Impacts of land use and climate on agricultural water demand - implications for water supply and management

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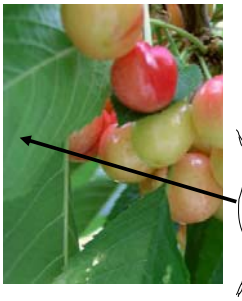
Linking water quantity and water quality in an agricultural context

- Nitrate losses to groundwater occur because:
  - Nitrogen (N) from fertilizer, manure, compost, soil organic matter readily converts to **nitrate which is highly soluble**
  - when **water** moves through the soil it **carries dissolved nitrate**
- Good nitrogen management requires
  - **Good water management** practices
  - **Judicious applications of N** to crops and turf

Structure of talk

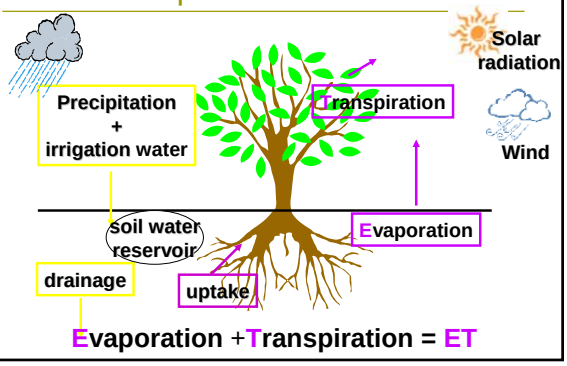
- Water management
  - Regional issues – water demand, climate change, land use
  - On-farm issues – irrigation best practices
- Nitrogen management
  - Plant requirements
  - Relationship to water management

Crop water demand



- Plants lose water from small pores on the surfaces of leaves **(transpiration)**
- If the pores close because of insufficient water in the soil the plant cannot grow

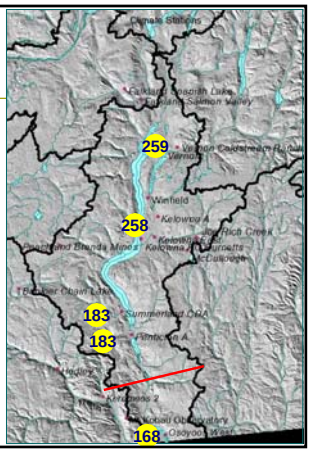
Crop water demand



Evaporation +Transpiration = ET

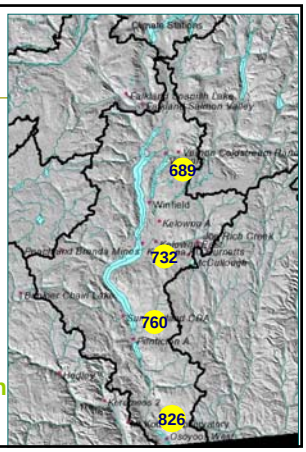
Okanagan Climate

- Environment Canada 1961-1990 averages
- April to October precipitation (mm)

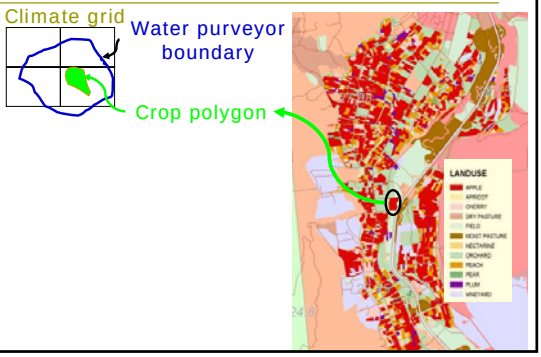


Okanagan Climate

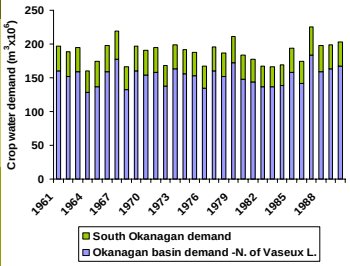
- Estimated ET (mm)
- April to October – 2002
- Deficit at Oliver
  - (826 168 = 658mm)
- **Crops require irrigation**



Model Structure

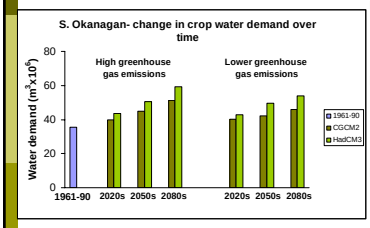


Range of crop water demand



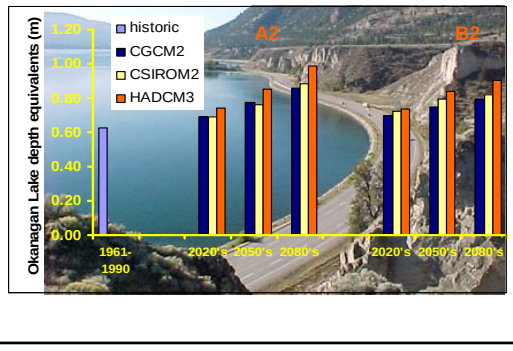
- South Okanagan demand ~20% of basin
- Great year to year variation in basin demand (160-225 mcm)
- Need to plan for years of high demand

Projected change in crop water demand over time in response to climate change

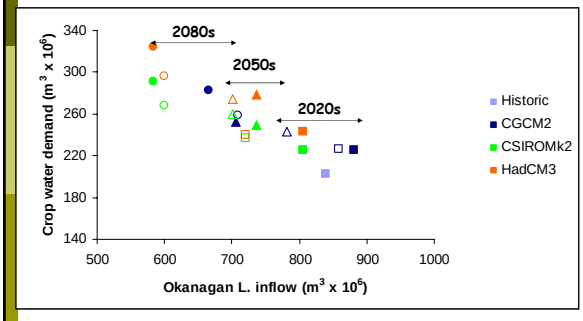


- All 12 climate change scenarios show an increase in crop water demand
- With continued high greenhouse gas emissions, this increase could be up to 15-20% by mid-century
- Increase due to longer growing season and greater ET

Depth of water required from Okanagan Lake to meet basin crop water demand

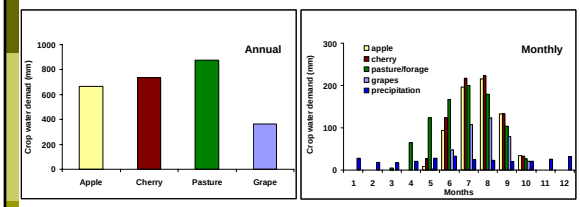


Average basin water supply/demand response to climate change



Supply –UBC watershed model (Merrit and Allila)

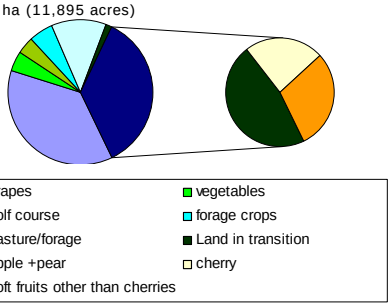
Crop type affects water requirements



- Crops differ in their annual water requirements
- Different growing season lengths and evapo-transpiration

Irrigated land use in the S. Okanagan (excluding domestic and municipal outdoor use)

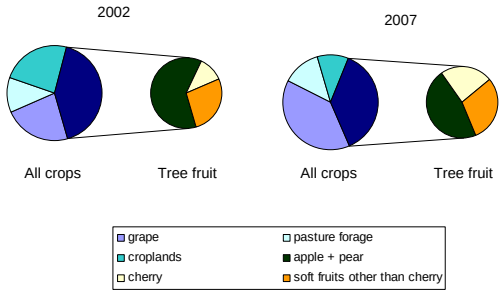
Total = 4816 ha (11,895 acres)



grapes	vegetables
golf course	forage crops
pasture/forage	Land in transition
apple +pear	cherry
soft fruits other than cherries	

Data from the Okanagan Agricultural Water Demand Model, 2007

Change in irrigated land use patterns in the S. Okanagan 2002-2007



British Columbia Food Security

Other global issues such as energy and transportation costs may require that we produce food closer to home

In 2001 we needed 2.15 million hectares for overall food sufficiency and 217,000 hectares of irrigated land in BC to be self sufficient in fruit, vegetables and dairy

By 2025 we will need 2.78 million hectares and 281,000 hectares of irrigated land

Current estimated total irrigated land is 189,000 hectares

Summary

- The region south of Vaseaux L. currently uses around 20% of the total basin water consumed by agriculture
- 15–20% increases in demand due to climate change projected for mid-century
- Current irrigation licence for the S. Okanagan is large enough to meet demand
- Need to plan for years of high demand and low supply
- Annual water demand varies with crop type, but the region needs the potential to grow a range of crops

Water management options

Regional water management

- Okanagan Basin water supply/demand study
- Agricultural water demand model
- Purveyor Management Tool
- Model developed for purveyors links:
  - Land use / irrigation system / calculated water use
  - Meter / water use

On-farm management

- Monitoring water use
- Improving irrigation system efficiency
  - Conservative systems (apply only to certain crops)
  - Certified Designs
  - Irrigation Assessments
  - Irrigation Scheduling

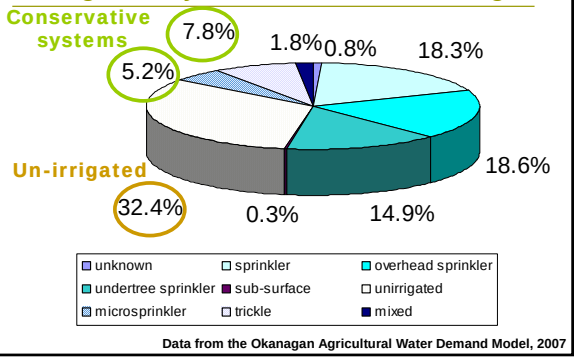
Monitoring – metering

- The meter does ***NOT*** save water.
- The meter is only a tool to:
  - Ensure a fair distribution of water
  - Ensure that agriculture is allocated sufficient water to meet needs
  - Assist districts to manage water and provide a useful tool in times of drought

Irrigation system performance

1. **Efficiency:** Select the most efficient type of irrigation system possible
2. **Uniformity:** Design the system to obtain the best uniformity
3. **Scheduling:** Schedule irrigation timing according to local site, soil moisture and climate data

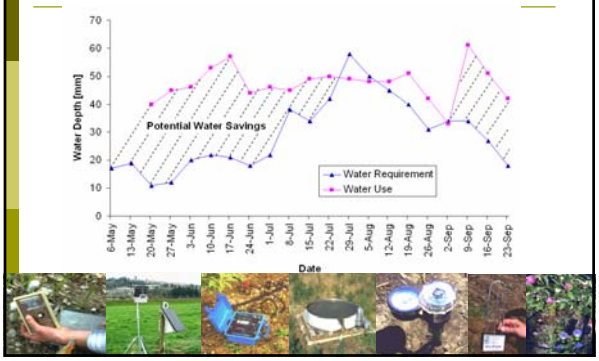
Percentage of agricultural land in different irrigation systems in the S. Okanagan



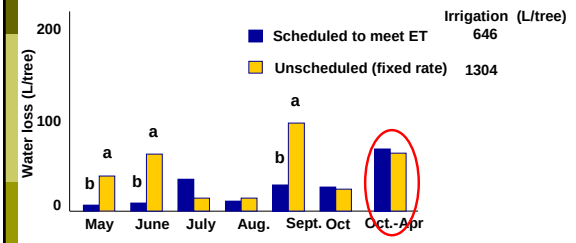
Data from the Okanagan Agricultural Water Demand Model, 2007

Conservative systems for tree fruits grape and vegetables

Improving Water Management- Scheduling irrigation to meet demands



Drainage losses of water to groundwater are reduced by irrigation scheduling



- Greater losses during spring and fall
- Oct-Apr losses mainly due to precipitation

Summary

To optimize water supply for agriculture and reduce drainage losses to groundwater and Osoyoos Lake

- Sound regional water management for agriculture requires that:
  - Irrigation water demand based on climate, crop and irrigation system (agricultural water demand model)
  - Is matched by measured actual use (meters)
- Sound on farm water management requires:
  - A well designed, most conservative irrigation system matched to the crop
  - That irrigation is scheduled to meet demand

Nitrogen management options

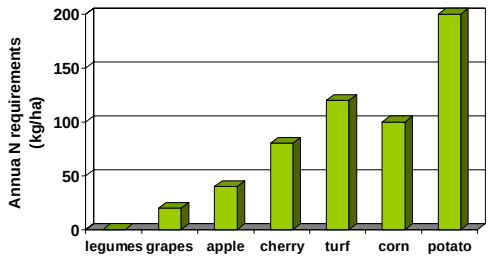
Nitrogen Management

- How much does the plant need?
- When does it need it?
- How can the nitrogen applied be best kept in the root zone?

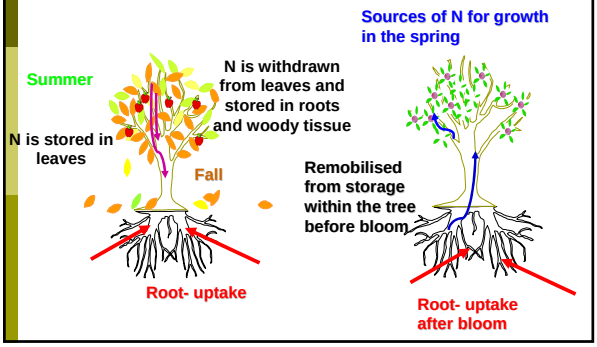
Preventing N from leaching

- Apply the right amount
- Apply small amounts frequently, when the plant needs it (e.g. apply fertilizer with the irrigation water)
- Use conservative water management
  - Scheduling

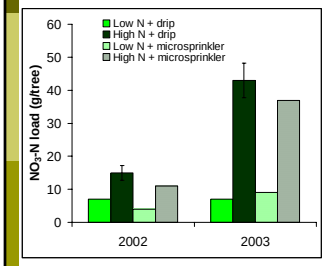
Relative N requirements for selected crops



Timed to meet demand – woody crops

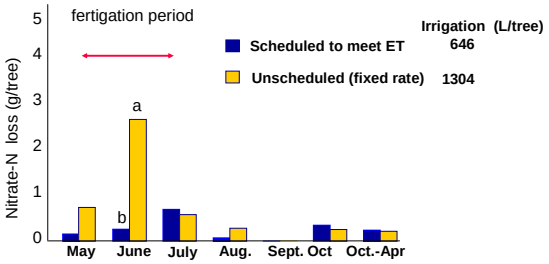


Annual N leaching losses in response to irrigation and N inputs



- Total N leaching load increased when fertilizer applications high
- For micro-irrigation, the amount of N applied is more important than type of irrigation system in determining leaching

Loss of nitrate beneath the root zone in response to irrigation scheduling



- water losses high under unscheduled irrigation during spring and fall
- N leaching occurs mainly in spring during fertigation period
- More N leaching occurs when irrigation is not scheduled

Summary

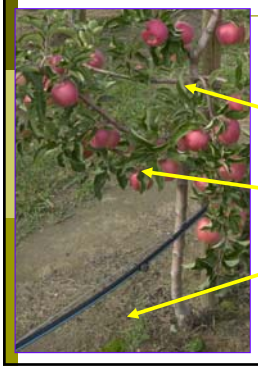
- Most of the crops grown around Osoyoos Lake require relatively small amounts of nitrogen
- To prevent nitrate leaching losses to groundwater and Osoyoos Lake requires that nitrogen applications are made:
  - At the correct rate for the crop
  - At a time when the plant will most readily take it up
  - In conjunction with best practices for water management

Thank you

Agriculture Action Plan

1. Local government planning processes (regional growth strategies and OCP's) retain agricultural lands. Develop Agricultural Plans that promote agriculture.
2. Water needs to be reserved for the ALR for future use.
3. Water that is currently allocated to agriculture will remain with agriculture – conservation efforts will be used for further food production or adaptation to climate change.
4. Municipalities and water purveyors have fair agricultural representation consisting of commodity nominated representatives.
5. Pricing of water for agriculture is affordable and equitable for the sector.
6. Drought Management plans should be developed on a watershed basis.
7. Okanagan Basin Water Board policies are consistent with the Provincial Water Strategy

Crop water demand



Solar radiation

Wind

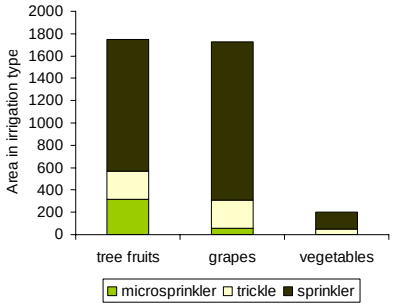
Transpiration from leaf surface

Evaporation from the leaf surface

Evaporation from the soil surface

Increases as **plant canopy grows** (seasonal, year to year)

Irrigation systems by crop type in the S. Okanagan



Data from the Okanagan Agricultural Water Demand Model, 2007

Regional water management

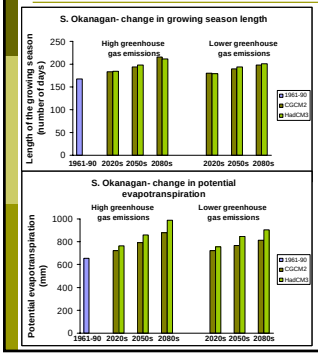
- Agricultural water demand model
- Part of the Okanagan Basin Water Supply/Demand study
- Database is linked to cadastre:
  - Land use / irrigation system
  - Climate
  - Soil type

Water use is determine by an algorithm that calculates water requirement for each property

Regional water demand

- **Initial study 2000-2004**
  - Mapped **plant water requirements** for each parcel of land based on
    - Calculations of estimated ET
    - Crop type
    - Current and future climate
- **New study (Okanagan agricultural water demand model)**
  - Maps **irrigation requirements** for each parcel of land based on
    - Calculations of estimated ET
    - Crop type (updated to 2006/7)
    - Current and future climate
    - Soil type
    - Irrigation system

Causes of increased crop water demand



- The growing season is longer (up to 30 days)
- Potential ET is higher

Crop needs differ

- Legumes (peas, beans, alfalfa, clover), with the help of bacteria fix N and do not need N fertilizer
- Pasture/forage with alfalfa/clover need very little N
- Woody plants need relatively small amounts – especially grapes
- Turf grass and other annual crops like potato or corn need the most