# Water Efficiency Management
*Why we need smarter water management for the world's most essential resource*

# As Cidades Mais Inteligentes fazem uso de três conceitos

Instrumentada + Interconectada + Inteligente = Cidade mais Inteligente
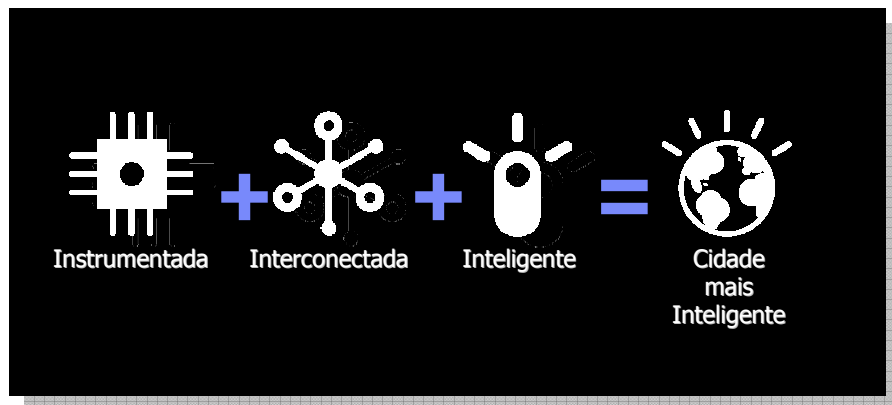
## 1 trilhão

Em breve, existirá 1 trilhão de dispositivos conectados, constituindo uma "internet de coisas"

## 15 petabytes

Todos os dias, 15 petabytes de novas informações são geradas.
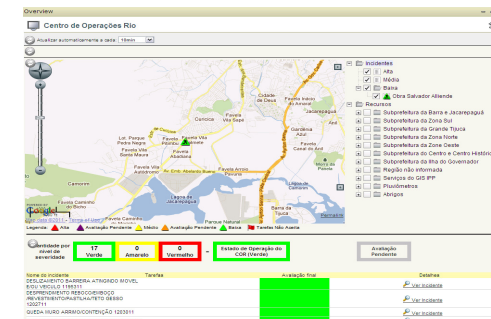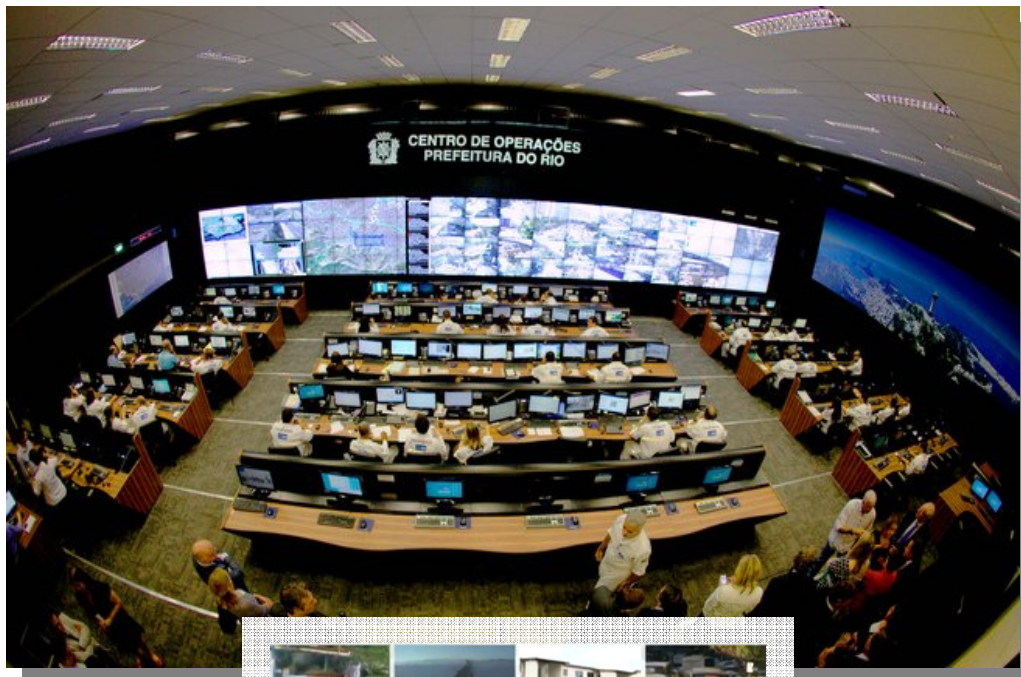Isto é 8 vezes mais que as informações de todas as bibliotecas dos EUA juntas.

## 1 Km$^2$

Novas formas de análise permitem previsão do tempo em alta resolução para áreas pequenas - entre 1 e 2 quilômetros quadrados.
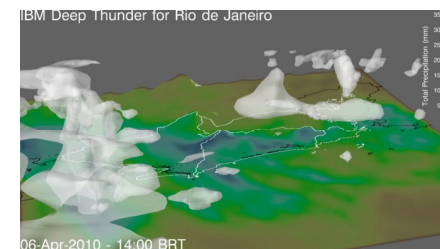
# Rio de Janeiro
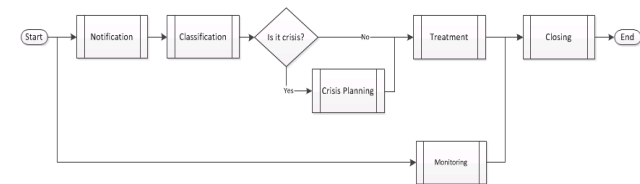


**Contingency Plan**



**Agencies Coordination** in preventing, respond and recover from events



**Weather Prediction**

IBM

# Water is a resource for which there is no alternative



**NATIONAL GEOGRAPHIC Daily News**

Home   Animals   Ancient   Energy   Environment   Travel/Cultures   Space/Tech   Water   Weird   News Photos   News Video   News Blogs

### Water Wars: Egyptians Condemn Ethiopia's Nile Dam Project

As the Grand Ethiopian Renaissance Dam takes shape, tempers rise.

**The World's Water**

The world's increasing population and development of agricultural land are putting pressure on the Earth's limited freshwater supplies. Find out what's at stake and how you can help.

**Why Should You Care?**
Learn more about the world's water challenge with photos, stories, videos, and more.

**Visualizing Our Water Footprint**
You might be surprised to see how the daily choices you make affect critical watersheds around the world.

Learn More About Freshwater »

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Credit Suisse M&A

The Grand Ethiopian Renaissance Dam being built along the Nile has ignited disagreement between Egypt and Ethiopia.



**BLUE GOLD**
THE WAR OVER YOUR WATER IS ABOUT TO BEGIN
IN THEATRES DECEMBER 12



**JORNAL DA UNICAMP**

Campinas, 31 de agosto a 7 de setembro de 2009 – ANO XXIV – Nº 439      | EXPEDIENTE | ASSINE O JU |

NAVEGUE NAS PÁGINAS DESTA EDIÇÃO

**Método detecta agrotóxicos na água e no solo de áreas do Aquífero Guarani**
Pesquisas feitas em parceria IQ-Embrapa concentraram-se na divisa de Goiás e Mato Grosso

LUIZ SUGIMOTO

Métodos simples e econômicos para determinar a presença de agrotóxicos na água e no solo das áreas de recarga do Sistema Aquífero Guarani (SAG) acabam de ser desenvolvidos e validados pelo Instituto de Química (IQ) da Unicamp, em parceria com a Embrapa Meio Ambiente de Jaguariúna (SP). O SAG é o maior reservatório de águas subterrâneas da América do Sul e o terceiro do planeta, localizando-se em sua quase totalidade no território brasileiro e se estendendo até a

Source:  Center for Economic Analysis, IBM Institute for Business Value

28 November 2013

**IBM**

# Water has a direct impact on health and is a critical enabler for development

- Access to safe drinking water is critical for health, especially for children

- Poor quality water can make workers unproductive and take them out of the workforce altogether

- Over 50% of the world's hospital beds are occupied by people suffering from water related diseases

- 80% of diseases in developing countries are attributed to poor quality water

*Water is the elixir of life*
*— Atharvaveda, 2000 BC*

**Water and Human Development**
*2011*

$R^2 = 0.65$

Human Development Index

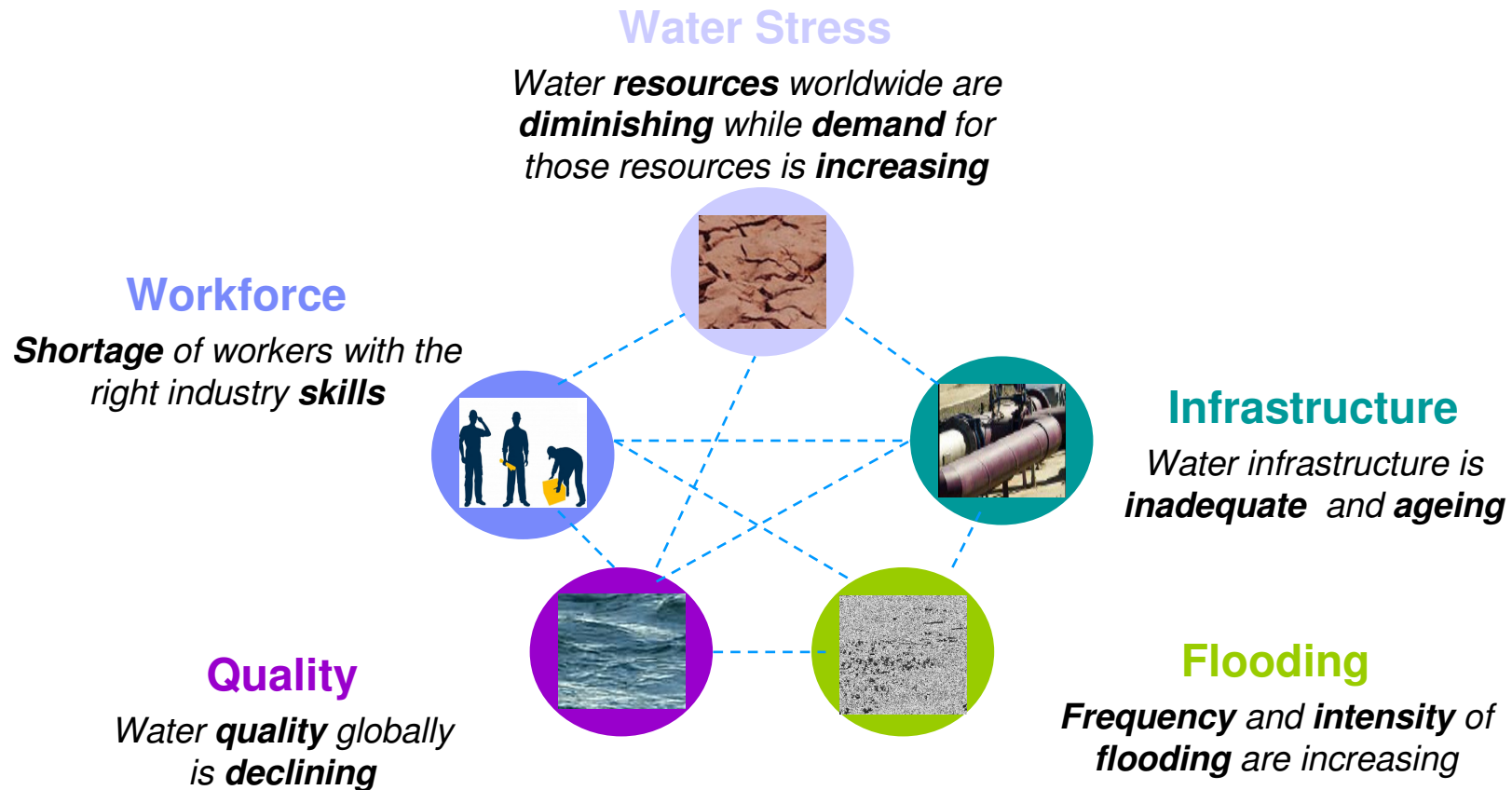% of population with access to improved source of water
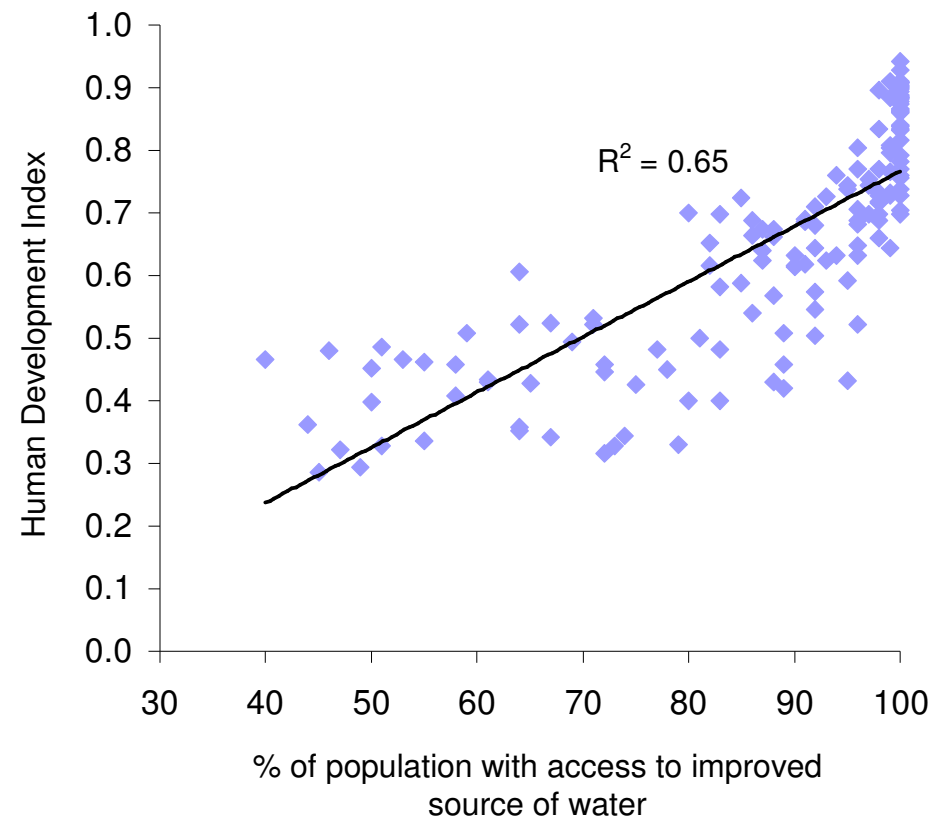
Source:  UN Human Development Report and World Bank World Development Indicators database
Note: Human Development Index is 2011 data and water series is latest available data, generally 2010

# Water is key for food production

**Water is a key driver of agricultural production** affecting yields and crop failure

**2000-5,000 liters water needed to produce a person's daily food**

Water scarcity will be the **major constraint on food production in the next few decades**

**Irrigated agriculture accounts for 80% of global water use** and 40% of world's food production

**Water**

**Food**

**Food production** will need to **increase by 70% by 2050**, impacting demand for water

Demand for **irrigation** and use of **agrichemicals** is a major source of **water pollution**

Source: FAO; Foresight. The future of Food & Farming (2011); UN Water

# The global water system is facing several interrelated challenges that lead to critical vulnerabilities

## Water Stress

Water **resources** worldwide are **diminishing** while **demand** for those resources is **increasing**

## Workforce

**Shortage** of workers with the right industry **skills**

## Infrastructure

Water infrastructure is **inadequate** and **ageing**

## Quality

Water **quality** globally is **declining**

## Flooding

**Frequency** and **intensity** of **flooding** are increasing

Source: IBV Analysis

# IBM's Smarter Water Solutions – driving value along the entire water cycle



| Surface Water Resource Mgmt | Water Treatment | Storage & Distribution | Consumers Usage | Sewage Collection & Treatment |
|---|---|---|---|---|
| SONOMA COUNTY WATER AGENCY | Rijkswaterstaat Ministry of Infrastructure and the Environment | VALLEY OF THE MOON Water District | MIAMI-DADE COUNTY PARKS, RECREATION AND OPEN SPACES | SUSTAINABLE DUBUQUE / THE CITY OF SOUTH BEND, INDIANA PEACE 1865 |
| Reduced water shortages and lost water with improved monitoring, improved mgmt. recreation areas | With better integrated information, prevent disasters, reduce cost of managing water by up to 15% | Use analytics to reduce water loss: optimize settings of pressure valves, pre-distribution network | Driving lower, efficient water use, proactive maintenance increased leak detection | Achieved 6.6% decrease in water consumption over a 9-week period / Reduced wet weather overflows (23%), cut dry weather wastewater overflows (27 to 1) 1st yr |

*Plus many other exciting projects across the water cycle (e.g. hydropower in China)*

# Water efficiency management **environment across the globe**

The World Bank estimates that more than **USD14 billion worth of potable water is lost every year** because of leaks, theft and unbilled usage—what is known in the industry as *non-revenue water* **(NRW)**.

A reduction of half the current levels of losses in developing countries, where relative losses are highest, could generate an estimated **USD 2.9 billion in cash and serve an additional 90 million people.**[1]

A recent American Water Works Association publication states that "**more than a million miles of pipes are nearing the end of their useful life** and approaching the age at which they need to be replaced."

These **replacement costs plus projected expansions costs will total more than USD1 trillion** over the next couple of decades.[2]

*Sources:*
1) Kingdom, Bill; Liemberger, Roland; Marin, Philippe, *The Challenge of Reducing Non-Revenue Water (NRW) in Developing Countries How the Private Sector Can Help: A Look at Performance-Based Service Contracting*, World Bank, Washington, D.C (2006): http://siteresources.worldbank.org/INTWSS/Resources/WSS8fin4.pdf
2) Folkman, Steven, *Water Main Break Rates in the USA and Canada: A Comprehensive Study*, Utah State University Buried Structures Laboratory (April 2012): http://www.watermainbreakclock.com/docs/UtahStateWaterBreakRates_FINAL_TH_Ver5lowrez.pdf

# Water efficiency management challenges faced by water operators

- **Water loss**, resulting in lost revenue
  - Leakage, theft, unbilled consumption

- **Over-pressurization** of pipes:
  - Reduced asset life
  - Higher energy (pumping) cost
  - Higher leak incidence

- **Reactive approach** to pipe bursts/leaks:
  - High repair costs
  - Damage to property and city operations (e.g. traffic)

- **Limited insight for capital planning** decisions

- **Silos, hindered holistic view** of infrastructure and operations
  - Non-revenue water and beyond (conservation / sustainability, water quality management, flood management, physical security)

# Water efficiency management **business value**

Enables water operators to reduce water loss, minimize network disruptions, make more informed decisions, drive holistic leak management

## Water Efficiency Management: Non-Revenue Water

- ✓ **Save money** - lower repair costs, extended asset life & reduced energy bills
- ✓ **Lower business risk** with preventative maintenance
- ✓ **Become more proactive** - change operational stance
- ✓ **Improve quality of service** to end users

**Pipe Failure Prediction**

**Asset Management**

**Non Revenue Water**

**Pressure Management**

**Energy Reduction**
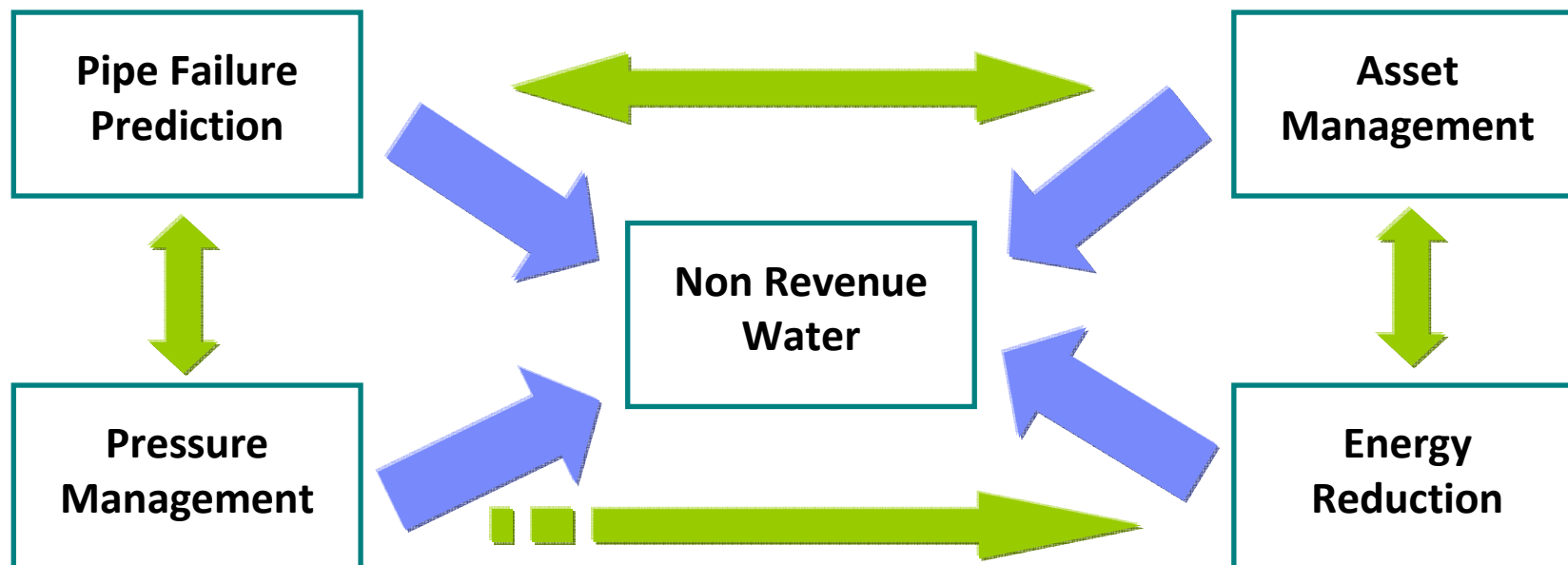
# Water efficiency management **solutions for water operators**

Enables water operators to **reduce water loss, minimize network disruptions**, make **more informed decisions**, drive **holistic leak management**

1) **Pressure Management.**  Explicitly manage to achieve network pressure targets with possibly conflicting goals. **LOWER COSTS, RECAPTURE REVENUE**

2) **Pipe Failure Prediction.**  Focus on system reliability, preventive maintenance effectiveness. **LOWER COSTS AND OPERATIONAL RISK**



3) **Asset Management + Operational Information.** Proactively / Effectively manage incidents and repairs. **LOWER REPAIR / MAINTENANCE EXPENSE**

4) **Situational Awareness.**  Leverage data holistically to create insights, improve water management.  **LOWER NETWORK RISK, IMPROVE EFFICIENCY**

# Water efficiency management - pressure management

Optimize network pressure – Lower energy costs, Decrease leak and burst incidence and extend life of assets

- **Data visualization**
  - Consolidates data from a variety of sources, e.g. SCADA, billing records…
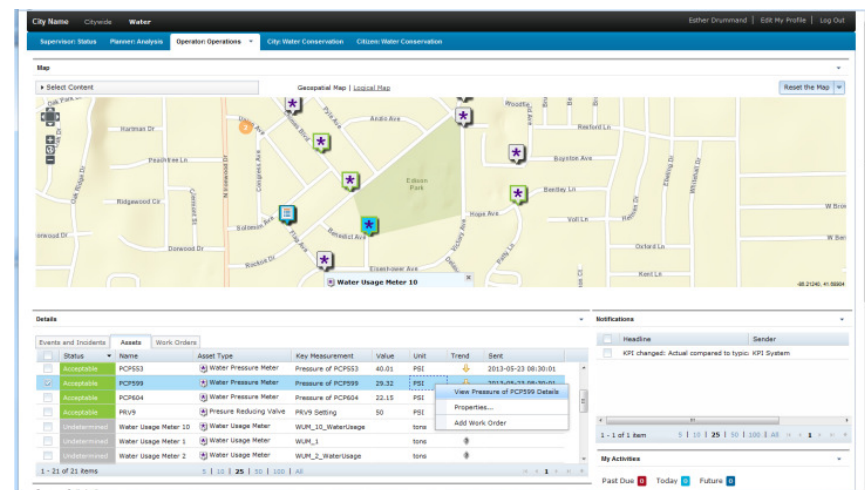  - Provides continual visibility and understanding of pressure status

- **Monitoring, insight**
  - Generates real-time anomaly alerts
  - Provides detailed trend information

- **Decision making**
  - Accepts input via intuitive user interface: desired targets at pressure critical points
  - Provides recommendations for detailed equipment operational settings

# US water management utility reduces leaks and proactively manages issues with a First-of-a-Kind, analytics-driven management solution

*Monitors pressure levels and automatically recommends when and how to adjust multiple pressure valves to their optimal settings*
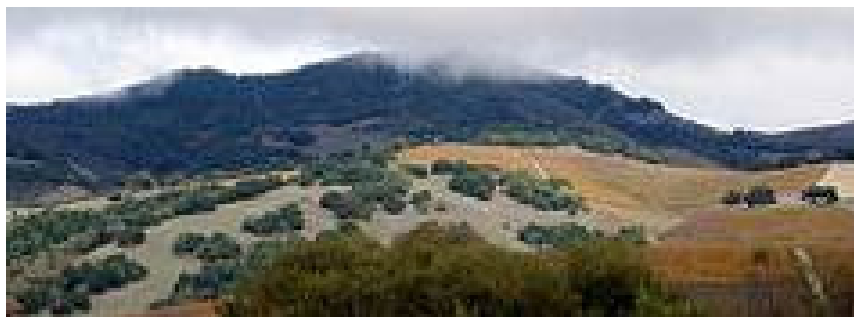


## >16%

reduction in instances of leaks and bursts in first year of deployment, as compared to the previous year *(19% compared to previous three-year average)*

## Minimized

the number of pressure spikes by moving from a reactive to proactive management approach

## Improved

tank levels and tank turnovers through pressure optimization

**Business Challenge:** Managing and optimizing the pressure of a water system is a highly complex and intricate undertaking. A typical delivery system comprises multiple pipes, valves and tanks that may all be highly interrelated. To gauge and optimize its system's pressure levels, the engineers of this utility made tiny adjustments to the network's 12 valves individually, waited for results and repeated the process until the desired result was achieved. The tedious and error-prone process was not only unsustainable, but also put the infrastructure at risk.

**The Smarter Solution:** This utility is optimizing pressure along its 92-mile infrastructure with a First-of-a-Kind solution that uses sophisticated analytics to track and monitor pressure levels, providing a granular level and near-real-time view of conditions. Data is captured and integrated from pressure logs that record information in 2 minute intervals. If levels change because of demand, weather and environmental conditions, engineers can run optimization models that provide recommendations for how to adjust valves simultaneously to achieve optimal settings. Insight also reveals trends in demand (anticipate, adjust in advance).

# Water efficiency management - pipe failure prediction

Identify riskiest pipes and drive preventative maintenance plans to reduce leaks and bursts. Lowers cost of expensive disruptions and improves Quality of service

- **Data visualization**
  - Pipe network, failure risk hotspots, risk factors distribution

- **Pattern analysis, modeling**
  - Analyzes seasonal patterns, spatial pattern, factor correlation, feature selection
  - Advanced data mining (e.g. decision tree, regression, neural network)

- **Prediction and planning**
  - Failure prediction: which pipe sections are most at risk of failure
  - Generate preventative maintenance plan





**15**
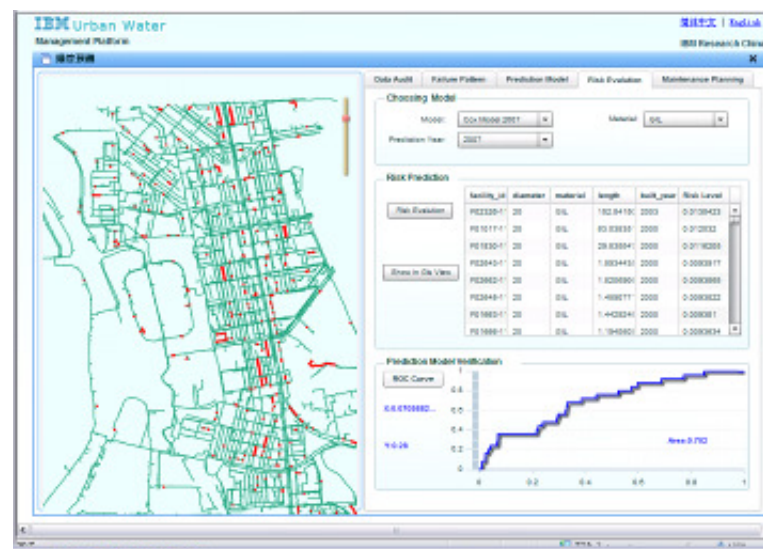
# A water department in Asia uses predictive models to identify and **proactively replace the pipes at highest risk of failing**

## >300%

increase in forecasting precision compared with previous approach

## 24%

reduction in failures achieved by replacing the riskiest 2% of pipes

## 7 million

citizens served by the water supply department



**Business Challenge:** This water department knew it needed to replace much of its aging pipe infrastructure, but it also needed insights into which pipes in the network had the highest risk of failure so that it could focus its replacement resources optimally and minimize pipe failures and the disruptions they cause.

**The Smarter Solution:** The department implemented a statistical failure-risk assessment model that incorporates the analysis of detailed data on past failures with near-real-time readings from sensors placed at strategic locations throughout the pipeline to identify those pipes that pose the highest risk of failure and the greatest potential for disruption.

*By incorporating predictive intelligence into our maintenance decisions, we're able to focus our resources on where it matters most and minimize the impact of disruptions on our citizens.*

# Water efficiency management – asset management and operational insight

Enhance situational awareness of operations and infrastructure by integrating and visualizing asset and work order information

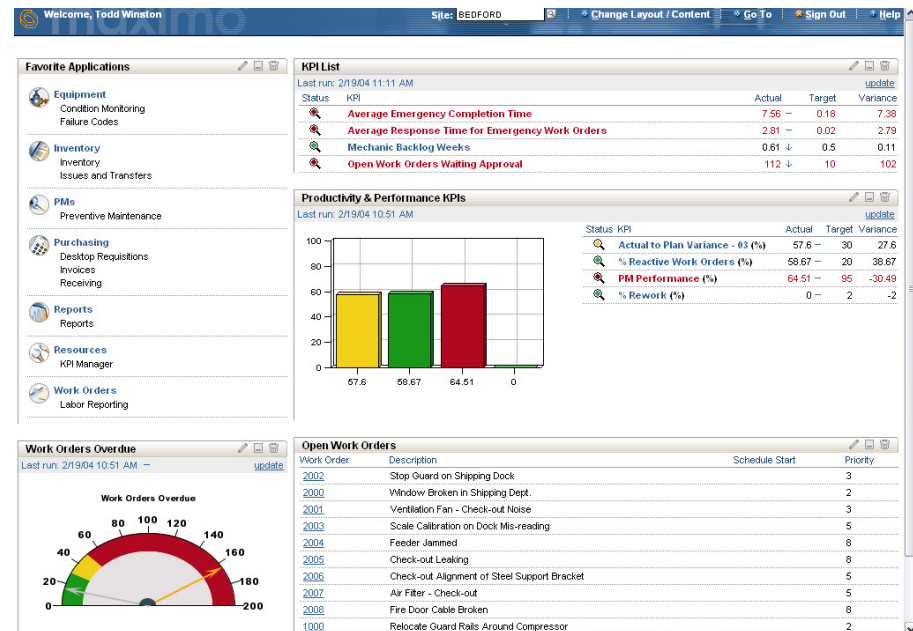- **Visualization and correlation**

  – Synchronize asset details from an enterprise asset management

  – Combine with operational information (e.g. pressure, flow, temperature)

- **Analysis and estimation**

  – Estimate cost of repair based on data (e.g. material, age, diameter, location)

- **EAM integration**

  – Create work order in EAM system

  – View status and details, GIS map view

# Water efficiency management – situational awareness

> Leverage data holistically to find hidden patterns, correlations - create insights to improve water management: improve decision making, enhance efficiency and reduce risk

**■ Visibility**

– Visualize near real time data, status and performance of water systems

 • SCADA systems, sensors, meters, video, etc.

– Visualize real-time / near real-time data feeds from external data sources

 • GIS / geographic information system
 • EAM / enterprise asset management
 • ERP / enterprise resource planning, etc.

**■ Situational awareness**

– View relationships, patterns, correlations

– Leverage key performance indicators, business rules, standard operating procedures

– Bridge gap between physical world of control systems and realm of business decisions

| Non-revenue water |
|:---:|

*….and beyond …*

| Water conservation | Water sustainability |
|:---:|:---:|
| Wastewater management | Urban flood management |

# DC Water

- *Asset and maintenance data collected in **real time***

- ***36% reduction** in customer calls through preventive maintenance and automated meter readings*

- *Number of emergency crews dispatched within 10 minutes increased **from 49% to 93%** due to streamlined processes*

- *Plans to **use analytics** to understand service demand*

- *Combined with map-based information and geo-analytics to*

  - ***predict** infrastructure problems*

  - ***maximize** number and priority of work orders per team*

  - ***optimize** truck rolls*
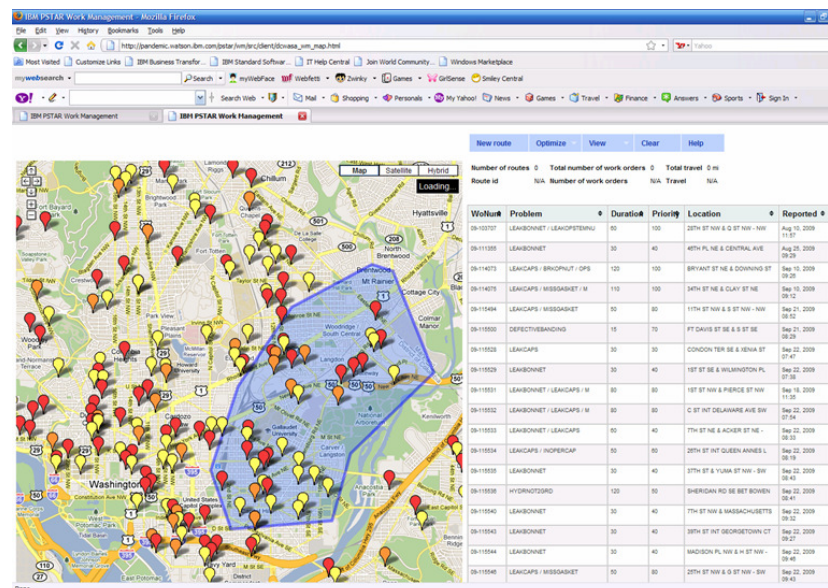
# IBM's Smarter Water Management Centers provides a flexible unifying innovation platform for intelligent operations and advanced analytics

## Smarter Water Management

**Leverage** operational data holistically to create insights and improve water management

**Anticipate** potential delivery disruption and better forecast long term water demand

**Coordinate** resources to protect water supply and drive conservation and sustainability



Connecting across multiple data sources for a single picture across the water system
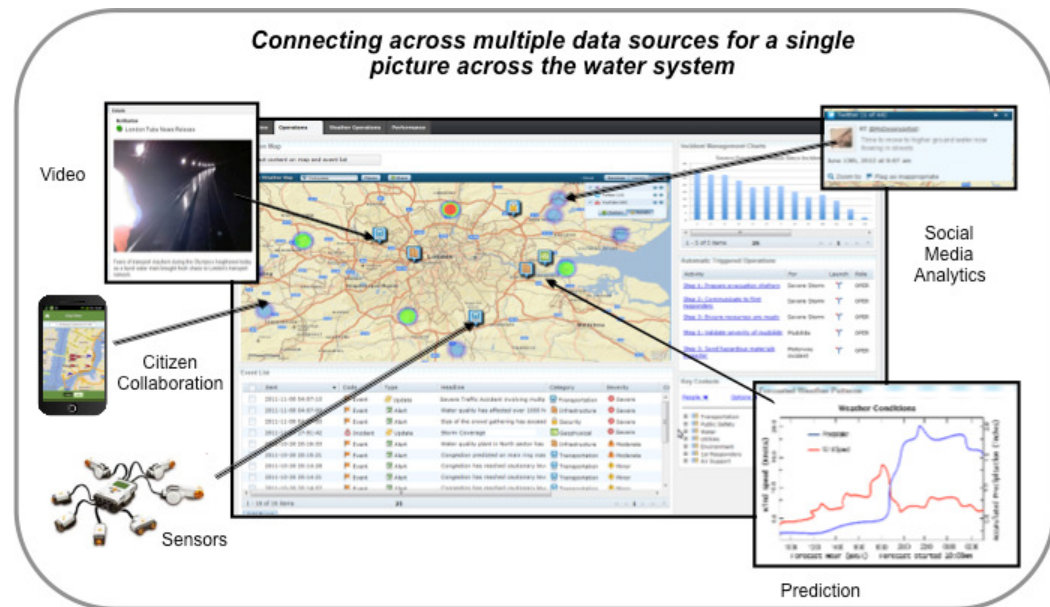
*Analyzing data to perform proactive maintenance, DC Water & Sewer Authority achieves ROI of 629% in 2 months*

**dc** water is life

*"Our assets give us headlights into the future, providing actionable insights."*
*— Omer Siddiqui, CIO DC Water*

IBM

# Digital Delta using Big Data to transform management of the Dutch Water System and **help keep the country safe**

## Up to 15%
reduction in the cost of managing water

## Help prevent disasters
and environmental degradation with better integrated information



**DIGITAL DELTA**
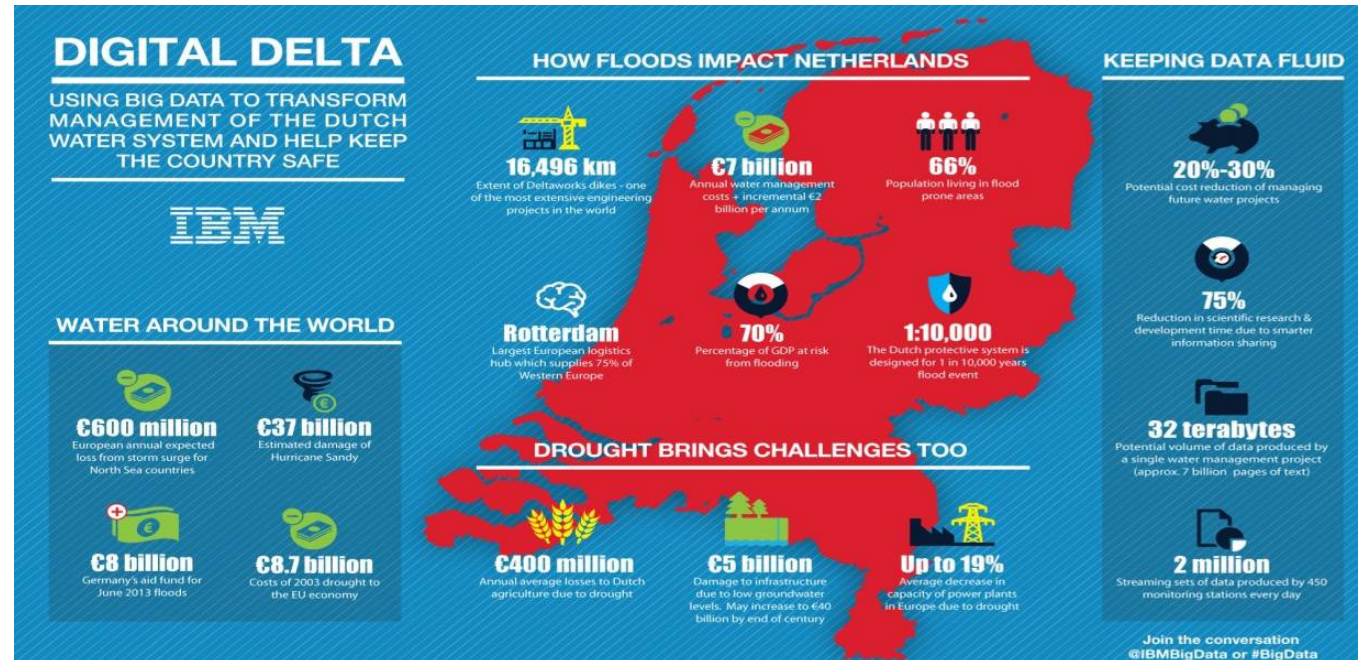USING BIG DATA TO TRANSFORM MANAGEMENT OF THE DUTCH WATER SYSTEM AND HELP KEEP THE COUNTRY SAFE

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**WATER AROUND THE WORLD**

€600 million
European annual expected loss from storm surge for North Sea countries

€37 billion
Estimated damage of Hurricane Sandy

€8 billion
Germany's aid fund for June 2013 floods

€8.7 billion
Costs of 2003 drought to the EU economy

**HOW FLOODS IMPACT NETHERLANDS**

16,496 km
Extent of Deltaworks dikes - one of the most extensive engineering projects in the world

€7 billion
Annual water management costs + incremental €2 billion per annum

66%
Population living in flood prone areas

Rotterdam
Largest European logistics hub which supplies 75% of Western Europe

70%
Percentage of GDP at risk from flooding

1:10,000
The Dutch protective system is designed for 1 in 10,000 years flood event

**DROUGHT BRINGS CHALLENGES TOO**

€400 million
Annual average losses to Dutch agriculture due to drought

€5 billion
Damage to infrastructure due to low groundwater levels. May increase to €40 billion by end of century

Up to 19%
Average decrease in capacity of power plants in Europe due to drought

**KEEPING DATA FLUID**

20%-30%
Potential cost reduction of managing future water projects

75%
Reduction in scientific research & development time due to smarter information sharing

32 terabytes
Potential volume of data produced by a single water management project (approx. 7 billion pages of text)

2 million
Streaming sets of data produced by 450 monitoring stations every day

Join the conversation
@IBMBigData or #BigData

**Business Challenge:** The Netherlands has one of the best-monitored water systems in the world. While large amounts of data are collected, relevant data can be difficult to find, data quality can be uncertain and with data in many different formats, this creates costly integration issues for water managing authorities

**The Smarter Solution:** The solution will provide water experts with a real-time intelligent dashboard to harness information so it can be shared immediately across organizations and agencies. Using data visualization and deep analytics, these insights can help prepare for imminent difficulties, enabling authorities to coordinate and manage response efforts and, over the longer term, to enhance the ongoing efficiency of overall water management.

# Digital Delta Regional Water Resources Management Platform

- *Initial collaboration between IBM and Rijkswaterstaat (Dutch Ministry for Water), Water Authority of Delfland and the University of Delft*

- *Breakthrough **cloud-based** innovation plaftorm*

- *Get insights from **big-data** to transform flood control and the management of the entire Dutch water system.*

- *Integrates disparate systems to share and **analyze water data** from a wide range of existing data sources*
  - *Precipitation measurements,*
  - *Water level and water quality monitors*
  - *Sensors, radar data, model predictions,*
  - *current and historic maintenance data from pumping stations, locks, dams, etc*

- *Open system **enable third-parties** to integrate instrumentation and develop new Smarter Water Analytics*



*Regionalized Big Data Exchange and Smarter Water Analytics Innovation Platform*

IBM
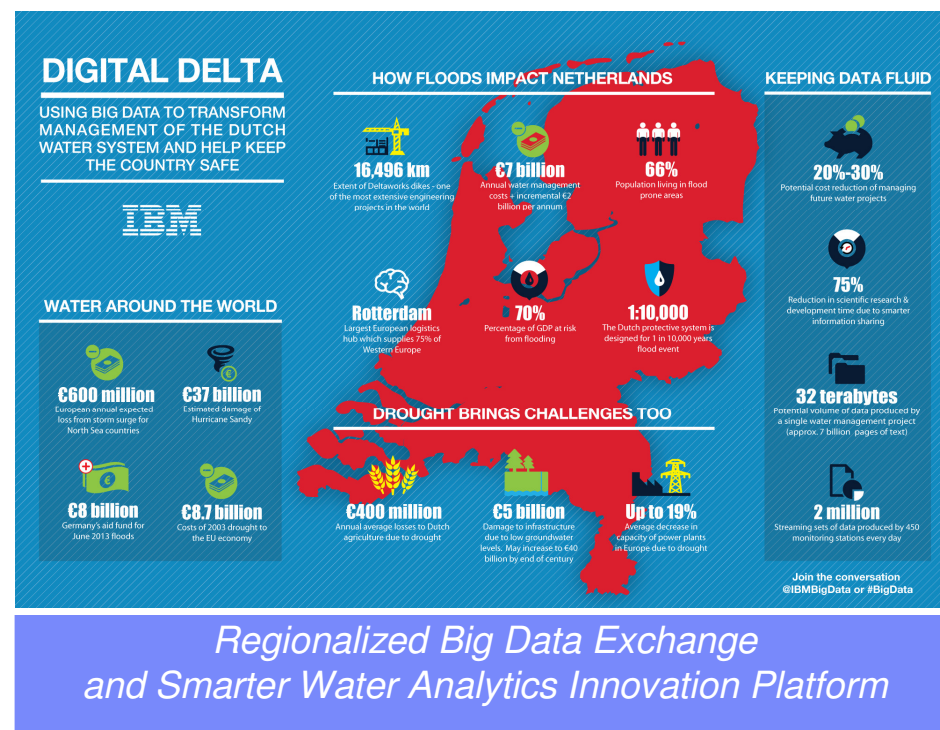
# Miami Dade Parks, Recreation and Open Spaces uses KPI analyses, geospatial maps and auto alerts to detect, identify and repair leaks quickly, dramatically cutting costs.

## >USD1 million

estimated savings related to water costs and proactive leak detection

## >95%

reduced lag time for locating leaks, from weeks to hours

## 40 meters

delivering near-real-time water intelligence from 13 parks



**Business Challenge:** This park system, the third-largest in the United States, was using roughly 360 million gallons of water per year at a cost of about USD5 million. Officials correctly suspected that some of the cost was due to leaks and water waste resulting from an aging infrastructure. Finding the exact location of a leak, however, and diagnosing the problem was extremely labor-intensive and costly.

**The Smarter Solution:** The department deployed a solution that tracks and monitors water use by collecting hourly consumption data from smart water meters. If, when analyzing data against key performance indicators (KPIs), the system detects a consumption spike or irregularity, it issues an alert so that operators can drill down to the meter level, investigate causes and dispatch repair crews quickly.

*This is a real game-changer…not only from the standpoint of savings and diagnosing problems more efficiently but also because the savings can be put toward developing the system and taking care of other needs in the community.*

# Social networking, crowd sourcing, and using "citizens as sensors" becoming more and more central to protecting environmental health

*Citizens Waterway Pollution in California*
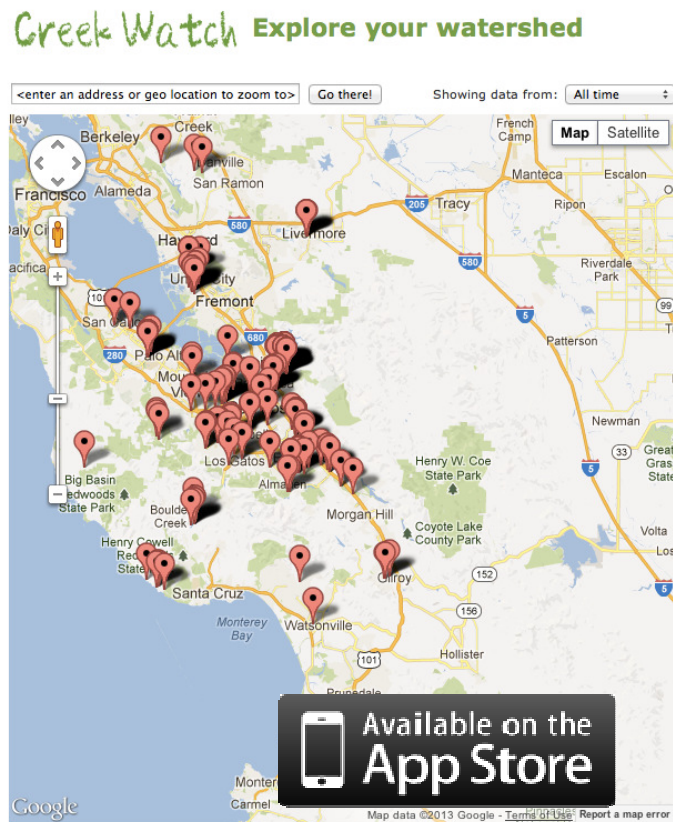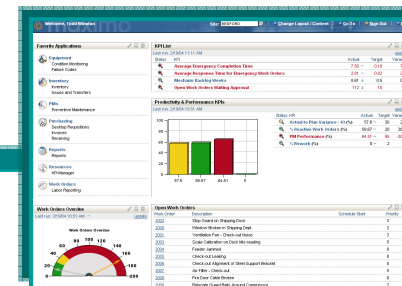
*Citizens Leak Detectors in Africa*





www.ibmwaterwatchers.co.za

# Complementary solutions



### Enterprise Asset Management:

Integration with an Enterprise Management System provides a "closed loop" to identify, mitigate and quickly address any disruptive events – **by linking predictive analytics, pressure optimization and asset management.**



### Video Analytics – Infrastructure Physical Security:

Video is another data feed for increased situation awareness with ability to search for events and analyze patterns. It can help secure high value assets in critical operations, widely dispersed assets – **by providing alerts in real time**.

# IBM's water efficiency management solution value:

**Solution helps:**

- **Reduce repair / maintenance costs** - reduced incidence of leaks and bursts

- **Increases life of assets** via lowered wear and tear, proactive asset maintenance and faster response to disruptions

- **Lower energy** consumption (less water lost , less pumping / less treatment)

- **Recaptured revenue** from lowered water loss and reduced emergency actions

- Improve **customer service** and water quality

- **Lower** the operational **risk profile** of customers

# No fundo, estamos falando do nosso
# FUTURO
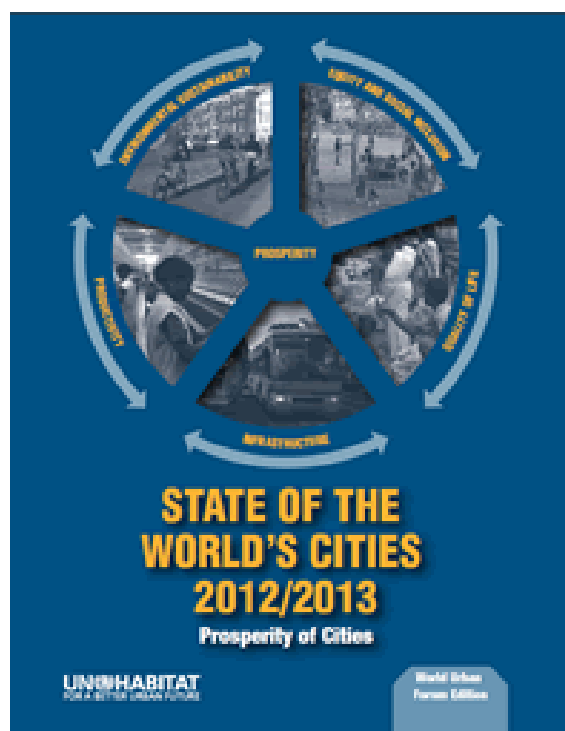


*"O bom ambiente urbano será tão determinante para as atividades econômicas e sociais no século XXI, como a proximidade às fontes energéticas e à matéria-prima o foi para a sociedade industrial, no século XIX."*

# Obrigado!

Smarter Cities – Helping Building Cities Smarter Every Day