A water secure world free of poverty and hunger: Challenges of the Water-Energy-Food Nexus to Manage Climate Change.

Felix Reinders

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INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE

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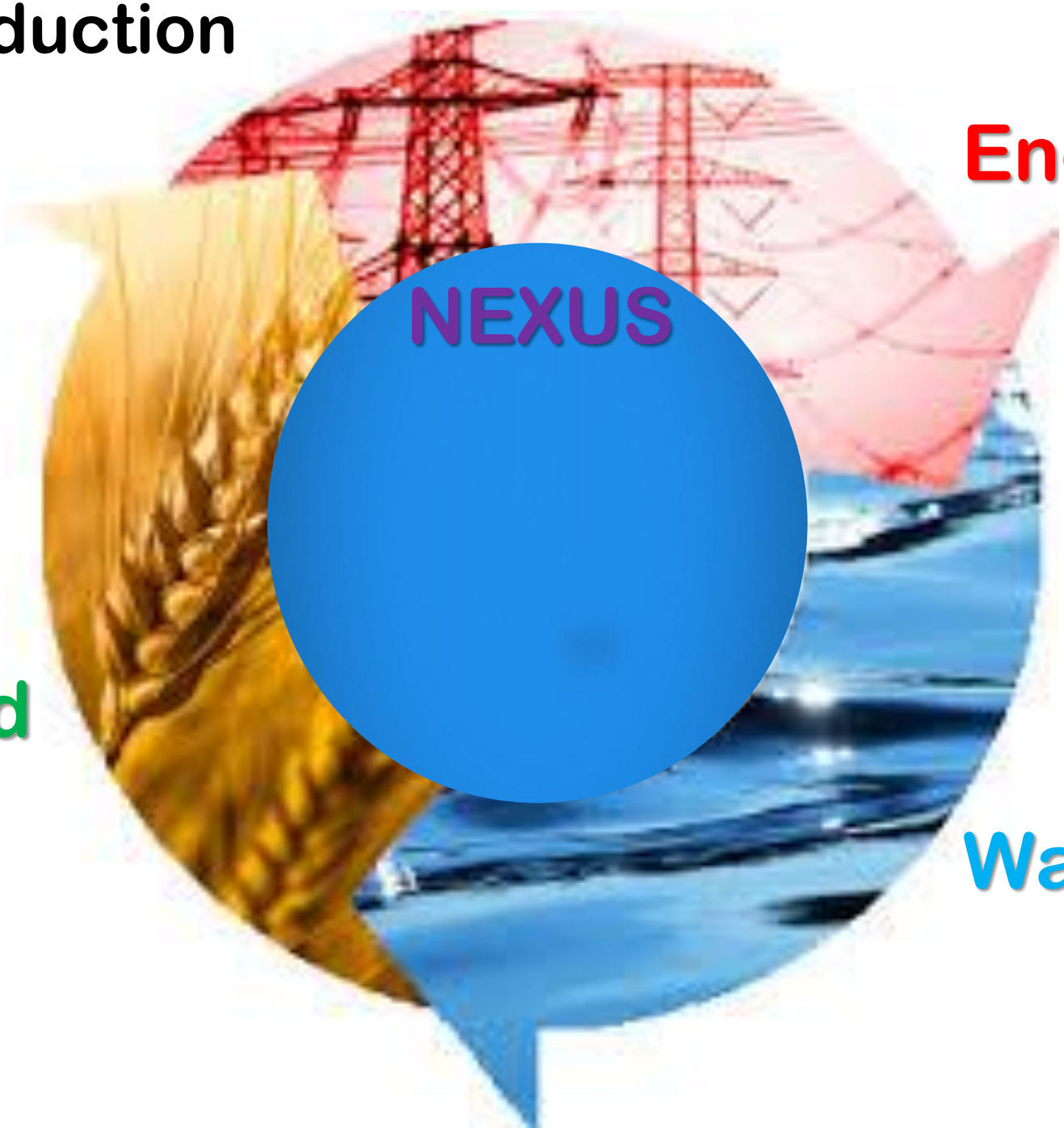
Coming up…..

- Introduction
- Water
- Energy
- Food
- Technology
- ICID
- Conclusion

ICID•CIID

Introduction



SIWI www.stockholmstatement.siwi.org

WORLD WATER WEEK in Stockholm, September 1–6, 2013

STOCKHOLM STATEMENT

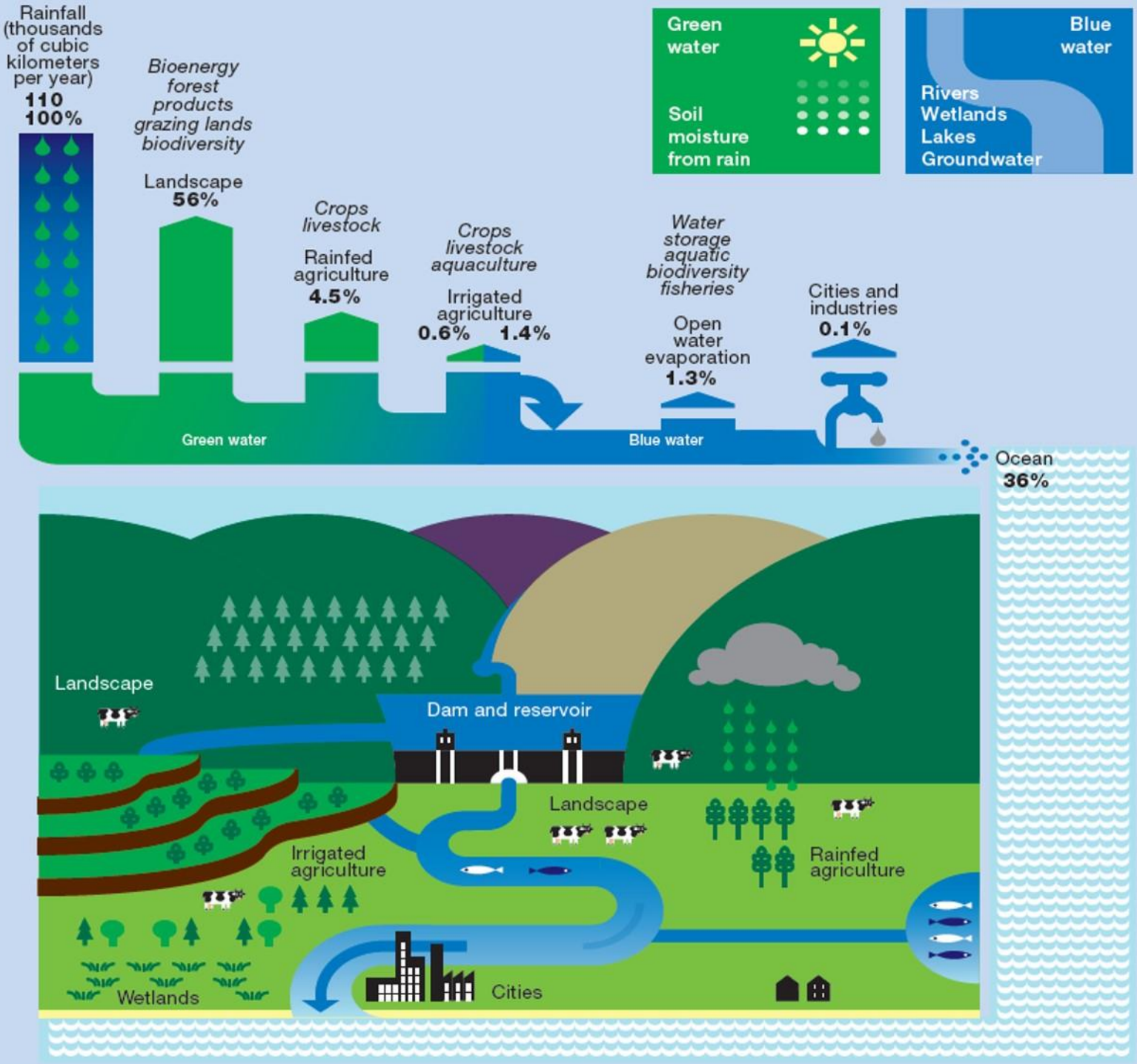
A Call for A Sustainable Development Goal on Water

As an outcome of broad consultations prior to and during the 2013 World Water Week in Stockholm, we call upon the United Nations and its Open Working Group to propose a **Sustainable Development Goal on Water.**

Water is at the core of sustainable global development and is a cross cutting resource. Within the post-2015 development agenda water should be considered and integrated into all relevant areas, such as energy and food security. Given the centrality of water for individuals, ecosystems and economic development, water is a powerful tool for cooperation across borders, sectors and communities.

A dedicated goal on water is necessary for a world where all people can live in safety and dignity.


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS


Rainfall (thousands of cubic kilometers per year)
110
100%
Bioenergy
forest
products
grazing lands
biodiversity
Landscape
56%
Crops
livestock
Rainfed
agriculture
4.5%
Crops
livestock
aquaculture
Irrigated
agriculture
0.6%
1.4%
Water
storage
aquatic
biodiversity
fisheries
Open
water
evaporation
1.3%
Cities and
industries
0.1%
Green water
Soil moisture from rain
Blue water
Rivers
Wetlands
Lakes
Groundwater
Green water
Blue water
Ocean
36%
Landscape
Dam and reservoir
Landscape
Irrigated
agriculture
Rainfed
agriculture
Wetlands
Cities

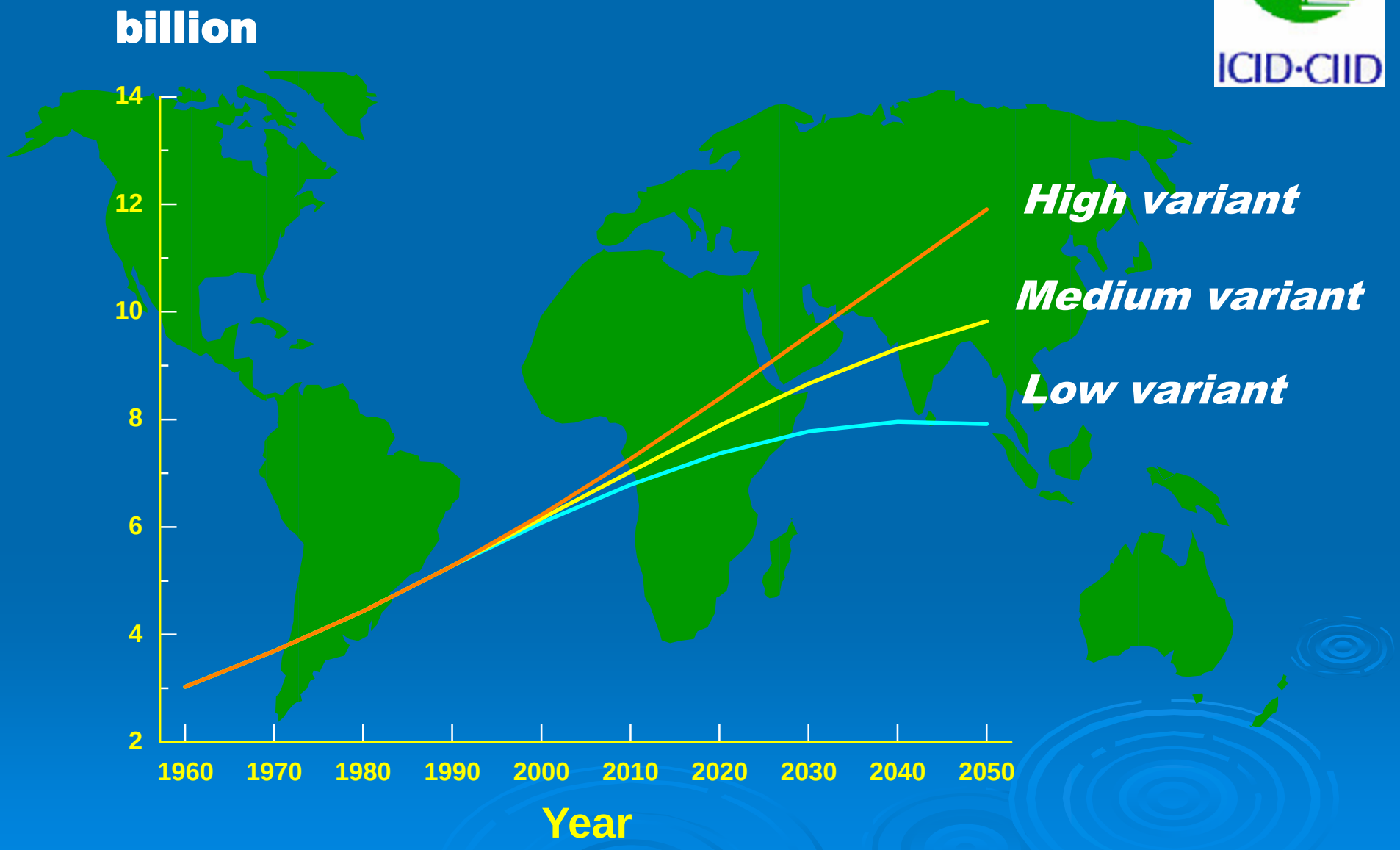
There are global opportunities for better efficiency and resources conservation in the water, food, and energy supply chains.

The idea is to improve components of the food production supply chain with respect to water and energy use as well as reducing food wastage.

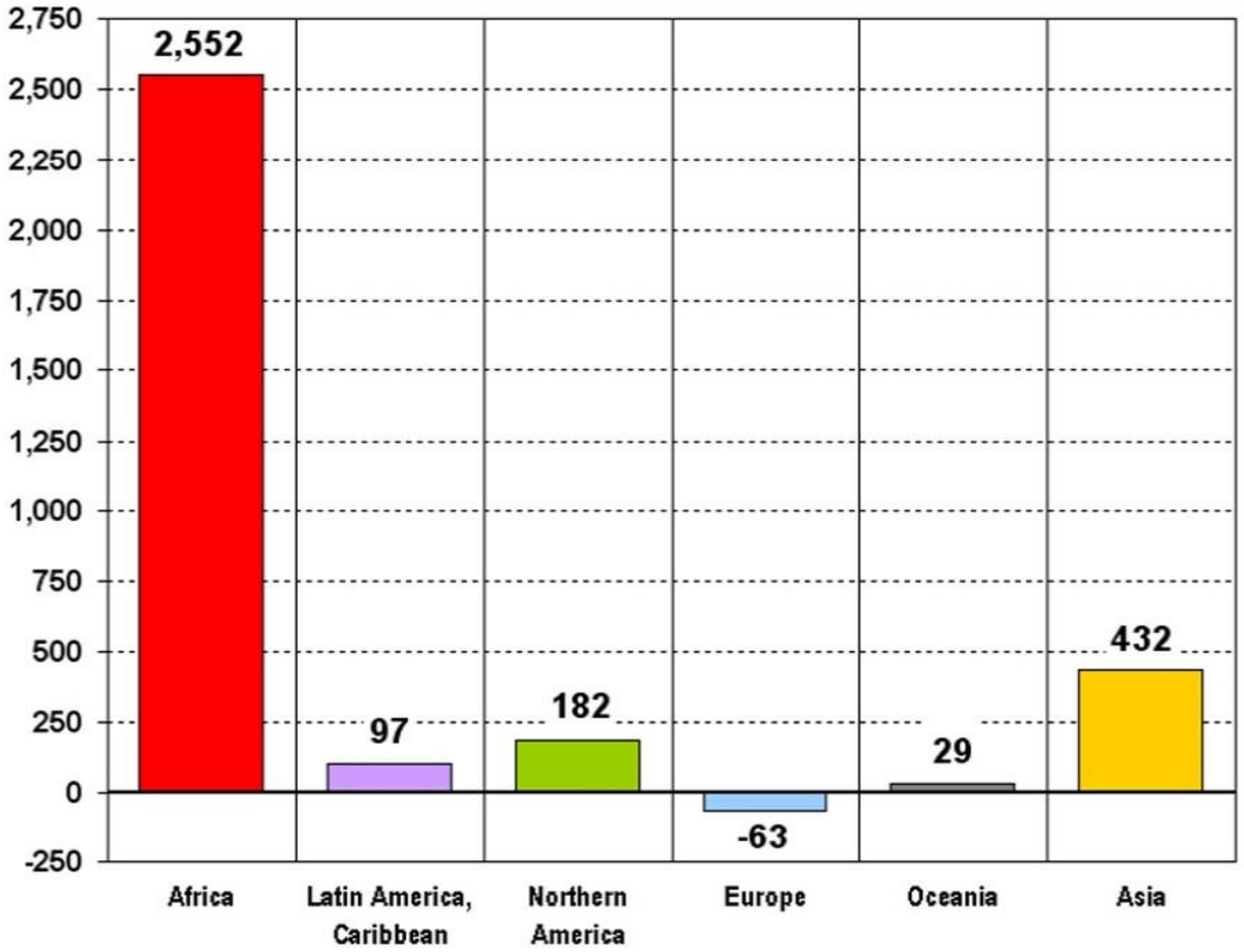
Food wastage accounts for 1380 km^3 of water being wasted every year globally and is equivalent to a value of US$ 252 billion.

Translated to an easier to understand volume it equates to a person wasting on average 243 litres a day of water in the food they throw away.

Global Population 1960 - 2050



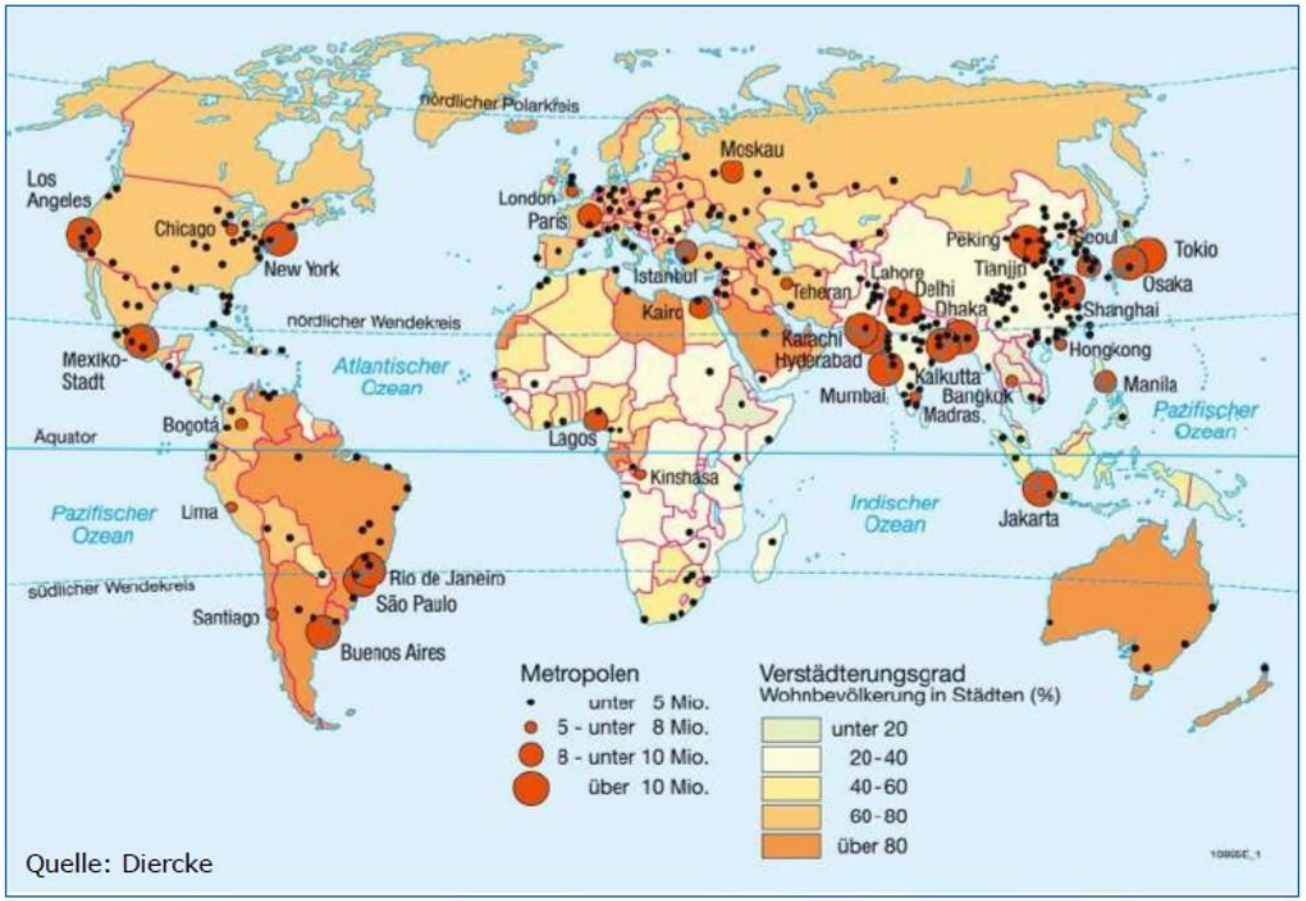
Change in Global Population between 2010 and 2100 ($X10^6$)



Source: United Nations, Department of Economic and Social Affairs, Population Division (2011): World Population Prospects: The 2010 Revision. New York

Trends in Urbanisation

- Today for the first time more than 50 % of the world's population live in cities; up to 2030 the global population will increase to five billion people.
- Urban growth will be most significant in Africa and Asia.



WORLD HUNGER

Category	1	2	3	4	5		
Undernourished	≥35%	20-34%	5-19%	2.5-4%	<2.5%	no data	incomplete data
Description	Very high	Moderately high	Moderately low	Very low	Extremely low		

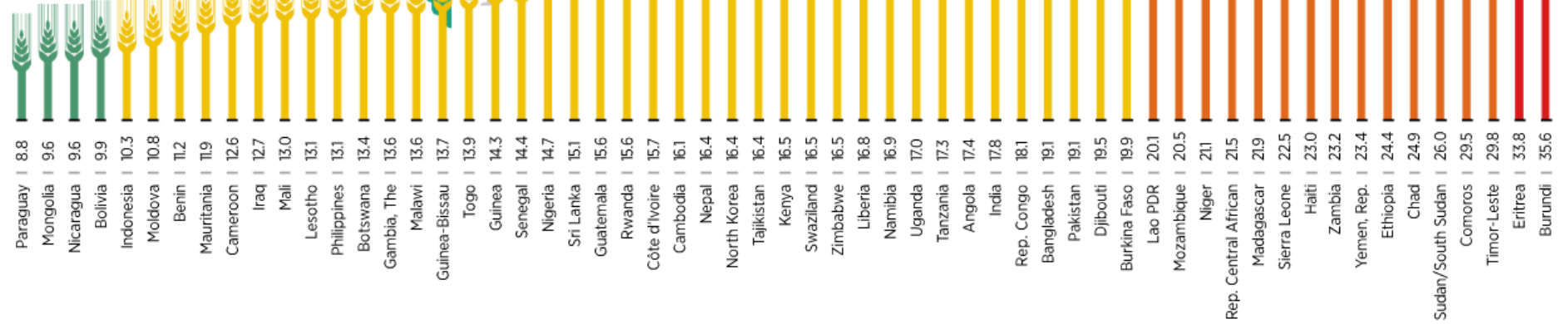
WFP
World Food Programme
Feeding The World's Hungry

www.wfp.org

WHERE TO FIND THE WORLD'S HUNGRY POPULATION

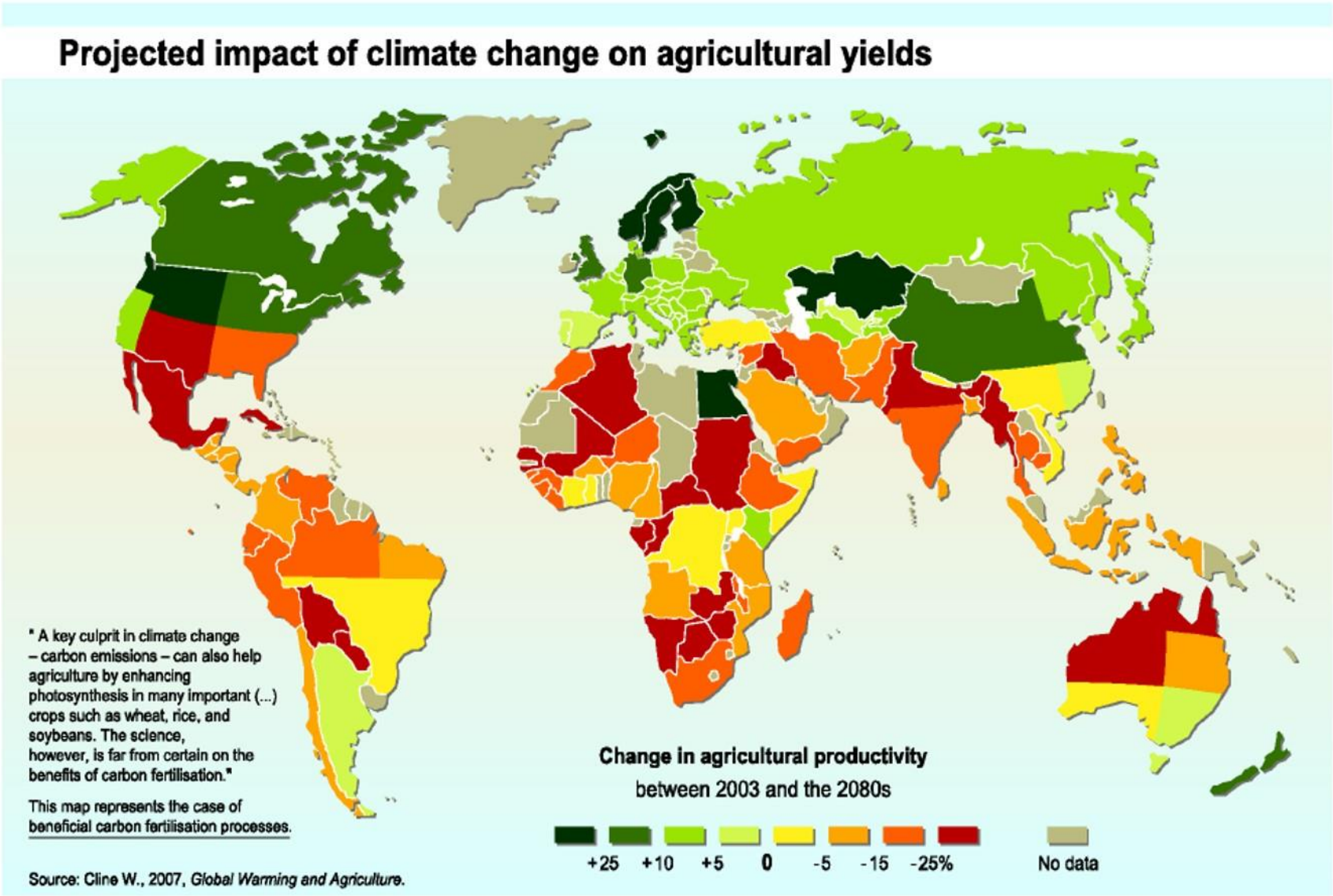
2014 Global Hunger Index

- EXTREMELY ALARMING **30 AND ABOVE**
- ALARMING **20.0–29.9**
- SERIOUS **10.0–19.9**
- MODERATE **5.0–9.9**
- LOW **4.9 AND BELOW**
- NO DATA
- INDUSTRIALISED COUNTRY

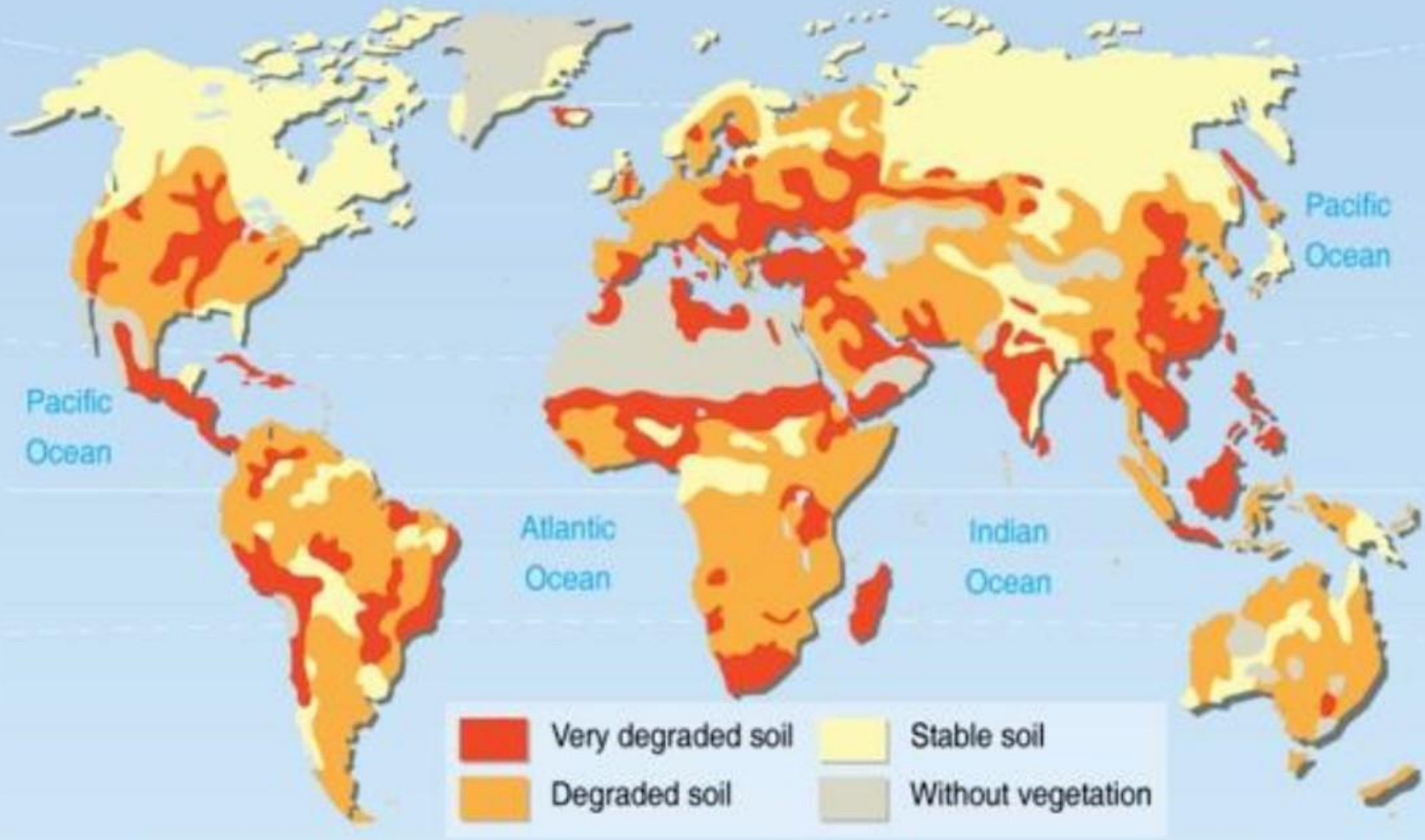


Source: Welthungerhilfe/IFPRI/Concern Worldwide 2014

Climate Change and Agricultural Yields



Soil degradation



Source: UNEP, International Soil Reference and Information Centre (ISRIC), World Atlas of Desertification, 1997.

Philippe Rekacewicz, UNEP/GRID-Arendal

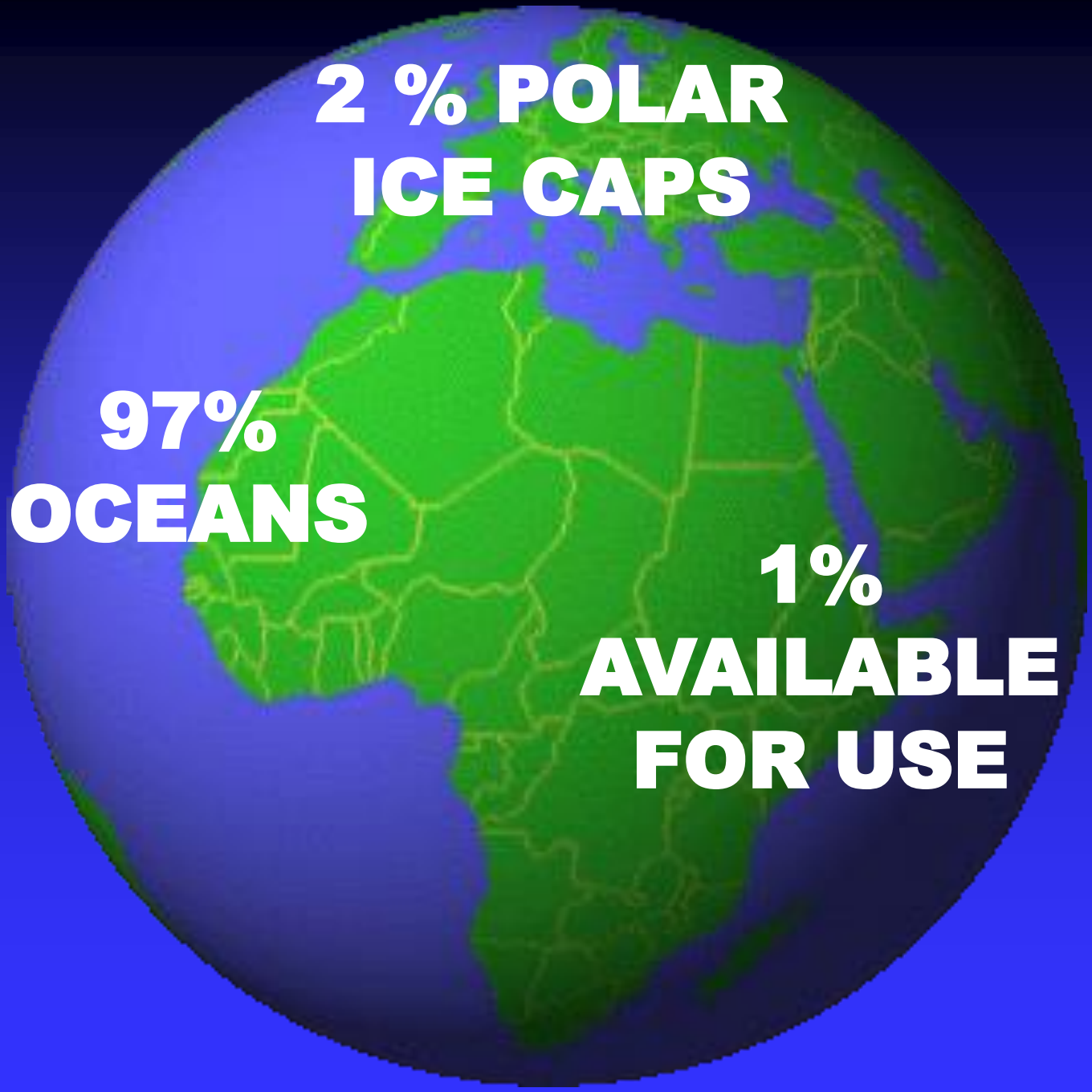
By the year 2030, the following should have been achieved:

- A doubling of global water productivity
- A realisation of the human right to safe drinking water and sanitation
- Increased resilience to water-related disasters
- Increased food production

A closer look at Water-Energy-Food Nexus

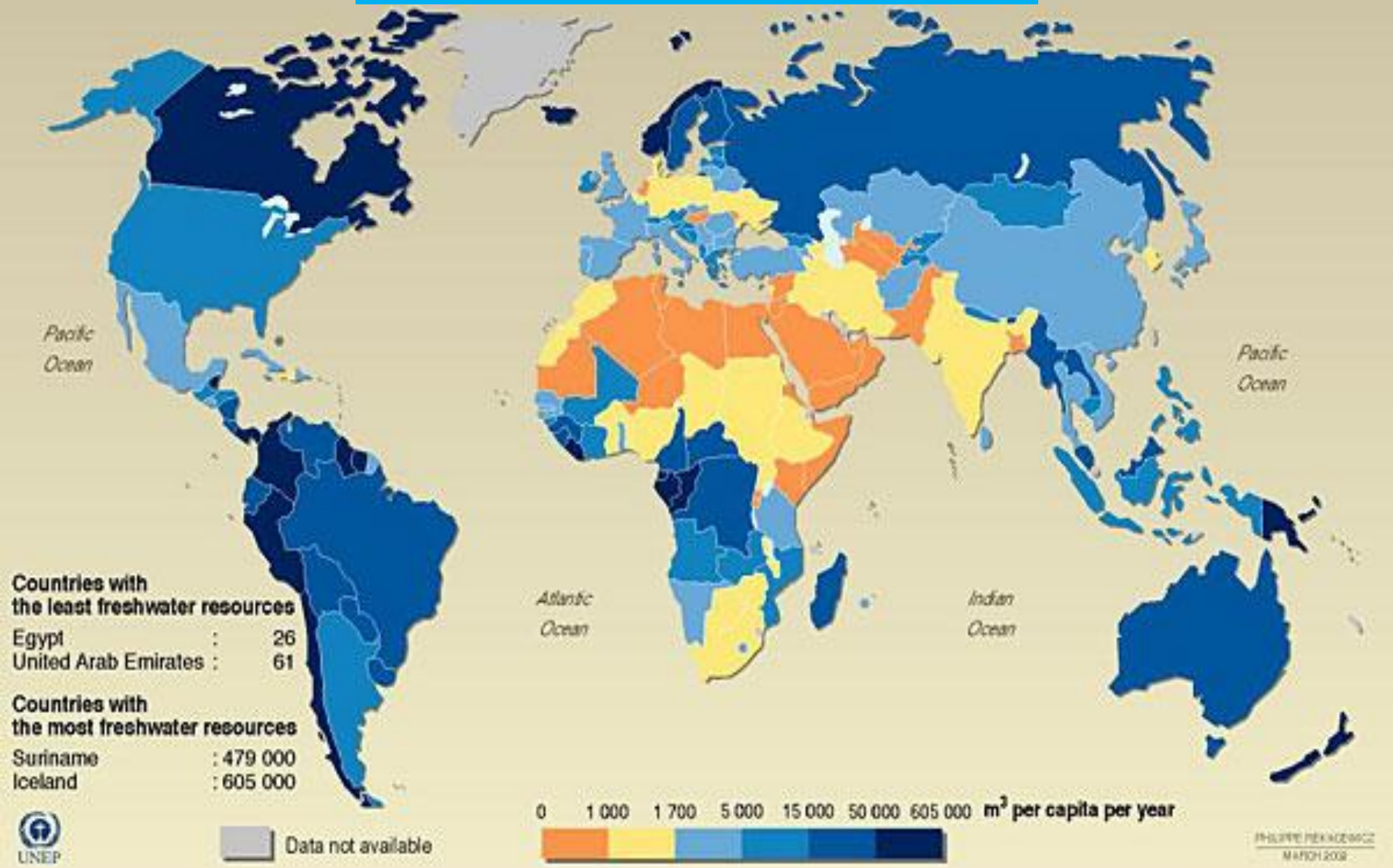

WATER

WATER



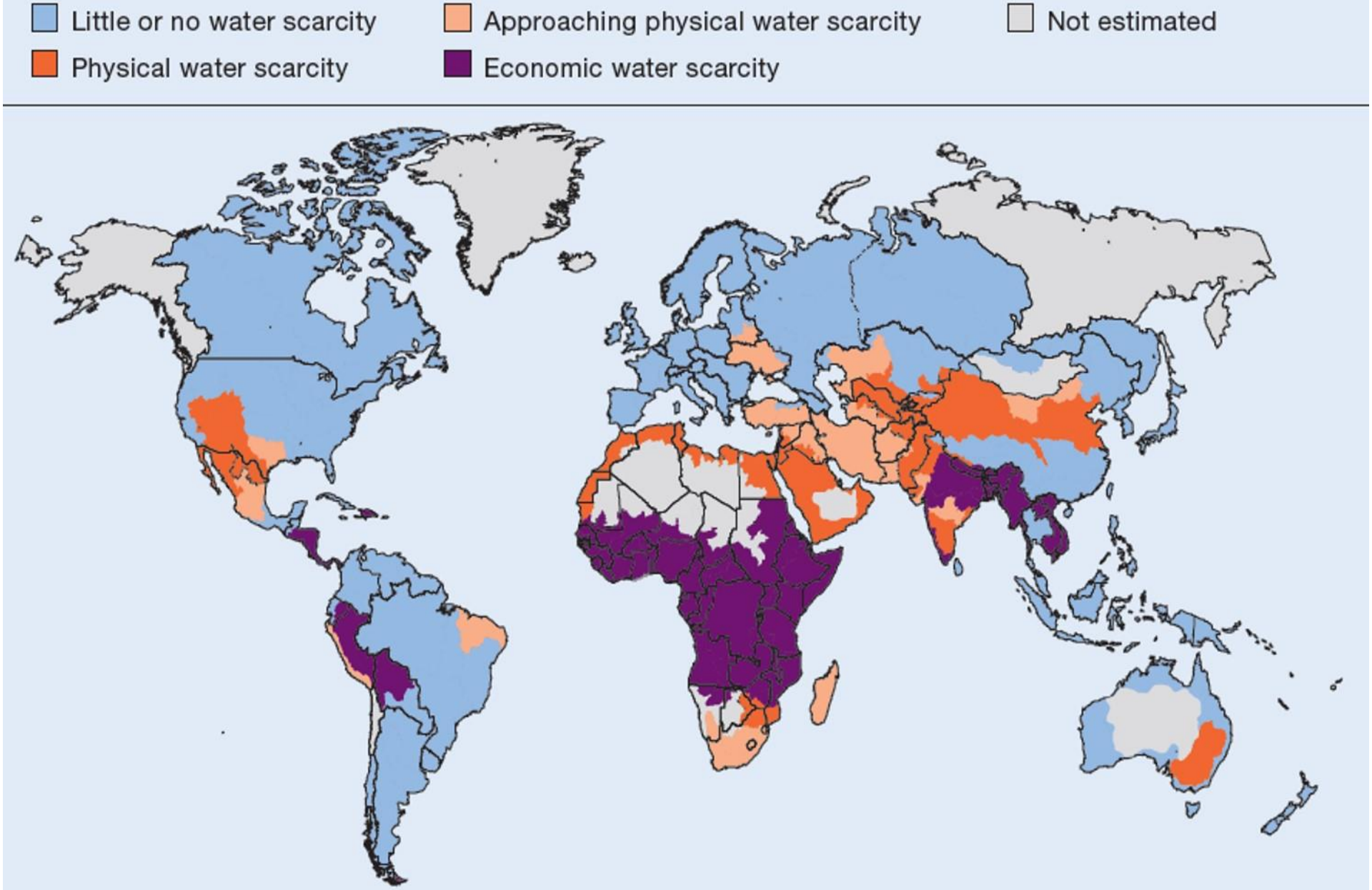
Availability of Freshwater

Average river flows and groundwater recharge

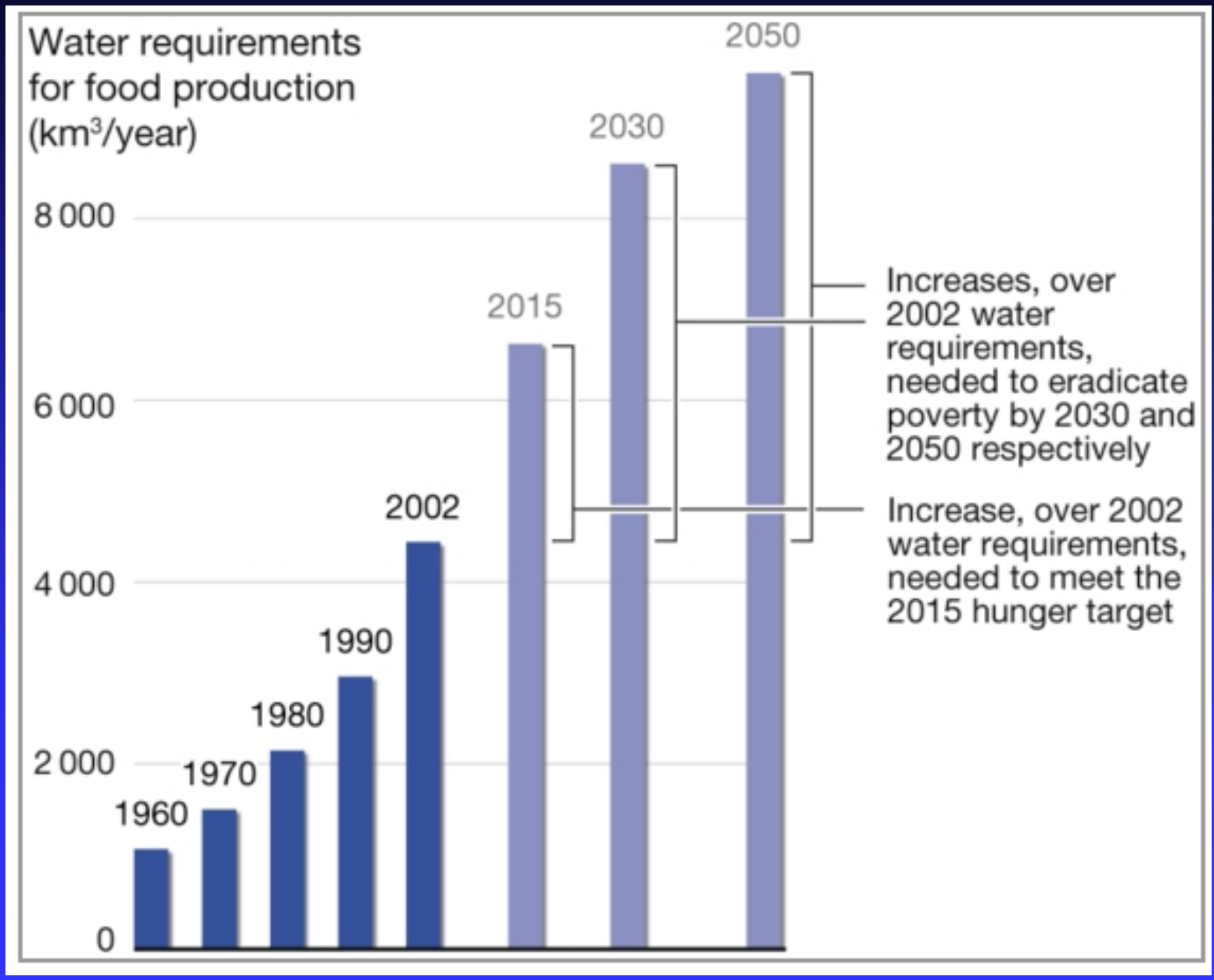


Source: *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000

Areas of physical and economic water scarcity

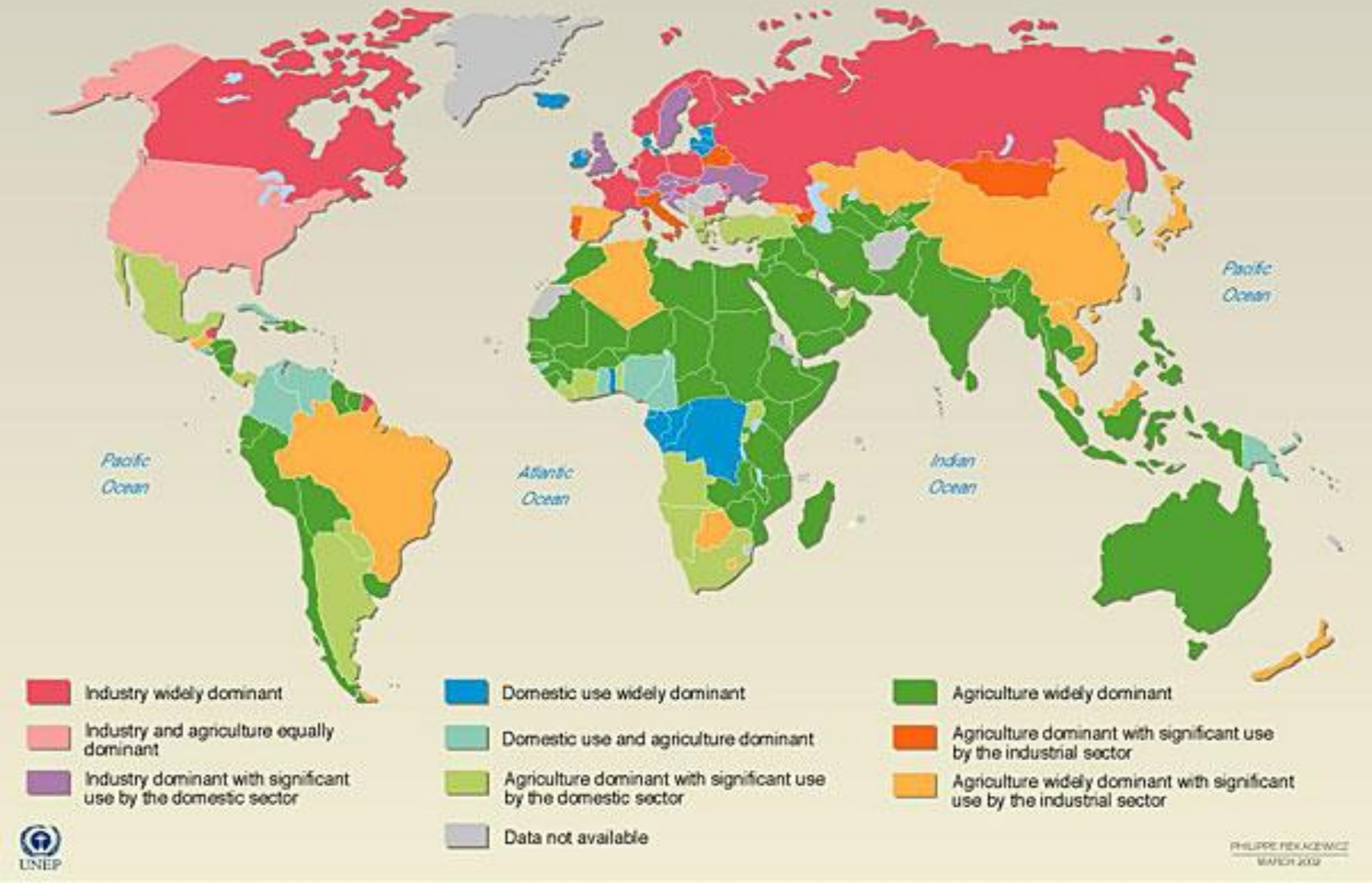


Water requirements for food production 1960-2050



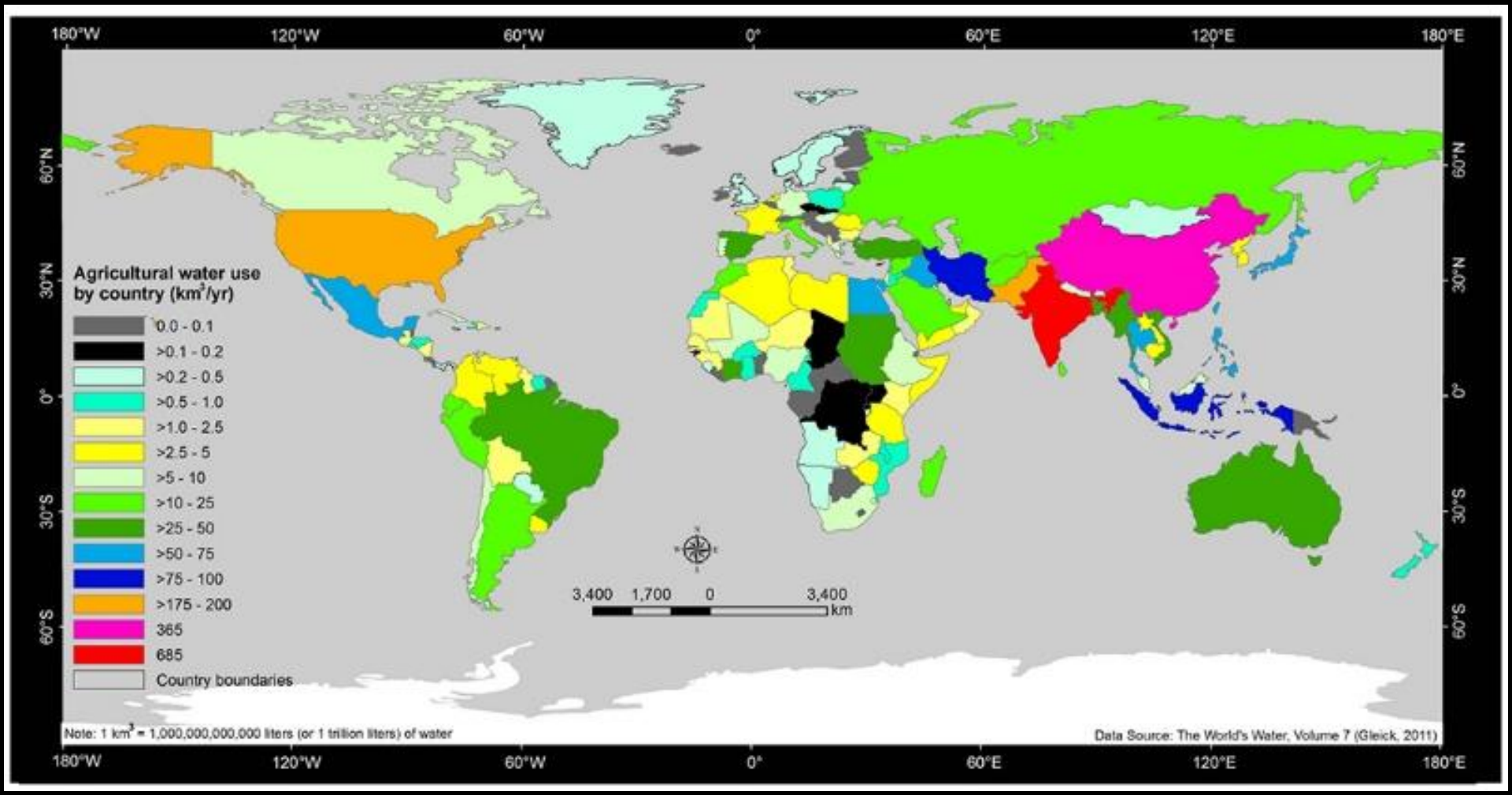
Global Freshwater Withdrawal

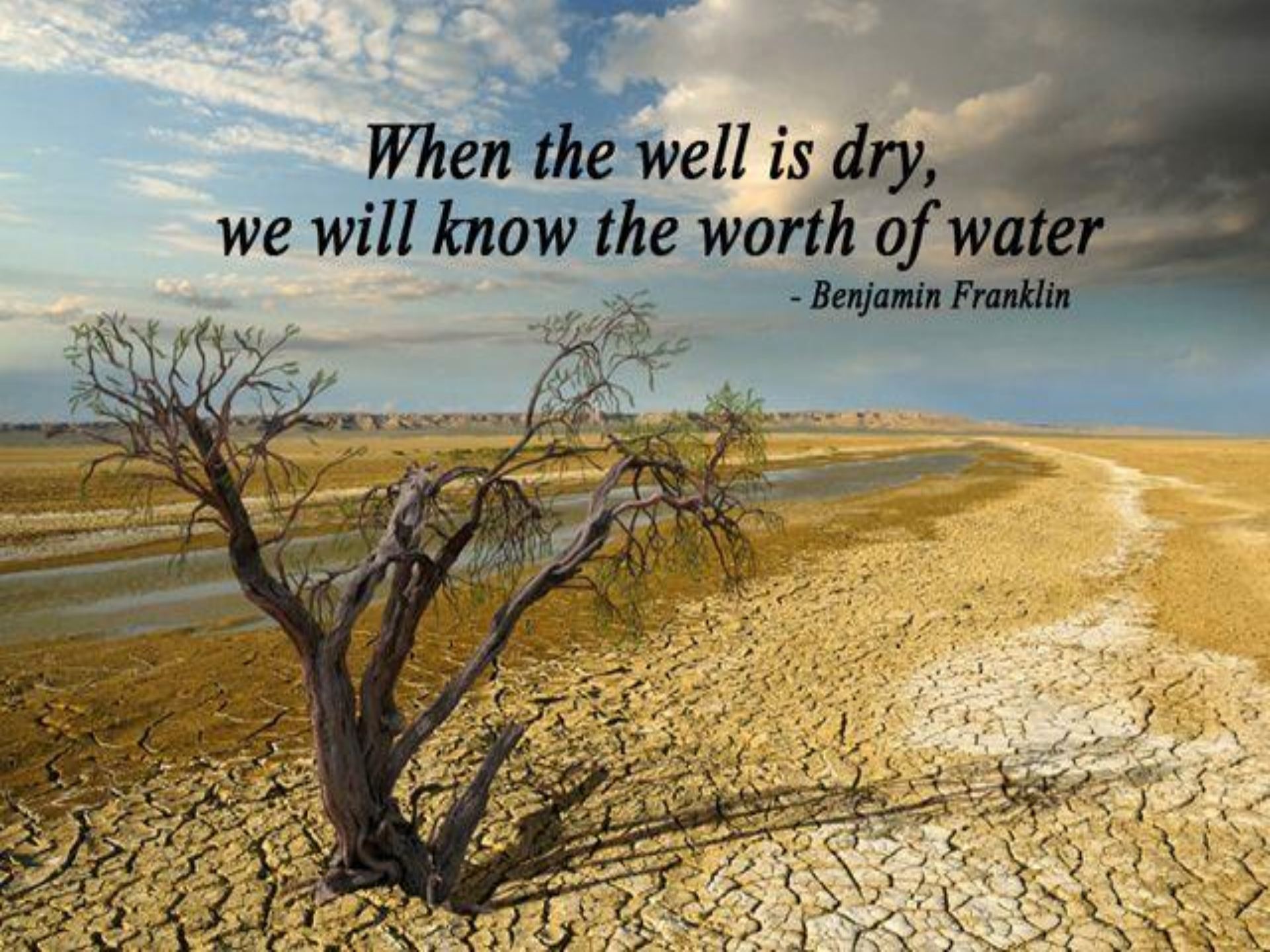
Country Profiles Based on Agricultural, Industrial and Domestic Use



Source: Based on data fromTable FW1 in *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000.

Agricultural water use by country




When the well is dry,
we will know the worth of water
- Benjamin Franklin

Two thirds of the world's population

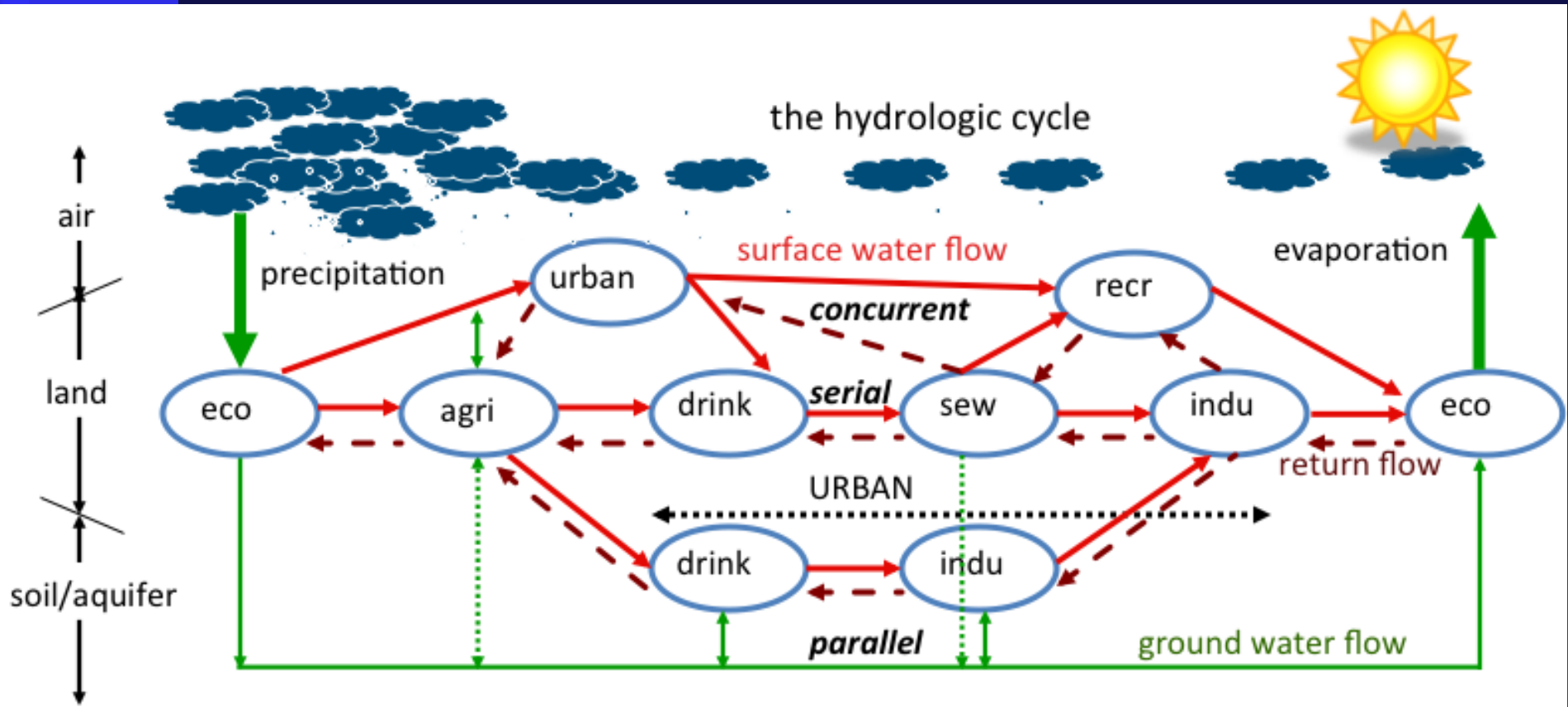
WILL BE AFFECTED BY WATER SHORTAGES BY THE YEAR 2030

The importance of water:

- **Water is the key to food security**
  - **without water, crops simply cannot grow.**
- **Water is not just for primary production**
  - **it plays a vital role at all stages along the agricultural value chain**
- **Water for agriculture connects us all together**
  - **In times of scarcity we all have a responsibility to use water wisely, efficiently and productively.**

We need to be more 'water smart'.

Water Supply Chain



Chain according water use:

eco - ecological water chain
agri – agricultural water chain
drink – domestic water chain
sew – sewer water chain
indu – industrial water chain
recr – recreational use

} URBAN water chain

Common terms in the chain:

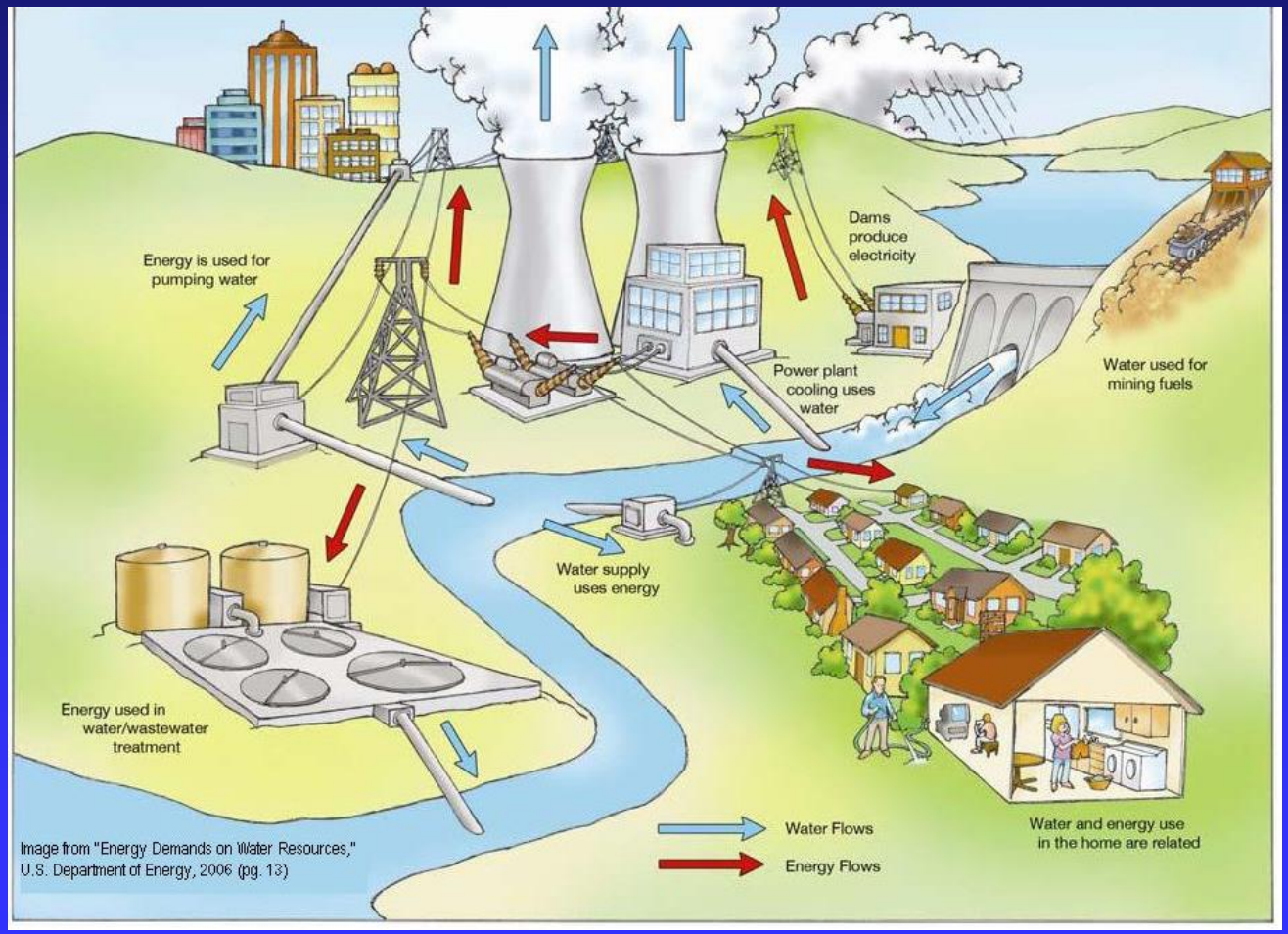
rainfall - runoff
irrigation - drainage
drinking water – sewage water
mixed or separate
process water – waste water

Efficiency of water management

Method	Efficiency	Remarks
Flood irrigation	60 – 90%	New water management control technologies
Sprinkler irrigation	70 – 90%	From high pressure to low pressure application
Trickle irrigation	80 – 85%	Reliability, durability and water management
Sub-surface irrigation	90 – 95%	Shallow soil management
Controlled drainage	50 – 85%	Maintain and manage high water table as appropriate
State of the art water management	85 – 100%	Soil moisture management and delivery system management

Water needs energy

Energy is vital to providing water → needed to power systems that collect, transport and distribute water.



(US Department of Energy, 2006)

KOSMOS

"Energy production consumes significant amounts of water; providing water, in turn, consumes energy.

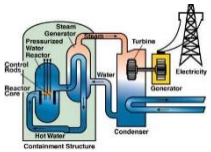
In a world where water scarcity is a major and growing challenge, ***meeting future energy needs depends on water availability*** *–and meeting water needs depends on wise energy policy decisions."*

(World Policy Institute and EBG Capital, March 2011)

Energy needs water

- Energy production depends on water → some 580 billion cubic metres of freshwater are withdrawn for energy production every year (IEA, 2012)
- Water is used for primary energy production as well as power generation especially for cooling at thermal power plants
- Extraction, transport and processing of fuels and irrigation to grow biomass feed-stock are also water intensive

Power Generation

Type	BioMass	Coal	Nuclear	Natural Gas	Solar	Wind
						
Water Impact	Moderate	High	High	High	Low	Low

Fuels	Description
Oil and gas	Drilling, well completion and hydraulic fracturing; injection into the reservoir in secondary and enhanced oil recovery; oil sands mining and in-situ recovery; upgrading and refining into products.
Coal	Cutting and dust suppression in mining and hauling; washing to improve coal quality; re-vegetation of surface mines; long-distance transport via coal slurry.
Biofuels	Irrigation for feedstock crop growth; wet milling, washing and cooling in the fuel conversion process.

Key uses of water for primary production (IEA, 2012)

People without access to electricity

	Without access to electricity	
	Population	Share of population
Developing countries	1 265	24%
Africa	590	57%
DR of Congo	58	85%
Ethiopia	65	77%
Kenya	33	82%
Nigeria	79	50%
Tanzania	38	85%
Uganda	29	92%
Other sub-Saharan Africa	286	66%
North Africa	1	1%
Developing Asia	628	18%
Bangladesh	88	54%
China	4	0%
India	293	25%
Indonesia	63	27%
Pakistan	56	33%
Philippines	16	17%
Vietnam	2	2%
Rest of developing Asia	106	34%
Latin America	29	6%
Middle East	18	9%
World**	1 267	19%

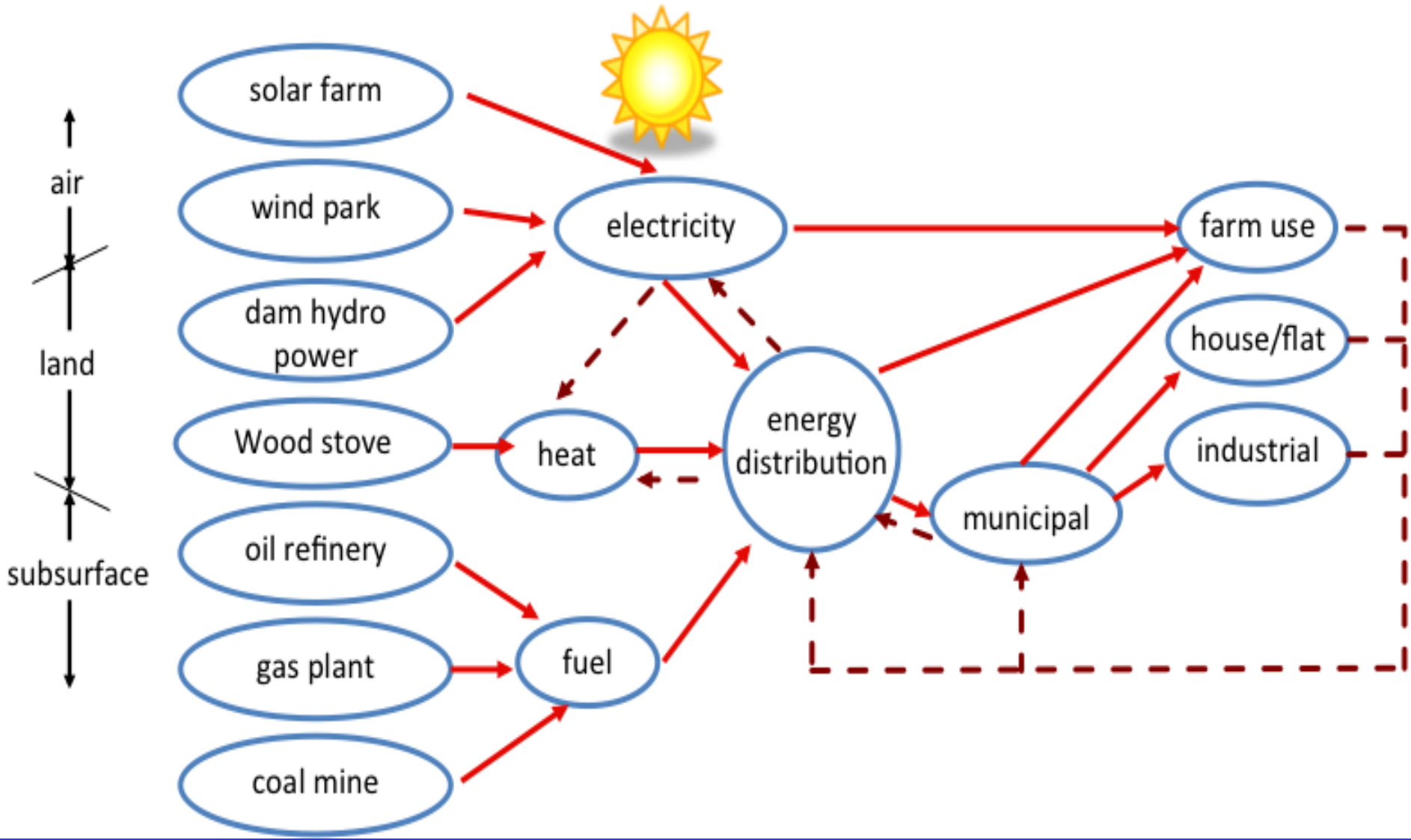
Africa
57%

Asia
18%

World
19%

Data source:
IEA WEO 2012 Table 18.1, p532

Energy Supply Chain



Examples of energy savings

- Virtual Energy
- LEPA: Low energy precision application systems
- LESA: Low Energy Sprinkler Application
- Utilising of low pressure drip irrigation technologies
- Improved Irrigation scheduling

FOOD

Do we have sufficient biomass for food production?

Challenges

Demand for food

1 billion people are threatened by hunger

2 billion people can not afford healthy diet

Additional drivers

+population increase

+additional demand for food
due to increased income

→ **Food production need to increase**

+42% until 2030

+ 70% until 2050

What is food security?

There are many different definitions of food security. The definition frequently used as defined at the World Food Summit of 1996:

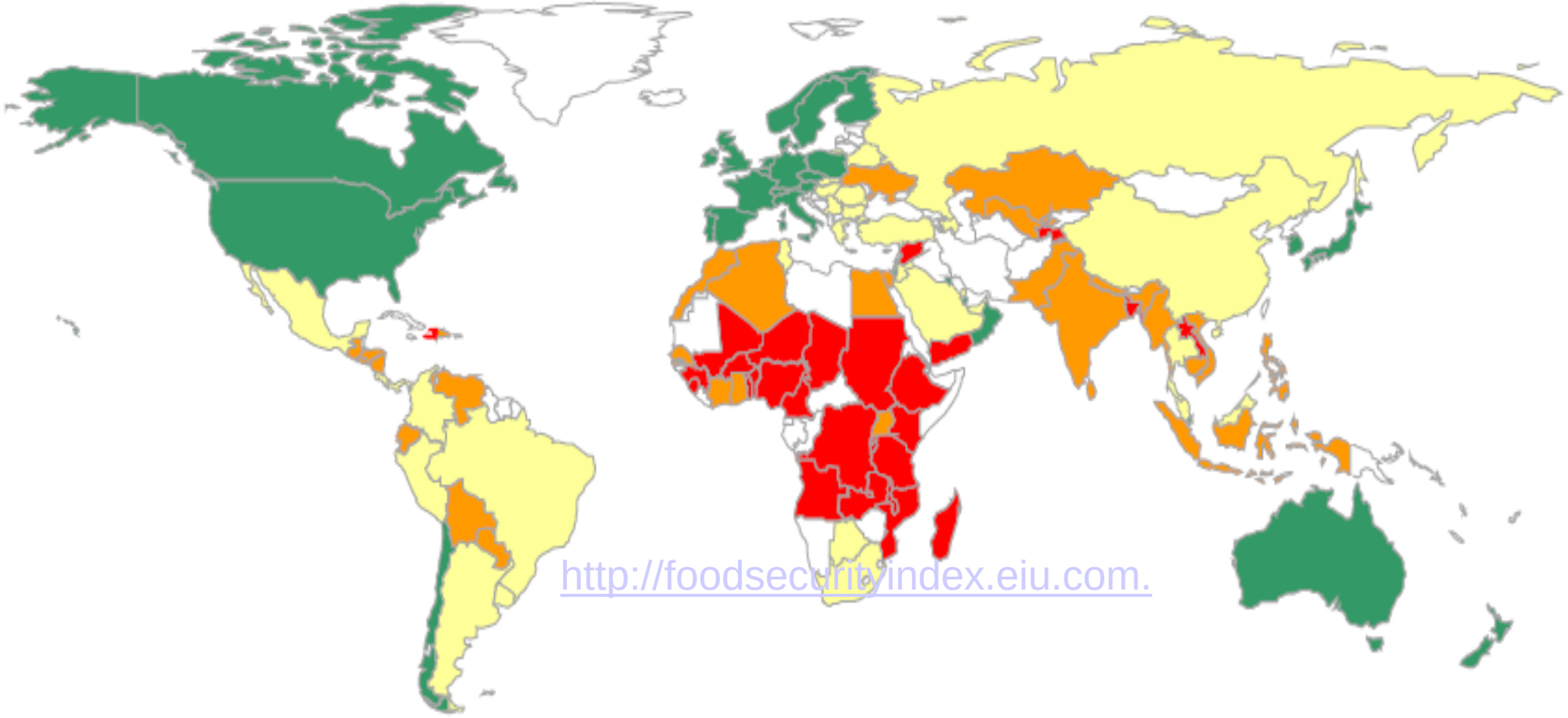
Food security is existing when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.

What is food security?

Food security includes the following aspects:

- Availability
- Access
- Affordability
- Quality
- Nutrition
- Safety

2017 Global Food Security Index



Score = Score in 2017, 0-100 where 100=best

Δ = Change in 2017 score compared with 2016

Green= score improved this year

Red = score deteriorated this year

VERY GOOD (TOP QUARTILE)		GOOD (3RD QUARTILE)		MODERATE (2ND QUARTILE)		WEAK (BOTTOM QUARTILE)	
Score	Δ	Score	Δ	Score	Δ	Score	Δ

Source: Economist Intelligence Unit/DuPont

Cultivated Land Worldwide

- 1 533 Mha – Total world Agriculture Area
- 300 Mha – Currently under Irrigation

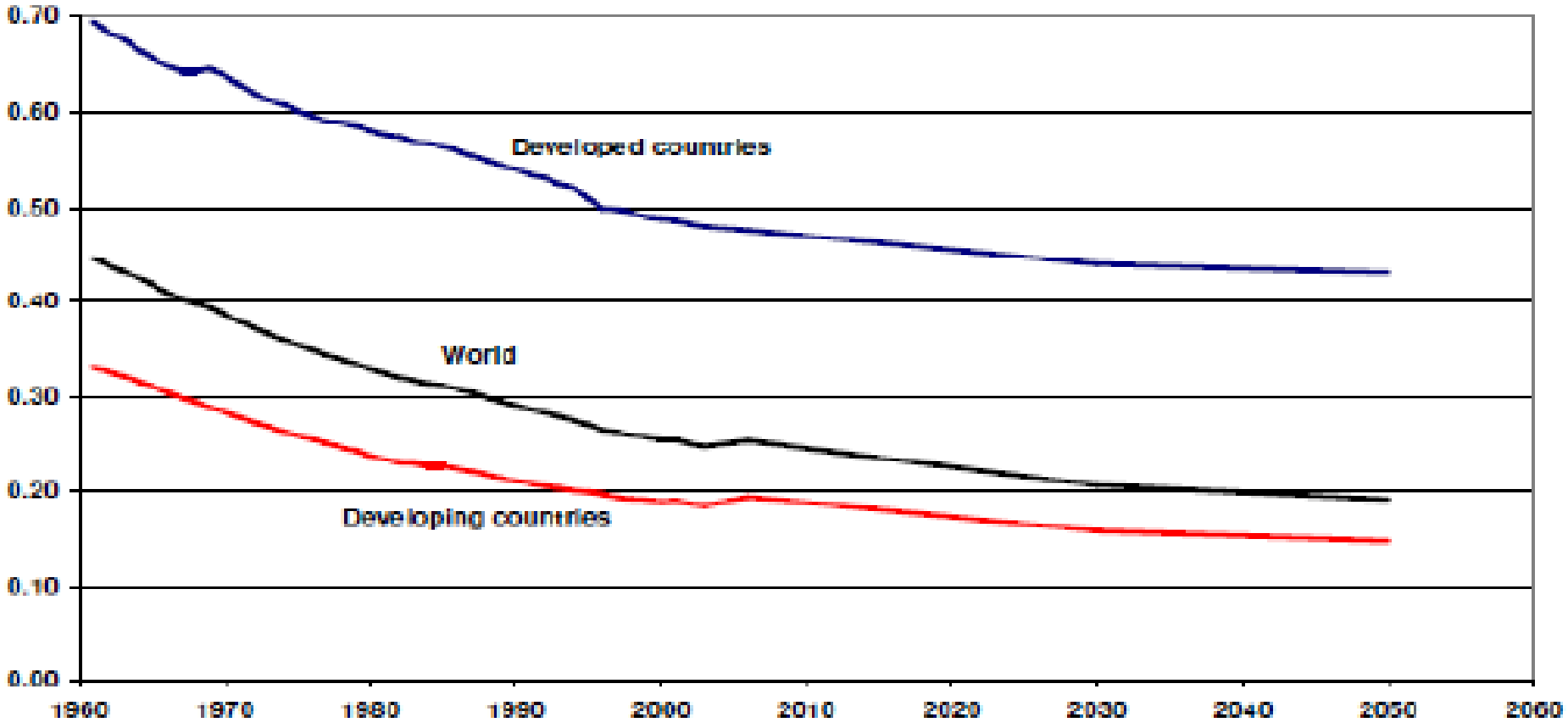
20% of total agricultural land area supplies about **40%** of the world's food

- 14 Mha - Drip irrigated

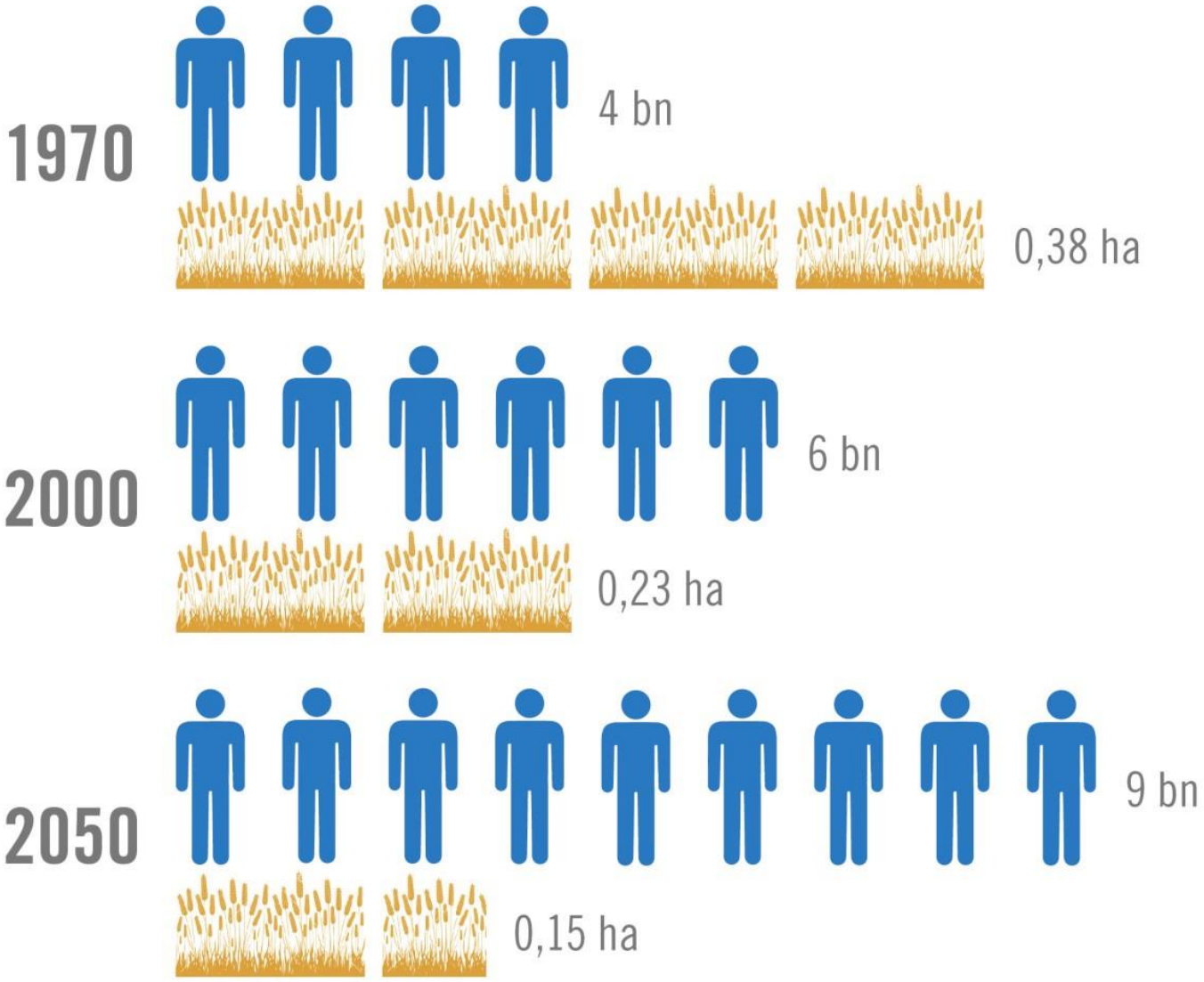
Crop productivity values:
- Rain fed 30% of Irrigation

Source: ICID - CIID

Arable land per capita in ha

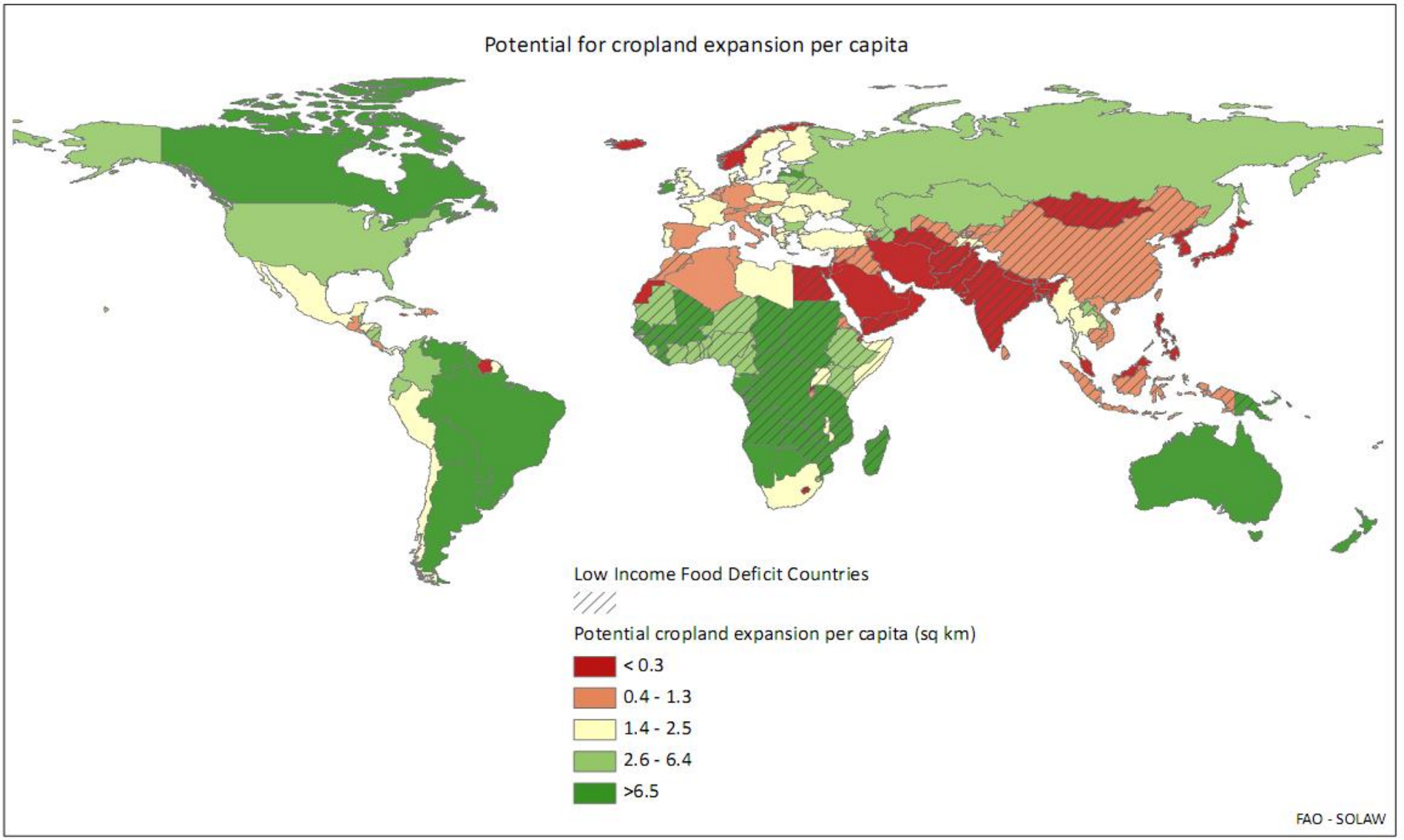


ARABLE LAND PER CAPITA



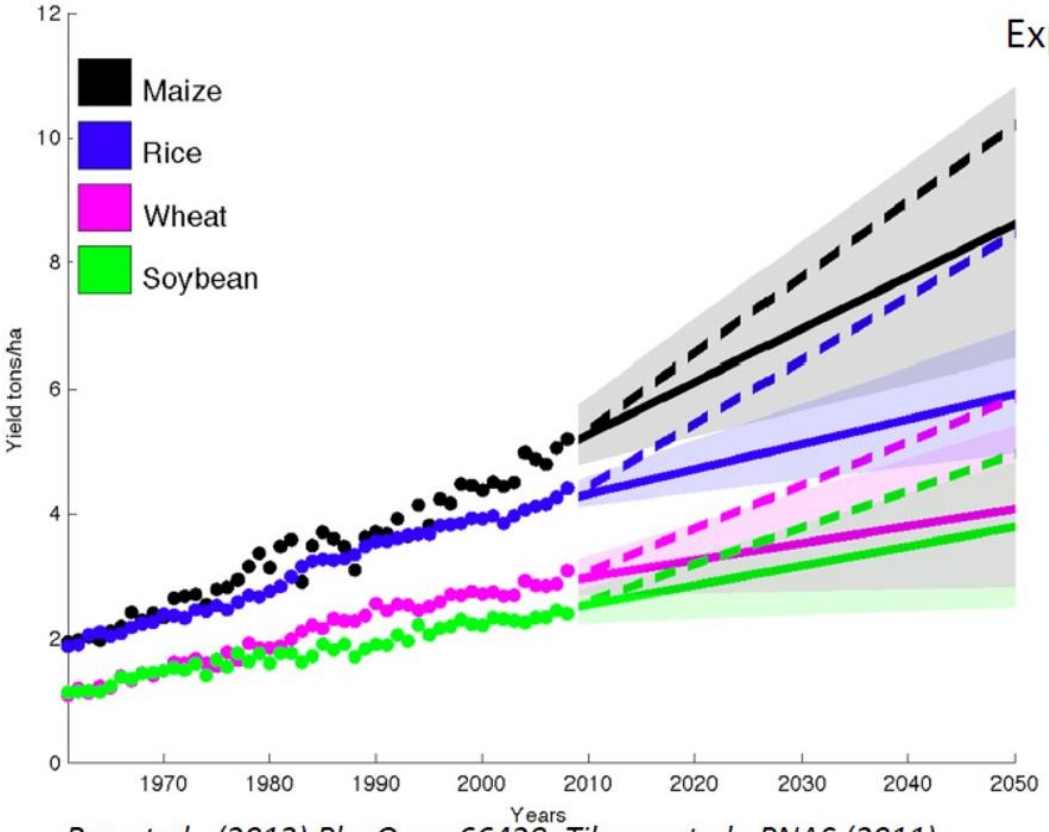
Source: FAO – Food and Agriculture Organization of the United Nations

Land available for crop expansion is limited



Data classified in quintiles.
The potential for cropland expansion (or Net Land Balance) is the result of:
S - (C+F+P+U)
S= Land classified as moderately suitable or better for rainfed crops (FAO-IIASA GAEZ)
C= Cultivated land (FAO-IIASA); F= Forest (FAO-IIASA)
P= Protected area (WDPA); U= Settlements (FAO-IIASA)

No equivalent increase in yield



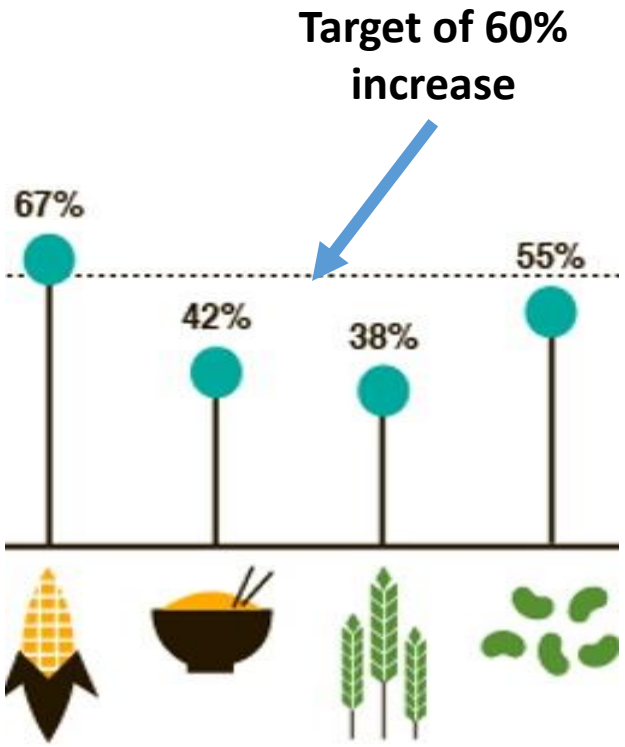
Expected increase (2050)

67 %

42 %

38 %

55 %

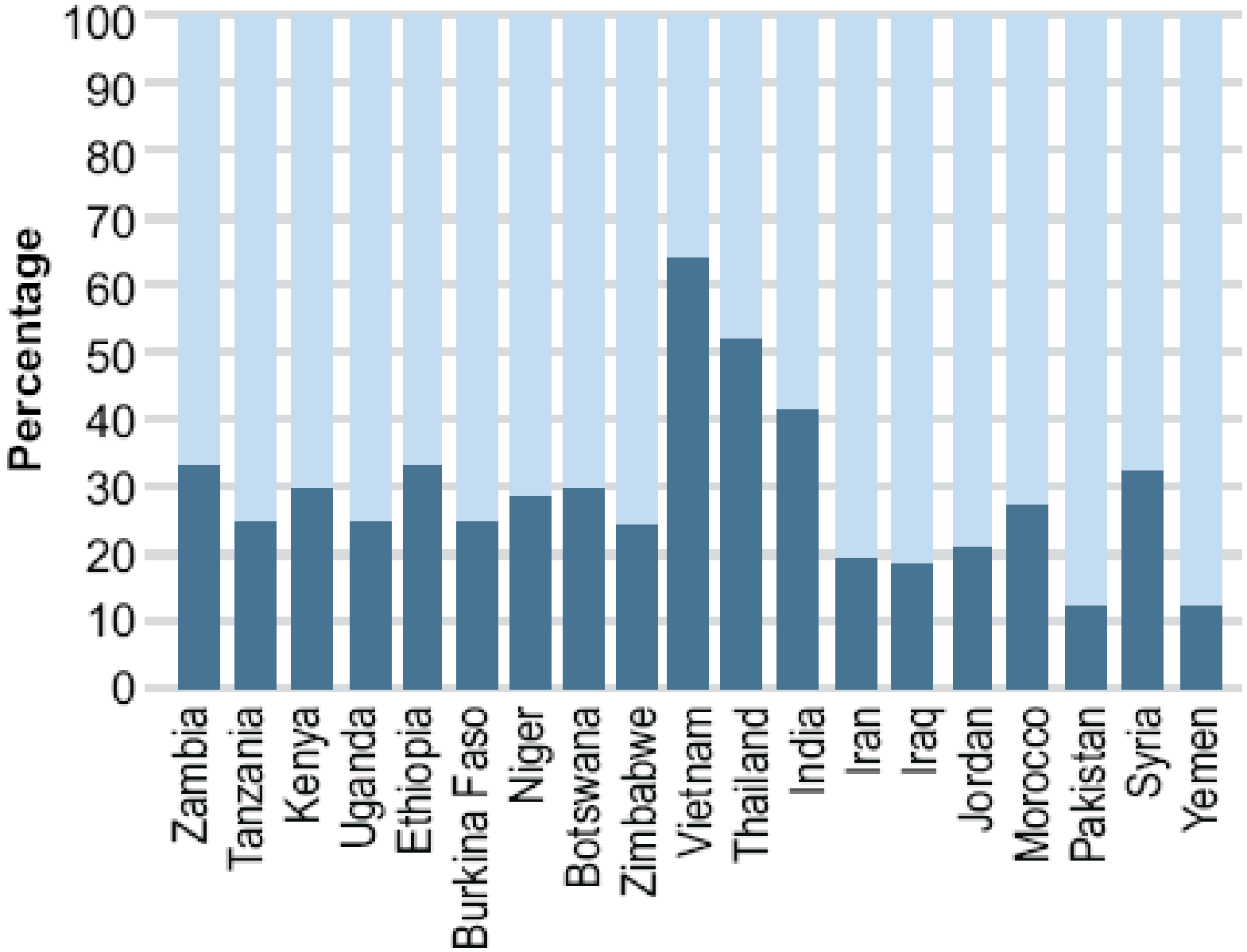


Ray et al., (2013) PlosOne e66428; Tilman et al., PNAS (2011)

Annual increase rates need to double

Game-changing solutions are needed to produce **„more with less“**

Gap between farmer's yields and achievable yields



Per capita food production

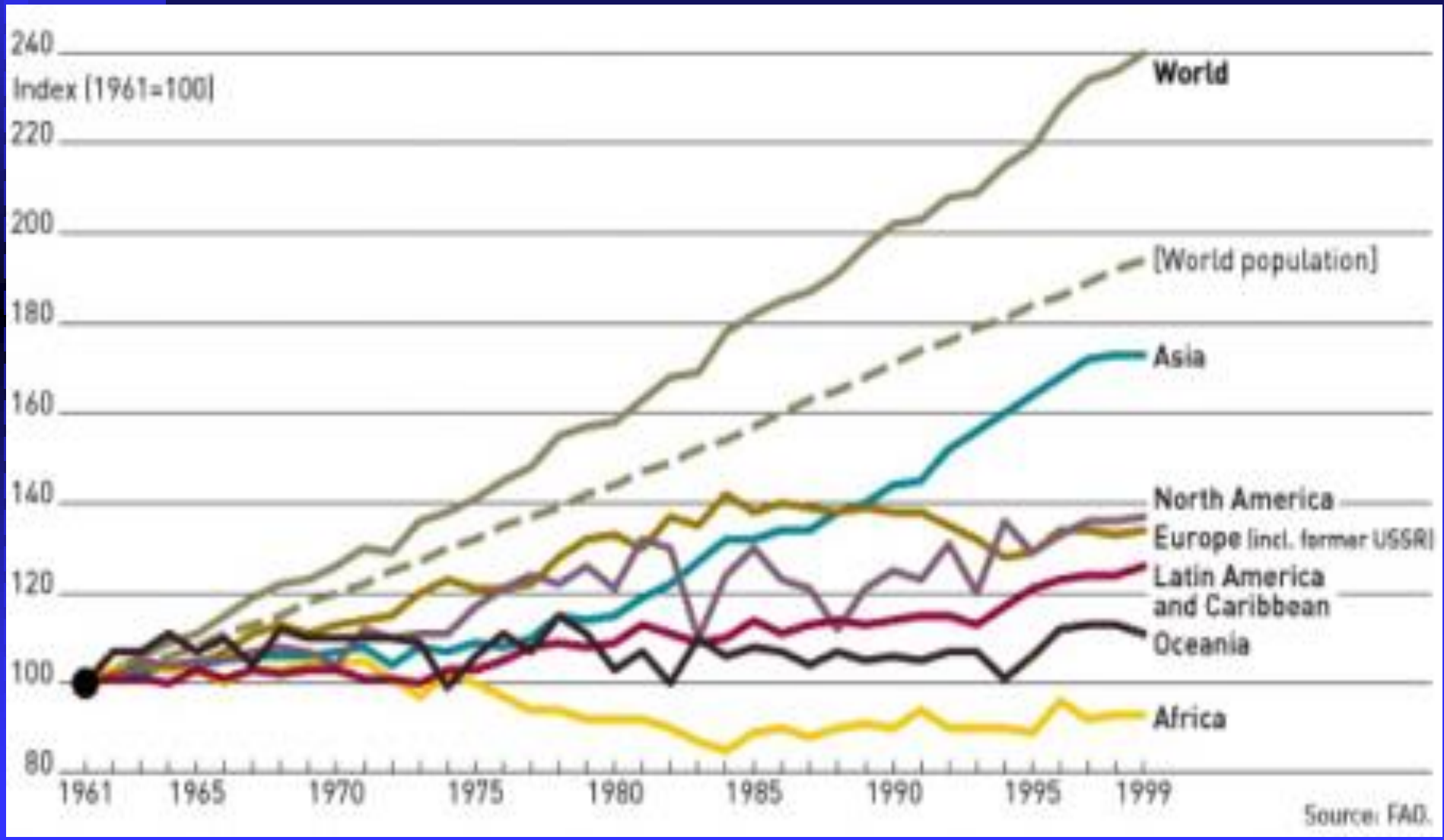
Calculated as: total production/population

Growing, but not as rapidly as total production

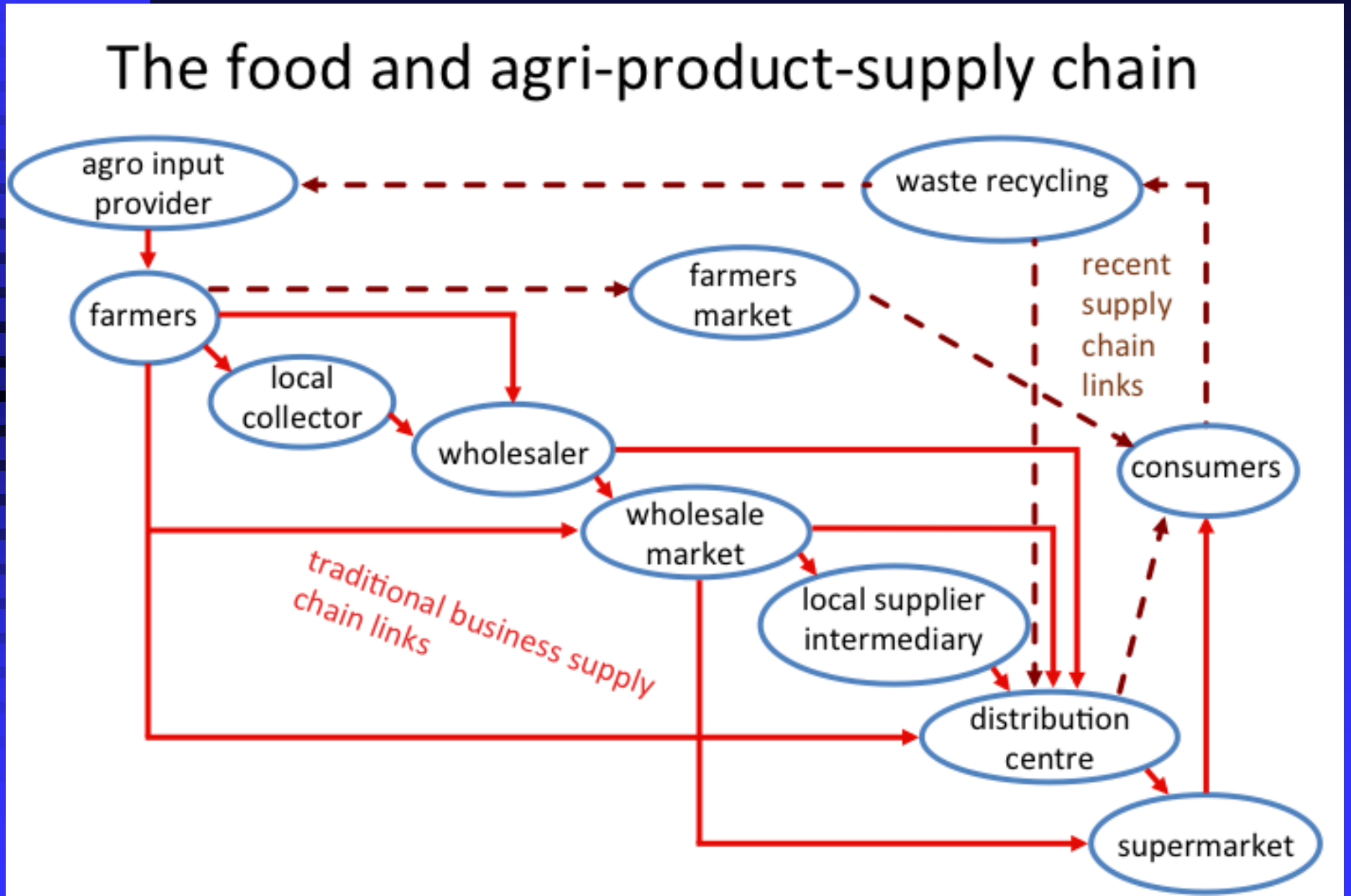
Annual growth rates:

1950s: 1.4%
1960s: 0.8%
1970s: 0.4%
1980s: 0.4% … and holding steady

World Agricultural production



Food Supply Chain

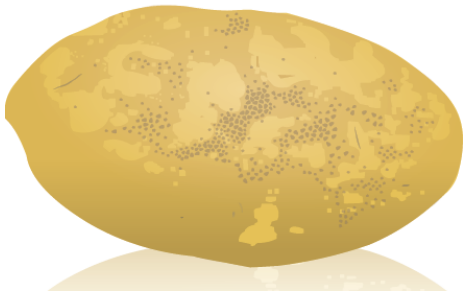


Virtual Water

Virtual Water is the amount of water that is embedded in food or other products needed for its production.

Virtual water refers to the amount of water required to produce a good from start to finish or it is the volume of freshwater used to produce the product, measured at the place where the product was actually produced.

1 potato



25

1 slice of bread

40

1 cup of coffee

140

litres

1 cup of tea

35

litres

1 glass of apple juice

190

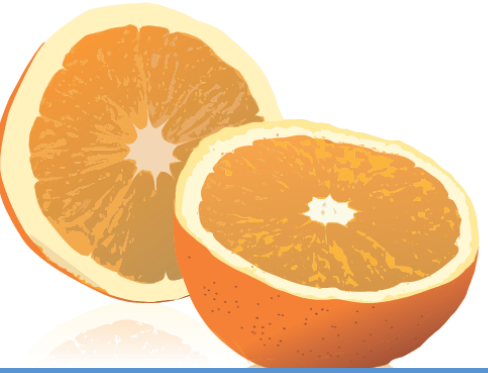
litres

1 glass of milk

200

litres

1 orange



50 litres

1 egg

135 litres

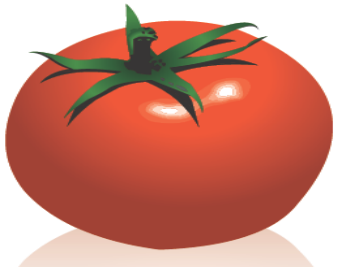
1 apple

70 litres

1 slice of bread with cheese

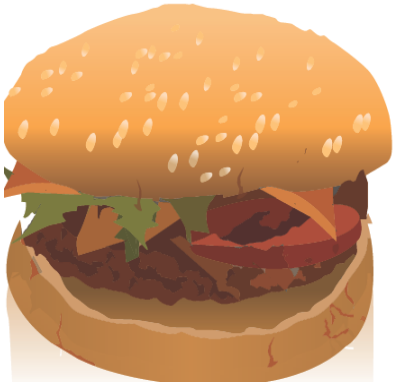
90 litres

1 tomato



13 litres

1 hamburger

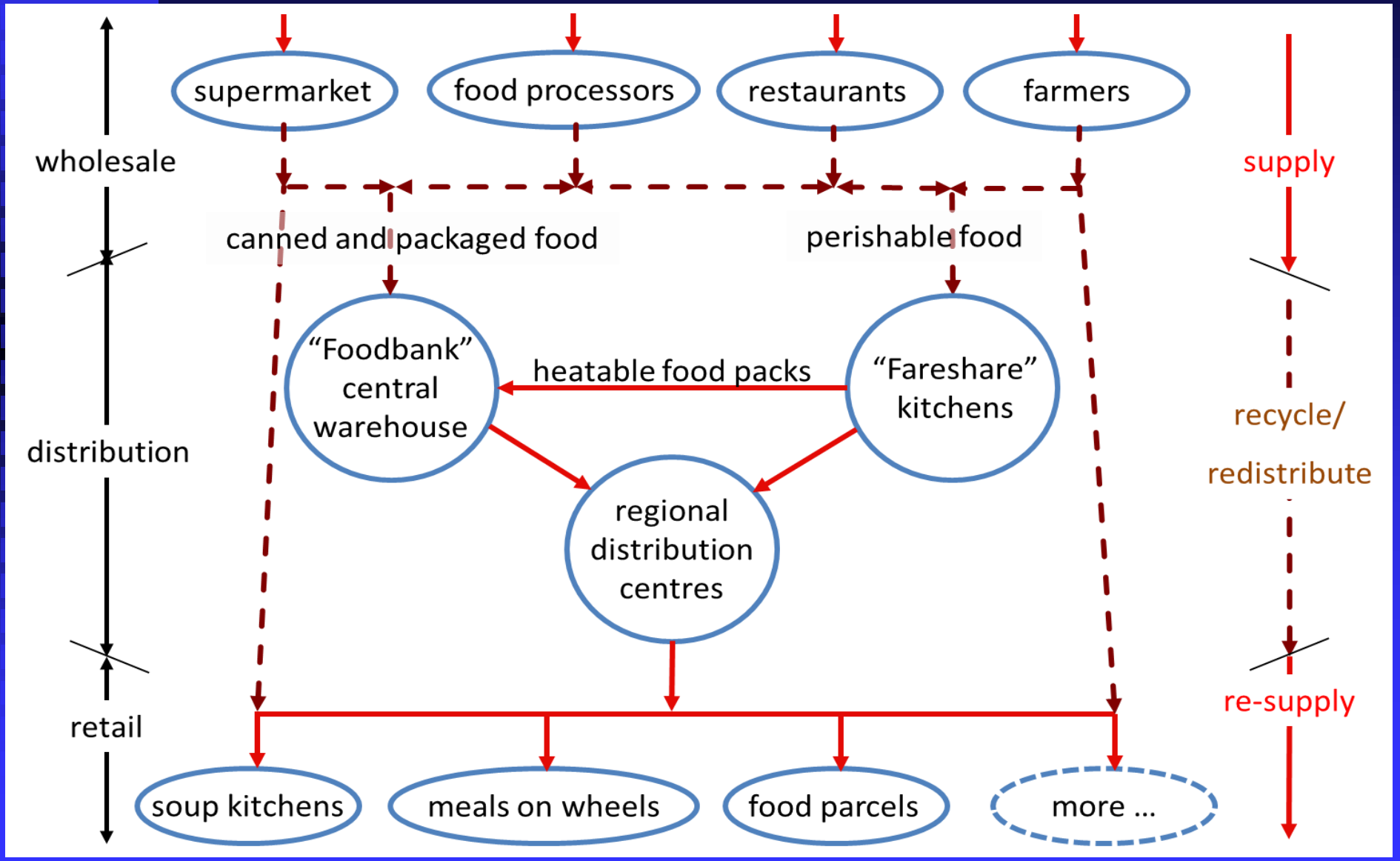


2400 litres

Examples of food saving

- Food wastage: 243 litres of water a day in the food they throw away =150% of daily home water use (UK Statistic)
- USA wastes 40% (think of virtual water & virtual energy).
- Other countries…?

Food recycling

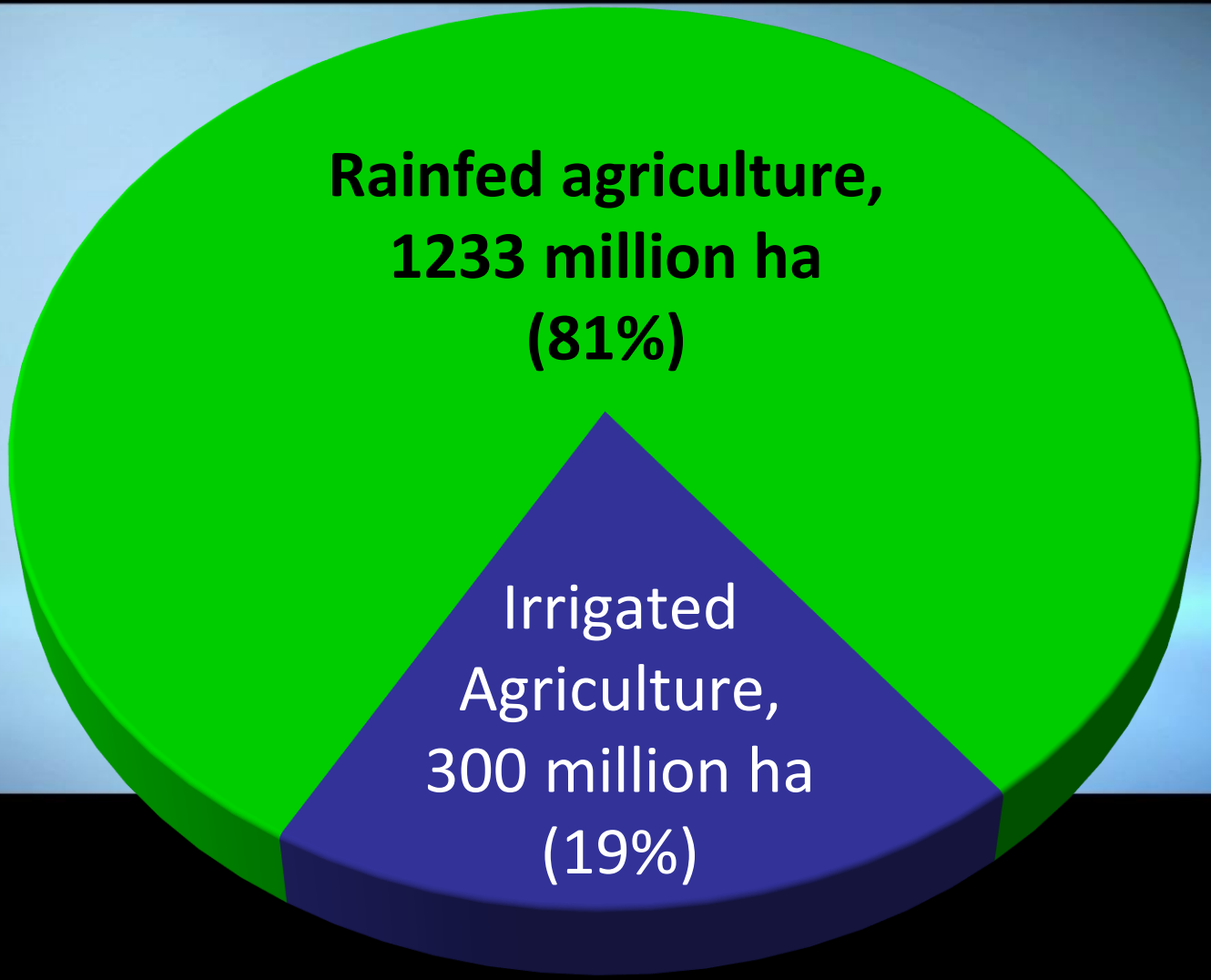


T e c h n o l o g y

Water dependant

Rainfed agriculture 1233 million ha

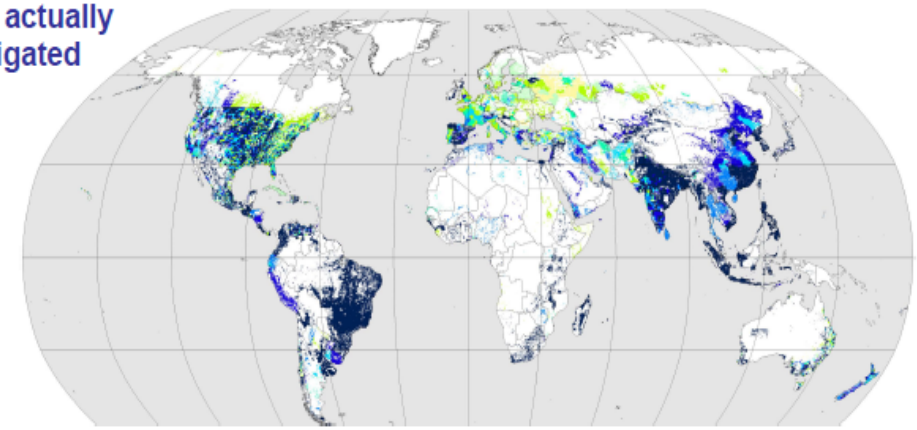
Irrigated Agriculture, 300 million ha


Rainfed agriculture,
1233 million ha
(81%)
Irrigated
Agriculture,
300 million ha
(19%)

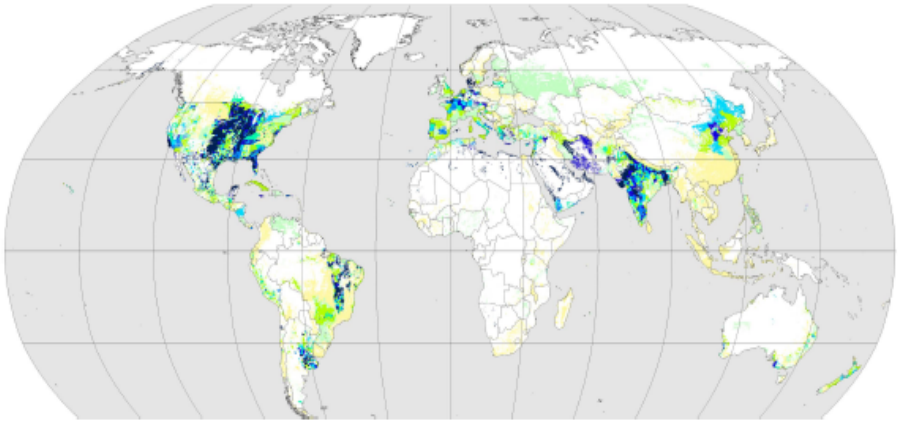
The digital global map of irrigation areas

October 2013

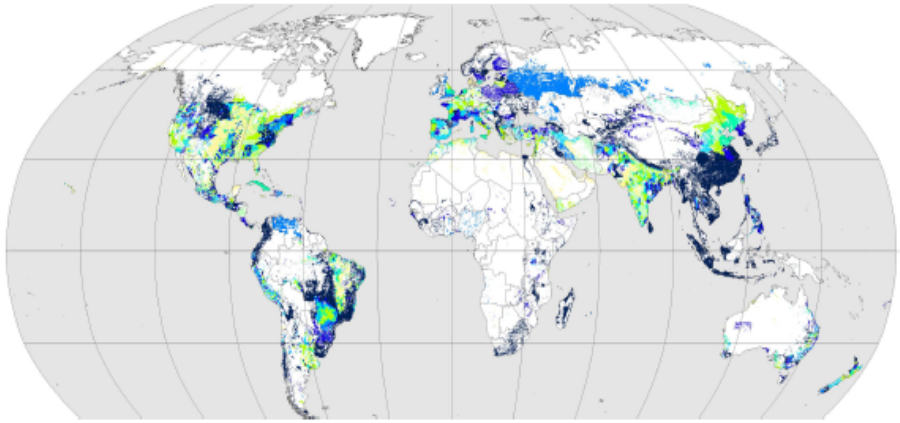
Area actually irrigated



Area irrigated with groundwater



Area irrigated with surface water



Percentage of area equipped for irrigation (AEI)

No AEI	60 - 70
< 10	70 - 80
10 - 30	80 - 90
30 - 50	90 - 100
50 - 60	

The maps show the percentage of area equipped for irrigation that is actually irrigated, irrigated with groundwater or irrigated with surface water. For the majority of countries the base year of statistics is in the period 2000 - 2008.

Projection: Robinson
Resolution: 5 arc-minutes

http://www.fao.org/nr/water/aquastat/irrigationmap/index.stm

Stefan Siebert, Verena Henrich (Institute of Crop Science and Resource Conservation, University of Bonn, Germany) and
Karen Frenken, Jacob Burke (Land and Water Division, Food and Agriculture Organization of the United Nations, Rome, Italy)

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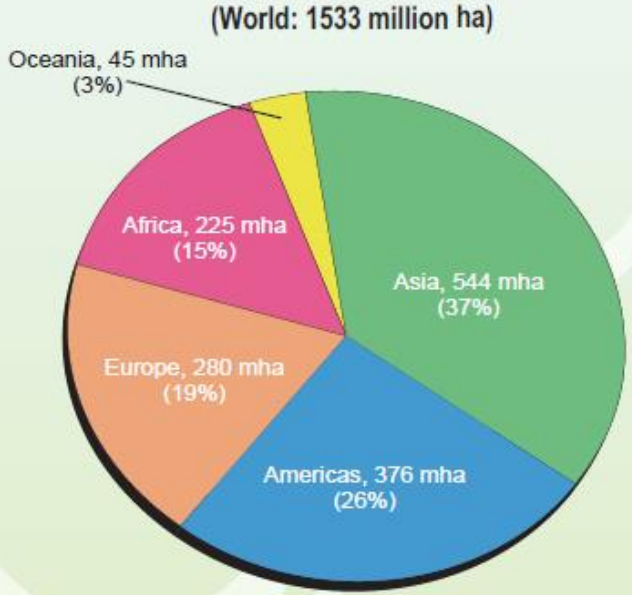
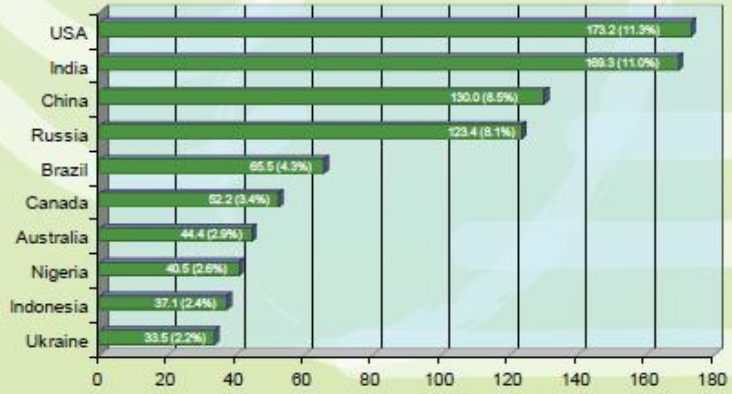
Regionwise Arable and Permanent Cropped Areas of the World



Arable and permanent cropped area (million ha) and its share in the total area (%)
Top 10 Countries



Source : ICID NCs (2010), FAO Stat-FAO Statistics Division (2011

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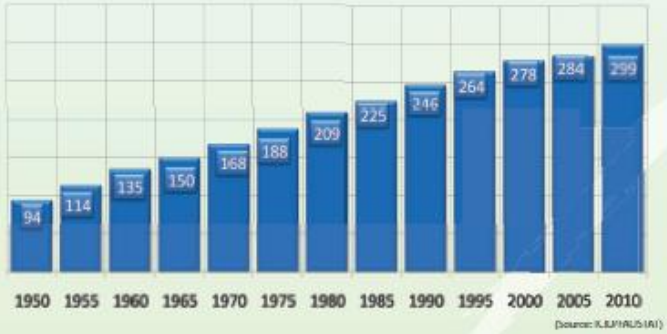
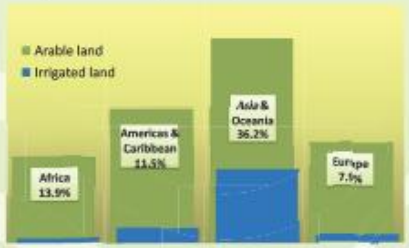
World Irrigation Scenario

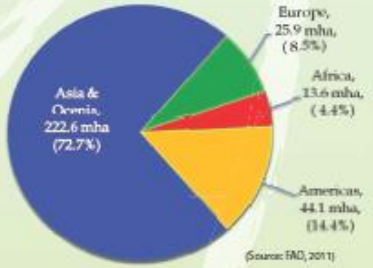
World irrigated area (million ha)



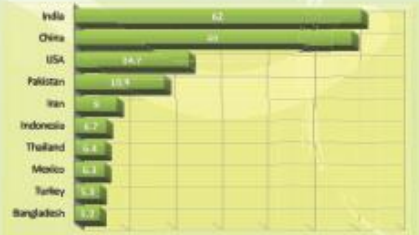
Irrigated area as percentage of arable land



Regional spread of irrigated area

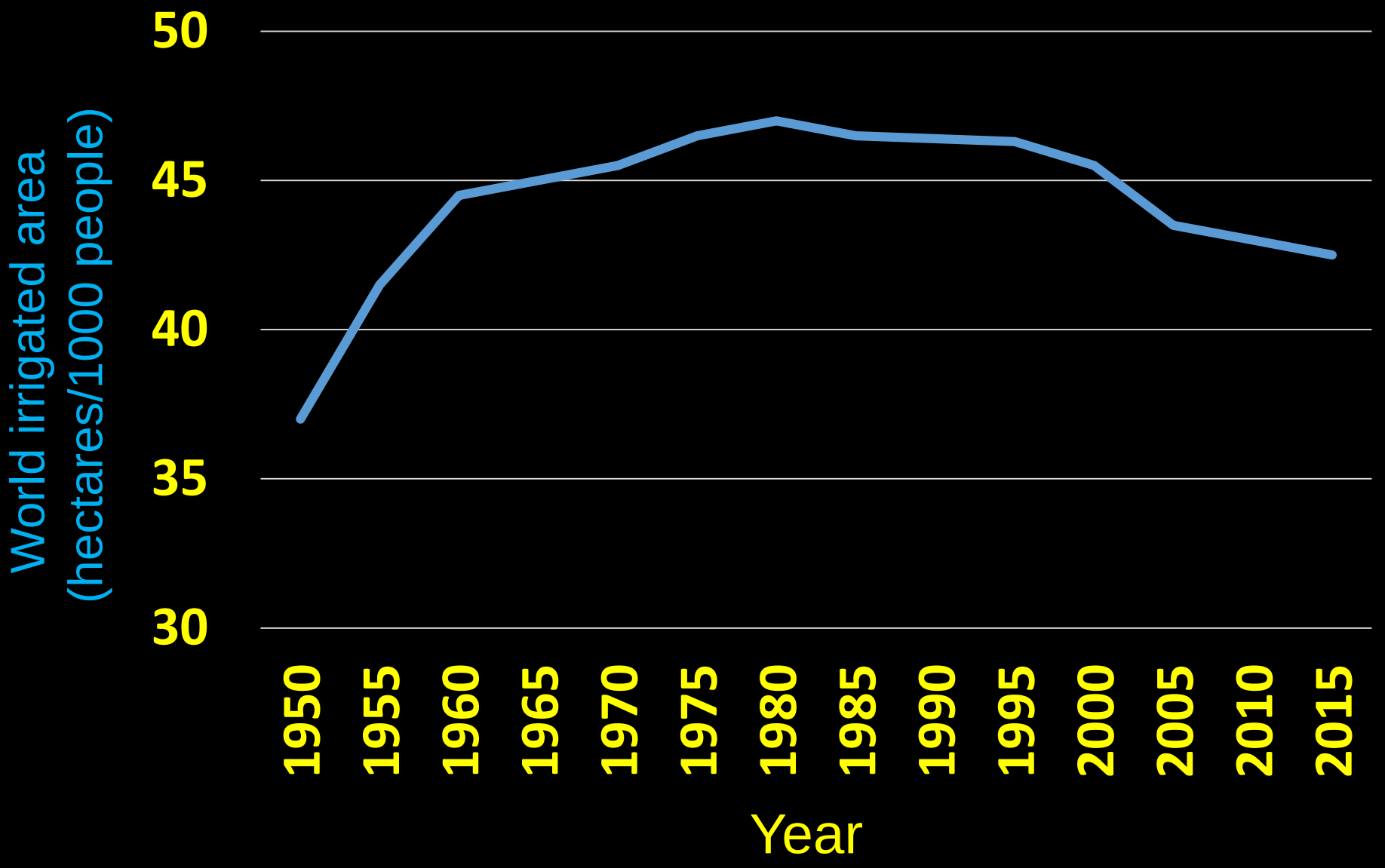


Irrigated area (million ha) - Top ten countries



World irrigated area (Hectares/1000 people)

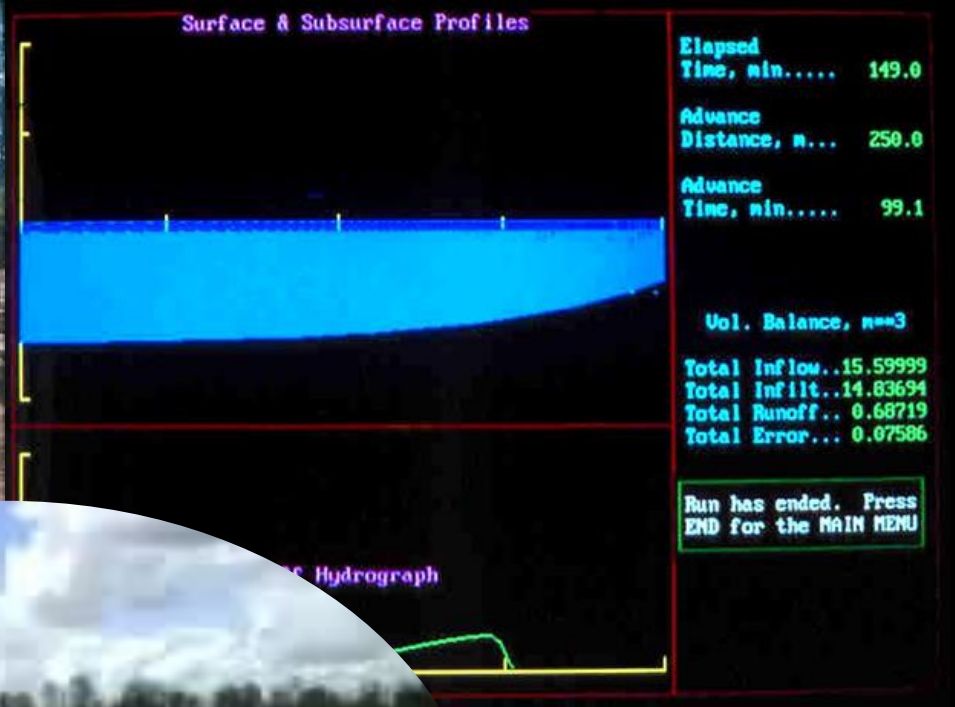
World irrigation scenario




e Regulation Range






Surface & Subsurface Profiles
Elapsed
Time, min..... 149.0
Advance
Distance, m... 250.0
Advance
Time, min..... 99.1
Vol. Balance, n=3
Total Inflow..15.59999
Total Infilt..14.83694
Total Runoff.. 0.68719
Total Error... 0.07586
Run has ended. Press
END for the MAIN MENU
Hydrograph

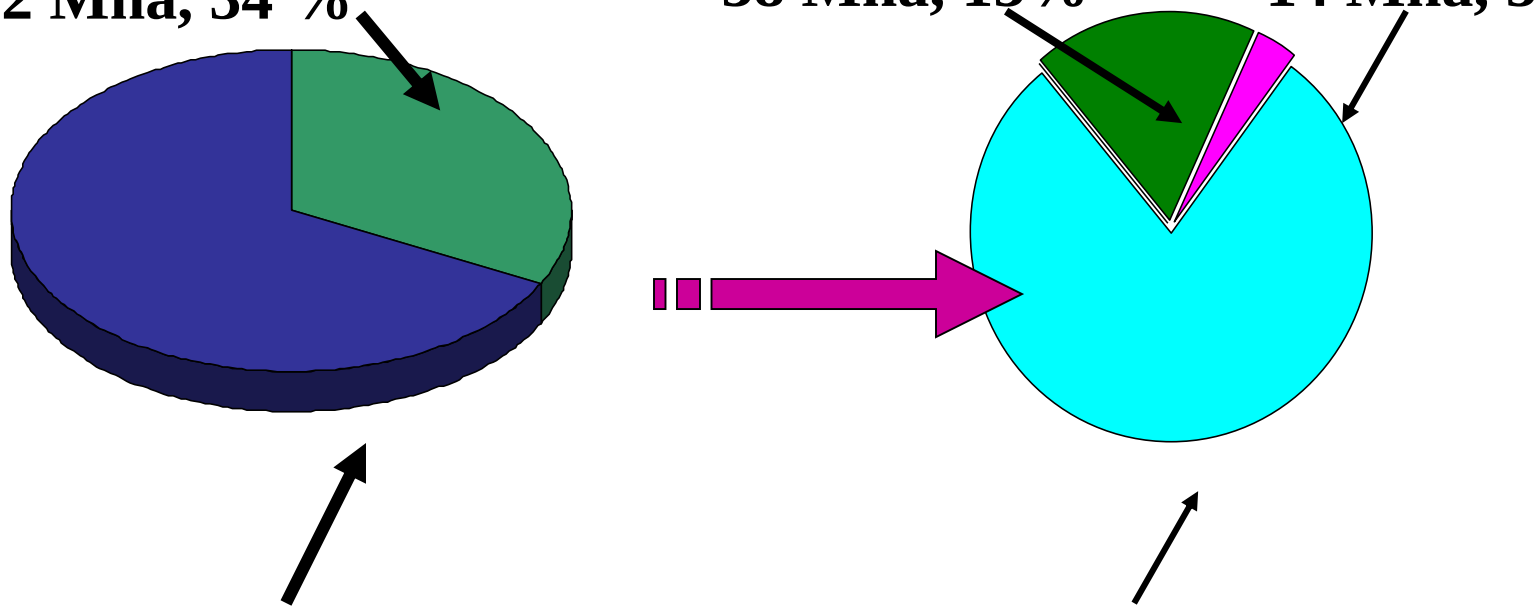
World-wide Coverage of Irrigation

Total irrigated area = 300 Mha

Rice irrigated Area
102 Mha, 34 %

Sprinkler,
38 Mha, 13%

Micro irrigation,
14 Mha, 5%



Irrigated area of other crops
198 Mha, 66 %

Gravity irrigation,
248 Mha,82%

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Outstanding Agricultural Engineering Achievements of the 20th Century

Division	Achievement
Power and Machinery Division	The development of the agricultural tractor
	The development, versatility and productivity of self propelled combines
	The development of the 3 point hitch and draft control system
	The invention and development of the chisel plough for erosion control and primary tillage
	The use of rubber tyres on tractors
Structures and Environment	Standard designs for agricultural structures
	The development of slotted inlets for ventilation in animal housing
	The integration of systems for low-cost and low-energy consuming greenhouses
	The development of cyclone air pollution abatement system

(Cuello and Huggins, 2000; Howard, 2007)

Outstanding Agricultural Engineering Achievements of the 20th Century

Division	Achievement
Food Processing	Understanding of the fissuring mechanism in rice
	Evaluation method for Mycotoxin sampling plans
	The development of mechanical grain aeration
	Development of grain dryeration processes
	Bulk curing of tobacco
Information and Electrical Technology	Rural electrification
	Refrigerated on farm milk storage
	Non-destructive quality evaluation of food and feed grains
	The development of automated milking machines
Other	The development of roll-over protective structures for wheeled agricultural tractors
	The developments of standards by the ASAE

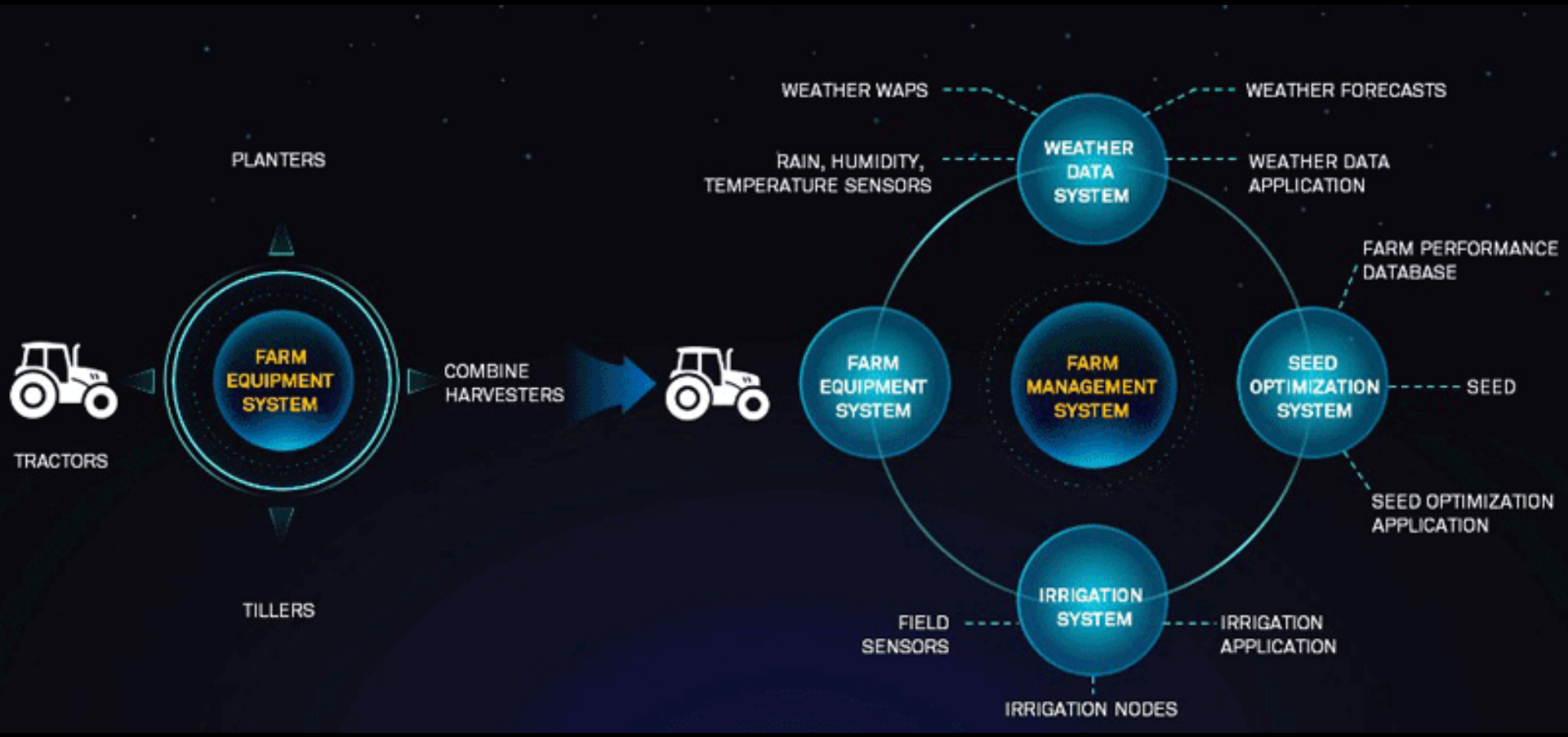
(Cuello and Huggins, 2000; Howard, 2007)

Outstanding Agricultural Engineering Achievements of the 20th Century

Division	Achievement
Soil and Water Division	Erosion prediction technology for soil conservation
	Design procedures for vegetative waterways
	The development of conservation tillage systems
	The design of the impact sprinkler
	The development of the centre pivot system for irrigation
	The small watershed programme for flood and erosion control
	The development of drip irrigation systems

(Cuello and Huggins, 2000; Howard, 2007)

Digitization is the future to process information into a digital format by generating a series of numbers that can be used for food production improvement.



Agricultural robots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Agribotix™
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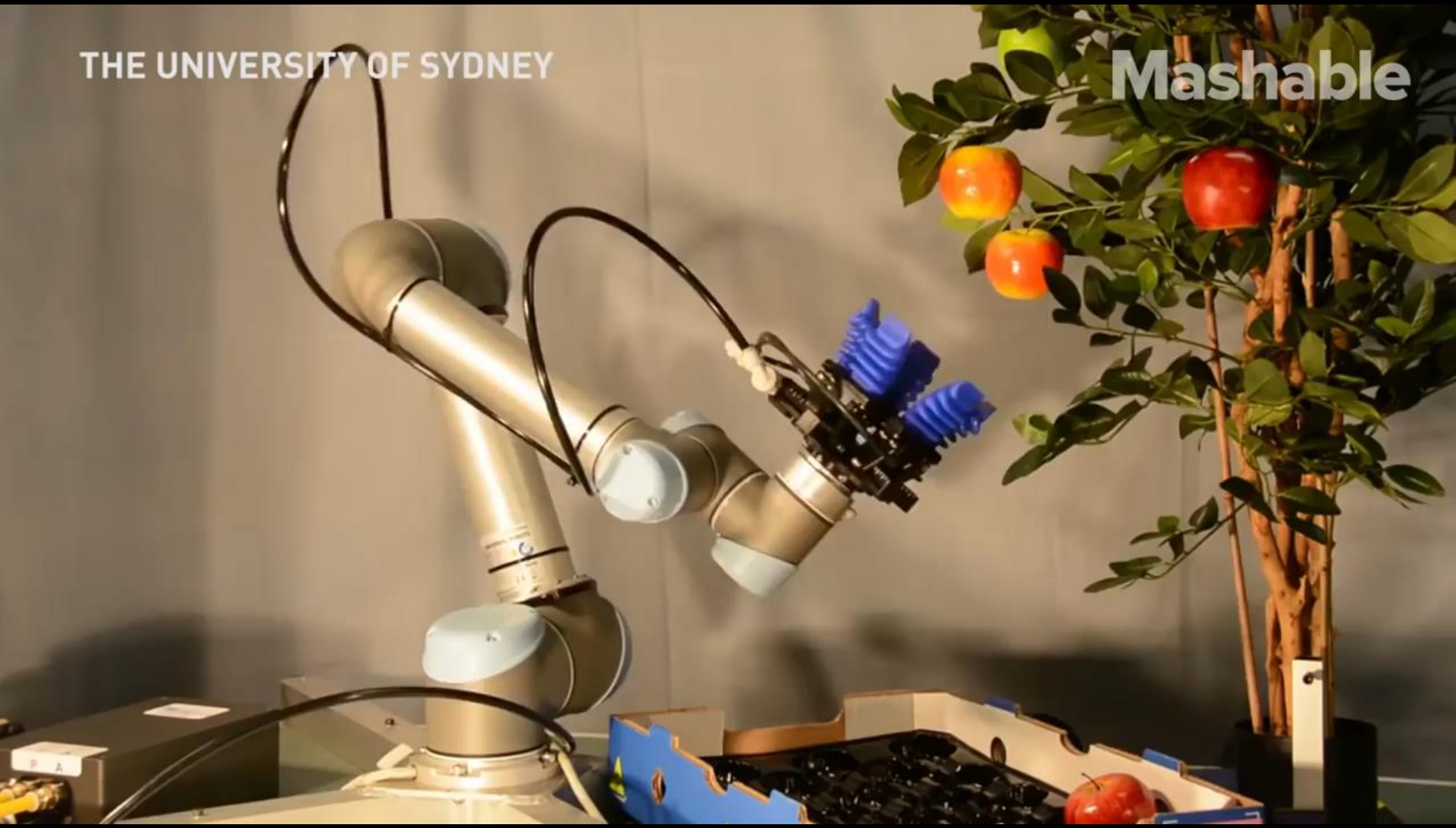
FIELDNET™
BY LINDSAY

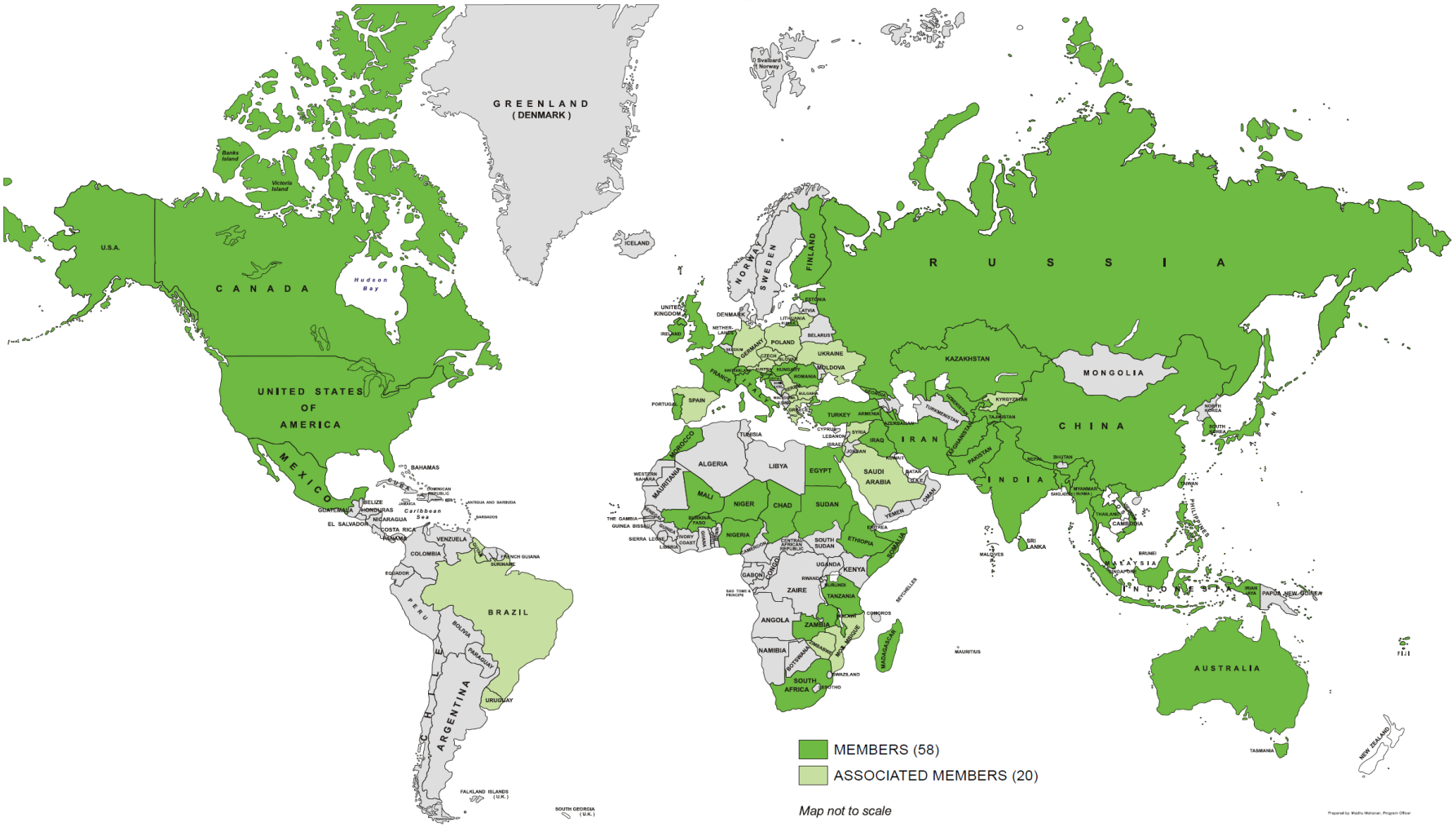
Introducing the new and improved FieldNET.

With new and patent-pending features to maximize resource utilization.


THE UNIVERSITY OF SYDNEY
Mashable

International Commission on Irrigation and Drainage

ICID Membership Network 2018



Present active network spread over 78 countries, covering over 95% of the irrigated area of the world

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http://www.icid.org/nc1.php

A ROAD MAP TO ICID VISION 2030

A WATER SECURE WORLD
FREE OF POVERTY AND HUNGER

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INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE

Roadmap to ICID Vision 2030
Vision and Mission

Vision

Water secure world free of poverty and hunger through sustainable rural development

Mission

Working together towards sustainable agriculture water management through inter-disciplinary approaches to economically viable, socially acceptable and environmentally sound irrigation, drainage and flood management

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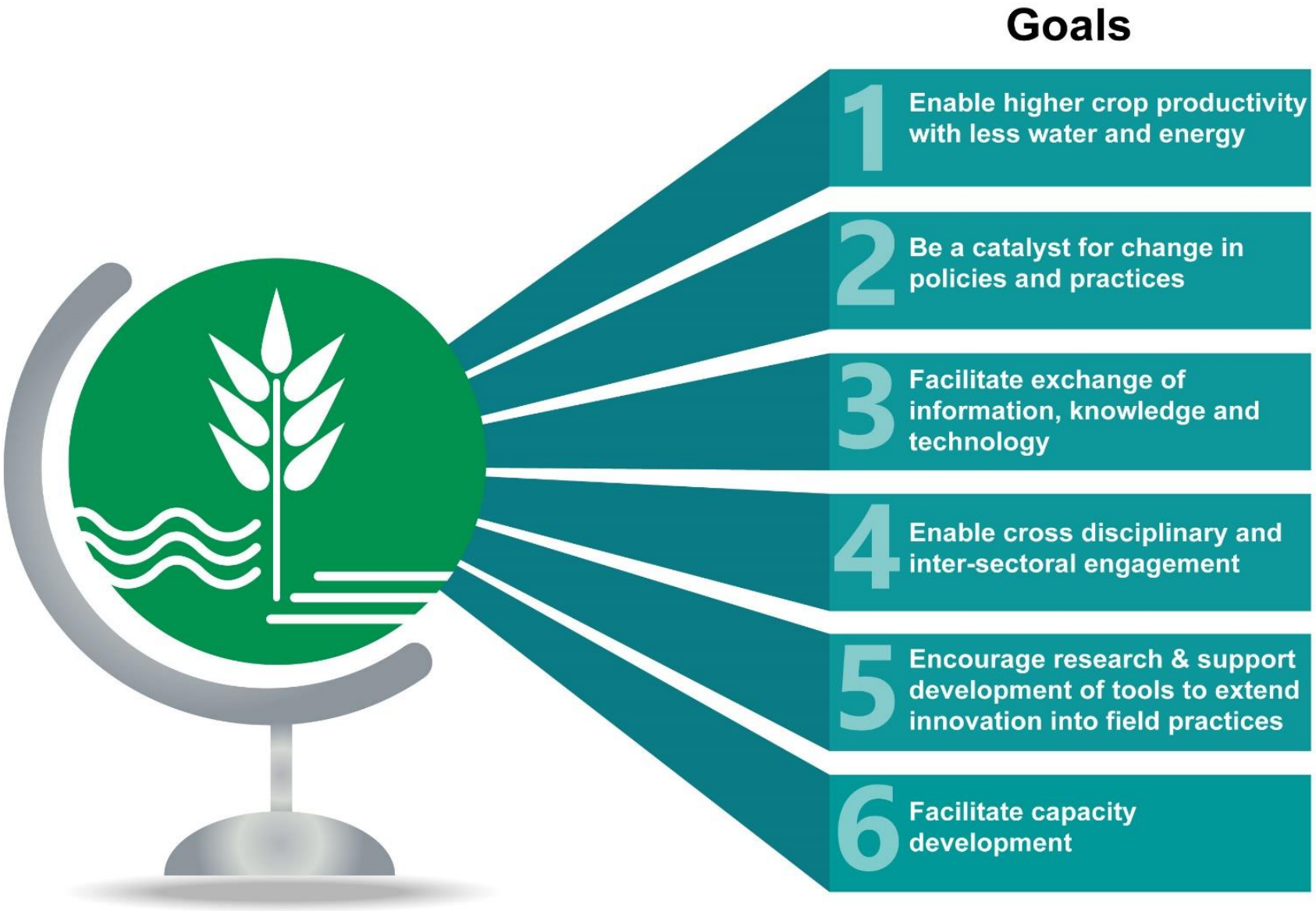
Roadmap to ICID Vision 2030
Organisation Goals



Action Plan
Strategies to achieve goals

Goal A: Enable higher crop productivity with less water and energy

Strategies

A1 : Modernization of irrigation systems

A2 : Improving O&M of Irrigation Systems

A3 : Implementing water saving techniques and technologies

A4 : Promoting Institutional Reforms

A5 : Supporting water productivity enhancement

A6 : Improving performance of irrigation systems

A7 : Using wastewater or poor quality water for irrigation

A8 : Encouraging participatory management of irrigation systems

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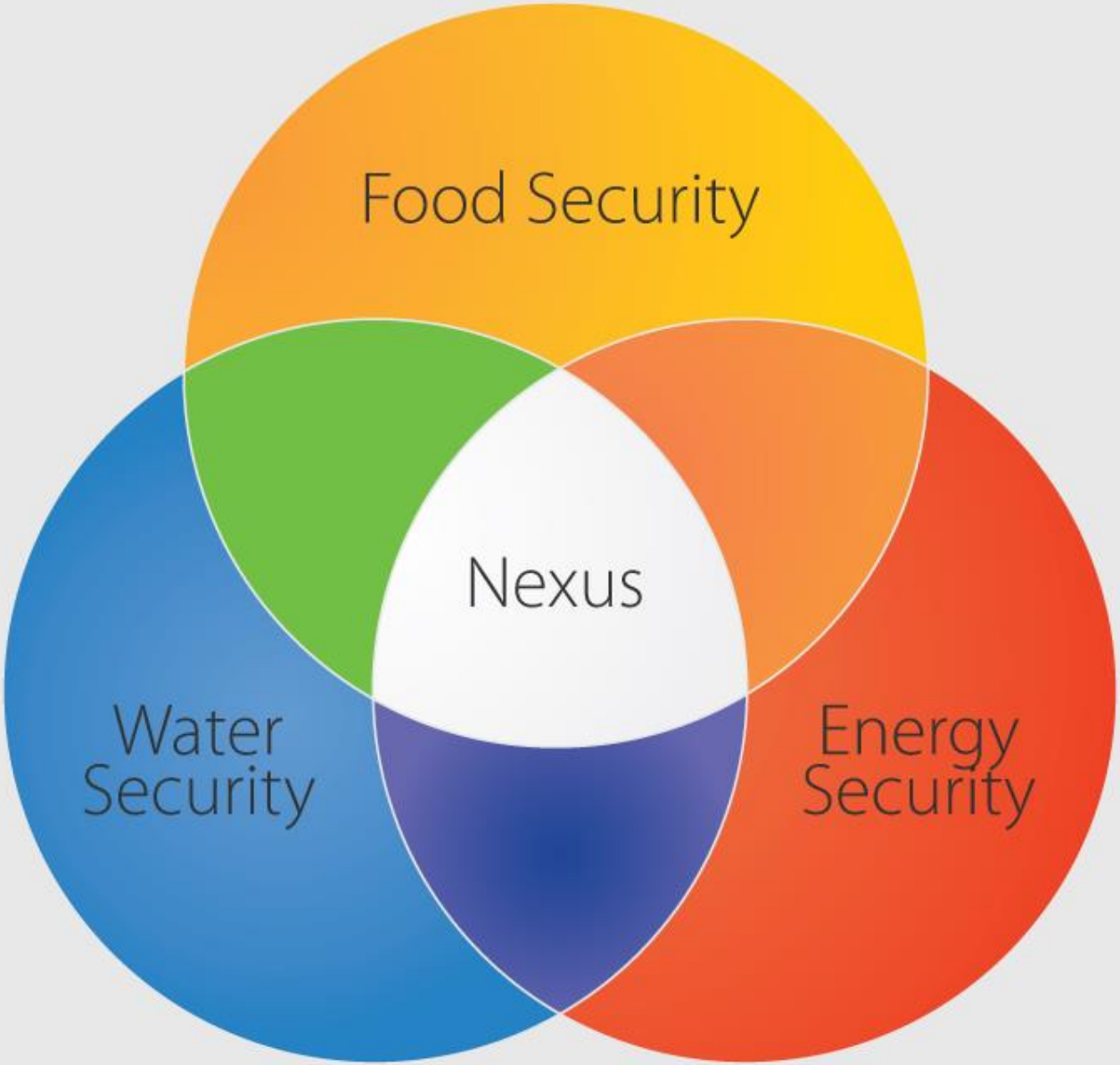
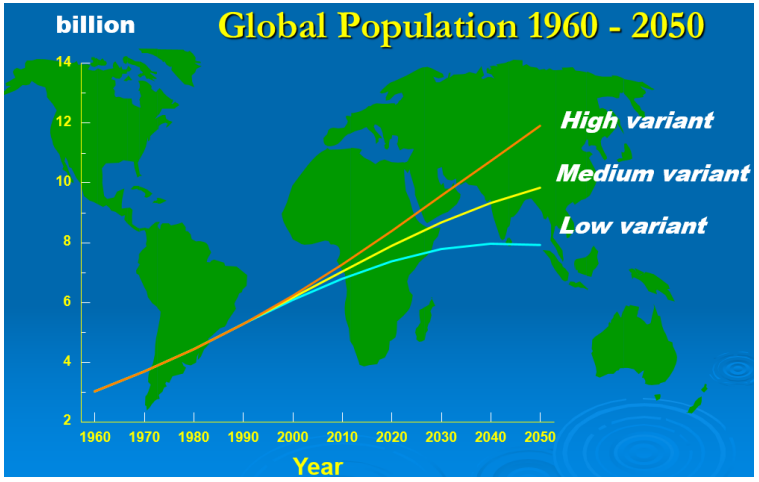
Conclusion


Food Security
Nexus
Water Security
Energy Security

What are some of the issues affecting world food security?

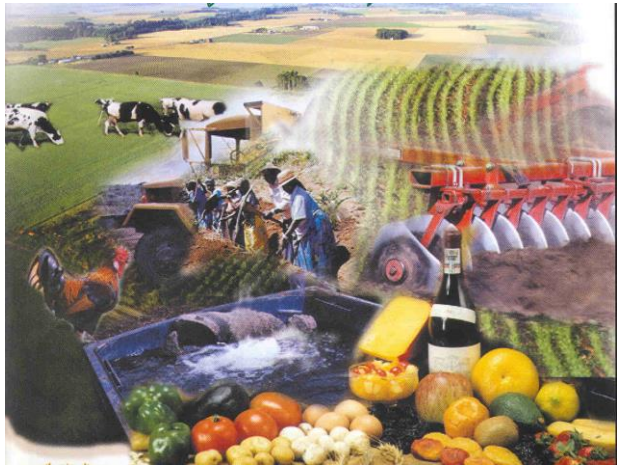
Food security is one of the biggest challenges facing humankind. There are many factors which have combined to make food security such a large issue. This includes:

- **Increasing population -** In 2012, the world population was 7 billion. By 2050, it is predicted to reach 9 billion. Our current output of food is not enough to feed a population of 9 billion.



What are some of the issues affecting world food security?

- **Changing diets -** As countries develop and people become richer they tend to eat a more varied diet, including more meat, which requires more energy to produce. This also means there is more competition for the same types of food.



- **Reduced arable land -** The drive to produce more biofuels for transport uses edible crops and has reduced arable land.

Transport costs - The relatively high price of oil in recent years has increased the price of food storage and distribution.

Climate change - Climate change is leading to a warmer world which will affect what crops can be grown where. Climate change can also lead to more frequent extreme weather events (e.g. floods) which can damage crops.

Pests and diseases - Pests and diseases are becoming more resistant to pesticides and sprays. The changing climate is also bringing pest and diseases into new areas where they could not previously survive.

Challenges of the Water-Energy-Food Nexus to Manage Climate Change

- Moving towards a Green and Bio-economy for sustainability
- Water efficiency: from 60% - 95%
- Energy efficiency: from high to low use, bio energy, limit wasteful transport of foods
- Food efficiency: stop wastage of 30 – 40%; it saves water and energy
- Apply technology to improve food production

Thank you