

2.2. ARIMA

ARIMA stands for AutoRegressive Integrated Moving Average. It is a widely used time series forecasting method that combines autoregression, differencing, and moving average techniques to make predictions about future data points based on the patterns observed in historical data.

AutoRegressive (AR): This part of ARIMA involves using past observations to predict future values. It assumes that the future data points can be linearly dependent on their past values. The "p" parameter represents the number of lagged observations used for prediction.

Integrated (I): This component is about differencing the time series to make it stationary. Stationarity means that the statistical properties of the time series, such as the mean and variance, remain constant over time. Differencing helps to remove trends or seasonality that might be present in the data. The "d" parameter represents the number of differencing steps required to achieve stationarity.

Moving Average (MA): The MA part of ARIMA uses past forecast errors to predict future values. It assumes that the error terms in the model are correlated with the past error terms. The "q" parameter represents the number of lagged forecast errors used in the model.

When combined, the ARIMA model can capture various time series patterns and help forecast future values based on historical data. The model's selection of appropriate values for the parameters "p", "d" and "q" is often determined using statistical techniques like grid search or optimization methods to achieve the best predictive performance.

This paper use ARIMA to predict their per capita and gross GDP. Then, we use an optimized Gray Model algorithm to predict the number of implements. Also, this paper proved the accuracy of the model by using a post-difference test. This paper found that the number of devices of mass disruption will decline in the future.

2.3. Handling of variables and correlation analysis

Among them, the Gray Relation Analysis and the Spearman correlation coefficient are methods to study the relevance of those groups of variables. This paper used two methods to make a comparison of the relevance and drew an objective conclusion.

First, this paper used the Spearman correlation coefficient. The Spearman correlation coefficient is a method to study the relevance among these groups of variables. It does not require to assume the normality of the population, and good results can be obtained. Therefore, here this paper use the Spearman rank correlation coefficient to test.

The calculation formula of the Spearman correlation coefficient is as follows:

$$\begin{cases} \rho = 1 - \frac{6 \sum d_i^2}{n^3 - n} \\ d_i = x_i - y_i \end{cases} \quad (5)$$

Where n is the sample size and d_i what is the difference between the levels of the two sets of data.

Then, this paper used the Gray Relation Analysis to test. The analysis is steps of the Grey Relation Analysis are as follows: First, dimensionless processing for data (Averaging and initialization); then, solve the value of the gray correlation coefficient between the parent sequence and characteristic sequence; next, solve the value of gray correlation degree; finally, sort the gray correlation value, and come to conclusion.

The definition of the correlation coefficient is as follows:

$$\begin{cases} V_i(k) = |x_0(k) - x_i(k)| \\ \max_i(V_i(\max)) = \max_k(\max |x_0(k) - x_i(k)|) \\ \min_i(V_i(\min)) = \min_k(\min |x_0(k) - x_i(k)|) \\ \zeta_i(k) = \frac{\min_i(V_i(\min)) + \rho \max_i(V_i(\max))}{|x_0(k) - x_i(k)| + \rho \max_i(V_i(\max))} \end{cases} \quad (6)$$

Where ρ is the resolution coefficient, $x_i(k)$ is the k-th number of the ith attribute.

In summary, according to the Gray Relation Analysis and the Spearman correlation coefficient, the correlation between the number of devices of mass disruption and those relevant circumstances is good. Therefore, this paper can use the four indicators to predict the number of devices of mass disruption in the next 100 years.

3. Results

3.1. The establishment of the simulation model

According to the establishment of the above model, this paper use MATLAB for Gray Prediction, which takes the number of countries with atomic devices from 1938 to 2022 as the data. In Figure 1, this paper can see that the number of countries with atomic devices will be 15 in the next 100 years. Based on the changes in attitudes towards devices of mass disruption at different times in the Position Column of the table, the following six countries are identified: Brazil, Libya, Iraq, Iran, Serbia, and South Korea. South Africa has had devices of mass disruption before. However, based on our model analysis, some policy, and international pressure, South Africa may not have devices of mass disruption in 100 years. First, the forecast results for the number of countries with atomic devices in the next 100 years are as follows:

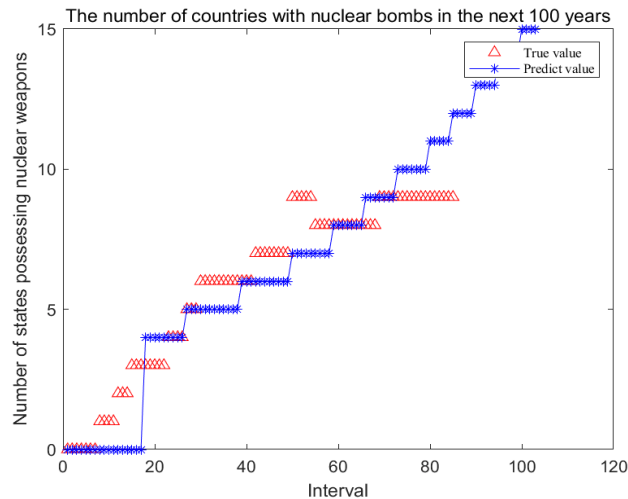


Figure 1. The number of countries with atomic devices in the next 100 years

Then, this paper use the gray prediction model GM (1, N) in 2.1 to establish a mathematical model with the total national GDP and the national per capita GDP as the influencing factors to predict the device of mass disruption state in 100 years. According to the establishment of the model, this paper use MATLAB to make a gray prediction, taking the number of countries with atomic devices, the total value of national GDP, and the per capita GDP of the country from 1960 to 2021 as the data, Projections of the number of atomic devices each country will have in the next 100 years.

Table 1. The predicted value after 100 time order

Country	posterior difference ratio	The predicted value after 100-time orders
China	0.315	467
France	0.348	550
India	0.153	569
Israel	0.213	307
North Korea	0.346	70
Pakistan	0.157	569
Russia	0.214	805
United Kingdom	0.335	198
United States	0.346	2118

In Table 1, this paper pre-process the data of the current atomic-armed countries, delete the years with 0 national storage capacity, and carry out subsequent calculations on the processed data. By adding up the number of devices of mass disruption in each country and using a time series forecast, this paper forecast the trend of the number of device of mass disruption countries in the future and the number of devices of mass disruption in the world in 2123. This paper conclude that the total number of devices of mass disruption will decrease year by year in the next 100 years, and the total number of devices of mass disruption will reach 5927 in 2123.

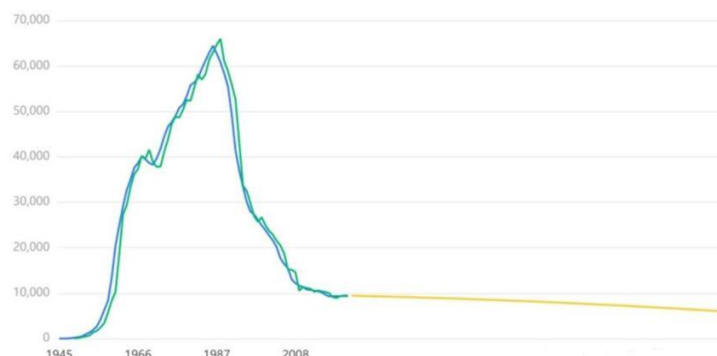


Figure 2. Trends in the global total number of devices of mass disruption

In Figure 2, this paper pre-process the data of the current atomic-armed countries. By adding up the number of devices of mass disruption in each country and using time series forecast, this paper forecast the trend of the number of device of mass disruption countries in the future and the number of devices of mass disruption in the world in 2123. This paper found that the accuracy of the predictions was calibrated for the nine countries that have already devices of mass disruption.

3.2. Analysis of experimental results

Seven countries have pursued devices of mass disruption, but the five countries that have pursued them for the longest time and have considered them for the longest time are Iran, Libya, Brazil, Serbia, and South Korea.

Since the value in the title data is zero, the prediction results of the gray model are all zero. This paper take the national GDP and per capita GDP value as the influencing factors to predict the five atomic thresholds, the national GDP, and the per capita GDP value in the next 100 years. Here is the formulation:

$$Y_{new} = y + \beta\omega\kappa \tag{7}$$

ω is related to the value of GDP per capita, as an impact factor of 1.

κ is related to GDP as an impact factor 2.

β is related to the region (and the region to the Middle Eastern countries rich in resources, more likely to build a bomb), as an impact factor of 3

GDP per capita is α_1 the country's GDP α_2 .

$$\omega = \lambda_1 \alpha_1 + b, \text{ let } \lambda_1 = 10^{-6}, b = 2 \tag{8}$$

Non-Middle Eastern countries:

$$\beta_1 = 1. \tag{9}$$

Middle East countries are distributed according to their comprehensive strength:

$$\text{Iran} : \beta_2 = 4$$

$$\text{Libya} : \beta_3 = 1.8, \tag{10}$$

$$\text{Iraq} : \beta_4 = 1.2$$

κ is divided into:

$$\kappa_1 = 20, a \in (30, 40)$$

$$\kappa_2 = 15, a \in (20, 30)$$

$$\kappa_3 = 10, a \in (10, 20)$$

$$\kappa_4 = 5, a \in (0, 10).$$

(11)

Table 2. The predicted value after 100-time orders

Country	The predicted value after 100-time orders
Brazil	38
Iran	44
Iraq	19
Libya	43
Serbia	21
South Korea	20

According to Table 2, this paper get the total number of atomic devices calculated in 2123 and the number of devices of mass disruption in each country, there is a formula:

$$f = \left| 1 - \frac{P_1}{P_2} \times 100\% \right|, \quad (12)$$

The sum of that atomic bomb count of each country in 2123 is recorded as P_1

The total number of atomic devices is P_2

$$P_1 = 5768, P_2 = 5927, \phi = 2.6\%. \quad (13)$$

4. Conclusions

First, this paper used the Gray Relation Analysis and the Spearman correlation sufficiently to study efficiently to study the relevance of those groups of variables. Then, this paper used Gray Models to predict the number of countries with atomic devices in the next 100 years. The analysis focused on factors affecting the number of devices of mass disruption in different countries, using indicators like "Devices of Mass Disruption Stockpiles" and "Devices of Mass Disruption Status." Ten countries were identified as possessing devices of mass disruption, with Russia and the United States having significantly larger stockpiles than others. A Line Chart was used to visually demonstrate the changing trends in devices of mass disruption for these countries. Overall, the study provides insights into the atomic capabilities of various nations, highlighting those with significant stockpiles. Finally, this paper got the result that the number of countries with atomic devices will be 15 in the next 100 years.

In this article, when selecting the gray model, the BP neural network, linear regression, support vector machine regression, and other models were first established. According to the evaluation results and fitting, the model was proved to be reasonable and accurate. In the establishment of a grey model, according to the specific requirements of the topic optimize the model, to make the results more accurate.

In this case, the data provided is small, and some of the data are from the network query data, so the model prediction has some errors. The grey model is only suitable for short and medium-term prediction. If the prediction time interval is longer, the accuracy of the model will decline.

When predicting device of mass disruption storage, only GDP, per capita GDP, year, some policies, and international situation are taken into account, and the influence of national scientific and technological development levels can be taken into account, to analyze the influence relationship of the number of devices of mass disruption more comprehensively. When predicting device of mass disruption storage, only GDP, per capita GDP, year, some policies, and international situation are taken into account, and the influence of national scientific and technological development levels can be taken into account, to analyze the influence relationship of the number of devices of mass disruption more comprehensively.

References

- [1] Pitsalidis, Charalampos, et al. "Biomimetic electronic devices for measuring bacterial membrane disruption." *Advanced Materials* 30.39 (2018): 1803130.
- [2] Walker, William. *Weapons of mass destruction and international order*. Routledge, 2019.
- [3] Shafer, Steven L. "Carfentanil: a weapon of mass destruction." *Canadian Journal of Anesthesia/Journal canadien d'anesthésie* 66.4 (2019): 351-355.
- [4] Albedwawi, Salim Ali Abdulla Mohamed. "Weapons of Mass Destruction (WMD) An Overview." *South Asian Journal of Social Sciences and Humanities* 3.3 (2022): 103-110.

- [5] Sidhu, Waheguru Pal Singh. "Weapons of Mass Destruction." *International Organization and Global Governance*. Routledge, 2023. 522-534.
- [6] Vahedjavan, Vahid, and Mojtaba Mirdamadi. "Evaluating the Incongruity of Prohibiting the Use of Mass Destruction Weapons in Emergencies." *Journal of Contemporary Research on Islamic Revolution* 4.12 (2022): 149-167.
- [7] Rodrik, Dani, and Stephen M. Walt. "How to build a better order: limiting great power rivalry in an anarchic world." *Foreign Aff.* 101 (2022): 142.
- [8] Gazzini, Tarcisio. "The changing rules on the use of force in international law." *The changing rules on the use of force in international law*. Manchester University Press, 2022.
- [9] Thompson, David. "Corrosive substance attacks: linking the weapon to the damage." *UWS Research Festival 2022*. 2022.
- [10] Manik, Lindung Parningotan, et al. "Indonesian scientists' behavior relative to research data governance in preventing WMD-applicable technology transfer." *Publications* 10.4 (2022): 50.