Provision of sustainable safe drinking water

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The Sustainable Drinking Water Agenda

- The Global Challenge
- A short history of water treatment
- Water treatment considerations
- Water safety planning
- The Centre of Expertise for Water (CREW) approach

The Global Challenge

“We have 20 years to arguably deliver something of the order of 40% more food, 30% more available fresh water and of the order of 50% more energy.

We can’t wait 20 year or 10 years indeed – this is really urgent.”

Professor John Beddington
Former UK Chief Scientist

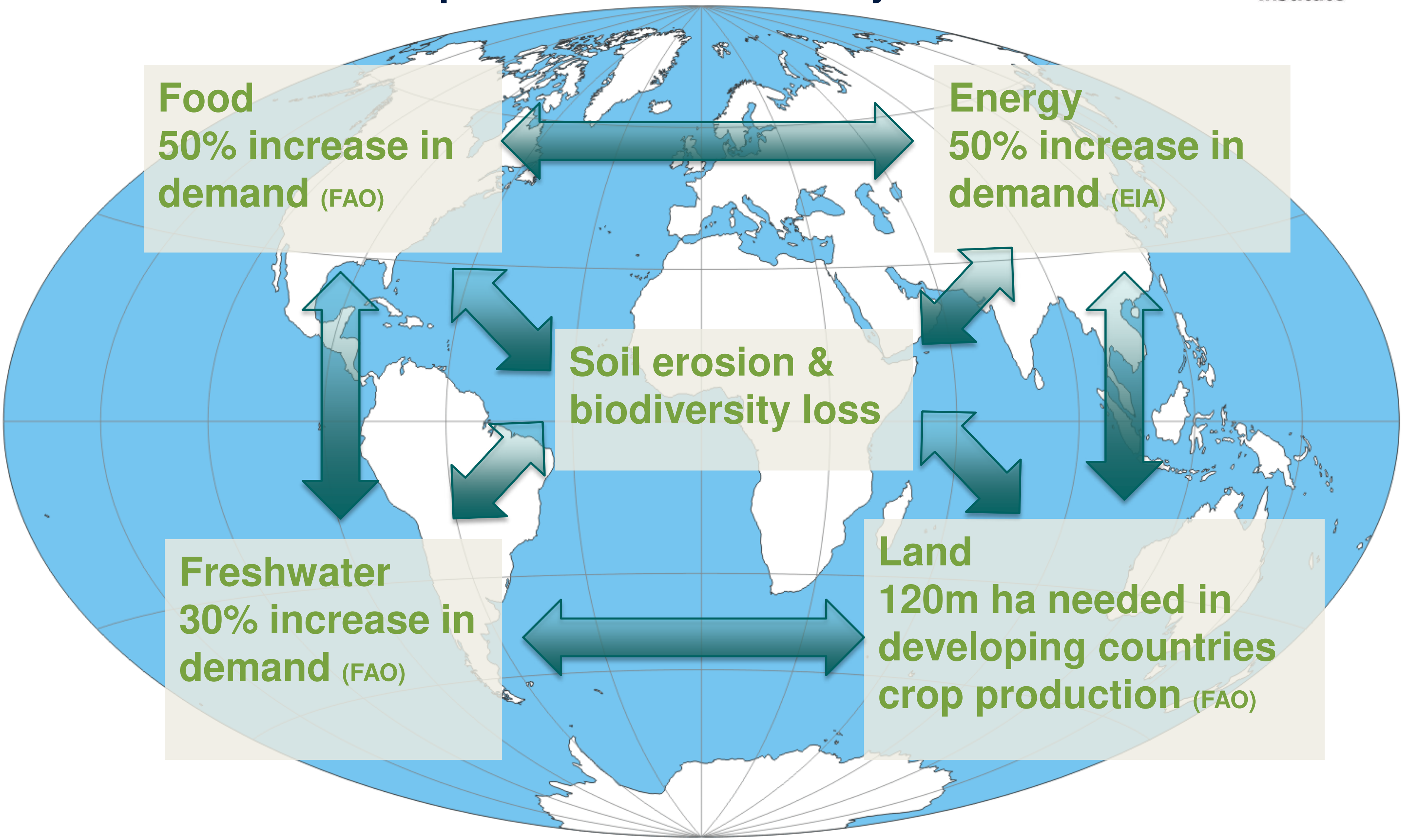
http://www.bbc.co.uk/news/science-environment-12249909

The Blue Planet

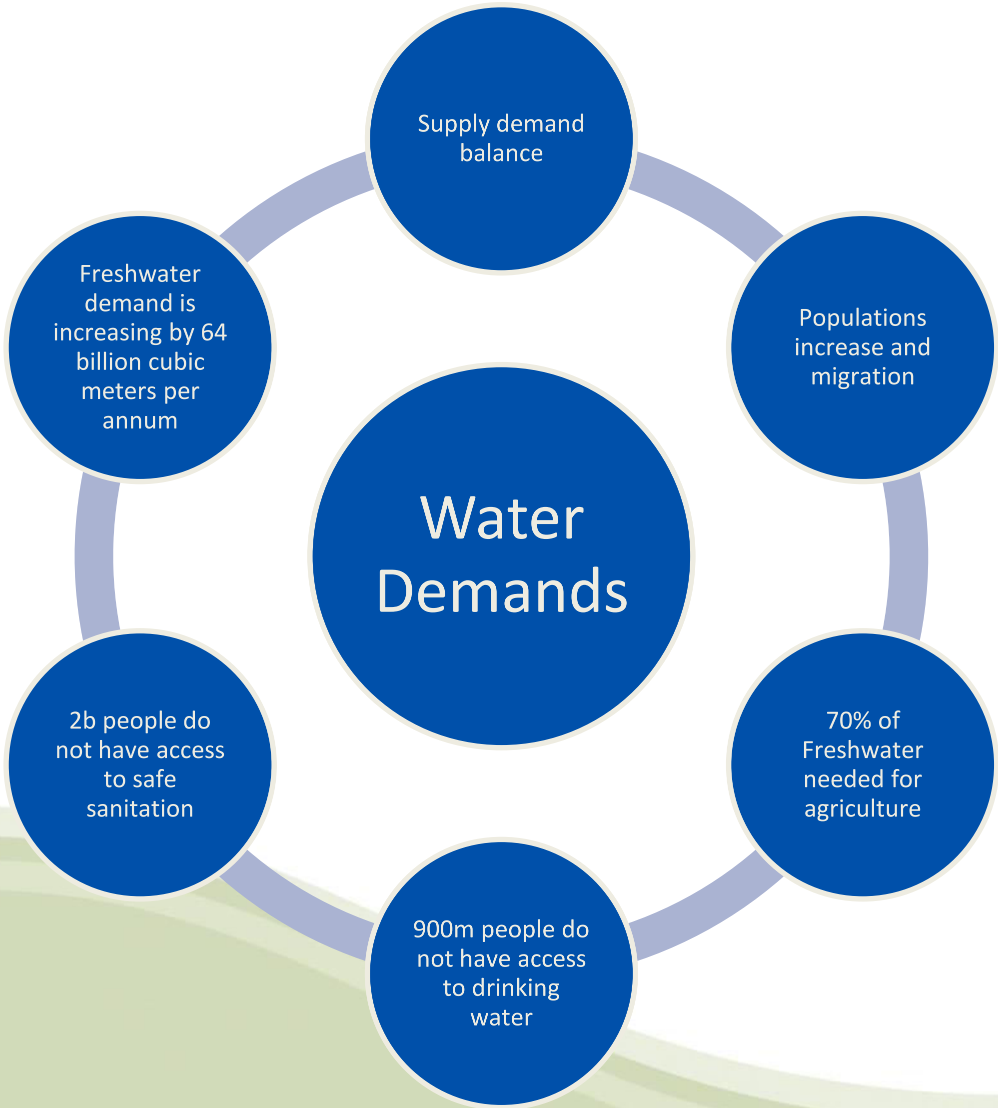
- **Total volume of water in the world is approximately 1.4b km^3**
- **Total volume of freshwater is approximately 35m km^3**
- **Total available freshwater is around 10m km^3 (<1%)**

The Global Challenge

Population of 8.3 billion by 2030 (UN)



Water – Strategic concerns



A (very) short history of improvements to water treatment

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- **1676** – Van Leeuwenhoek fist observed water born Microorganisms
- **1804** – First known municipal treatment works was build (in Scotland) by Robert Thom.
- **1854** – John Snow made the link between a Cholera outbreak and sewage. Used Chlorine to disinfect.
- **1890** – USA introduced large scale slow sand filtration to protect public health.
- **1890 – 1910** – Coagulation, Calcium Hypochorite and ozone introduced
- **1914** – First drinking water standards were applied, based on coliforms.
- **1970s** – Tri-halo methanes discovered in water by R.Hook.
- **1970 – 1990s** – Aeration, flocculation, activated carbon and membrane technology introduced.

A simple representation of the water management system components

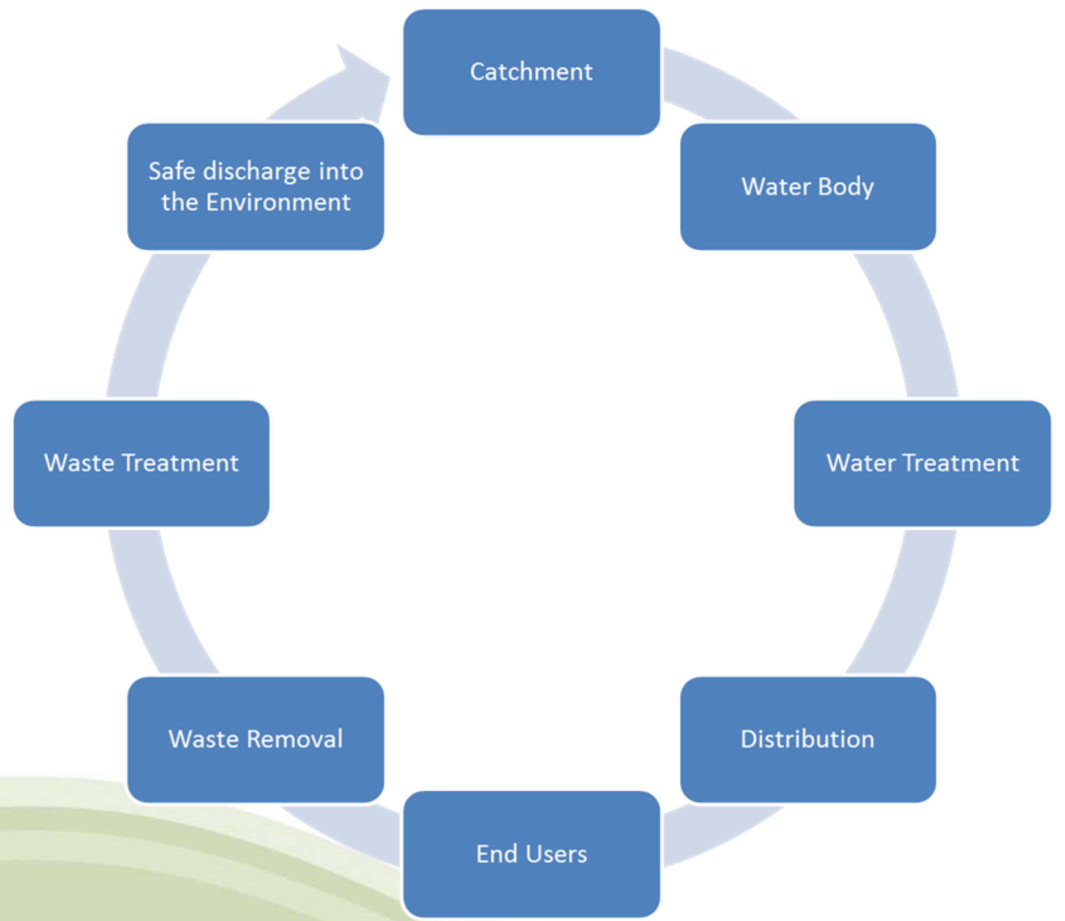

Figure 1: A simple representation of elements that make up a water management system.

Basic Treatment Water

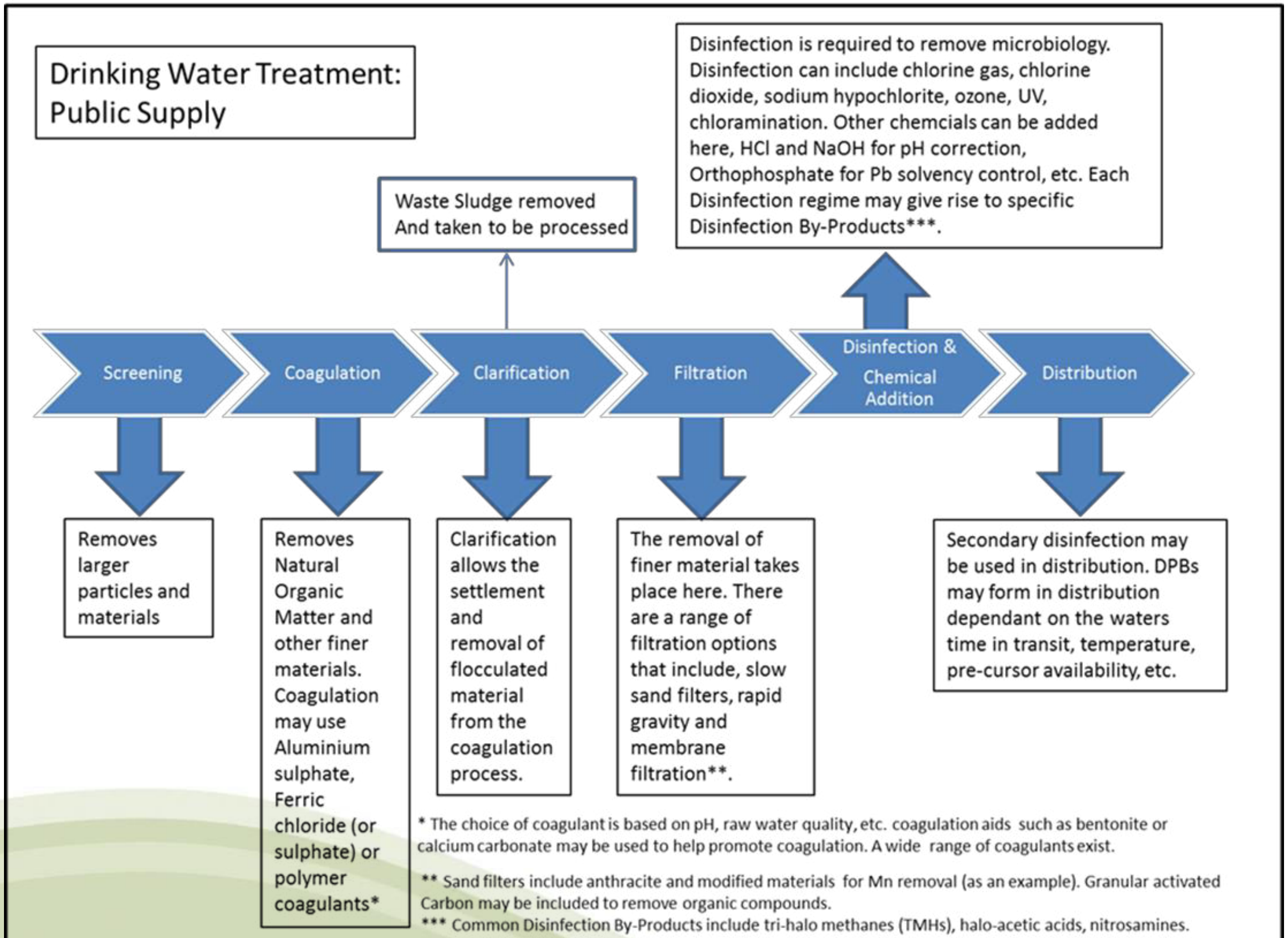

Figure 2: Principle Drinking Water Treatment Processes.

Basic Treatment Wastewater

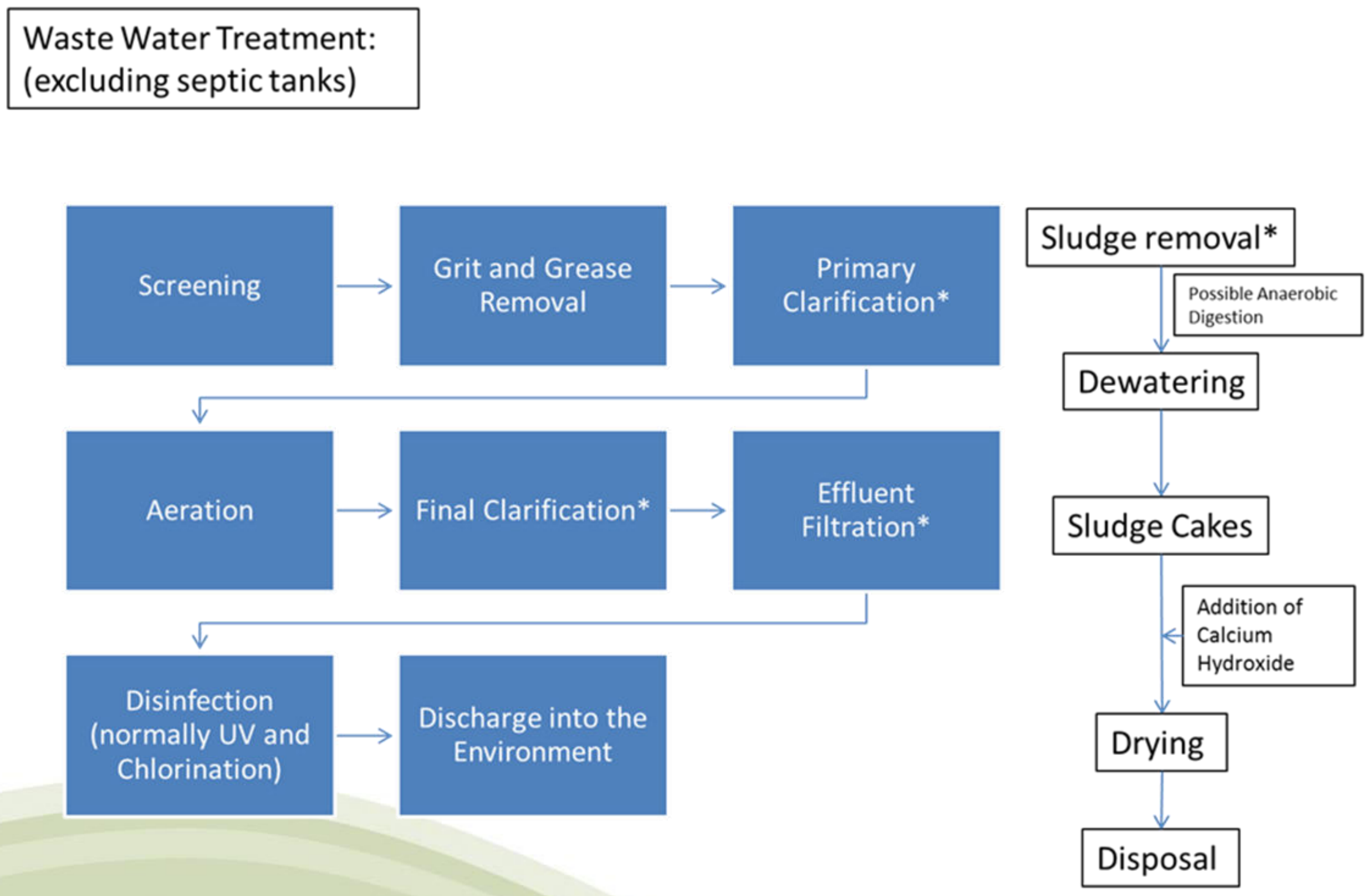

Figure 3: A representation of the basic components of the waste water treatment process.

Considerations for service delivery

Private Water Systems

- Raw water sources vary
  - Groundwater
  - Surface water
  - Rainwater
- Protection of source is variable
- Treatment varies
  - Filtration
  - UV
  - Disinfection
- Often septic tanks (or equivalent) are located close to water sources increasing the risk of contamination

Examples of small systems

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Private Water Supplies in Scotland: Supplies 3% of Population

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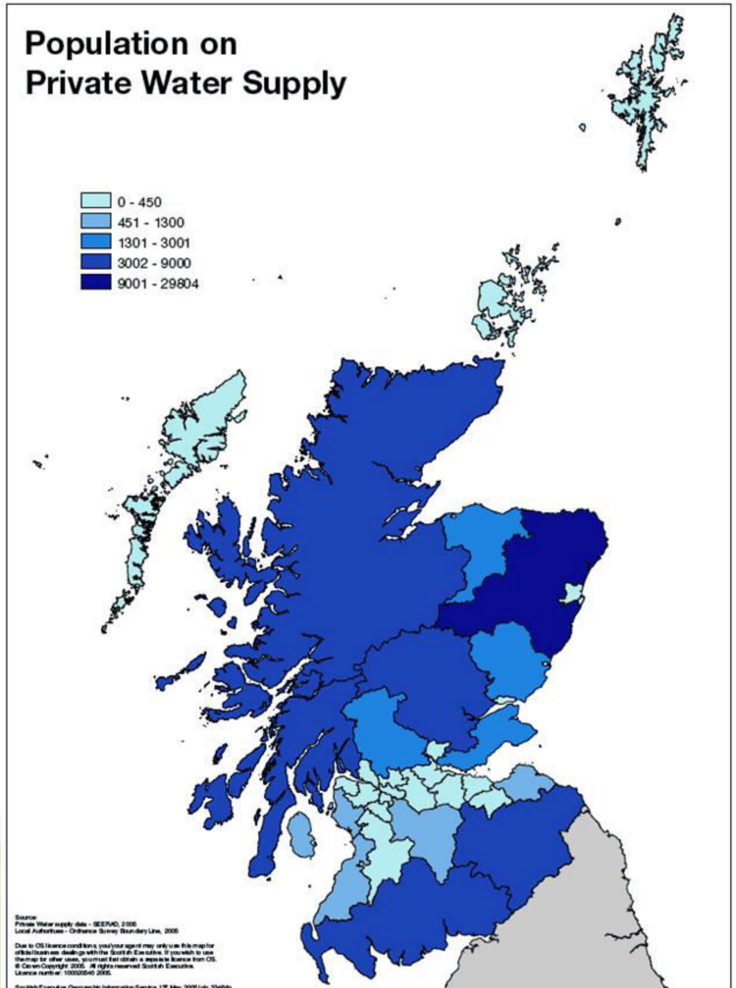
- Regulations based on two supply categories (A & B)
- Type A is supplies >10Ml per day and/or supplying >50PE.
- Type B are supplies of <10Ml per day and that generally supply single properties.
- There are 2330 Type A supplies and 17,863 Type B supplies in Scotland.
- 95.58% of Type A supplies have been risk assessed.
- Sampling compliance is 90.09%.
- 13.6% Type A supplies failed for E.Coli, with 20.22% of Type B supplies failing.

Private Supplies in Scotland



Private Supplies

Compliance by Parameter

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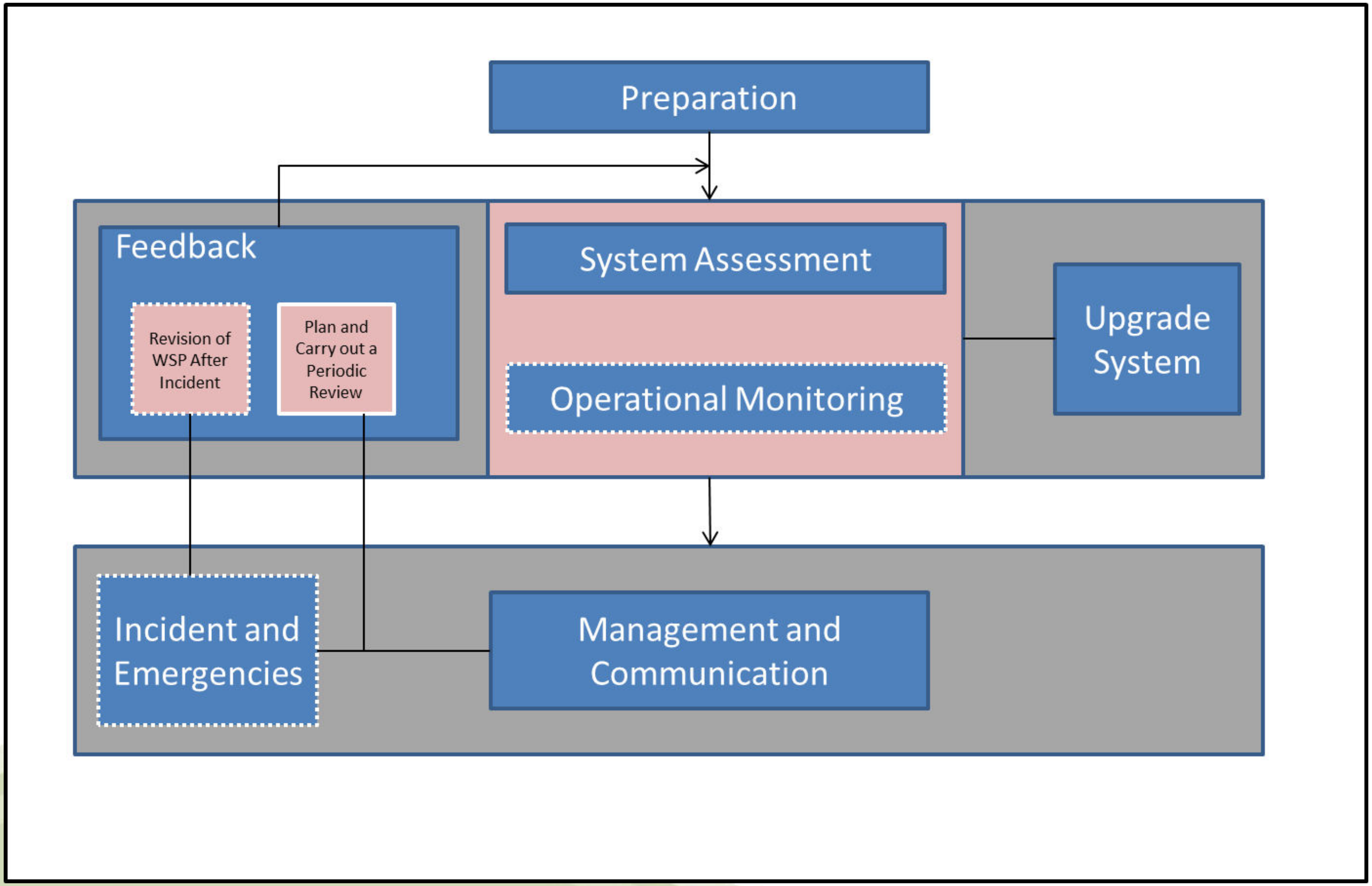
	Type A supplies				Type B supplies			
	Number of tests	Number of Failures	% Fails	% Compliance	Number of tests	Number of Failures	% Fails	% Compliance
All Parameters	40,620	2,241	5.52	94.48	14,521	1,632	11.24	88.76
Aluminium	543	11	2.03	97.97	77	9	11.69	88.31
Ammonium	2,001	9	0.45	99.55	161	4	2.48	97.52
Coliform Bacteria	2,138	530	24.79	75.21	1,167	478	40.96	59.04
Colony Counts 3@22^{o}C	2,115	-	-	-	297	-	-	-
Colour	1,988	305	15.34	84.66	224	31	13.84	86.16
E. Coli	2,135	290	13.58	86.42	1,167	236	20.22	79.78
Hydrogen ion (pH)	2,107	333	15.8	84.2	1,075	308	28.65	71.35
Iron	987	130	13.17	86.83	676	86	12.72	87.28
Lead (25)	982	41	4.18	95.82	975	36	3.69	96.31
Manganese	872	59	6.77	93.23	648	83	12.81	87.19
Odour	1,581	2	0.13	99.87	713	0	0	100
Taste	1,247	14	1.12	98.88	253	0	0	100
Total Trihalomethanes	48	3	6.25	93.75	4	0	0	100
Turbidity	2,098	40	1.91	98.09	984	52	5.28	94.72

Water Safety Planning



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Considering risks to Public Health

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High risk magnitude Low confidence in risk magnitude estimate (high uncertainty) *DBPs* 2	1 High risk magnitude High confidence in risk magnitude estimate (low uncertainty) *arsenic, microbial pathogens*
3 *pesticides* Low risk magnitude Low confidence in risk magnitude estimate (high uncertainty)	4 *sodium* Low risk magnitude High confidence in risk magnitude estimate (low uncertainty)

risk magnitude

confidence

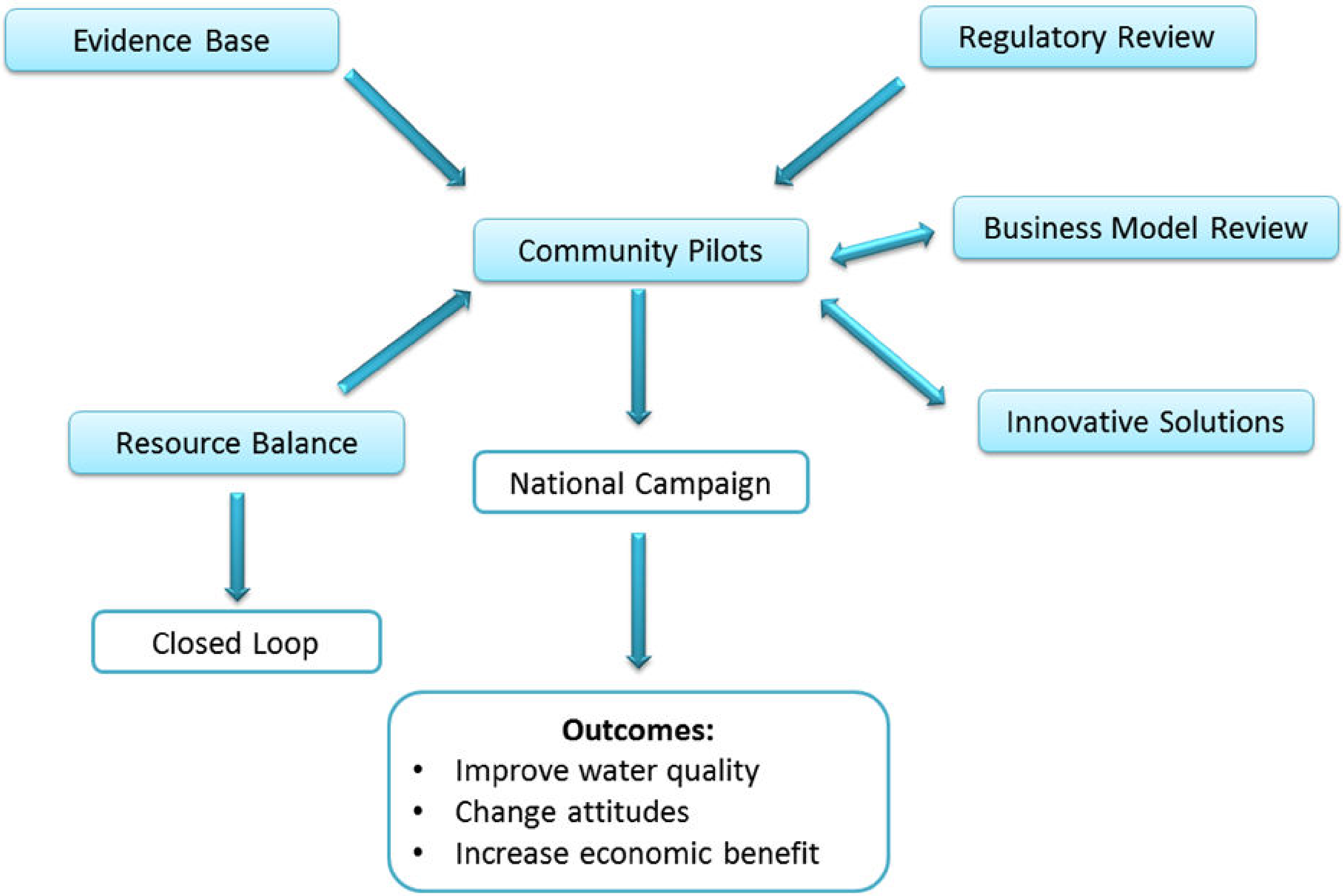
Risk magnitude = probability x consequences
At or below levels which **have occurred** in drinking water

Higher **prevalence** will increase probability

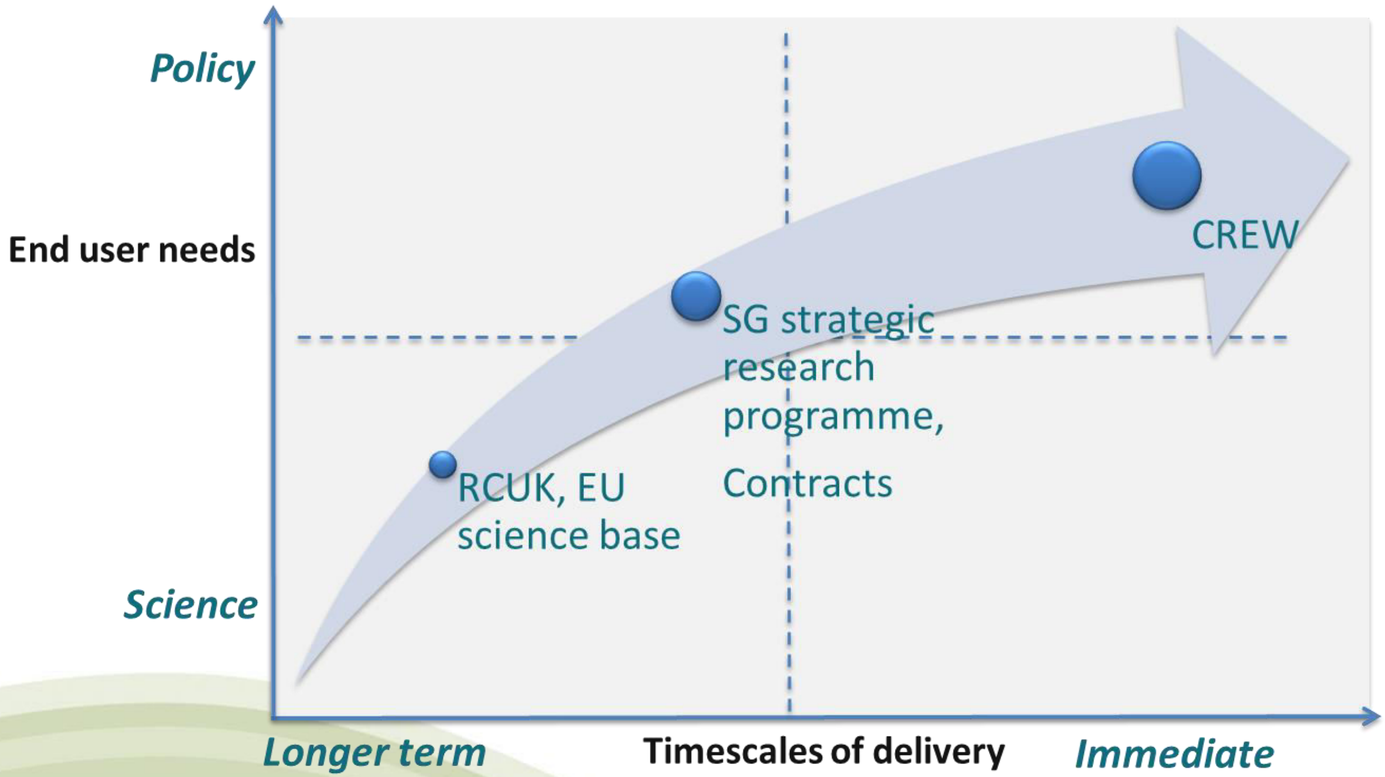
Confidence refers to causation via drinking water exposure

Hrudey et al. 2012. Managing uncertainty in the provision of safe drinking water.
www.cwn-rce.ca/assets/resources/pdf/managing-uncertainty-in-the-provision-of-safe-drinking-water.pdf

The CREW approach



The Policy/Research Lanscape



Examples of CREW projects

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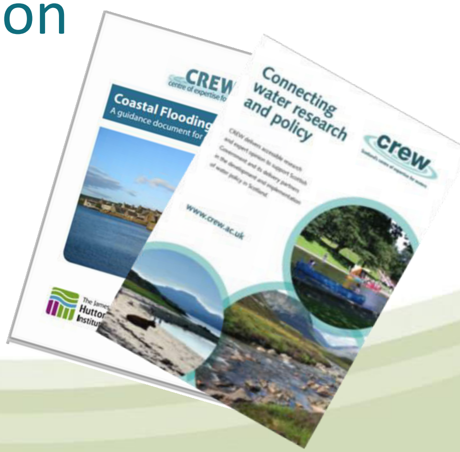
- Workshop to **share knowledge** on NFM implementation
- **Coastal flooding** in Scotland: a **guidance document**
- Land manager **attitudes to NFM** and **economic analysis** of NFM measures
- Surface water **flood forecasting** in urban communities
- **Land management** and flood peak synchronisation
- **SRDP: Targeting** agri-environment measures



The research agenda

- Is a close loop sustainable water system possible?
- What innovations will add value and enhance public health protection?
- What are the impacts of changes in the catchment on existing treatment systems?
- Modular systems design to allow tailored solutions for local conditions.
- Low cost and low maintenance solutions are needed at a local level.
- Understanding social justice and community need is central.

Summary

- Sustainable water is a global challenge.
- Water treatment is essential for protecting pubic health.
- Science and engineering should continue to seek innovative ways of achieving sustainable water and wastewater systems.
- The water treatment process has multiple nodes of failure, the operators should know the systems well and manage the risks.
- Microbiology continues to be the most significant risk to public health and needs pro-active management.

End of Presentation