LEVEES WORKING GROUP NEWSLETTER

Issue 12 | November 2025

THE WORKING GROUP ON LEVEES AND FLOOD DEFENCES UNDER THE EUROPEAN CLUB OF ICOLD

Waterfall in Hønefoss in the watercourse Drammenselva (Photo: Trond Reitan, NVE) – Featured on Page 13

Rémy Tourment | Chairman

Note From the Chairman

I can't believe it has been almost two years since we last published a newsletter... The reason for this hiatus is, in great part, the change of member in the UK Environment Agency which supports the editorial tasks related to our newsletter; our esteemed colleague Adrian Rushworth who has been a great help in both the EurCOLD LFD WG and the ICOLD TC LE has changed position and it took some time for his replacement to be appointed. Now Phil Welton is the new UK EA member and he has secured the help of a young colleague Matthew Brooks to help in these editorial tasks. Thanks to Phil and Matt we hope to go back to a normal frequency of publication, of about three issues per year. Matt has written a short article in this newsletter issue to introduce himself.

In the same order of delays, you may have noticed that our website activity has been halted for many months. This was caused by the change of web platform; INRAE which supports the web site has decided to move the existing web sites from WordPress to eZplatform and it took a lot of time and effort from my colleagues to migrate the site content. The new web site address has been active for a few months and you can again access levee related news, lists of events, and lots of other levee related information.

Do not hesitate to share information about levees, flood defences and flood events in the newsletter and/or the web site, from Europe but also from anywhere in the world. Sharing information helps everyone progress.

Matthew Brooks | Editor

Note From the Editor

I'm a civil engineer with the Environment Agency, working in flood risk management. My interests lie in how we can share knowledge across Europe to improve the performance and adaptability of our flood defences.

As the new editor of the EurCOLD Levees Working Group Newsletter, I'm keen to highlight the great work happening across the community and encourage collaboration through shared experiences, research and innovation.

IN THIS ISSUE

VISIT THE WEBSITE

Click here to visit website

Since our last edition, several new articles have been published on the website. These articles highlight the ongoing work and developments across our community. We've selected some recent articles for this newsletter. We encourage readers to explore these in more detail, along with many other articles on the on the LFD WG EurCOLD website.

ARTICLE | 23 October 2025 | By: Rémy Tourment, 30 Sept 2024

Keynote lecture on complex levee failure scenarios

I was happy and proud to be part of the XXXIInd national meeting organised by the Mexican Society of Geotechnical Engineering in Mexico City where I have been invited to give a keynote lecture. The title of this lecture was " Levee failure scenarios - Complex levee failure scenarios and examples".

Know More

ARTICLE | 17 June 2025 | By: Robert Slomp

Emergency Management of Flood Defences

An international working group has published a book with the basic principles of emergency management for flood defences. The handbook is more a practical guidance with principles, issues, methods and examples as well in the preparedness as in the response phase. This describes the problems manager…

Know More

ARTICLE | 07 July 2025 | By: Yida Tao (Deltares, NL)

Retrofitting and reinforcement of Levees

The ISSMGE Technical Committee 201 (TC201) on Dikes and Levees is preparing a joint report on the retrofitting and reinforcement of levees. This report aims to advance the international exchange of knowledge on techniques for strengthening levees.

Know More

Dam World 2025

More Countries Tackling the Levees Issues

BY RÉMY TOURMENT

Earlier this year, I had the pleasure to take part in the DamWorld 2025 conference in Lisbon (Portugal), where I was invited to deliver a keynote lecture about levee failure modes. The DamWorld series of conferences has been organized by Brazilian and Portuguese organisations, but is now attracting more and more countries. I had the opportunity to discuss levee safety with different people from Brazil and Portugal; both these countries are in the early stage of developing a national policy on levee safety management and are happy to benefit from the experience of countries having already followed this path. Following this I have been invited, along with Richard Varuso from USACE, to participate in a webinar organized by ABRHidro (Brazilian Association of Water Resources) on "Flood Control Levees: Safety, Governance, and International Experience". For those interested the webinar is online in the YouTube channel of ABRHidro, both in Portuguese and in English (two different videos).

Let's bet that these countries' National Dams Committees will be interested in the actions of the ICOLD TC LE, and also for Portugal in our own EurCOLD LFD WG.

News from the ICOLD Technical Committee on Levees

BY RÉMY TOURMENT

The ICOLD Technical Committee on Levees (ICOLD TC LE) is currently working in a critical phase, between the annual ICOLD meetings of 2025 and 2026, when it will finalise its ongoing activities and prepare its future.

The bulletin on "Levees and flood defences across the world - Characteristics, risks and governance" will soon be published in its final form, and the bulletin on "Comparison of dams and levees - Similarities, differences and recommendations" is prepared and ready to be submitted for approval by the ICOLD general Assembly in 2026, as well as a position paper on levees in ICOLD.

In parallel to the achievement of these deliverables, the TC is preparing its future activities that will be defined in its future Terms of Reference that will also be presented to the 2026 ICOLD General Assembly. These Terms of Reference will be based on ongoing work to identify themes for future TC bulletins and the potential for collaborating with various other ICOLD TCs. I hope to see many of you in Guadalajara for ICOLD 2026 (see page 6 in the "Coming up" section about future events) where the TC will hold a meeting and a workshop, and where also many other information related to levees (and dams…) will be shared.

SUBSCRIBE TO NEWS

Subscribe to the website news in order to get latest information notifications.

Non-Intrusive Embankment Monitoring

Powderham Banks Improvement

BY JIM WHITELEY

The Powderham Banks Improvement project uses non-intrusive, digital technologies to holistically assess the condition of a deteriorating 200-year-old flood defence in Devon. This novel approach combines drone and geophysical monitoring data to identify areas for low impact early intervention repairs and to monitor their efficacy.

BACKGROUND

Powderham Banks is a 1.6km flood defence located on the Exe Estuary. It protects the London to Penzance mainline railway, the RSPB Exminster and Powderham Marshes Reserve and approximately 100 properties. There are no as-built records for the defence. Historically, the embankment has required targeted repairs to visually damaged parts of the stone-and pitch revetment (upgraded in the 1960s) or in response to piping failures in the landward face.

In March 2023, a void opened in the crest, accompanied by piping in the landward face. The Environment Agency tasked AtkinsRéalis with identifying further sections that could fail. AtkinsRéalis proposed a novel drone and geophysics-based solution to the Environment Agency. This used drones (by AtkinsRéalis and Lewis Brown) to obtain imagery, topographic, multi-spectral imaging (which collects data from a wide range of spectral wavelengths across the electromagnetic spectrum) and thermal data. This was carried out alongside ground-based geophysics (by Zetica) including ground penetrating radar, electromagnetic and three-dimensional resistivity data to locate potentially deteriorated 'at risk' sections of the embankment (Figure 1).

AtkinsRéalis used a Proactive Infrastructure Monitoring and Evaluation (PRIME) resistivity monitoring system from the British Geological Survey to better understand when failures might occur (Chambers et al., 2022). This was installed across the most vulnerable 1.3km of the embankment to identify and monitor seepage through the structure (Figure 2 and Figure 3).

WHAT DID YOU DO DIFFERENTLY?

Our initial investigation mapped 20 'at risk' locations in April 2024, categorising risk based on lines of evidence collected across the different non-intrusive techniques. Within 14 months of the initial survey, 25% of the 20 'at risk' locations identified by the non-intrusive investigation failed (four piping failures and one section of storm-related revetment damage).

The PRIME system, installed in September 2024, acquires up to 13 resistivity datasets per day, providing near-real-time images that are interpreted to identify changes in subsurface moisture content and detect potential leaks. Daily data from PRIME are collected remotely and autonomously, and interpretation is supported by quarterly drone surveys to record instances of surface damage and deterioration.

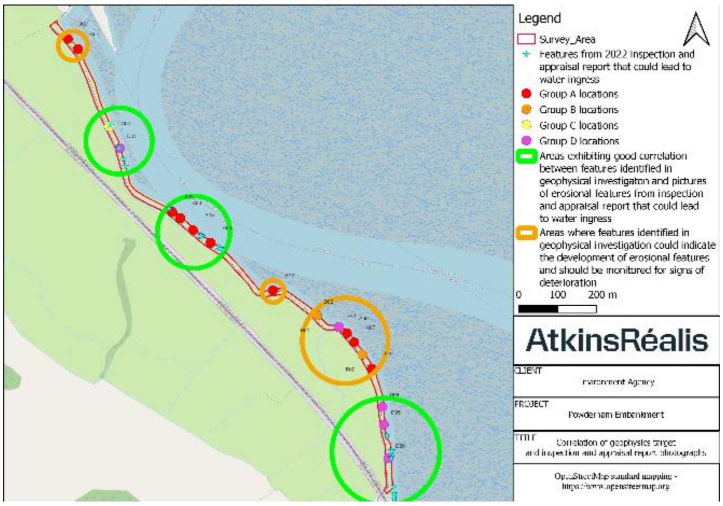

Figure 1: Risk category map showing the locations identified as 'at-risk' of future failure based on the non-intrusive surveys

Figure 2: PRIME cable showing the electrodes through which a current is injected into the embankment. There are 512 electrodes in the Powderham Banks system.

Figure 3: A completed PRIME system installation at Powderham Banks. All cables are buried for protection and to minimise visual intrusion. The system is fully autonomous and operates on solar power.

CASE STUDY: HOW THIS APPROACH WORKS

In January 2025, two low resistivity anomalies were identified in the time-lapse PRIME models (Figure 1). Resistivity is the inverse of conductivity; as saline water is very conductive (i.e., has low resistivity), these anomalies were suspected to indicate leakage through the embankment.

During a site walkover on the following day, a low-level leak was identified at the location of 'January resistivity south' (Figure 4), approximately 0.5 m above the toe of the embankment. There was minor flooding to the landward side of the embankment (caused by inland flooding rather than embankment seepage), which made

Article Continued Overleaf...

the low-level leak difficult to identify. Without early-identification from PRIME, it is unlikely this would have been noted during a site inspection.

The early identification of the low-level leakage allows for early intervention using less expensive and less environmentally impactful repairs. At the location identified in January 2025, a marine mortar was used to repair the revetment blockwork on the estuary face. This work aims to reduce the water infiltrating through the embankment, preventing the progression of leakage to piping failure. An aerial image from a drone survey in December 2024 (Figure 6) shows a marine mortar repair to the estuary face and a corresponding intrusive repair to the landward face following a piping failure in October 2024. In this example, the extents of the marine mortar repair costs ~£25k, compared to the intrusive repair which costs over £100k. PRIME monitoring means these early indicators of leakage can be identified and fixed before they become more significant failures. Furthermore, the PRIME data can monitor the efficacy of these repairs, to ensure that the inferred moisture content of the embankment interior is decreasing following estuary face repairs.

LESSONS LEARNT AND FUTURE USES

The investigation and monitoring approach taken at Powderham Banks offers an unprecedented insight into the internal deterioration of ageing embankments. It sees more than is possible by visual inspections, without intrusive works (asides from the excavation of a shallow trench, up to 20 cm deep) and with minimal personnel on-site. The PRIME data enables data-driven decisions to plan early interventions. Our project team are now seeking to deploy this approach at new sites to extend asset serviceability and sustainably improve the resilience of ageing flood defences.

ADDITIONAL INFORMATION

This particular deployment was focused on addressing known issues with internal seepage within the embankment, which are believed in some cases to progress to piping failures. The main driver of the monitoring is to detect early onset of seepage and is therefore targeted more toward detecting the precursory conditions of failure, with a view to then monitoring the evolution of these precursory conditions and implementing early interventions to prevent future failure.

The system is transferrable to other types of earth embankments and may be more restricted where significant volumes of metal are present (e.g., sheet piling) as this could introduce distortions in the current used to monitor water ingress. To date, the system has been used in research trials on other estuarine and fluvial flood embankments, reservoir dams, canal walls, transport infrastructure (road and rail) cuttings and embankments, and natural landslides. Given the subsurface nature of the measurements, it is entirely possible to also use the system to look at issues associated with paleochannels.

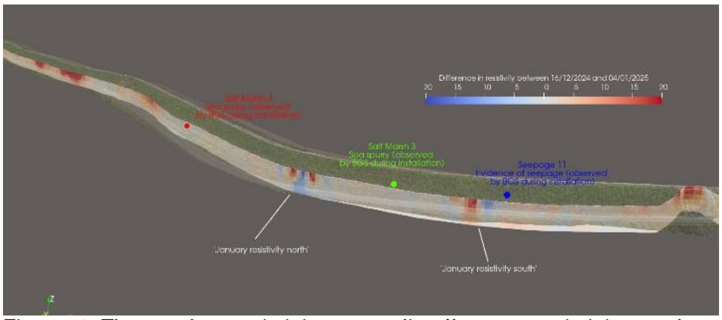

Figure 4: The two low-resistivity anomalies (January resistivity north and January resistivity south) identified in the PRIME models in January 2025. The landward side of the embankment is closest in the above model.

Figure 5: Low-level leakage identified at the location of 'January resistivity south' from the PRIME data.

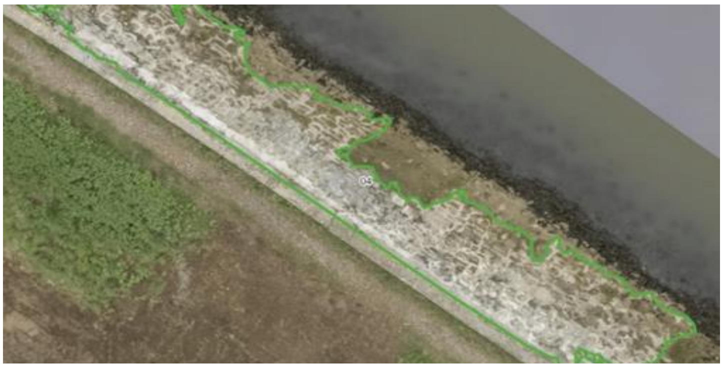

Figure 6: An example of a marine mortar repair (estuary face) and excavation and re-compaction repair to a piping failure (landward face). The marine mortar repair costs ~£100k less for the extents shown

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Chambers, J., Holmes, J., Whiteley, J., Boyd, J., Meldrum, P., Wilkinson, P., Kuras, O., Swift, R., Harrison, H., Glendinning, S., Stirling, R., Huntley, D., Slater, N. & Donohue, S. 2022. Long-term geoelectrical monitoring of landslides in natural and engineered slopes. *The Leading Edge,* 41**,** 768-776. 10.1190/tle41110768.1

Further information, if needed can be obtained from: Jim Whiteley, Engineering Geophysics Lead, AtkinsRéalis jim.whiteley@atkinsrealis.com

Hindcasting Of Levee Slope Instability

The Leendert de Boerspolder experiment

BY JOB KOOL, WIM KANNING, MONIQUE SANDERS, BAS JONKMAN

Due to sparse evidence, the actual present circumstance explaining the failure of a dam or levee is uncertain. This makes it difficult to explain the failure and its causes. A new systematic method of hindcasting of levee and dam failures is presented as part of forensic engineering in Kool et al. (2019). The method is applied to a large-scale levee slope instability experiment in the Leendert de Boerspolder (in the Netherlands in 2015) (Kool 2022), where evidence was very extensive (Figure 1) (de Gast 2020).

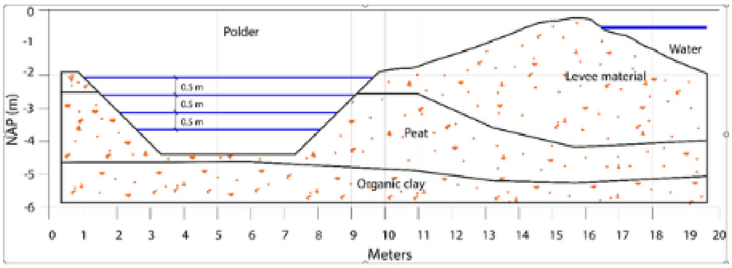

Figure 1 shows the Centre cross-section geometry, which is projected from the southwest. Measurements are provided by estimation.

The analysis in this article uses two levels of information:

- Typical information that is normally present such as shear strength parameters, layering and geometry.
- The geometry of the observed slip surface is included in the analysis

The recorded water drawdown level at the time of failure (approximately 1.6m) is used to validate the results of the sensitivity analysis. Also, the validity of the proposed hindcasting method is validated by comparing a situation with normal information and a situation with detailed information.

HINDCASTING METHOD

The most likely scenario and most representative model choices that characterize the failure most accurately are identified using a sensitivity analysis considering two levels of information. Variables that are unknown: 1) Water level in the ditch at time of failure (i.e. -1.0m, -1.5m, or -2.0m of drawdown), 2) Drainage rate of the soil, and 3) Most appropriate Limit Equilibrium Method (LEM) (van Deen & van Duinen 2016).

First, the influence of different options of (1) water level drawdown and (2 & 3) model choices are analysed on the stability of the slope (Factor of Safety) (Figure 2). Second, the observed geometry of the slip surface is included in the analysis and compared with the computed critical slip surface resulting from the first step.

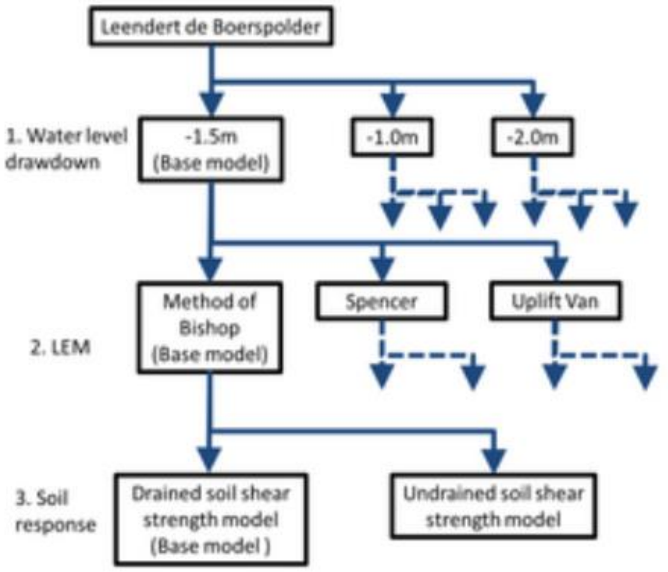

Figure 2: All to vary scenarios of water level drawdown possibly triggering the failure and model choices in the sensitivity analysis.

CONCLUSION

The most likely set of water level drawdown and most representative model choices to characterize the failure most accurately are identified systematically. Including observational information in the hindcasting appears to be essential for the identification of the most accurate characterization of the failure. The most accurate characterization of the Leendert de Boerspolder failure includes a water level drawdown between 1.5 m and 2.0 m, a LEM of Spencer, and an undrained shear strength model. After possibly some adjustments, it is expected that the developed hindcasting method (Kool 2022) can also be applied to other failure mechanisms of levees and dams.

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de Gast, T. 2020. *Dykes and Embankments: a Geostatistical Analysis of Soft Terrain* (Publication Number ISBN 978-94-028-1915-1) [Dissertation, Delft University of Technology]. Delft.

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Kool, J., Kanning, W., Heyer, T., Jommi, C., & Jonkman, S. N. 2019. Forensic analysis of levee failures: The Breitenhagen case. *International Journal of Geoengineering Case Histories, 5*(2), 70-92.

van Deen, J., & van Duinen, A. 2016. *Schematiseringshandleiding macrostabiliteit*. Tech. Rep., Deltares report 1220083-008-GEO-0005.

Further information, if needed can be obtained from: Job Kool, job.kool@rws.nl

COMING UP...

2025 November 24th

NETHCOLD Student Event

November 24th 2025 3-5PM

EVENT OVERVIEW AND PURPOSE

The event focuses on dams and hydraulic engineering, connecting students with international experts and practical examples.

PRESENTATIONS BY EXPERTS

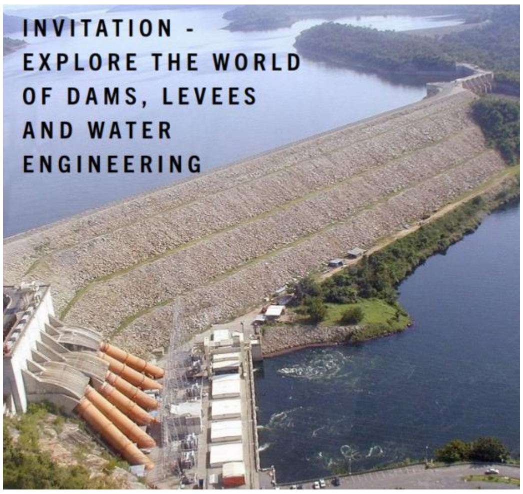
• Introduction to ICOLD and NethCOLD by Monique Sanders (NethCOLD)
• Making a Dam(n) Difference: the case study of Thessaly by Davide Wüthrich (TU Delft)
• Spillway repair works Akosombo dam Ghana by Jan Doeksen (Haskoning)

NETWORKING OPPORTUNITY

After the program, students can network with speakers and peers while enjoying drinks, fostering connections and knowledge exchange.

WHEN: 24 November, 3PM - 5PM **WHERE:** Haskoning Delft (Mijnbouwstraat 120, Delft)

REGISTRATION: send e-mail to chair@nethcold.org (not compulsory but appreciated for purchasing drinks)



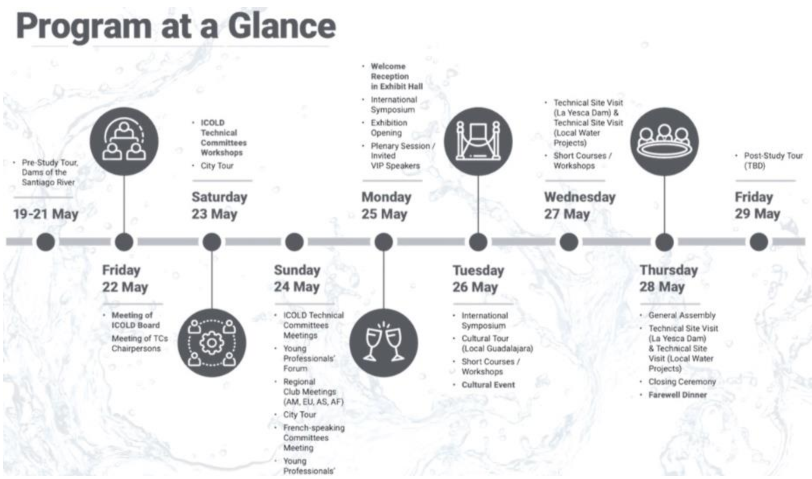
2026 May 23-29th

ICOLD 2026 in Guadalajara (Mexico)

May 23-29th 2026

Next year's ICOLD annual meeting will be held in Mexico. There will definitely be some levee related content then, under the umbrella of ICOLD TC LE, but also in the symposium organised by the Mexican Committee. Check the meeting web site: https://icoldmex2026.com.

There is a reduced registration rate valid until the of this year 2025: https://www.icoldmexico2026.com/copia-de-registro.



2026 June 14-19th

21st International Conference on Soil Mechanics and Geotechnical Engineering in Vienna (Austria)

June 16-19th 2026

Registration is open now! If you need help, here you will find a short instructional video on how to register for ICSMGE 2026 in Vienna.

Instructional video for registration

2026 AUSTRIA VIENNA WHERE IT ALL BEGAN 21st ICSMGE

2026 June 22-26th

32nd EWG-IE & 7th EWG-OOE Meeting

June 22-26th 2026

BY RÉMY TOURMENT

Deltares, Rijkswaterstaat and TU Delft are organising the 32nd workshop of EWG-IE (internal erosion) and the 7th workshop of EWG-OOE (overflow and overtopping erosion), which will take place in Delft from 22-26 June 2026. This event follows similar sessions held in Brno in 2025.

📌 **22–24 June** – *32nd EWG-IE Meeting* (Internal Erosion in Embankment Dams and their Foundations)

📌 **24 June** – *Technical visits*

📌 **24–26 June** – *7th EWG-OOE Meeting* (Overflow and Overtopping Erosion)

32nd EWG-IE Meeting
7th EWG-OOE Meeting
Delft, the Netherlands
22-26 June 2026

The aim of the workshops is to share the latest knowledge and innovations in the field of dam and levee safety, with a focus on internal erosion, overflow, and overtopping erosion.

The workshops are intended for the broader water management community, including academics, consultants, and practitioners involved in the design, management, technical supervision, and research of hydraulic structures.

More detailed information can be found on the conference website: ewgiooe2026.sciencesconf.org. You are invited to submit an extended abstract, conference contribution, or academic journal article by **18 January 2026.**

Spring Floods in Finland

Typical and Exceptional Events

BY EIJA ISOMÄKI

In Finland, melting snow raises river water levels every spring, often leading to flooding. Many homes and fields are located near rivers and are therefore at risk. The west coast region of Ostrobothnia is especially prone to flooding due to its flat terrain. Several areas in this region are designated flood risk zones under the EU Flood Risk Directive.

River water levels naturally sit close to ground level. Roads are built higher, so during floods, water may press against them. In some cases, land was raised before houses were built, and some homes even have their own flood embankments. Many rivers also have embankments, some with gates leading to fields. If towns or villages are at risk of flooding, these gates can be opened to release water into the fields.

In spring 2024, flooding was exceptionally severe. A rapid temperature rise caused snow to melt quickly. Ice began to move, forming ice blocks and dams and rainfall added to the problem. Water levels rose, flooding fields and pressing against roads. The towns of Ylivieska and Alavieska in western Finland (Ostrobothnia), both designated flood risk areas, faced a challenging situation. Water reached yards, buildings needed protection, and some households were evacuated. One flood embankment was overtopped, and water entered several homes with little warning.

Sometimes ice dams are blown up, but only when conditions are safe. Afterwards, close monitoring is needed as new ice dams may form downstream. In Ylivieska and Alavieska, it was deemed unsafe to blow up the ice dam, so an excavator was used to try to break it apart.

During the flood, rescue authorities had many tasks besides evacuation. They pumped water from basements and provided boat transport to homes surrounded by water.

The flood was classified as a 1-in-100-year event. Insurance companies compensated many affected households.

There is a video on YouTube that illustrates ice dams and flooding in the region.

Figure 1: In Ylivieska water covers wide areas along road Visalantie

Further information, if needed can be obtained from: Eija Isomäki, Dam Safety Expert,
Centre for Economic Development, Transport and the Environment eija.isomaki@ely-keskus.fi

CALL FOR CONTRIBUTIONS

Information about levees and flood defences projects and works

News, medias or press releases on current flood or storm events involving levees and flood defences.

Current, ongoing or recently completed research projects.

Documents related to levees or flood defences: handbooks, guidance, reports and regulations.

Information on any event or conference relating to levees or flood defences.

Links to informative / educational web sites and related organisations

Pictures to be used in the web site banner, randomly chosen every time a page loads (resolution has to be 1024*300)

Contact the WG website team:
prj-lfd-eurcold@inrae.fr

Assessment of Erosion Resistance of Grass-Covered Embankments

Insights from In Situ Overflow Tests at the Living Lab Hedwige-Prosper Polder

BY KRISTOF VERELST

Grass-covered levees commonly protect river and estuarine areas against flooding. Climate-induced water level changes may increasingly expose these levees to wave overtopping and overflow events. Within the INTERREG 2Seas project Polder2C's it has investigated to what extent grass-covered levees can withstand such events, and under what conditions failure may occur. Between 2020 and 2022, full-scale wave overtopping and overflow tests were conducted at the Living Lab Hedwige-Prosperpolder along the Dutch–Belgian Scheldt Estuary to assess erosion resistance under varying hydraulic conditions, vegetation states and current anomalies. Insights resulting from in-situ overflow tests were recently published by Flanders Hydraulics in MDPI Water [1] and are presented hereafter.

Within the INTERREG-project Polder2C's, 27 full-scale overflow tests were executed on levee sections with varying vegetation states and structural anomalies. To establish a continuous overflow with controlled characteristics on the landward side of the levee, an overflow generator was developed and built by Flanders Hydraulics (Figure 1).

The design and application of the overflow generator is described by Vercruysse et. al [2]. The overflow generator was placed on the upper part of the riverside levee slope. The flow crosses first the levee crest and then flows down the levee slope at the landward side. The flow is contained between plywood boarding walls inserted into slits in the levee cover layer to limit leakage. The width of a stream section was typically 2m, though it was reduced for some tests to increase the specific discharge. The overflow tests were executed in different sessions of 1-2 hours, with only brief interruptions (5-10 min) to evaluate the state of the grass cover and detect developing defects or irregularities. During these interruptions, images were captured with a camera system. Instrumentation included acoustic water level sensors, electromagnetic velocity meters, and a camera system. Data was collected continuously and processed using statistical and geospatial techniques.

Figure 1: View of the setup and monitoring system on the levee slope before and during overflow. The installation features overhead cameras, and water level and velocity meters.

Article Continued Overleaf…

The 27 executed overflow tests can be subdivided into three categories, as a function of the initial state of the levee cover. Hydraulic tests were conducted on levee sections without significant pre-existing anomalies and were considered visually in good condition. Damage tests were conducted on levee sections where any form of anomaly was present prior to testing: large (animal) burrows, presence of trees, artificial damage, etc. These tests were designed to evaluate the impact of such anomalies on the residual strength and the damage evolution of the levee slope. A third category of tests concerned so-called repair tests, conducted on a levee section being repaired after having failed following a previous test. Finally, special tests include student design challenges for levee repair methods. The latter two are considered out of scope for the published paper. For some test sections details about the evolution of the grass cover and the levee slope state during the overflow tests are described in the published paper [1]. Each test is described in detail in [4] for test sections situated on the Belgian levee and in [5] for test sections situated on the Dutch levee.

During the overflow tests, flow velocity was measured at three locations on the levee slope (upper middle and lower slope). Beyond the inception point of air-entrained water flow, both the acoustic water level sensor and the electromagnetic current meter provided unreliable measurement data. As an alternative to direct measurements on the lower slope, a terminal current velocity was calculated using Manning's formula. Results of the measurement of the flow velocity and the calculation of the terminal current velocity are described in the published paper [1] and in [3].

The erosion resistance of a vegetated cover layer is generally illustrated as a velocity duration diagram. The curves based on [6] are redrawn in Figure 2 and used for comparison with the results of overflow tests. The latter were added as vertical bars alongside the reference curves in Figure 2. The lower end of each bar represents the measured velocity on the upper slope, which ranged between 2 and 4 m/s for all observations. The upper end of the vertical bar represents the calculated terminal velocity on the levee slope. For a large group of tests with durations of 5-30 hours, the upper slope velocities fall within the failure thresholds defined by the curves. However, when the terminal velocities are considered, these thresholds are exceeded. For most tests, the end state of the test was intact, indicating the grass-covered clay layers are at least as resistant as anticipated by the curves for these durations. These no-failure tests demonstrated that a well-maintained levee grass cover without any anomaly can withstand overflow with high (terminal) velocities for several hours, up to 20 hours and more. Within the group of tests where the levee cover layer failed, two tests resulted in failure after more than 10 hours of overflow, representing late failures that occurred in sections with some degree of pre-existing damage. Even with such initial damage, the levee was still able to retain its structural integrity for several hours.

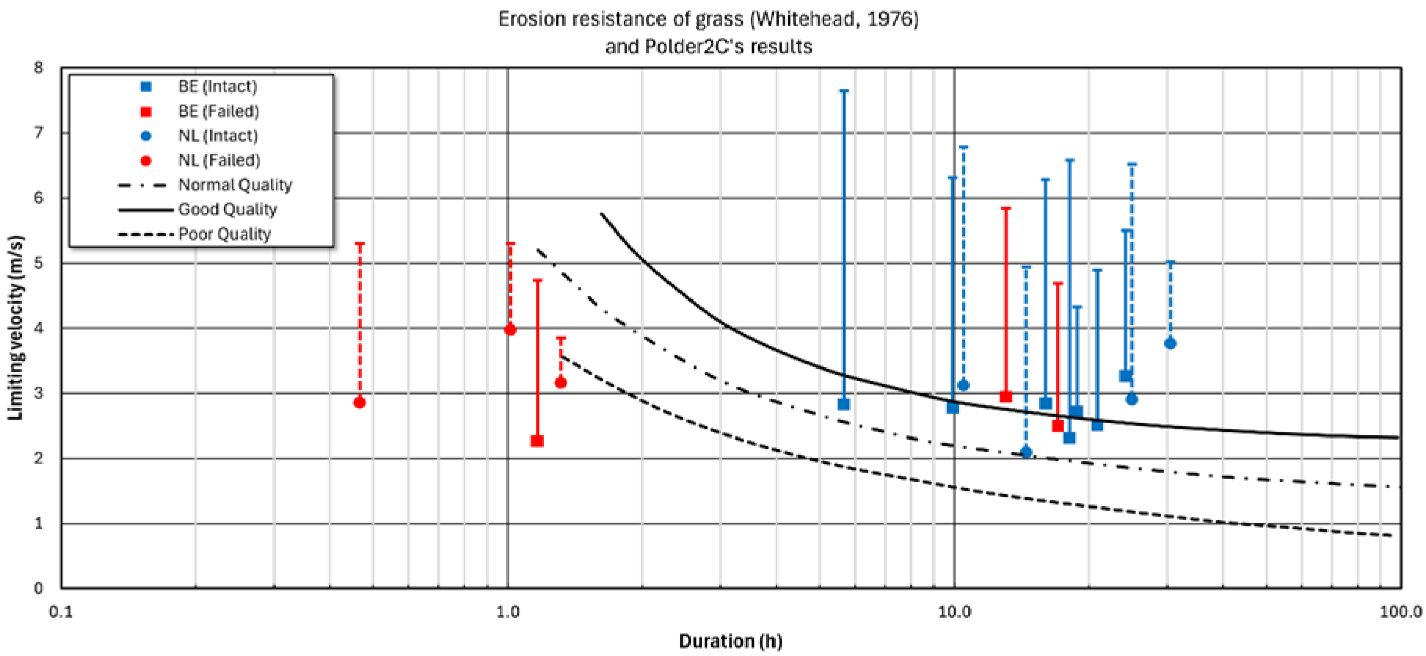


Figure 2: Erosion resistance of grass cover layers. Black curves represent the poor, normal and good grass cover quality, as referred to in [6]. The results from the experiments are represented by vertical bars, for which the lowest value is the measured upper slope velocity and the highest value is the calculated terminal velocity.

Article Continued Overleaf…

Tests resulting in damaged or failed sections and durations of less than two hours were characterized by initial anomalies: reed fields on soft soil, large burrows, pre-existing cliffs. Also, artificial damage was a contributing factor to this group. The published paper provides a description of the failure mechanism of the levee cover layer when animal burrows are present. From a management perspective, the speed and scale of this type of failure proved to be unmanageably high. It led to the insight that animal activities on a levee can seriously undermine the overall strength and resilience of a levee system.

The results of the overflow tests show that controlled overflow of a grass-covered levee may be acceptable under strict conditions. Therefore, the levee must be in good structural condition, with high-quality maintenance and regular inspection, particularly regarding large animal burrows, significant vegetation irregularities, or morphological anomalies. Vegetation management also plays an important role in preserving the surface integrity of the grass cover. However, once slope failure initiates, the chain of events unfolds rapidly, leaving practically no time for an emergency intervention. This highlights the importance of preventive measures, since post-failure mitigation is unlikely to be timely in real-world overflow scenarios.

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Forecasting Levee Risks from Dry Weather

BY ANDREW RITCHIE & JACK CLAPSON

England has seen an exceptionally dry spring and summer in 2025. Rainfall for February to April was the driest on record since 1956. Several Environment Agency areas remain in Prolonged Dry Weather or Drought status, raising concerns about the resilience of flood defence assets, particularly levees. Dry weather can significantly impact these assets, causing issues such as soil shrinkage, ground movement and loss of grass cover. All of these issues increase the risk of failure.

In response, the Environment Agency has developed a new Dry Weather Asset Risk Tool. This tool combines weekly Soil Moisture Deficit data with ground shrink-swell potential, to identify levees most vulnerable to dry weather impacts. Still in its early stages, the tool could provide value in prioritising inspection and maintenance activities and could become a key component in our future dry weather incident response.

METHODOLOGY

The Dry Weather Asset Risk Tool uses Geographic Information System (GIS) technology and nationally available datasets. The tool is designed to assess and visualise risk levels across England and can be updated weekly to reflect changing conditions on the ground.

The primary objective of the tool is to combine environmental and geological data to create a national risk picture of levees vulnerability due to soil shrinkage. It uses two key datasets:

1. MORECS Soil Moisture Deficit (SMD): Provided weekly by the Met Office, this dataset indicates how dry the soil is across the UK. Each 40x40km grid square is assigned a SMD value, with higher values representing drier conditions. This allows for a near real-time assessment of soil moisture across the country.

2. BGS GeoSure Shrink-Swell Dataset: Published by the British Geological Survey (BGS), this data is presented as a 5km hexagonal grid and classifies the ground's susceptibility to shrink and swell. Each area is rated as Low, Moderate, or Significant.

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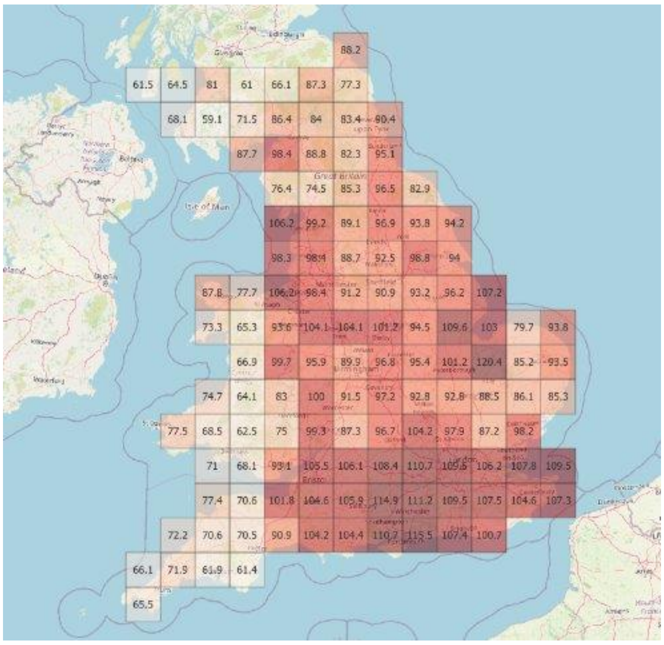

Figure 1: MORECS SMD Data

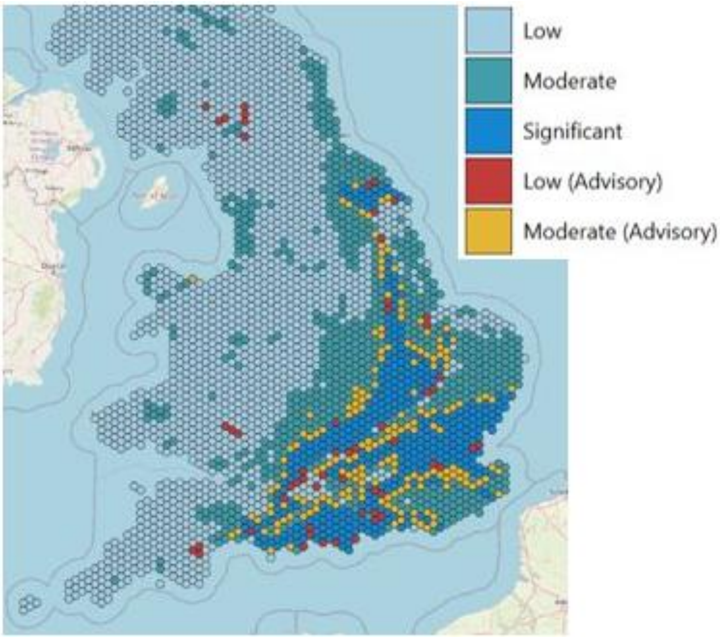

Figure 2: BGS Shrink Swell Data

COMBING THE DATA

The two datasets are overlaid so that each resulting polygon represents a unique combination of a MORECS square and a BGS shrink-swell hexagon. Each polygon is then assigned two values:

1. A Soil Moisture Deficit (SMD) Factor based on how dry the soil is,
2. A Shrink-Swell Factor based on the ground's susceptibility to movement.

These two factors are multiplied together for each polygon:

Dry Weather Risk = SMD Factor × Shrink Swell Factor

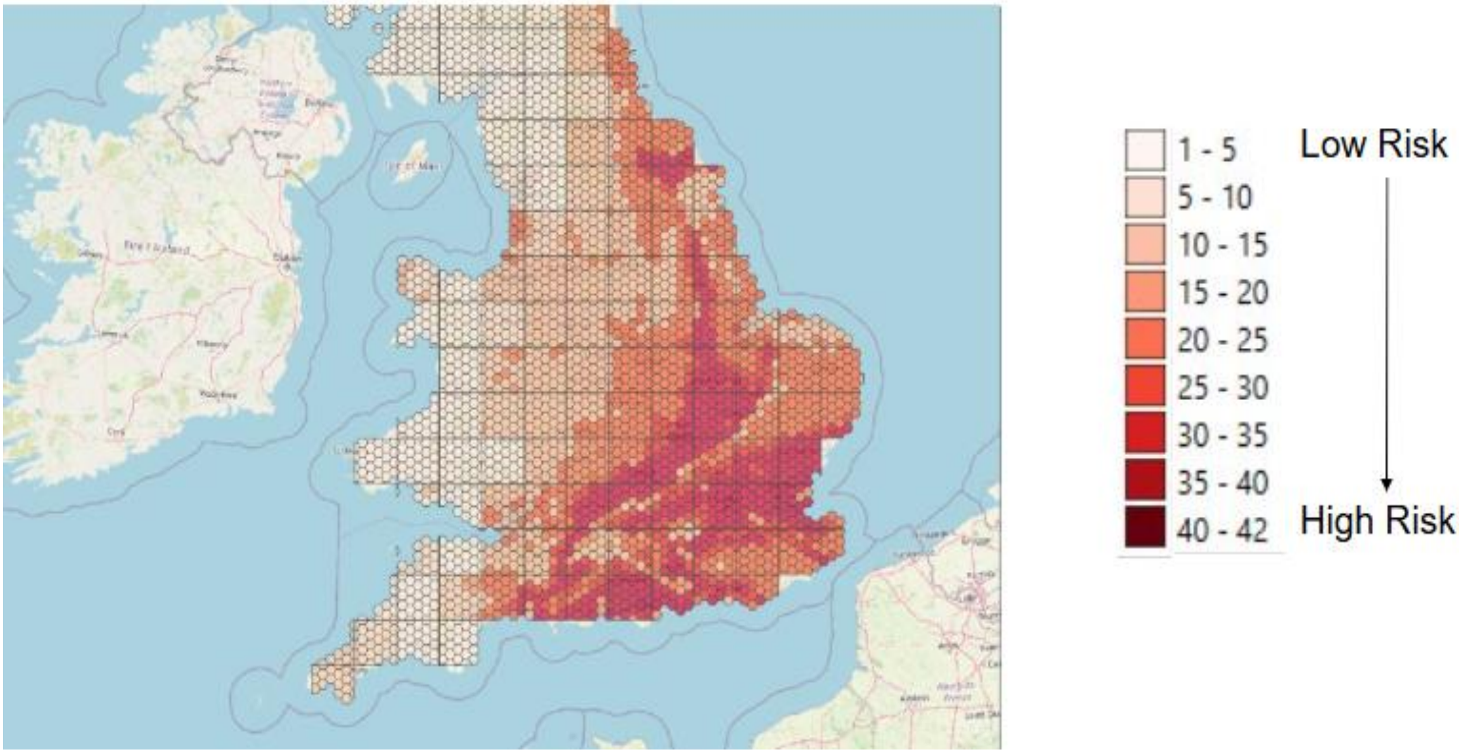

Figure 3: Nationwide Map of Risk

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USING THE TOOL ON LINEAR LEVEES

The output can be used as a standalone risk overview or combined with other datasets, such as Civil Asset Prioritisation, to identify high priority levees in high-risk areas. Civil Asset Prioritisation, a separately developed Environment Agency tool, assesses the consequence of each linear defence and assigns them to one of five criticality categories. Applied to levees across England, these categories allow a list to be produced, showing the relative importance of each flood defence asset.

The prioritised levees list can then be combined with the outputs of the Dry Weather Asset Risk tool to identify the highest consequence levees most at risk from prolonged dry weather. This enables targeted monitoring, inspection and early intervention where it is most needed.

FUTURE DEVELOPMENT

The tool is currently being updated with historic MORECS data, enabling long-term trends to be identified and new maximum soil moisture deficits to be flagged.

Future improvements include enhancing the resolution of input data to increase confidence in local level outputs and exploring the use of Sentinel-2 satellite imagery to monitor grass cover, strengthening understanding of levees condition nationally.

Ultimately, the tool offers a data-driven way to proactively manage embankment risk during prolonged dry weather, helping to reduce the likelihood of flood defence asset failure and better protect communities.

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Extreme Weather

Storm Hans and the Braskereidfoss Dam Incident in Norway

BY PRISKA H. HILLER

Extreme weather conditions caused flooding and landslides in Sweden and Norway in the start of August 2023. This is a short summary about the extreme weather event called "Hans" and its consequences. The summary is based on entry "Ekstremværet Hans" in the database about natural disasters provided by the Norwegian Water Resources and Energy Department, NVE, (NVE, 2023 a). You can also find some additional information there in Norwegian, including a timeline, maps, precipitation and discharge data, etc.

The extreme weather was a result of unusual weather conditions coming from the southeast. It caused a large amount of precipitation over a larger area. Between the 7-9th of August there was over 100mm of rainfall in two out of three days. The return period of weather event of this magnitude is above 100 years according to the Norwegian Meteorological Institute. The rainfall caused landslides, debris flows and flooding. This caused huge amounts of damage to infrastructure and property. The counties Innlandet and Viken in South-Eastern Norway were hit most severely, especially around the watercourses Glomma and Drammenselva.

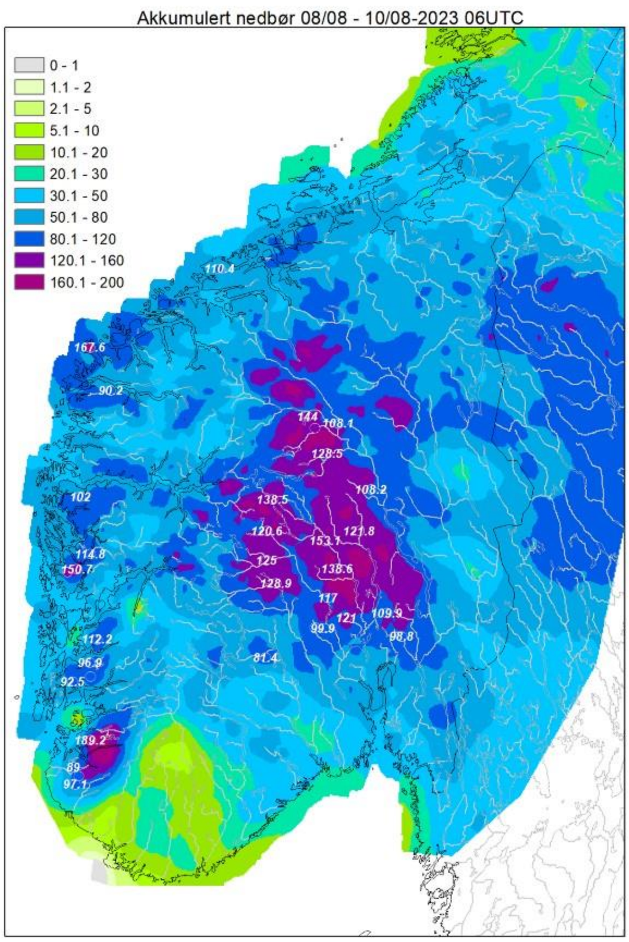

Figure 1: Accumulated precipitation in mm, 8.-10. August 2023 (Norwegian Meteorological Institute, 2023)

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FLOODING AND LANDSLIDES

The first warnings for flooding and landslides were sent Saturday 5th August based on the weather forecast. On Sunday 6th August, the warnings were updated from yellow (expected flood discharges up to 2-3 years return period) and orange to red level (highest flood warning level in Norway, expecting flood discharges exceeding 50 years return period). During heavy rainfall on the 7-9th of August, the water levels raised and there were landslides in many places. The increase in water level was long lasting, especially in the bigger watercourses Drammenselva and Glomma. A second period of heavy rainfall on 27 August caused additional flooding. Water levels rose again across large parts of the Drammenselva river, reaching their peak on 30th August. Flood warnings remained in effect and were not downgraded to yellow level until 7th September.

Figure 2: Waterfall in Hønefoss in the watercourse Drammenselva (Photo: Trond Reitan, NVE)

AFFECTED INFRASTRUCTURE AND DAMAGES

Several landslides, triggered by heavy rainfall, destroyed houses. Many places were evacuated due to imminent danger of landslides or flooding. Finally, several thousand people were evacuated. There was also huge damage to infrastructure, such as roads, railways, industry or farmland. National transport was affected between the three largest cities Oslo, Bergen and Trondheim. For some days, all road- and railway connections between Oslo and Trondheim were closed, and transportation was heavily hampered for several weeks. The main railway between Trondheim and Oslo was disconnected because of a destroyed bridge for over half a year from August 2023 to May 2024.

According to Finans Norge (trade and employers' association for the financial industry in Norway) caused the extreme weather Hans probably the largest costs ever due to natural disaster in Norway. Recovering will take time and be costly. The Norwegian Natural Perils Pool registered over 103,800 damages, with insurance reimbursements estimated at 6.5 billion NOK (approximately 550 million EUR) as of March 2024.

DAM INCIDENT AT BRASEREIDFOSS

The following information is based on a presentation by NVE 11.12.2023 with information from the dam owner (NVE, 2023 b), and the incident investigation report (DNV, 2023). Partly closed spillway gates at Braskereidfoss dam in the river Glomma caused uncontrolled rising water levels, overtopping and finally dam breach on 9th August 4.

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The dam constructed in 1978 provided water to a run-off-the-river power plant. It consisted of a 22,5m high embankment and a concrete dam section (slab buttress), including the spillway gates, and was classified in dam class 1 (low consequence, second lowest of a 5 class-scale, 0-4). Fortunately, there were no fatalities, and the dam breach wave did not increase considerably due to already high flood water levels downstream. The gates were opened 20% around midnight, and in the morning of the 9th of August overtopping of the slab buttress started in the morning. Overtopping of the embankment started at 11:15 and the dam failed at 16:30, see figure 3. The flood discharge was 2100 m³/s at this time, corresponding to a flood with a return period of ca.50 years. The design flood for the dam had a return period of 500 years, corresponding to 3573 m³/s The incident investigation report (DNV, 2023) concludes that the reason was not error or fail of the technical system. The situation was not identified to be severe due to several underlaying reasons, mainly a combination of technical vulnerability and human and organizational circumstances.

The dam incident at Braskereidfoss will probably be presented in more detail in any ICOLD publications or meetings.

Figure 3: Dam Braskereidfoss during the embankment dam failure (Photo: Police/NVE)

Figure 4: Overtopping of the embankment at dam Braskereidfoss (Photo: Politiet/NVE)

FURTHER INFORMATION

More information about the extreme weather Hans and the flooding is available in Norwegian on https://naturhendelser.varsom.no/20230008/oversikt

Drammenselva watercourse includes the lakes Krøderen, Sperillen, Randsfjorden, Tyrifjorden

Glomma watercourse includes the rivers Glomma and Vorma and the lakes Mjøsa and Øyeren.

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FEEDBACK REQUEST

We are always seeking for ways to improve this newsletter content and topical areas, and would welcome your feedback to

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