Environmental issues and water scarcity

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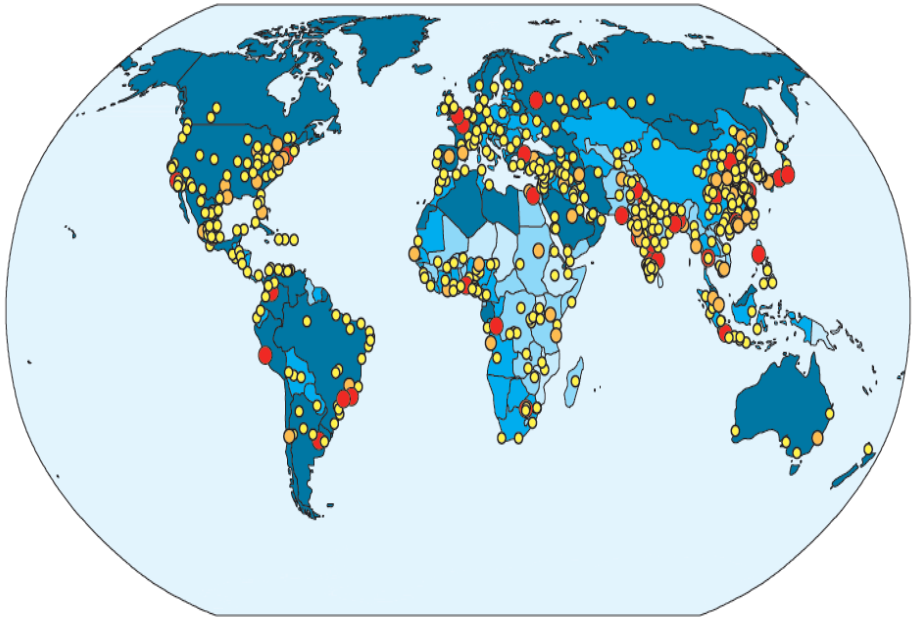
Resource smart systems needed to deliver on sustainable development goals

These are food systems in which the environmental bases to deliver food security for current and future generations is not compromised

Pressures on natural resources are increasing

Population growth and urbanisation



City population
- 1 -5 million
- 5 - 10 million
- 10 million or more

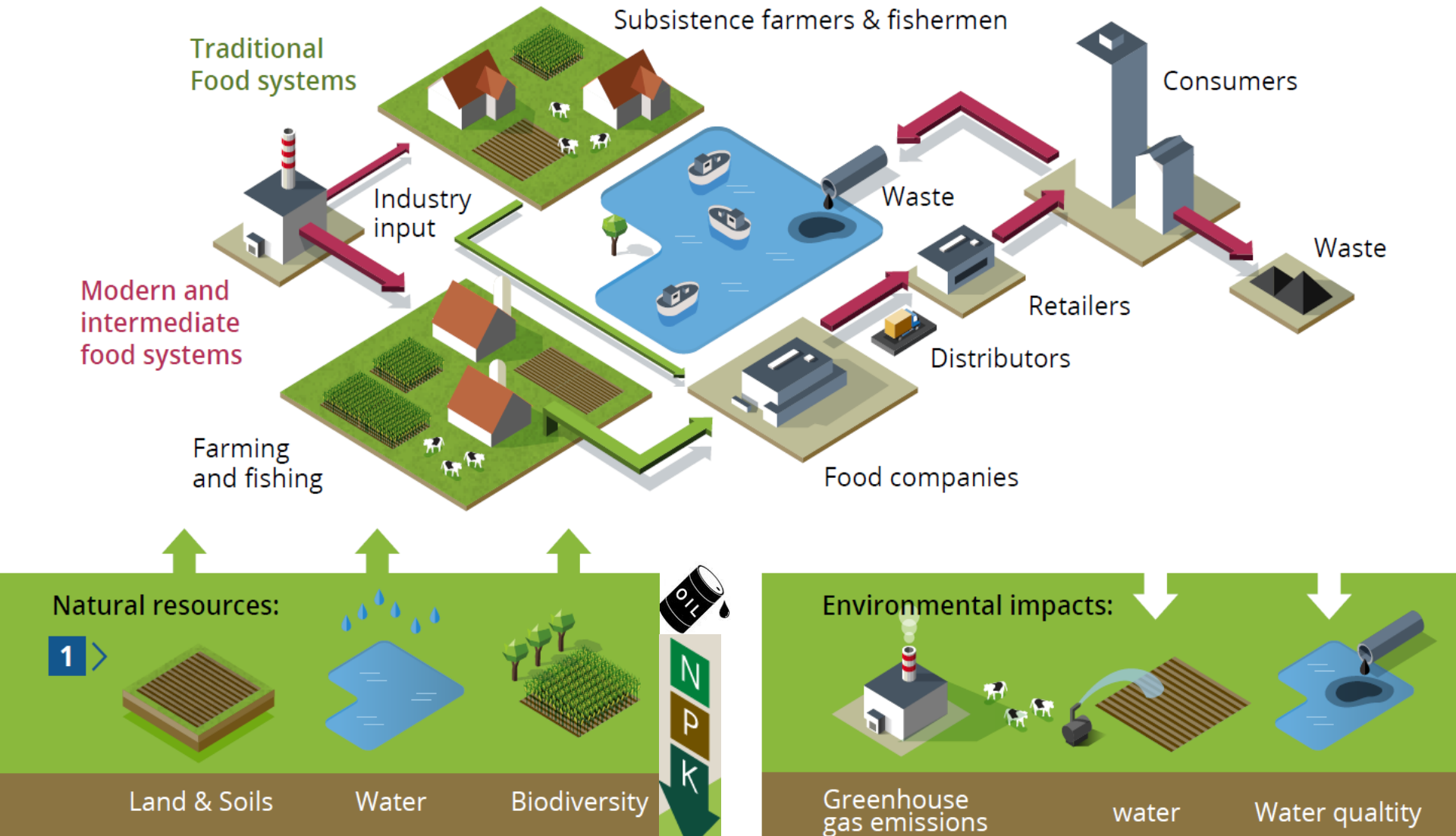
Percentage urban
- 0 - 25
- 25 - 50
- 50 - 75
- 75 - 100

Climate change

Supermarketisation

Dietary changes

Food systems differ widely interconnected and same resources



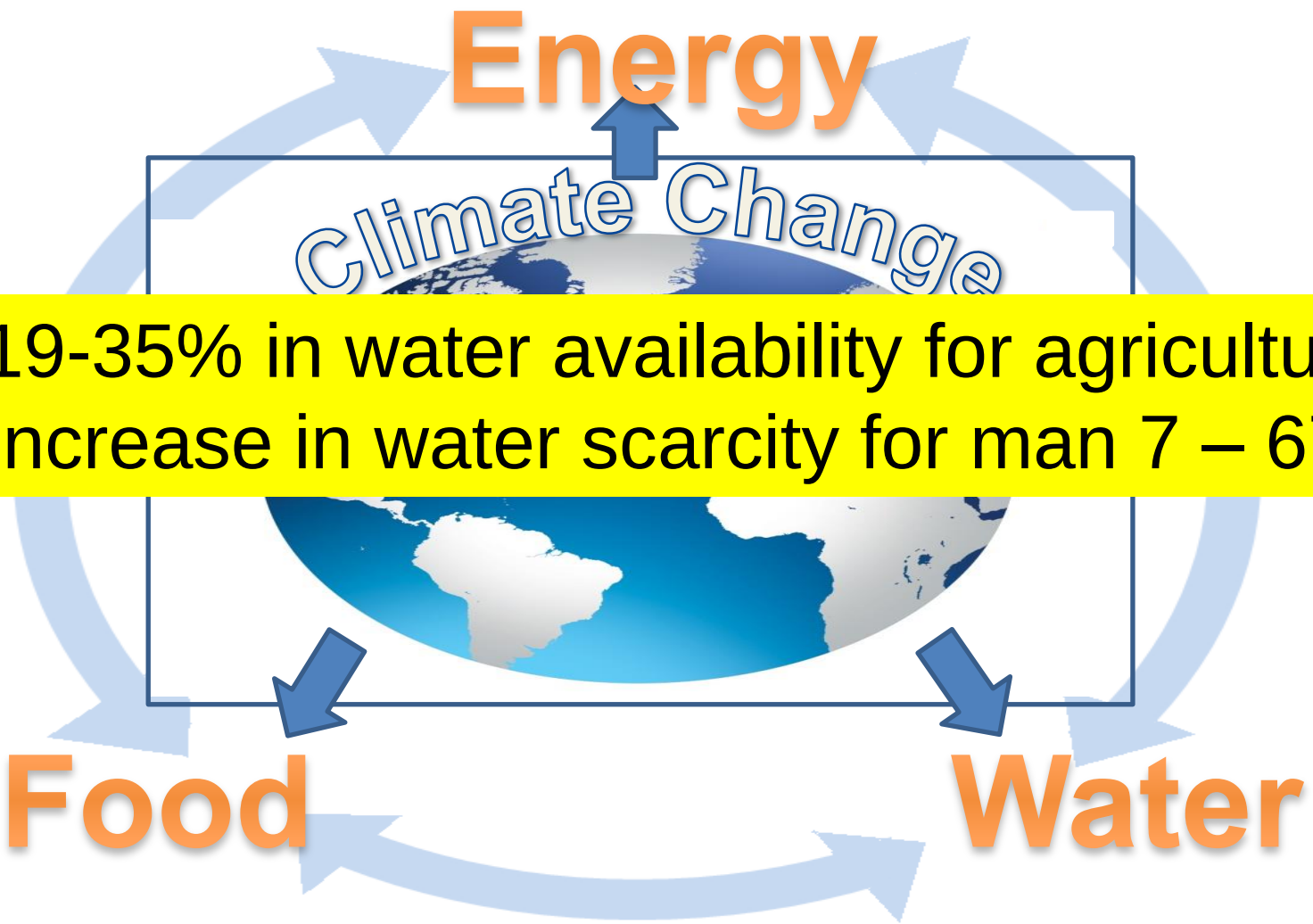
The food system is failing on sustainability…

- Agriculture currently consumes 75% of total global water withdrawals from rivers and aquifers, many of which are overexploited (~ 30% livestock)

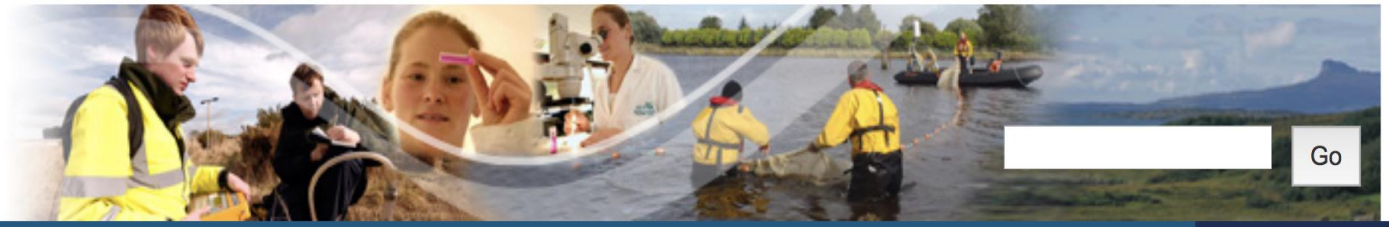
- Of 11.5 billion ha of vegetated land on earth, around 24% has undergone human induced soil degradation

- Agriculture directly contributes 10-12% of GHG emissions

John Beddington's Perfect Storm Scenario



- 19-35% in water availability for agriculture
- Increase in water scarcity for man 7 – 67%



Water scarcity

Although generally considered a wet country, Scotland can be vulnerable to periods of dry weather, which can result in pressure upon the environment and water users in some areas. In addition, climate change is likely to bring uncertainty and, with a projected decrease in summer rainfall, may exert pressure in areas that have not yet experienced water scarcity.

It is vitally important that Scotland is prepared to deal with water scarcity both now and in the future and people work together to plan for and manage water scarcity events. The National Water Scarcity Plan sets out how we will work with water users (authorised abstractors and recreational users) and key organisations, such as Scottish Water, to manage water resources during periods of low rainfall. All water users have a role to play to ensure that resources are used sustainably and the potential impact on the environment is reduced.

Current situation

- **Water Scarcity Situation Report - 16 November 2018**

The report above will always be the most recent. Previous **reports for 2018** are also

Related items

Abstractions

Funding is available for irrigation lagoons to help maintain supplies and protect low flows. More information on Rural payments service website.

Water levels

Application for irrigators switching abstraction to groundwater

Application for temporary abstraction

Under pressure: Preparing for UK water shortages

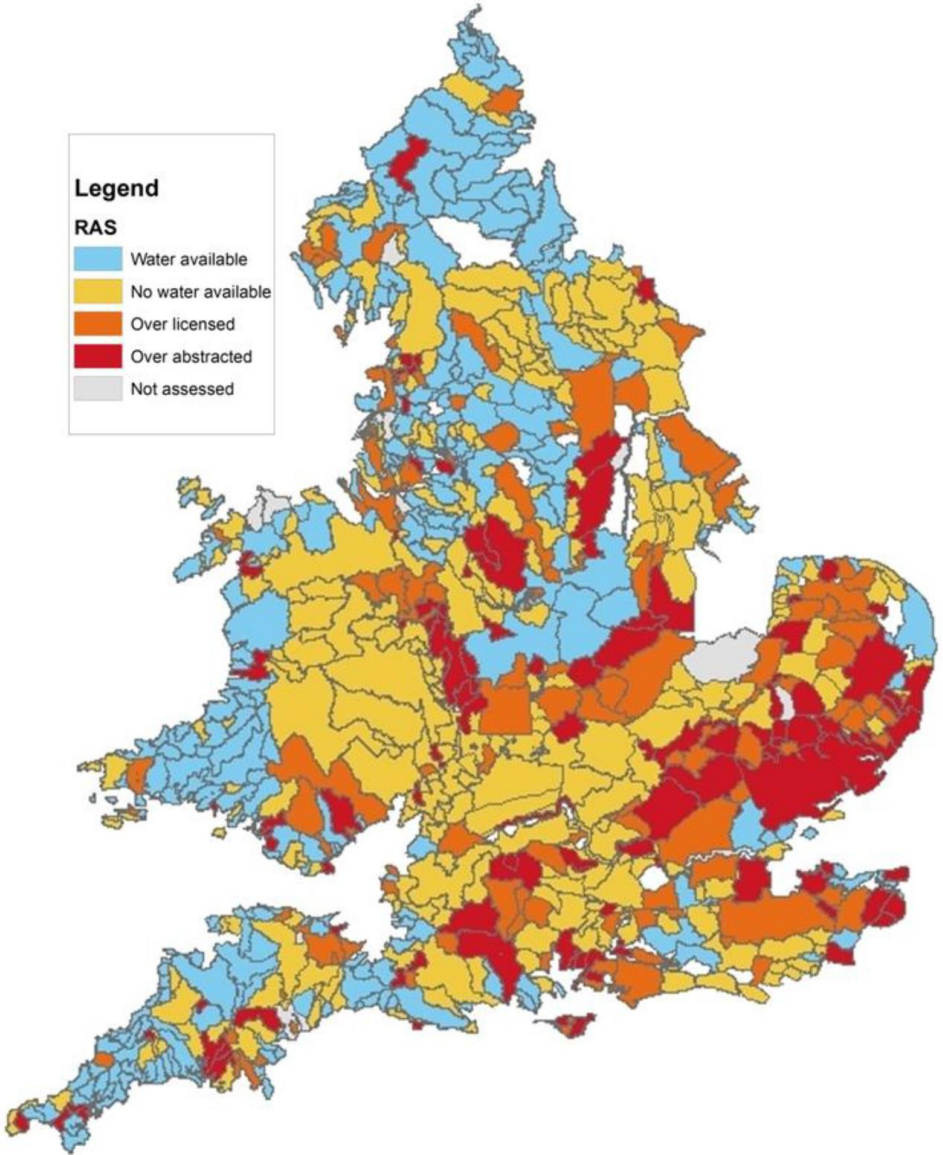
12 September 2017
Gemma Holmes

Climate change is likely to contribute to increased risk of water supply deficits. Although plans to manage the UK's water supply and demand are in place, water companies may need to be more ambitious as they develop strategies for the future, says Gemma Holmes.

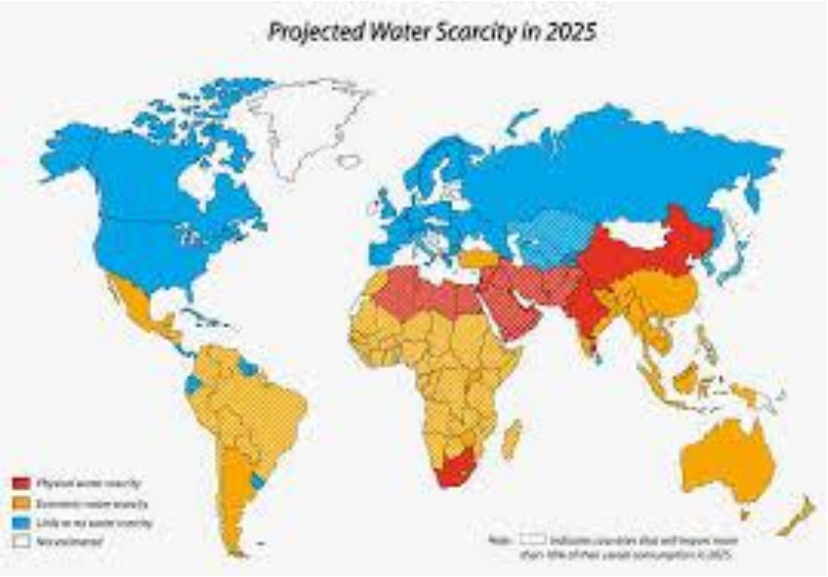
When the UK experiences several months, or years, of low rainfall there is a risk of water shortages, droughts and the dreaded hosepipe bans. A severe drought could lead to household water supplies being cut for part, or all, of the day and makeshift water tanks being set up in our streets. In England and Wales, we use 16 billion litres of clean drinking water every day – that's equivalent to 6,400 Olympic sized swimming pools. Currently, water companies can provide slightly more than we need – 2 billion litres are available above and beyond what we're using. In some areas, though, such as south east England, there is no surplus and, as such, these regions are more likely to face supply restrictions in a dry year. Water companies are currently working to address the potential shortfalls.

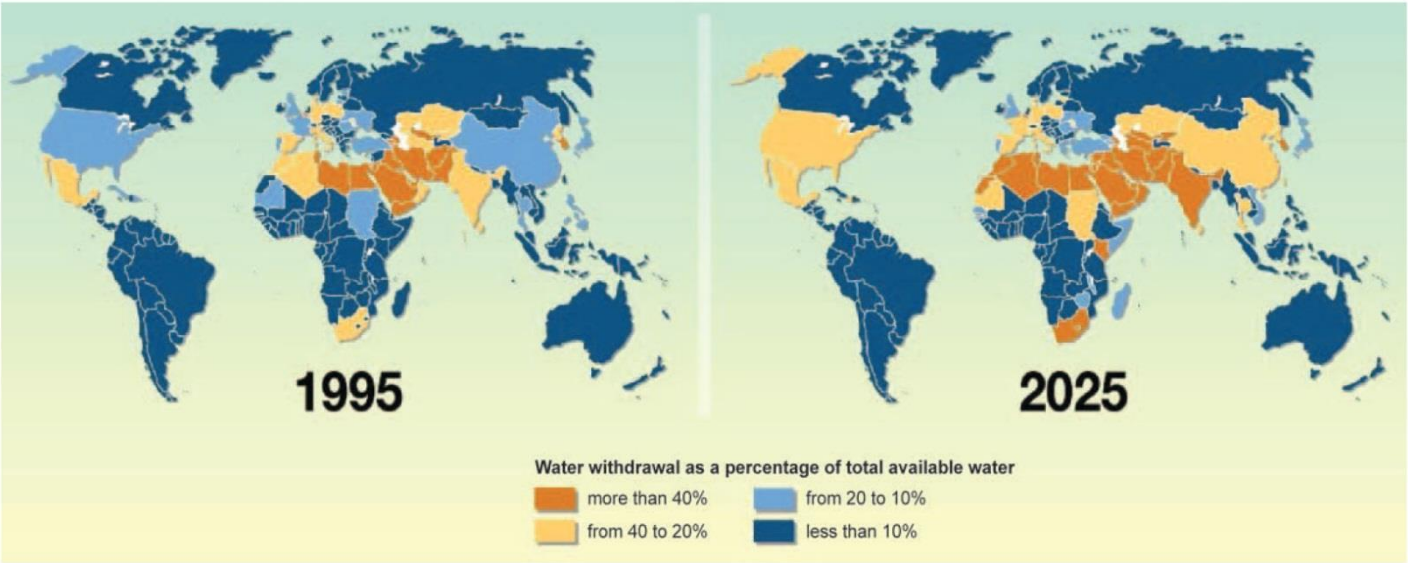
Climate change is likely to mean higher temperatures which may drive up the demand for water (alongside population growth) and increase evaporation from reservoirs and water courses during spring and summer. The impact of climate change on total rainfall is uncertain, but the rain that does fall is likely to arrive in heavier bursts in winter and summer. Heavier rain tends to flow off

Catchment management abstraction showing blue water supply in catchments



- **Water scarcity:**
  - annual renewable supply (ARS) <1,000 m3/person
- **Water stress:**
  - extraction >20% of ARS





Dimensions of water scarcity

- scarcity **in availability** of fresh water of acceptable quality with respect to aggregated demand, in the simple case of physical water shortage

- scarcity **in access** to water services, because of the failure of institutions in place to ensure reliable supply of water to users

- scarcity due to the **lack of adequate infrastructure**, irrespective of the level of water resources, due to financial constraints

Water availability and dairying

Highly dependent on water in its various forms
Important to know the water demand of a dairy system

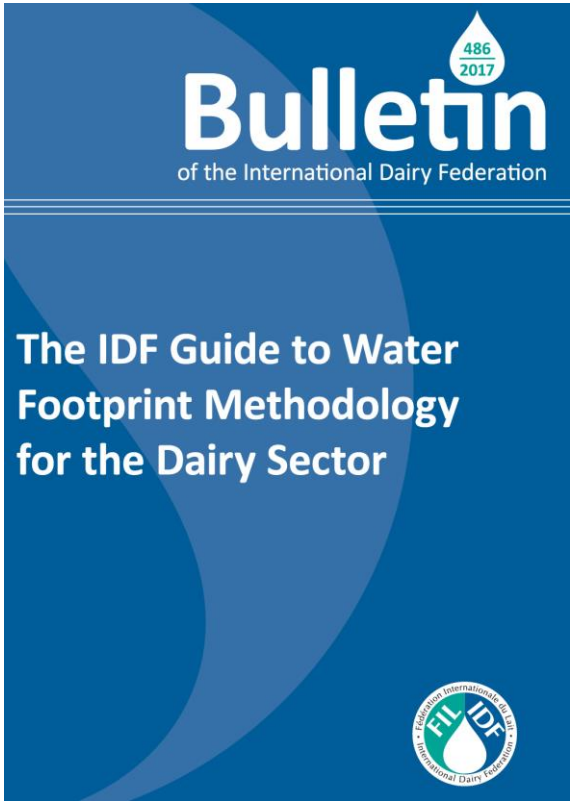
Global milk production (FAO, April 2018)

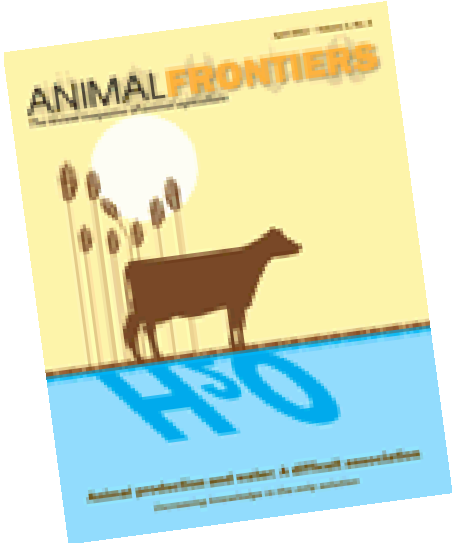
PRODUCTION: TOTAL MILK

thousand tonnes

	2015	2016	2017 *prelim.*	Change 2017 over 2016 (%)
World	**801 316**	**799 097**	**810 652**	**1.4**
India[1]	155 693	159 396	165 612	3.9
EU	162 900	163 000	165 400	1.5
United States	94 619	96 343	97 735	1.4
China	42 666	41 952	41 289	-1.6
Pakistan	41 592	39 652	40 167	1.3
Brazil	34 860	33 878	35 233	4.0
Russian Fed.	30 791	30 752	30 990	0.8
New Zealand[2]	21 909	21 568	21 341	-1.1

1/ Dairy years starting April of the year stated (production only).
2/ Dairy years ending May of the year stated (production only).





http://www.animalfrontiers.org
April 2012

Water footprint definition

- Water Footprint is measured in terms of volume of water consumed, evaporated and polluted
- Three corresponding categories:
- **Blue Water Footprint:** the amount of surface water and groundwater required (evaporated or used directly) to make a product
- **Green Water Footprint:** the amount of rain water required (evaporated or used directly) to make a product
- **Grey Water Footprint:** the amount of freshwater required to mix and dilute pollutants enough to maintain water quality according to certain standards as a result of making a product

www.waterfootprint.org and ISO 14046 [2016]

Physical and virtual water flows in whole dairy system

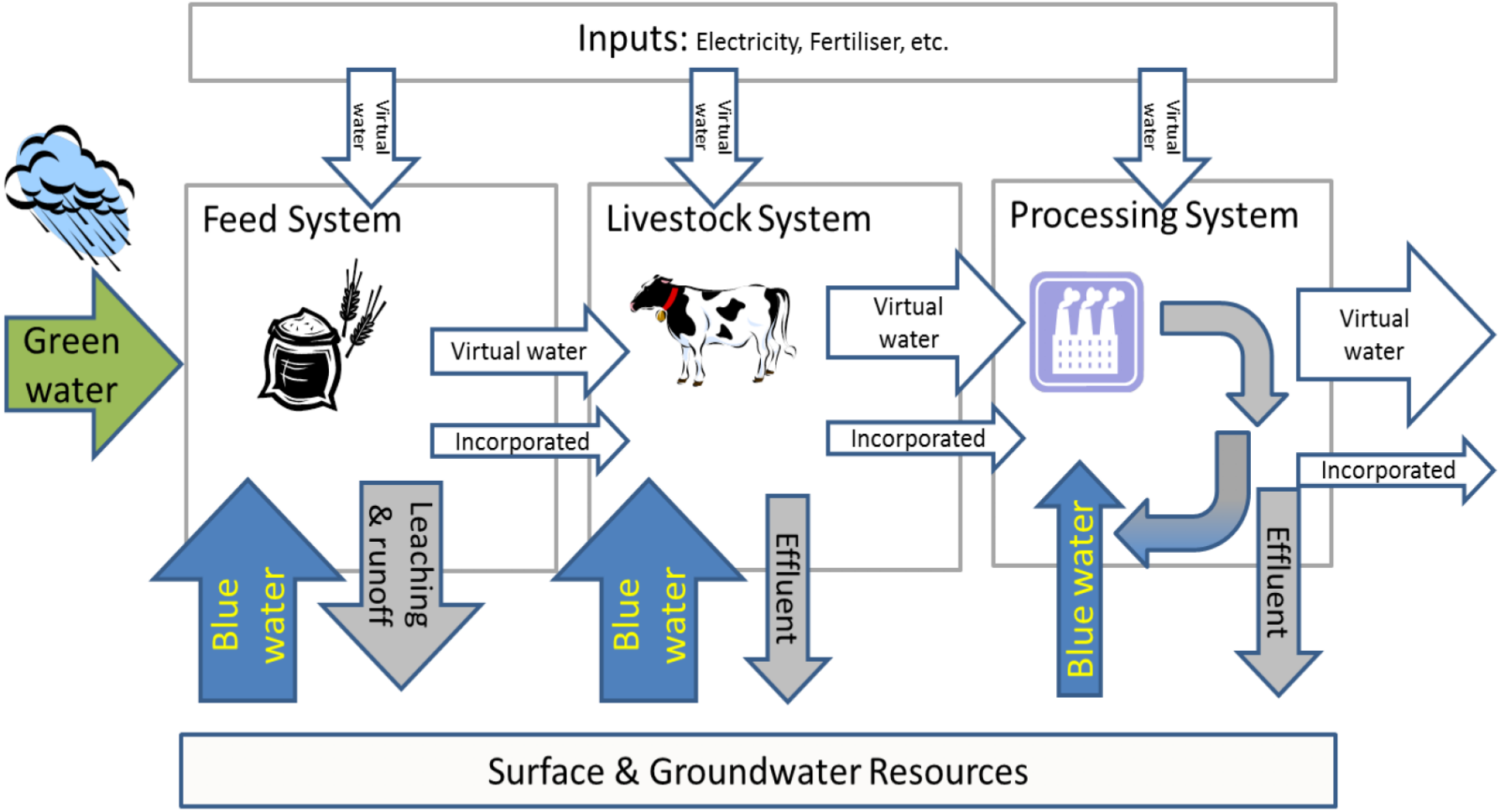


Figure 1 Physical and virtual water flows in the whole dairy system. Note that this analysis only goes up to the farm gate, so that processing is limited to cooling in the dairy parlour.

Total water used in British dairy systems

Table 1 Averaged total water used in British dairy systems, litres per kg fat and protein corrected milk (FPCM). This is to the farm gate, and does not include water used subsequently for milk processing.

Production system	Blue water, l/kg FPCM	Green water, l/kg FPCM	Total water use, l/kg FPCM
Spring calving	7.4	678	685
Autumn calving	7.5	683	691
All-year calving	7.5	681	688
Zero grazing	7.6	706	713
Organic	8.1	1,006	1,014

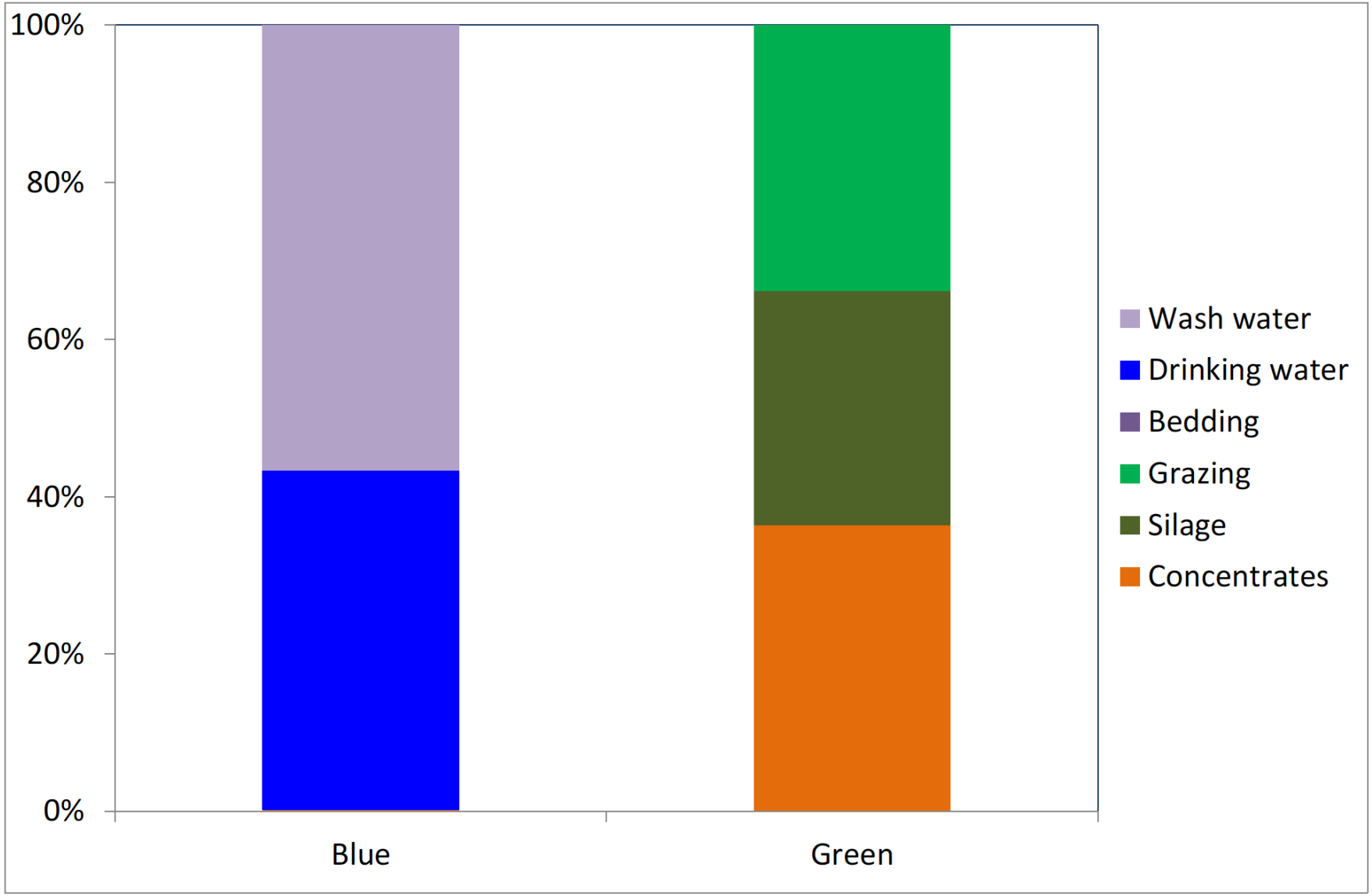
Notes.
Values for green water use would normally be rounded to 2 significant figures, but the whole values have been shown to illustrate the relatively small effect of blue water and be arithmetically correct.
1 kg FPCM is 1.01 litre milk

Effect of milk yield level on water consumption

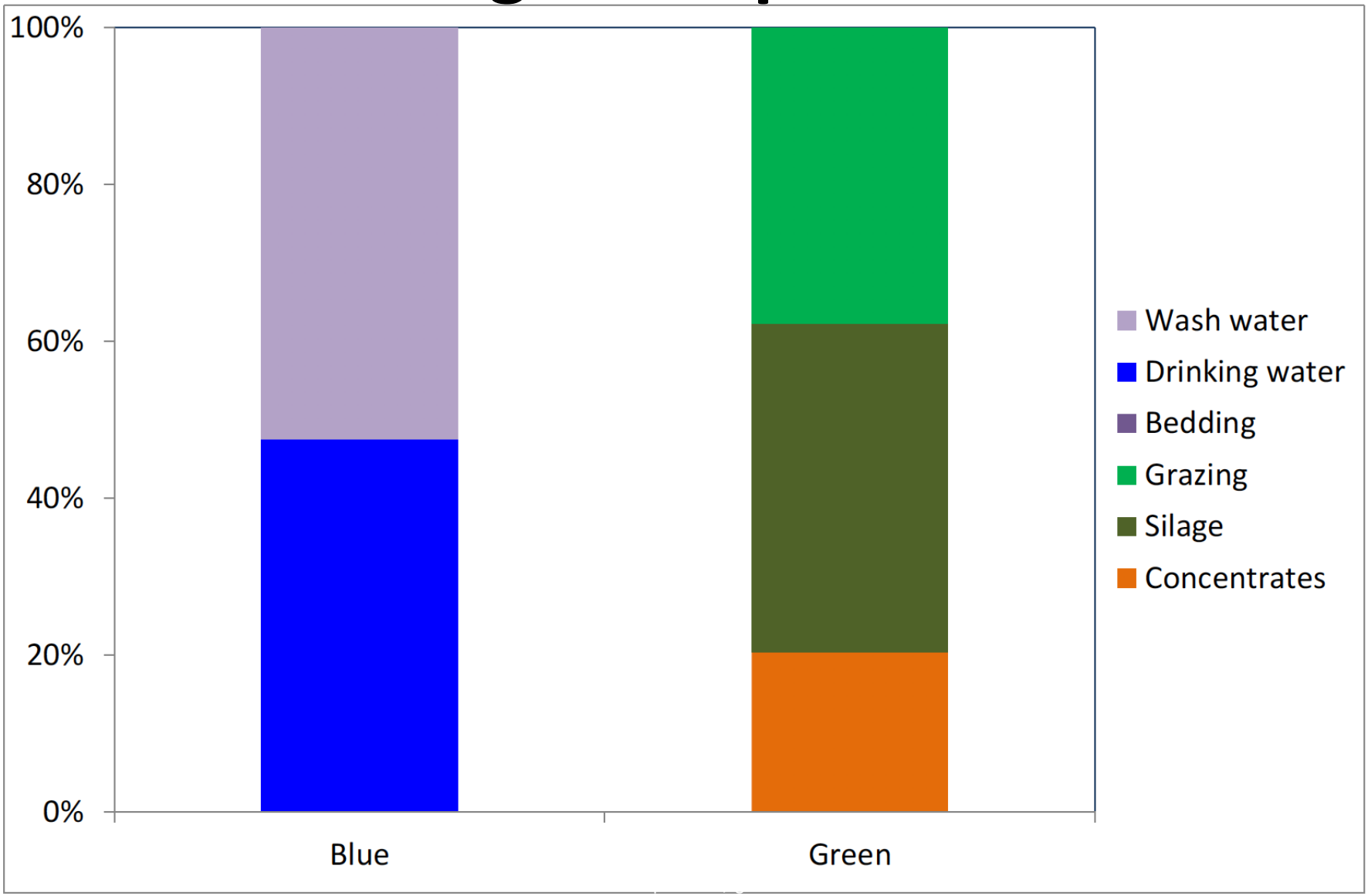
Table 10 Effects of milk yield level on the water consumption in average British milk production

Production system	Yield, kg /year	Blue water consumption relative to medium yield	Green water consumption relative to medium yield
Organic	5470	115%	118%
	6470	100%	100%
	7470	90%	89%
Autumn calving	6770	107%	116%
	7770	100%	100%
	8770	91%	93%
Spring calving	6770	116%	116%
	7770	100%	100%
	8770	91%	92%

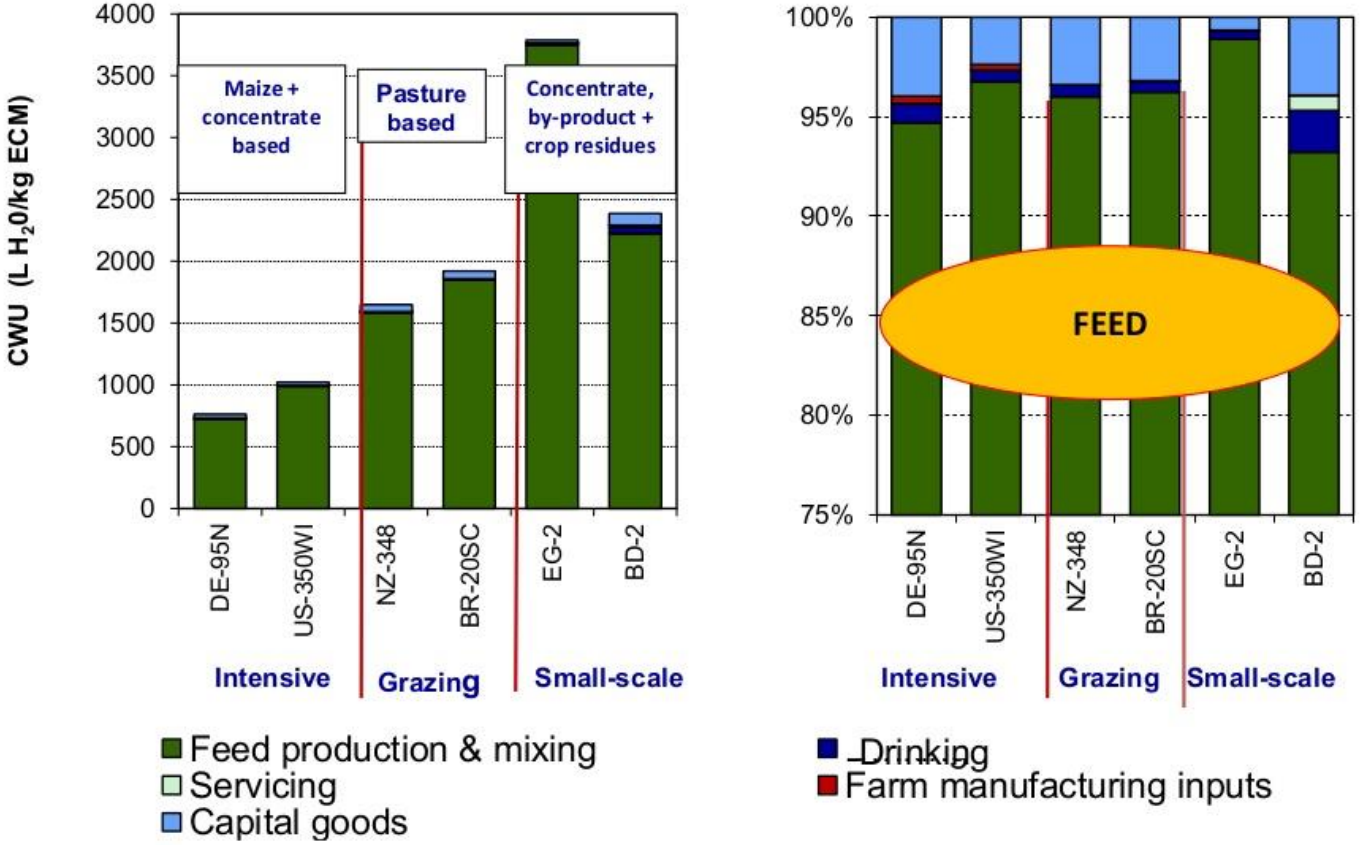
Breakdown of blue and green water in average milk production



Breakdown of blue and green water in average milk production



Consumptive water use in selected dairy systems



CWU = Consumptive water use

Table 2. Total green and blue water use per kilogram of animal product[1]

Product	Average[2] green water use, L/kg	Average blue water use, L/kg	Range of blue water use,[3] L/kg
Beef	14,414	550	0 to 1,471
Pork	4,907	459	205 to 3,721
Chicken	3,545	313	24 to 995
Eggs	2,592	244	24 to 1,360
Milk	863	86	0 to 147

[1]Data from Mekonnen and Hoekstra (2010).
[2]Average = weighted average for 7 countries (Australia, Brazil, China, India, the Netherlands, Russia, United States) and 3 systems (grazing, mixed, industrial).
[3]Range = least to greatest footprint among the 21 countries or systems.

Environmental impacts of milk production

Global warming

Nutrient enrichment

Carbon sequestration / soil fertility

Biodiversity

A Sustainable Agricultural Land Management Strategy for N. Ireland – Launched 21/10/16

With United Support from UFU & Environment NGOs!!!

"To provide Farmers, Policy Makers & Regulators, with a Strategy for Land Management, that delivers a Future for N. Ireland Agriculture, which is Economically, Environmentally & Socially Sustainable; while achieving the "Ambition," laid out in the "Going for Growth" Report."

Observations
Current Environmental Performance in N.I.

Since 2004 - N balance down 10%; N efficiency up 12%
P balance down 32%; P efficiency up 28.5%
N Levels in Water, Good 15 – 20mg

But

- **62% of Water Bodies failing Good Quality Status**
  EU average 47% failing Good Water Quality status
- **80% of P enters water by "Over Land" flow**
- **The Tail of our Phosphate legacy,** 50 Years **????**
- **Only One, of 49 Priority Habitats, at Favourable Status**

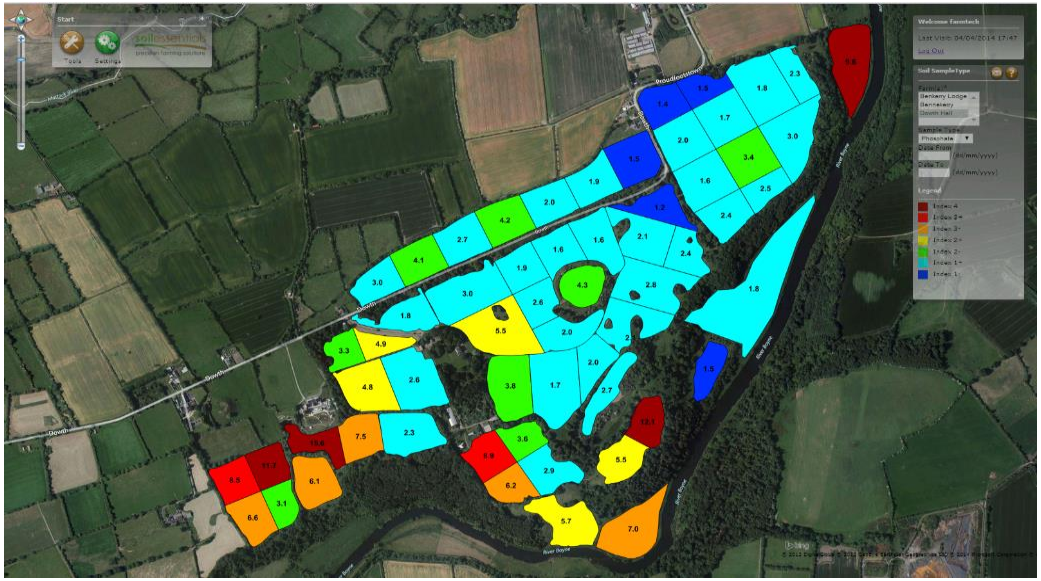
Observations of Current Farming Production Efficiencies & Practices in N.I.

- **Grass DM Utilisable Yields –** NI Average 5.1t/ha/yr
  Top Grassland Yields 16t/ha/yr
- **Soil Analysis –** Only 2% analysed on an annual basis
- **Soil pH –**Optimal 6.0, 64% not achieving optimal
- **% Soils at optimal fertility** – 18%
- **30% of Land in rented on 11 month lease -** Conacre

Our Conclusions :-
Creating a GPS Base Line from the Start
“Measuring & then Managing!!”

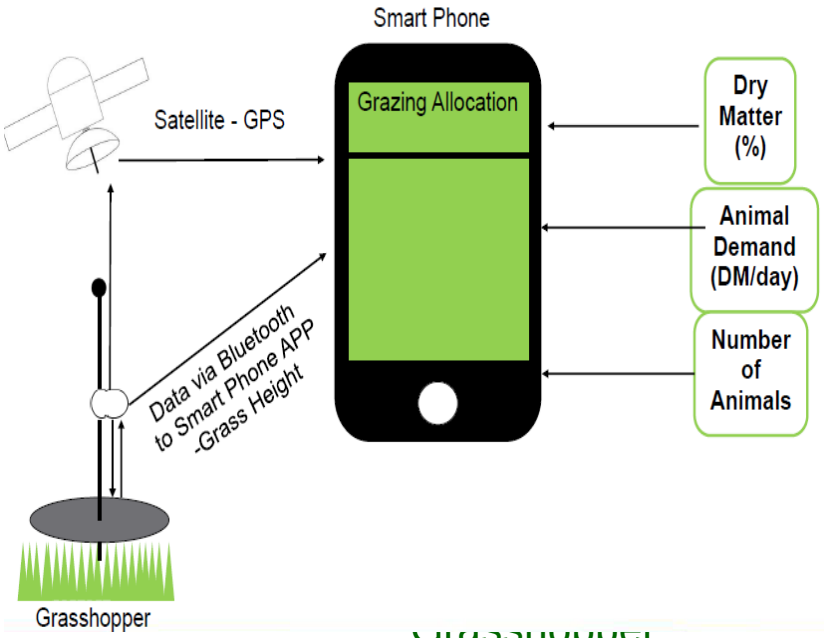
1. GPS Soil Sampling & Analysis of Productive Land

pH, P,K, Soil Organic Matter, Mg, Calcium, 2 ha areas



Creating a GPS Base Line from the Start
"Measuring & then Managing!!"

2. Measuring Grass Growth (DM t/ha)



Grasshopper

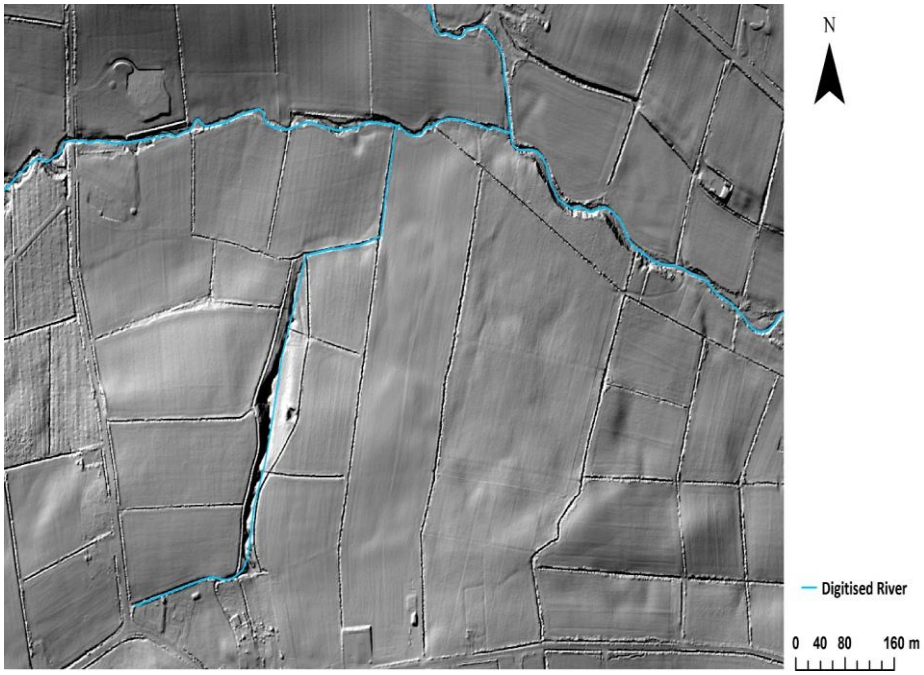
John Deere

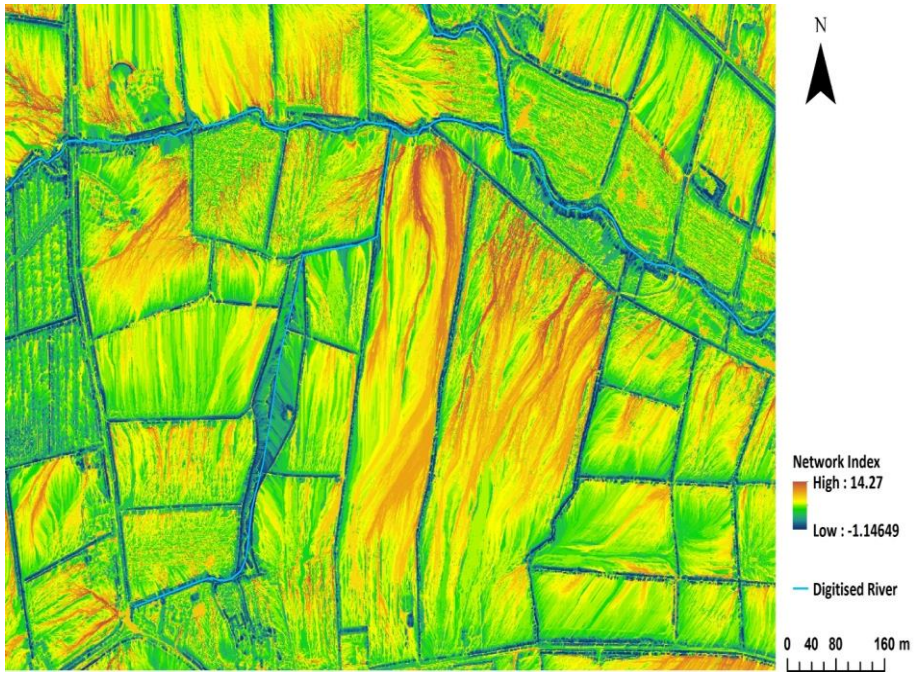
GPS Digital Recording by "Hand" or by "Machine"

Creating a GPS Base Line from the Start
"Measuring & then Managing!!"

3. Aerial LiDAR Survey over Total of N. Ireland

Water "Run Off," Auditing Above Ground Carbon & EFAs





R. Cassidy, AFBI

Creating a GPS Base Line from the Start
"Measuring & then Managing!!"

4. Hourly Monitoring of Catchment Water Quality

60 – 80 of 403 NI Catchments to be Real Time monitored

Results used through Discussion Groups to secure change

D. Wall, Teagasc

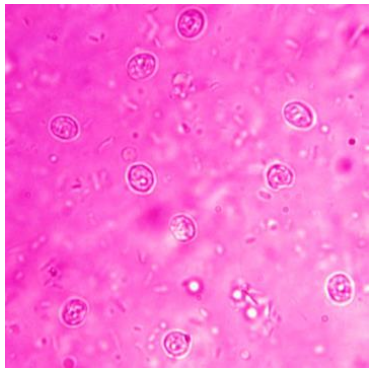
Creating a GPS Base Line from the Start
"Measuring & then Managing!!"

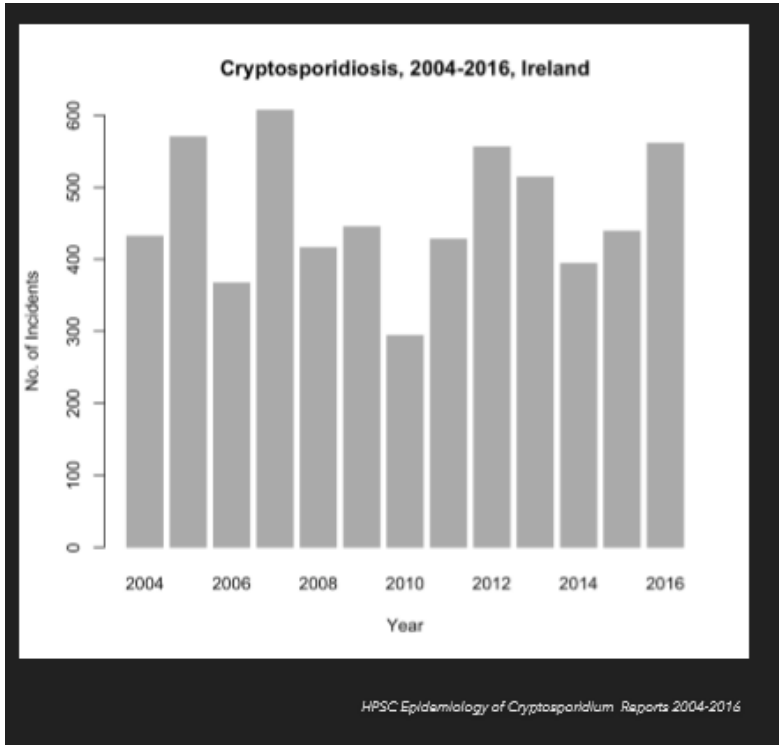
5. **Creation of Central Data base** to collate results & other relevant data e.g. Tellus, Priority Habitats, LPIS maps, Weather Records etc…..

6. **An Online, Cloud-based, Decision Support Tool** to give farmers & chosen "advisers" access to comprehensive detailed information about their own farm and not their neighbours, or wider catchment, to empower farmers to make "informed" decisions of how to manage land in best way

Cryptosporidiosis in Ireland

- Among the highest incidence in the world
- Source is animal manure / slurry
- Infective oocysts are very hard to eliminate in treated water

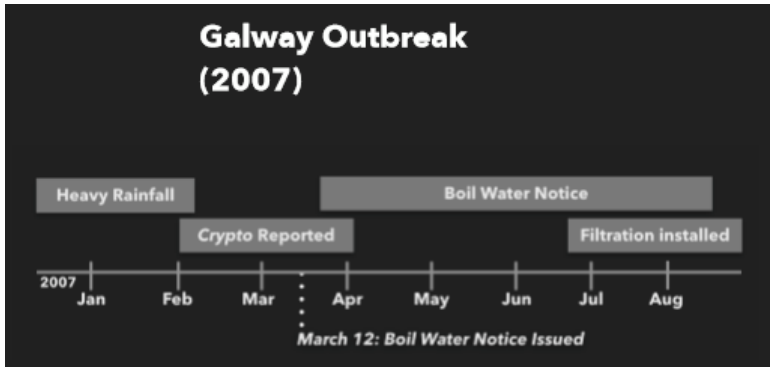


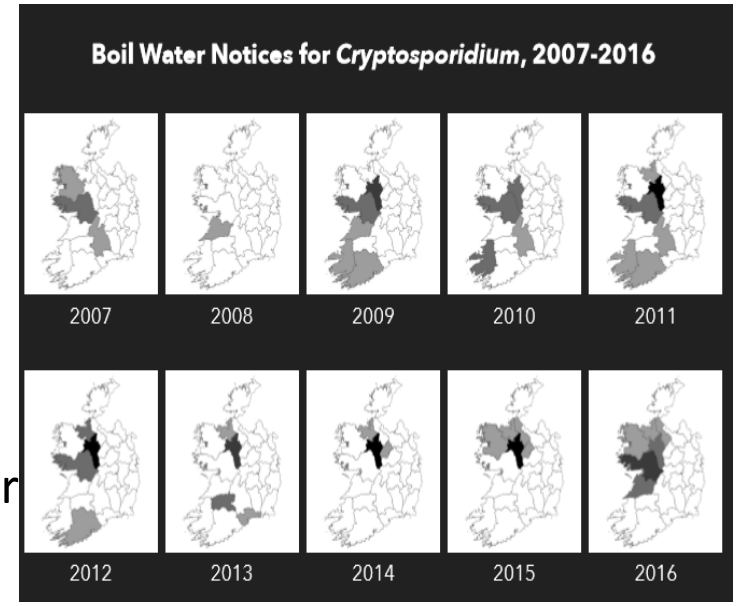


Cryptosporidiosis

- Approach currently reactive
- Galway
  - >700 estimated cases (severe diarrhoea)
  - 120,000 under boil water notice for 5 months
  - Cost €19M to households and hotels*
- Roscommon
  - Boil water notice for 8 years

- Prevention cheaper than remediation
- Yet slurry spreading continues, sometimes in poor conditions





(*Chyzheuskaya et al. EID 2017, 23, 1650)

Source: Patrcik Bresnihan, TCD (WISDOM project)

Water for thought

- Water is essential to life and to agriculture
- 70%. Freshwater used in agriculture and increasing
- Water foot printing – increasing
- Models - Assessing both consumptive water use and degradative water use
- Reducing amount of water used per unit product – especially in areas of high water stress
- Water quality – and impact on human health

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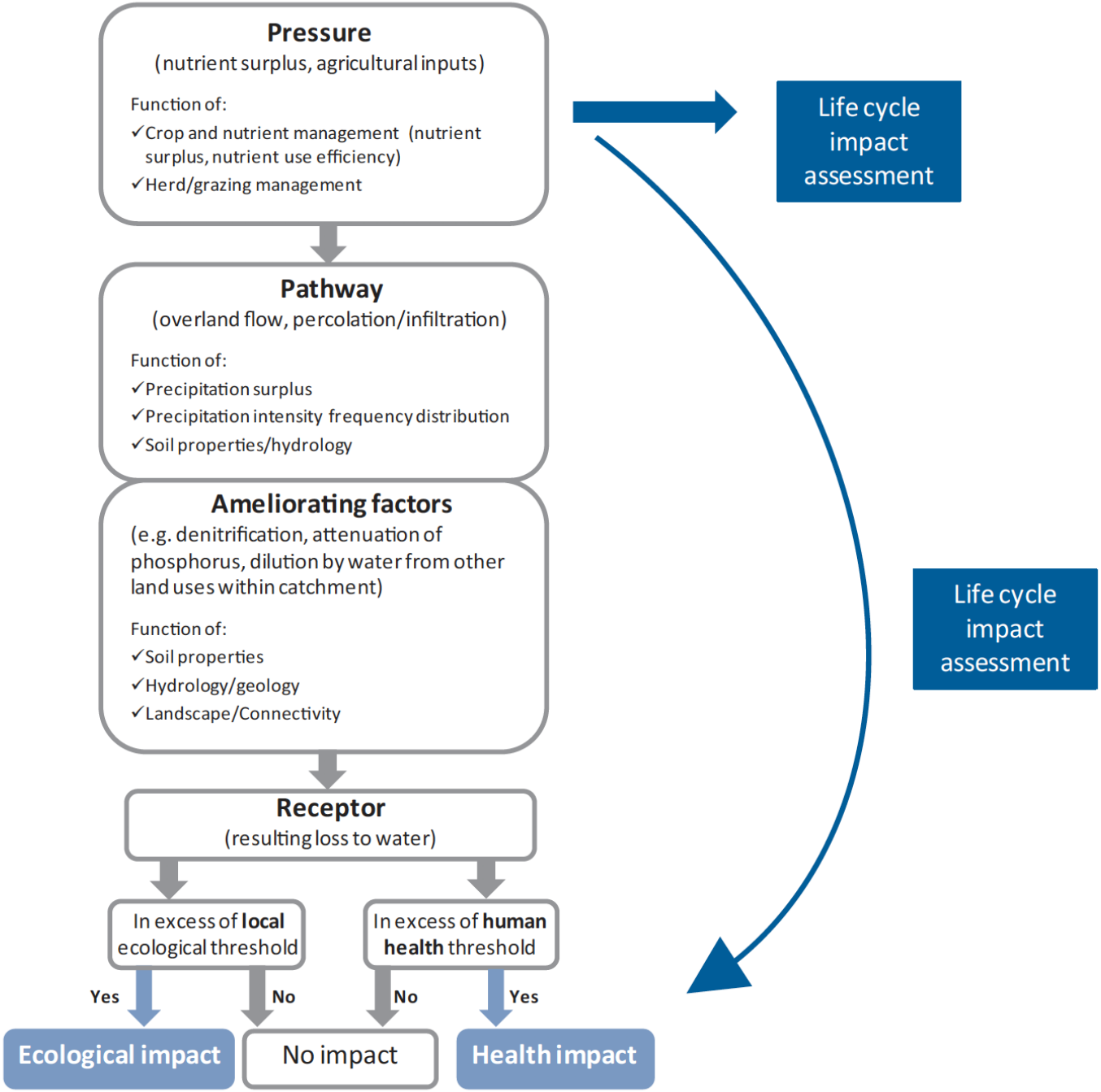


Figure 6: Conceptual framework for assessing the potential impact of livestock farming on aspects of water quality

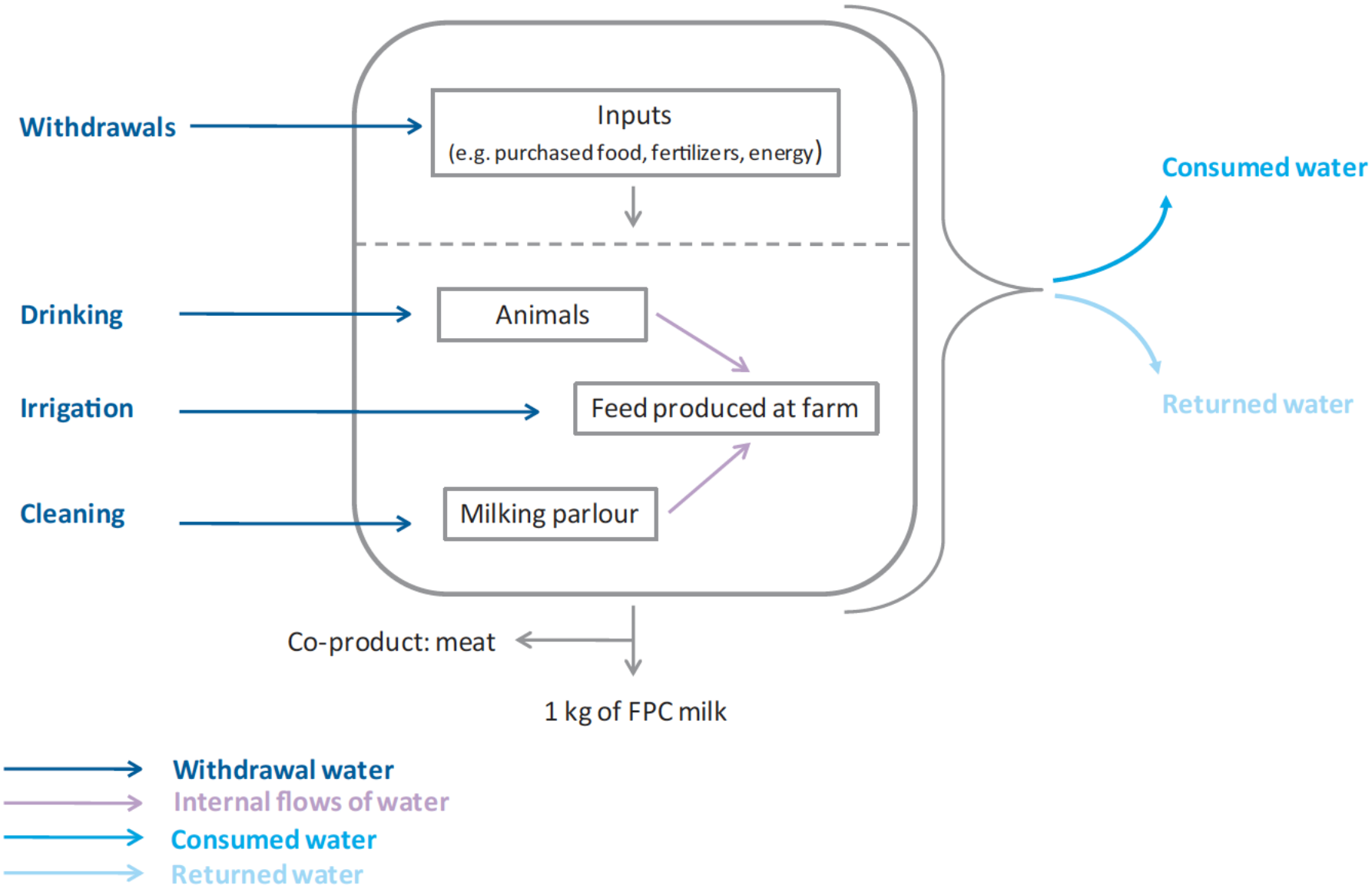
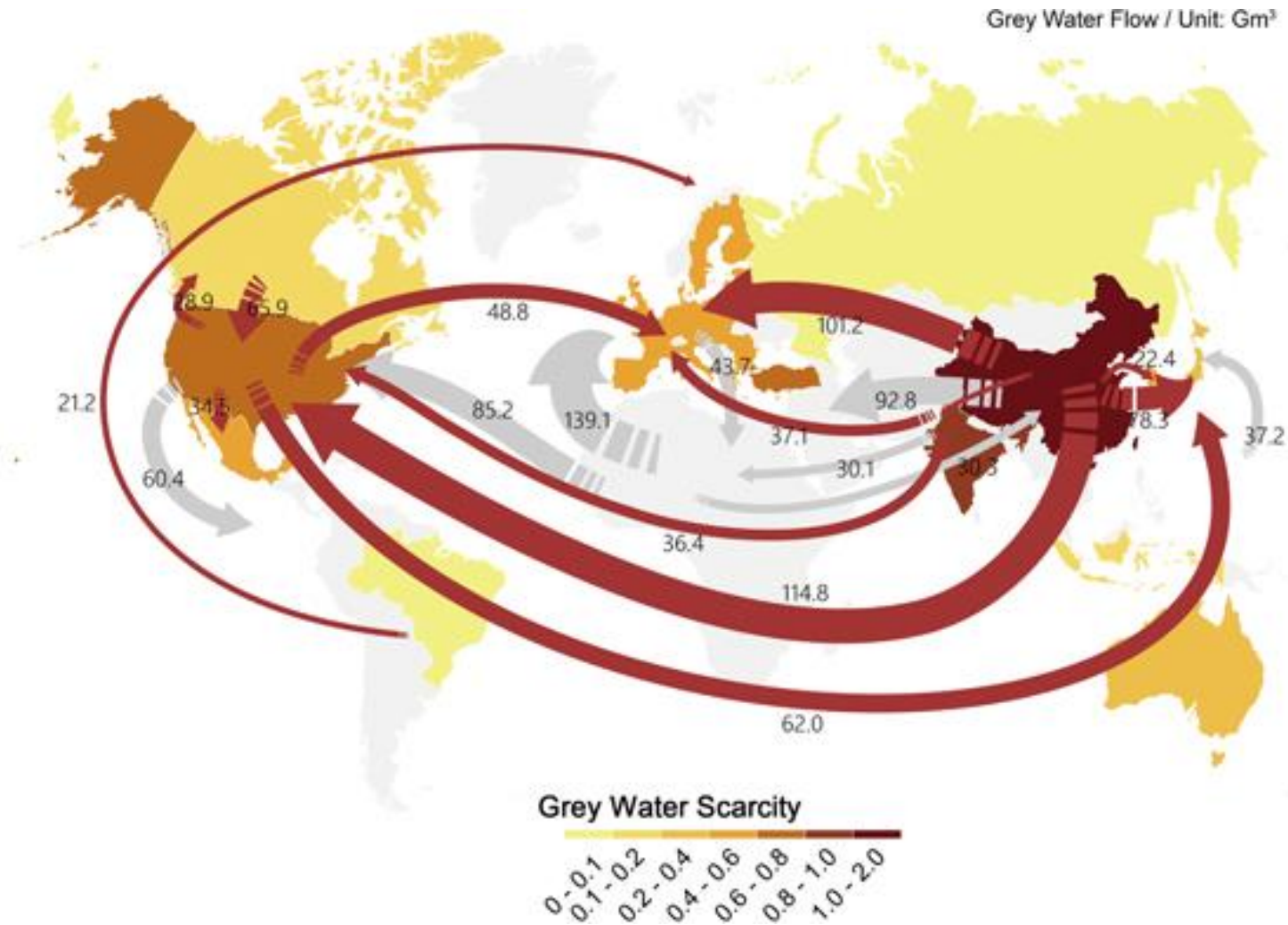


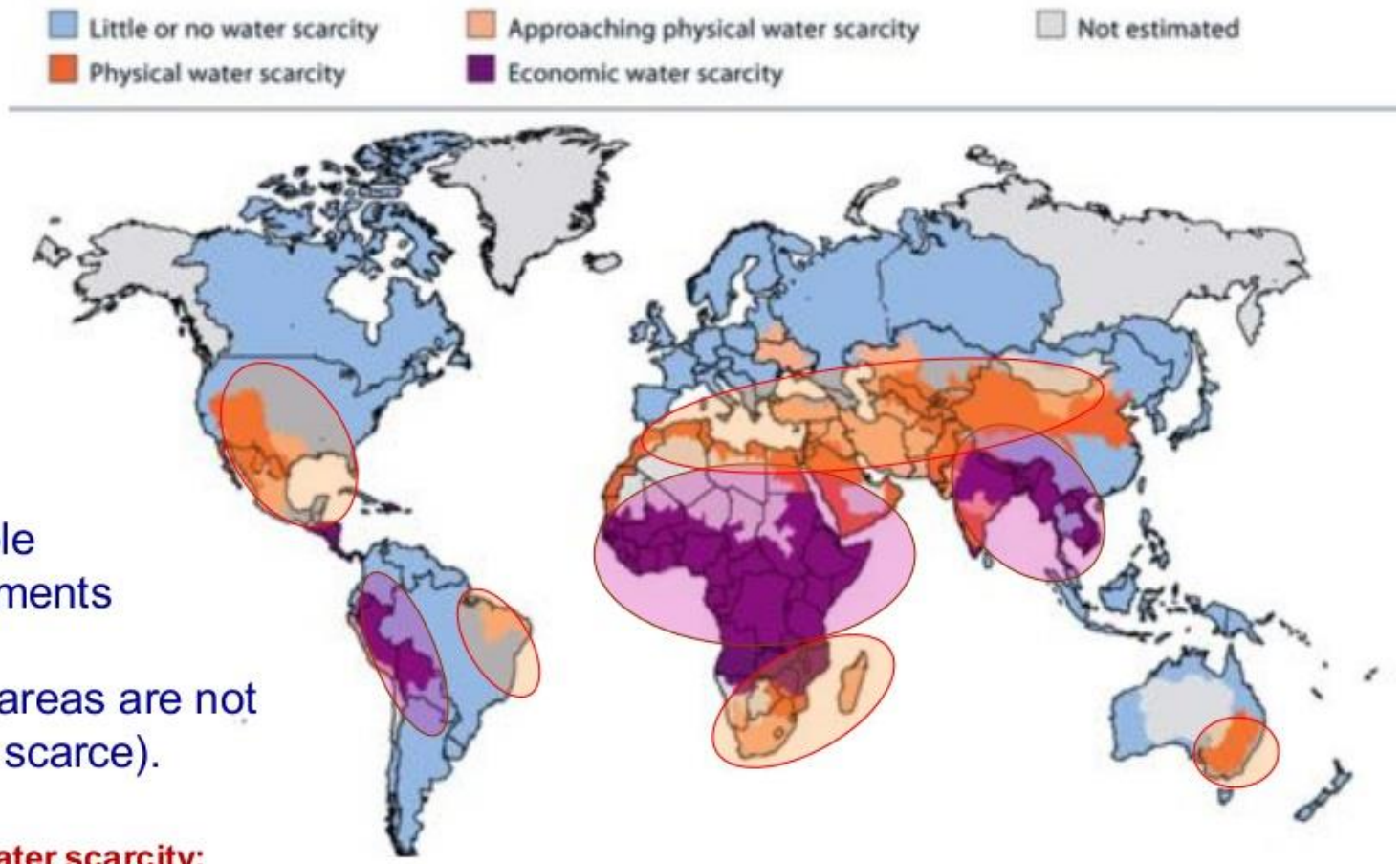
Figure 3: Physical flows of water at the dairy farm level (from Gac et al., 2012)

Figure 2. from Impacts on quality-induced water scarcity: drivers of nitrogen-related water pollution transfer under globalization from 1995 to 2009

Liyang Wan et al 2016 Environ. Res. Lett. 11 074017 doi:10.1088/1748-9326/11/7/074017



Holistic view of water scarcity problem by regions



Water scarcity

measures:
freshwater available
for human requirements

→implies that dry areas are not
Necessarily water scarce).

Physical water scarcity:

- >75% of river flows are withdrawn for agriculture, industry and domestic purposes.

Economic water scarcity:

- <25% of water withdrawn from rivers for human purposes but not enough water infrastructure to make water available for use

Source: IWMI = International Water Management Institute, 2007.

For assessing the environmental impacts of consumptive water use (where consumptive water use is water removed from available supplies without return to a water resource system):

- Quantities of water used (including water withdrawal and release)
- Types of water sources used (including for water withdrawal and water receiving body)
- Forms of water use (irrigation, storage)
- Changes in drainage, stream flow, groundwater flow or water evaporation that arise from land use change, land management activities and other forms of water interception (where relevant to the scope and boundary of the study)
- Locations of water use (including for water withdrawal and release) that are required to determine any related environmental condition indicator of the area where the water use takes place
- Seasonal changes in water flows, water withdrawal and release, when relevant
- Temporal aspects of water use, including, if relevant, timing of water use and length of water storage

Source: ISO 14046

<200 l/kg

>15,000 l/kg

Table 2. The water footprint of 2 different diets in industrialized countries

Item	Meat diet			Vegetarian diet		
	kcal/day[1]	L/kcal[2]	L/day	kcal/day[3]	L/kcal[2]	L/day
Animal origin	950	2.5	2,375	300	2.5	750
Vegetable origin	2,450	0.5	1,225	3,100	0.5	1,550
Total	3,400		3,600	3,400		2,300

Meat and milk comprises approx
25% of global water footprint

For assessing the impacts of degradative water use, data describing water quality should also be collected:

- Quality of water used from the different types of water resources
- Emissions to air, water and soil with impact on water quality
- Locations of water use influencing water quality
- Seasonal changes in water quality

Source: ISO 14046