NRW as a % of System Input Volume just doesn't work!

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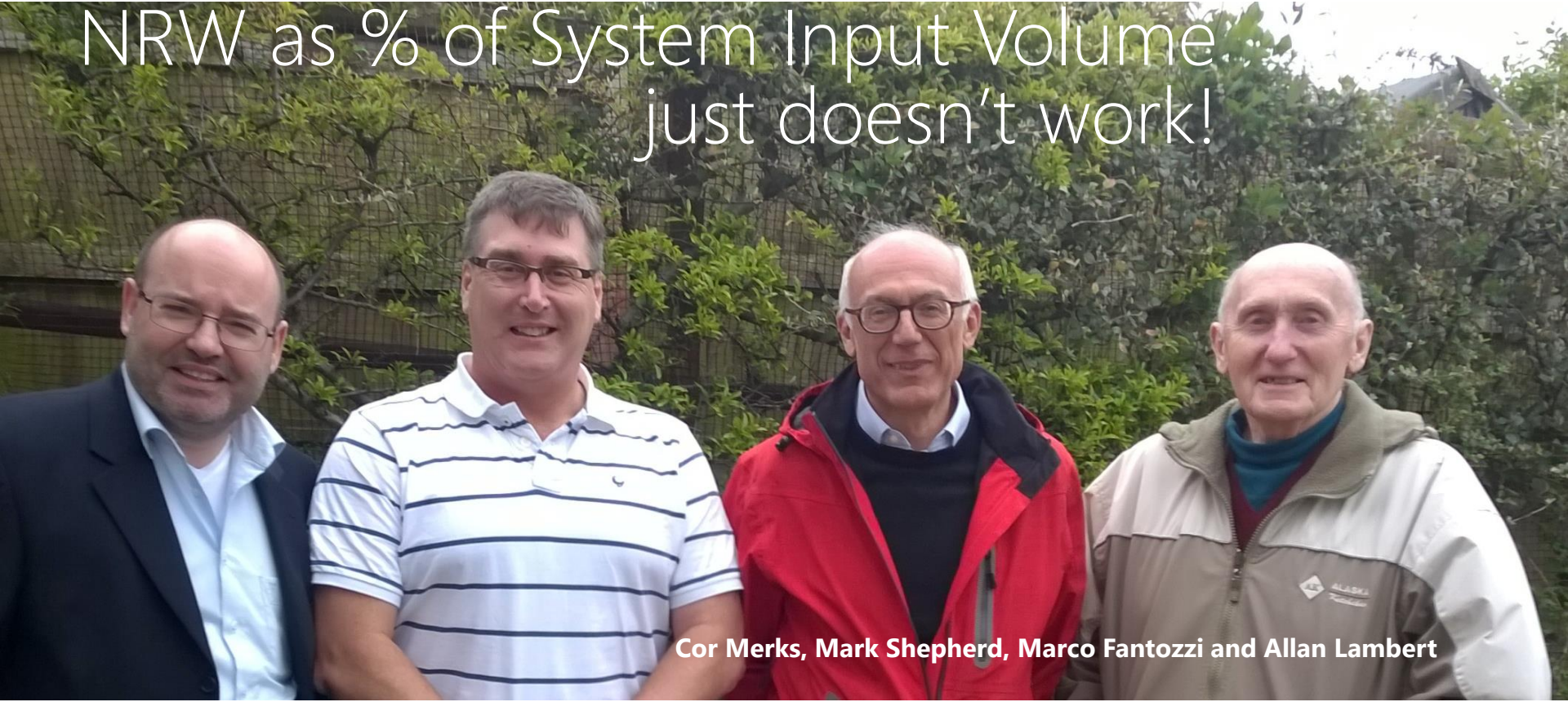


Cor Merks, Mark Shepherd, Marco Fantozzi and Allan Lambert

Performance indicators for water supply services

"A *performance indicator* is a quantitative measure of a particular aspect of the undertaking's performance or standard of service. It assists in the monitoring and evaluation of the efficiency and effectiveness of the undertaking, thus simplifying an otherwise complex evaluation."

1st Edition (2000) of *Performance Indicators for Water Supply Systems*.

Recommended *water losses* and *non-revenue water* indicators

Point of view	Water resources	Operational	Financial
Level 1 (L1)	Inefficiency of use of water resources (%)	Water losses (m^3/service connection/year) Real losses (l/service connection/day when system is pressurized)	Non-revenue water by volume (%)
Level 2 (L2)			
Level 3 (L3)		Apparent losses (m^3/service connection/year) Infrastructure leakage index (-)	Non-revenue water by cost (%)

1st Edition (2000) of *Performance Indicators for Water Supply Systems*.

Details on *water losses* and *non-revenue water* indicators

Indicator	Code	Recommended units
Inefficiency of use of water resources	WR1	Real losses as % of SIV
Water losses	Op23	m^3/service connection/year
Apparent losses	Op25	m^3/service connection/year
Real losses	Op27	l/service connection/day when system is pressurized
Infrastructure leakage index	Op29	Ratio of real losses to UARL
Non-revenue water by volume	Fi46	Volume of NRW as % of SIV
Non-revenue water by cost	Fi47	Value of NRW as % of cost of running system

1st Edition (2000) of *Performance Indicators for Water Supply Systems*.

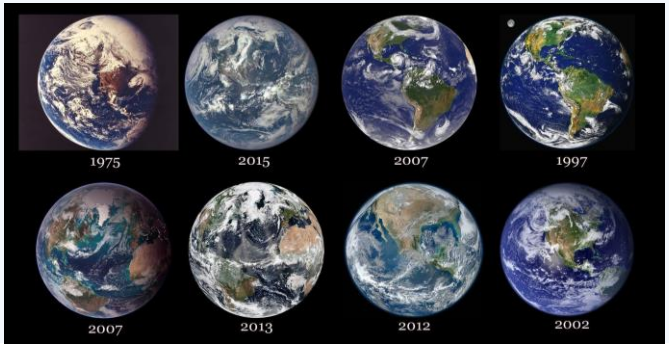
Comments on *water losses* and *non-revenue water* indicators

Code	Recommended units	Comments
WR1	Real losses as % of SIV	Unsuitable for assessing efficiency of management of distribution systems.
Op27	l/service connection/day when system is pressurized	Allows for intermittent supply situations.
Op29	Ratio of real losses to UARL	Technical achievable low-level real losses are equal to the best estimate of so-called Unavoidable Annual Real Losses, UARL. They include system specific allowance for main length, number of connections, customer meter location on service, and current average pressure.
Fi46	Volume of NRW as % of SIV	Can be calculated from simple water balance.

1st Edition (2000) of *Performance Indicators for Water Supply Systems*.

Appreciation *water losses* and *non-revenue water* indicators

- Need for Fit for Purpose PIs is unchanged; EU Reference document (© EU, 2015)
- Strengths and weaknesses of PIs have become more clear over the last 17 years
- An increasing number of national organisations, countries, water utilities and leading water professionals have decided on moving away from volumetric percentage PIs



NASA pictures of the Earth from the Moon; the Earth didn't change, our view on it changes.

‘Fit for Purpose’ leakage Performance Indicators

OBJECTIVE	GOOD PRACTICE PERFORMANCE INDICATOR FOR LEAKAGE, FIT FOR PURPOSE						
	Volume per year	litres/ service connection	m^3/km mains	litres/ billed property	% of System Input Volume	% of Water Supplied	Infrastructure Leakage Index, with Pressure
SET TARGETS AND TRACK PERFORMANCE, FOR AN INDIVIDUAL SYSTEM	YES, for large systems	YES*	YES*	YES (UK)	NO	NO	Only if all justifiable pressure management completed
TECHNICAL PERFORMANCE COMPARISONS OF DIFFERENT SYSTEMS	NO	NO	NO	NO	NO	NO	YES
DRAW GENERAL CONCLUSIONS FROM SINGLE OR MULTIPLE SYSTEMS	NO	NO	NO	NO	NO	NO	YES, together with other context factors
* Choose services connection density > 20/km; if not, choose mains; or base choice on country custom and practice							

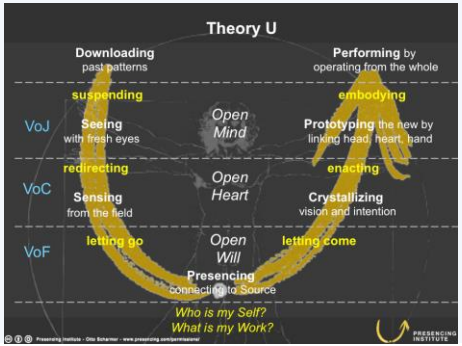
Summary of recommendations in EU Reference document Good Practices on Leakage Management (© EU, 2015)

Professionals abandon Percentages of System Input Volume

- Initiative for voluntary registration to PaP from December 27th 2016
- Now (April 27th 2017) already 109 supporters from 22 countries
- Ceased to support the use of % of SIV, or % of water supplied, as PIs for:
  - setting targets and tracking progress
  - technical and financial performance comparisons
  - drawing general conclusions regarding management of NRW and its components
- Professionally use more appropriate and meaningful performance indicators

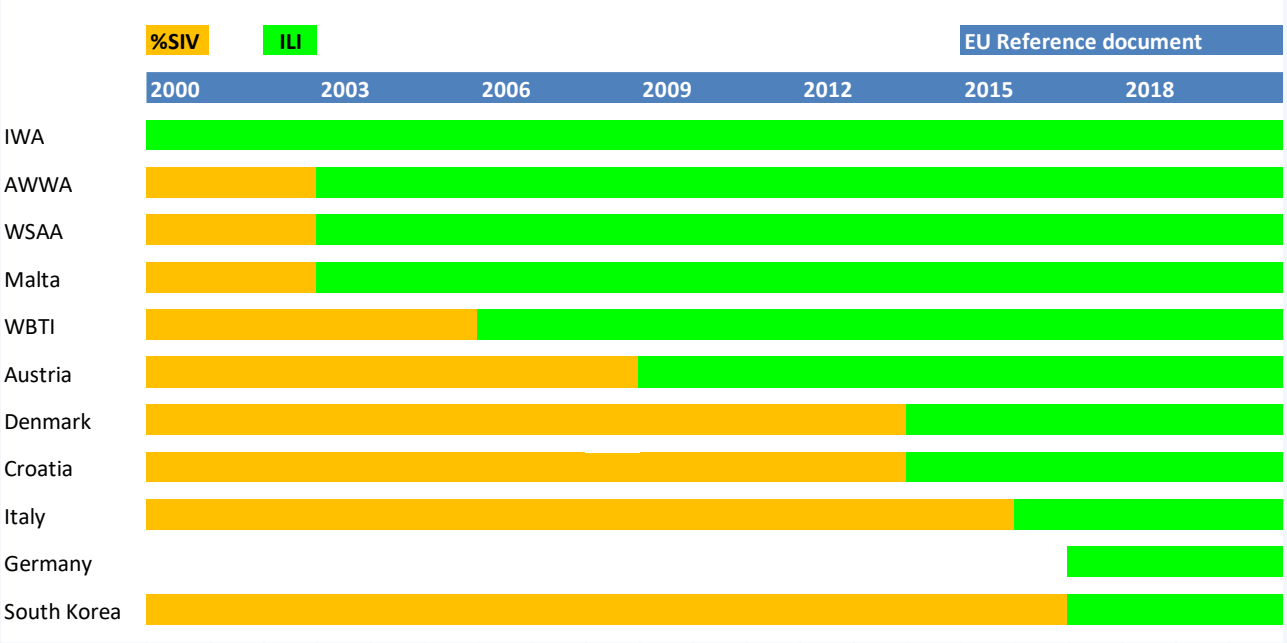
Why do large numbers of professionals support PaP?

- It is difficult to let the past go, but necessary to recognise when change is overdue!
- Volumetric % PIs are easy to calculate and disseminate, but frequently misleading
- The more appropriate and meaningful PIs indeed require some background and experience in the world of water loss management



C. Otto Scharner, Leading from the Future as it Emerges, San Francisco, 2009

National organizations and countries adopting the ILI



Just a few examples of weaknesses of volumetric % PIs

Examples of failure to track progress:

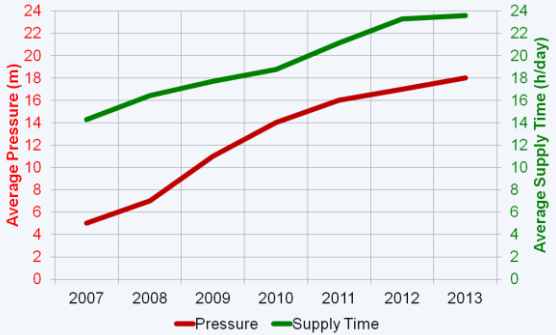
- Manila, Philippines – a Miya project
- Zagreb, Croatia – a water utility experience
- iLembe District Municipality, South Africa – a JOAT Consulting (Pty) Ltd project
- Philadelphia Water Department, USA – a water utility experience

Manila, Philippines (1 of 3)

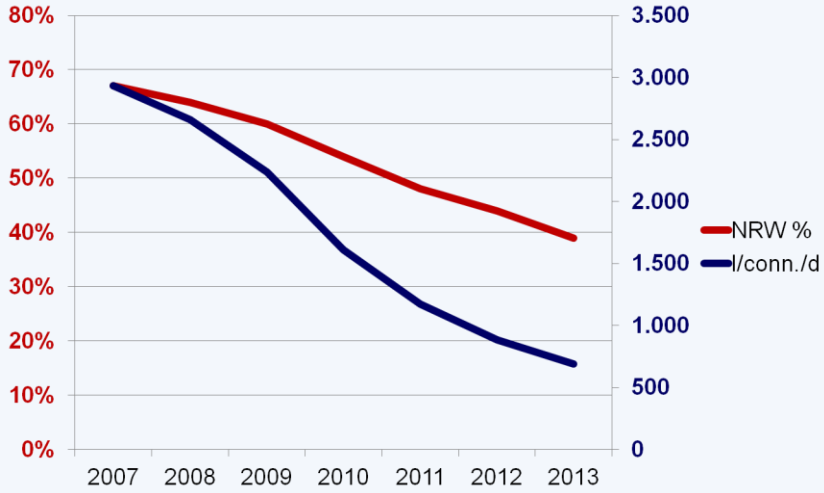
- Miya partnered with Maynilad Water Services on a NRW reduction project between 2008 and 2014
- At the beginning of the project NRW was 1,580 million litres/day, three million people could not be connected and supplied, and millions of others suffered from intermittent supply, extremely low pressures and poor water quality
- Project goal was to build NRW management capacity, establish a NRW management system, re-structure and improve the water distribution network, and reduce physical and commercial losses to enable supply to the entire population in the service area

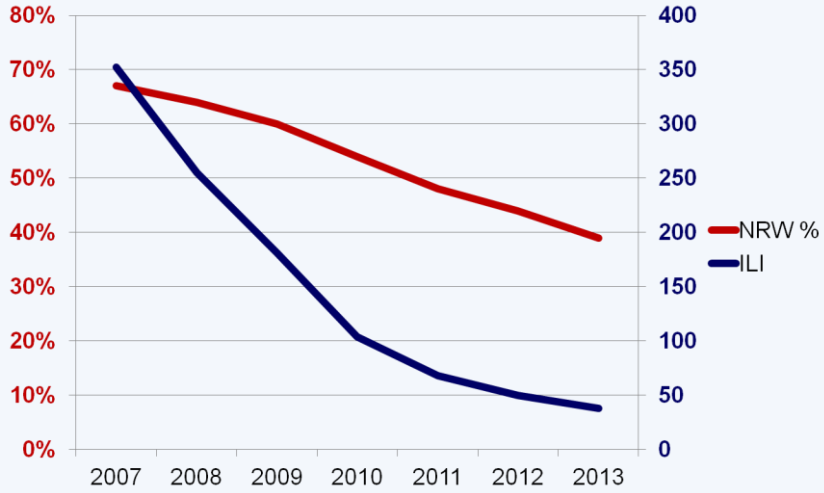
Manila, Philippines (2 of 3)

- Results:
  - NRW reduced from 1,580 to 650 million litres/day
  - Number of customers increased from 700,000 to 1,160,000
  - Tremendously improved level of service
  - 1,500 DMAs established, 1,500 km of pipelines replaced
  - 277,000 leaks detected and repaired
  - Maynilad's net income tripled
- Additional revenues during this seven year period already exceeded the investments



Manila, Philippines (3 of 3)





Zagreb, Croatia

- Utility with high leakage
- Introduced district metering and pressure management in 2012
- In 2013 significant reductions in annual volumes were achieved
- Good work undertaken in the field, but not according to performance judged on change in % of SIV

Water Balance Annual Volumes expressed in Million cubic metres (Mm3)					
Year	System Input Volume	Revenu Water	Non-Revenu Water	Apparent Losses	Real Losses
	Mm3	Mm3	Mm3	Mm3	Mm3
2012	120,7	49,4	71,3	2,0	69,3
2013	114,1	47,3	66,8	1,9	64,9
Change (2013-2012)	-6,6	-2,1	-4,5	-0,1	-4,4
% Change	-5,5%	-4,3%	-6,3%	-5,0%	-6,3%

Water Balance Annual Volumes expressed as & of System Input Volume					
Year	System Input Volume	Revenu Water	Non-Revenu Water	Apparent Losses	Real Losses
	% of SIV	% of SIV	% of SIV	% of SIV	% of SIV
2012	100,0%	40,9%	59,1%	1,7%	57,4%
2013	100,0%	41,5%	58,5%	1,7%	56,9%
% Change	0,0%	0,5%	-0,5%	0,0%	-0,5%

iLembe District Municipality, South Africa (1 of 5)

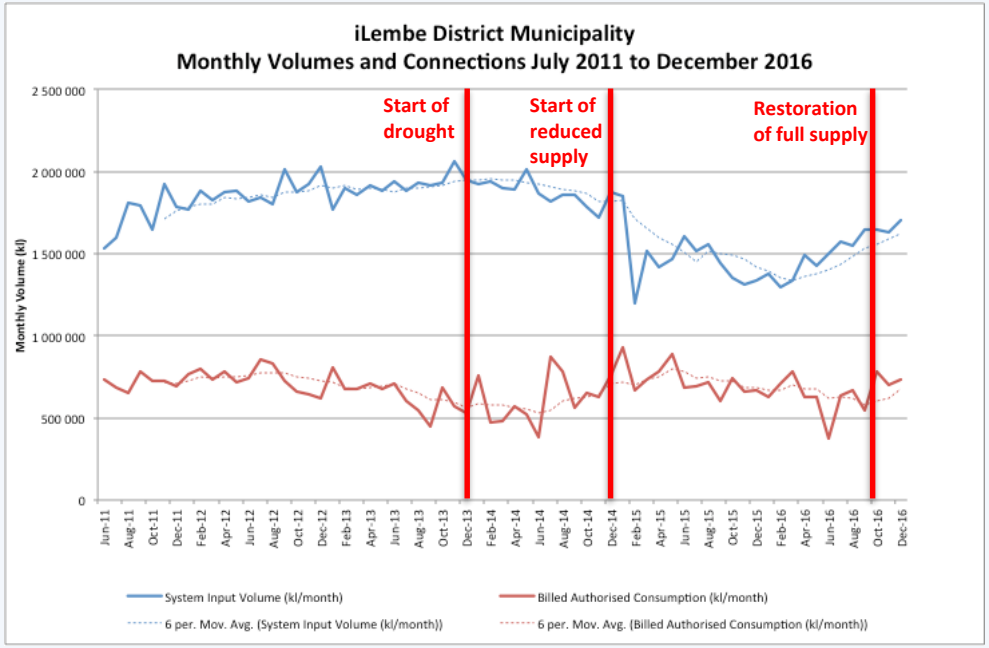
Example of incorrect use of %NRW in drought response

- iLembe District Municipality serves approx. 630,000 people in a predominantly rural / peri-urban service area with holiday influx
- Experienced severe drought which commenced in circa 2013 and led to intermittent / reduced supply from December 2014
- Drastic leakage reduction and water conservation intervention was very quickly rolled out to meet reduced supply

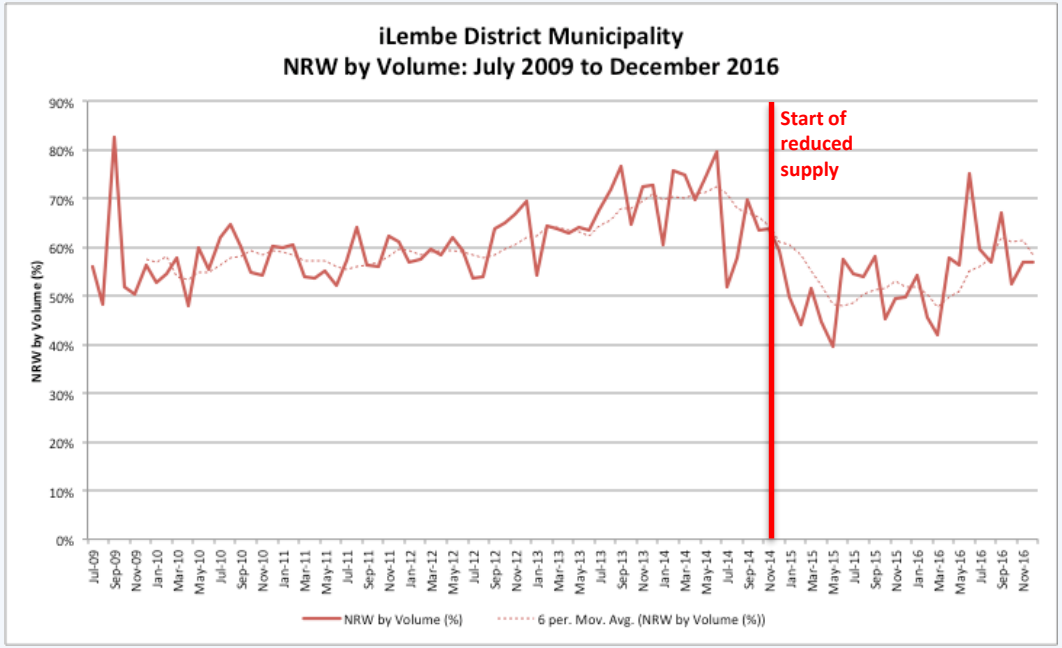
iLembe District Municipality, South Africa (2 of 5)

- The SA Government's Department of Water and Sanitation requires quarterly reporting in %NRW and either rewards or penalises on this KPI
- However, during this drought response, %NRW did not reflect the good work undertaken in the field and in fact showed the opposite

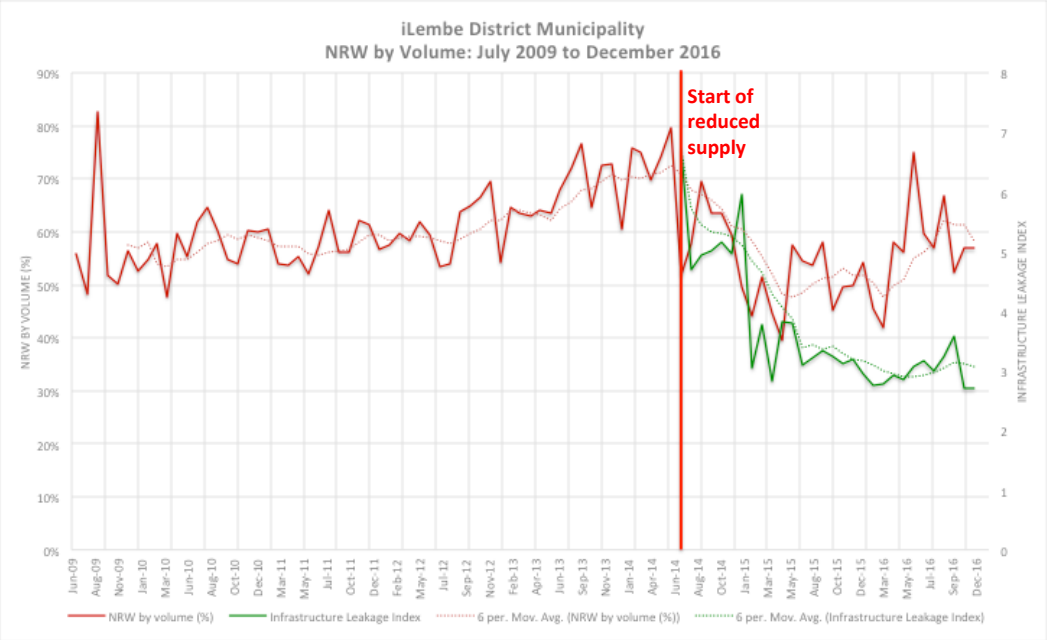
iLembe District Municipality, South Africa (3 of 5)



iLembe District Municipality, South Africa (4 of 5)

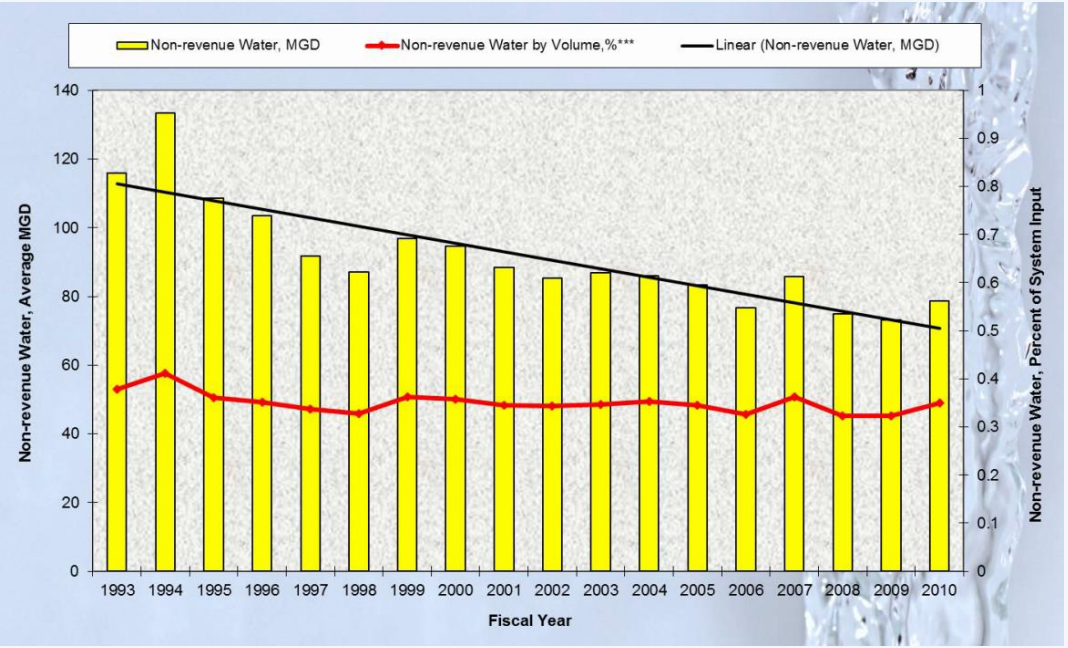


iLembe District Municipality, South Africa (5 of 5)



%NRW did not reflect the good work undertaken in the field and in fact showed the opposite

Philadelphia Water Department, USA



NRW by Volume versus NRW by % of Supply:

- Large reduction in NRW volume
- Little change in NRW percentage

Just a few examples of weaknesses of volumetric % PIs

Examples of failure for making comparisons of performance:

- Example on data by Roland Liemberger (2000) re-analyzed by Allan Lambert (2017)
  - comparisons between Utilities in different countries
- DANVA Water in figures 2015 – process benchmarking also on ILI (2014 values)
  - comparisons between Utilities within a country

Data analysis by Allan Lambert (1 of 5)

Country	Utility	Performance Indicator for Real (Physical) Losses				
		% of System Input Volume	m3/km mains/day wsp*	Litres/service connection/ day wsp*	Litres/conn/day /metre of pressure wsp*	Infrastructure Leakage Index ILI (incl. UARL)
Austria	Vienna	8,5%	10,3	334	8,3	6,0
Cyprus	Lemesos	12,5%	5,4	56	1,2	1,0
Tajikistan	Dushanbe	16,5%	278	4989	312	278
UK	Bristol	16,8%	8,6	123	2,6	1,9
Malta	Malta WSC (Gozo)	19,7%	6,8	72	1,6	1,6
USA	Philadelphia	25,8%	49,6	536	13,7	12,6
* when system pressurised						

Data analysis by Allan Lambert (2 of 5)

Rank	Performance Indicator for Real (Physical) Losses				
	% of System Input Volume	m3/km mains/day wsp*	Litres/service connection/ day wsp*	Litres/conn/day /metre of pressure wsp*	Infrastructure Leakage Index ILI (incl. UARL)
1	Vienna	Lemesos	Lemesos	Lemesos	Lemesos
2	Lemesos	Gozo	Gozo	Gozo	Gozo
3	Dushanbe	Bristol	Bristol	Bristol	Bristol
4	Bristol	Vienna	Vienna	Vienna	Vienna
5	Gozo	Philadelphia	Philadelphia	Philadelphia	Philadelphia
6	Philadelphia	Dushanbe	Dushanbe	Dushanbe	Dushanbe
* when system pressurised					

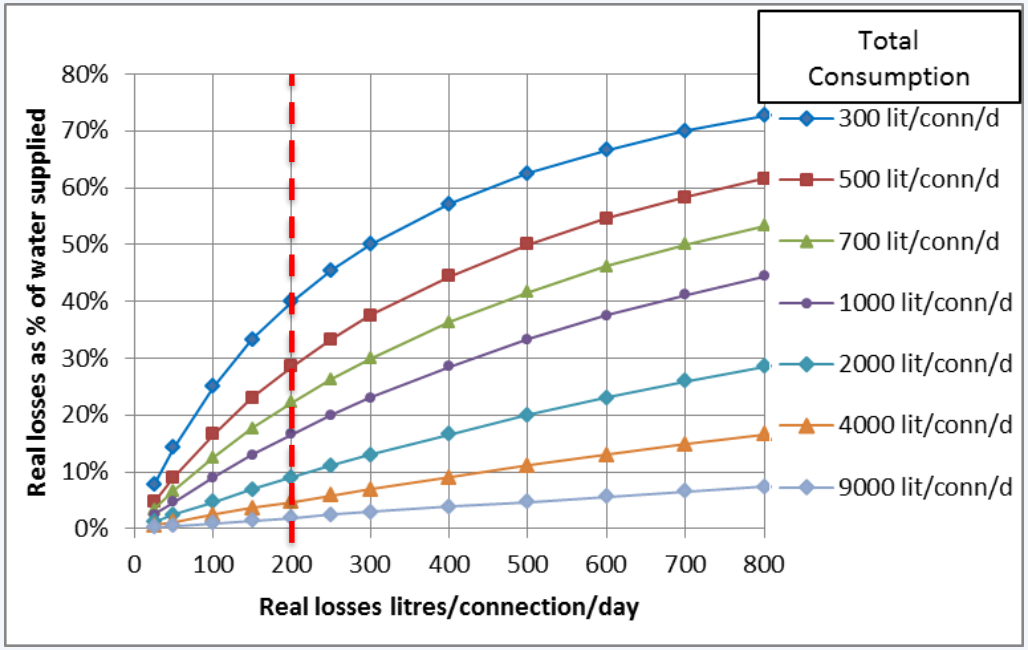
Data analysis by Allan Lambert (3 of 5)

Does the Performance Indicator make allowance for:	Performance Indicator for Real (Physical) Losses				
	% of System Input Volume	m3/km mains/day wsp*	Litres/service connection/ day wsp*	Litres/conn/day /metre of pressure wsp*	Infrastructure Leakage Index ILI (incl. UARL)
% of time pressurised?	No	Yes	Yes	Yes	Yes
water exported?	No	Yes	Yes	Yes	Yes
length of mains?	No	Yes	No	No	Yes
number of connections?	No	No	Yes	Yes	Yes
average pressure?	No	No	No	Yes	Yes
connections/km mains ?	No	No	No	No	Yes
length of services ?	No	No	No	No	Yes
how low could you go?	No	No	No	No	Yes**
* when system pressurised		** Unavoidable Annual Real Losses UARL			

Data analysis by Allan Lambert (4 of 5)

- % of System Input Volume just doesn't work:
  - does not make allowance for any system-specific key factors
  - gives misleading perspective of true performance
  - Strongly influenced by changes and differences in consumption per connection – variables which may vary substantially from one year to another, not under control of the undertaking
- The ILI is designed for technical performance comparisons between systems
- Volumetric PIs are good for setting targets and tracking progress
- Litres/connection/day/metre of pressure also allows for differences in pressure

Data analysis by Allan Lambert (5 of 5)

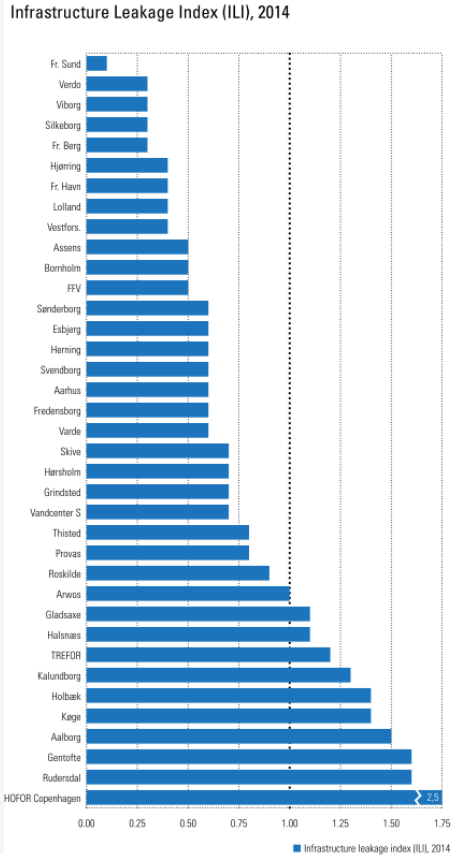


200 litres/connection/day real losses would be:

- 2% of Water Supplied if consumption 9000 lit/conn/d (Singapore)
- 10% of Water Supplied if consumption is 2000 lit/conn/day (cities)
- 40% of Water Supplied if consumption is 300 lit/conn/day (rural areas)

DANVA Water in figures 2015, Denmark

- The Danish water industry is known to have a very low loss of water in its pipeline network
- Water consumption and water loss decreases every year
- Weighted average NRW as % of SIV was 8.09 in 2014 (48 participating companies)
- The ILI of 27 out of 37 companies in 2014 was ≤ 1.0
- The highest ILI value was 2.5 in 2014, a reasonably good value for a metropolitan area



Let the past go

- Move away from volumetric percentage performance PIs and move towards using:
  - the Apparent Losses Index, ALI
  - the Infrastructure Leakage Index, ILI (*Op29*)
  - "volume/service connection/day" (*Op23 and Op27*) or "volume/km mains/day" *(Op24 and Op28)*
- Professionally use:
  - the ILI for technical performance comparisons of water supply systems
  - "volume/service connection/day" or "volume/km mains/day" for setting targets and tracking progress
- Support the PaP initiative

www.leakssuitelibrary.com

www.leakssuitelibrary.com/kpis-fit-for-purpose/pros-abandon-percents-of-siv/

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PaP supporters per May 8th 2017

Tamar Al-Assa'd, Alexandru Aldea, Mohammed Alshafey, Alin Anchidin, Lucy Andrews, Drew Blackwell, Ken Brothers, Fatima Carteado, Steve Cavanaugh P.E., Hugh Chapman, Bambos Charalambous, Andrew Chastain-Howley, George Crowder, Hubert Demard, Jamie Eichenberger, Dr. Marco Fantozzi, Dimitris Foufeas, Ing. Stephen Galea St John, Fabio Garzon-Contreras, Kate Gasner, Albert Hoffman, Will Jernigan P.E., Dr. Joerg Koelbl, Jurica Kovac, George Kunkel Jr., Alain Lalonde, Allan Lambert, Larry Lewison, Roland Liemberger, Cor Merks, Iulia Mihai, Ali Mousakhani, Carlos Mustoni, Dr. David Lloyd Owen, Dr. Atanas Paskalev, David Pearson, Nicholas Petroulias, Pedro Pina, Stefan Riolo, Dr. Ing. Alex Rizzo, Kelvin Romain, David Sayers, Mark Shepherd, Stuart Stapely, Reinhard Sturm, Julian Thornton, Gary Trachtman, Michel Vermersch, Tory Wagoner P.E., Alan Wyatt, Prof. Kobus van Zyl, and 58 staff of various consulting engineers and other organizations.