Presentation Structure

- Introduction
- Continuous water supply VS intermittent
- IWS statistics
- Growing population
- Water scarcity chart
- IWS – average supply hours
- IWS via CWS networks
- New IWS index
- How to if one had to?

Introduction

- Without water, life cannot be sustained
- Adequate water supply is normally defined as continuous water supply, of acceptable quality and at reasonable supply pressure

Continuous Water Supply (CWS)

- Most water supply systems around the world are conceptually designed for continuous water supply (CWS)
- These systems remain pressurised for 24 hours per day, every day

Intermittent Water Supply (IWS)

- Intermittent water supply: when water is distributed to users for less than 24 hours per day
  - ✓ Long term strategy
  - ✓ Short term / O&M / unplanned
- IWS more common in developing countries
- IWS mostly out of necessity, often because:
  - ✓ Insufficient raw water available
  - ✓ Limited hydraulic capacity
  - ✓ Financial constraints preventing CWS

IWS Statistics

- IWS is experienced by:
- $^1/_3$ of total population in Africa,
- $^1/_2$ of total population in Asia,
- and $^2/_3$ of total population in Latin America

…where piped water supply is available

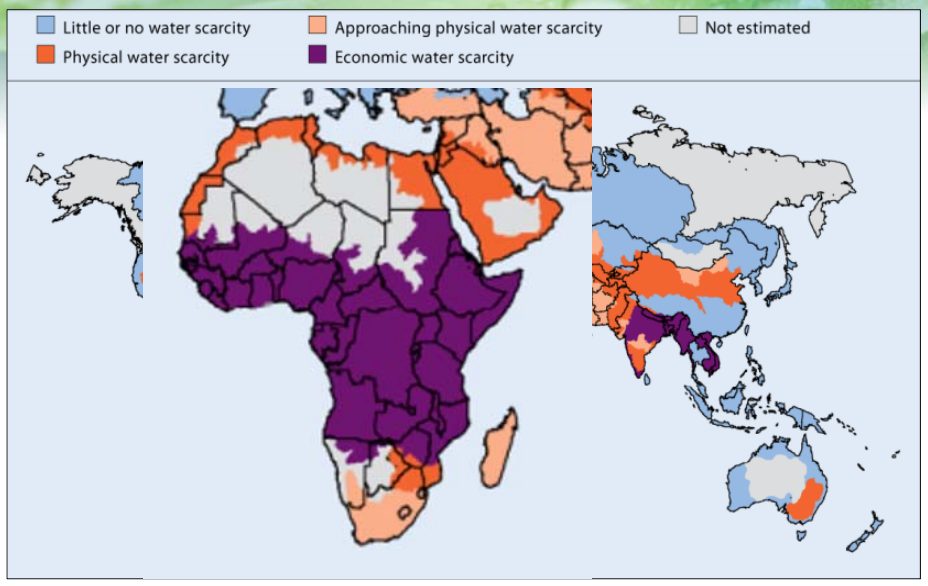
Growing population

- Water Supply Authorities' biggest challenge - growing global population
- 83 million more people every year
- In the previous 12 years the global population grew by 1 billion people
- In total: ~7.6 billion people by mid 2017

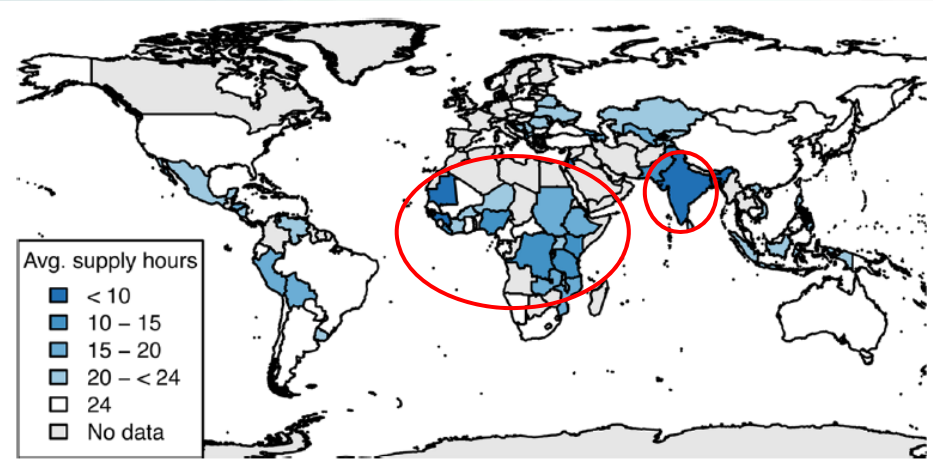
Population projections

Region	Population (billions)			
	2017	2030	2050	2100
World	7.6	8.6	9.8	11.2
Africa	1.3	1.7	2.5	4.5
Asia	4.5	4.9	5.3	4.8
Europe	0.74	0.74	0.72	0.65
Latin America and the Caribbean	0.65	0.72	0.78	0.71
Northern America	0.36	0.40	0.44	0.5
Oceania	0.04	0.05	0.06	0.07

Water scarcity chart



IWS - Average supply hours



IWS via CWS networks

- CWS networks are not suitable for IWS
- Why?
  - ✓ Expensive, designed to withstand pressure, not designed to operate under free-flow conditions
  - ✓ Supply driver - pressure rather than gravity (slope)
  - ✓ Thus, water supply to all consumers only warranted under pressurised conditions
  - ✓ Supply inequalities – consumers on the upper end of networks will always run out of water first during conditions IWS
  - ✓ Thus, it is impossible to supply water to all consumers fairly and equally under IWS via CWS networks

IWS via CWS networks

- CWS networks are not suitable for IWS
- Why?
  - ✓ Equipped with air valves to expel air that enters the system periodically and almost “by accident”
  - ✓ Air valves not adequately spaced nor do these have adequate capacity to expel air from pipelines that are emptied every day
  - ✓ Leaks, while undesirable, do not constitute health hazards, because water leaks out of pressurised pipes, not back into pipes such as during conditions of IWS (IWS “sucks”)
  - ✓ Surge transients relatively infrequent, thus biofilms are not constantly sheared off CWS pipe walls

Atlantis dunes


MN F1

Question

- Why would we as civil engineers even consider using our expensive, state of the art CWS supply networks for IWS?
- It certainly does not make any sense from an engineering perspective

Why do we still do it?

- Emergency measure, e.g. raw water sources inadequate
- Limited hydraulic capacity
- Financial constraints
- **We as civil engineers consider it an option!**

New IWS Index

Causes of IWS → Impacts of IWS

Causes			Intermittent water supply (IWS)	Impacts		
Main cause	Fundamental principle	Underlying reasons		Main impact	Fundamental principle	Underlying reasons
Water resource	Forces of nature	Limited maximum available resources		Consumer delivery failure	Water supply interruptions	Supply to consumers shut off for various reasons
		Climate change		Poor water quality	Microbiological contamination	Intrusion and backflow
		Droughts				Flushing
Water demand	People movement and habits	Population growth				Stagnation leads to decay of disinfectant residuals
		Urbanisation			Chemical contamination	Intrusion
		Temporal variation		Water losses	Supply network losses	Leaks increasing due to system degradation
Supply network deficiencies	Lack of competent or adequate human resources	Inadequate system planning			Consumer wastage	Taps left open, tanks overflowing etc.
		Data not available		Financial impacts	Water supply authority impacts	Network degradation leads to increased maintenance costs
		Lack of infrastructure management			Consumer impacts	Installation of on-site tanks, private boreholes, etc.

New IWS Index

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New IWS Index

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System degradation due to IWS

- Regular pressurisation and de-pressurisation leads to accelerated ageing of water networks
- Large quantities of air, concomitant with pressure cycles increase water hammer, which leads to further degradation
- Pressure cycles and water hammer lead to increase pipe breaks
- Which in turn leads to accelerated leaks
- And more intrusion under IWS conditions

New IWS Index

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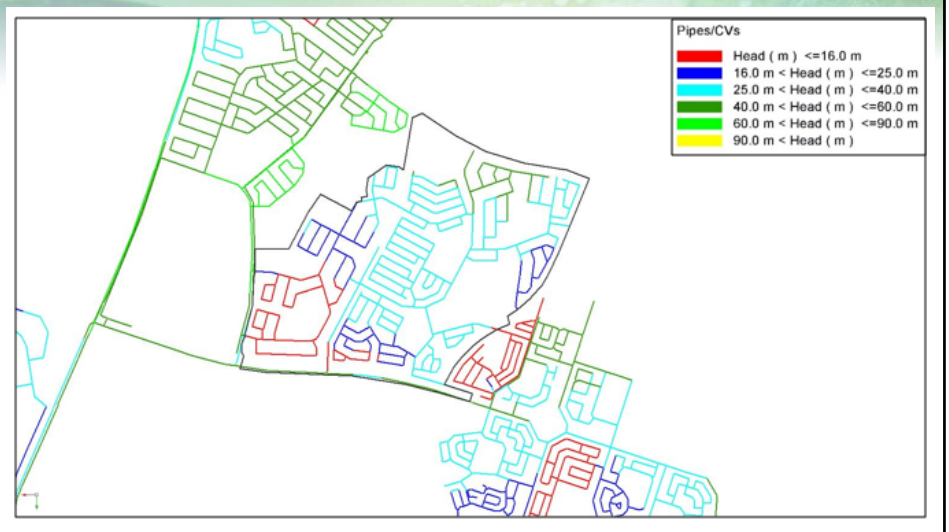
Microbiological contamination

- **Intrusion**
- **Backflow**
- **Flushing (increased shear stresses during charge-up leads to biofilms dislodging from pipe walls)**
- **Stagnation (stagnation during periods of no supply leads to decay of disinfectant residuals)**

How to (IWS) if one had to?

- **Two possible ideas:**
  - ✓ **Smart meters that can be used to control consumer supply at homes from a remote location (e.g. via cell phone or radio)**
  - ✓ **WaterBank®**

Smart meters for controlled supply



Controlled supply

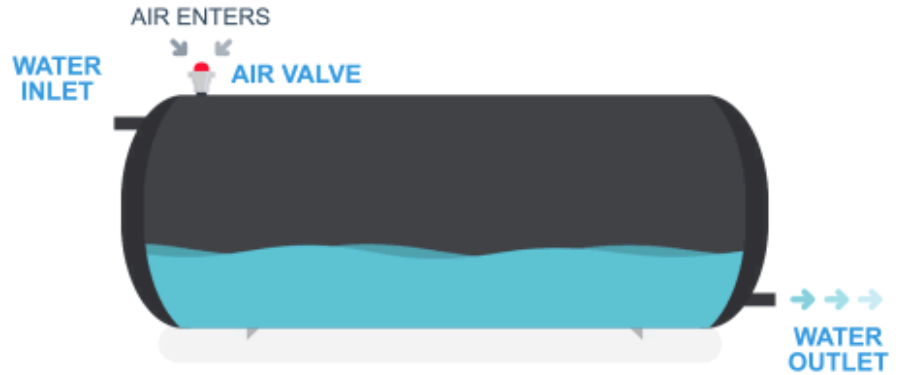
- Supply shut off at consumers, not at reservoirs
- Smart meters controlled remotely will allow for per suburb shut downs over specific, pre-communicated time frames (similar to electrical load-shedding)
- Distinct advantage that the network remains pressurised
- Therefore side-stepping most of the problems associated with IWS

WaterBank®

WaterBank® 200 litre tank

NORMAL WATER SUPPLY
Water flow is normal due to the incoming supply pressure

WaterBank® 200 litre tank



INTERRUPTED WATER SUPPLY
Water flow is weaker and under gravity

IWS – Solution or Villain?

- IWS often the result of an emergency condition, implemented out of necessity
- IWS without fail via CWS network that is not suited for that application
- IWS causes a host of undesirable effects, and has no known benefits
- Causes accelerated network degradation and contamination of potable water
- Could lead to waterborne illnesses
- IWS is therefore not a solution!

THANK YOU !