# Measuring the Water Footprint in the Okanagan using the Virtual Water Concept

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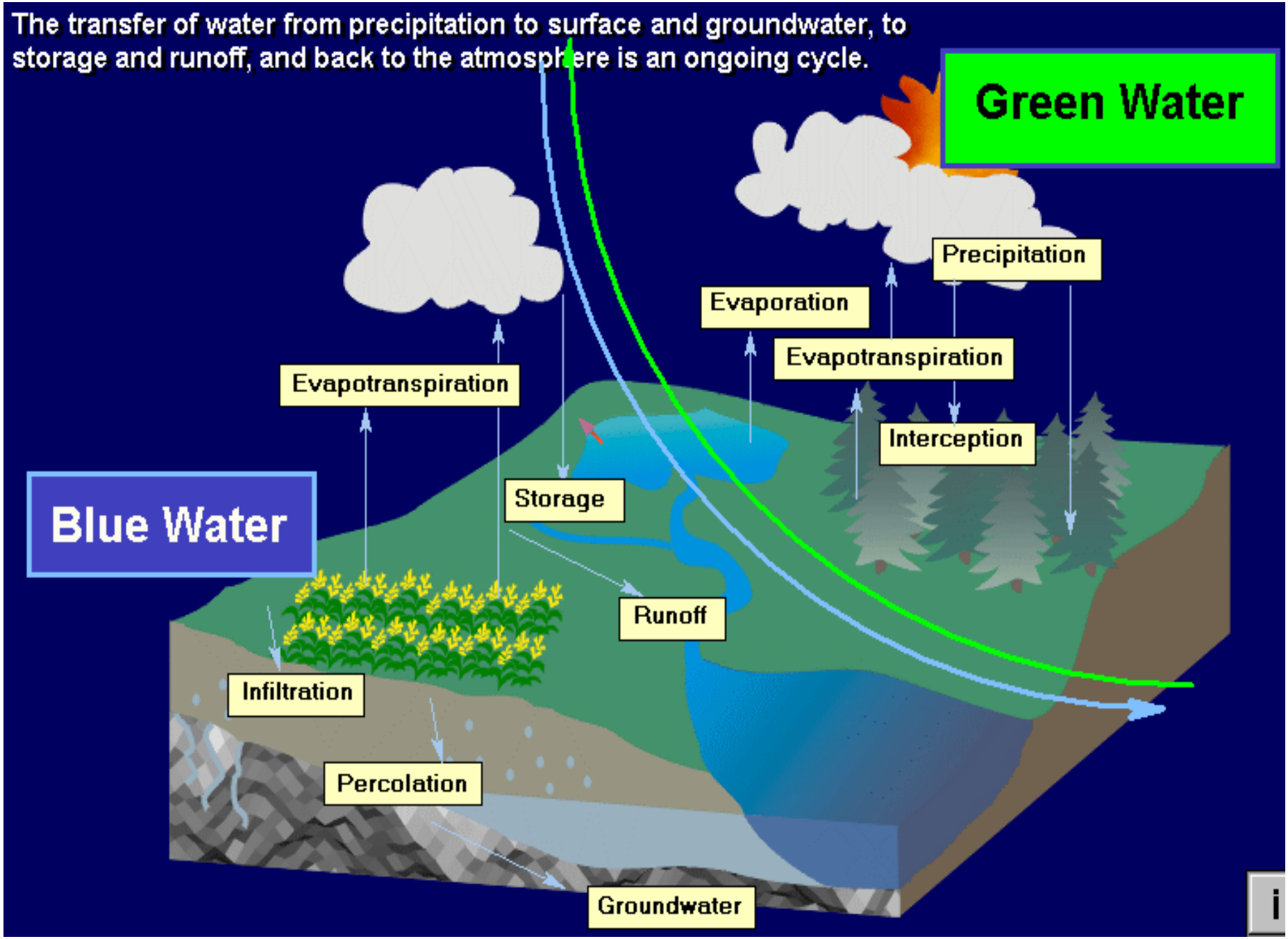
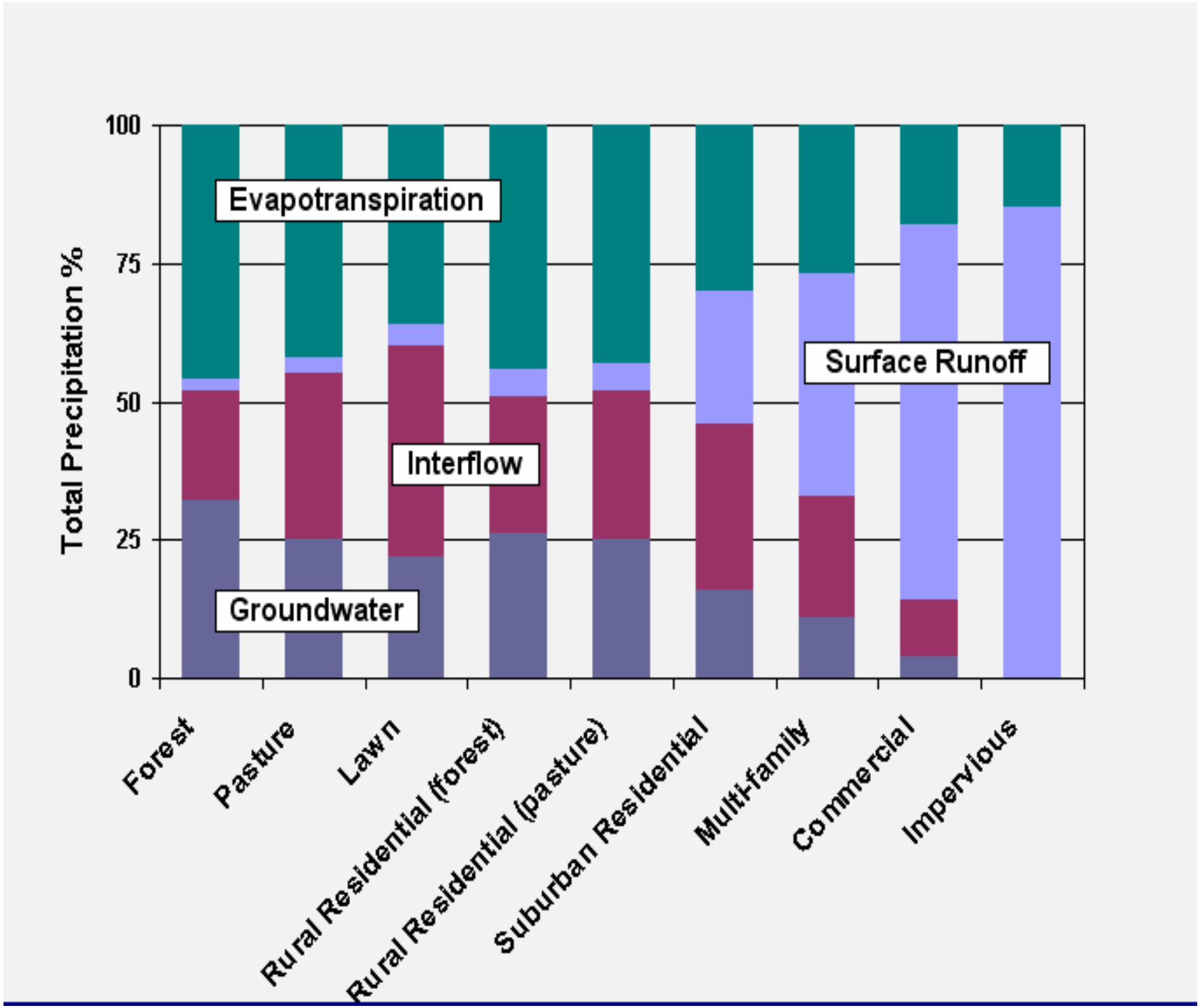
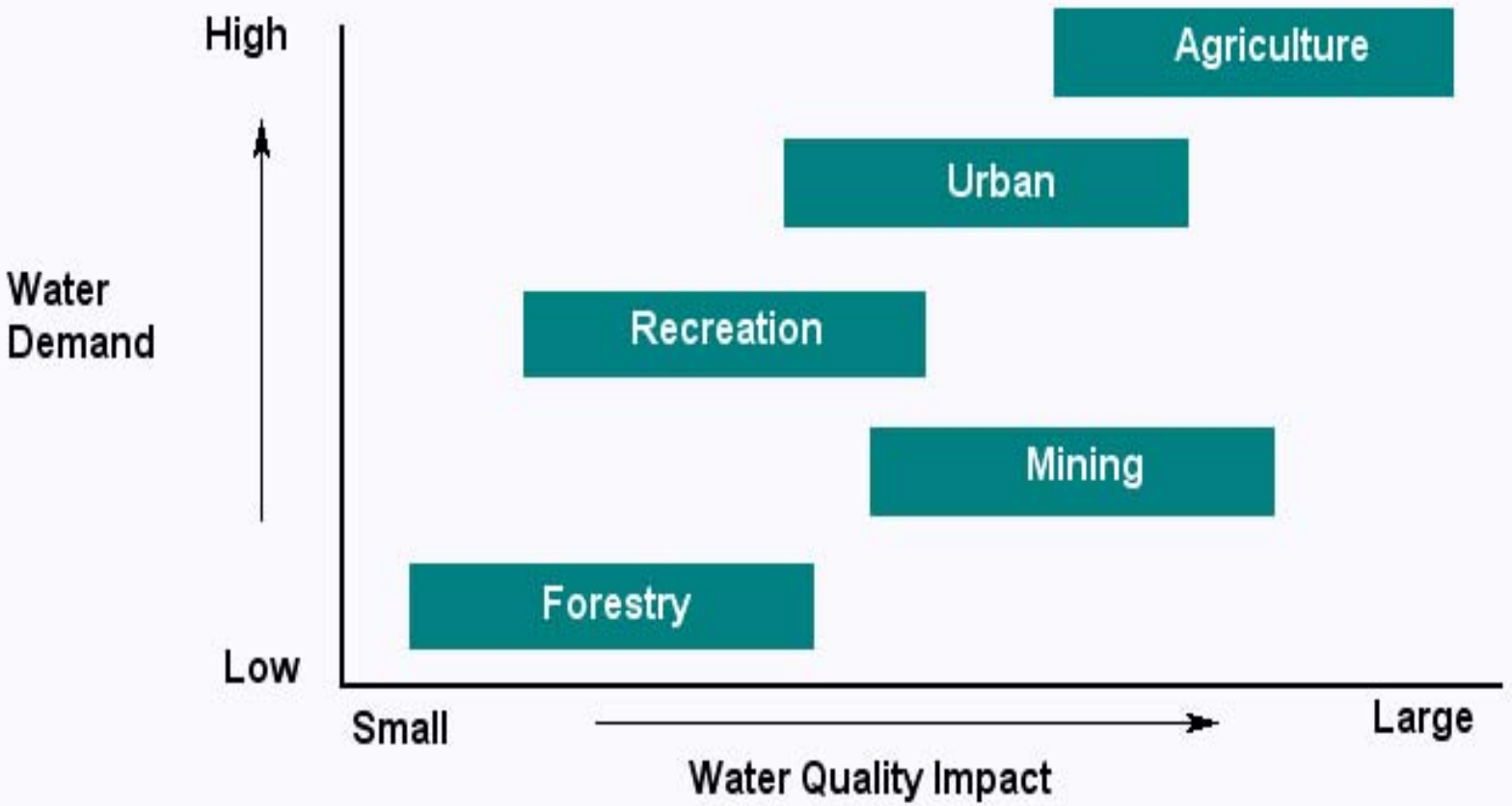
Blue Water
Green Water
Virtual Water

Water Footprint


The transfer of water from precipitation to surface and groundwater, to storage and runoff, and back to the atmosphere is an ongoing cycle.
Green Water
Blue Water
Precipitation
Evaporation
Evapotranspiration
Evapotranspiration
Interception
Storage
Runoff
Infiltration
Percolation
Groundwater


Total Precipitation %
100
75
50
25
0
Evapotranspiration
Surface Runoff
Interflow
Groundwater
Forest
Pasture
Lawn
Rural Residential (forest)
Rural Residential (pasture)
Suburban Residential
Multi-family
Commercial
Impervious


High
Agriculture
Urban
Water
Demand
Recreation
Mining
Forestry
Low
Small
Large
Water Quality Impact





Your Expectations
Plenty of Water
Good Quality and Safe
Available: Anytime Day and Night
Low Cost

# Water for Food: Are We Heading for a Crisis?

## Projections:

50% increase food production is needed over the next 30 years.

## Why?

2 Billion new pople
0.8 Billion have not enough
1 Billion is changing diets
10-20% of food biomass for ethanol & biodiesel

## Water Use by Agriculture:

Agriculture uses about 70% of all fresh water

40% of all food comes from irrigated land



**Can we increase the irrigated areas in agriculture ?**
**Can we produce more food from rainfed agricultural land ?**

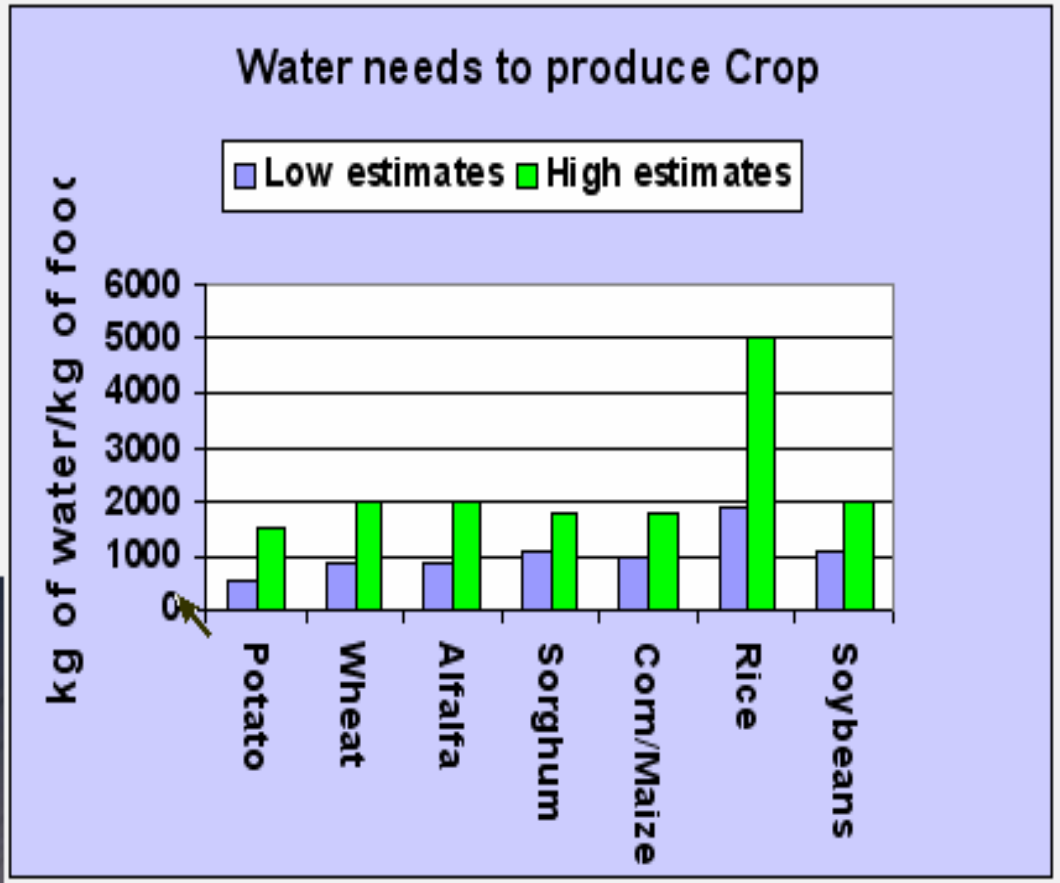
**When:**

1. **Demand for water for other uses is increasing**
2. **The agricultural land base is shrinking**
3. **Climatic variability is increasing**
4. **Soil and water degradation problems are increasing**
5. **Energy problems are accelerating**


Water Needs for Grain

Water Needs for Meat

Water Needs for Different Diets




As a general estimate we can state that we need about 1200 L of water to produce 1 kg of basic staple food.

Based on Seckler et al. 1998, Alcamo, 1997, and Gleick 1997

Water Needs for Grain

Water Needs for Meat

Water Needs for Different Diets

## Water Needs for Meat Production

Water requirements to produce 1 kg of meat

Chicken: 3500 - 5,700 kg of water / kg of meat
Beef: 15,000 -70,000 kg of water / kg of meat

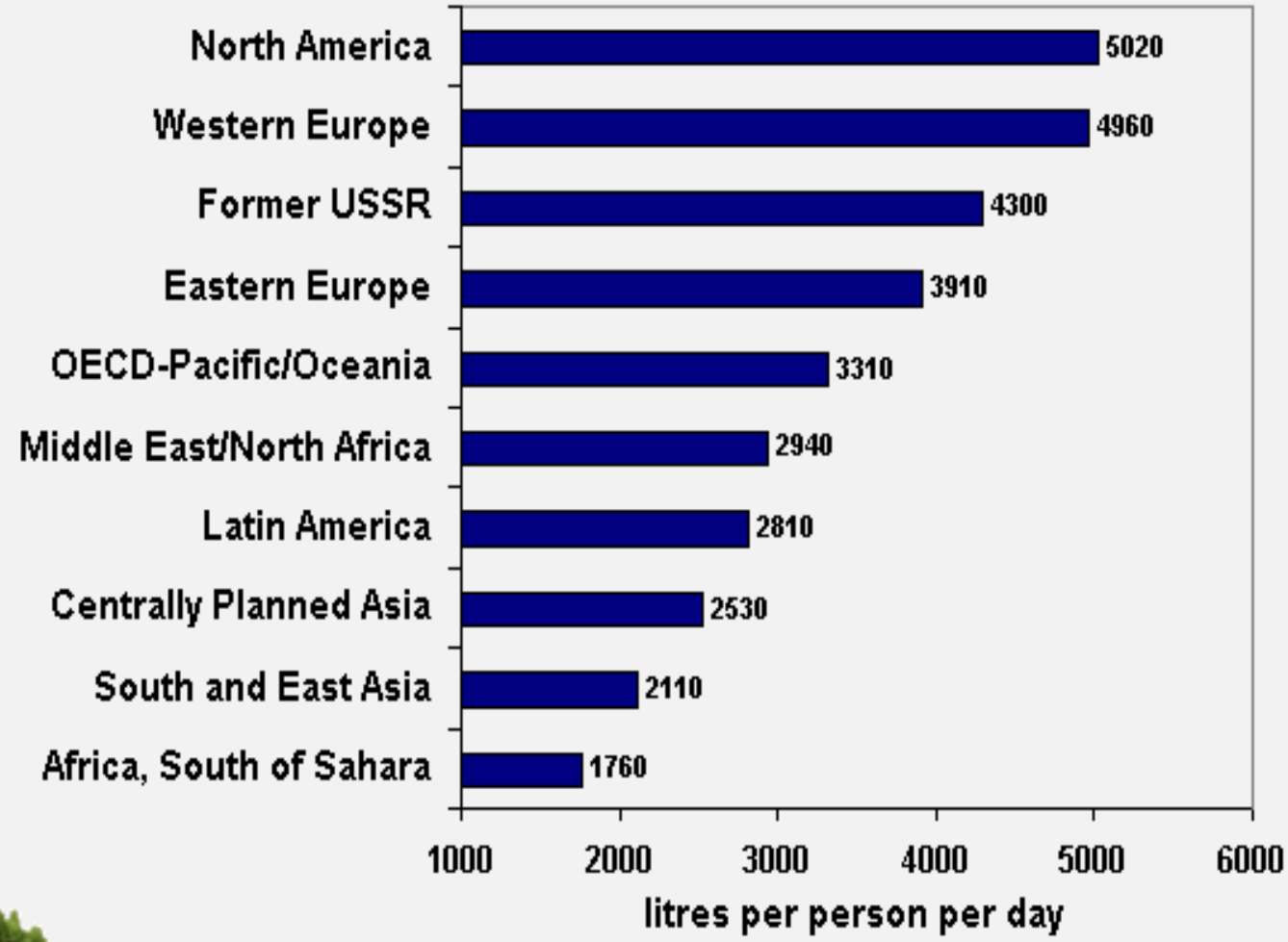
We need about:
3 x more water to produce 1 kg of chicken meat or
20-30 x more water to produce 1 kg of beef than to produce 1 kg of basic staple food (grain).

Water Needs for Grain

Water Needs for Meat

Water Needs for Different Diets

## Water Needs for Typical Diets




Please note: This does not include water needs for industrial use.

Definitions

Calculation

## Vitual Water

The virtual water content is the volume of water required to produce a product.

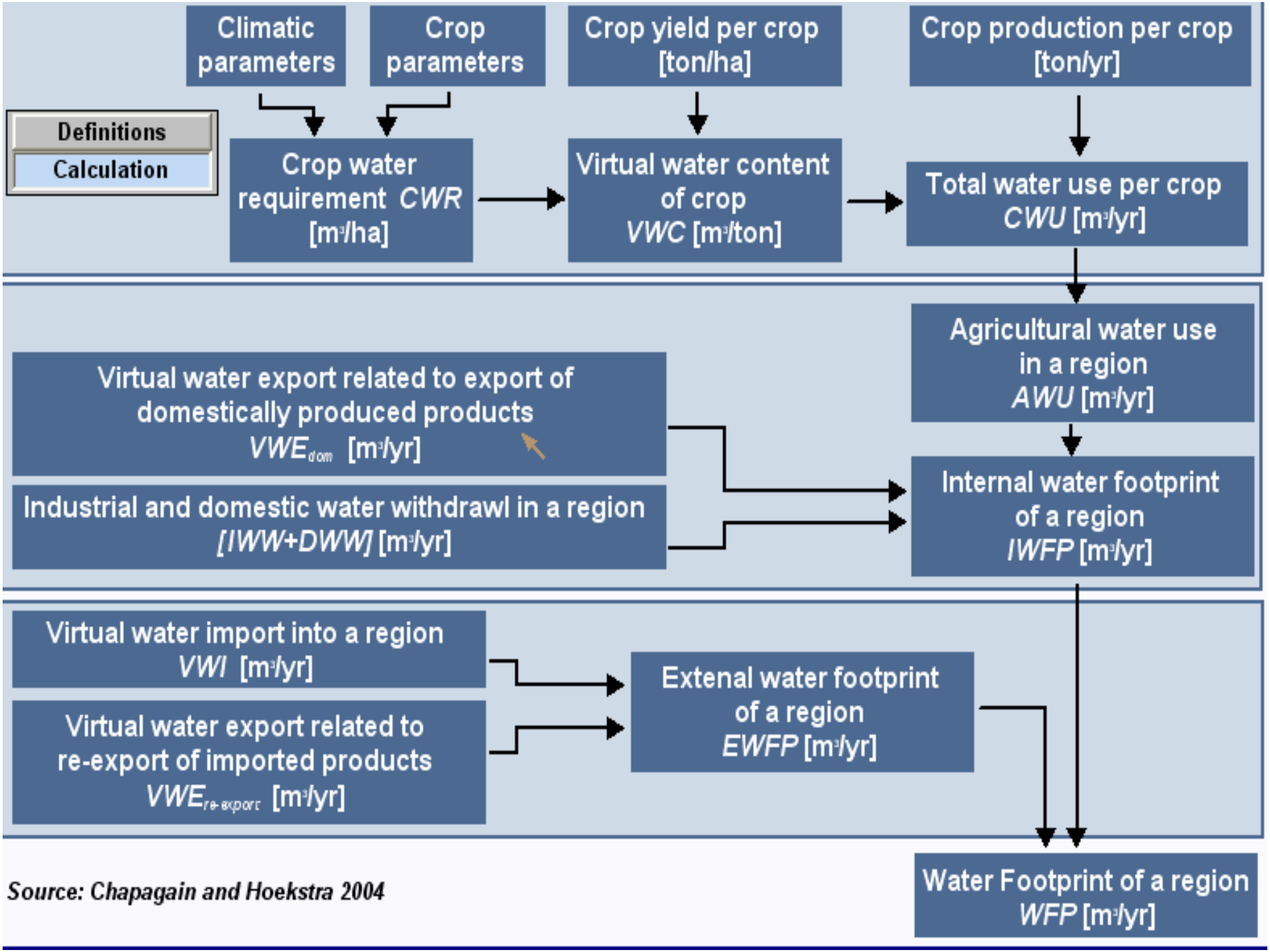
1350 L water

1 Kg wheat

## Water Footprint

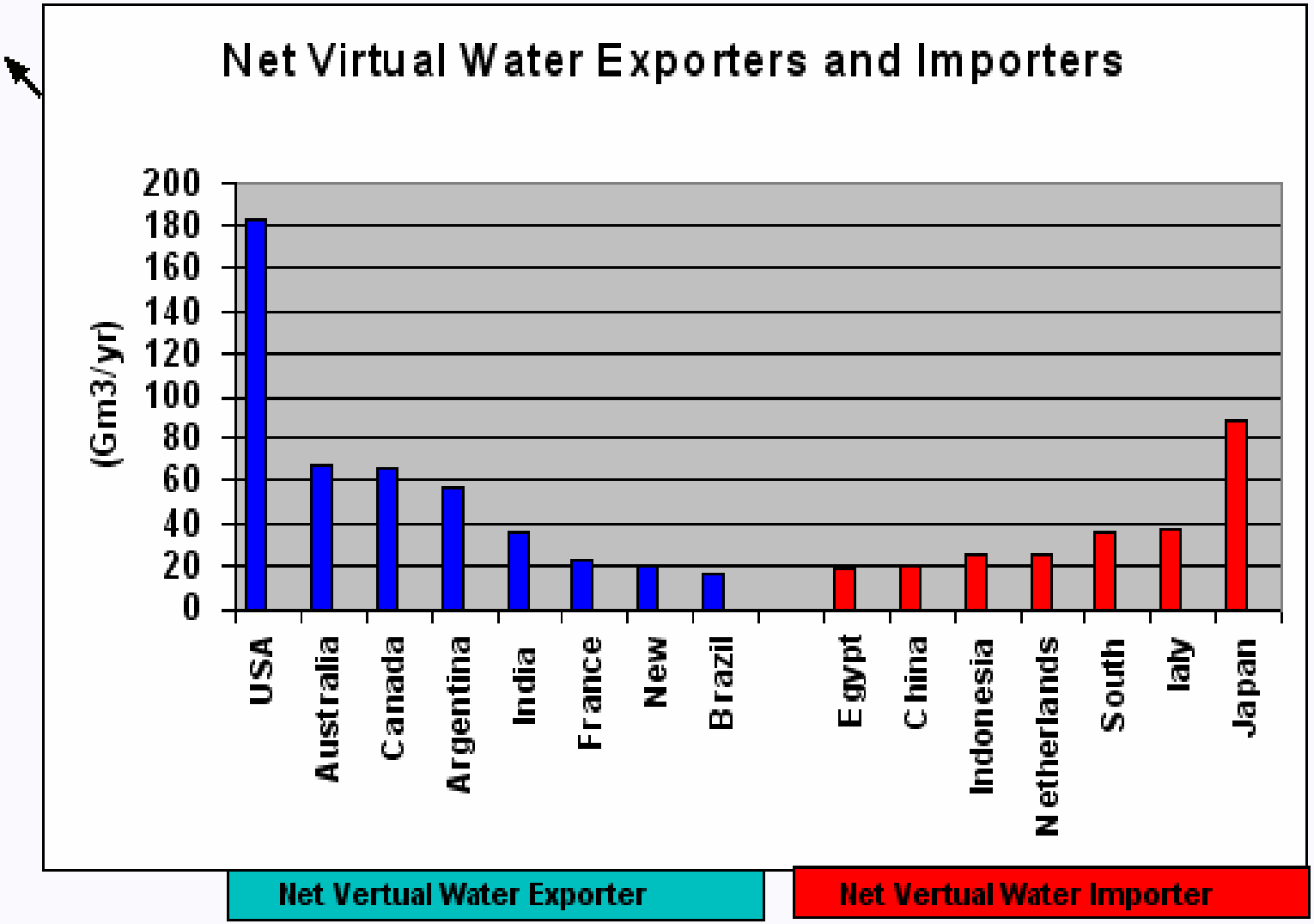
The water footprint of an individual, business or nation is defined as the total volume of fresh water that is required to produce the foods and services consumed by the individual, business or nation. A water footprint is generally expressed in terms of the volume of water use per year.

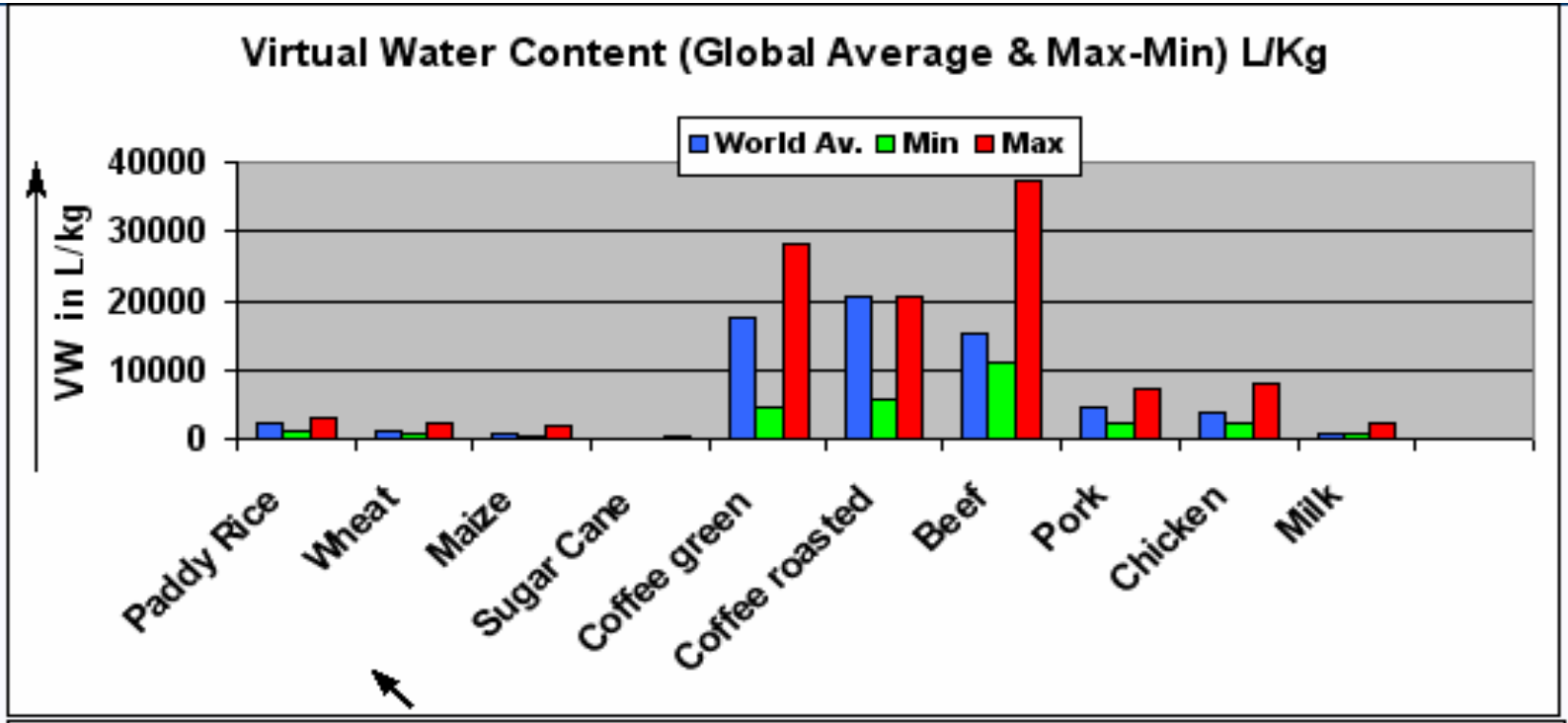
*from www.waterfootprint.org*

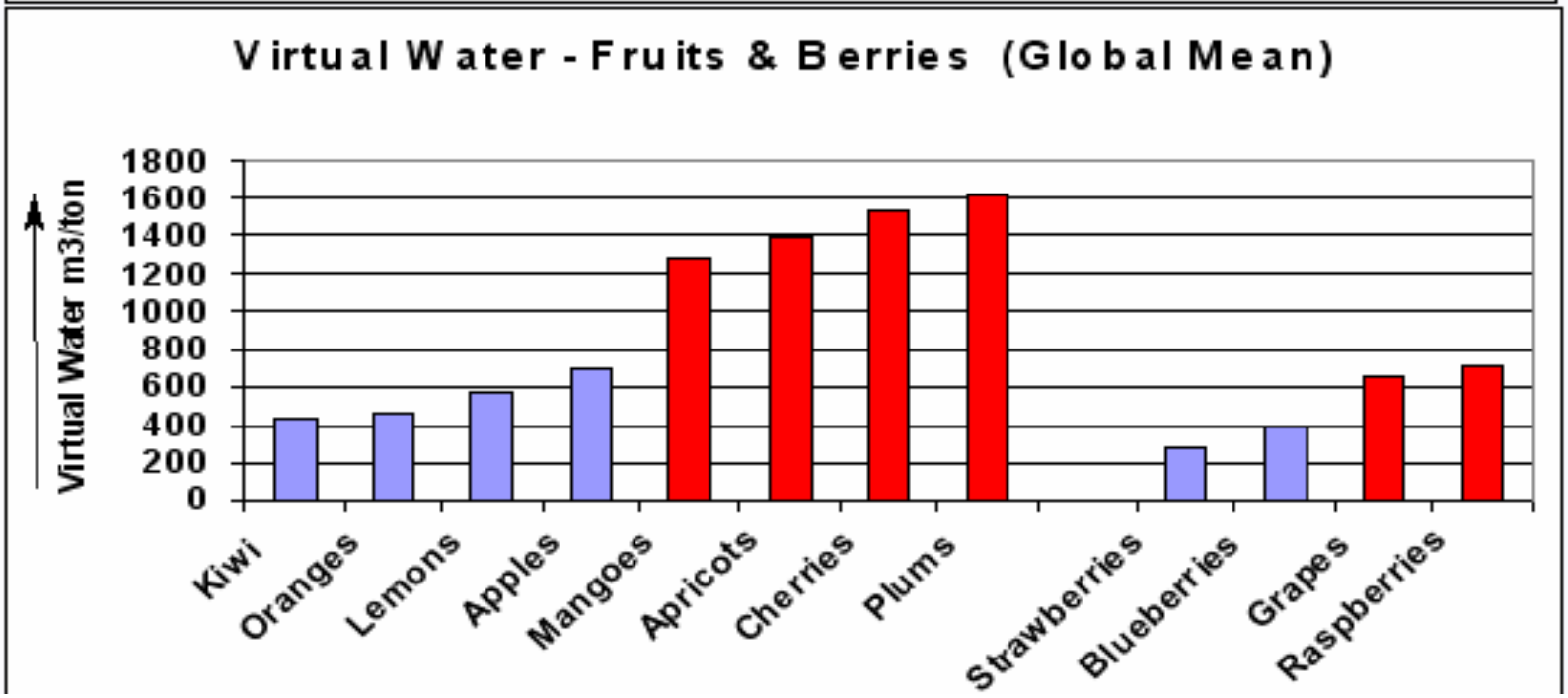


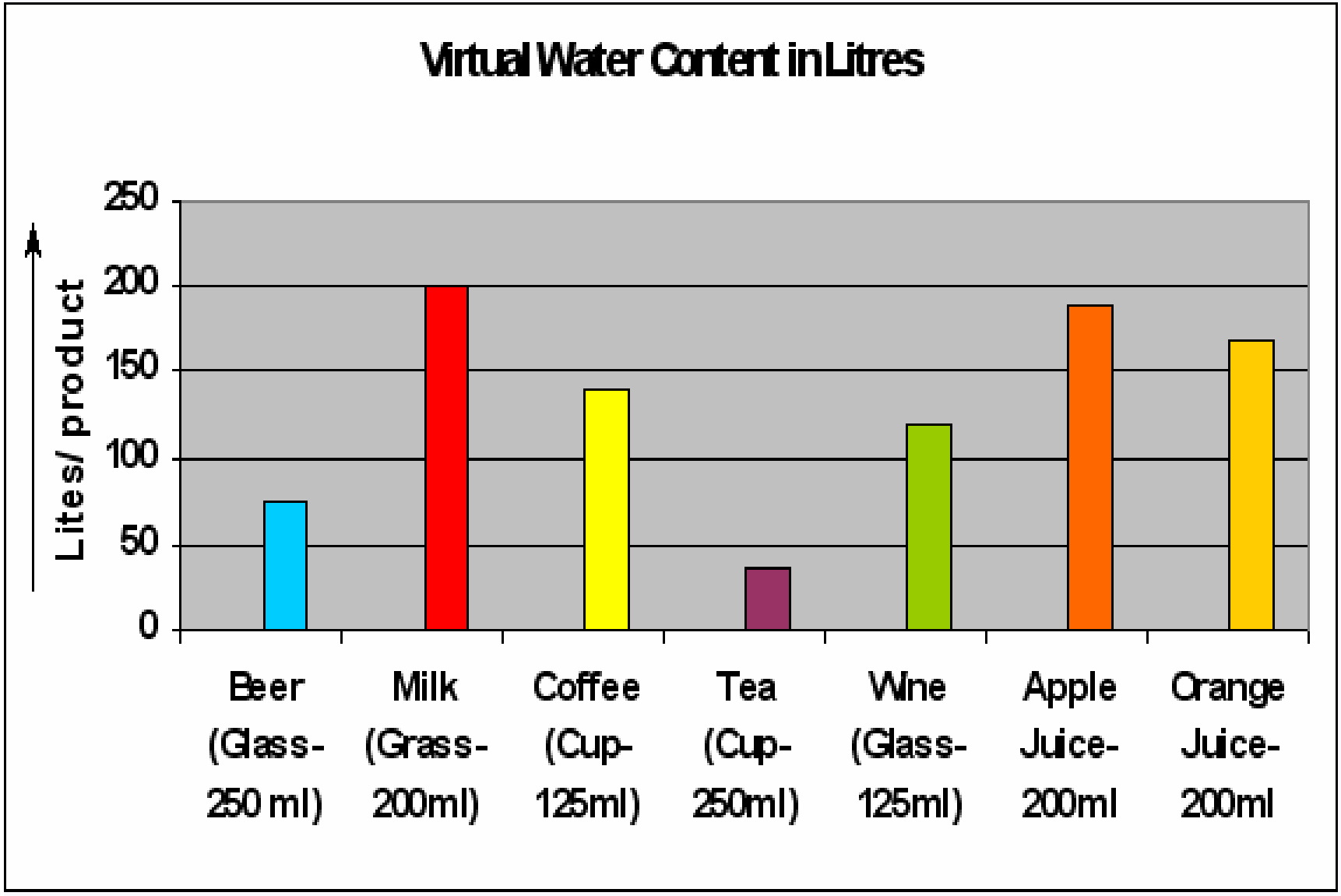

*Source: Chapagain and Hoekstra 2004*

# Countries with the greatest amount of virtual water export and imports (Based on data from Chapagain and Hoekstra 2004)

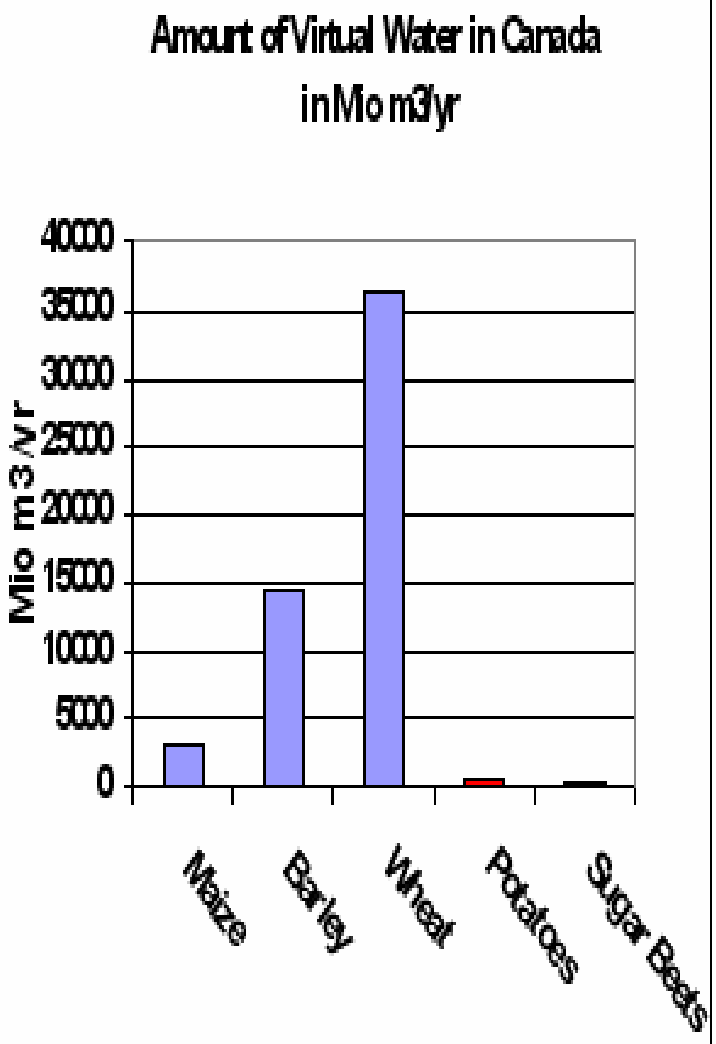


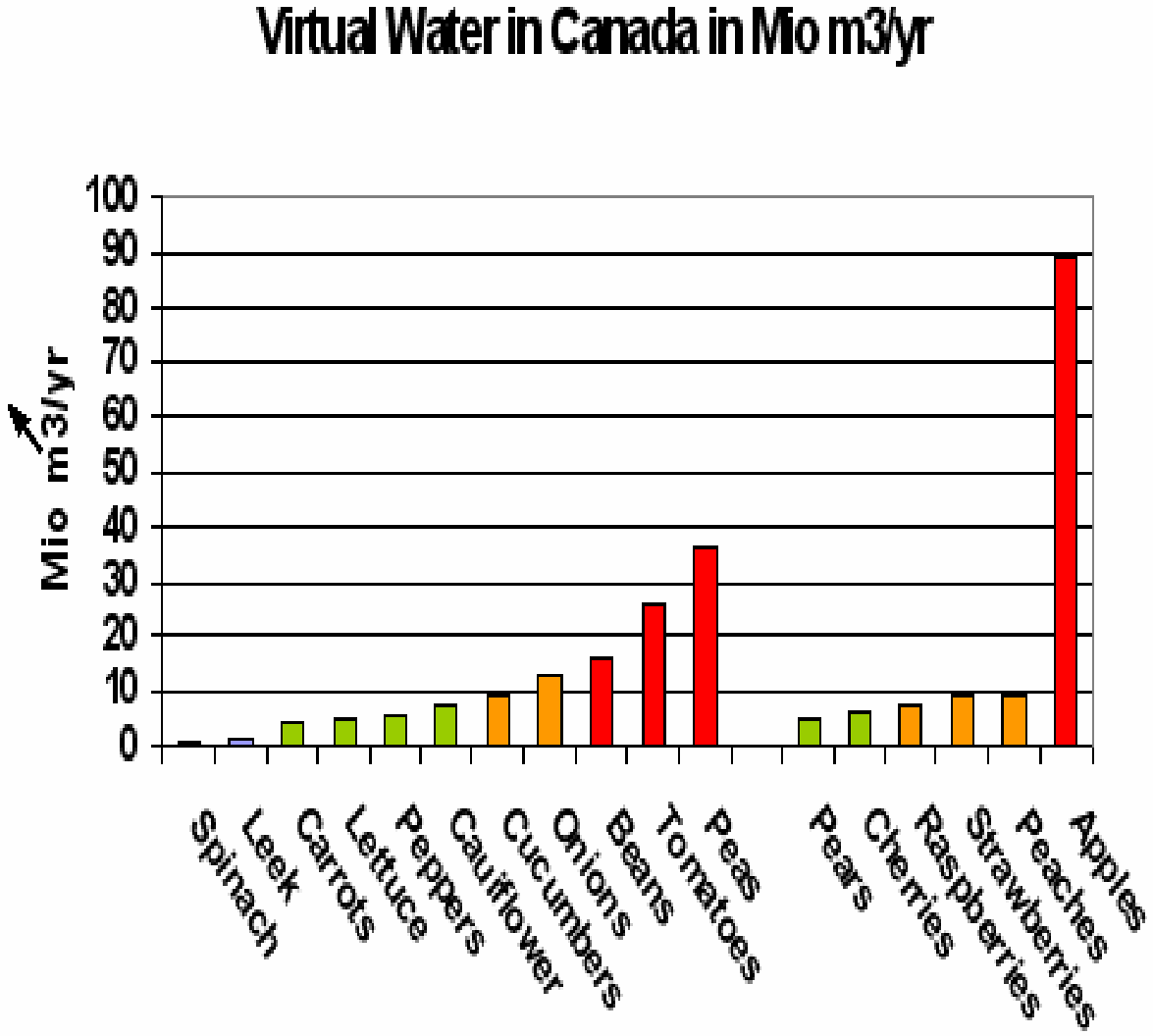

Virtual Water Content (Global Average & Max-Min) L/Kg
World Av.
Min
Max
VW in L/kg
40000
30000
20000
10000
0
Paddy Rice
Wheat
Maize
Sugar Cane
Coffee green
Coffee roasted
Beef
Pork
Chicken
Milk


Virtual Water - Fruits & Berries (Global Mean)
Virtual Water m3/ton
1800
1600
1400
1200
1000
800
600
400
200
0
Kiwi
Oranges
Lemons
Apples
Mangoes
Apricots
Cherries
Plums
Strawberries
Blueberries
Grapes
Raspberries


Virtual Water Content in Litres
Lites/ product
250
200
150
100
50
0
Beer (Glass- 250 ml)
Milk (Grass- 200ml)
Coffee (Cup- 125ml)
Tea (Cup- 250ml)
Wine (Glass- 125ml)
Apple Juice- 200ml
Orange Juice- 200ml

# Virtual Water: Vegetables vs. Fruit

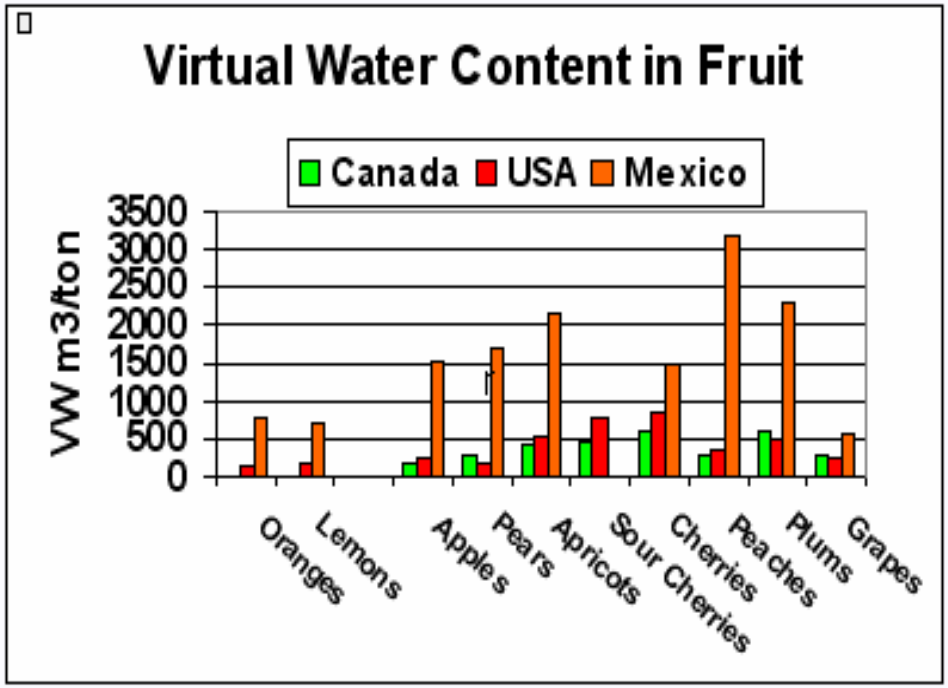


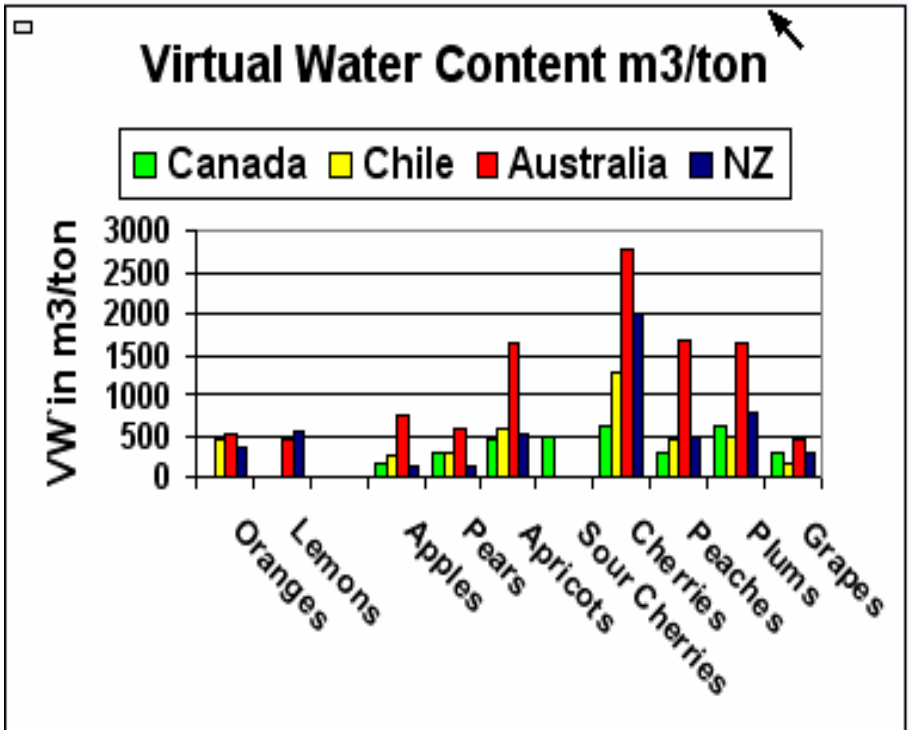



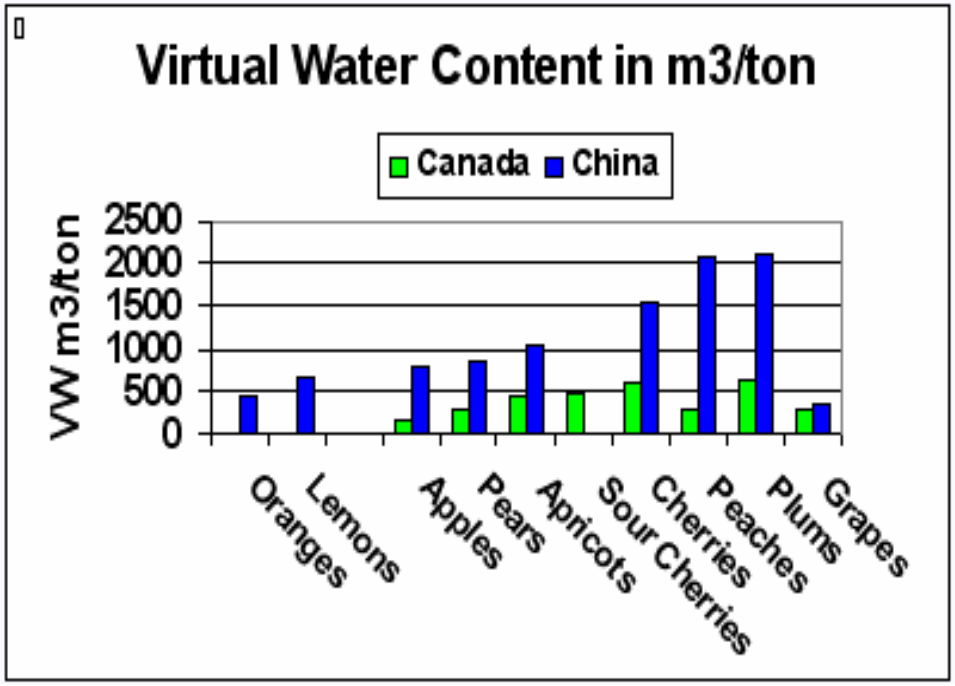
Canada/Mexico/USA

Canada/China

Canada/Chile/Australia

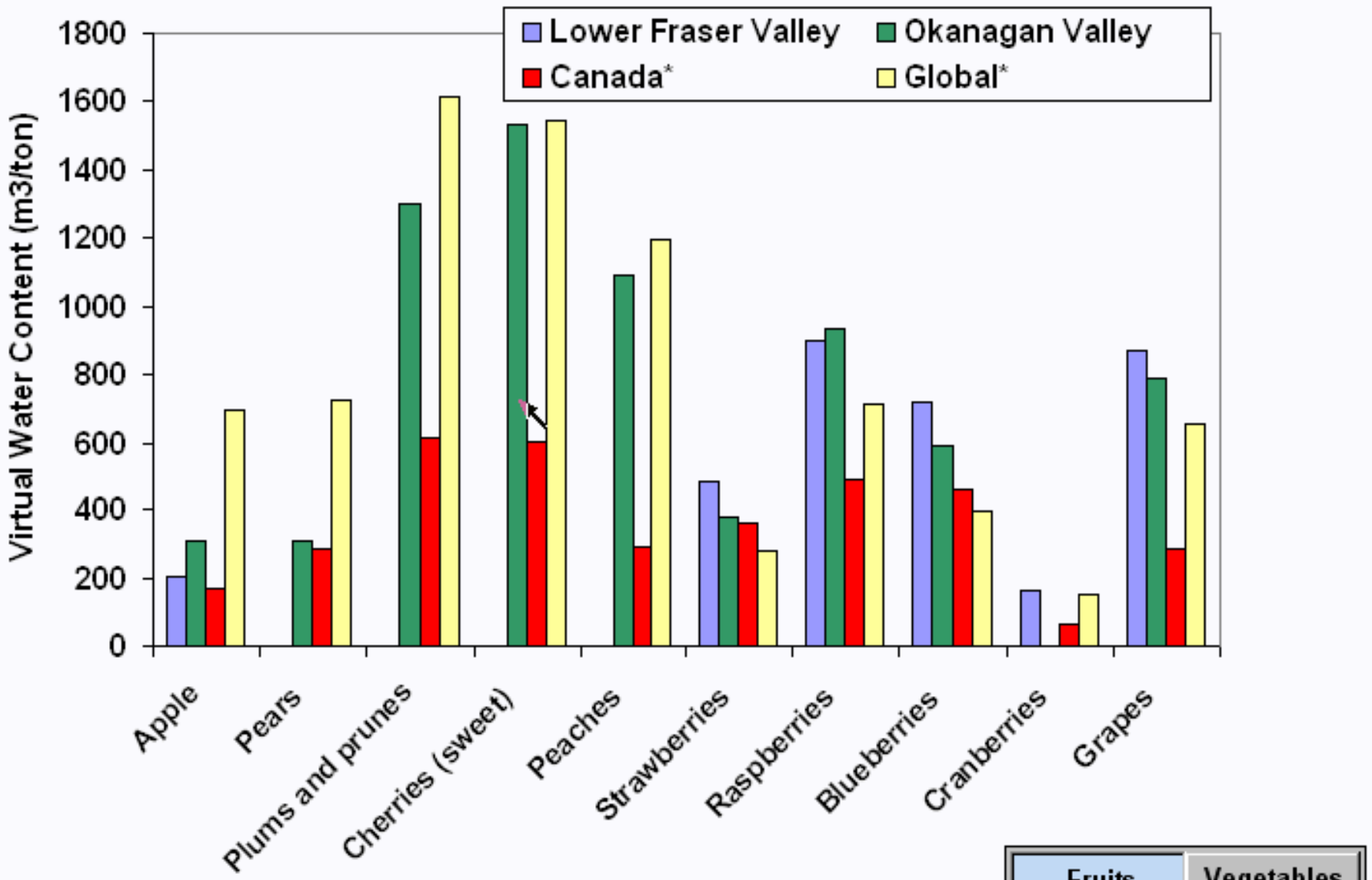


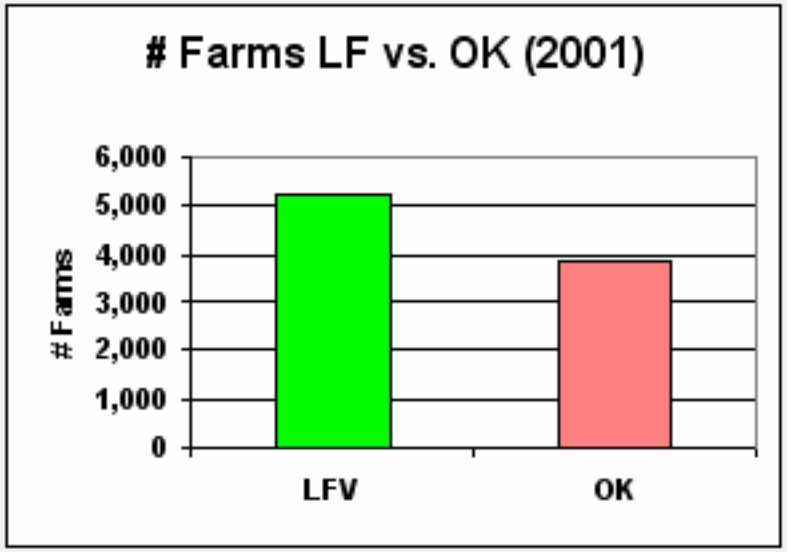
## Virtual Water Content Comparison

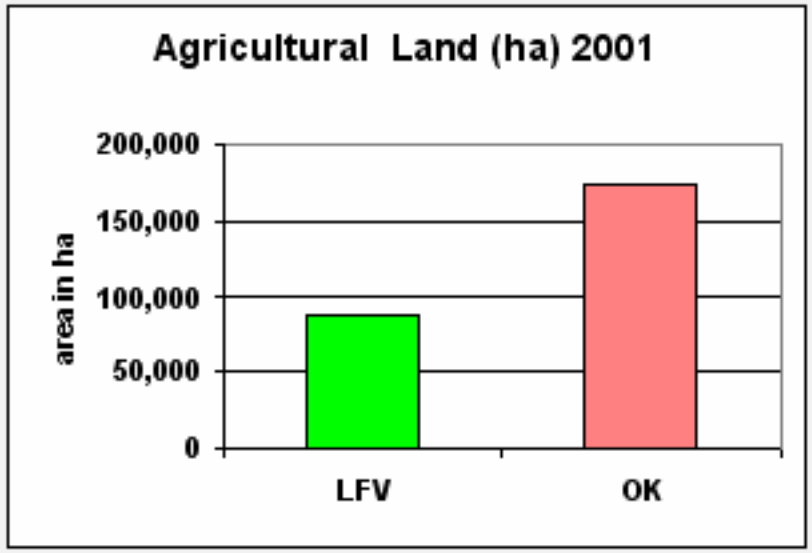
**Comparison between virtual water calculations based on global and national data and those derived from local data.**

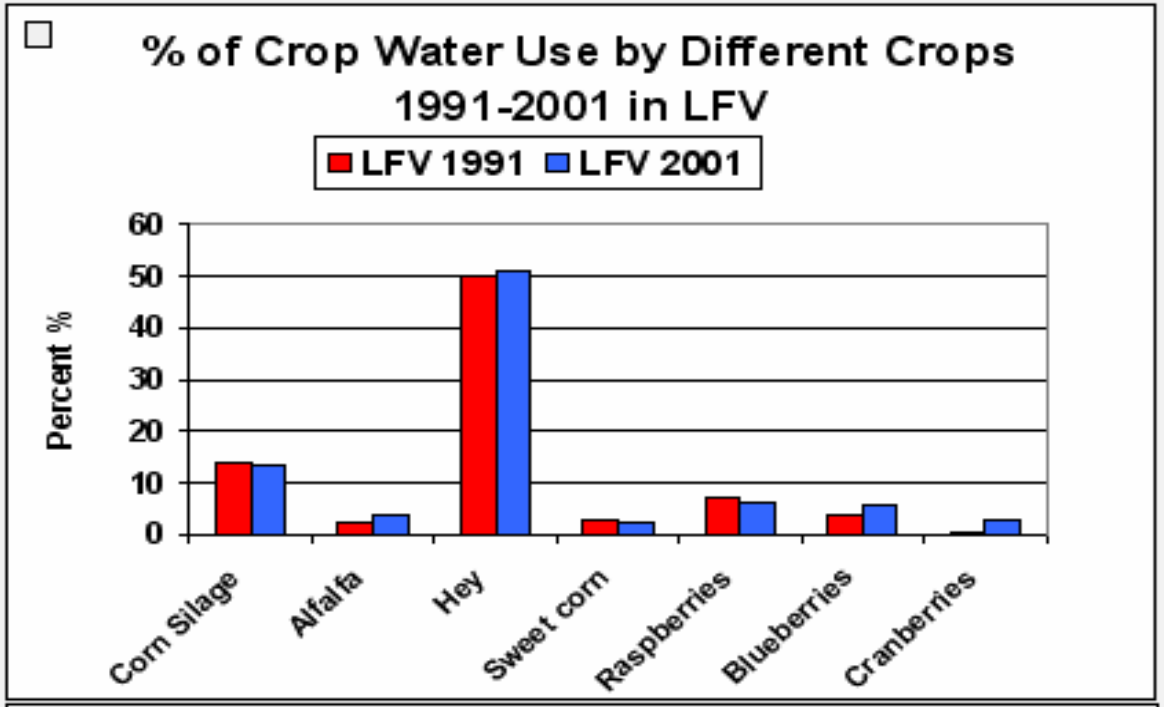


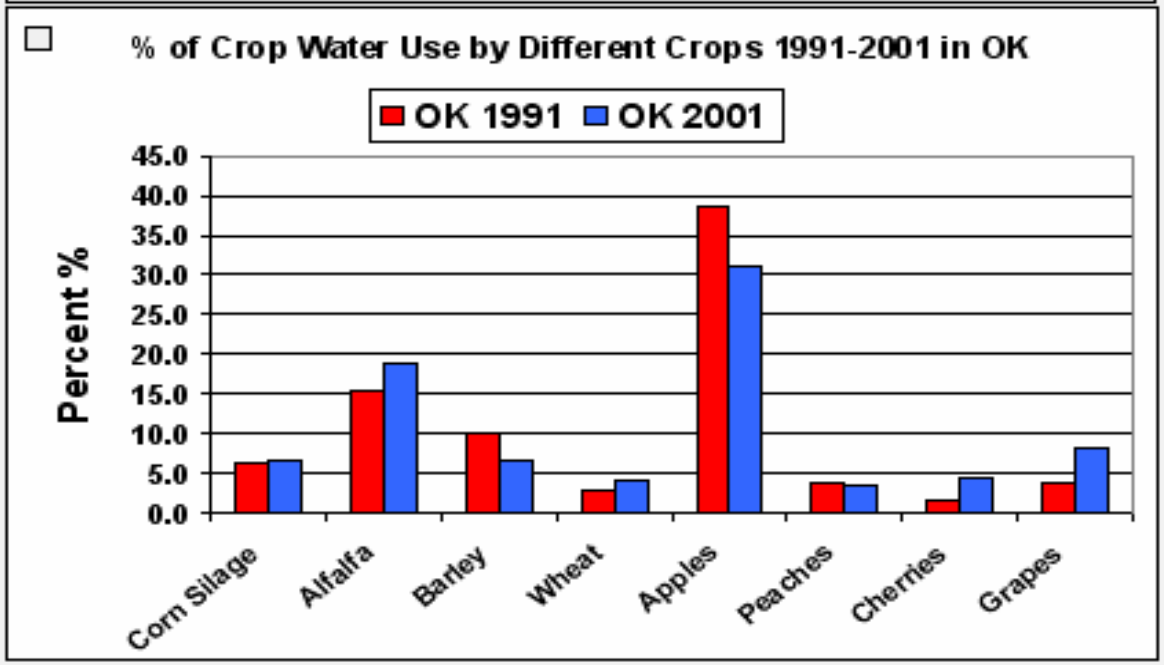

** from Chapagain and Hoekstra 2004*

| Summary of VWC for Livestock | LFV 1991 | LFV 2001 | | OK 1991 | OK 2001 |
|---|---|---|---|---|---|
| Number of farms | 5,542 | 5,262 | | 3,863 | 3,888 |
| Ha of agricultural land | 85,825 | 87,389 | | 158,518 | 173,541 |
| | | | | | |
| No. of cattle | 131,472 | 118,769 | | 67,356 | 75,924 |
| No. of dairy cows | 48,610 | 52,461 | | 4,062 | 5,100 |
| No of beef cows | 8,800 | 6,289 | | 22,510 | 24,124 |
| No of pigs | 154,726 | 131,181 | | 22,776 | 4,745 |
| No of sheep | 14,233 | 11,254 | | 3,616 | 11,624 |
| No of chickens | 8,963,978 | 16,082,175 | | 747,443 | 1,205,817 |
| o of chickens (incl turkey | 9,682,764 | 16,519,439 | | 748,320 | 1,206,955 |




% of Crop Water Use by Different Crops
1991-2001 in LFV
LFV 1991
LFV 2001
Percent %
60
50
40
30
20
10
0
Corn Silage
Alfalfa
Hey
Sweet corn
Raspberries
Blueberries
Cranberries

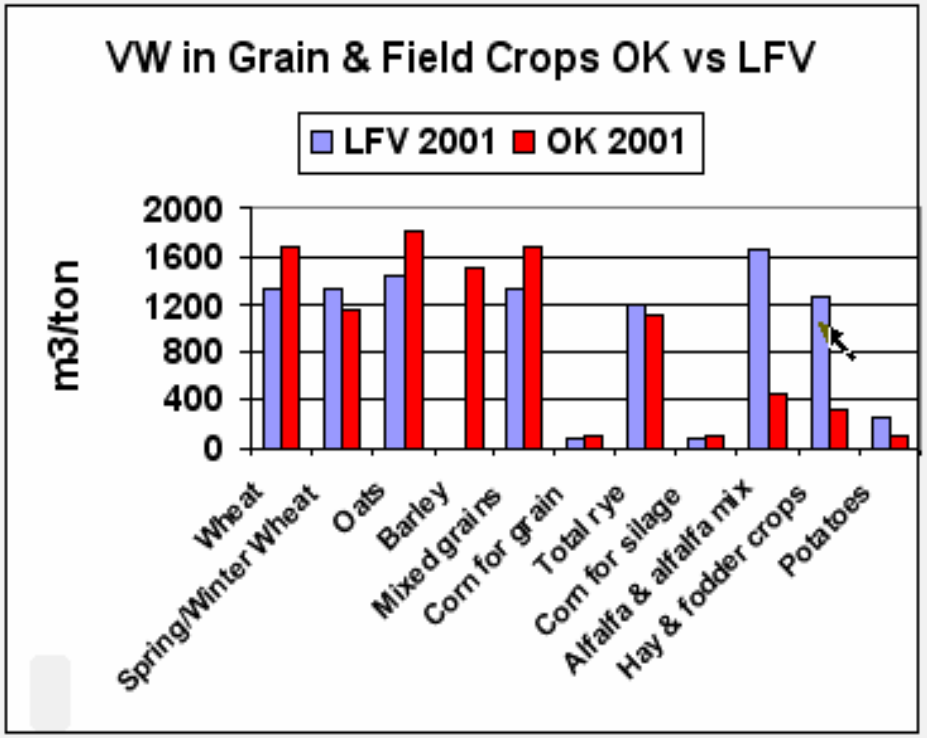

% of Crop Water Use by Different Crops 1991-2001 in OK
OK 1991
OK 2001
Percent %
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Corn Silage
Alfalfa
Barley
Wheat
Apples
Peaches
Cherries
Grapes

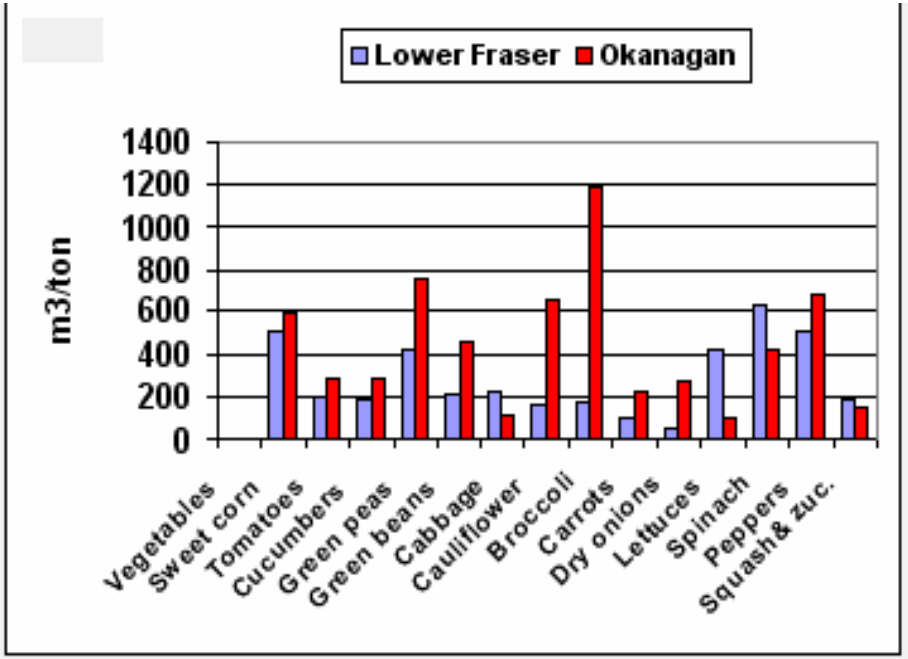
Field Crops

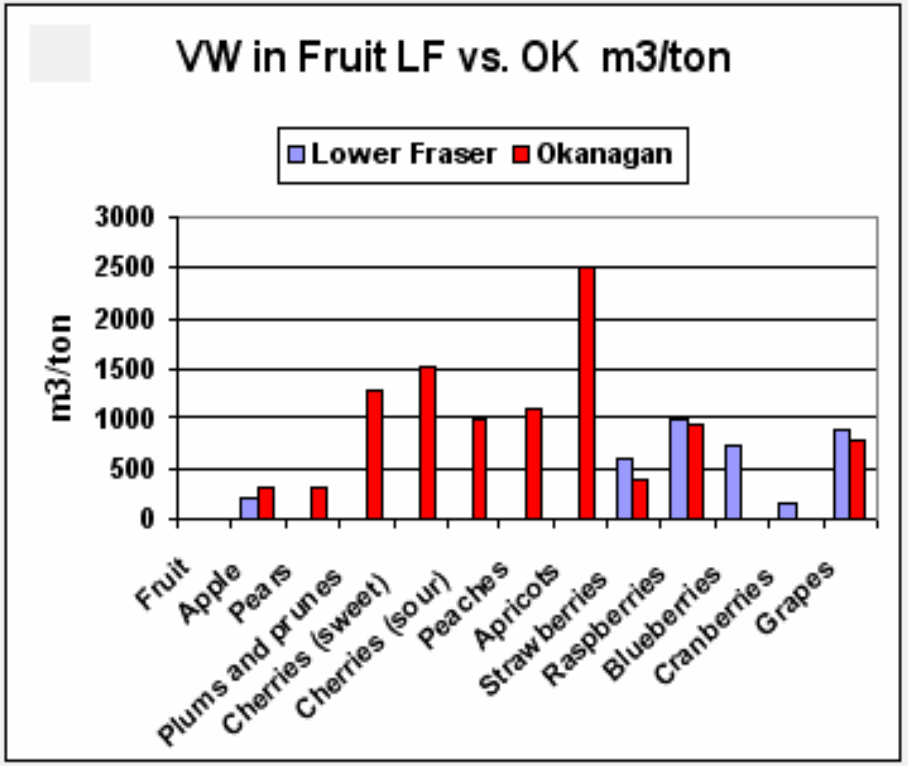
Vegetables

Fruit

# Virtual Water in m3/ton
# Lower Fraser vs. Okanagan



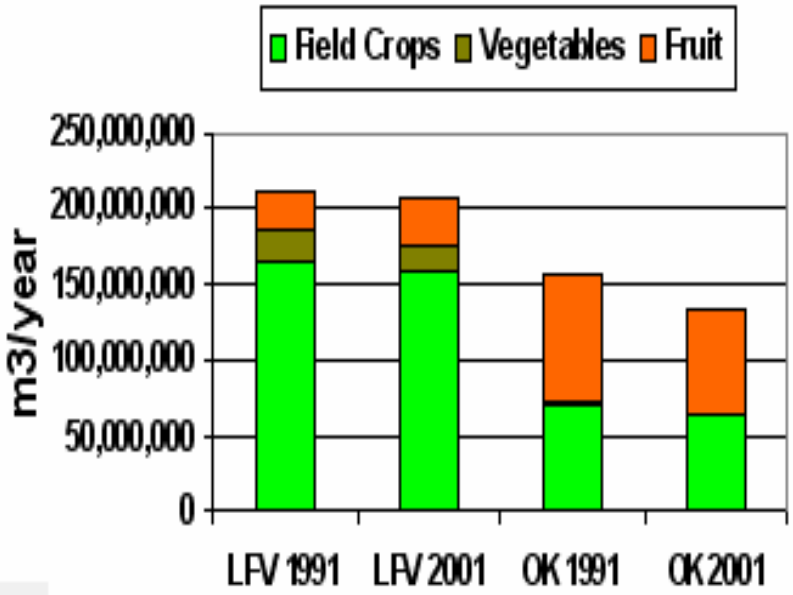
Field Crops

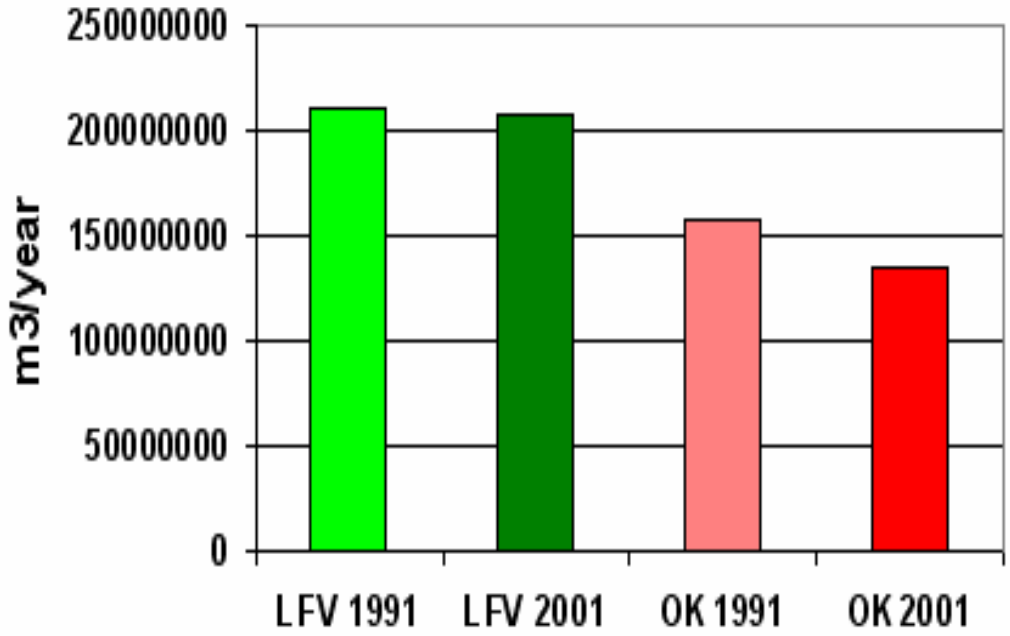
Total

Livestock

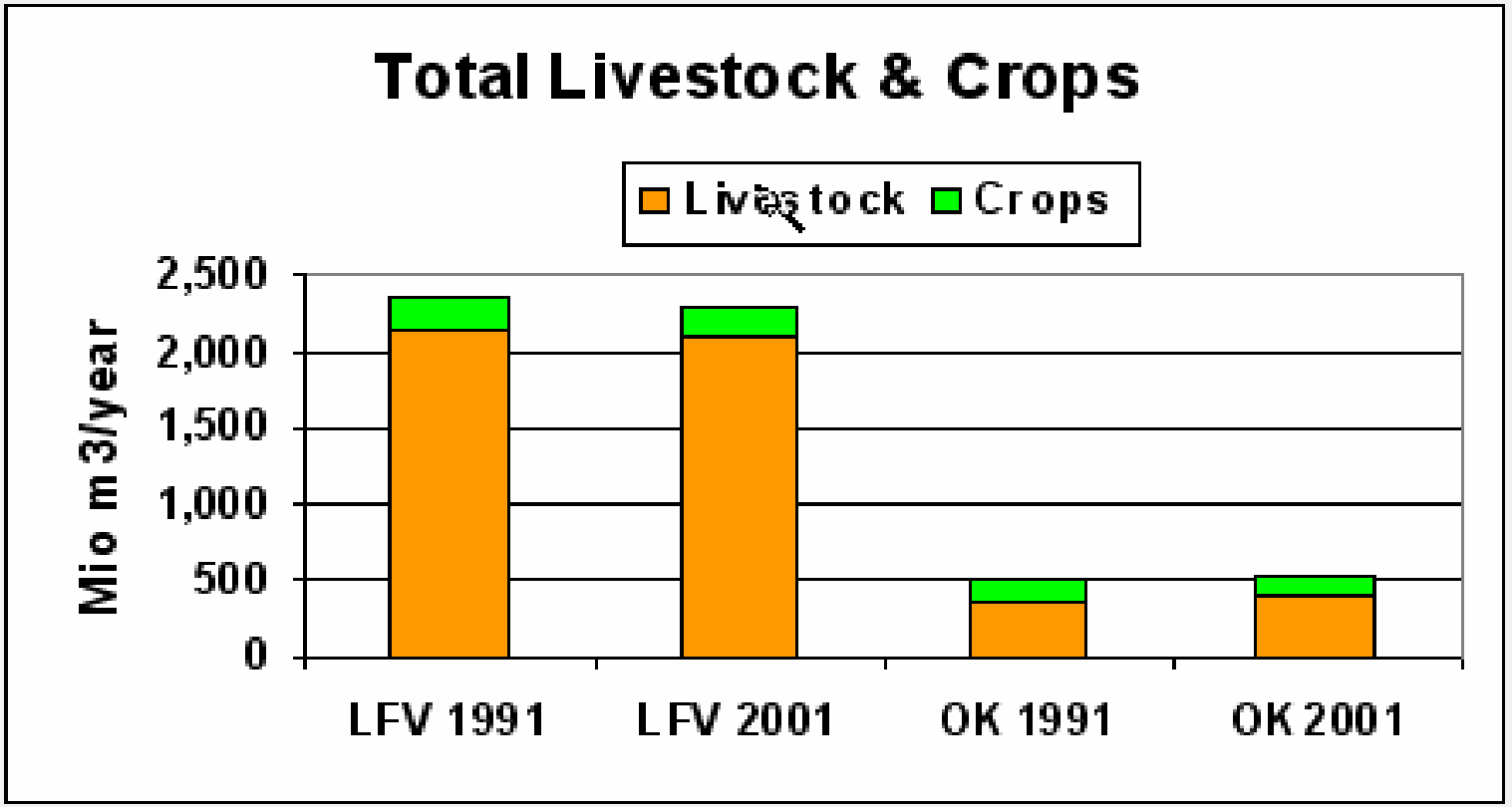
## Total Virtual Water m3/year LF vs. OK 1991-2001

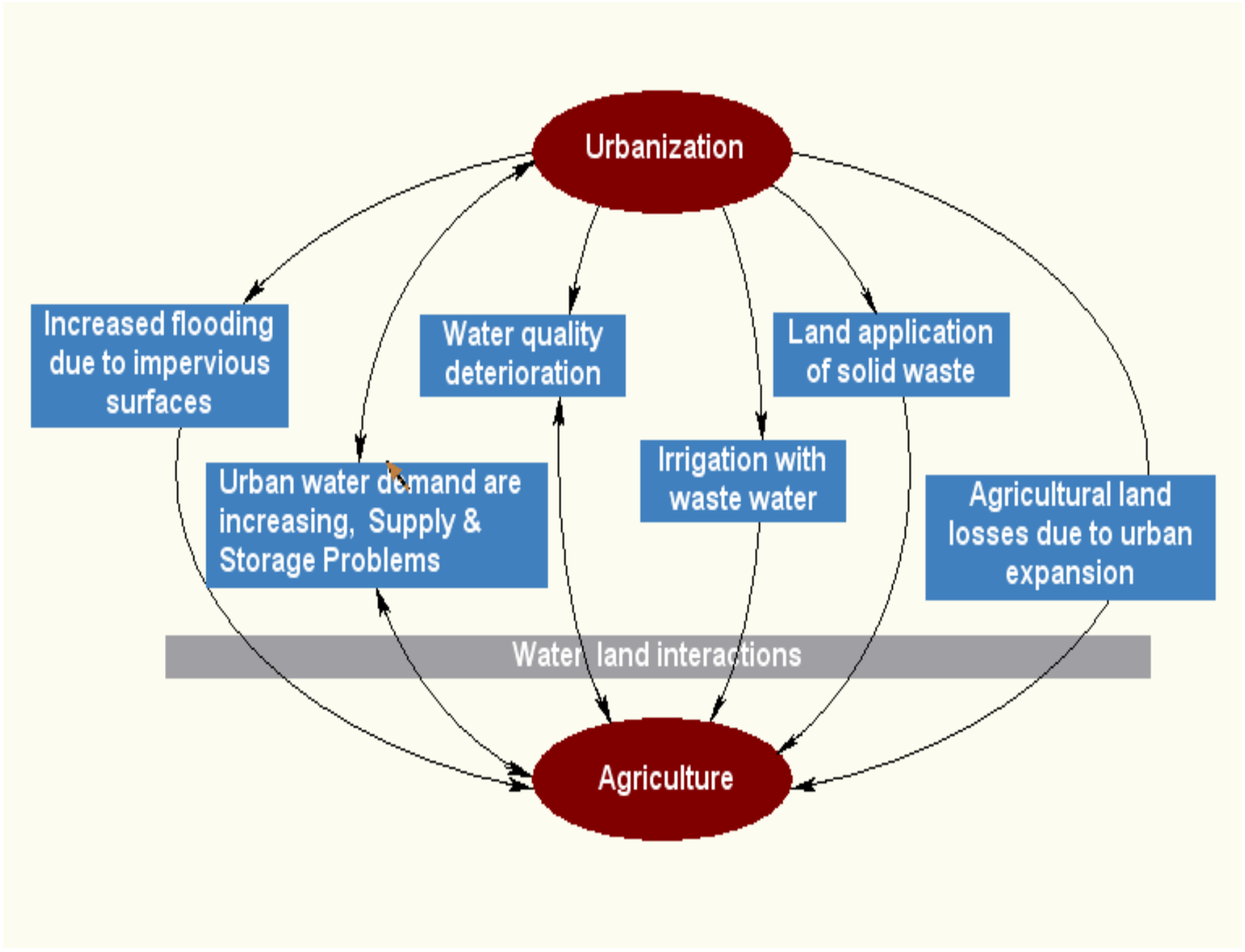
| | LFV 1991 | LFV 2001 | OK 1991 | OK 2001 |
|---|---|---|---|---|
| Field Crops | 164,963,330 | 159,479,059 | 69,594,308 | 63,181,241 |
| Vegetables | 19,392,666 | 15,656,188 | 3,217,771 | 2,432,820 |
| Fruit | 27,090,883 | 32,091,391 | 85,344,894 | 69,318,124 |
| Total | 211,446,876 | 207,226,633 | 158,156,973 | 134,932,184 |

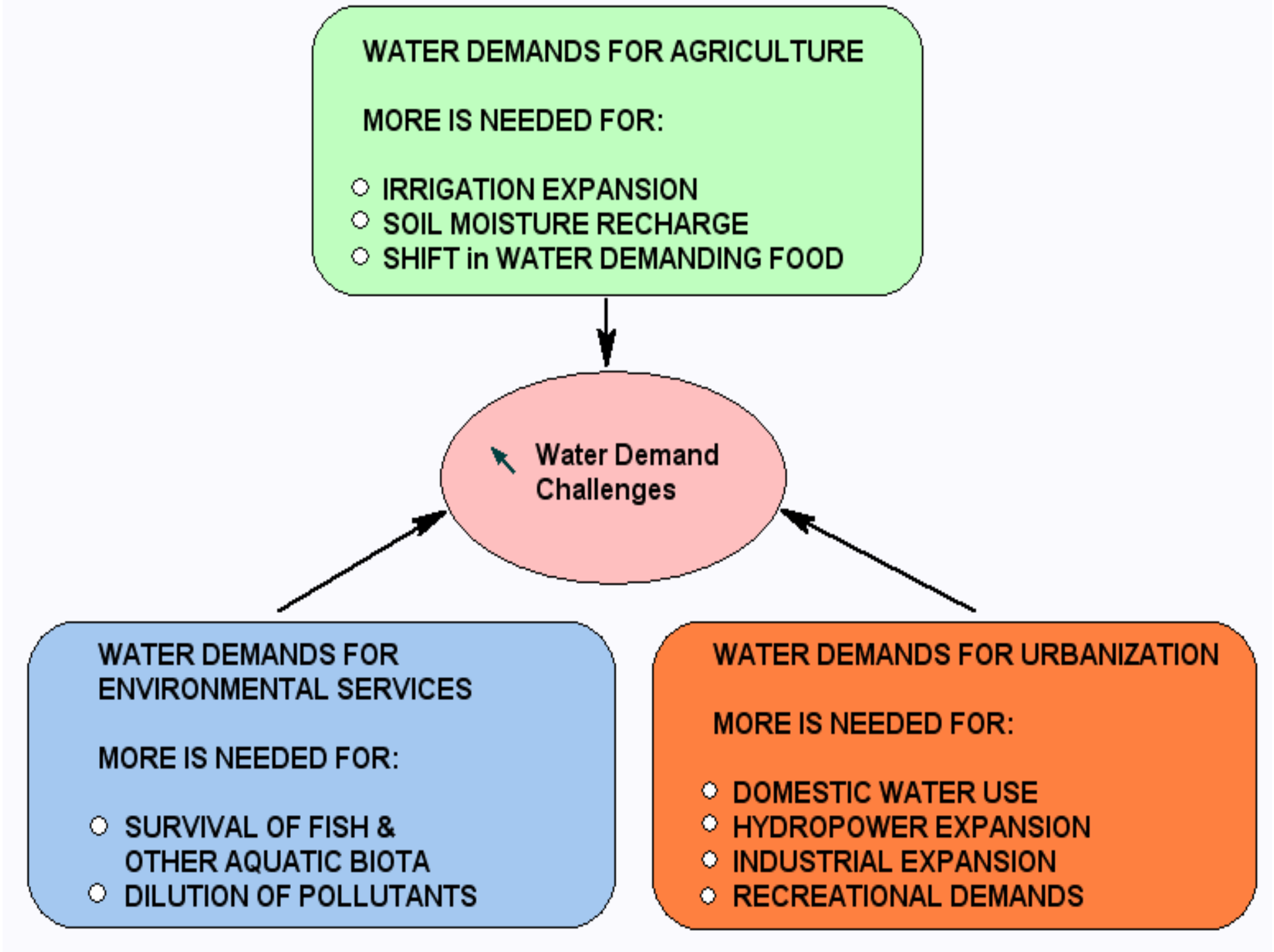


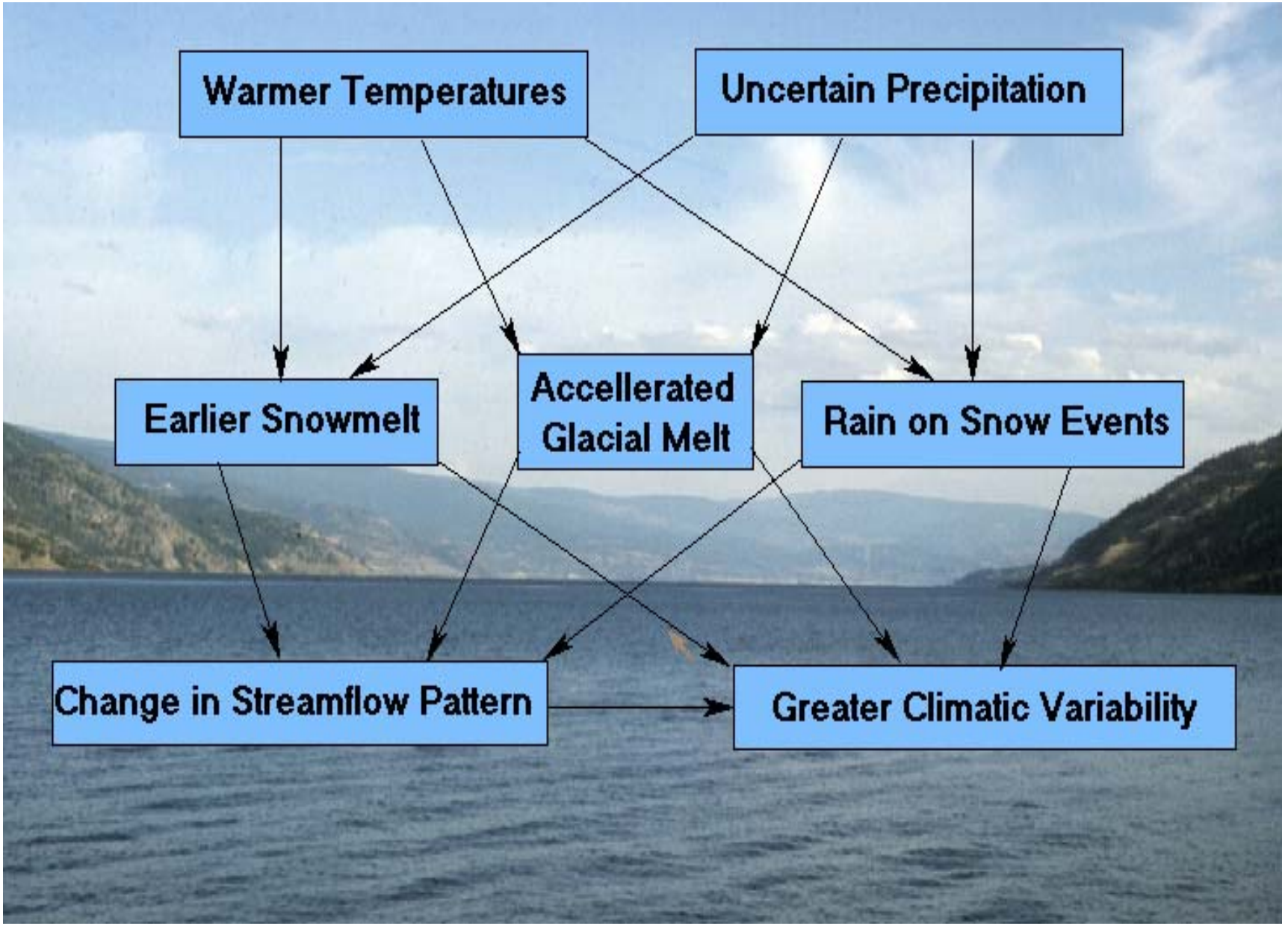
| | LFV 1991 | LFV 2001 | OK 1991 | OK 2001 |
|---|---|---|---|---|
| Livestock | 2,144 | 2,081 | 357 | 399 |
| Crops | 211 | 207 | 158 | 135 |
| | | | | |
| Total | 2355 | 2288 | 515 | 534 |



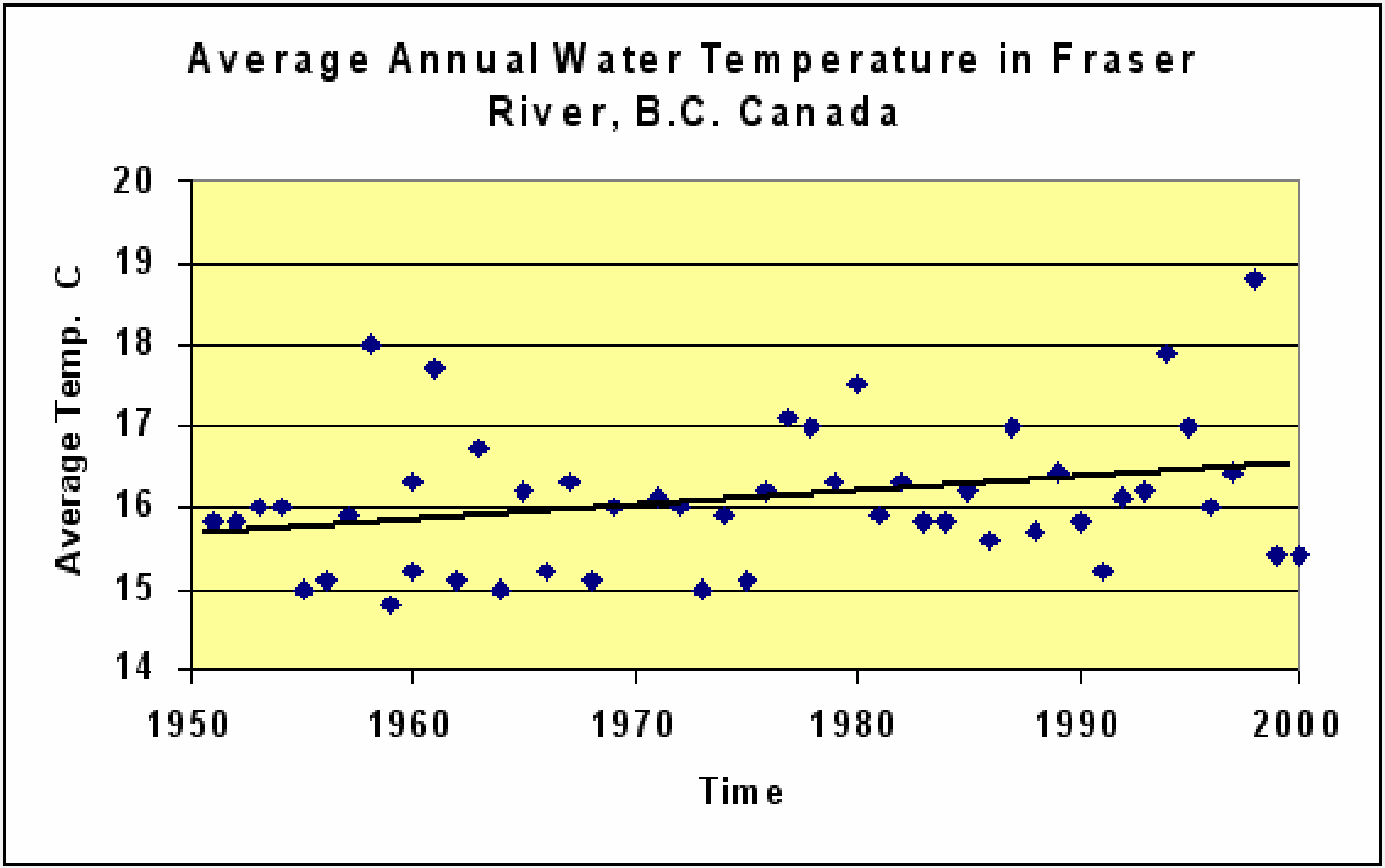

Urbanization
Increased flooding due to impervious surfaces
Water quality deterioration
Land application of solid waste
Urban water demand are increasing, Supply & Storage Problems
Irrigation with waste water
Agricultural land losses due to urban expansion
Water land interactions
Agriculture


WATER DEMANDS FOR AGRICULTURE
MORE IS NEEDED FOR:
IRRIGATION EXPANSION
SOIL MOISTURE RECHARGE
SHIFT in WATER DEMANDING FOOD
Water Demand Challenges
WATER DEMANDS FOR ENVIRONMENTAL SERVICES
MORE IS NEEDED FOR:
SURVIVAL OF FISH & OTHER AQUATIC BIOTA
DILUTION OF POLLUTANTS
WATER DEMANDS FOR URBANIZATION
MORE IS NEEDED FOR:
DOMESTIC WATER USE
HYDROPOWER EXPANSION
INDUSTRIAL EXPANSION
RECREATIONAL DEMANDS

# Water Issues & Climate Change

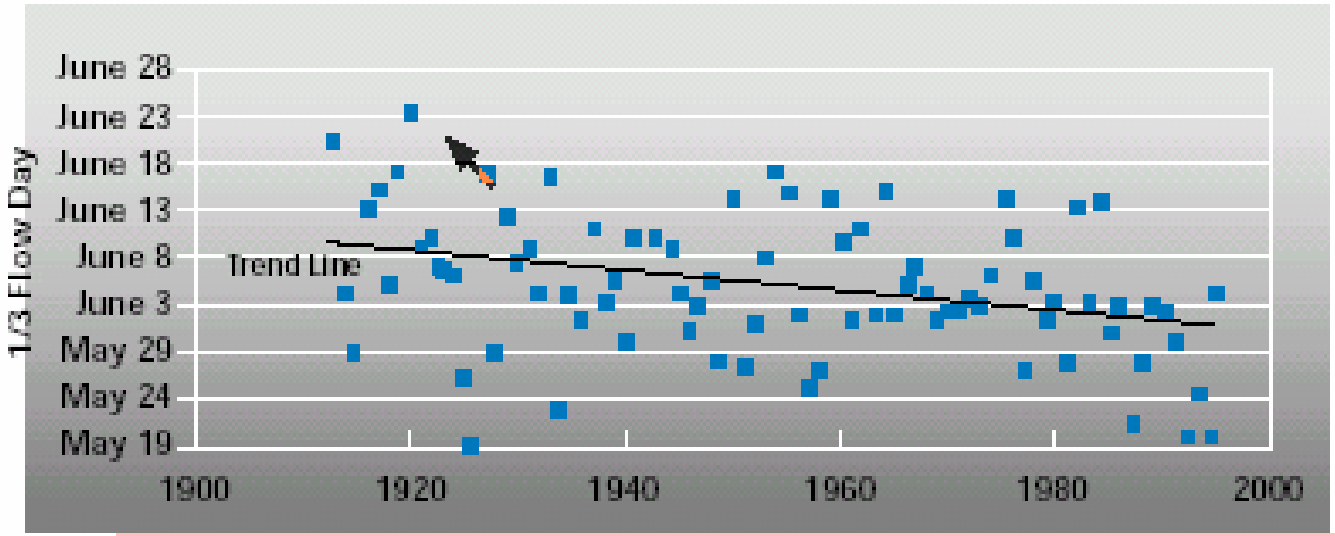

Warmer Temperatures
Uncertain Precipitation
Earlier Snowmelt
Accellerated Glacial Melt
Rain on Snow Events
Change in Streamflow Pattern
Greater Climatic Variability

As the Air-Temperatures increased so did the water Temperatures (see Graph below). This has serious implications for Fish Migration.



# Changes in the Timing of Peak Flow in the Fraser River

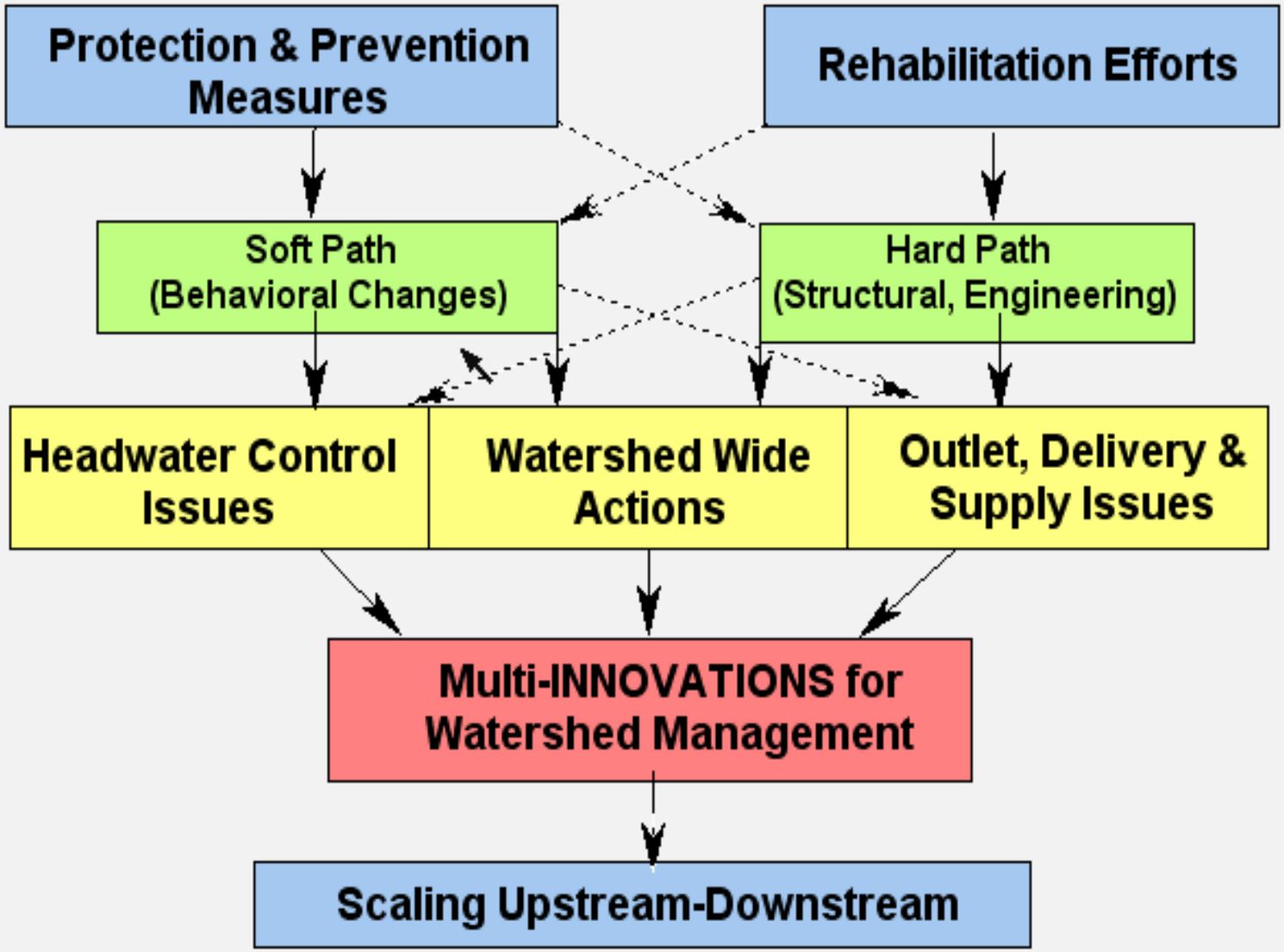
## Change in Timing of One-third of Fraser River Annual Flow, 1912-1998




Source: Environment Canada & WLAP 2001

- Impact on Salmon spawning and live-cycle
- Flooding pattern might change
- More channel modification affects aquatic habitat
- Power generation pattern might change
- Potentially lower flows in late summer affects aquatic population and fish migration

# A MULTI -INNOVATION APPROACH TO WATERSHED MANAGEMENT



What have we been doing?

# Changing Course

What should we be doing?

| Traditional Approach | Innovative Approach |
| --- | --- |
| Green Revolution (low Carbon Input) | Increase Soil Carbon |
| Intensive Land Use (Soil Compaction) | Minimize Soil Compaction |
| Minimizing Buffer Zones | Maximizing Buffer Zones |
| Draining Wetlands | Creating Wetlands |
| Excessive Drainage | Detaining Drainage Water |
| End of Pipe Treatment | Source Control |
| Point Source Pollution | Non-Point Source Pollution |
| Expanding Water Supplies | Controlling Demand (Water Smart) |
| Dealing with Single Pollutants | Cumulative Effects |
| Water Use for Human Activities | Water for Environmental Services |
| Flood Irrigation | Innovative Irrigation |
| Managing Blue Water | Managing Green Water |

## Summary

1. Improve Green Water Management
2. Examine Water use efficiency by different crops
3. Account for the amount of water needed to produce a crop or a product (Virtual Water)
4. Business should consider their water footprint (determining water use per product)
5. Need for Water Conservation and Water Harvesting
6. Use BMP's to minimize water pollution (e.g Nutrient Budgets)

# SOME CHALLENGES :

Full water accounting requires data on evapotranspiration which is difficult to obtain

We need adaptation scenarios for climate change which requires innovative conservation measures (e.g. water harvesting & irrigation)

Agriculture needs better BMP's in order to reduce water pollution (source control, nutrient budgets, buffers)

Businesses need to do full water accounting (determine water to grow the crop and water for processing the food)