Implementation of Delft-FEWS at Seqwater
Operations, calibration, design and more
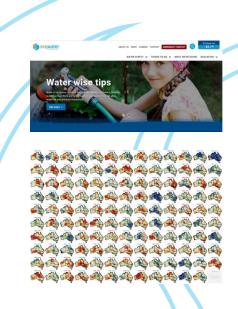
SOURCE STORE SUPPLY

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Presentation overview

1. Overview of Seqwater

2. Australia's rainfall variability

3. Implementation of Delft-FEWS at Seqwater
   - Operational hydrology / dam operations
   - Calibration
   - Design hydrology
   - More…

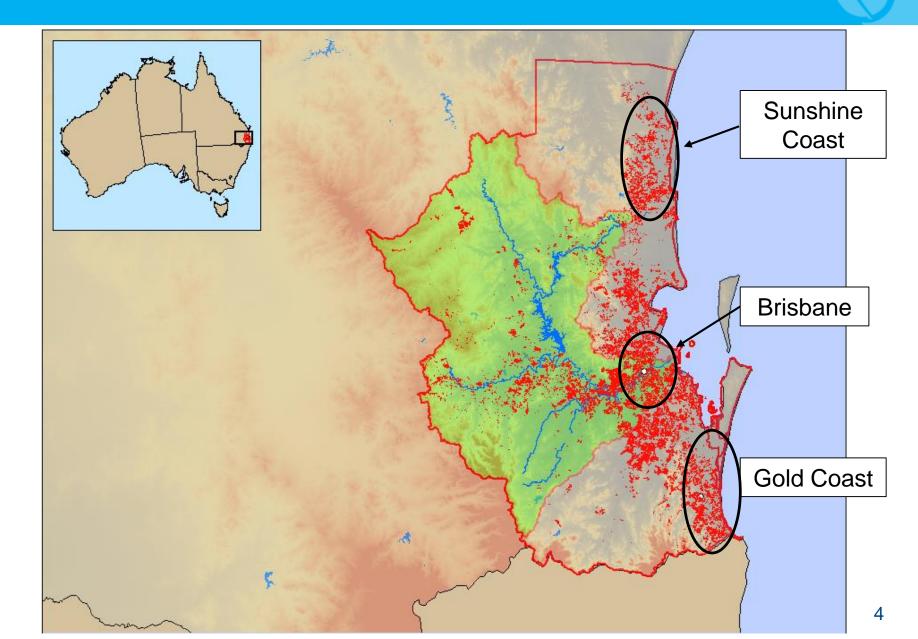
Operations

Design

Calibration

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Part 1: Overview of Seqwater

Queensland Bulk Water Supply Authority
&
The Seqwater Flood Operations Centre

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Seqwater's operational responsibilities

Sunshine Coast

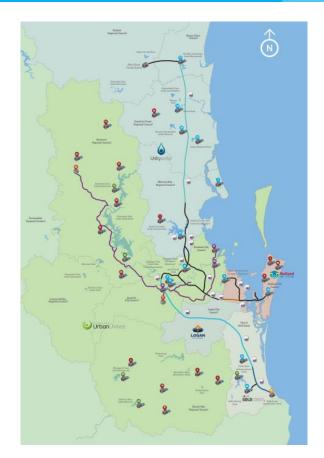Brisbane

Gold Coast

Seqwater's operational responsibilities

Drinking Water
We are responsible for providing a safe, reliable and affordable bulk drinking water supply for 3.2 million people across South East Queensland.

The SEQ Water Grid is a bulk water supply network of:

- 12 dams (connected to the grid)
- 36 conventional water treatment plants
- 3 purified recycled water treatment plants
- 1 desalination plant
- 28 bulk water reservoirs
- 22 pump stations
- 600 km+ of bulk water supply pipelines.

WATER TREATMENT

SEQ WATER GRID

Seqwater's operational responsibilities

Irrigation and catchment management
We manage catchment health and offer community recreation facilities, and provide water for irrigation to about 1,200 farmers across seven water supply schemes.

Seqwater only owns around 65,000 hectares of this land, so it is vital we work in partnership with our neighbours, catchment land owners and the broader community to achieve better land management and water quality outcomes.

Fire management

Catchment management

Irrigation

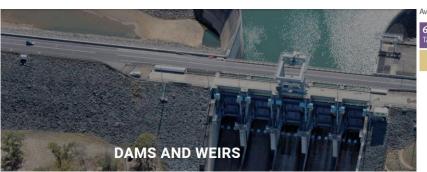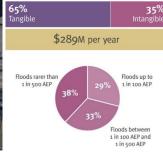

CATCHMENTS

Seqwater's operational responsibilities

Flood Mitigation
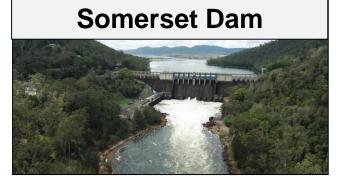We provide essential flood mitigation services

Dam owner:
- 26 referable dams (3 gated dams & 23 ungated dams)
- 51 weirs
- Major populations downstream of gated dams:
  - (Brisbane) Average annual damages: $289M per year
  - (Brisbane) "the damage estimate, should a 1 in 100 (1%) AEP flood occur, is $6.8 billion"

Source: Brisbane River Strategic Floodplain Management Plan, Technical Evidence Report Executive Summary and Recommendations, October 2018

DAMS AND WEIRS

Average Annual Damage

| 65% Tangible | 35% Intangible |

$289M per year

Floods rarer than 1 in 500 AEP — 38%
Floods up to 1 in 100 AEP — 29%
Floods between 1 in 100 AEP and 1 in 500 AEP — 33%

Wivenhoe Dam

Somerset Dam
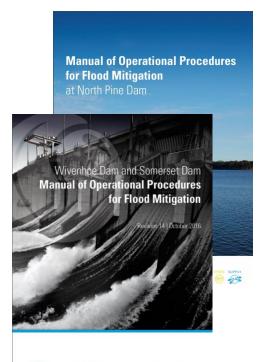

North Pine Dam

Seqwater Flood Operations Centre

The Seqwater Flood Operations Centre's responsibilities include:

- Maintenance and continual improvement of the Flood Forecasting System

- Directing the operations from Wivenhoe Dam, Somerset Dam and North Pine Dam in accordance with a predetermined set of rules (Flood Manuals)

- Communicating, planning and liaising with stakeholders and the community
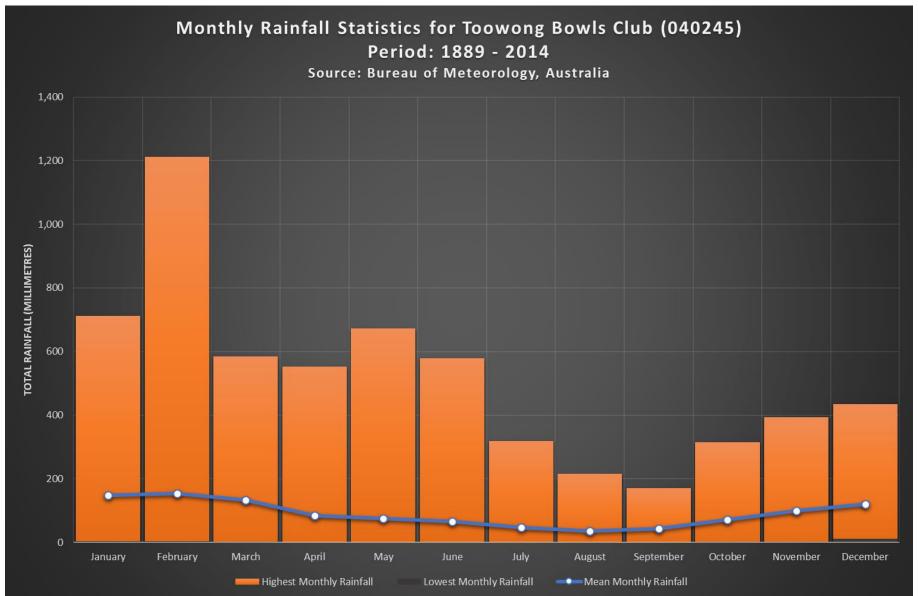
- Training and assessing Flood Operations Centre staff

Flood Forecasting System

Manual of Operational Procedures for Flood Mitigation at North Pine Dam

Wivenhoe Dam and Somerset Dam
Manual of Operational Procedures for Flood Mitigation

Revision 14 | October 2016

Part 2: Climate variability

Climate variability and flooding
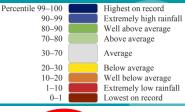
Australia's rainfall variability
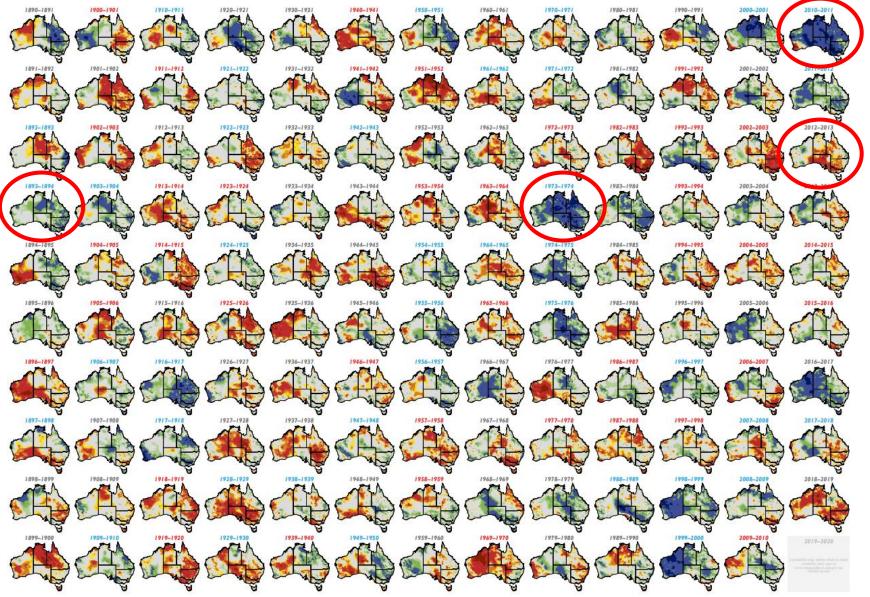
Monthly Rainfall Statistics for Toowong Bowls Club (040245)
Period: 1889 - 2014
Source: Bureau of Meteorology, Australia

Australia's rainfall variability

Percentile		
99–100		Highest on record
90–99		Extremely high rainfall
80–90		Well above average
70–80		Above average
30–70		Average
20–30		Below average
10–20		Well below average
1–10		Extremely low rainfall
0–1		Lowest on record

11
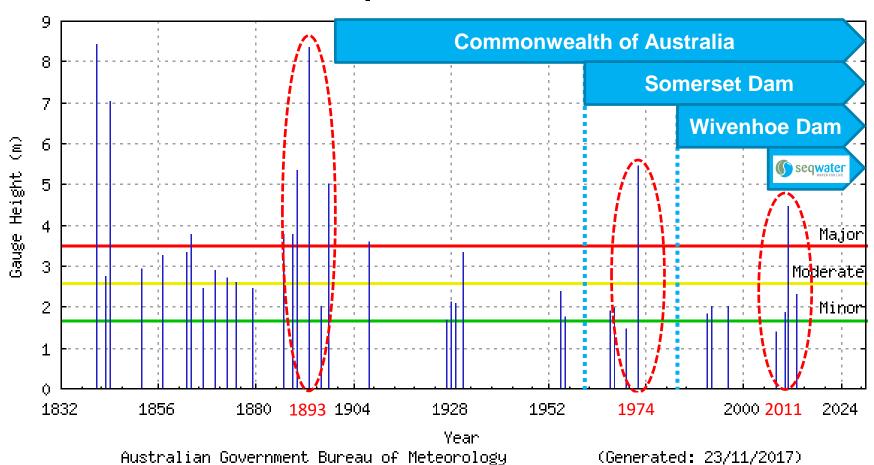
Historical floods in Brisbane
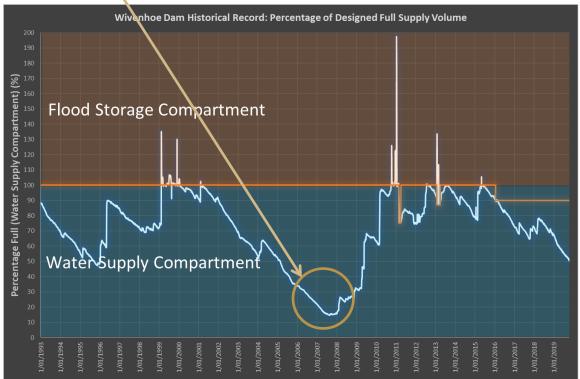
Brisbane R at Port Office #
Highest Annual Flood Peaks

Commonwealth of Australia

Somerset Dam

Wivenhoe Dam

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Major

Moderate

Minor

Australian Government Bureau of Meteorology   (Generated: 23/11/2017)

Source: Known floods in the Brisbane & Bremer River Basin, Bureau of Meteorology. Accessed at: http://www.bom.gov.au/qld/flood/fld_history/brisbane_history.shtml, 12 October 2019

Wivenhoe Dam: Droughts and floods
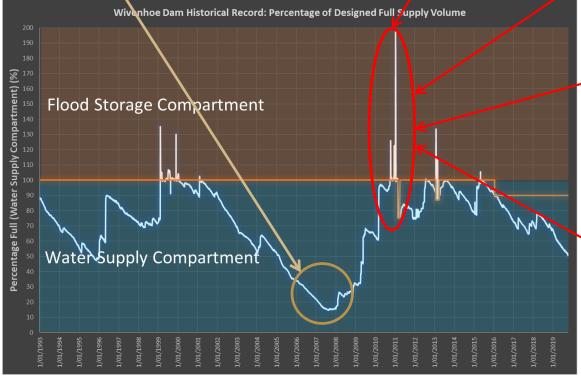
Wivenhoe Dam Water Volume (%)

Wivenhoe Dam: Droughts and floods
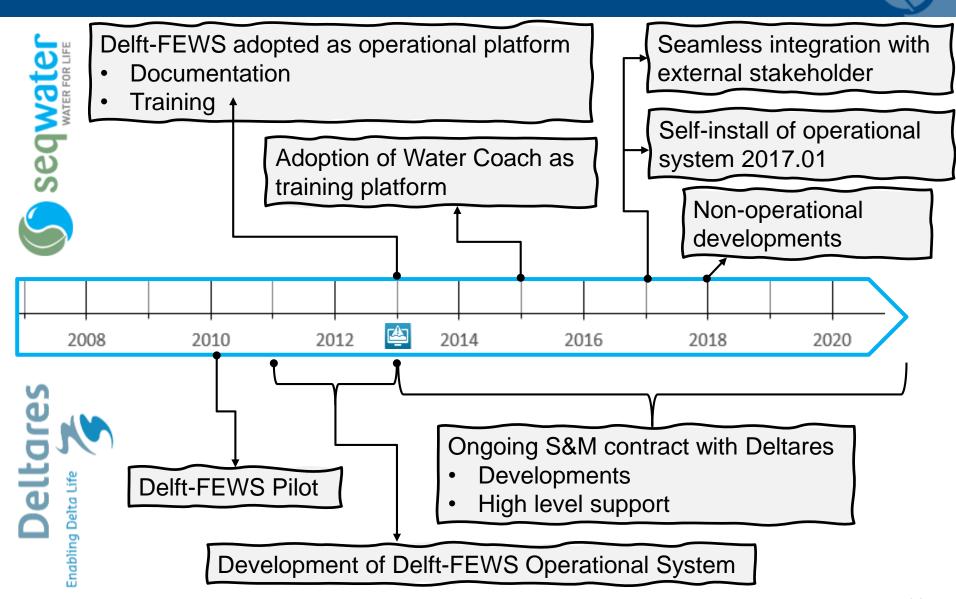
Wivenhoe Dam Water Volume (%)

Part 3: Delft-FEWS at Seqwater

Implementation of an operational system to assist dam operations in south east Queensland

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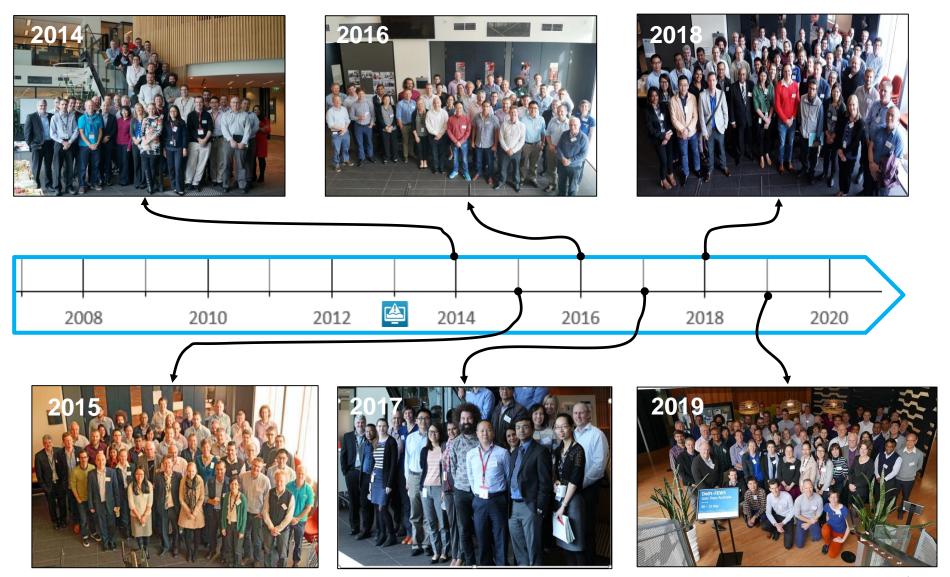
History of Delft-FEWS Implementation at Seqwater

Delft-FEWS adopted as operational platform
- Documentation
- Training

Adoption of Water Coach as training platform

Seamless integration with external stakeholder

Self-install of operational system 2017.01

Non-operational developments

2008   2010   2012   2014   2016   2018   2020

Delft-FEWS Pilot

Ongoing S&M contract with Deltares
- Developments
- High level support

Development of Delft-FEWS Operational System

16

Australian Delft-FEWS User Days
(Co-hosts: Deltares, Bureau of Meteorology, Seqwater)

Delft-FEWS implementation at Seqwater: Operations
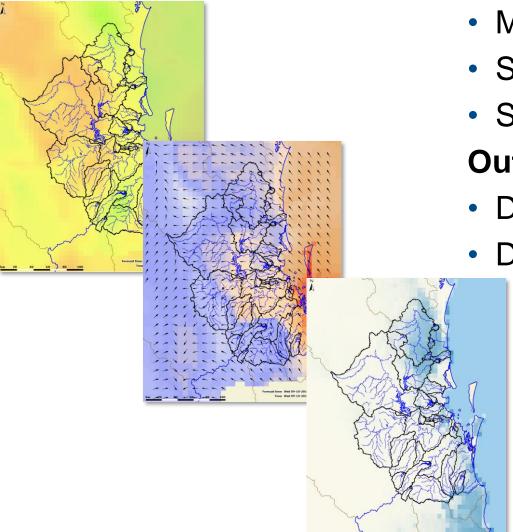
Data

- Real-time ALERT data
- More than 350 water level stations
- More than 500 rainfall stations
- One real-time acoustic doppler current profiler (side-looker)
- Manual readings from site

Delft-FEWS implementation at Seqwater: Operations

Forecasts
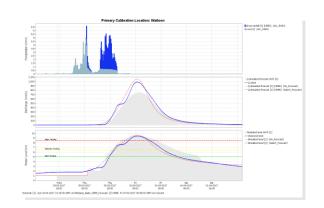
Incoming
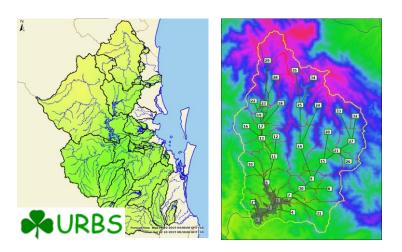
- Meteorological forecasts
- Soil moisture estimates
- Streamflow forecasts
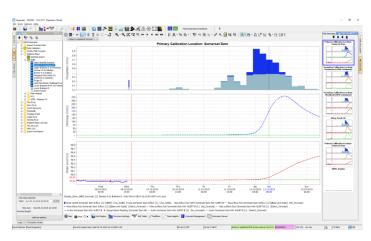
Outgoing

- Dam outflow forecasts
- Dam water level forecasts

Delft-FEWS implementation at Seqwater: Operations

Models

Hydrologic
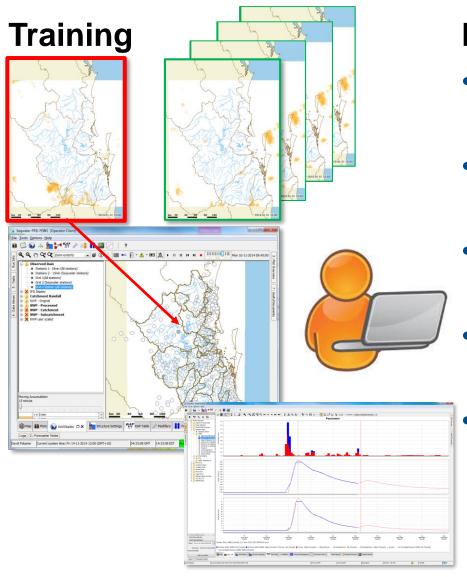
- 29 hydrologic (URBS) models
- Spanning 26 dams and surrounding catchments

Reservoir

- RTC tools v1 for 3 gated dams

Hydraulic
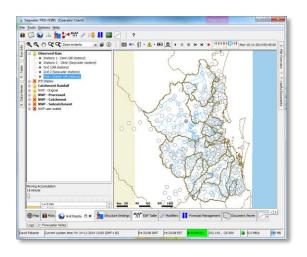
- Mike11
- TUFLOW (under development)

Delft-FEWS implementation at Seqwater: Operations

Training
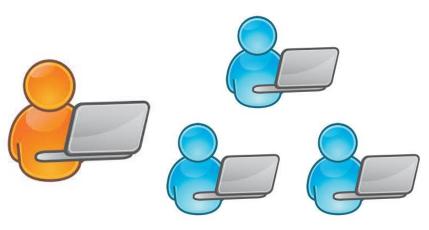
Data driven exercises

- Training sessions seeded by synthetic rainfall
- 'observed' data generated behind the scenes
- Users attempt to match 'hidden' routing parameters
- Extends training dataset beyond historical records
- Utilised to assess competencies

Delft-FEWS implementation at Seqwater: Operations

Training

Fully interactive

- Fully interactive training: Water coach + participant mode
- Realistic internal and external interactions
- Realistic workloads
- Suited to inter-agency exercises
- Scalable

Key rainfall events: SeqFEWS

- **Ex. Tropical Cyclone Oswald: January 2013**
- Ex. Tropical Cyclone Marcia: February 2015
- East coast low: May 2015
- Ex. Tropical Cyclone Debbie: March 2017

January 2013

February 2015

May 2015

March 2017

Key rainfall events: SeqFEWS

- Ex. Tropical Cyclone Oswald: January 2013
- **Ex. Tropical Cyclone Marcia: February 2015**
- East coast low: May 2015
- Ex. Tropical Cyclone Debbie: March 2017

January 2013

February 2015

May 2015

March 2017

Key rainfall events: SeqFEWS

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- Ex. Tropical Cyclone Debbie: March 2017

January 2013

February 2015

May 2015

March 2017

Key rainfall events: SeqFEWS

- Ex. Tropical Cyclone Oswald: January 2013
- Ex. Tropical Cyclone Marcia: February 2015
- East coast low: May 2015
- **Ex. Tropical Cyclone Debbie: March 2017**

January 2013

February 2015

May 2015

March 2017

Part 4: Delft-FEWS at Seqwater
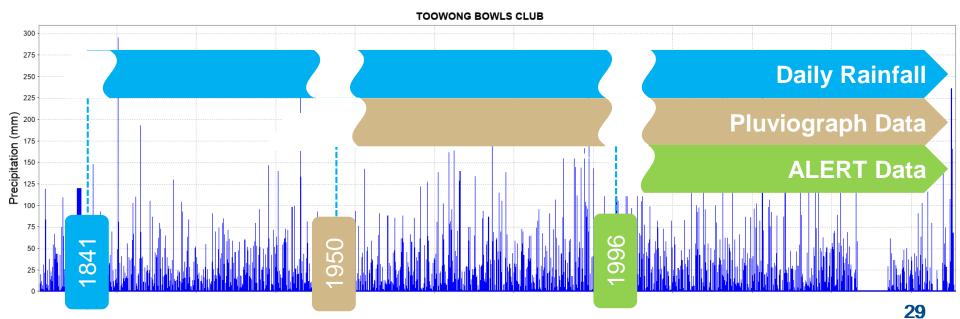
Application to calibration

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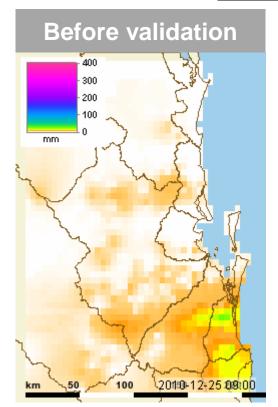
Calibration: underpinning operational models
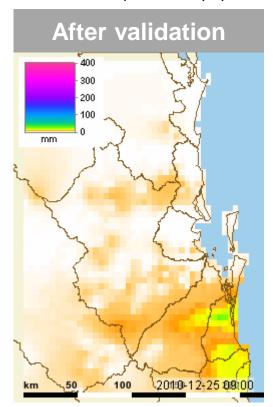
1. **Data**: Primary focus on rainfall: Develop a verified rainfall grid spanning full extent of available data (15 minutes)

2. **QA**: Implement 'some' automated cleaning of data in addition to manual methods

3. **Standardisation**: Standardised calibration reports

4. **Archiving**: Archiving of historical rainfall and water level data and model calibration time series

Delft-FEWS implementation at Seqwater: Calibration

Key feature of Delft-FEWS: Secondary validation: Spatial homogeneity

- *"Overwrites the flag of the timeseries with unreliable or doubtful when the estimation of the value based on neighbouring values differs too much from the observed value"* Spatial homogeneity, Delft-FEWS Wiki.

- **new feature** Allows for filtering based on relative <u>and</u> absolute values for local maximums <u>and/or</u> minimums (or both) (2019.02 onwards)

Before validation

After validation

- Local rainfall maximums are statistically differently to local rainfall minimums
- Parameters can be tuned to filter 'good' and 'bad
- Option to validate one time by series using another*

Key feature of Delft-FEWS: Secondary validation: Spatial homogeneity

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Before validation | After validation

- Local rainfall maximums are statistically differently to local rainfall minimums
- Parameters can be tuned to filter 'good' and 'bad
- Option to validate one time by series using another*

Key feature of Delft FEWS: Disaggregation: accumulative reference pattern

- Nearest pluviograph used to disaggregate daily rainfall
- Provide automated method to disaggregate large amounts of data
- Extending the usefulness of daily data to sub-daily time scales

Delft-FEWS implementation at Seqwater: Calibration

Calibration process and reporting

Part 5: Delft-FEWS at Seqwater

Application to design hydrology

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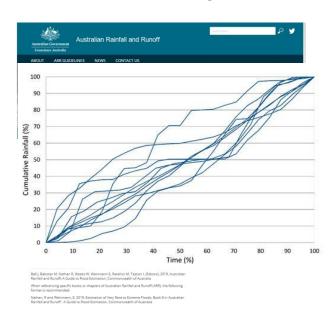
Delft-FEWS implementation at Seqwater: Design
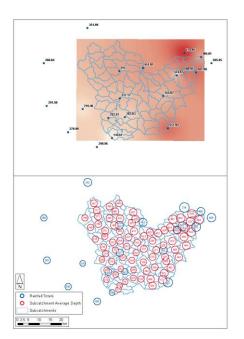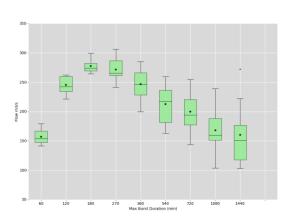
Opportunity

Updates to the Australian guidelines presented many challenges surrounding data management:

- 10+ temporal patterns per AEP and duration (typically 2400 simulations per catchment)
- Various approaches to estimate spatial patterns
- Post-processing of results

Source: Australian rainfall and runoff. Accessed at http://arr.ga.gov.au/

Delft-FEWS implementation at Seqwater: Design
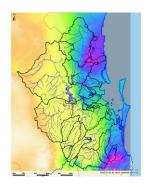
Key functions of Delft-FEWS supporting design hydrology*:*
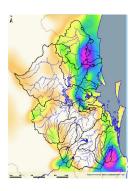
Configuration
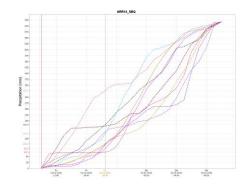
- *Workflow templates and locationSets*: allows for rapid application to other catchments

- *Parallel running of ensembles:* complete utilization of CPU. Faster run times

- *Timeseries element in Filters.xml*: Efficient way to configure visualization of ensemble members
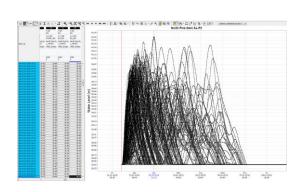
Visualisations

- *Grid display:* No separation of temporal and spatial patterns (space-time grids)

- *Filters display:* Filter ensemble results using location, parameter and qualifier,

- *Report module:* Exporting of critical data
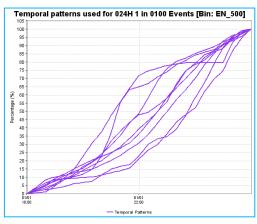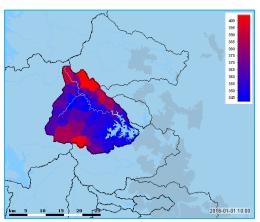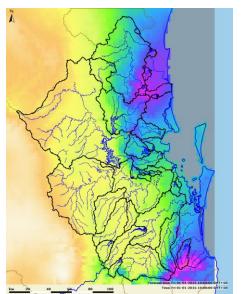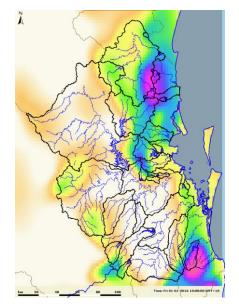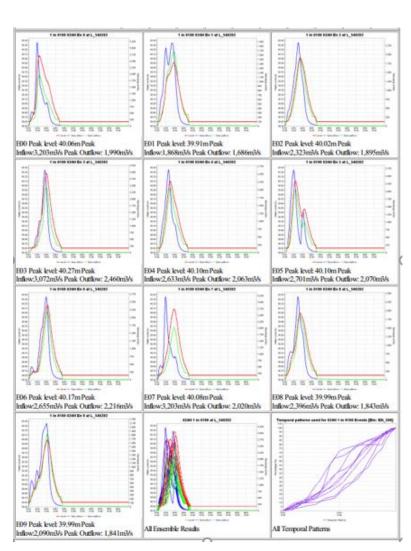
Example of report outputs

Delft-FEWS implementation at Seqwater: Design HTML report

Beyond static reports: interactive web reports

- Summaries of all the design inputs and results
- Easily distributed to stakeholders
- Results exported from FEWS in different formats
- Combination of HTML, JavaScript, Memory variables

Part 6: Delft-FEWS at Seqwater

…and more
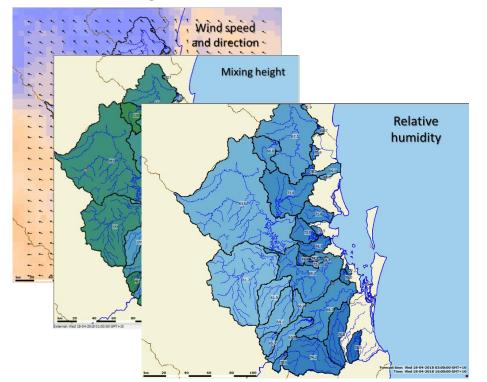
Delft-FEWS at Seqwater: Beyond flood operations

Fire management at Seqwater (Pilot)

- Land occupier: *Queensland Fire and Emergency Services Act 1990*
- Responsible for management of fuel, hazard and fire
- Burn season: February - August

Implementation using Delft-FEWS

- Providing critical information to decision makers

Closing remarks

Variable climate

- **Rainfall variability:** Australia is a country "of droughts and flooding rains"
- **Flood operations:** Floods don't happen in south east Queensland every year, although the FOC is continually in a state of readiness

Delft-FEWS Implementation

- **Operational system implementation:** Pilot: 2010, operational 2013. Many ongoing improvements. Now the primary modelling platform providing important data to internal and external stakeholders.
- **Calibration in Delft-FEWS**: Preparing a quality controlled standardized dataset. Possibilities for testing other models, continuous simulation, rainfall analysis
- **Design hydrology in Delft-FEWS**: Suited to bulk processing of new design rainfall data and application to all catchments with south east Queensland
- **Delft-FEWS Community:** Seqwater is an active member of the Australian Delft-FEWS community: knowledge sharing and the Australian Delft-FEWS User Days

The future…

- Dam operations: workshops next…

Delft-FEWS at Seqwater

Thank you

Questions?

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