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# Investigation and analysis of the recently discovered sabo facilities built in Tateyama Caldera 100 years ago

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## Introduction

Efforts have been made to protect people living on the Toyama Plain, Toyama Prefecture, from the potential flow of  $200 \times 10^6 \text{ m}^3$  of unstable sediment from Tateyama Caldera, which is situated over 1,000 m above sea level. Sabo works commenced over 100 years ago in the basin of the Joganji River, which is among Japan's steepest rivers, and activities continue to this day.

The value of Tateyama Sabo facilities in Tateyama Caldera further evaluated in the "Toyama Declaration" at INTERPRAEVENT 2018 in the Pacific Rim.

In this report, we introduce the results of research into the Sabo Works built by Toyama Prefecture (Hereafter "SWTP") early 1900's.

## History to date

Tateyama Caldera is a large oval basin that is approximately 30 km southeast of Toyama, Japan; it measures 6.5 km  $\times$  4.5 km, and 500–1,700m in elevation difference. During the Hietsu Earthquake of 1858 (magnitude 7.1), a massive landslide (Mount Tonbi landslide) occurred that formed landslide dams at Tateyama Caldera. Following snowmelt floods,

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these landslide dams collapsed on April 22 and June 7 of the same year, and large-scale debris flows damaged areas downstream on the Toyama Plain.

The Joganji River became a typical raised-bed river and prone to further sediment-related disasters. In response, Toyama Prefecture started sabo works in 1906, which was continued by the Japanese Government from 1926.

The construction site early 1900's was located upstream of the site of the later, and because of the severe environment (high altitude, riverbed gradient of 30 degrees or more, difficult access, slow snow melting), the time available for construction of sabo facilities was much less than now. For this reason, it was thought that the sabo facilities built at this location did not exist.

From 2007 to 2009, a survey about the SWTP during the Meiji and Taisho eras was conducted in several valleys near the location of the Mount Tonbi landslide, and revealed some of the SWTP. However, due to safety concerns regarding the rugged terrain and severe weather conditions, the scope of the field survey was limited and it was not possible to survey all of the valleys.

## **Field survey and results**

In our latest topographic analysis with laser profiler data, sabo facilities are represented as lines across rivers. The results of the analysis were compared to previously collected data, and unmanned aerial vehicles were used to review some locations. From these data, we identified the regions in which sabo facilities constructed early 1900's were likely to exist, and conducted field surveys at those locations during 2018.

Based on the 2018 field survey, 21 sabo facilities were discovered, including check dams and hillside works. These sabo facilities were built by stacking boulders 40-80 cm in diameter. Foundation of some sabo facilities had scouring, but most other facilities had no anomaly. Even today, these sabo facilities have been capturing large amount of unstable sediment flowing from upstream. The masonry styles of some of the facilities were analyzed, and compared with photographic evidence from the Meiji and Taisho era to confirm that these were the same sabo facilities.

Specifically, it was confirmed that these facilities were built by Toyama Prefecture before the start of the sabo works conducted by the Japanese Government (Fig.1). The existence of these structures is proof that sabo works by Toyama Prefecture around 100 years ago prevented the outflow of unstable sediment, enabled safe construction in the downstream area, and protected the Toyama Plain for a long time.

## **Conclusions**

In 2019, Toyama Prefecture began conducting detailed field surveys and analyses, based on surveys conducted previously (up to 2018). Our survey revealed that many SWTP still exist over 100 years in the steep mountainous upstream region of the Joganji River. The SWTP of around 100 years ago are still effective, and it is thought that they formed the

foundation of the sabo works subsequently carried out by the Japanese Government, such as the construction of the Shiraiwa sabo dam.

We intend to continue our investigation and analysis, and aim to explore further the achievement of the SWTP. Moreover, we will continue to make efforts to register for World Heritage so that the value of Tateyama Sabo will be shared throughout the world and will be handed over to the next generation as a treasure of mankind.

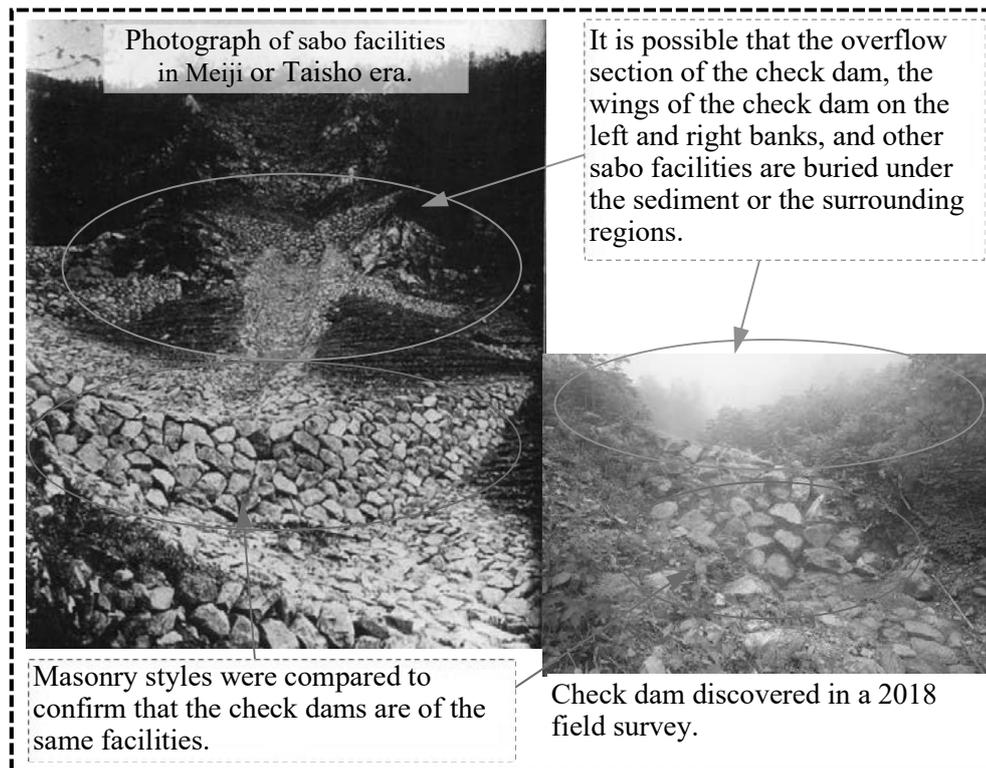


Fig. 1 An example of the 2018 survey and analysis.

## References

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