



# CURRENT DAM SAFETY SITUATION IN FINLAND

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## ABSTRACT

*The dams in Finland are getting old. Lately, a number of renovation works have been completed, are ongoing or are planned. New dams are not really built any more, apart from tailings dams and levees. Dam expertise and construction know-how is also disappearing, as the people involved are getting old.*

*No real education on dam safety issues has been available in Finland but there is still a need for the know-how. The last dam safety training course was arranged in 2005. Between 2017 and 2019, a new education project was planned and it started in September 2019. The entire course will be finished by May 2020 but it will be available over the next few years at the University of Tampere. The material includes videos, written material and exercises.*

*Education is a step towards safer dams. Previous steps have included an updated / revised Dam Safety Act in 2009 and Government Decree on Dam Safety in 2010. A dam safety information system was introduced by the Dam Safety Act and it was created between 2010 and 2013. There has since been lot of work with developing the system and now, for example, dam owners can upload new information directly into the system*

## 1. DAM SAFETY IN FINLAND

### 1.1 Dam safety legislation

The revised Dam Safety Act (494/2009) came into force in 2009 when the previous act was 25 years old. The revised Government Decree on Dam Safety (319/2010) came into force in 2010. After the new legislation came into force, the Dam Safety Guide was published in 2012 and translated into English and Swedish. The Dam Safety Guide was updated in 2018 and the updating of the translations will be carried out in 2020.

The Dam Safety Act and Decree describe, for example, how dams are classified, by the dam safety authority, in three classes according to the hazard they pose. They also describe the dam owner's responsibilities, as the owner has an overall responsibility for his dam.

The Dam Safety Guide explains and simplifies the contents of the Dam Safety Act and the Decree on Dam Safety. The Guide contains recommendations on how to meet the legal dam safety requirements and provides some general guidelines on the planning, design, construction, operation, inspection and maintenance of a dam.

### 1.2 Classified dams

The dam safety legislation covers all dams in Finland, although not all dams are classified. There are some 451 classified dams in Finland. The law applies to all dams regardless of height: watercourse dams, flood embankments, tailings dams and waste dams. All dams, including non-classified dams, have to be maintained in a safe condition.

Dams are classified by the type of hazard they pose if an accident occurs:

- Class 1 dam, which in the event of an accident causes danger to human life and health or considerable danger to the environment or to property.
- Class 2 dam, which in the event of an accident may cause danger to health or greater than minor danger to the environment or to property.
- Class 3 dam, which in the event of an accident may cause only a minor danger.

Even a threat to one single person living in a dam hazard area places a dam in class 1. The dam safety authority decides on dam classification. A classification is not required if, in the opinion of the dam safety authority, the dam does not cause any danger. Dams in different classes are subject to different treatment under law.

Finland is a flat country and therefore dams in Finland are not high. There are 56 large dams according to the ICOLD criteria. In Finland underground structures are not counted in the height measurement. The 56 large dams have been classified as class 1 and 2 dams. Altogether, among the 451 classified dams, there are

- 86 dams in class 1
- 259 dams in class 2
- 106 dams in class 3.

The classified dams are shown on the map in Figure 1.

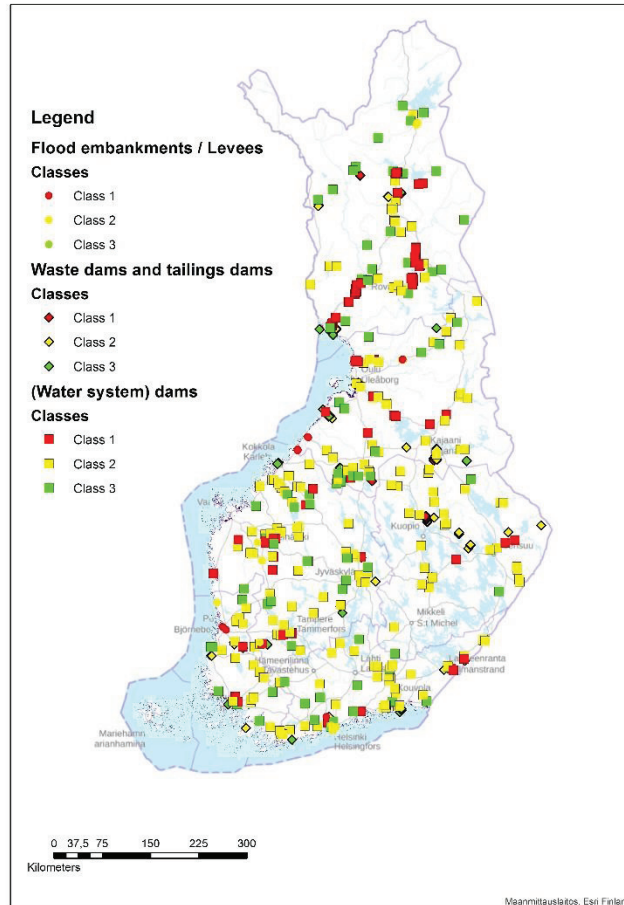


Figure 1 : There are 451 classified dams in Finland.

## 2. AGEING

### 2.1 Old Dams

The first electricity-generating hydropower station in Finland was built 1891 in Tampere. By the end of the Second World War Finland had lost one third of its hydropower capacity. Most of the hydropower stations were built between 1950 and 1970. The construction years of the large dams in Finland are shown in Figure 2.

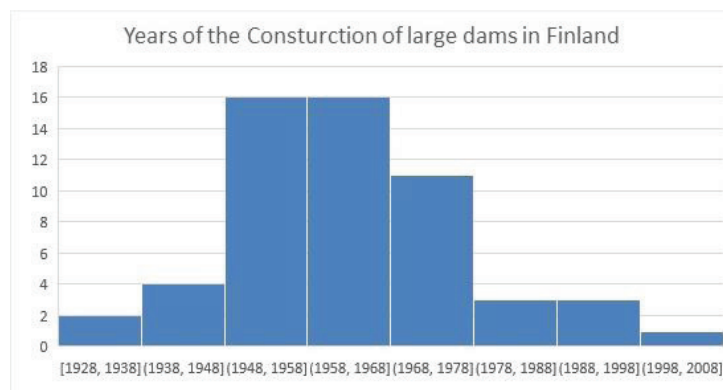


Figure 2 : Years of Construction of the large dams (ICOLD criteria) in Finland.

The last hydropower dam was built in 2001. A few years ago, one more hydropower station received a permit and at the moment it seems that this will be the last permit ever given in Finland as environmental values are highly appreciated. The permit holder has yet to take the final decision to build this last hydropower station.

Many new flood embankments and tailings dams have been built in Finland in the 21st century. As the Floods Directive (2007/60/EC) came into force, the need for new flood embankments increased. New flood embankments have been built and old ones have been upgraded. The mining industry has also been growing and new tailings dams have therefore been built.

As the hydropower dams and other watercourse dams are getting older, there is also an increasing need to upgrade them.

## **2.2 Know-how**

There used to be a degree program for hydraulic engineering at the Helsinki University of Technology in the 20th century and also hydraulic engineering courses were part of the construction engineering studies in the Oulu University. At the end of the century the need for hydraulic construction decreased and, at that time there were plenty of competent employees in the field. The need to educate hydraulic engineers disappeared.

There is still a Master's Programme in Water and Environmental Engineering at the Aalto University (formerly Technical University) but the programme covers actually more of other water issues.

## **3. RENOVATION**

### **3.1 Renovation projects**

Over the past few years there have been a number of dam renovation projects in Finland and new projects are planned. This is because the dams are getting old. New cases emerge every year. Harjavalta, Tammerkoski and Imatra are examples of renovation projects in Southern Finland.

The Water Act (587/2011) requires the dam owner to apply for a permit for dam construction work from the regional administrative agency. The dam safety authority supervises dam safety issues related to dams and cofferdams. The need for classification of a cofferdam must be decided and e.g. all classified dams have to have a monitoring programme.

### **3.2 Harjavalta**

Harjavalta hydropower station was taken into operation 1939. The dam height is 37 metres. The owner of the dam and hydropower station is Länsi-Suomen Voima Oy. Renovation work was completed between 2013 and 2017. A new turbine was added to improve the capacity, two old ones and a dam bridge were upgraded and the embankment dam was raised. This dam is part of an extensive river system. Planning and work scheduling had to account for seasonal floods and winter conditions. Figure 3 was taken during the renovations works in 2015 at the end of the spring flood.



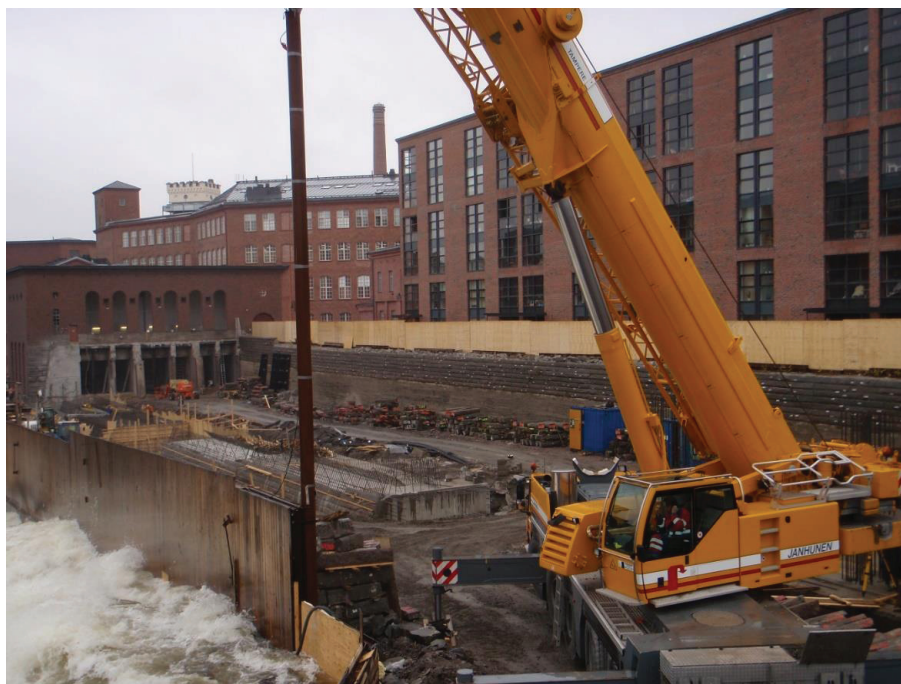
**Figure 3 :** Harjavalta renovation works. (Twitter.com/Harjavaltahydro 28.5.2015)

### **3.3 Tammerkoski**

There are three hydropower stations on less than one kilometre on a channel from lake Näsijärvi to lake Pyhäjärvi. The channel, called Tammerkoski, is located in the Tampere city centre. This is the location of the first electricity producing hydropower station in Finland, built in 1891.

Two upper power stations belong to Tampereen Sähkölaitos hydroelectric power company. The extensive renovation work was completed for most of the related structures of these power stations between 2009 and 2012. Canal walls were repaired, new hydraulic steel gates were installed and a bridge for bicycle and pedestrian traffic was built above the new gates. The trash racks were renewed, a safety barrier was erected and the hydropower station interior was also renewed.

As Tammerkoski has great historical value, the National Board of Antiquities was involved. All stones in the canal walls were removed one by one, marked and after the wall behind them was redone, returned to their original positions. Some of the stones are seen in figure 4, a photo taken during the renovation work.



**Figure 4 :** Tammerkoski renovation works – river / canal wall (4.10.2011).

### **3.4 Imatrankoski**

Imatrankoski hydropower station is the biggest in Finland. It has 7 turbines and a maximum capacity of 192 MW with an annual power generation of 1000 GWh. The gross head is 24 m. The hydropower station was originally built in the 1920s. Altogether, there is 1 km of concrete dams and 3 km of embankment dams. Renovation works were carried out between 2015 and 2018. Again, many issues had to be approved by the National Board of Antiquities.

A sector gate was replaced and the roller drum gates were repaired and upgraded for winter conditions. A new dam bridge was built, all concrete and stone structures were repaired and some strengthened. The project included pressure grouting as well as anchors. In Figure 5, concrete and stone structures next to the flood gates are being repaired.



**Figure 5 :** Flood gates of the Imatrankoski dam. Repair works 11.12.2015.

### **3.5 Other projects**

Aging is not the only reason for construction projects. Quite a many fishway has been built in the past few years. Climate change has not been reason for alteration projects, but as renovation works have been planned climate change had been taken into count.

## **4. THE DAM SAFETY INFORMATION SYSTEM**

### **4.1 Background**

In 2009, as the new Dam Safety Act came into force, it described the new dam safety information system. The owner of a dam must provide the dam safety authority with his or her contact information and information on the staff operating the dam, as well as technical information concerning the dam. The dam safety authority enters the information into the information system.

The dam safety information system holds the information of all classified dams. The dam safety decree requires the owner of a dam to provide the following information, to be included in the safety database:

- permit decisions and other official decisions concerning the dam;
- information on the hydrological dimensioning of the dam;
- planning documents concerning the plan which show the realisation of the technical safety requirements when the dam was being constructed and any alteration and repair works on the dam;
- the dam monitoring programme;
- a dam break hazard analysis, if such an analysis is required for the dam;
- an emergency action plan, if such a plan must be prepared for the dam;
- a description of the safety arrangements, if such a description is required for the dam;
- periodic inspection data;
- the condition studies prepared on the dam.

The dam owner can access the information on his own dam in the dam safety information database and may allow others (e.g. consultants) to access the information. The dam safety authority and the rescue services and certain other officials have access to the information on all dams in the information database.

The dam safety authority and the owner of the dam must keep up-to-date printouts from the information system for each dam as well as other important documents concerning the dam in such a way that these are readily available in case of disturbance. The printed document is known as the dam safety file. The information on the dam is checked every five years in a periodic inspection undertaken by the dam owner.

The dam safety information database has proven useful. As our technology improves, there are also plans to improve the information system. The system has made it easier to share the information with, for example, the rescue services. Additionally, it has made it easier to make sure that everybody is focused on the correct aspects and facts.

## **5. TRAINING**

### **5.1 PATU 2004-2005**

Between 2004 and 2005 the Finnish Environment Institute and the Ministry of Agriculture and Forestry of Finland launched the PATU dam safety course. This course was highly appreciated. However, there has not really been any further dam safety training in Finland, apart from supplementary training seminars.

### **5.2 Dam Safety 2019-2020**

The dam safety authority gathered information on the need for training concerning dam safety issues in 2015. A questionnaire was sent to dam owners, consultants, rescue services and other concerned parties. The replies to the questionnaire showed a need for further courses. A new course was prepared by the Dam safety authority (ELY Centre for Kainuu), FINCOLD, the Finnish Mining Association and the University of Tampere.

#### **5.2.1 Contents of the training course**

It was decided that the course will consist of 12 days of lectures, to be held each day separately or on two consecutive days. The subjects are:

1. purpose and boundaries
2. hydrology
3. earthfill dams
4. concrete dams

5. dam break hazard analysis
6. emergency action plan
7. geotechnical design
8. gates and decommissioning
9. inspections and monitoring
10. tailings dams and waste dams I
11. tailings dams and waste dams II
12. dam safety in modern world

The specific subjects and dates are shown in Figure 6 in Finnish.

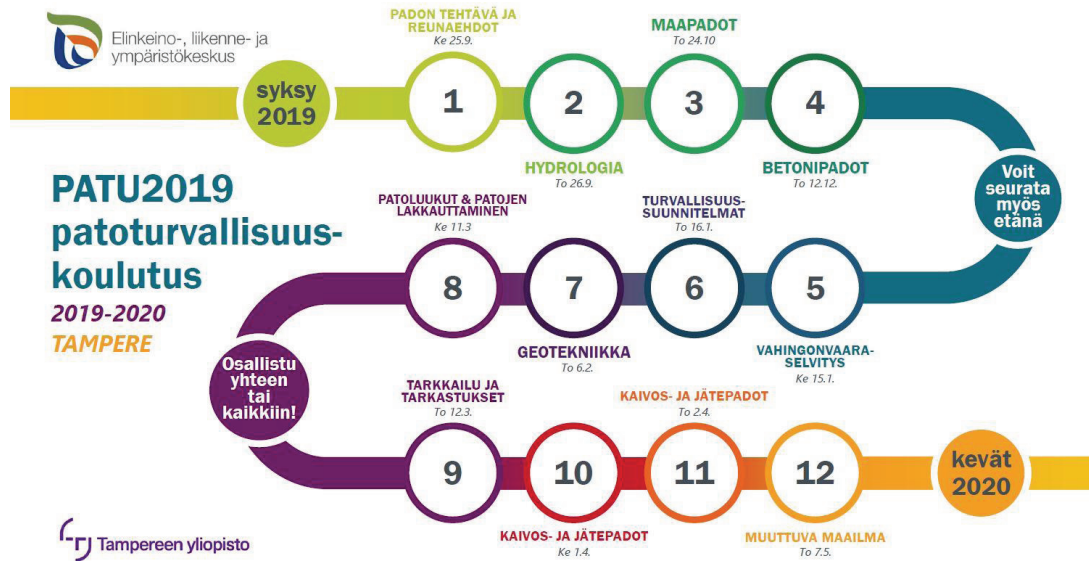


Figure 6 : Dam safety course in Finland.

### 5.2.2 Course arrangements

The practical arrangements for the dam safety course were completed by The University of Tampere and ELY Centre Kainuu. The first lecture day was arranged in October 2019 and the last will be in May 2020. Lectures are held at Tampere University but it is also possible to participate online. The first lecture had 86 participants in Tampere and 59 online.

About 30 participants are university students. Altogether there are more than 200 people pre-registered for one or more study days.

The lecturers came from different parts of Finland and from different backgrounds: government employees, consultants, company employees, rescue personnel, private persons. After each day there is an exercise. There are also two bigger group exercises for those doing the whole education package and working for study credits.

### 5.2.3 Practicality

So far, the dam safety course has had only positive feedback. The lecture subjects have been wide-ranging and interesting. A wider course on water issues is also planned.

## 6. CONCLUSIONS

The state of dam safety in Finland has improved over the past 10 years. There is, however, still more work to be done, not least because the dams are ageing.

The dam safety information system will need updating every year. In addition, the database itself might have to need some developing as technology takes huge steps every year.

Climate change is something that has to be studied as it surely has an effect on dam safety.

Dam safety legislation is in pretty good shape in Finland. We consider that it is suitable for our circumstances.

## REFERENCES

- Häme Centre for Economic Development, Transport and the Environment. 2012. Dam safety guide. [https://www.environment.fi/en-US/Waters/Use\\_of\\_water\\_resources/Dams\\_and\\_dam\\_safety/Dam\\_Safety\\_Guide](https://www.environment.fi/en-US/Waters/Use_of_water_resources/Dams_and_dam_safety/Dam_Safety_Guide), (7.1.2020)
- Isomäki E. 2017. Dam safety information system in Finland. ICOLD Symposium Proceedings 2017.
- Patoturvallisuuslaki. 26.6.2009/494. <https://www.finlex.fi/fi/laki/ajantasa/2009/20090494> (7.1.2020) Dam Safety Act. 26.6.2009/494. Unofficial translation [https://www.finlex.fi/fi/laki/kaannokset/2009/en20090494\\_20091511.pdf](https://www.finlex.fi/fi/laki/kaannokset/2009/en20090494_20091511.pdf) (7.1.2020)
- Suurpadot – Suomen osasto ry. 1991. Voimaa koskesta. Imatra, Oy Ylä-Vuoksi.
- Suurpadot – Suomen osasto ry. 2010. 1960-2010 Historiaa ja toimintaa. Hämeenlinna, Kariston kirjapaino.
- Valtioneuvoston asetus patoturvallisuudesta 29.4.2010/319. <https://www.finlex.fi/fi/laki/alkup/2010/20100319> (7.1.2020). Dam Safety Act. Unofficial translation [https://www.finlex.fi/fi/laki/kaannokset/2009/en20090494\\_20091511.pdf](https://www.finlex.fi/fi/laki/kaannokset/2009/en20090494_20091511.pdf) (7.1.2020)
- Vesilaki. 27.5.2011/587. <https://www.finlex.fi/fi/laki/ajantasa/2011/20110587> (7.1.2020) Water Act. Unofficial translation <https://www.finlex.fi/fi/laki/kaannokset/2011/en20110587.pdf> (7.1.2020)