

BEYOND COMPLIANCE

The Future Dam Engineer's Role in Building
Climate-Resilient Water Infrastructure

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WATER IS LIFE - SANITATION IS DIGNITY



water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA



WE INHERITED A SYSTEM BUILT FOR A DIFFERENT CLIMATE

“Every design flood in South Africa’s dam stock was calculated from a rainfall record that assumed the future would look like the past.”



That assumption is the single biggest thing our generation has to fix.

The engineering was excellent. The hydrology behind it was honest about everything except one thing — that the climate itself would move.

WHAT WE HAVE INHERITED

South Africa is no longer a dam-building country. We are a dam-keeping country.

5 700+

dams on the national
Dam Safety Register

1 100+

large dams — 15 m high,
or storing over 3 million
m³

~74%

of the register is earthfill,
the type least forgiving of
overtopping

~66%

of South Africa's mean
annual runoff sits behind
these walls

The build peak was the 1970s and 1980s.

Most of the stock is now 40 to 60 years old. It was designed with slide rules and stationary statistics, for a downstream landscape that has since filled up with people. Very few of you will spend your career designing a new large dam — almost all of you will spend it keeping these ones safe.

COMPLIANCE — THE FLOOR, NOT THE CEILING

National Water Act (Act 36 of 1998), Chapter 12, and the Dam Safety Regulations

1

REGISTER

Any dam with a safety risk must be registered with the Dam Safety Office.

2

CLASSIFY

Category I, II or III — set by the size of the dam and the hazard it poses downstream.

3

CERTIFY

Design, construction and safety evaluation signed off by an Approved Professional Person.

4

RE-EVALUATE

A dam safety evaluation at prescribed intervals — typically every five years.

Compliance proves the dam met a standard. It does not prove the dam is ready for what is coming.

STATIONARITY IS DEAD

The assumption that the past is a fair sample of the future no longer holds.

WHAT WE WERE TAUGHT

- The historic record predicts the future
- One design flood, one answer
- Fixed freeboard, fixed operating rule
- Design once, then inspect forever

WHAT WE ARE SEEING

- Rainfall intensity and seasonality shifting
- Drought and flood back-to-back in one catchment
- Records too short to see the trend they sit inside
- A “1:100 year” flood that no longer means 1 in 100

The design flood methods most of us were trained on rest on records that stop before the trend began.

FOUR PRESSURES ON EVERY EXISTING DAM

1

Non-stationary hydrology

Design floods and spillway capacity derived from a record that no longer represents the catchment's climate.

2

Ageing infrastructure

Concrete, joints, gates, drains and instrumentation reaching or passing the end of their service life.

3

Sedimentation

Storage lost quietly, year on year. Flood routing, outlet capacity and yield all shift with it.

4

Consequence creep

Settlements and infrastructure have grown downstream. The same dam is now a higher-hazard dam.

FROM “DOES IT PASS?” TO “HOW DOES IT BEHAVE?”

COMPLIANCE ASKS

Does this structure meet the standard, today, on paper?

RESILIENCE ASKS

What happens when the load exceeds the standard — and how fast do we see it, absorb it and recover?

FOUR CAPACITIES A RESILIENT DAM SYSTEM NEEDS

SENSE

Instrumented and read in near-real time

ABSORB

Margin designed in beyond the design event

ADAPT

Operating rules that move with conditions

RECOVER

Emergency plans that have been rehearsed

Resilience is not simply a bigger spillway. It is a system that senses, absorbs, adapts and recovers.

THE FUTURE DAM ENGINEER'S TOOLKIT

Six capabilities that will define the next twenty years of this profession.

1

Hydrology under uncertainty

Scenario and probabilistic design — a range, not a single number.

2

Data and instrumentation

Telemetry, live monitoring, gauging that holds up at extreme flows.

3

Risk-informed decisions

Prioritising limited budget across a portfolio of dams, not one.

4

Rehabilitation and raising

Strengthening, re-armouring and raising — where most work now is.

5

Environment and society

Downstream flow needs, catchment health, communities and consent.

6

Digital tools

2D hydraulic modelling, remote sensing, digital twins, ML on sensors.

WHERE THE WORK ACTUALLY IS

“Fewer new dams will be built in South Africa. The emphasis has shifted to the operation, maintenance, rehabilitation and raising of existing dams.” — SANCOLD

OPERATE

MAINTAIN

REHABILITATE

RAISE

RE-PURPOSE

That is not a smaller job. It is a harder one.

Designing a new dam on a clean site is a well-posed problem. Deciding which of two hundred ageing dams gets this year's budget — with incomplete data, a shifting flood estimate and a community living below the wall — is not. That is the work. It takes judgement, and judgement takes a career to build. Start now.

YOU CANNOT MANAGE WHAT YOU CANNOT MEASURE

Design flood estimation, dam safety evaluation, operating rules and flood early warning all rest on the same foundation: reliable flow and rainfall data.

- **Gauging structures that stay honest.** A weir rated only to its design capacity tells you little about the flood that matters most — the one that exceeds it.
- **Spillway ratings that are verified.** Modelled and checked against observation, not inherited from a drawing nobody has questioned in forty years.
- **Instrumentation that is acted on.** Piezometer and seepage readings trended and escalated — not filed.



South Africa holds one of the longest continuous hydrological records on the continent. Its value depends on whether we keep measuring well.

Climate resilience begins at the gauging weir, not at the dam wall.

SANCOLD — WHO WE ARE

The South African National Committee on Large Dams

1965

representing South Africa
on ICOLD since

235

individual members

37

corporate members

100+

ICOLD member countries
you gain access to

OUR FOUR OBJECTIVES

- Educate South Africans on the role of dams in sustainable water resource development
- Build knowledge in the planning, design, construction and management of dams
- Represent South Africa democratically on ICOLD
- Grow collaboration across local industry and with partners across Africa

SANCOLD is deliberately not an engineers-only club: technicians, scientists, environmentalists, social scientists, dam owners and operators all sit in the same room.

WHAT SANCOLD PUTS WITHIN YOUR REACH

Technical committees

Sit alongside the people who wrote the guidelines you work from.

The annual conference

Present a paper, get it published, become known in a small industry.

Training and site visits

Dam surveillance, dam break analysis, rehabilitation of concrete.

Postgraduate scholarships

Funding for research in dam-related fields.

ICOLD

Congresses, annual meetings and the technical bulletin library.

The Register of Large Dams

The national record of the asset base, plus best-practice guides.

Individual and corporate membership — sancold.org.za

THE SANCOLD YOUNG PERSONS FORUM

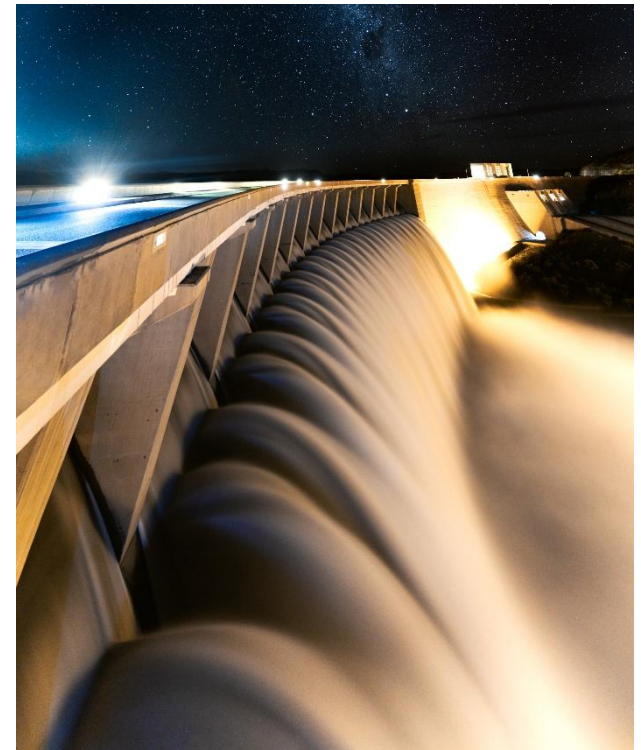
Founded in 2012 as the Young Engineers' Forum, after ICOLD's own forum in 2011. Renamed in 2017 to include everyone in the dam industry, not only engineers.

40 and under

You are automatically a member of the YPF.
Engineers, technicians, scientists, environmentalists
— all welcome.

WHAT WE RUN

- **Webinars** with dam specialists — free, online, and recorded
- **Site visits** to dams under construction, rehabilitation and surveillance
- **Workshops and formal courses** on specialist dam engineering topics
- **Networking socials** alongside the annual conference



The purpose in one line: move knowledge from the generation that built these dams to the generation that must keep them safe.

WHY SPECIALISE IN DAMS

1

A scarce, protected skill

The pool of Approved Professional Persons is small and ageing. This is a specialisation the country cannot import its way out of.

2

Consequence

Few civil structures carry this much downstream. Your judgement protects lives, not only assets.

3

Breadth

Hydrology, geotechnics, structures, mechanical, environmental and social — all in one asset.

4

Longevity

A forty-year career on structures designed to last a hundred.

5

Global mobility

ICOLD makes dam expertise portable across more than a hundred countries.

Nobody drifts into dam engineering.

It is a specialisation you choose — deliberately, and early.

Water security is South Africa's binding constraint. Dams are where that constraint is engineered — and where a career still means something forty years from now.

WHAT TO DO ON MONDAY

- 1 **Join SANCOLD:** sancold.org.za
- 2 **Attend the webinars and YPF socials.** They are free, and they are where you meet the people who do this work.
- 3 **Write a paper for the SANCOLD Annual Conference.** The YPF Best Paper Prize exists specifically for you.
- 4 **Find a mentor who has signed a dam safety evaluation.** Ask them what keeps them awake at night. Then go and work on that.
- 5 **Change the question you ask of your own designs.** Not “does this comply?” but “what happens when the climate does something the record never showed us?”

These dams were built by a generation that assumed the climate was fixed. They will be kept safe by a generation that knows it is not.



THANK YOU

Questions — and please come and find me afterwards.

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