Irrigation Scheduling
FACTSHEET

Order No. 500.320-2
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AGRICULTURE WATER DEMAND MODEL

The Agriculture Water Demand Model (AWDM) is a water management planning tool to provide current and future agriculture water demands in the Okanagan Basin. The AWDM can be used for any regions provided with the appropriate land use and climate information.

Background

An Okanagan Basin Water Strategy was initiated by Land and Water British Columbia (LWBC) in 2004 in response to significant pressures being exerted on the water resources in the Okanagan Basin. Rapid population growth, drought conditions, climate change, and the overall increased demand for water are driving this trend. Several recent studies have supported the scenario of a pending water crisis as Okanagan water resources are expected to be fully allocated in the next 15 to 20 years.

Climate change scenarios developed by the University of British Columbia (UBC) and the Pacific Agri-Food Research Centre (PARC) in Summerland predict that winter snow packs will decrease as the climate warms and the snow level moves higher up the mountains. While precipitation may increase, most of it will be in the form of rainfall in the winter months which changes the hydrology of the region (Figure 1). Reservoirs may still fill up but with a reduced snow pack. The spring freshet will come earlier and end sooner, requiring the region to depend on storage for a longer time period over summer months. Hotter summers and longer growing seasons attributed to climate change will also increase the amount of water required to grow a crop.

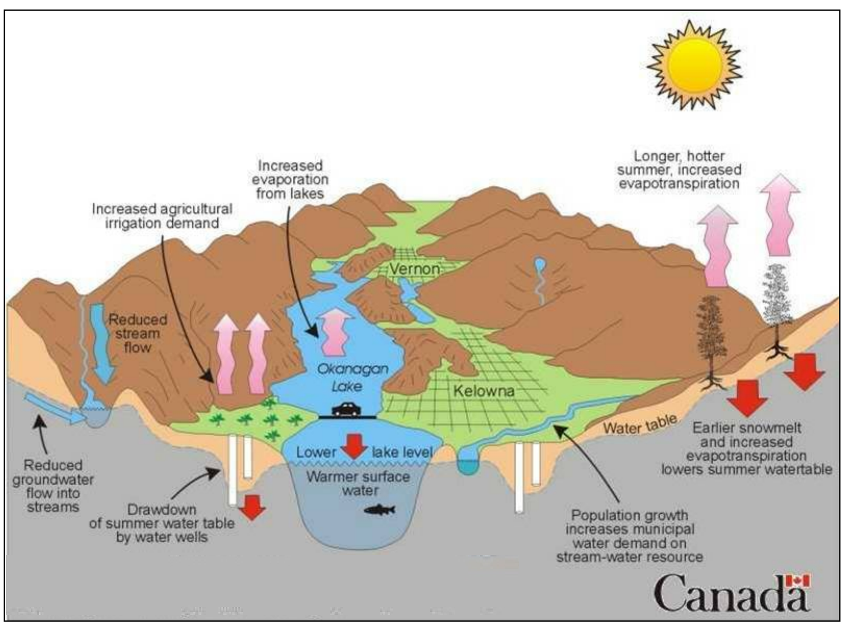

Figure 1 Okanagan Valley Water Budget

Source: Agriculture and Agri-Food Canada

Overview

The Agriculture Water Demand Model (AWDM) was developed to provide current and future agriculture water demands in the Okanagan Basin. The Okanagan Basin has been divided into 81 sub basins, 309 groundwater areas, 67 water purveyors and 12 local governments. The AWDM calculates water use on a property by property basis and sums each property to obtain a total for sub-basins or the entire basin. Crop, irrigation system type, soil type and climate data are used to calculate the water demand. Since the AWDM can calculate future water demands based on climate change scenarios, it can help purveyors to make informed decisions on water use and land use planning.

Land Use Inventory

Cadastral information provided by the Regional Districts and local governments in the Basin was unified into one seamless layer for the entire Basin. The AWDM is based on a Geographical Information System (GIS) that generated 398 map sheets to capture all agricultural areas in the Basin as shown in Figure 2.

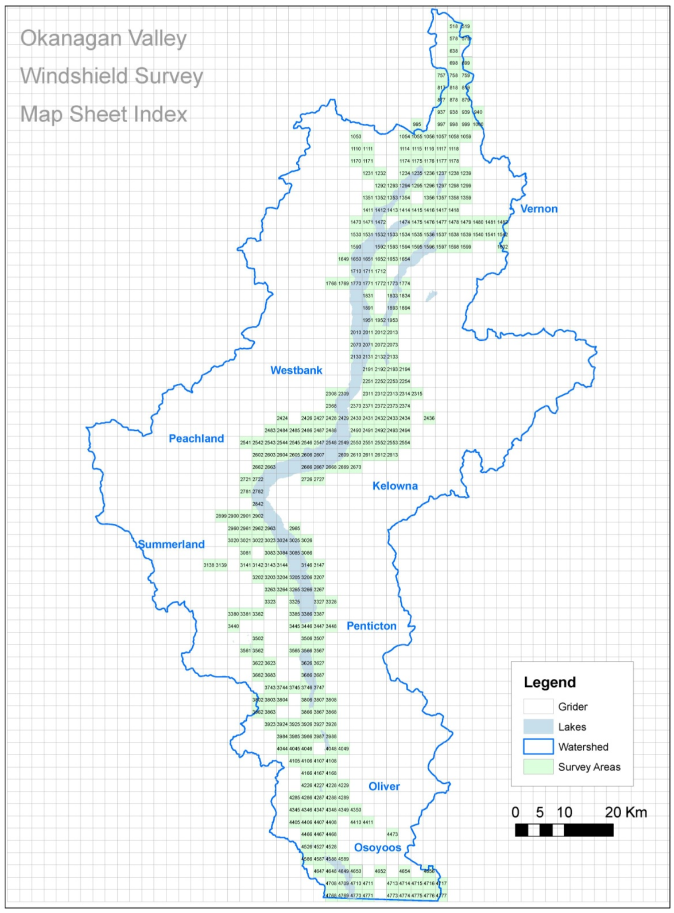

Figure 2 Agricultural Areas in the Okanagan Basin

Figure 3 shows a sample map sheet and how the cadastre and land use polygons were added. A polygon is determined by a change in crop, soil type or irrigation system type within a cadastre. Polygons are designated as blue lines within each cadastre as shown in Figure 3(b) where the cadastre has six polygons. Each cadastre has a unique identifier as does each polygon. This allows the survey team to call up the cadastre in the database, review the number of polygons within the cadastre and ensure the land use is coded accurately for each polygon. A total of 126,419 polygons were generated for the Okanagan agricultural area within the Agricultural Land Reserve (ALR) and properties outside the ALR where there is active agriculture.

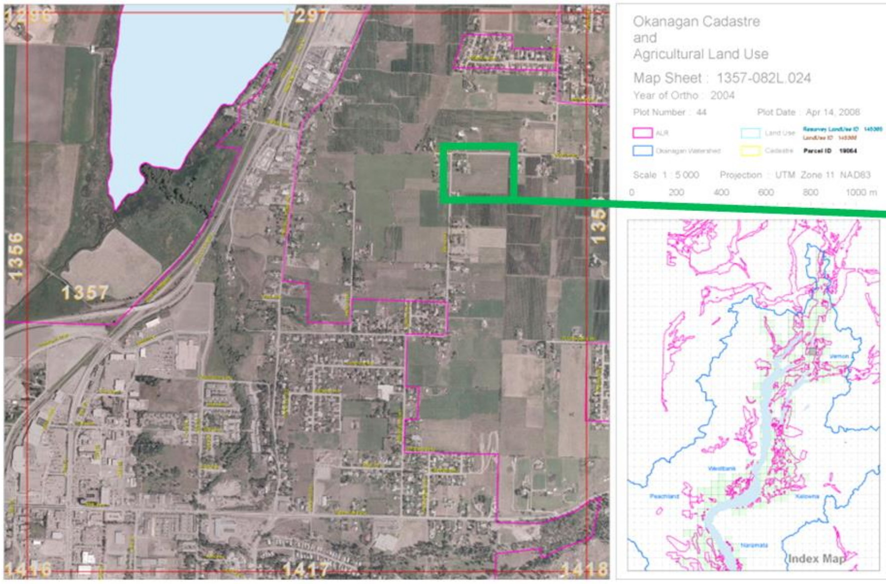

Figure 3(a) Sample Map Sheet

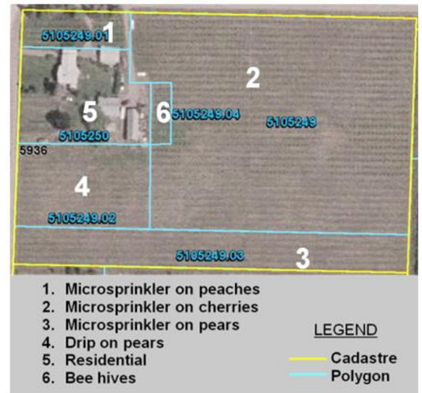

Figure 3(b) Sample Polygons

Crop, Soil, Irrigation and Climate

The AWDM calculates water use for each polygon on a daily basis using information on crop, soil, irrigation system and climate.

Crop information includes rooting depth, availability coefficient, crop coefficients, and drip factor that are specific to the crop in each polygon. **Soil** information includes maximum soil water deficit which is calculated using crop's rooting depth and available water storage capacity based on the soil texture in the polygon. **Irrigation** information is basically the efficiency of irrigation system in each polygon.

The **climate** in the Okanagan is quite diverse. It generally gets cooler and wetter from south to north and as elevation increases. To incorporate the climatic diversity, climate layers were developed using a 500 m x 500 m climate grid totaling to 32,000 grid cells. Each grid cell is populated with daily climate data from 1961 to 2006 using a stepwise regional regression analysis technique in which residual maximum temperature and minimum temperature are interpolated from climate stations in and around the Okanagan Basin. The daily climate data which includes maximum temperature, minimum temperature and precipitation allows the AWDM to calculate a daily reference evapotranspiration (ET_o) rate value. Figure 4 illustrates how the climate layer is incorporated in the land use data. Six different Global Climate Models have been developed for each grid cell allowing the AWDM to generate future water use in the basin until the year 2100.

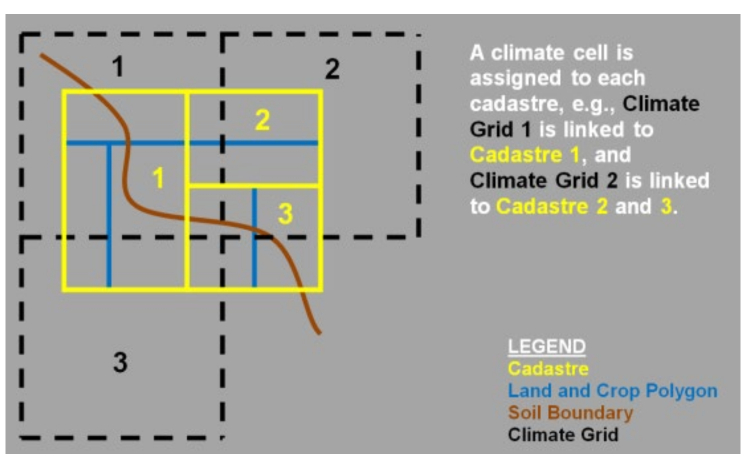

Figure 4 Integration of Climate Layer into Land Use Data

Crop Coefficient

There are many factors that are used to calculate water demand in the AWDM. One of the more significant factors is the crop coefficient (K_c) for adjusting daily reference evapotranspiration (ET_o). The K_c takes into account the crop type and crop development to adjust the ET_o for that specific crop. There may be several crop coefficients used for a single crop throughout an irrigation season depending on the crop's developmental stage. The ET_o is calculated using climate data obtained from a climate station. All ET_o is based on a grass crop and is provided by www.Farmwest.com. Daily ET_o is multiplied by K_c to obtain the water demand for a specific crop at a specific stage of crop development. Daily water demands can then be added to provide a weekly, monthly or annual water demands for each property or for the entire basin.

Figure 5 shows how K_c changes over the growing season for apples and alfalfa. For apples, K_c slowly increases as it gets hotter, levels off towards the end of the season, and slowly drops after the season is over. Forage crops like alfalfa have several cuts during the season, and therefore have a new growth cycle for each cut represented by a series of curves.

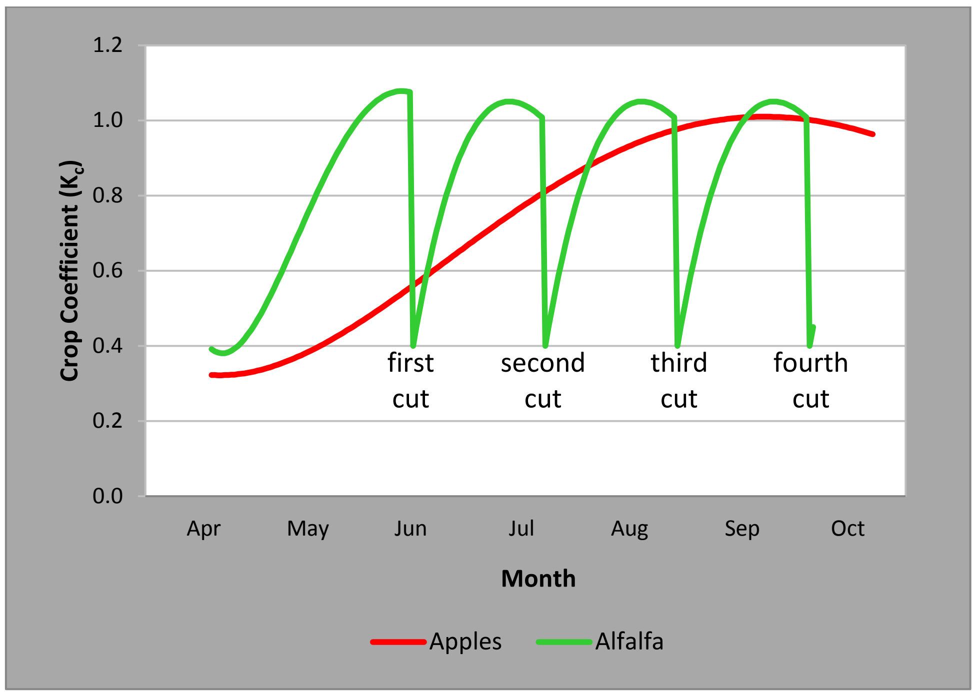

Figure 5 Crop Coefficients of Apples and Alfalfa

Results

The AWDM calculates water use daily on a polygon basis and adds up polygons to determine water demand for each property. It also allows water demand to be determined for 81 sub-basins, 309 aquifer areas, 67 water purveyors, and 12 local governments. The AWDM calculates the daily demand for each polygon throughout the growing season, adds the polygons within each property together to get the demand for each property, and then adds all the properties together to determine the water demand for the entire Okanagan Basin. It can run for any time period chosen but an annual demand is the normal request. Management criteria can be adjusted in the AWDM based on general water management practices as poor, average or good.

Below lists the steps of how the AWDM is operated:

1. The AWDM selects the climate data set that is being asked for and the area for which the AWDM is being asked to run.
2. The AWDM accesses the database and for each polygon obtains the data that is stored for the soil type, crop and irrigation system in the database.
3. A calculation is made for each of the 126,419 polygons on a daily basis over the growing season. The start and end of the growing season for each polygon also needs to be determined based on the crop type and climate data which has been assigned for that polygon.
4. The water demand for each polygon is calculated for the time period that was selected, stored and added to other polygons within that cadastre (property).
5. All the properties are then added to determine the water demand for the regions or basins selected.
6. A reporting tool then allows the user to report out the results in various formats.

Table 1 shows a sample summary of the irrigation demands by crops for the entire Okanagan Basin in 2003. For a full report of the AWDM for the Okanagan Basin, refer to Factsheet 500.300-3 ***Agriculture Water Demand Model – Okanagan Basin*** available online.

Applications and Future Projects

The AWDM is operational for the Okanagan Basin, and is being used to determine current and future agriculture's water requirements. It may also be used to establish a water reserve for agriculture as committed to under the B.C.'s Water Plan: Living Water Smart.

The AWDM is an integral component of the Okanagan Water Supply and Demand study being led by the Okanagan Basin Water Board and the Ministry of Environment. The study used the outputs from the AWDM to determine the agricultural water demand for future scenarios. The AWDM has also been expanded to determine the water demand for all outdoor irrigation, including parks, golf courses and all domestic irrigation in the Okanagan. The AWDM also includes population growth scenarios and determines estimated indoor uses spatially for the entire Okanagan Basin.

Since the AWDM has been developed, it has been used by many local governments in the Okanagan for water management and planning purposes

Furthermore, land use data has also been collected to operate the AWDM in the Similkameen, Nicola, Bonaparte and Salmon River Basins. As of 2011, projects are underway to implement the AWDM in Metro Vancouver and the Kettle Valley Basin.

Table 1 Crop Water Demand 2003

Year: 2003	Okanagan Basin - Average Irrigation Management											
Water Source	**Water Licence**			**Reclaimed Water**			**Groundwater**			**Total**		
Agriculture **Crop Group**	Irrigated Area (ha)	Irrigation Demand (m3)	Average Req. (mm)	Irrigated Area (ha)	Irrigation Demand (m3)	Average Req. (mm)	Irrigated Area (ha)	Irrigation Demand (m3)	Average Req. (mm)	Irrigated Area (ha)	Irrigation Demand (m3)	Average Req. (mm)
Alfalfa	1,275	9,010,934	707	96	647,964	677	852	5,767,594	677	2,222	**15,426,491**	694
Apple	4,070	29,174,202	717	-	-	-	211	1,511,750	717	4,281	**30,685,952**	717
Berry	44	291,916	672	-	-	-	18	110,656	603	62	**402,572**	651
Cherry	1,074	8,120,474	756	-	-	-	45	367,359	819	1,119	**8,487,833**	759
Corn	409	1,956,321	479	23	120,830	525	189	821,606	436	620	**2,898,757**	468
Forage	2,964	27,446,657	926	429	4,132,948	964	1,703	13,877,787	815	5,096	**45,457,392**	892
Fruit	792	6,576,735	830	-	-	-	102	771,618	759	894	**7,348,354**	822
Grape	2,290	9,780,281	427	6	15,923	250	436	1,863,362	427	2,733	**11,659,566**	427
Nursery	253	2,543,339	1,006	185	1,263,641	684	127	1,047,376	823	565	**4,854,356**	859
Turf Farm	60	606,512	1,008	-	-	-	46	414,190	911	106	**1,020,702**	966
Vegetable	370	2,732,012	739	-	-	-	137	845,546	618	507	**3,577,558**	706
Inactive	190	-	-	0	-	-	23	-	-	213	-	-
	13,790	98,239,383		739	6,181,306		3,887	27,398,844		18,416	**131,819,533**	
Turf												
Golf	446	4,471,113	1,002	298	3,095,884	1,041	317	3,095,360	977	1,061	**10,662,357**	1,005
Landscape Turf	488	4,779,235	980	17	172,714	1,004	101	973,438	960	607	**5,925,388**	977
Domestic Outdoor	5,169	50,987,109	986	0	1,312	1,006	741	7,578,839	1,023	5,910	**58,567,260**	991
	6,104	60,237,457		315	3,269,910		1,159	11,647,637		7,577	**75,155,005**	
Total	**19,893**	**158,476,840**	**797**	**1,054**	**9,451,216**	**897**	**5,046**	**39,046,481**	**774**	**25,993**	**206,974,538**	796

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