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Summary

The 85th annual meeting of the International Commission on Large Dams was held in Prague in the Czech Republic in July 2017. This article provides a summary of the events from various UK representatives and covers:

- summaries of the meetings of the technical committees
- the symposium
- technical workshops
- the general assembly
- a report on the European club meeting
- the technical tours
- associated social events.

Notations

None

Keywords

N/A

ICOLD 2017 Annual Meeting in the Czech Republic

1. Introduction

The 85th Annual Meeting of the International Commission on Large Dams (ICOLD) was held in Prague in July 2017. The event was attended by approximately 20 delegates from the UK with representatives from consultants, dam owners, contractors and suppliers. In total, more than 1100 delegates from the great majority of the 100 member countries attended. Over the course of the week the event included:

- An Exhibition from nearly 50 exhibitors
- A Symposium with presentations on nine themes, supplemented with poster exhibits
- Meetings and workshops for the ICOLD technical committees
- Young Engineer Forum (YEF) meeting and social events
- Regional Club meetings including a meeting of EurCOLD
- The General Assembly
- Technical tours to dam sites
- Tours for accompanying persons and other social events

2. Technical Committee Meetings

Committee A - Computational aspects of analysis and design of dams

No report.

Committee B – Seismic Aspects of Dam Design (Ljiljana Spasic-Gril)

During two technical sessions, the following technical matters were presented and discussed:

1. New Zealand, Kaikouro earthquake of 16 November 2016.
   This earthquake was of magnitude M7.8, caused some 100,000 landslides and damaged several small dams. It caused a maximum fault displacement of 12 m and a maximum recorded peak ground acceleration (PGA) of 1.3g. A 150 m-high landslide dam was created. Resonance oscillations in small reservoirs caused seiches that overtopped some of the small dams (run-up > 1 m).

2. Japan, Kumamoto earthquake of 14 April 2016.
   The earthquake had a magnitude M6.5 foreshock and a M 7.3 main shock (Japanese magnitude scale). 670 dams required post-earthquake inspection. Five dams suffered some damage. A fault passes through the Ookirihata Reservoir and water had to be released through the damaged bottom outlet (this dam will be decommissioned).

3. Mr McCann from Stanford University presented a dams and earthquakes database, which includes coordinates and details of 137,000 dams worldwide;

4. The Canadian representative presented an update of the seismic work carried out in British Columbia (BC). This included a 6-year project for a probabilistic seismic

hazard analysis in BC. Earthquakes with magnitudes up to M4.6 were observed in Canada as a result of fracking and waste water injection. Measurements showed that shear wave velocities Vs30 in BC were of the order of 3 km/s, which is considerably higher than the 750 m/s used in building codes for characterising rock.

5. Lessons learnt from the Wenchuan earthquake on the seismic safety of dams (Wang). A presentation was made on the dynamic concrete strength properties of the 132 m-high Shapai roller compacted concrete (RCC) arch dam, which was subjected to a strong ground shaking during the 2008 Wenchuan earthquake. The test results showed that there was no difference in dynamic strength between an RCC and a conventional mass concrete dam. Also, a new seismic hazard map for China was published in 2016. The seismic hazard is generally larger than in previous maps. The Chinese code on seismic design of dams and hydraulic structures is being translated into English.

6. Seismic design aspects of concrete faced rockfill dams (CFRDs), dams with an asphalt core, and dams with other types of liners and internal membranes (working group by Hoeg, Marulanda and Matsumoto). An updated draft report on the seismic design of embankment dams with an asphalt core or facing, prepared by Hoeg, was presented and discussed.

7. Review of nonlinear seismic analysis procedures for concrete and embankment dams (Marulanda and Zenz). A guideline on the nonlinear static and dynamic analysis of concrete dams is being prepared. The United States Society on Dams (USSD) is working on a document on the nonlinear dynamic analysis of embankment dams. This document shall form a basis for a similar ICOLD bulletin. It was proposed to have two separate documents, i.e. one for embankment dams and the other for concrete dams.

8. Interpretation of seismic data obtained from dams (Sasaki and Babbitt (USA)). An update was given by Sasaki, who has done further processing of the recorded strong motion data in Japan. There is also a 3-year French-Japanese cooperation program on seismic reanalysis of concrete dams, in which data from the Japanese strong motion data base were used. The final report is in preparation.

Committee C – Hydraulics for Dams

No report.

Committee D – Concrete Dams (Malcolm Dunstan)

A total of 17 members and 15 observers attended the meeting. Eight bulletins and technical papers are presently included in the committee's terms of reference (ToR). These are:

1. Bulletin 165: Selection of materials for concrete dams

This Bulletin was approved at the 2013 Seattle general assembly and is available on the ICOLD website but still awaits French translation.

2. Update of ICOLD Bulletin 126 (ICOLD, 2003): RCC dams

The whole of the afternoon session was taken up with discussions on this Bulletin. The committee had agreed to update Bulletin 126 at the 2013 Seattle Annual Meeting. Preliminary drafts have been completed for most of the chapters and it was agreed that the principal authors of the drafting sub-committee should meet in the autumn of 2017 so that the final draft could be completed by the end of 2017. The draft could then be submitted to the general assembly for approval at the 2018 Vienna ICOLD congress.

3. Expansion phenomena in concrete dams

An updated draft was discussed. The objective is to have the final draft completed by March 2018 so that it can be submitted to the general assembly for approval at the 2018 Vienna ICOLD Congress.

4. Waterstops and joints

A draft had been prepared but included waterstops for CFRDs. It was agreed that it should be redrafted to only include waterstops and joints in concrete dams.

5. Sustainable concrete dam construction

It was originally agreed that a technical paper should be prepared on low-cement RCC dams with the objective of minimising the energy consumption. There was considerable discussion on this subject and it was concluded that the paper should be expanded to include the total carbon footprint of concrete dams. During construction of Olivenhain dam in California there was a maximum allowable discharge of carbon particulates and every piece of plant on the site had to be included. This limited the volume of RCC that could be placed each day to 12,250 m^3. A decision is needed on whether this should continue to be a technical paper or upgraded to a bulletin (or even if it should be deleted from the ToR).

6. Decommissioning of concrete dams

It was decided to remove this subject from the Concrete Committee's ToR.

7. Database on the physical properties of concrete

Little progress has been made since this was included in the Committee's ToR in 2012. The chairman will discuss whether ICOLD would be willing to maintain the database when/if it is completed.

8. Database on expansion in concrete dams

It was decided to defer this activity until the bulletin on 'Expansion phenomena in concrete dams' had been completed.

It was agreed that the latest version of the database of RCC dams (www.rccdams.co.uk) was very useful and the chairman is to discuss with ICOLD whether it might be worthwhile to expand the database to include all concrete dams so that the ICOLD data could be more readily available and whether ICOLD would be willing to maintain such a database in the future.

There was also a discussion on the future ToR of the committee from 2019 to 2021. The following were ideas put forward:

a) Modern methods for arch dams and arch dam analysis;
b) Raising of concrete dams;
c) A workshop on the 'Performance of RCC facing systems';
d) Performance of concrete dams (in collaboration with the Dam Surveillance Committee);
e) Physical properties of ageing concrete;
f) Guidelines for inspection of ageing concrete dams;
g) Expectations for ageing of concrete dams
h) A framework for estimating the remaining life of ageing concrete dams

The chairman will review these suggestions and prepare a draft ToR for discussion at the next meeting.

Committee E - Embankment Dams (Rod Bridle)

The committee presented a workshop on asphalt concrete embankment dams (ACED) and met with the committee on cemented materials dams. We paid tribute to our Russian (originally USSR) member, Vadim Radchenko, who had retired from the committee.

Asphaltic Core Embankment Dams (ACED) Workshop

The workshop was a prelude to discussion on the near final draft of the ACED Bulletin scheduled for the Technical Committee Meeting. It included presentations on ACED given by specialists on asphalt cores. A Walo representative described a dam with an asphalt core with 6% 70/100 bitumen, limestone powder filler and gneiss aggregates. A Strabag representative described the Sur flood protection dam, constructed in hot conditions in Wadi Fulaji in Oman. An unusual feature was the 800 mm-wide asphalt core. A Viedekke representative described Namvass Dam, constructed in cold conditions in Norway. A difficulty here was that the volume of asphalt was small, insufficient to justify providing a batching plant at the site. The asphalt core material had to be transported in insulated trucks from an existing plant 200 km from the site. After trials, including one in which the bitumen was too hot and separated from the mix, a satisfactory mix and temperature regime was developed. Test panels were completed, as recommended, and with a bitumen content of 7%, the air-voids ratio was 3%, as specified. At Nagore Dam in Spain, about 6,000 m^3 of asphalt was transported for about one hour with satisfactory results.

Professor Wang Weibiao spoke about the 174 m-high Quxue Asphalt Core Dam in a very steep asymmetric gorge in China. ACED was chosen because the core would be vertical on to a plinth across the valley. A concrete faced rockfill dam (CFRD) was considered but rejected because of the

complexities of the peripheral joint location in the steep gorge. RCC was also considered but transporting materials over large distances made the cost too great.

Dr Jean-Pierre Tournier described the La Romaine Dams constructed by Hydro-Quebec in Canada. No moraine materials were present – only bare rocks – and an ACED was the only feasible dam type. The dams have performed very satisfactorily, with little leakage (0-2 l/s), and limited settlements (80-320 mm).

Joint meeting with the Committee on Cemented Soil Dams

The new committee deals with cemented soils (treated with various binders, lime, cement, flyash, blast-furnace slag, etc). The discussion with the Embankment Dams Committee was based on a 2016 draft of the Bulletin on Cemented Soil Dams and related only to clay and loam treated with lime or cement. Cemented sand and gravel would be dealt with separately by updating Bulletin 54 (ICOLD, 1986) 'Soil-Cement to Embankment Dams'. Treating clay with lime is a technique widely used in road construction to improve the workability of clay soils and provide strengthening against dynamic traffic loads on the top of embankments. There was a proposal to use it to build homogeneous cemented clay dams up to a height of 50 m.

Clay environments are limited internationally, but where encountered provide good fill materials for dams, particularly for low permeability cores. Clay foundations are sometimes difficult. High pore pressures resulting from loading in clay fill and foundations often necessitate slow construction rates or foundation drainage e.g. sand drains, to avoid instability. It is not known if treated clay fill would develop 'construction pore pressures'. Cemented clay fill would probably be more brittle than non-treated clay and consequently it may crack as the dam settles on clay foundations. The walls of a treated clay crack would be more resistant to internal erosion than in untreated soil, but tests have shown that, if initiated, erosion would continue at the same rate as in untreated clays. Treated clay might be used for cores in clay dams, but untreated clay would be at least as watertight and more flexible. Consequently treated clay cores appear to offer no advantage. Similarly, in clay environments, cores in materials other than clay also offer no advantage.

Treated clay soils may be useful, following research, for protection against wave damage on upstream slopes, or protection against scour by overtopping flows on downstream slopes.

Technical Committee meeting on Embankment Dams

Vadim Radchenko (Russia) had retired from the Committee. He was our Vice-Chairman and had been a member for many years; he is listed as a committee member in Bulletin 95 of 1994 (ICOLD,

1994) and may have joined long before. He led an interesting life, playing a small part in international events in the world of dams. His father was a very senior engineer in the Russian Army, and became the senior officer commanding in the Russian Sector of (east) Berlin at the end of the World War II. His mother too was a senior Red Army officer, and Vadim showed us photos of family outings to the damaged Reichstag at weekends. Later, following the coups of General Naguib and Colonel Nasser, and the take-over of the Suez Canal, Egypt broke off relations with the 'west' and developed them with the Union of Soviet Socialist Republics (USSR), and Vadim's father was appointed as the Chief Engineer on the construction of the High Aswan Dam in Egypt. Vadim's early civil engineering experience included working as a young engineer on site at Aswan, alongside now very senior Egyptian engineers.

Vadim was a most enthusiastic supporter of our work on internal erosion. He worked hard to transfer Russian guidance on the subject, called 'seepage strength' in Russia, into the Bulletin because it had been successful in building dams resistant to internal erosion in USSR. He arranged a meeting of the ICOLD European Working Group to St Petersburg in 2010 where we visited laboratories and heard presentations from famous Russian engineers on their approaches to resist internal erosion. Some are included in ICOLD Bulletin 164 on Internal Erosion (ICOLD, 2015) but it was difficult to find translations from Russian into English. Professor Jaromir Riha (Czech Republic) hunted through Czech references, with little success. Recently Florian Landstorfer (Austria) found references in an (east) German textbook and made an English translation. We are considering how to make this more widely available.

Proposed Bulletin on Foundation Treatment in Tropical Soils

Little progress had, as yet, been made on the working group, proposed by Past-President Adama Nombre (Burkina Faso) to prepare a bulletin on foundation treatment for embankment dams on tropical soils. Representatives from countries with weathered residual soils in Africa and South America, Indonesia and China may be invited to participate also. Terms of reference were required to initiate action on what would become valuable guidance on this challenging topic. It would add to the existing ICOLD Bulletins on Dams in Residual Soils (ICOLD 2009) and Cut-Offs (ICOLD 2010).

Internal Erosion Bulletin 164 on Internal Erosion in Existing Dams, Dikes and Levees

Volume 1 (ICOLD, 2015) had long been completed in English and French, and is available as a final preprint from the ICOLD website.

Volume 2 (ICOLD, 2016) was complete in English in May 2016 and is available as a preprint from the ICOLD website. Translation into French is in progress by Dr Jean-Jacques Fry (France) and Valerie Frechette (Canada). It should be complete in late 2017.

Last year the possibility of keeping a database of internal erosion incidents was discussed. Michel Poupart (France) already maintains a dam incident database. The Chairman would investigate how this could be accessed. Depending on the detail included, some case histories might be used for back-analysis to calibrate the present understanding of internal erosion mechanics.

Florian Landstorfer's discovery, mentioned above, of references in German to former-USSR 'seepage strength' analyses might also be used in back-analysis.

The 25th Meeting of the ICOLD Working Group on Internal Erosion subsequently met in Delft in September 2017.

Bulletin on Asphaltic Core Embankment Dams (ACED)

Professor Peter Tschernutter (Austria) presented the now almost complete ACED Bulletin. Further commentary had been added with advice from Dr Kaare Hoeg (Norway) and Dr Martin Wieland (Switzerland), Chairman of the ICOLD Seismic Committee, on special measures to be taken near the crest to improve resistance to earthquakes (see Hoeg and Wang, 2017). The Bulletin was very thorough, and the only concern expressed by the committee was that the Bulletin may be too optimistic about ACEDs. They seemed to suit every situation, any climate, were easily constructed, could accommodate foundation settlement (2.2 m at Eberlaste), and were flexible and resistant to earthquakes. Had any difficulties been overlooked in the Bulletin? Alberto Marulanda (Colombia) made the point that the most demanding parts of an asphalt core were at the base and abutments where the core had to be placed by hand. Rodney Bridle (UK) remembered being concerned about the low vertical stress measured below an asphalt core, about 50% of the weight of the core above, which had increased only slightly on impounding. The dam was performing very well in service, with almost no leakage. However, could the situation be more extreme in higher dams, possibly leading to hydraulic fracture when the water pressure from the reservoir exceeded the tensile strength of the asphalt? The issue is recognised and discussed in Hoeg and Wang (2017), and Professor Wang had confirmed that the vertical stress in the core would always exceed the hydraulic pressure. In response to another concern, Professor Tschernutter said that ACED, like most dam types, would not be suitable at sites where substantial movement on faults was expected during earthquakes.

The chairman would ask at the Executive Meeting for agreement to circulate the final draft of the Bulletin to National Committees for comments, leading to final approval by the Executive in 2018.

Bulletin on Geotextiles in Embankment Dams

Danie Badenhorst and Kelvin Legge (South Africa) had circulated the final draft of the update to Bulletin 55 (ICOLD, 1986a) on Geotextiles as Filters and Transitions in Fill Dams for comments. Early comments from France had led to an important change in the title, which is now 'Geotextile Filters in Dams'. This highlighted the new recommendation to use geotextile filters as adjuncts to sand filters in critical situations, such as downstream of cores. The manufactured geotextile filters would provide a consistent filtering capability throughout, and the granular filter, of less consistent filter capability, would settle and adjust in the early years to leakage flows through any cracks or openings, or seepage through coarser more permeable parts of the core, and take over filtering duties if the geotextile filter deteriorated in the long term. This major change was mentioned but not highlighted in the conclusions.

The Bulletin gives comprehensive information and advice on all aspects of geotextiles and geofilters, including constituents and durability, and on positions and placement of geofilters and geotextiles in embankment dams. A coarse filter should be provided downstream of the sand filter if additional drainage capacity is needed. Final approval of the final Bulletin is planned at the Executive Meeting in 2018.

Bulletin on Granular Filters, Drains, Transitions and Slope Protection

Professor Antonio Soriano (Spain) made a full presentation of the proposed content of the bulletin on granular materials in embankment dams (primarily those with clay cores), as filters, transitions, drains and slope protection. This was based on drafts of Spanish guidance. The Bulletin would update Bulletin 95 (ICOLD, 1994) on Filters and Drains. It had been proposed partly because of suggestions to use very fine filters to protect cores in dispersive soils. Discrete element modelling had been used to model fluid flow through pore spaces between particles in transitions. Dr Jean-Pierre Tournier (Canada), Chairman, noted that using the significant wave height (H_s) to derive the D_{50} size-weight of rip-rap results in the movement of smaller sizes when the significant (or larger) wave occurs. For the La Romaine ACED dams in Canada, the significant wave height was used to set the size of the D_{min} rock. This results in larger rock and possibly more transitions, but this is not a difficulty in rock environments.

The Bulletin would include case histories of internal erosion, resulting from filters not being taken to the top of the crest, and ineffective cut-offs and incorrect positioning of filters at an inlet tower and tunnel.

The draft Bulletin in English would be circulated during 2018.

Report on management of dam incidents

Juha Laasonen (Finland) had circulated the Final Report of the ICOLD European Working Group on 'Management of Dam Incidents'. The report is intended to assist dam owners in preparing Incident management handbooks for their dams and in training staff in actions to be taken during incidents. This is in addition to regular inspections, monitoring and maintenance work to avoid 'incidents'. The report uses the ICOLD (1974) definition of an 'incident' which is 'either a failure or an accident, requiring major repair'. 'Failure' and 'accident' are also defined in ICOLD (1974) and quoted in ICOLD (2015).

Oroville Dam

John France (USA) gave a presentation on the damage to the spillway chute at Oroville Dam. He is the Chairman on the Board examining the causes of the extensive damage to the spillway as it passed flood flows. Another board is advising on repairs to the spillway to restore it before floods in winter 2017-18.

Oroville Dam at 235 m (770-ft) is the tallest dam in the United States. It is an embankment dam, completed in 1967. The lower part of the spillway chute was extensively damaged as it passed flood flows in February 2017, following a long period of drought. When the damage was first seen, the spillway gates were closed to limit further damage, and it was intended that the flood flows would pass over the emergency spillway at a higher level. However, there were leaks and back-cutting towards the emergency spillway weir, and much erosion on its unlined outlet chute, leading to fears of failure and the release of a 10 m-high floodwave. This led to the evacuation of 180,000 people downstream. To reduce water level, releases once again had to be made through the damaged main spillway, damaging it further. Eroded materials (over one million m^3) partially blocked the river, raising water level at the power station upstream, making it inoperable and unable to release some of the flood flow. As the water level subsided, emergency work was put in hand to clear the debris, commence repairs and restore operations at the power house.

A report on the causes and lessons to be learnt, particularly whether the causes could affect many dams, is expected later this year. The cause is not immediately obvious because the spillway has passed substantially larger flows in the past without any damage. The dam is upstream of the spillway, and was not affected by the incident.

Mosul Dam, Iraq

David Paul (USA) gave a report on Mosul Dam, an embankment dam completed in 1985, where grouting to mitigate solutioning of gypsum and anhydrite from the foundations is now in progress again, having been interrupted by fighting nearby since about 2014. The team of the Iraq Ministry of Water Resources (MoWR), Trevi Group from Italy, and the U.S. Army Corps of Engineers (USACE), in the role of Engineer-of-Record, assisted by engineers from AECOM, is now mobilised on site. Dave Paul is Dam Safety Officer for the Mosul Dam Task Force which is providing technical support to MoWR to address dam safety issues. An inoperable gate on one of the two bottom outlets has been rehabilitated and both outlets can now be used to control reservoir water level, which is being operated at a lower elevation until re-grouting is complete. The team are also considering options for the future including continuous grouting; a cut-off wall; and the possibility of a replacement dam, or dams downstream to reduce the risk to the lives of the two million people in the flood zone.

Colonel Mike Farrell, a military engineer in the US Army Corps of Engineers (most of our USACE colleagues serve as civilians), who is the Officer Commanding, Mosul Dam Task Force, also gave a talk at the Symposium. He explained that his major military role, assisted by the internal security force of Italian Marines, is to ensure that supplies and people can reach the dam, and to keep the dam, working areas and accommodation secure, with absolutely no access allowed to any fighters, friend or foe.

We can note that the international task force at Mosul is fulfilling ICOLD's objectives for all dams, to keep them safe and able to play their role in maintaining peace and restoring prosperity to the people they serve.

New Bulletins

Suggestions for new or updated Bulletins included:

Cofferdams: Dave Paul (US) would look out recent US guidance on this.

Cracking in embankment dams: Dr Gavan Hunter (Australia) would consider cracking, he would consult Professor Robin Fell, who was active on this issue, particularly cracks on dam crests, potentially vulnerable to concentrated leak erosion during floods.

Dr J-J Fry (France) suggested that a further Bulletin on internal erosion case histories and analyses could be commenced in about 2020.

Committee G - Environment (Tracey Williamson)

The Technical Committee on the Environment was formed in 2012 and had a tenure until 2017. The term of office of the committee was proposed to be extended for three years to 2020. The committee has fourteen country-members and one co-opted member. Seven members were present at the Prague meeting.

Following retirement of the President of the committee, during the Prague meeting, the committee proposed by election the nomination of:

- Jean-Luc Pigeon (France) as President of the Committee on the Environment; and
- Tracey Williamson (UK) as Vice-President of the Committee.

The following new terms of reference were also proposed:

'Integrating dams with the environment: Case studies involving planning, construction and operation of dams demonstrating environmental and socio-economic benefits'.

All proposals were approved at the ICOLD General Assembly.

A tentative programme and structure were discussed in order to produce the new bulletin as a result of the Committee's work at the end of the term of office.

Japan, which is leading a separate task group, updated the committee on their project to review and compare models available worldwide for evaluating the future water quality in reservoirs. A draft report has been completed, comprising fifteen different models, with a comparison of their performance. This will be progressed as a technical paper with the aim to obtain approval to publish this at ICOLD 2018 General Assembly.

Committee H – Dam Safety (Andy Hughes)

The Dam Safety Committee is proposing to replace/rewrite Bulletin 154 (ICOLD, 2017).

The new Bulletin will have the following chapters:

1. Introduction
2. Dam development phases and actions
3. Key issues
4. Overarching safety management systems
5. Engineering principles
6. Conclusion

The dam development phases will discuss elements including a flyover to decide the dam location, quickly followed by hydrological, topographical studies which lead into a feasibility study for one or more sites. Once the project is defined, a number of sites might be examined but eventually one scheme is taken to full design and then onto tendering and construction.

The process often includes the investor, the owners, the designer, proposed site supervisior and contractor.

The key issues section will include risks, both technical and non-technical. The elements of uncertainty and the dealing with natural hazards are widely discussed with respect to risk management. The document will elaborate on the risks in design, site investigation, detailed design, dam construction and constraints, operation and documentation, and operational, maintenance and surveillance manuals.

The bulletin will also cover the importance of emergency preparedness plans and emergency action plans. The key issues section will also consider dam rehabilitation works.

Risks are stated as being dynamic and vary with time and with phases of the project. Risks are also created, for example, when the various roles in the project are not integrated and communication is lacking.

The bulletin will stress the importance of site supervision and the creation of 'as built drawings'.

Safety management systems of all the players in the project, for example, designer, owner and contractor must be integrated to ensure the safety of the project.

The bulletin will also discuss contractual issues and will stress the importance of continuity of the design. The chapter on engineering principles will cover the basics of design, defence of the design principles, safe design principles and safety assessment principles. In each area, detailed information relating to best practice and/or good practice and knowledge and experience will be given.

The Dam Safety Committee database on dam failures and incidents continues. Fields have been added on incident mode, main cause, secondary cause, and detection mode. It is linked to the World Register on Dams and it is likely it will appear on the ICOLD website in about 2 years' time. Tailings dams are not included.

Analysis of consequences and hazard potential for dam failure is progressing. The table of contents and outline has been set. The first draft is about 35% complete. Four have been agreed:

- General characteristics of consequence analysis
- General procedures of consequence analysis
- Examples of applications (various countries)
- Summary of responses to questionnaire on practices

The fundamentals of consequence analysis will be covered and the principles stated will be to ensure an undertaking of the key elements of the natural, cultural, societal and built environments that could be impacted, the use of best practicable methods appropriate to the purpose of the study, undertaken with an assessment of the consequence being evaluated. Other aspects will include the evaluation of intangible consequences and their significance, as well as vulnerable populations and perhaps more importantly limitations of the study methodology and whether the limitations might affect the results. Four levels of consequence analysis are proposed from initial through intermediate to advanced and to comprehensive.

An update on the World Bank study on legal and institutional frameworks for dam safety was given.

There are 60,000 dams registered by ICOLD but more than 19,000 dams are more than 50 years old. The World Bank suggest there are large numbers of deteriorating dams requiring portfolio assessment and management approach. They suggest many countries have strengthened legislation and standards after incidents and accidents.

Currently there are 322 financed projects costing US$72 billion. The World Bank are involved mainly in the East and Far East in the remediation of irrigation and water supply dams but is also financing some government and private hydro schemes. The study has looked at legislative frameworks, the maintenance and surveillance regimes and the financial issues which of course vary widely across the various countries studied.

There is a proposal to produce an ICOLD bulletin for dam safety management for countries that don't have programmes. Two documents are proposed: one gives dam safety guidelines and the second covers developing dam safety regulatory frameworks.

Committee L – Tailings Dams and Waste Lagoons (Mike Cambridge)

The meetings were preceded by the now-conventional ICOLD city tour which normally comprises a gentle 1.5 to 2-hour stroll through city streets. However, for this conference it turned into a 4-hour route march in the heat of the day for many of us; very enjoyable but somewhat tiring. As a result, we welcomed the chance for a restful day in committee on the Monday, discussing the new bulletin.

The formal meeting of the Tailings Dams and Waste Lagoons Committee was preceded by a meeting of the drafting group to discuss the new bulletin entitled 'Tailings dams technology update'. This bulletin is specifically intended for those stakeholders involved in the engineering of tailings dams and details, in particular, new technologies as well as updating geotechnical and geochemical data relating to the performance of extractive waste facilities worldwide. The drafting group comprises delegates from Australia, Brazil, Canada, Chile (unavoidably absent in Prague), South Africa, Sweden, United Kingdom and United States. The tone of the meeting had been set in the preceding months through a series of conference calls during which the final draft was discussed and modified. The Chair presented the latest version for discussion which was approved for final edit by him and for submission to the group and subsequently to the ICOLD committee later in the year.

The formal Technical Committee meeting was chaired by Mr Harvey McLeod (Canada) and attended by representatives from Australia (2), Brazil, Canada (3), Chile, China (3), Finland, France, Iran, Russian Federation, Slovak Republic, South Africa, Sweden, United Kingdom (2), and the United States. The Chair presented the relevant outcomes of the previous day's technical committee meeting and reported, in particular, on the efforts being made to improve translation and timely publication of new bulletins and to improve web access. After a general review of the work of the other committees, current issues of direct interest were presented as follows:

1. The status of the bulletin 'Tailings dams technology update'.
2. The ICOLD tailings dam register currently being co-ordinated by Australia to which the UK is to submit relevant details in the next few months.
3. The proposed new bulletin on instrumentation and monitoring, the scope of which may, subject to discussion, be extended to include elements of inspection and construction quality assurance. This bulletin is to be discussed in detail in Vienna in 2018.

The 'country updates' from each representative involved presentations of trends in each member country, with examples of recent tailing dam design sections as well as new technology and regulation. The key points of each are summarised below:

- Australia: review of the permit design for a new disposal project involving 'dry stacking' of filter tailings, which did not include either closure planning or sustainable post-closure surface management. The meeting agreed that filtered tailings disposal is not the ultimate

panacea, with issues of seismicity, erosion, long-term surface stability, water management and closure remaining major design and cost issues.

- Brazil: following the Sao Marco failure there remain regulatory concerns regarding the adoption of upstream construction systems for new disposal facilities and it is inferred that no future upstream construction designs are likely to be permitted. However, the regulators have not addressed the issue of existing tailings dams designed and operated as upstream systems and these have now become a major concern for all stakeholders.
- Canada: following the Mount Polley Dam Failure and the publication of the expert report, both CDA and MAC guidelines are being reviewed and updated. Publication of some of these guidance documents is scheduled for August 2017 and is awaited with interest. Of note is the re-definition of the role of the engineer of record and of the use of expert review panels/inspecting engineers.
- Chile: the aftermath of the recent 8.8 magnitude earthquake and, in particular, its impact on the country's extensive catalogue of tailings dams is being studied. It was noted that in a country where "five earthquakes are experienced every day before lunchtime" conventional seismic design does not apply and a site-specific approach is essential.
- China: the most up-to-date statistics for the country's extensive catalogue of tailings dams were presented, the highlight of which are the numerous dams more than 200m in height, the highest being 325m. Of this extensive catalogue, 90% are constructed using the upstream system with only 10% via the centreline method. Details of the prevailing Chinese design standard for tailings dams were also reported
- Finland: the current emphasis is on reviewing design performance, particularly for new tailings management facilities.
- Iran: the new construction and design guidelines were presented.
- South Africa: the recent poor performance of a decant system was presented and reviewed.
- Sweden: the report focused on the current updating of the dam inspection guidelines and the modification of the Gruvridas inspection system.
- United Kingdom: 'The hydraulic transport and storage of extractive waste: guidelines to European practice' is to be published by Springer books in 2018 (Cambridge, 2018) with completion of the new EU standard (ongoing) following thereafter. In a valedictory presentation, current UK issues related to risk, consequence and interpretation of regulation were highlighted. The report ended with warnings regarding the risks associated with inappropriate standards and guidelines being adopted by non-EU consultants when working on EU projects, and of the need to develop the next generation of expert members for the ICOLD Committee on Tailings Dams and Waste Lagoons.
- United States: engineering standards and availability of suitable guidance are the current key concerns.

The committee meetings being completed, we enjoyed an excellent dinner with the British and Irish contingent and, though some of us suffered from a surfeit of fried cheese, all parties behaved impeccably in the very convivial surroundings. Our thanks to Tracey for her impeccable organisation.

On our final day, we decided that battling the tourists in Prague city in the heat was not sensible, and we therefore took the boat up the Vlatva River and lunched in comfort to the strains of the local accordionist (thankfully at some distance from our table) whilst admiring the architecture both old and new from midstream. So ends my sojourn as the UK representative on this committee, and I hope that my replacement enjoys the experience, and learns as much as I have.

Committee N – Public Awareness and Education (Alison Bartle)

ICOLD's media manager, Emmanuel Grenier, reported that he was now employed full-time at ICOLD's central office. In addition to monitoring press reports about dams and various other duties, he was currently involved in liaising with the World Water Council, and helping with preparations for ICOLD's input to the next World Water Forum (Brasilia, 2018). He drew attention to ICOLD's updated and redesigned website, which included a number of new features, and the use of more photos to enhance its visual impact.

In referring to negative press coverage about dams, he mentioned a recent article which had appeared in *Nature*, criticising dams in the Amazon river basin, and calling for a 'dam environmental vulnerability index' "to avoid cumulative and far-reaching impact in the future". Discussion followed on the need for individual countries, via their national committees, to identify appropriate spokespersons who would be ready and well qualified to respond to critical media reports. Alison Bartle pointed out that this had been a point strongly recommended in ICOLD's communication plan. This plan, developed 16 years ago and revised, updated and refined at regular intervals, has not been circulated to national committees, and the current members of the committee realised that they were not familiar with it. It was therefore decided to circulate it and review it again. The committee will read it and suggest new updates.

A proposal made some years ago for the production of a video based on the ICOLD 'Dams and the world's water' was discussed again. It was agreed that this would be valuable, but the challenges of financing the project were mentioned. The Chairman suggested deferring this project until a suitable strategy for implementation had been found.

It was agreed last year in Johannesburg that the 1999 ICOLD publication 'Benefits and concerns about dams' (TRCOLD, 1999) was to be reviewed and updated, and the task had been allocated to Alison Bartle. At the meeting, she circulated her initial proposed edits and corrections to the existing document, as well as ideas about additional information which she felt could be usefully added such as case studies which would illustrate some of the points made, and for which information should be easily available, e.g. from published papers. The draft of the proposed revisions has been circulated among the committee members for their comments and additional suggestions.

It was agreed that the original terms of reference of the committee would be reviewed in the coming year.

Committee P - Cemented Material Dams (Peter Mason)

This committee was formed in 2013 and had a tenure until 2017. The Chairman is Dr Jia Jinsheng of China and the deputy, Michel Lino of France.

At an earlier meeting in 2014 it was decided to expand the work of this committee into the production of three separate bulletins covering different types of cemented material dams (CMDs) as follows:

- Hardfill dams

- Rockfill concrete dams
- Soil-cement dams

Recent years have seen a number of dams designed and built using the principles of roller compacted concrete but using material which is much weaker and nearer to cement-bound sands and gravels. The term 'hardfill' has been used to describe this material and the dams concerned are often trapezoidal with similar slopes upstream and downstream but much steeper than would be the case for a fill embankment. The material is essentially porous and so such dams also require a waterproof upstream face, typically formed in reinforced concrete similar to the arrangements used for concrete faced rockfill dams but membranes have now also been used.

The Japanese have developed similar dams which they describe as trapezoidal cement-sand-gravel (CSG) dams as have China who describe them as cement-sand–gravel-rock (CSGR) dams. The Japanese have produced prescriptive guidelines for trapezoidal CSG dams and the Chinese for CSGR dams. At the meeting, an earlier draft of a bulletin attempting to cover all these plus hardfill was replaced by an English version of the prescriptive Chinese code for CSGR dams. It was agreed that this was not acceptable as ICOLD bulletins should reflect and discuss alternative international practice rather than be prescriptive about one. It was agreed that the bulletin would be re-worked to reflect normal ICOLD practice with contributions from all the various countries involved and perhaps using sections which had already been drafted earlier.

Rock-filled concrete (RFC) dams are a very recent innovation from China. They comprise grouted rockfill to form mass concrete. Something similar was attempted in the UK in the 1950s and called 'colcrete', but the results were variable. The Chinese approach comprises placing 300mm and above rockfill in shutters and effectively grouting it up using a small diameter aggregate, super-plasticised concrete. A number of dams have either been completed or are under construction using this technique including arch dams. It features particularly good thermal characteristics with net temperature rises on hydration in the order of only 5 to 8 degrees Celcius as the hydration heat of the cement paste is absorbed into the rockfill. Interlock and shear transfer between layers is of course excellent. It had earlier been agreed to reflect other forms of masonry dam in this bulletin. However, it was agreed in Prague that the focus should be RFC dams and drafted by the Chinese, given their dominance in the area. It was also emphasised, as for hardfill dams, that the bulletin on RFC dams should be a discussion document rather than simply reflecting prescriptive Chinese practice.

Soil-cement dams are those where fine soils such as sand, silt and clay are cemented with a binder such as cement or lime. The lime chemically alters the clay fraction. It is used extensively throughout Europe and can produce significant cost savings when compared to soil-only solutions. Typically, the savings are approximately 40% and it is estimated that approximately 180 Mm^3 of such material is produced in Europe every year. The bulletin will focus on how this can and is being used for dams and hydraulic structures. A draft bulletin is under preparation by the French committee which will be circulated and expanded for wider review. At present more data is needed on where this material has been used on hydraulic structures and also evidence of its long-term performance.

It was agreed that a request would be made to extend the tenure of the committee and that the hardfill and RFC bulletins would proceed first, ideally with drafts available next year in Vienna, followed by the bulletin on soil cement.

All three forms of construction were also covered in a seminar on cemented material dams which covered related examples.

Committee Q – Surveillance and associated technical workshop 'Lessons learnt from case histories' (Ian Hope)

The opening workshop was introduced by the following statement: "*Human achievement is founded upon avoiding previous mistakes. It is often said that we learn a lot more from a project that goes wrong.*"

The ICOLD technical committee for dam surveillance has set out to succinctly disseminate lessons learnt from major incidents and dam failures. These summaries act as an essential signpost to dam engineers in shaping their approach and thinking on current and future projects.

The need for suitable performance monitoring was emphasised by the following quote from Ralph Peck, "*There is no substitute for systematic and intelligent surveillance*". The following hierarchy appeared throughout the afternoon to underpin the strategy of approach: data, information, knowledge, and insight.

The draft bulletin 'Lessons learnt from case histories' comprising summaries of major dam disasters and accidents together with the lessons learnt had been circulated before the conference for comment. This opening workshop was attended by 87 ICOLD representatives, who heard selected summaries from the bulletin. The attendance and interest in the bulletin was particularly encouraging as there were several concurrent workshops that afternoon.

The presentations will be available through the ICOLD website. The opening presentation expanded upon the different types of real time monitoring. Further presentations covered case histories expanding upon the application of real time monitoring. It was interesting to note how the sudden plethora of information from a newly instrumented, existing dam, through a 12-month cycle needed to be understood. The influence of critical variables (seasonal temperature variations, water levels etc.) through annual cycles (compared with previous annual readings for example) had influenced thinking on dam behaviour and occasionally brought new insight.

The use of InSAR data to monitor the slope stability of dams was also presented and discussed. It was accepted that a "general overview of the stability of reservoir slopes can be achieved" however this has served to "determine the areas of movement" in order to target geotechnical monitoring. It was encouraging to note that InSAR was being employed to optimise and not replace topographic monitoring. Pilot trials in Sweden and Spain had concluded that the millimetre accuracies claimed by the marketing fraternity were overstated.

The following day the working group met to discuss the draft bulletin and produce further case histories. There were 21 participants and 8 observers at the meeting. Publication of the bulletin, its translation into French, authorisation of data release and need for more photographs was discussed at length. Currently the bulletin comprises 9 benchmark case histories and 71 case histories from 22 countries.

Figure 1 Technical Committee Q (Surveillance)

Incident reporting was also discussed. Delegate countries outlined respective approaches to the reporting of incidents. It was interesting to note that across the world, behaviours were similar. In Egypt for example, there was very limited voluntary incident reporting because dam owners sought to avoid potential punishment for what could be interpreted as possible maloperation ahead of sharing knowledge. Another common factor came from the perception that smaller, privatised companies were typically more reluctant to release information. Excuses extended to potential concerns over prosecution through to the excuse that insurance companies may use the information. All agreed that the purpose of incident reporting was to learn and not criticise.

The increasing use of drones (unmanned aerial vehicles, UAVs) was also discussed. Generally, an improved picture of dam condition and performance was being established across the world. Increasing legal requirements from the use of this new technology was being experienced by most member countries.

The development of the second bulletin was discussed, its objectives and the techniques used by the dam industry to determine the behaviour of the dam. The layout of the bulletin was debated at length. The tenacity of the new Chairman, Louis Hattingh, from South Africa to steer members through the necessary structure of the bulletin and provide clarity on the frames of reference was evidenced by a completed structure and scope for the bulletin with the full endorsement of all members. The UK representative has volunteered to be a lead contributor on Chapter 5 (Training). Markus Aufleger from Germany delivered a fascinating presentation on dam security and early warning systems in the event of an emerging problem with a dam. He expanded on the perceived dilemma in making inundation maps public in Germany. Delegates expanded on the position in their countries.

Case histories of dam failures were discussed. Following the Teton Dam failure in 1976, the 7.6m-high Kelly Barnes Dam in the USA had failed killing 39 people. Further information is being sought about this incident in preparation for a summarised write up.

The UK representative had submitted a summary of the Taum Sauk failure and lessons learnt in the required format, which was discussed. One key lesson learned was the need to have independent accountability through to board level for dam safety. The most recent event at Oroville and need for release of information to the industry was emphasised. Two papers on the current Oroville incident had previously been circulated by the French and UK representatives.

Committee S – Flood Evaluation and Dam Safety (Alan Warren)

A new bulletin on 'Evaluation of floods and dam safety' is complete in English and is awaiting translation into French.

A number of presentations were made in the morning session. Peter Hill gave an overview of an update to ANCOLD guidelines on 'acceptable floods'. This will not cover flood estimation. A risk-based approach is proposed with the PMF being assigned an exceedance probability (not zero). It will provide guidance on reservoir initial starting level and freeboard requirements. The guide will recommend a risk-based approach with provision for a simplified method for small dams and feasibility studies for large dams. Studies on Probable Maximum Precipitation (PMP) are under way for the south-east and north-eastern territories of Australia, recognising that the greatest uncertainty is for extreme rainfall over large catchment areas.

Brian O'Mahony of ESB gave an update on the River Lee flood incident of 2009 and the court case ruling which found ESB 60% liable for flooding in Cork in relation to reservoir operations. The case has gone to appeal. Similarities with the Brisbane flood of 2011 were discussed.

Bernard Joos (Switzerland) gave an update on new Swiss guidelines on flood safety for dams.

The chairman, Michel Tremblay (Canada) and Kit Yin Ng (USA) gave an overview of the Oroville incident in 2017 from a hydrological perspective. The flood was large but well below the design event for the dam. The incident arose due to structural issues with the main spillway chute.

Michel also gave a presentation on the Ottawa River flooding of 2017 which was in part due to late snowmelt combined with high rainfall.

The committee discussed progress on a further bulletin entitled 'Flood evaluation, hazard determination and risk management'. This will be in four chapters:

1. Effect of combined hydrological events (Kit Yin Ng)
2. Role of flood volume (Michel Tremblay and Bernard Joos)
3. Stochastic approach to flood hazard determination (Zoran Micovic)
4. Forecast for proactive flood risk management (Uwe Müller and Masayuki Kashiwayanagi)

A first complete draft of the bulletin should be available before the end of 2017.

Committee V - Hydromechanical Equipment (Ken Grubb)

ICOLD formed a hydromechanical committee in 2013 and tasked it to "consider and analyse current practices as regards the design, manufacture and maintenance of hydromechanical equipment". It

currently has formal representatives from Australia, Canada. Sweden, Morocco, France, Brazil, Australia, Russia and USA as well as corresponding members from New Zealand and South Africa. Ken Grubb of KGAL Consulting Engineers represents the BDS on this committee.

At previous meetings in Stavanger and Johannesburg, the committee set itself the task of developing a best practice guide in respect of dam protection gates and related machinery.

Meetings of the technical committee have been ongoing, via Skype, throughout 2015, 2016 and 2017, and after some struggle, a draft version of the bulletin was available for review in Prague. This is later than the project deadline originally committed to, but much good work has been incorporated.

The bulletin will incorporate a recommendation to:

- Evaluate hazards and risks
- Demonstrate that the machinery designed is sufficiently reliable to address the risks at all sites new and existing
- Apply a risk-based approach to design and, where involved, design and build contracts.

The current draft recognises that there are differences around the world as to how risks are assessed and legislated for. For instance, there is a difference between the Napoleonic Civil Code and Common Law. The Napoleonic approach allows engineers to fulfil their obligations by proving compliance with a code. The Common Law approach requires risks to be 'as low as reasonably practicable' which may require considerably more to be done.

Other differences in approach relate to valuing lives, which the UK does via an economic analysis of cost versus lives saved, whereas in the USA it is considered distasteful to put a monetary value on lives lost.

Because of the above, the bulletin will avoid being specific as to how the analysis is made. This will allow local preferences to come to the fore.

In addition to design, the bulletin includes recommendations on best practice in respect of construction, testing and maintenance. This will provide much useful reference material for asset owners.

The committee is trying to encourage the sharing of near-miss and accident information in a form which is anonymous in terms of organisation or site names. It is hoped that this will enable greater transparency in respect of opportunities to learn from experience. If any members have incidents or near-miss experiences with hydromechanical equipment protecting dams please feed this through to Ken Grubb who will add the information to the general database that is being assembled.

Committee Y – Climate Change (Steve Usher)

The committee was chaired by Mr Dennis Aelbrecht (France) who started the meeting by giving an overview of each chapter of Bulletin 169 'Global climate change, dams, reservoirs and related water resources' . The bulletin preprint was made available for download from the ICOLD website in January 2017 and is the first bulletin of ICOLD dedicated to climate change. Aelbrecht reported that the process of translating the report into French will be executed by representatives from Cameroon, Canada and France. The target date for completion of the translation work is late 2018.

Committee members then shared climate change related updates from their own countries. Kristoffer Hallberg (Sweden) presented examples of hydropower and the future energy mix in Sweden. He noted a recent study by the Swedish Energy Agency and Swedish Grid looking at the impacts of climate change on generation. He also noted the recent changes to legislation in Sweden and the introduction of climate change to the code of practice for design flow estimation guidelines. Climate change was mentioned in the 2007 revised guidelines and again, more clearly, in the 2015 revision.

George Annandale (USA) then introduced the new RESCON2 software developed with funding from the World Bank. This is an update of the original RESCON (REServoir CONservation) approach developed in 1999 by the World Bank. The research project sets out to develop an approach for the assessment and promotion of sustainable management of reservoirs, with special emphasis on the economic evaluation of sediment management and the promotion of sustainable development. Annandale noted that RESCON 2 assesses, at the pre-feasibility stage, the technical feasibility and economic optimality of sedimentation management approaches, including preliminary assessment of climate change effects.

Following the English language launch of Bulletin 169, the committee members will now begin the next phase of work. Aelbrecht reported the new terms of reference for the committee. The proposed work will explore 'the role of dams and reservoirs in climate change mitigation and adaptation'. This will be achieved by the study of two thematic areas.

Theme 1 will focus on the identification and management of water issues especially as they relate to water shortages and drought management. To address these issues, the contribution of dams and water storage to adaptation and to changes in water resources will be reported. The impacts of climate change to existing water regulated systems and natural water resources will also be investigated alongside the opportunity for new dams and reservoirs to mitigate the impacts of climate change. Finally, case studies especially in semi-arid or arid regions linked to climate change (for example from Africa, Middle-East, Asia, America, South-Europe, Australia), will be presented.

Theme 2 will assess the role of hydropower in climate change mitigation. It will identify climate-linked opportunities for hydropower (including pumped-storage) in the generation mix for new energies and as a balance of intermittent renewable power resources (for example from wind and solar).

Aelbrecht expressed his hope that each of the topics above should include lessons from actual climate adaptation case studies. In particular, the committee will investigate how uncertainties have been handled and how multi-decade time horizons can be appropriately addressed in the adaptation decision-making process.

Other Technical Committees

The other technical committees and UK representatives are:

A: Computational aspects of analysis and design of dams (Loizos Pelecanos)

C: Hydraulics for dams*

F: Engineering activities with the planning process for water resources projects*

I: Public safety around dams*

J: Sedimentation of reservoirs*

K: Integrated operation of hydropower stations and reservoirs*

M: Operation, maintenance and rehabilitation of dams (John Gosden)

O: World register of dams and documentation*

R: Multipurpose water storage (Craig Scott)

T: Prospective and new challenges for dams and reservoirs in the 21st Century (ad hoc committee)*

U: Dams and river basin management*

W: Selection of dam type (ad hoc committee) (Peter Mason)

Z: Capacity building and dams*

The committees marked with an asterisk currently have no UK representative. Information on the progress on bulletin preparation under these committees can be sought from the respective chairmen through the British Dam Society (BDS). The BDS is currently specifically seeking nominees for UK representatives on Committees C, F, I, K, T, Y and Z.

Symposium

The Symposium was split into nine themes:

1. Investigation and application of advanced materials, technologies and solutions in dam engineering
2. Enhancements in dam surveillance systems for dam safety and site security
3. Uncertainties and risk-informed decision making in dam design, construction and operation
4. Balancing technical, socio-economic and environmental aspects of dam engineering
5. Advancements in analysis and design within flood protection reservoirs, levees and tailing dams
6. Recent improvements and modern applications in reservoir and catchment management
7. Design and operational considerations of global climate change, regional droughts and other extreme events
8. Assessment of aging dams considering remaining service life and decommissioning
9. Hydro-electro-mechanical equipment of dams.

A total of 302 papers were published in the Proceedings (ICOLD, 2017) drawn from 459 submitted abstracts. 76 papers from 37 countries were selected for oral presentation in three parallel sessions. There were also 188 poster presentations.

Opening Ceremony (Christine McCulloch)

The 85th Annual Meeting of the International Commission on Large Dams Symposium began with a fanfare, a musical introduction to Prague in the Czech Republic. The 1111 participants included for the first time a delegation from Bhutan, who received a warm welcome from Milan Zukul and Ladislav Satrapa (CZCOLD) as representatives of the 100th member country of ICOLD. Rousing speeches followed to define the purpose of the conference.

Prof. Anton Schleiss, ICOLD President, said that dams had been built since the Middle Ages ("no dams, no beer") but now more ambitious, multipurpose dams were needed for a better world. This required a multi-disciplinary approach to dam building. Pavel Punčochář spoke of the importance of dams in the Czech Republic for mitigating droughts and floods. Climate change would increase this danger of extremes and 65 sites had been reserved for future dam construction.

Michael Rogers (USA, ICOLD Vice President) brought the latest news and interpretations of the Oroville dam incident. Rapid headcutting by water flowing in the emergency spillway came within 2 hours of causing a breach. Excellent first responder co-ordination had evacuated 180,000 people without casualties. A $275m construction contract has been let and spillway recovery was underway. There are 15,000 high hazard dams in the USA which need vigilant maintenance. Lessons from Oroville showed that past performance does not assure future reliability; emergency spillways are service spillways in need of monitoring. Speculation about the incident must be resisted; the facts will only be fully understood with the release of the official report.

Session 1 (Andy Hughes)

Dr Hughes (UK) chaired a session late on Wednesday covering part of Topic 1: investigation and application of advanced materials, technologies and solutions in dam engineering (part IV) and also the design and operational considerations of global climate change, regional droughts and other extreme events.

Negatiater (Iran) et al looked at the behaviour of a galley in an earthfill/rockfill embankment where soil settlement and creep took place. Numerical analysis was used to assess the amount of consolidation settlement along the galley and maximum stresses experienced.

Michael Abebe (Ethiopia) talked about the problems of managing the dams on the Eastern Nile. He pointed out that the flood data analysed by different countries along the Nile gave very different results with widely varying flood estimation techniques varying from country to country. He also pointed out the lack of coordination of the potential impact of these reservoirs in cascade, flood regulations and attenuation in the planning and design process. He recommended putting in place a regional hydrological design standard in guidelines to achieve consistency in approach to design flood estimation down the Nile.

The final paper dealt with the foundation of a 167 m high RCC dam in Laos where a folded zone with several weak horizontal layers were uncovered in the area of the right abutment. Detailed geological investigations including drilling, X-ray, diffraction and computed tomography scanning were used. A multiple wedge and finite element analysis was carried out which resulted in a shear key being designed to penetrate the weak layers and improve the resistance to sliding.

Session 2

No report.

Session 3 Uncertainties and risk-informed decision making in dam design, construction and operation (part 1) (Tracey Williamson)

This session covered uncertainties and risk informed decision making in dam design, construction and operation.

System approach and simulation in risk assessment of dams (Przemyslaw Zielinski)

The opening presentation in this session was delivered by Przemyslaw Zielinski and covered a cascade of seven dams owned by Ontario Power Generation and the total system risk posed by overtopping failure. As the dams were categorised as high or very high consequence, the design criteria for flood flows was the Probable Maximum Flood. The routing of flows through the system was compared to the demand on flow control equipment, and overtopping durations used to determine the risk of failure. These were then compared with the risk profile post-upgrade of the flow control devices and used as justification for investment.

Addressing the Failure Modes of Risk Informed Decision Making (Eric C Halpin, USA)

Eric Halpin of the USA presented an overview of his research into the level of adoption of risk based governance within the dam industry and the factors which contribute to successful risk based decision making. This covered a broad scope ranging from complexity and uncertainty, all the way to the very people who are carrying out the risk assessments and their skill set. Some of the key factors that preclude good risk informed decision making were highlighted such as correctly defining the scope of risk studies as well as transparency within the risk assessment process. The key point from the presentation was to always remember that risk does not bring about challenges, but exposes them so that they can be resolved.

Total risk and seismic hazard analyses of large dams in northwest Anatolia, Turkey (Hasan Tosun)

Hasan Tosun (Turkey) presented details on the Kuzey Edge basin and Gediz basin in the northwest Anatolia region of Turkey. Both basins contain a combined total of 15 dams with a height greater than 35m which are influenced by the graben fault system to the west of Turkey. Deterministic and probabilistic seismic analyses were carried out to evaluate the failure modes of these dams and the results showed that 40% of the assets were within the 'high risk' category. This information has allowed the prioritisation of further analysis and performance improvement works within the region.

Risk Assessment for a dam with a vegetation lined spillway (David Bowles, USA)

David Bowles of the USA presented a case study of the application of quantitative risk assessment in a dam with multiple potential failure modes. The failure modes were service spillway apron break up, embankment toe erosion, embankment overtopping, and erosion of the grass-lined emergency spillway. The paper highlighted the interdependency between each failure mode and how the risk profile changes should one of the failure modes initiate.

Use of quantitative risk results to inform dam safety governance application to Vado Dam (Martin David Galan, Spain)

David Galan Martin (Spain) presented on his team's experience in utilising risk analysis to inform the reservoir safety investment programme at El Vado dam. The main theme of the presentation covered the wide variety of disciplines within the risk analysis team including both civil engineers and geotechnical engineers, as well as risk professionals and asset management colleagues. This team guided the reservoir safety investment decisions made by the owner and operator.

Reliability-based rock erodibility for dam foundations, spillways and tunnels. (Michael George, USA)

The final paper in this session was presented by Michael George (USA) and covered his research into the erodibility of rock foundations on spillways and tunnels. The paper highlights the difficulty in assessing the scour of rock formations and varying parameters that influence this, such as hydraulic load from discharge structures and the inherent strength of the rock itself. The paper highlights that identification of the most influential variables on rock scour allows for site specific risk assessments to take place. The inherent variability of rock structures is noted as the key limiting factor in the applicability of the research, however more experimentation will take place to provide a more inclusive rock erodibility risk appraisal method.

Session 4: Balancing technical, socio-economic and environmental aspects of dam engineering (Christine McCulloch)

Vanier Benoit spoke of Hydro-Quebec's action plan on biodiversity adopted in 2015. 49 studies had measured the impact on biodiversity of 62 hydroelectric generating schemes whilst new mitigation measures, including weirs, fish passages and spawning grounds were introduced to protect fish, amphibians and reptiles. He claimed that biological productivity of only a third of the rivers had declined and a similar number had even improved.

Emmanuel Branche (France) listed the advantages and disadvantages of hydropower infrastructure to identify a Hydropower Sustainability Assessment Protocol. Whilst not all negative impacts can be avoided, many may be minimised, mitigated or compensated. Management of flow regimes, catchment management in co-operation with local communities to control sediment production, bypasses, gated structures for sediment flushing, trapping and filtration were reviewed. To avoid

problems of hungry water flowing from dams, the best action was to keep sediment in the water by flushing.

Andy Hughes (UK) described a difficult scheme to remediate historic dams in a much-loved environment in a large London park, Hampstead Heath. The Eighteenth-Century cascades of reservoirs had been built without adequate spillways and posed a threat to a densely-populated part of London downstream. Opposition to interference with the wooded reservoirs, used for swimming and recreation for hundreds of years, was so great that £3m was spent on consultation and the scheme was only approved after recourse to the High Court. The landscaping of the finished works was given close attention.

Devendra Kumar Sharma (India) reported remarkable success in gaining consent of the affected local people when planning the Thana-Plaun hydroelectric project on Beas river in India. This had been achieved by following the recommendations of the World Commission on Dams and by giving environmental and social issues equal consideration with financial and engineering issues.

Mahdi Zolfagharian (Iran) spoke on mitigation of eutrophication causing algal blooms in a reservoir, Chitgar Lake in N W Tehran. Introduction of fish had not worked but filtration had reduced the phosphate load by 15% in a year.

Session 5

No report.

Session 6 Recent improvements and modern applications in reservoir and catchment management (Christine McCulloch)

Michael Detering (Germany) stressed the importance of calculating sedimentation risks. Too often the response was to do nothing. Yet the results of trapping sediments in reservoirs had far-reaching effects downstream such as the disintegration of the Mississippi delta. The best methods of sediment removal from reservoirs transfer sediment downstream of the dam as well as regaining reservoir volume. There was no one, standard solution but a business case for sediment control should be established when planning reservoirs.

Martin Petkov (Bulgaria) reviewed upgrading and rehabilitation of four dams and a tailings pond in Bulgaria.

Ick Hwan Ko (Korea) described intelligent water facilities operation in the Cisangkuy River Basin, Indonesia. ICT incorporation, involving big data, machine learning, robots, real time monitoring and interactive water supply, had demonstrated the advantages of non-structural coordinated operation and planning.

Bastiaan Kuijper (Netherlands) explained a need to control the level of Lake Ijssel in the Netherlands with climate change causing sea level rise. Two options were possible: either installing huge pumps to maintain the lake level, or reinforcing the dikes surrounding the lake to allow an increase in level. A model has been developed of discharges into the lake and discharge through sluices to analyse these options.

Takahiro Koshiba (Japan) monitored bedload transport rates in Koshibu sediment bypass tunnel with a plate microphone and vibration sensor and, together with laboratory studies, developed a practical calibration formula.

Vicky Ariyanti (Indonesia) explained the importance of the Sabo dams system in managing sediment movement in volcanic catchment management. 2.3 million m^3 of lahar sediment arising from the 2010 Merapi eruption in Indonesia could be retained by 259 Sabo dams as well as use of the stored water for irrigation. Maintenance of safety standards is a challenge.

Session 6

No report

Session 7 (Andy Hughes)

The first paper by Bozorgzadeh (Iran) et al described a Decision Support System (DSS) for planning water resource management. The system described used a series of existing software including Arc GIS, HECRAS, MODSIM etc. The system has been developed to screen the development scenarios for hydropower schemes in Iran.

Antonella Frigerio (Italy) described a very ambitious scheme to address the problems of flooding and drought in Italy. The scheme proposed is likely to cost more than 25 billion dollars and take more than 25 years to complete, and involved building a number of new dams (725 in number) and using existing dams along the Apennines range of hills, stretching the whole length of Italy, and interconnecting them to provide storage and attenuation in times of flood.

Hutton Jesse (USA) described how the remote country of the Metlakatia Indian Community in Alaska suffered water shortage problems in 2015 because of lack of precipitation and also over use. A solution involving an extension of the intake into the main lake which supplied water to the community, Chester Lake, was deemed to be the best solution to their problems. He explained the problems associated with the extremely remote location with no vehicular access necessitating lifting everything by helicopter. The conclusion was that the project was completed on time, safely and below budget.

Session 8 Assessment of aging dams considering remaining service life and decommissioning (Christine McCulloch)

Andy Hughes (UK) related his experience of assessing redundant assets and how to deal with them. Decommissioning was complex and often expensive.

Helmut Stahl (Switzerland) described a practical concept for the safety assessment of small dams developed in response to revision of Swiss Dam Safety Guidelines.

Evgehiy Bellendir (Russia) described methods of assessment of remaining service life and extension of the lifespan of high hydraulic fill storage facilities in Russia, paying attention to pollution control.

Bohuslav Barta (South Africa) described water management in South Africa with 36 inter-basin water transfer schemes. The National Development Plan 2030 (published 2012) calculated “Remaining Useful Life” of medium and large dams and depreciation replacement costs.

Session 9 Hydro-electro-mechanical equipment of dams (Christine McCulloch)

Joshua Vines (Brazil) discussed a British Columbian hydropower project to rebuild a 1940s dam with a turbine bypass system on the Campbell River designed to protect habitats of five salmon species for First Nation, commercial and recreational fishing.

Xiaoyun Wu (China) discussed the Three Gorges dam pinion-toothed, rack-climbing vertical ship lift. This five-step ship lock is the most complicated in the world, designed to withstand earthquakes up to intensity VIII. Vessels up to 100m long and 17.2m wide can be lifted in 4 hours.

Martin Wieland (Switzerland) illustrated, with examples in Iran, seismic aspects of safety-relevant hydro-mechanical and electro-mechanical elements of large storage dams. Shaking might lead to spillway gates not opening whilst rockslides and landslides often presented a delayed threat of overtopping.

Peter Townshend (South Africa) made a strong case for use of automatic spillway gates to remove problems with electro-mechanical gates, particularly in developing countries with dams in remote sites, poor communications, unreliable power supplies, poorly-trained operators and vandalism.

Technical Workshops

TW2 – Specific Traits of Small Dams and Reservoirs (Andy Hughes)

The workshop on small dams covered a wide range of issues. Many of the presentations focussed on dams in the Czech Republic and Germany where the floods in the last 10 years caused many failures. The concept of 'small dam' actually covers most of the dams in the UK. The Germans and Czechs made the point that the floods have been the catalyst to do something about these reservoirs.

One speaker talked about their business of fish production and they owned more than 20,000 ponds rearing large amounts of carp for the food production sector.

Andy Hughes (UK) presented a paper on small dams in the UK covering our legislation, the sort of problems we face and how we resolve the issues, applying 'appropriate engineering' where possible.

2nd Technical Workshop on Cemented Materials Dams (CMD's) (Malcolm Dunstan)

Eight papers were presented to the 2nd Workshop on CMD's.

The first paper was by the co-Chairman of the Workshop Prof. Jinsheng Jia (China). He presented an overview of the various forms of CMDs ranging from the hardfill dam (also known as the cemented sand and gravel (CSG) dam in Japan and cemented sand, gravel and rockfill (CSGR) dam in China), the cemented rockfill dam (CRD), the subject of a paper later in the Workshop, and the cemented soil dam (CSD). Prof. Jia summarized the concepts and principles of the various forms of CMDs and described a number of different dams that had been constructed in China.

The second paper was by the other co-Chairman, Michel Lino (France), who described the feedback from 25 years of experience of the faced-symmetrical hardfill dam (FSHD). The ICOLD CMD Technical Committee database holds details of some 93 hardfill dams of which 87 are complete and six under construction. Of these, 21 are cofferdams, 50 are dams and 16 are other types of structure. Mr Lino concluded that FSHD dams were particularly economic on difficult sites, i.e. those with foundations having poor mechanical properties, severe and/or uncertain floods or high seismic loading.

The third paper was by Malcolm Dunstan (UK) who described two very small early RCC dams constructed in the south-west of England, both being flood alleviation dams. The first, completed in 1982, was Holbeam Wood dam near Newton Abbot. Since it was completed it has operated on five occasions and is estimated to have saved at least £40M of potential damage for a structure that initially cost £0.63M: quite a return on the investment. The second dam was Newmill dam near Truro and was one of the first symmetrical-trapezoidal RCC dams in the world. The shape was necessary because of the very poor foundation.

The fourth paper was by Nario Yasuda (Japan) and was a summary of the long-term performance of two CSG dams in Japan: Tobetsu (52 m high) and Kim (39 m high). The data reviewed was the seepage, the uplift and the displacement of the dams relative to the elevation of the reservoir. The performance of both dams was somewhat different from that found at embankment and traditional concrete gravity dams but there were no abnormalities. Nevertheless, it was recommended that the

monitoring of the dams should continue to obtain a better understanding of how trapezoidal-shaped dams perform.

The fifth paper was by Ali Noorzad (Iran) and was a description of the 33m high Sinesar hardfill that is under construction in Iran. The main features that justified this form of dam were a weak foundation, high seismic loading and the lack of a suitable pozzolan in the area.

The sixth paper was by Francisco Ortega (Spain) and was a comparison of trapezoidal hardfill dams with low-cementitious RCC gravity dams. There are a number of common features, such as the total cementitious content (with little or no pozzolan), the construction methodology and the design of the impermeable membrane on the upstream face. The main differences are the specification of the materials (usually the aggregates used in hardfill do not need to have the quality that is required in an RCC dam), the structural design and the bearing capacity of the foundation.

The seventh paper was by Prof. Feng Lin (China) and was a description of the cemented rockfill dam (CRD). Since the first CRD in 2005, some 60 of these dams have either been completed or are under construction in China. The dams usually have an upstream reinforced concrete face that is placed ahead of the body of the dam. The latter consists of pre-placed large aggregates (up to 300mm in size) into which is pumped high-workability high-strength concrete. As the latter only forms 40 to 45% of the total, the actual cement content is less than in traditional RCC dam.

The eighth, and final, paper was by Daniel Puiatti (France) and was a series of comments on the use of stabilised soils treated with cement or lime for use in the hydraulic structures. These ranged from the lining of canals, to reinforcing the faces of fill dams and to the improvement of cores in embankment dams with lime. This essentially described materials that could be used in CSDs (cemented-soil dams), which are now a sub-set of CMDs.

A wide range of papers were presented to the Workshop but the common feature running through most of the papers was that for a CMD to be economic, a pre-requisite was for the foundation to have poor mechanical properties that were insufficient to support a gravity section.

General Assembly (Tracey Williamson)

Figure 2 Tracey Williamson and Alan Warren representing the BDS (source: www.facebook.com/icoldcigb)

Figure 3 General Assembly representatives (source: www.facebook.com/icoldcigb)

The 85th General Assembly (GA) took place on Friday 7 July 2017 at the Clarion Congress Hotel Prague. Tracey Williamson, Chair of the British Dam Society (BDS), represented the United Kingdom (UK) as the ICOLD voting member, with support from Alan Warren, BDS Vice Chair. Jordan Langdon and Sam Tudor from the BDS Young Professionals attended as observers.

New country applications for membership were received and approved from Angola, Afghanistan and the Kingdom of Bhutan; the latter being the 100th member of ICOLD.

Two new Vice-Presidents (VP) were voted onto the Board; namely, Gerald Zenz of Austria and Jean-Pierre Tournier of Canada. There are two VP posts available for 2018; one from the African region and one from all regions other than Europe, due to two European VPs already in post from this region.

A presentation was given on the arrangements for next year's ICOLD conference in Vienna, Austria. The conference will run from 1st to 8th July 2017 and combine three events; the 86th International Commission of Large Dams (ICOLD) Annual Meeting, the Austrian Commission of Large Dams (ATCOLD) Symposium Hydro Engineering and the 26th ICOLD World Congress. Further information can be found at: https://icoldaustria2018.com/.

The Canadian Dam Association will host ICOLD 2019, the 87th Annual Meeting, between 8th and 14th June 2019 in Ottawa. India will host ICOLD 2020, the 88th Annual Meeting in New Delhi. An invitation was received and approved for France to host the 89th Annual Meeting in Marseille in 2021; and an invitation was received from Iran to host the 90th Annual Meeting in Shiraz in 2022, which will be put to the vote at the GA in Vienna.

Two new Technical Committees were proposed; one on resettlement and one on Levees. Both were approved. It is proposed to nominate a UK representative for the Technical Committee on Levees.

Extensions of the terms of office, new terms of reference, new Chairs, Vice Chairs and Members for Technical Committees were received and approved. This included several new UK representatives and appointments as follows:

- Technical Committee A on Computational Aspects of Analysis and Design of Dams – Loizos Pelecanos approved as the UK Member
- Technical Committee G on the Environment – Tracey Williamson elected to the role of Vice President
- Technical Committee M on Operation, Maintenance and Rehabilitation of Dams – Craig Goff approved as the UK Member to take over from John Gosden
- Technical Committee S on Flood Evaluation and Dam Safety – Alan Warren approved as the UK Member to take over from Martin Airey
- Technical Committee Y on Climate Change – Steve Usher approved as the UK Member to take over from Martin Airey.
- Committee XX Young Engineers Forum (YEF) – Sam Tudor was elected to the ICOLD YEF Board for a three-year term.

The ICOLD Regional Clubs provided an update. The African Club made a presentation on an event held in Morocco, which was not well attended due to funding and other logistical issues. The Asian Club advised about two events that they have held during the last year; one in Japan and another in the region on floods. The Americas Club (known as INCA) spoke about a workshop attended by thirteen countries from INCA. They are currently organising a symposium in Uruguay. Details of the European Club are provided separately in this paper.

A new ICOLD Innovation Award was announced.

Agreement has been reached to publish ICOLD publications with a professional publisher, CRC Press Balkema-Talylor & Francis Group, with the aim to improve worldwide dissemination and speed up publication.

A new 'Technical Dictionary' is accessible on ICOLD's website providing terms in various languages. The website has been refreshed and a regular newsletter is to be started, with requests for articles to be sent to Central Office.

The next World Water Forum, which is held every three years and is attended by more than 20,000 people, will be held in Brasilia in 2018. There will be several sessions on dams.

ICOLD's Board organised and attended the 2nd Africa 2017 conference in Marrakesh in March 2017.

The Secretary General, Michel de Vivo, was re-appointed for a further three years starting on 1 January 2018.

Three reports for publication have been submitted since the last GA as follows:

1. A bulletin preprint from the Technical Committee on Hydraulics for Dams called "Technical advancements in spillway design – progress and innovations from 1985 to 2015" is now available on the ICOLD website.
2. A bulletin preprint from the Technical Committee on Integrated Operation of Hydropower Stations and Reservoirs called "Integrated Operation of Hydropower Stations and Reservoirs" is now available on the ICOLD website.
3. A bulletin preprint from the Ad Hoc Committee on Capacity Building called "Action Plan on Capacity Building" is now available on the ICOLD website.

Honorary Awards were given to Dr Zheng Shouren of China and Joao Francisco Alves Silveira from Brazil.

Other event dates to be aware of:

- The United States Society of Dams (USSD) Annual Conference "A balancing act: dams, levees and ecosystems" from 30th April to 4th May 2018 in Miami.
- The 7th Annual Conference on Water Resources and Renewable Energy Development (ASIA 2018) in Vietnam between 13th and 15th March 2018.
- The 11th European Club Symposium in Crete, Greece in October 2019.

The ICOLD President, Professor Anton Schleiss, then closed the meeting.

Report on the European Club Meeting (Tracey Williamson)

The Board of the European Club (EurCOLD) met on 4 July 2017. Tracey Williamson represented the UK as the EurCOLD Board Member. Alan Warren, BDS Vice Chair, and Chrissy Mitchell (Environment Agency) attended as observers.

The EurCOLD President, Jean-Jacques Fry, welcomed the new representatives and presented a report on the activities of the past year. Then the activities of the four European Working Groups (EWG) were presented as follows:

- **EWG on Internal Erosion in Embankment Dams.** The Chair, Jean-Jacques Fry, provided a short update. A report has been published on the work of this group and is available on the website at http://cnpgb.apambiente.pt/IcoldClub/index.htm

- **EWG on Management of Dam Incidents.** The Chair, Juha Laasonen, advised that the objectives of the EWG were to collect experiences and improve the practices for handling dam incidents. Examples of practices have been collected by sending questionnaires to European Club members. Twelve answers were received from Czech Republic, Finland, France, Wales, England, Italy, the Netherlands, Poland, Slovenia, Norway and Brazil. These were discussed in a meeting in Helsinki, Finland in November 2015 and a report was produced dated June 2017. The intention is that this will be further developed, improved and updated with, for instance, the national incident data and case histories.

- **EWG on Levees and Flood Defences.** The Chair, Remy Tourment, advised that during the 2015 ICOLD Annual Meeting and Congress in Stavanger, the first formal meeting took place, with 33 representatives and observers from 11 countries being present. In 2016, the first draft of an Inventory Report on (characteristics, risks and governance of) Levees, containing chapters from six countries, was presented during the ICOLD Annual Meeting in Johannesburg where it was decided that the topic of Congress Question 103 was to be 'small dams and levees'. The Group met again in Lyon, just before the FLOODrisk2016 conference. A website and first Newsletter (editors IRSTEA and UK Environment Agency respectively) have been produced, see https://lfd-eurcold.irstea.fr/. A scoping workshop for the second EWG Report was hosted in January 2017 by Rijkswaterstaat, and produced a template and starting materials for a 'Dam-Levee comparison' report. Finally, a combined USA-French-Dutch initiative was developed to use the ICOLD Congress in Vienna in 2018 as an opportunity to propose a permanent position within ICOLD for levees. *This proposal was later approved at the Prague ICOLD board meeting.*

- **EWG on Dams and Earthquakes.** The Chair, Jean-Jacques Fry, provided an update on the group's work and first two meetings in St Malo and Rome. He advised that the third meeting and symposium will be held in Lisbon on 18 to 20 April 2018. The following issues will continue to be discussed:
    - The definition of seismic hazards for dams
    - The dynamic behaviour of materials and structures
    - The numerical techniques which need to be tested and validated.

  The outputs are likely to be case studies comparing model results with experimental data, dynamic monitoring and measurements of dam responses under seismic events.
  Further details can be found on: http://ewg2018.lnec.pt

More detailed reports and deliverables from these EWGs can be found at http://cnpgb.apambiente.pt/icoldclub/index.htm

New Ad Hoc Task Forces and EWGs were requested. Guido Mazza from Italy proposed a new ad hoc Task Force on 'Dams and territories: assessment of the relationship between dam owners and host territories'.

ITCOLD, the Italian Committee on Large Dams, has previously set up a Working Group to assess how dam owners' actions have addressed sustainable development and how these are perceived by the other stakeholders in the same territory. The investigation considered the social, economic and environmental role of dams and the relationship between dams and host territories. Whereas negative externalities of dam owners' activity is fully acknowledged, transparent and measurable, positive externalities are usually ignored or only partly appreciated. Indeed, the evaluation of the costs borne by dam owners is not, in general, matched by a similar evaluation of the corresponding benefits for the stakeholders. They now aim to:

- Define possible improvements of the methodology.
- Specialise the methodology according to specific conditions in the countries that decide to apply it.
- Organise possible common events.

An update on the 10th European Club Symposium in Antalya in Turkey was presented and a candidature for the 11th European Club Symposium in Crete in October 2019 was invited and approved by the Board.

A proposal was presented to appoint a new Secretary General for EurCOLD; namely Alfredo Granados García from Spain. The proposal was approved.

The Portuguese Committee Chairman advised that the EurCOLD website had been updated and could be viewed at http://cnpgb.apambiente.pt/IcoldClub/index.htm

The EurCOLD President, Jean-Jacques Fry, closed the meeting.

Technical Tours

Five one-day technical tours were offered to delegates.

Slapy Dam (Ian Hope)

Starting early, on what was to become a very long, hot summers day, 200 ICOLD members embarked by river from central Prague to see the Slapy Dam which lies 40 km upstream. To expand, upstream of Prague lay the Vlata cascade comprising the government owned Vrane, Vltavov and Slapy dam. Further beyond the Slapy dam and beyond the scope of our visit to the Vltava cascade lay two further hydro power plants, Kalmyk and Orlik. To facilitate navigation to the Slapy Dam, each of the lower dams incorporated a lock gate. The preceding months had been very dry and river flows were reduced to about 4 cumecs which was insufficient for navigation. Our destination, the Slapy Dam and its upstream reservoir, some 43km in length, held the solution to creating a navigable river and an additional 79 cumecs was released from the dam starting the day earlier.

The cruise toward the first dam, the Vrane Dam (crest level 203.6m), entailed navigation through the Central Prague locks. Beyond the Vrane Dam, the oldest dam in the cascade, completed in 1935, lay Stechovice Dam (crest level 220.8m), completed in 1945 (Figure 4). Each concrete gravity dam incorporated an electrically operated lock (Figure 5). A very important aspect of our visit was the opportunity for convivial conversation with other ICOLD representatives from member countries.

Figure 4 Approaching the Stechovice Dam with lock

Figure 5 The 20m-high lift within the locks (for scale, note the spectators on the gate)

Our passage up river was greeted by the ringing of bells and blasting of horns from remote holiday retreats. It was becoming clear that the presence on the river of a large, 200-person capacity vessel was rare. So rare in fact that we felt that we were being cast in a re-make of Deliverance! Rarity of our experience was further emphasised when both the crew and captain also took photos of their passage through each lock. Later inspection of tourist cruise routes from Prague demonstrated the rarity of upriver navigation....it just wasn't available. We later learnt that the four licences required for up-river commercial navigation had only been sourced the night before, a process that normally takes four weeks, which was quite an achievement.

Finally we moored amidst trees and disembarked, with our first full view of the Slapy Dam emerging from the forest pathway leading up from the river.

Figure 6 Keen interest as the radial gates start to open

We were afforded a cooling shower as a dramatic discharge followed a demonstration of the opening of the central two of the four radial gates (Figures 6 and 7). Whilst gate opening worked smoothly it was apparent from rusting paint work and cracked concrete that maintenance was perhaps not the highest priority.

Figure 7 Partial radial gate opening

As we traversed the 62 year old dam (crest length 260m) we viewed each of the four gated spillways. We appreciated the opportunity that our hosts, the owner of the dams, Czech Republic and operators, State Enterprise, Povodi Vltavy, afforded us for the visit.

Figure 8 Proud operators from Povodi Vltavy, the dam operators

Partly visible through the trees, from the Slapy dam crest, were the feed and discharge pipelines to the elevated pentagon shaped 5 ha concrete Homole Reservoir, which formed the Stechovice II pumped storage project.

In the afternoon, we visited Konopiste Castle. An ancient castle housing an extremely polished presentation of brutality toward both man and animal. An unduly long wait between arrival at the castle and guided visit enabled the more adventurous to visit the rose garden and witness an afternoon in the life of a peacock.

Our appreciation of the death of and indeed life of Franz Ferdinand d'Este was greatly extended when we visited his castle. To place his lineage into context we were to view an extremely detailed family tree, illustrated as a physical tree that featured Marie Antionette in the lower branches and finally gave fruit to the last owner of the castle, Franz Ferdinand. Franz Ferdinand travelled extensively through nearly three decades, wiping out great swathes of wildlife as he went. He meticulously recorded his kills, often mounting, stuffing and preserving key animal parts. This macabre and frankly shameful collection of animal parts formed the foundation of his decorative approach to every room and hallway in the castle. By the time he was assassinated in 1914, his toll of kills had reached just short of 300,000.

Probably the most valuable collection in the world today of early armourer, guns and rifles was acquired by Franz Ferdinand through a family connection. His mercenary approach to life, emerged early when at the age of 12 he changed his surname to qualify for this inheritance. Curiously many of the guns and rifles were fashioned from ivory and were therefore for exhibition only. Whilst Franz Ferdinand had added to this collection of guns, his private collection of instruments of torture complete with the residues of blood and other bodily fluids appeared to really rock his boat.

The Czech aristocratic tradition of maintaining a captive bear in the castle moat was still being maintained by the current owners of Konopiste Castle, the Czech Republic National Museum. For the unfortunate bear, the final accolade (or insult) that awaits, is to be stuffed and exhibited alongside its predecessors. Slightly less fortunate predecessor bears were those whose incarceration was cut short during WW2. When the SS took charge of the castle the two bears were not tolerated and they were shot. The SS did however maintain tradition and had them stuffed. Today these two bears also form part of the exhibition.

Residing well into the base of Maslow's triangle was our appreciation for a cool room and refreshing drink following a hot and exhausting day.

Nechranice Dam

No report.

Parizov Dam

No report.

Mšeno Dam (Alan Warren)

This tour covered two dams and a chateau in the north of the country.

The delegates first visited the crest of Josefuv Dul (Figure 9) which is the youngest dam in in the Jizerske Mountains. There are two embankments, the main embankment and a significant saddle dam, both of earthfill with an asphaltic concrete facing and with a similar height of approximately 44m. The reservoir is used for water supply and flood protection. Delegates were told not to wander

onto the banks of the reservoir in case of contamination of the raw water. No-one seemed to take any offence! The catchment area did appear unspoilt. The dam was completed in 1982 and appears to have performed well. There was evidence of some patching work having been done to the upstream facing.

Figure 9 Josefuv Dul dam and spillway shaft

The spillway was unusual in featuring a morning glory shaft with interior 'pro-vortex' guide walls. This practice was common in the country in the second half of the 20th Century. A presentation on this approach was provided during the Symposium by Mr Miroslav Brouček of the Czech Technical University. His paper explains that the guide walls can reduce the magnitude of pressure fluctuations within the shaft which might be considered important if the spillway tunnel passes through the dam body rather than though rock, although the devices trade overall hydraulic capacity in relation to more traditional axial flow designs.

The tour then continued to Mšeno Dam (Figure 10) which was completed in 1910. This is a 16 m-high arched gravity dam constructed of granite blocks. The dam is part of a wider scheme of reservoirs and transfer structures to mitigate flooding in the region. It also serves to regulate downstream river flow for industrial water supply and provides hydroelectricity. The region is famous for its glass and artificial jewellery production. It was evident that the reservoir is greatly appreciated by the community with a wide range of recreational activities and parkland around the reservoir.

The dam appears to have performed well. The foundation watertightness had recently been improved by grouting from within a new grouting gallery under the dam.

Figure 10 Mšeno Dam

Dolni Rozinka Tailings Dam

No report.

Associated Social Events

Concert (Christine McCulloch)

The eclectic versatility of dam builders with a cultural hinterland was demonstrated by a memorable musical event to celebrate the Symposium. Delegates, looking unusually smart, gathered in the impressive Rudolfinum concert hall to hear the Prague Radio Symphony orchestra, conducted by Ondrej Lenard, play Czech music by Smetana and Dvořak, culminating in an emotional rendition of the New World Symphony.

British/Irish Dinner (Christine McCulloch)

The British-Irish delegates held a dinner at a traditional Czech restaurant, Restaurace Bredovsky Dvur, in the heart of Prague. With hearty food washed down with golden beer in heavy glass mugs, a convivial meal was enjoyed by nineteen members relishing a chance to exchange anecdotes and interesting experiences.

Figure 11 Dinner guests

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