



**1st IAHR  
Online Forum**

Challenges and trends of hydro-environmental  
solutions and research for water security

5—7 July  
2021

# Hydraulic structures engineering: trends, concerns, and needs

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International Association  
for Hydro-Environment  
Engineering and Research

Hosted by  
Spain Water and IAHR, China



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# Context

- IAHR HSTC LT reflection about future of hydraulic structures engineering



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- IAHR HSTC LT reflection about future of hydraulic structures engineering
- Publication of an opinion paper in WIREs Water journal in 2020

Epicum, S., Crookston, B., Bombardelli, F., Bung, D., Felder, S., Mulligan, S., Oertel, M., and Palermo, M. **Hydraulic structures engineering: an evolving science in a changing world.**  
<https://doi.org/10.1002/wat2.1505>





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# Definitions

- Hydraulic structure: a structure in interaction with water



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Wyaralong Dam (Australia)





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Wyaralong Dam (Australia)



© A. Evette (Irstea)

New Romanche banks downstream  
of Gavet dam (France)





## Definitions

- Hydraulic structure: a structure in interaction with water



Wyaralong Dam (Australia)



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New Romanche banks downstream  
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© transportrail

Pont du Gard (France)

# Definitions

- Hydraulic structure: a structure in interaction with water
- Hydraulic structures engineering: all questions related to the planning, design, construction, operation, management, safety, and sustainability of hydraulic structures





## Hydraulic structures (engineering)

- Critical for water management
- As old as Civilization
- Contribute to development of human societies
- Evolve over time along with scientific understanding



# Hydraulic structures (engineering)

- Critical for water management
- As old as Civilization
- Contribute to development of human societies
- Evolve over time along with scientific understanding

→ Form the foundation of water management worldwide





## But

- Aging infrastructures
- Neglect and underfunding
- More and more conflicting goals
- Changing solicitations and requirements



Nisramont Dam  
(Belgium)





## But

- Aging infrastructures
- Neglect and underfunding
- More and more conflicting goals
- Changing solicitations and requirements
  
- Increasing multidisciplinary & fast evolution in science and engineering



Nisramont Dam  
(Belgium)



# Framework has to continue to evolve

Fundamental role of HS will remain

but with greater consideration of environmental and societal costs

and considering changing environment



# Framework has to continue to evolve

*Economic solution to meet  
single objective at times*







## Framework has to continue to evolve

*Economic solution to meet  
single objective at times*

*Multiple objectives –  
Resilience*





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*Lifecycle management*





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*More comprehensive  
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# Framework has to continue to evolve

*Economic solution to meet  
single objective at times*

*Multiple objectives –  
Resilience*

*Lifecycle management*

*More comprehensive  
approach of global safety*

*Questioning availability*



# New framework for hydraulic structures engineering

## Sustainability of Hydraulic Structures



### Availability

Societal Goals,  
Demands, and  
Expectations;  
Justice and  
Inclusion.



### Stewardship

Existing  
Infrastructure  
and the  
Environment;  
Wise use of  
Resources.



### Global Safety

Public Safety,  
Incidents,  
Potential Failure  
Modes, Hazards.



### Resiliency

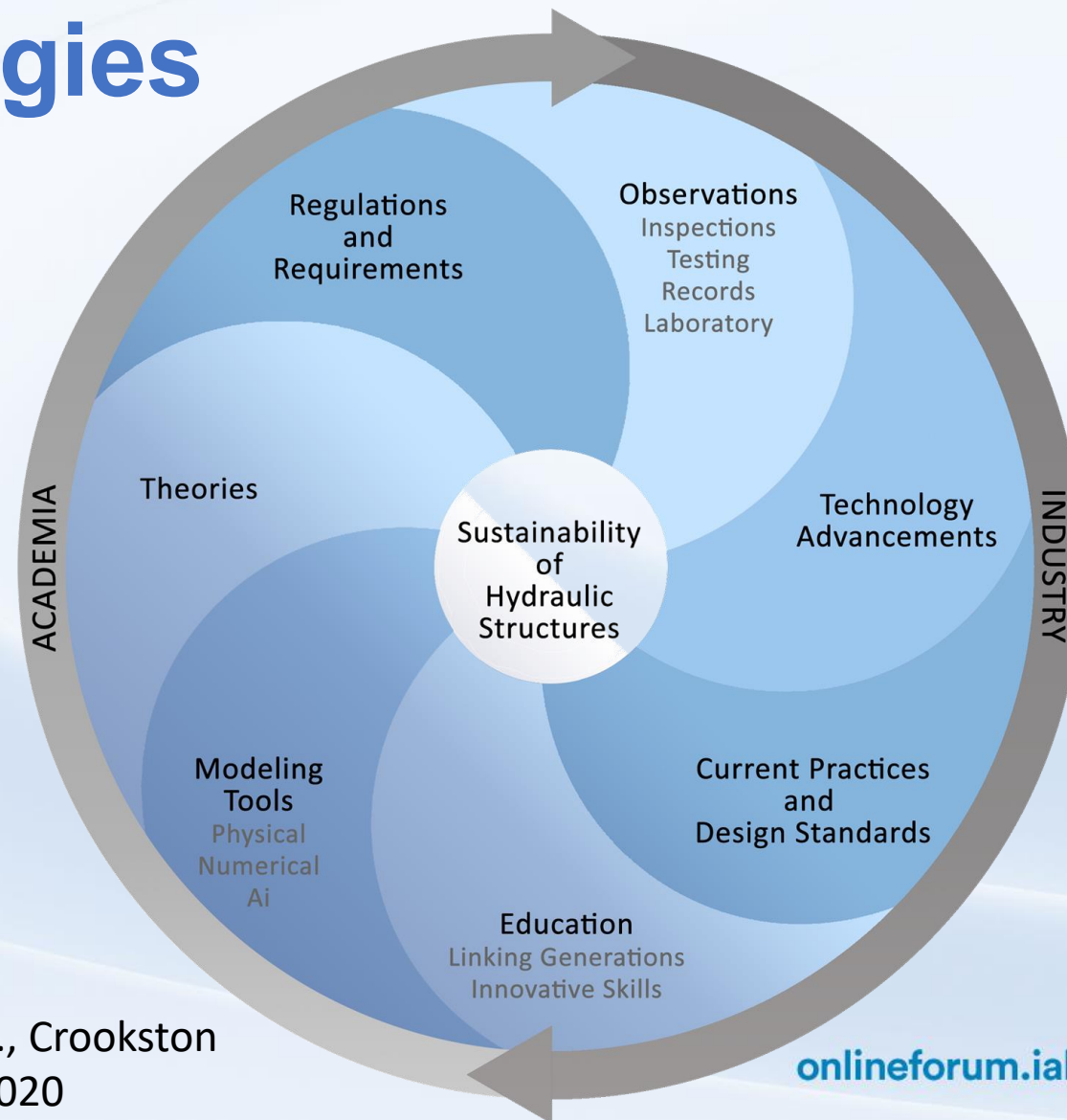
Climate Change,  
Socio-economic  
Change,  
Extreme Events,  
Performance.



### Management

Lifecycle  
Management,  
Risk Management,  
Operations,  
Optimization,  
Standards.

# Tools and methodologies





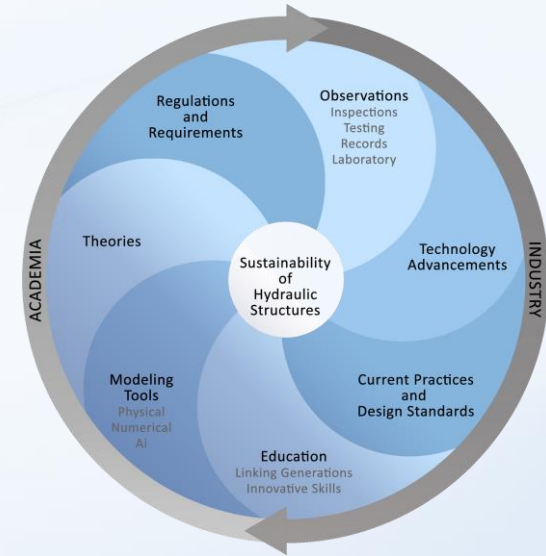


# Tools and methodologies

- Observations



Marèges Dam (France) physical model built in 1933  
close to the dam construction site (Erpicum S.,  
Crookston B. et al., 2020)





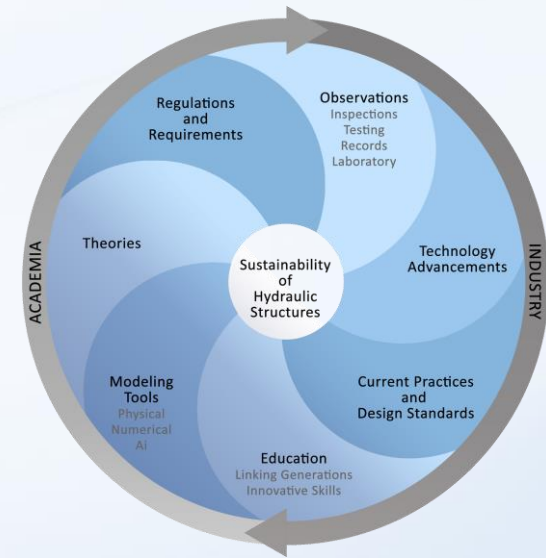


# Tools and methodologies

- Observations
- Advances in technology for data collection



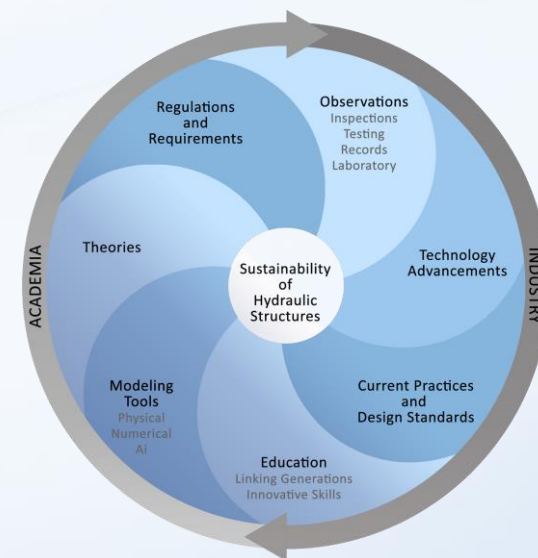
Marèges Dam (France) physical model built in 1933 close to the dam construction site (Erpicum S., Crookston B. et al., 2020)





# Tools and methodologies

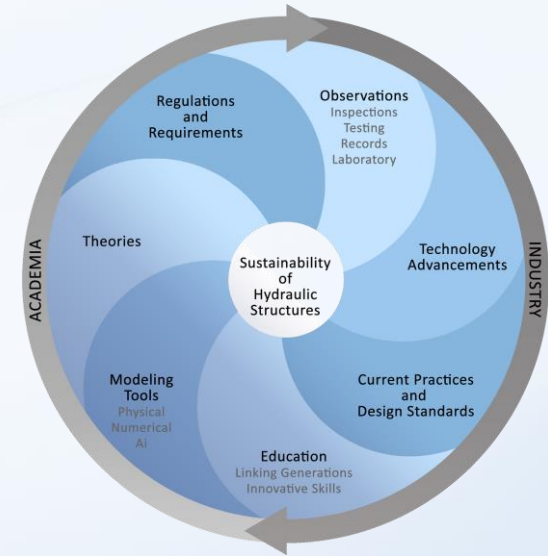
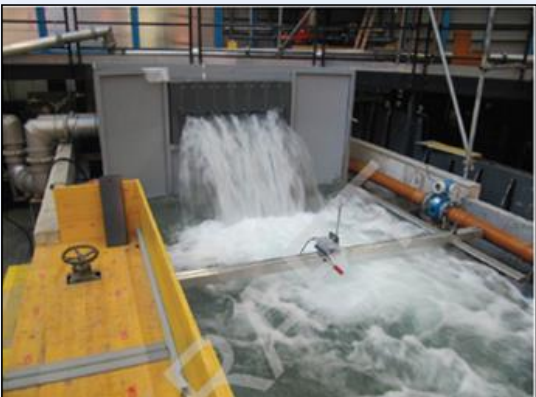
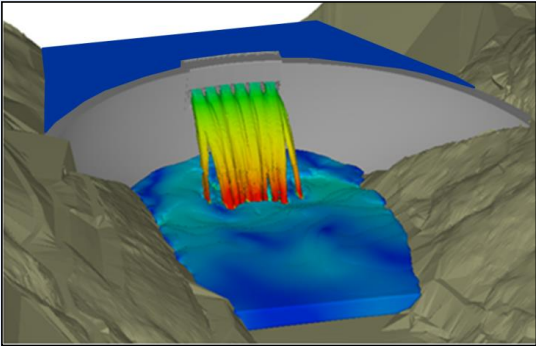
- Theories





# Tools and methodologies

- Theories
- Modeling tools

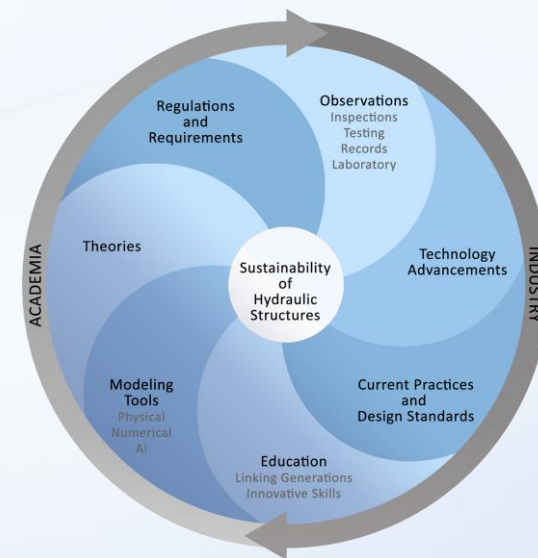


Kariba Dam (Zambia and Zimbabwe) – Numerical and physical model (left), prototype (right) (Daux C. et al., 2017)



# Tools and methodologies

- Regulations and requirements
- Current practice and design standards

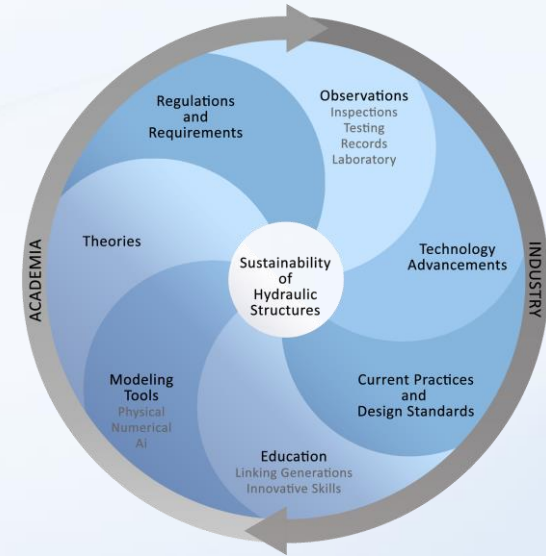






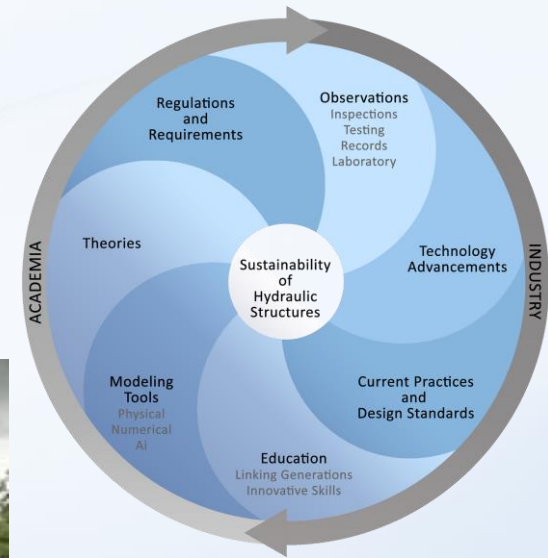
# Tools and methodologies

- Regulations and requirements
- Current practice and design standards
- Education

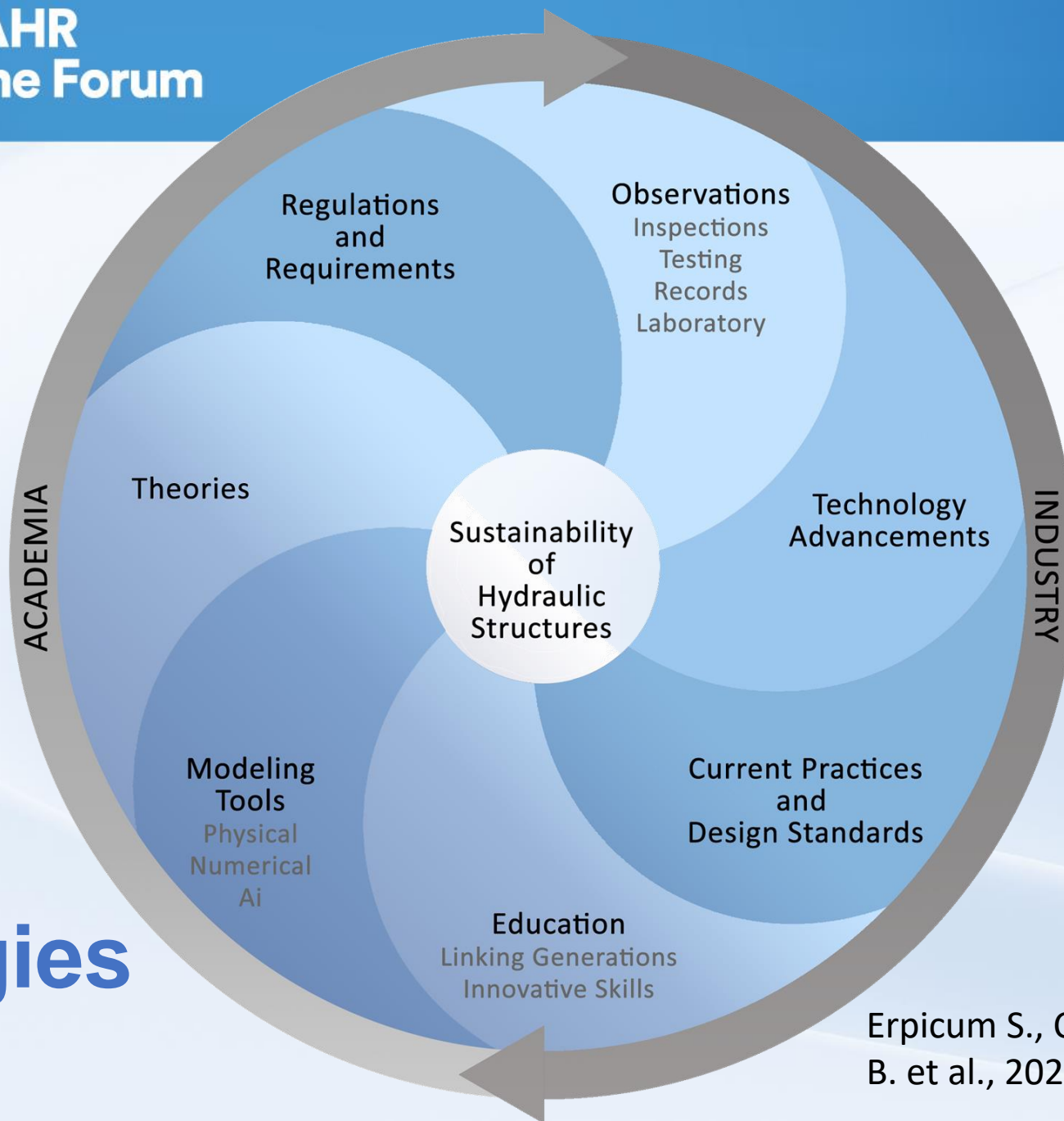


# Tools and methodologies

- Collaboration between research community and industry



Sarrans Dam bottom outlet (France) – 1:35 scale model (left) and prototype (right) (Ercicum et al., 2020)  
[#IAHRonlineforum](https://twitter.com/IAHRonlineforum)



# Tools and methodologies

#IAHROnlineforum

Epicum S., Crookston  
B. et al., 2020

[onlineforum.iahr.org](https://onlineforum.iahr.org)



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# To conclude:

Hydraulic structures engineering:

an evolving science...

... in a changing world





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# To conclude:

Future developments of hydraulic structures engineering require:



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Future developments of hydraulic structures engineering require:

- Continuous updating of tools and methodologies



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- Addressing the lack of detailed field data



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Future developments of hydraulic structures engineering require:

- Continuous updating of tools and methodologies
- Addressing the lack of detailed field data
- Increasing multidisciplinary





## To conclude:

Future developments of hydraulic structures engineering require:

- Continuous updating of tools and methodologies
- Addressing the lack of detailed field data
- Increasing multidisciplinary
- Restoring a strong collaboration between academia and industry

# Thank you for your attention!

Please use the Q/A option to post questions and comments in view of the **roundtable discussion** to be held on Friday 9 Jul, 11:00-12:00 UTC

Friday, 9 July 2021

UTC	Madrid	Beijing	New York
11.00 AM	01.00 PM	07.00 PM	07.00 AM

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Jul. 01, 2021 Jul. 02, 2021 Jul. 05, 2021 Jul. 06, 2021 Jul. 07, 2021 Jul. 08, 2021 **Jul. 09, 2021**

Possible Directions for Hyd...

Livestreaming will start in

05 DAYS	22 HOURS	04 MINUTES	30 SECONDS
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About **Q&A**

Join the chat



## References

- Daux, C., Libaud V., Oukid Y. (2017). Apports et enjeux de la modélisation hydraulique 3D pour la conception et la réhabilitation des ouvrages hydrauliques, Proc. of Colloque CFBR-SHF Hydraulique des barrages, 29-30 Nov 2017 – Chambéry, France
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- Erpicum, S., Crookston, B., Bombardelli, F., Bung, D., Felder, S., Mulligan, S., Oertel, M., and Palermo, M. (2020). Hydraulic structures engineering: an evolving science in a changing world. WIREs Water. 2020; e1505. <https://doi.org/10.1002/wat2.1505>

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