

# The Imamura vs. Omori Earthquake Forecasting Debate

**Robert J. Geller**

**Abstract:** *There was an ongoing public debate on earthquake forecasting in the early 20th century between two Japanese seismologists, Akitsune IMAMURA and Fusakichi OMORI. In 1905 Imamura pointed out in a magazine article that historically Tokyo had been hit by large earthquakes every 100 years on average. Imamura argued that as the last one was 50 years ago, assuming quasi-periodicity, another one could be expected in the next several tens of years. Imamura's thesis was reported sensationally in several newspaper articles in early 1906. Omori responded by making strong criticisms of Imamura's work in a magazine article. The debate flared up in 1912, and simmered in following years. On Sept. 1, 1923 the Great Kantō earthquake occurred, killing approximately 105,000 persons. Some people regarded the occurrence of the 1923 earthquake as proof that Imamura made a successful prediction and that Omori's criticisms were wrong. This episode has lessons for us even today.*

**Keywords:** *Great Kantō earthquake (1923), Imamura vs. Omori Debate, Earthquake Forecasting*

## Introduction

Fusakichi OMORI<sup>1</sup> (September 13,

1868–November 8, 1923) received his undergraduate degree in physics in 1890, from what is now the University of Tokyo.<sup>2</sup> In 1897 he was promoted to full Professor of Seismology in what is now the Faculty of Science at the University of Tokyo; he served in that post until his death in 1923. Omori's promotion at such a young age was occasioned by the untimely death of his predecessor, Seikei SEKIYA (January 28, 1855–January 8, 1896) at age 40. Akitsune IMAMURA (June 14, 1870–January 1, 1948) was Associate Professor<sup>3</sup> in Omori's laboratory (kōza) from 1901 until December 26, 1923, when he was promoted to full professor as Omori's successor. Under the kōza system—which was almost universally in effect in Japanese national universities until the 1980s, but now has been widely although not completely phased out—Associate Professors were subordinated to the Professor of their kōza in administrative matters, but largely free to carry out their own research.

Let us use the English language version of Wikipedia (Anonymous, n.d.) not as an authoritative source, but just as an example of what some people now think of Imamura's statements in the decades before the Great Kantō Earthquake. (Broadly similar views may also be found in Japanese, e.g., Fuji, 2016).

“[Imamura] predicted the timing and magnitude of the 1923 Great Kantō earthquake 16 years in advance.”

[snip]

“In a paper written in 1905, [Imamura] predicted that a major earthquake would hit the Kantō region around Tokyo within 50 years and kill over 100,000 people, and advocated that measures be taken. His worries materialized when the Great Kantō earthquake devastated Tokyo in 1923, claiming more than 100,000 victims.”

Let us examine in more detail what was said by Imamura, and also in what respects Imamura’s statements were criticized by Omori. The following summary is based primarily on Hagiwara (1982, p. 51–61). Note that Hagiwara, who became a professor emeritus of the University of Tokyo after his retirement in 1969, was also a former director of the Earthquake Research Institute of the University of Tokyo and had been the chair of several key government committees. Recent reportage by Ueyama (2018) contains many complete or nearly complete texts of the various newspaper and magazine articles involved in the controversy and also a bit more chronological detail than Hagiwara (1982); some details in the following are based on Ueyama’s account.

The main events in the controversy were as follows. Imamura pointed out in an article he wrote and published in the September 1905 issue of the popular magazine article “Taiyō” (太陽) that historically, Tokyo had been hit by large earthquakes every 100 years on average, and that the last one was 50 years ago. Assuming quasi-periodicity, Imamura argued that another large earthquake could be expected to strike Tokyo in the next fifty years, and advocated that Tokyo should prepare appropriately. This article did not provoke undue controversy.

In January 1906, several newspapers reported Imamura’s arguments in a more sensationalized way, which engendered some public unease. On February 24, 1906, an earthquake of about magnitude-7 occurred

under Tokyo Bay, amplifying public fears. With that as background, Omori wrote and published an article in the March 1906 issue of “Taiyō” denouncing Imamura’s work as propagating unfounded rumors (浮説). Omori pointed out that Imamura did not have a long enough time series to make a statistically significant inference of the recurrence time of earthquakes in Tokyo. However, neither Omori nor Imamura questioned the idea that earthquakes were (quasi)-periodic phenomena, and Omori also agreed that precautions against earthquakes in Tokyo were warranted.

In mid-November 1912, while Omori was attending a government ceremony in Kyoto, there was a swarm of moderate earthquakes in a belt extending from the middle of Chiba Prefecture to the offshore region. Imamura was interviewed about this by the media, and said that there was a very slight chance this swarm might represent foreshocks of a larger event, so that people should take precautions with cooking and heating fires. This should not have been controversial, but was reported by the media in a way that served to unduly amplify public anxiety. When he returned from Kyoto, Omori angrily reprimanded Imamura and told him to leave immediately and go home. After that, according to Hagiwara (1982, p. 60), Imamura only came to work on Saturday afternoons (normal working hours included all day Monday to Friday and a half day on Saturday morning) after Omori had gone home, and when he did, he just went into his office and sat at his desk.

On September 1, 1923, the Great Kantō earthquake occurred, killing about 105,000 people. At that time, Omori was attending a scientific meeting in Australia. During the course of his return to Japan by ship he became ill and even briefly lost consciousness; he was diagnosed as having a brain tumor (Ueyama, 2018, p. 156–157). Upon his return to Japan on October 4, 1923, Omori was immediately hospitalized, and he died on November 8,

1923.

## **Learnable Lessons**

### ***What is the Question?***

The occurrence of the 1923 Great Kantō Earthquake is widely taken as showing that Imamura was right and Omori was wrong (e.g., Fuji, 2016; Anonymous, n.d.). However, the issue should not be decided by treating Imamura's warning as a Nostradamus-type prophecy that proved correct or incorrect. The question should be whether Imamura's warning was based on a scientifically sound method that was objectively testable and reproducible and could be used successfully for any region, at any time. The answer to this question is a clear no. As for the "success" in 1923, there is no way to show, based on only this one instance, that this wasn't just a lucky coincidence. Also, even if one wants to argue that this was a success, the success would be forecasting that an earthquake of this magnitude in this region would occur sometime between 1906 and 1956.

### ***The Forum***

It is remarkable that Imamura and Omori, two scholars at Japan's leading university, debated each other in the popular press, rather than in a scientific forum (e.g., in the pages of a scholarly journal, in seminars, etc.). This essentially made it impossible for them to have a serious academic debate, which could have facilitated a calm and rational resolution of the debate.

### ***What Were they Arguing About?***

Although Omori had some scientific criticisms of Imamura, the actual differences in their scientific positions may have been less

pronounced than suggested by the angry tone of some of their exchanges. Perhaps Omori felt that it was necessary to dispel public unease about the possibility of an impending earthquake, or perhaps he had been requested by the government to do so.

### ***Risk Communication***

The nuances of Omori's criticisms might not have been properly understood by the media and the public, and might have inadvertently created the mistaken impression that there was no risk of a large earthquake in the Kantō region. Omori should probably have added a disclaimer such as, "Even though reliable and accurate earthquake forecasting is not presently possible, we should all remember that Japan is an earthquake-prone country and a large earthquake can occur at any time, anywhere, and without warning."

### ***The Physicist's Contribution***

One of the most famous physicists in Japan during the Taisho era was Torahiko TERADA (1878-1935) of what is now the Faculty of Science of the University of Tokyo (the same affiliation as Omori and Imamura). Terada (1916) wrote a short article for a popular science magazine on problems in seismology. Even though he didn't mention Omori nor Imamura by name, it seems inconceivable that he didn't have his colleagues in mind. Terada pointed out the extreme difficulty of making short-term earthquake predictions (days or hours in advance) because of the extreme non-linearity and lack of fine-scale knowledge of the conditions in the Earth's interior. He also pointed out that while long-term predictions (on a scale of 50 years or more) were perhaps in principle possible, there were many uncertainties and the benefit to the public was far from clear. (The author is unaware of any

evidence that either Omori or Imamura paid heed to Terada's article.)

### **The Quasi-Periodicity Assumption**

Neither Imamura nor Omori seem to have questioned the idea that earthquakes occurred (quasi)-cyclically. Even today, many researchers, perhaps most, continue to adopt this assumption. However, there is much evidence that the frequency of occurrence of past earthquakes cannot be conflated with the probability of future earthquakes (Mulargia et al., 2017). It is time for seismologists, geologists, and earthquake engineers to fundamentally rethink this issue.

### **Discussion**

One hundred years later, the lessons of the Omori-Imamura debate seem not to have been fully taken on board by either scientists or the media; similar debates occur from time to time in the present age, both in Japan and elsewhere.

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## Notes

<sup>1</sup> The names of Japanese scientists in roman letters herein are written as they themselves wrote them, with the family name last, as continues to be common practice today. To avoid any confusion, family names are written in all capitals in this paper when full names are given. When only family names are given, just the initial letter of the family name is capitalized.

<sup>2</sup> Omori's affiliation with the university began in 1887, when he enrolled as an undergraduate student. From March 2, 1886 until June 22, 1897 the official name of the university was Imperial University (帝国大学), and from the latter date until September 30, 1947 the official name was Tokyo Imperial University (東京帝国大学). On the latter date, the name was changed to the present name (東京大学 in Japanese).

<sup>3</sup> *Jokyouju* (助教授), which can also be translated as assistant professor. This position was replaced by *junkyouju* (准教授, associate professor) in April 2007.