Estimating Monthly Water Withdrawals, Return Flow, and Consumptive Use in the Great Lakes Basin

Introduction

Water-resource managers and planners require water-withdrawal, return-flow, and consumptive-use data to understand how anthropogenic (human) water use affects the hydrologic system. Water models like MODFLOW and GSFLOW use calculations and input values (including water-withdrawal and return flow data) to simulate and predict the effects of water use on aquifer and stream conditions. Accurate assessments of consumptive use, interbasin transfer, and areas that are on public supply or sewer are essential in estimating the withdrawal and return-flow data needed for the models.

As the applicability of a model to real situations depends on accurate input data, limited or poor water-use data hampers the ability of modelers to simulate and predict hydrologic conditions. Substantial differences exist among the many agencies nationwide that are responsible for compiling water-use data including what data are collected, how the data are organized, how often the data are collected, quality assurance, required level of accuracy, and when data are released to the public. **This poster presents water-use information and estimation methods summarized from recent U.S. Geological Survey (USGS) reports with the intent to assist water-resource managers and planners who need estimates of monthly water withdrawals, return flows, and consumptive use** (fig. 1). This poster lists references in Shaffer (2009) for water withdrawals, consumptive use, and return flows. Monthly percent of annual withdrawals and consumptive-use coefficients are used to compute monthly water withdrawals, consumptive use, and return flow for the Great Lakes Basin.

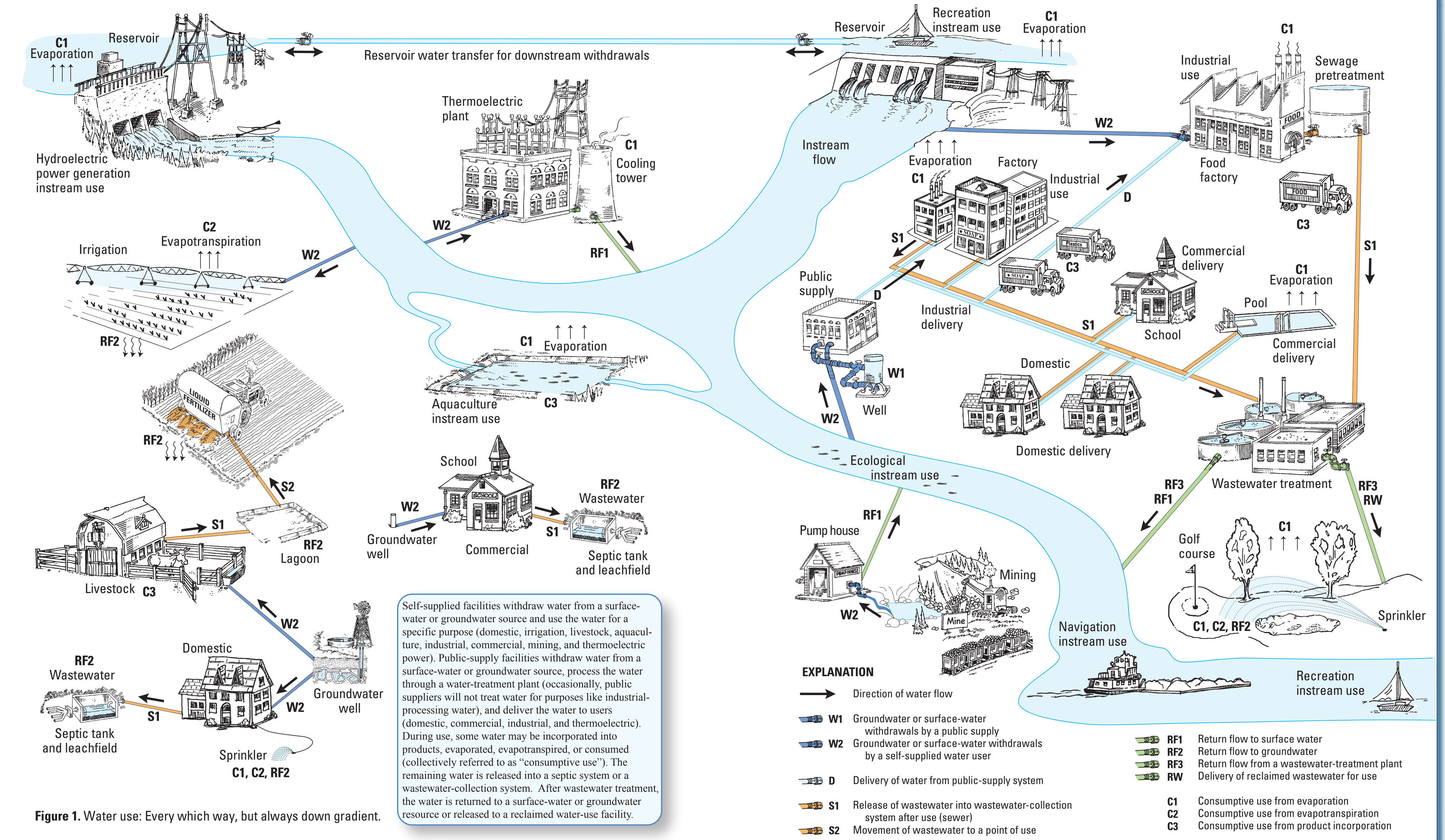

Figure 1. Water use: Every which way, but always down gradient.

Estimating Annual Water Withdrawals

Case Studies

Table 1. Water demand by water-use category and facility size for Ohio and Indiana, 1999–2004.

[Facility size was computed by percentiles of withdrawals for records; "small" is less than the 33rd percentile; "medium" is from the 33rd to 66th percentiles; "large" is from the 66th to 90th percentiles; "very large" is from the 90th to 98th percentiles; and "extra large" is greater than the 98th percentile; Mgal/d, million gallons per day; N, number of records; <, less than; the sum of "Percent of total withdrawals" may not equal 100 owing to rounding.]

Water-use category	Facility size	N	Median withdrawal (Mgal/year)	Percent of total withdrawals by water-use category
Public supply	Small	2,157	25.6	1
	Medium	2,160	102	5
	Large	1,570	464	18
	Very large	524	1,940	27
	Extra large	131	14,700	49
Industrial	Small	1,078	1.46	<1
	Medium	1,078	32.8	1
	Large	784	237	4
	Very large	261	1,990	11
	Extra large	66	47,400	84
Thermoelectric power	Small	161	54.8	<1
	Medium	160	8,940	6
	Large	116	110,000	44
	Very large	39	284,000	36
	Extra large	10	449,000	14
Irrigation, golf	Small	1,354	2.19	4
	Medium	1,356	11.0	19
	Large	918	25.6	33
	Very large	327	51.1	24
	Extra large	82	113	19
Irrigation, nursery	Small	260	3.65	2
	Medium	258	11.0	12
	Large	188	40.2	29
	Very large	63	153	38
	Extra large	16	296	20
Irrigation, crop	Small	2,822	3.65	5
	Medium	2,037	18.2	18
	Large	682	36.5	28
	Very large	171	87.6	24
	Extra large	171	270	24
Commercial	Small	858	0.73	<1
	Medium	855	3.65	2
	Large	624	21.9	11
	Very large	206	172	28
	Extra large	51	1,330	59
Mining[1]	Small	496	7.3	1
	Medium	495	142	14
	Large	360	409	33
	Very large	120	1,190	30
	Extra large	31	3,440	22

[1] Mining numbers may include dewatering

Estimating Monthly Water Withdrawals

[1] For rows to add up to 100 percent, thermoelectric (April) value of 7.3483 was rounded to 7.4 percent.

[2] For row to add up to 100 percent, golf-course irrigation (Aug.) value of 21.7521 was rounded to 21.7 percent.

[3] For row to add up to 100 percent, irrigation, other (Dec.) value of 0.455 was rounded to 0.4 percent.

[4] For row to add up to 100 percent, aquaculture (Aug.) value of 7.5497 was rounded to 7.6 percent

Table 3. Estimated monthly water withdrawals for the Great Lakes Basin (U.S. and Canada) in billion gallons, 2006.

[Numbers were computed by multiplying 2006 annual water withdrawals from Great Lakes Commission (2010) and percentage of monthly water withdrawals (Shaffer, 2009). Numbers are rounded to three significant figures.]

Water-use category	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Public supply	169	171	163	163	171	184	197	192	184	169	163	163
Self-supply domestic[1]	14.5	14.7	14.0	14.0	14.7	15.7	16.8	16.5	15.7	14.5	14.0	14.0
Self-supply industrial	132	132	129	130	135	140	145	151	147	142	135	130
Self-supply thermoelectric power	843	821	810	822	910	1,050	1,100	1,090	990	910	880	880
Self-supply irrigation	.460	.460	1.23	3.38	7.05	23.8	47.8	45.7	15.3	4.91	2.45	.767
Self-supply livestock	3.58	4.14	3.83	3.88	3.99	4.60	5.16	5.57	4.29	4.04	4.09	3.93
Self-supply other[2]	10.1	10.5	11.8	13.9	14.9	17.0	16.6	18.4	18.2	15.8	13.2	11.2
Total	1,170	1,150	1,130	1,150	1,260	1,440	1,530	1,520	1,370	1,260	1,210	1,200

[1] Public supply monthly percentage of annual water withdrawals was used for self-supply domestic.

[2] Self-supply other is water used for fish/wildlife, environmental, recreation, navigation, and water-quality purposes. Specifically, water used to maintain levels for navigation, recreation, fish and wildlife habitat creation and enhancement, flow augmentation (or diversion), sanitation, pollution confinement, and other water-quality purposes and agricultural activities (services) other than those directly related to irrigation such as field drainage are included. Water used in temporary or immediate emergency situations (e.g., fighting forest or peat fires) also is reported here. As some of these water uses are included in the U.S. Geological Survey commercial water-use category, the monthly commercial coefficients were used.

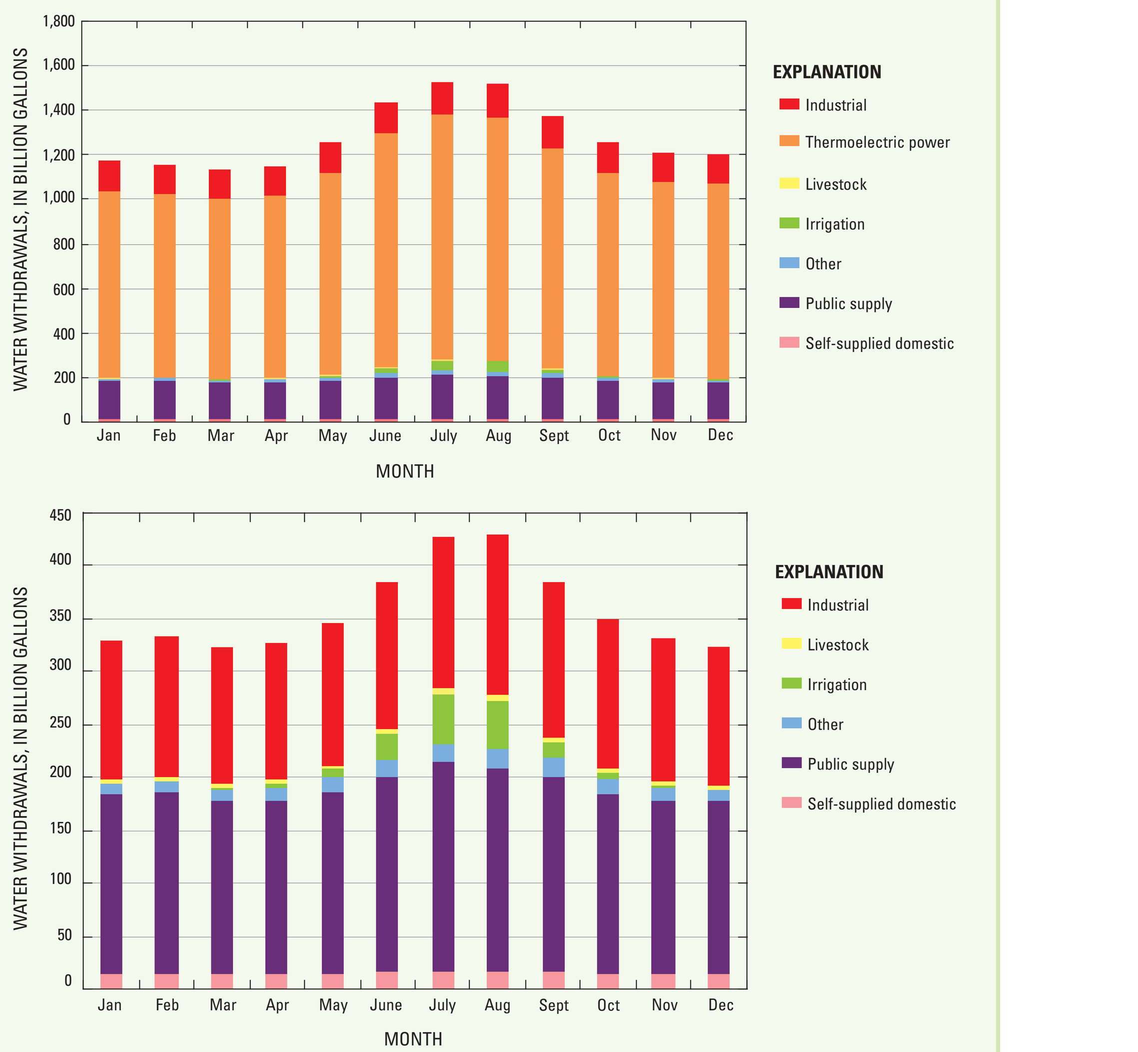

Fig. 2a (above) and 2b (below). Water withdrawals are highest during May - September and are affected by thermoelectric withdrawals. Irrigation and public-supply withdrawals also are highest during these months.

Estimating Consumptive Use and Return Flow

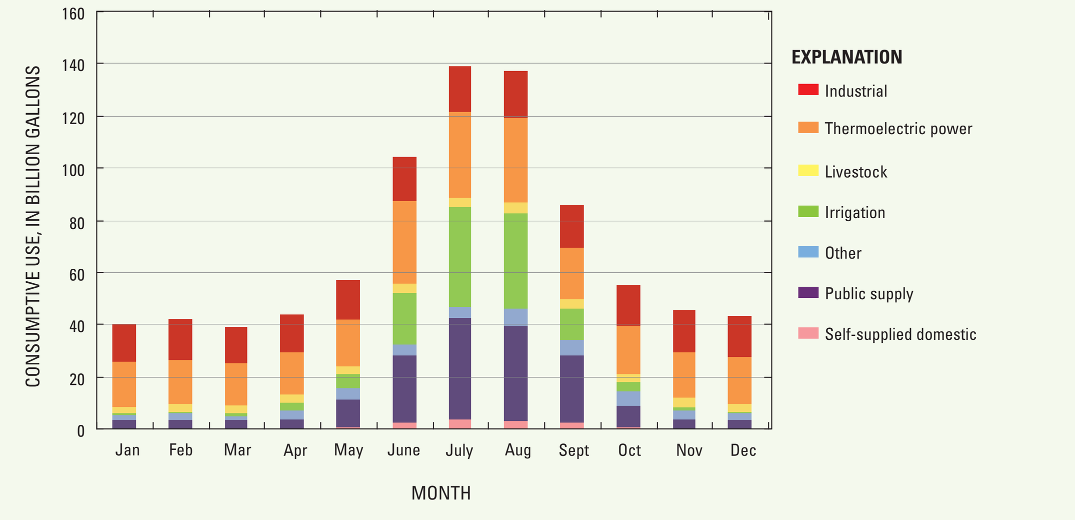

Fig. 3. Consumptive-use was highest for thermoelectric power. Irrigation, public supply, and self-supplied domestic consumptive use was highest during June to September.

References Cited

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