

WATER USE IN HAWAII

1980

Report R71

Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with
State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Water and Land Development

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By

RICHARD H. NAKAHARA

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HONOLULU, HAWAII

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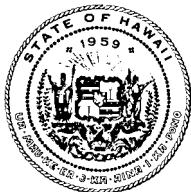


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WATER USE IN HAWAII, 1980

By Richard H. Nakahara

ABSTRACT

This is the second in a series of water-use reports for Hawaii, the purpose of which is to aid managers and planners in the development and implementation of state water-management plans and programs.

Letters and questionnaires were sent to principal water users throughout the State; 94 percent of the questionnaires for 1980 were returned. Estimates, based on previous surveys were made for the remaining 6 percent. In Hawaii, significant quantities of water are withdrawn daily from streams and underground sources for uses that include irrigating crops, raising livestock, providing for human domestic needs, generating hydroelectric power, carrying wastes, cooling, cleaning, and processing food and industrial commodities. The 1980 water-use survey indicated that agriculture was the leading water user. When seawater was included as a source of water, industrial-thermoelectric became the major water user.

The composite data, resulting from the 1980 survey, are shown in tabular and graphical forms.

INTRODUCTION

In 1975, the State of Hawaii, through its Board of Land and Natural Resources, entered into a cooperative agreement with the U.S. Geological Survey, Water Resources Division, to conduct a water-use data program. The purpose of the program was to publish data reports that would enable managers and planners to analyze the various uses and thereby aid them in the development and implementation of state water-management plans and programs.

Significant quantities of water are withdrawn daily from streams and underground sources for uses that include irrigating crops, raising livestock, providing human domestic needs, generating hydroelectric power, carrying wastes, cooling, cleaning and processing food and industrial commodities. The agricultural industry, especially that of sugar, has long been the principal user of water within the State. In recent years, however, competition for supplies from the other categories has increased steadily.

WATER-USE SURVEY

This report is published through the joint effort of the State Department of Land and Natural Resources and the U.S. Geological Survey.

As in the first report, letters and questionnaires were sent to the principal water users in the State, namely the sugar and pineapple plantations, the county water departments, State and Federal agencies, ranchers, farmers, and private industries. The water users were then personally visited or contacted by telephone to stress the purpose of the survey, to solicit their cooperation, and to clarify any questions that may have arisen.

In this survey, 94 percent of the questionnaires were answered. Estimates based on previous water-use surveys were made for the remaining 6 percent.

OVERVIEW OF WATER USE

1980

The total amount of water used throughout the State of Hawaii for 1980 was 620 billion gallons (1.70 billion gallons per day). In addition, 450 billion gallons (1.23 billion gallons per day) of seawater was used (see Definition of Terms).

The daily per-capita use was 1,750 gal (gallons); total daily per capita use, including seawater, was 3,020 gal. These figures are an indication of the large amount of water used by agriculture throughout the State (see Table 1).

Statewide, Maui was the largest water user, with a total of 213,990 Mgal (million gallons) for the year.

In agriculture, Maui led in surface-water usage with 129,130 Mgal. Oahu was the principal user of ground water with 70,310 Mgal and Kauai was the leading user of recycled water with 19,840 Mgal.

As for commercial use, Kauai was the largest ground-water user with 1,760 Mgal. The data for commercial use are not complete since some are probably incorporated into other water-use categories.

For domestic use, Maui led in surface-water usage with 3,500 Mgal while Oahu led in ground-water usage with 63,250 Mgal. Water for developing hydroelectric power on Hawaii, Kauai, and Maui totaled 74,200 Mgal.

Industrial water use was broken down into two categories: thermoelectric and other industrial uses. Water for thermoelectric plants (primarily for cooling purposes) amounted to 479,130 Mgal, of which 93 percent was seawater. About 95 percent of the seawater was used on Oahu.

Water for other industrial uses totaled 32,350 Mgal. Kauai used the most surface water, 4,200 Mgal and Oahu used the most ground-water, 7,340 Mgal. Kauai used the most recycled water, 1,870 Mgal.

Recycled water was used for agricultural and other industrial uses on Maui, Kauai, Hawaii, and Oahu. Recycled water amounted to 8 percent of all agricultural water and 8 percent of industrial water (other uses) used in the State.

The breakdown (by percentages) of types of water use, compared with the total water used, is as follows:

<u>Types of Water Use</u>	<u>Water used (percent)</u>	<u>Water used-- including seawater (percent)</u>
Agricultural -----	65	38
Commercial -----	1	- (less than 1 percent)
Domestic -----	12	7
Hydroelectric -----	12	7
Industrial - thermoelectric -----	5	45
Industrial - other uses -----	5	3
Total	<u>100</u>	<u>100</u>

WATER-USE DATA

The water-use data are presented as follows:

Initially, the total water use for the State in 1980 is given in table 1 and fig. 1.

Secondly, (a) water use by type and source is given for each island in table 2 and fig. 2, and (b) all islands are compared by type and source of water use in table 3 and fig. 3.

Finally, water use, according to hydrographic areas, by type and source on each island, is given in tables 4-10, and figures 4-10.

REFERENCE

Nakahara, R. H., 1980, Water Use in Hawaii, 1975; Hawaii State Division of Water and Land Development Report R58, 26 p.

UNITS OF MEASUREMENT

The following table may be used to convert measurements in the inch-pound system to the International System of Units (SI).

<u>Multiply inch-pound units</u>	<u>By</u>	<u>To obtain SI units</u>
<u>Length</u>		
inch (in.) -----	25.4 -----	millimeter (mm)
foot (ft) -----	0.3048 ----	meter (m)
yard (yd) -----	0.9144 ----	meter (m)
mile (mi) -----	1.609 ----	kilometer (km)
<u>Area</u>		
acre -----	4,047 ----	square meter (m ²)
square inch (in ²) -----	0.0006452 --	square meter (m ²)
square foot (ft ²) -----	0.0929 ----	square meter (m ²)
square mile (mi ²) -----	2.590 ----	square kilometer (km ²)
<u>Volume</u>		
acre-foot (acre-ft) -----	1,233 ----	cubic meter (m ³)
cubic foot (ft ³) -----	0.02832 ----	cubic meter (m ³)
gallon (gal) -----	3.785 ----	liter (L)
million gallons (Mgal) -----	3,785 ----	cubic meters (m ³)
<u>Volume Per Unit Time (includes Flow)</u>		
cubic foot per second (ft ³ /s)---	0.02832 ----	cubic meter per second (m ³ /s)
cubic foot per second-day (ft ³ /s-d).	2,447 ----	cubic meter (m ³)
gallon per minute (gal/min) ----	0.06309 ----	liter per second (L/s)
million gallons per day (Mgal/d)	0.04381 ----	cubic meter per second (m ³ /s)
<u>Miscellaneous</u>		
foot per mile (ft/mi) -----	0.1894 -----	meter per kilometer (m/km)
cubic foot per second per square mile [(ft ³ /s)/mi ²].	0.01093 ----	cubic meter per second per square kilometer [(m ³ /s)/km ²].

DEFINITION OF TERMS

Agricultural - includes water used for irrigation of crop lands and for livestock.

Commercial - water used for commercial purposes, such as golf courses, retail outlets, hotels, resorts, parks, and laundries.

Domestic - water for human consumption and for household purposes.

Ground water - water from wells, tunnels, and shafts.

Hydroelectric - water used to generate hydroelectric power.

Industrial: thermoelectric - water used to remove heat in the generation of thermoelectric power.

Industrial: other uses - water used for other industrial purposes, such as by sugar mills, pineapple canneries, breweries, bakeries, schools, private clubs, military forces, meat companies, construction product companies, rug cleaners, and universities.

Recycled water - sewage effluent, mill effluent, or other water that is reused.

Seawater - water taken directly from the ocean or from coastal wells that draft seawater as stated by the water users.

Surface water - water from streams and springs.

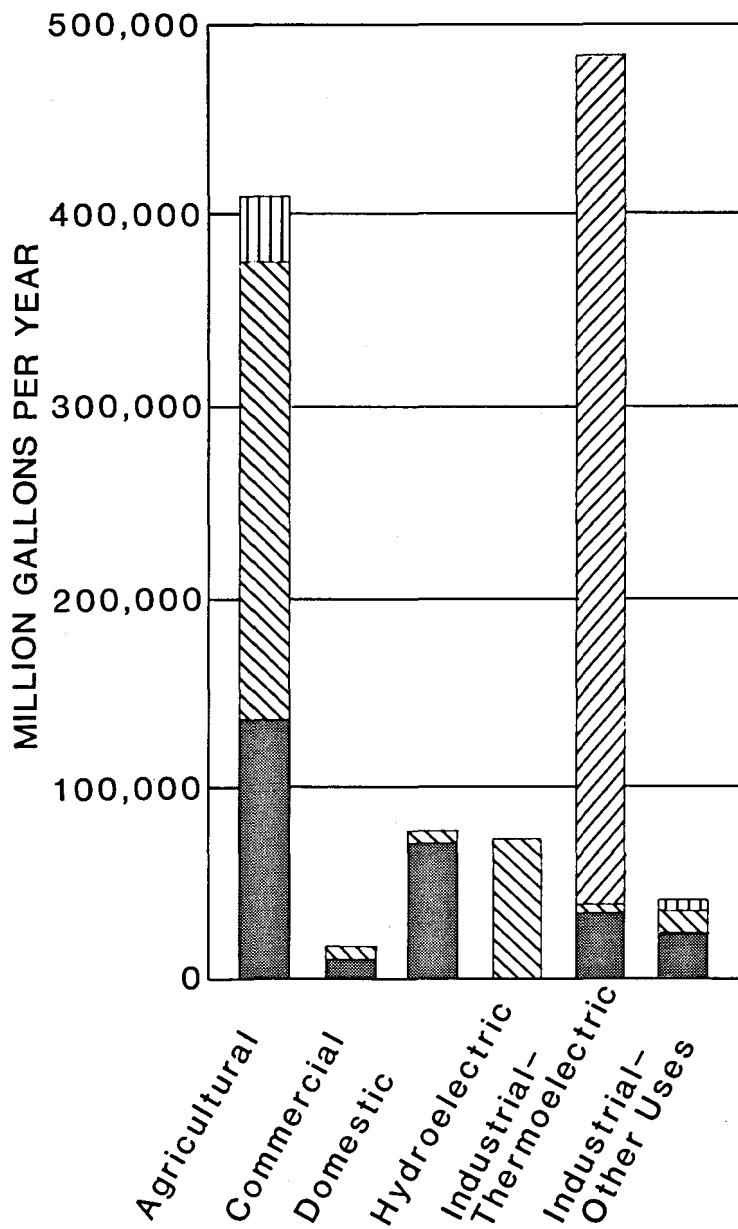
Table 1. 1980 Water use in the State of Hawaii by type and source

[Quantities, in million gallons per year]

Water use	Ground water	Surface water	Recycled water	Total (Ground, surface, and recycled water)
Agricultural -----	136,460	237,930	32,970	407,360
Commercial -----	3,640	30	-----	3,670
Domestic -----	71,770	3,850	-----	75,620
Hydroelectric -----	-----	74,200	-----	74,200
Industrial:				
Thermoelectric --	29,150	2,170	-----	31,320
	<u>1/21,910</u>	<u>1/425,900</u>	-----	<u>1/447,810</u>
Other uses -----	18,680	11,220	2,450	32,350
Total -----	<u>281,610</u>	<u>755,300</u>	-----	<u>1,072,330</u>
	(259,700)	(329,400)	(35,420)	(624,520)

1/ Seawater.

() Total does not include seawater.



EXPLANATION





-  Seawater
-  Recycled water
-  Surface water
-  Ground water

Figure 1. 1980 water use in Hawaii by type and source.

Table 2. Water use for individual islands by type and source
 [Quantities, in million gallons per year]

Water use	Hawaii	Maui	Lanai	Molokai	Oahu	Kauai	Niihau
(Ground water)							
Agricultural ---	1,720	47,300	330	140	70,310	16,650	10
Commercial -----	1,470	-----	---	---	410	1,760	--
Domestic -----	2,280	3,830	140	270	63,250	1,990	10
Industrial:							
Thermoelectric	24,740	-----	---	10	2,510	1,890	--
1/3,140	1/3,140	1/14,820	---	---	-----	1/3,950	--
Other uses ---	2,030	2,810	---	---	7,340	6,500	--
Total -----	35,380 (32,240)	68,760 (53,940)	470	420	143,820	32,740 (28,790)	20
(Surface water)							
Agricultural ---	3,630	129,130	---	990	16,150	88,030	--
Commercial -----	30	-----	---	---	-----	-----	--
Domestic -----	100	3,500	---	80	-----	170	--
Hydroelectric --	22,840	14,620	---	---	-----	36,740	--
Industrial:							
Thermoelectric	-----	-----	---	---	-----	2,170	--
1/425,900	-----	-----	---	---	1/425,900	-----	--
Other uses ---	4,080	2,910	---	30	-----	4,200	--
Total -----	30,680	150,160	---	1,100	442,050 (16,150)	131,310	--
(Recycled water)							
Agricultural ---	50	9,730	---	---	3,350	19,840	--
Industrial:							
Other uses ---	220	160	---	---	200	1,870	--
Total -----	270	9,890	---	---	3,550	21,710	--

1/ Seawater.

() Total does not include seawater.

Figure 2. Water use for individual islands by type and source.

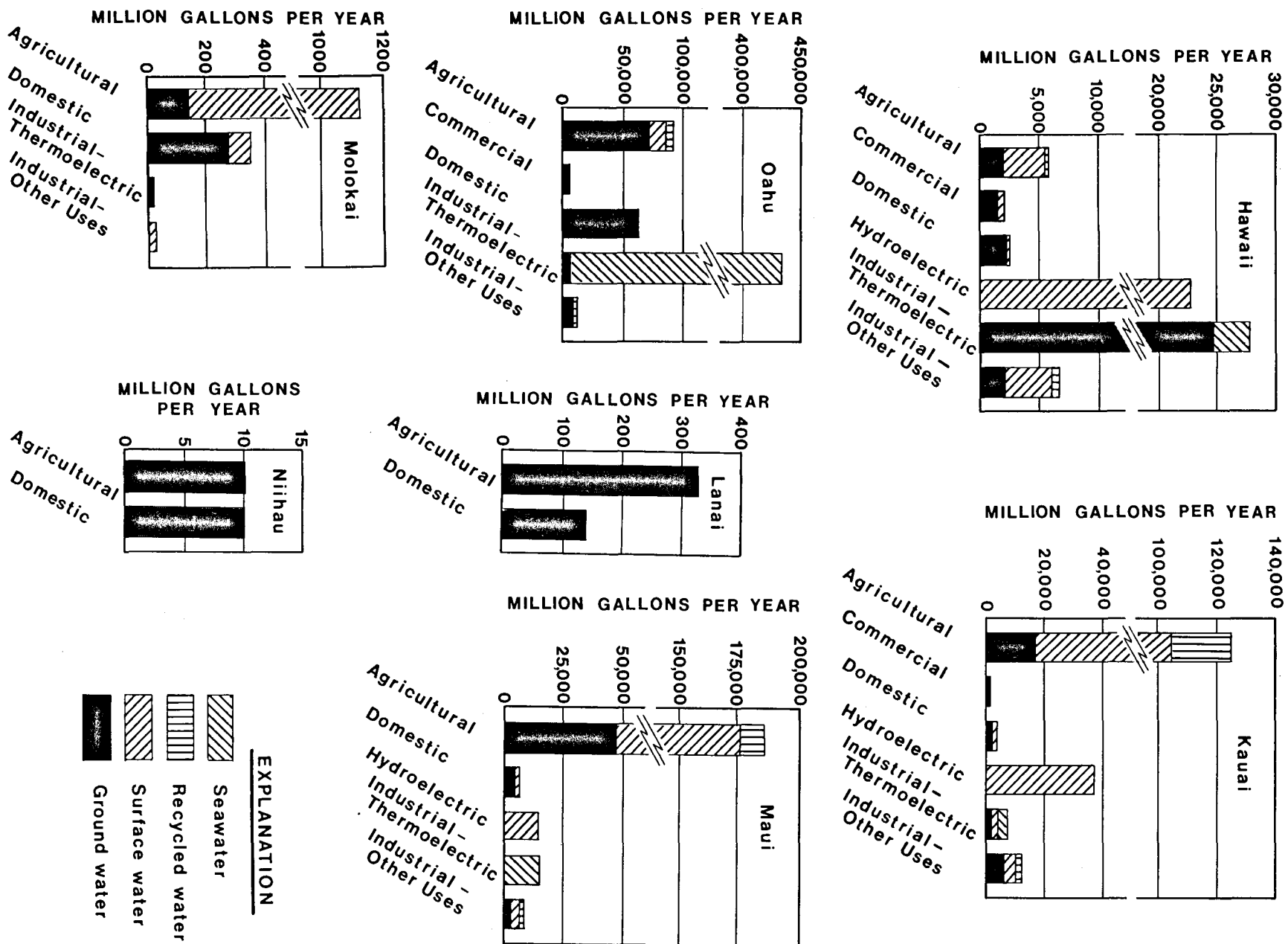


Table 3. Comparison of islands by type and source of water use
 [Quantities, in million gallons per year]

Island	Agricultural			Commercial			Domestic		Hydro- electric	Industrial: Thermoelectric		Industrial: Other uses		
	Ground water	Surface water	Recycled water	Ground water	Surface water	Recycled water	Ground water	Surface water	Surface water	Ground water	Surface water	Ground water	Surface water	Recycled water
Hawaii ---	1,720	3,630	50	1,470	30	-----	2,280	100	22,840	24,740 <u>1/3,140</u>	-----	2,030	4,080	220
Maui -----	47,300	129,130	9,730	-----	-----	-----	3,830	3,500	14,620	----- <u>1/14,820</u>	-----	2,810	2,910	160
Lanai ----	330	-----	-----	-----	-----	-----	140	-----	-----	-----	-----	-----	-----	-----
Molokai --	140	990	-----	-----	-----	-----	270	80	-----	10	-----	-----	30	-----
Oahu -----	70,310	16,150	3,350	410	-----	-----	63,250	-----	-----	2,510 <u>1/425,900</u>	-----	7,340	-----	200
Kauai ----	16,650	88,030	19,840	1,760	-----	-----	1,990	170	36,740	1,890 <u>1/3,950</u>	2,170	6,500	4,200	1,870
Nilhau ---	10	-----	-----	-----	-----	-----	10	-----	-----	-----	-----	-----	-----	-----

1/ Seawater.

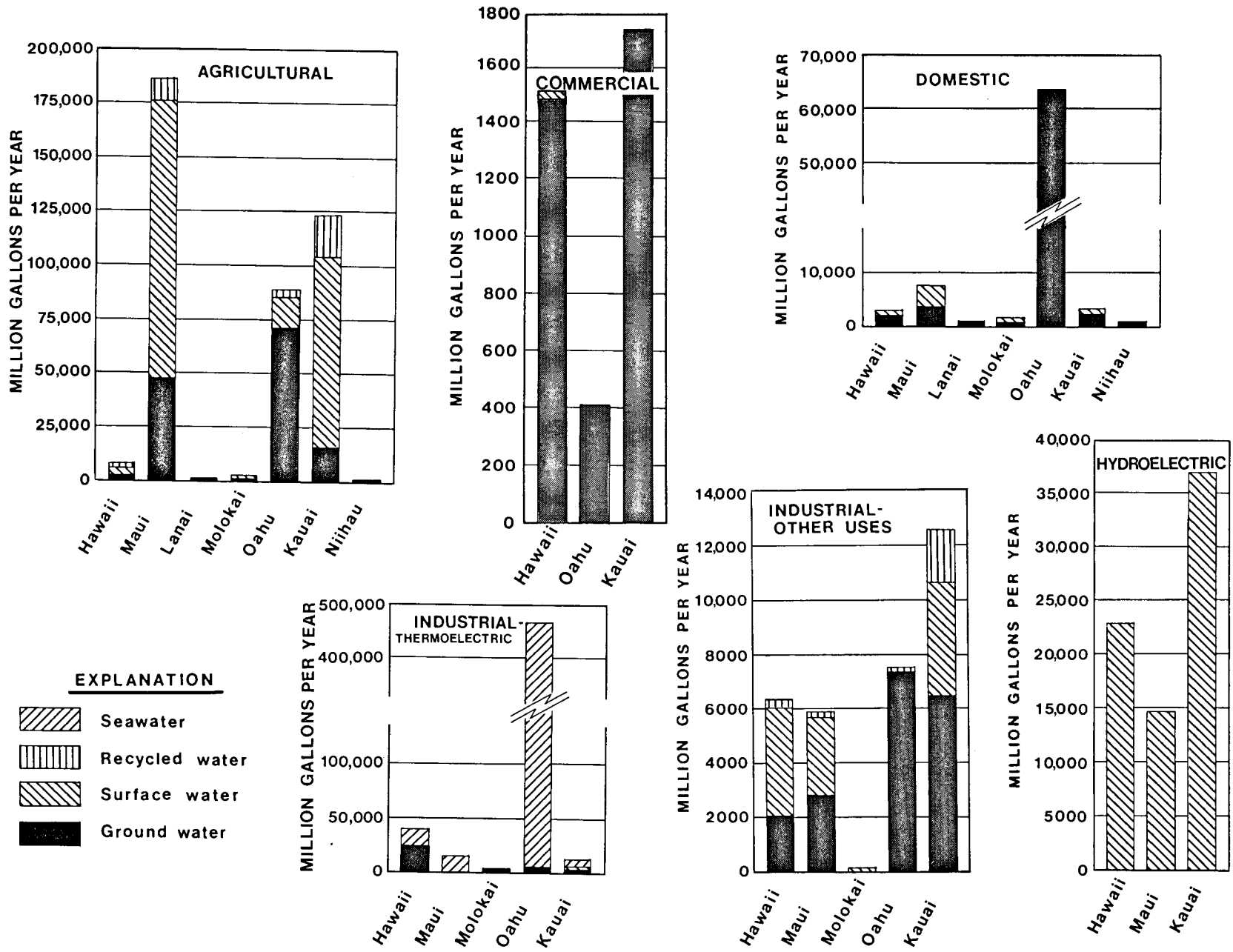


Figure 3. Comparison of islands by type and source of water use.

Table 4. Water use for hydrographic areas by type and source,
Island of Hawaii

Hydrographic areas ^{1/}	Water use	Quantities, in million gallons per year		
		Ground water	Surface water	Recycled water
I	Agricultural -----	70	3,630	40
	Commercial -----	40	-----	---
	Domestic -----	190	100	---
	Industrial:			
	Other uses -----	-----	2,070	---
II	Agricultural -----	220	-----	---
	Commercial -----	880	30	---
	Domestic -----	1,080	-----	---
	Hydroelectric -----	-----	22,840	---
	Industrial:			
	Thermoelectric ---	24,230	-----	---
Other uses -----	<u>2/3,140</u> 780	1,840	---	
III	Agricultural -----	500	-----	10
	Commercial -----	130	-----	---
	Domestic -----	370	-----	---
	Industrial:			
	Other uses -----	950	-----	190
IV	Agricultural -----	280	-----	---
	Commercial -----	380	-----	---
	Domestic -----	450	-----	---
	Industrial:			
	Other uses -----	-----	30	10
V	Agricultural -----	650	-----	---
	Commercial -----	40	-----	---
	Domestic -----	190	30	---
	Industrial:			
	Other uses -----	300	140	20

^{1/} See figure 4.

^{2/} Seawater.

Figure 4. Water use for hydrographic areas by type and source, Island of Hawaii.

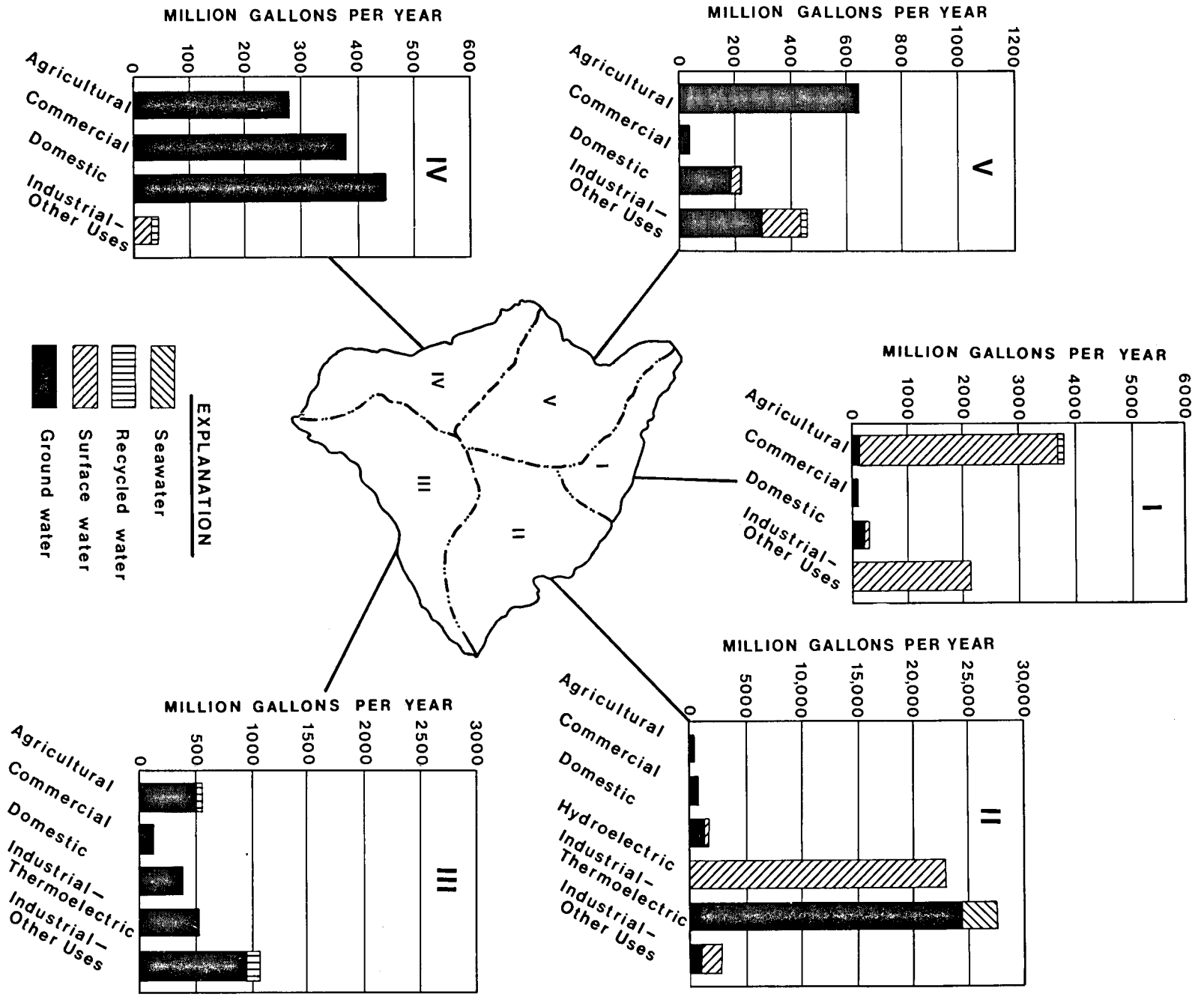


Table 5. Water use for hydrographic areas by type and source,
Island of Maui

Hydrographic areas ^{1/}	Water use	Quantities, in million gallons per year		
		Ground water	Surface water	Recycled water
I	Agricultural -----	4,680	25,320	4,600
	Domestic -----	470	990	-----
	Industrial:			
	Other uses -----	2,810	350	160
II	Agricultural -----	80	18,070	-----
	Domestic -----	3,340	1,830	-----
III	Agricultural -----	42,490	84,440	5,130
	Domestic -----	-----	680	-----
	Hydroelectric -----	-----	14,620	-----
	Industrial:			
	Thermoelectric ----- ^{2/} 14,820	-----	-----	-----
Other uses -----	-----	2,560	-----	
IV	Agricultural -----	50	1,280	-----
	Domestic -----	20	-----	-----
V	Agricultural -----	-----	20	-----

^{1/} See figure 5.

^{2/} Seawater.

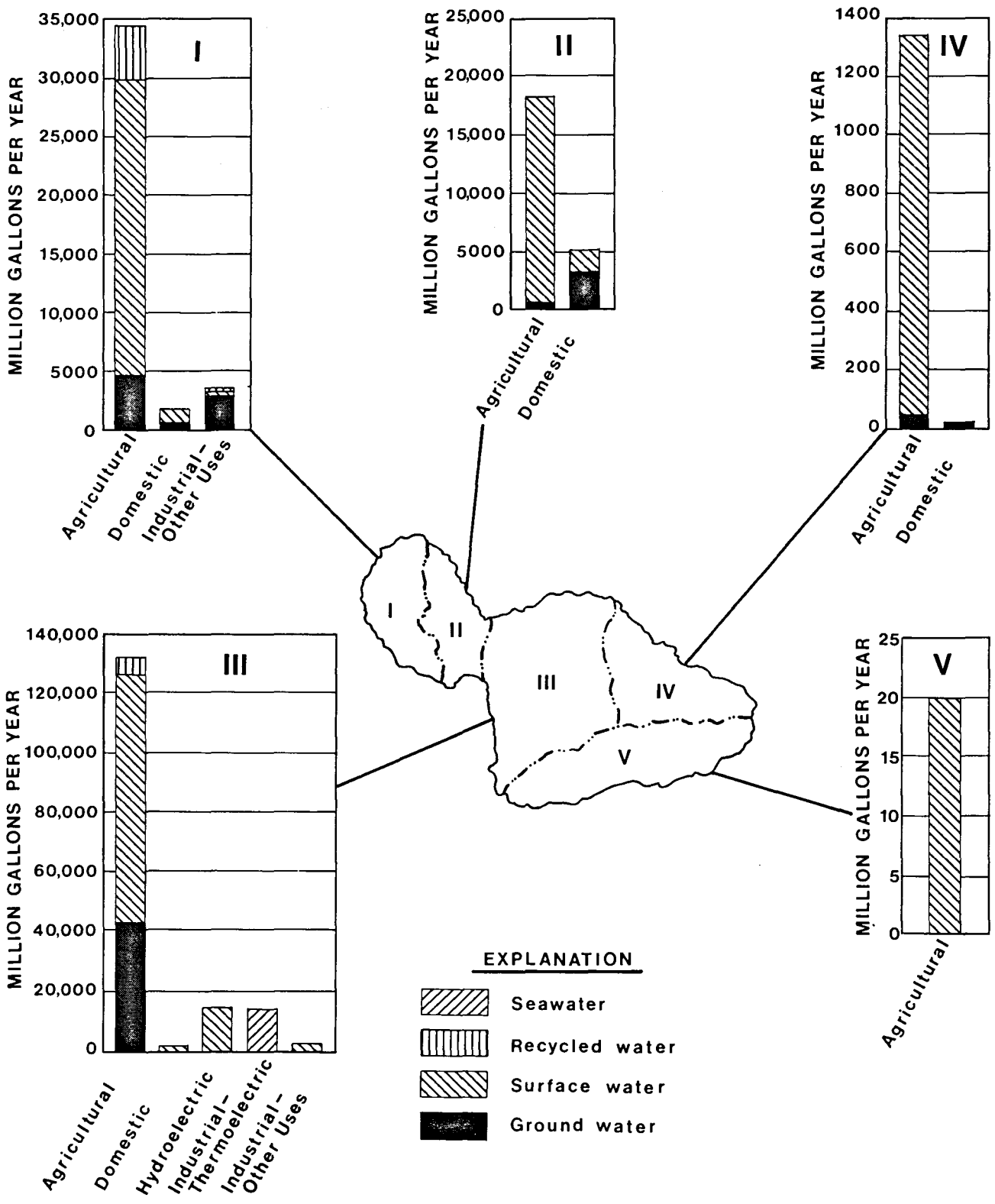


Figure 5. Water use for hydrographic areas by type and source, Island of Maui.

Table 6. Water use for hydrographic areas by type and source,
Island of Lanai

Hydrographic area ^{1/}	Water use	Quantities, in million gallons per year	
			Ground water
II	Agricultural -----		330
	Domestic -----		140

1/ See figure 6.

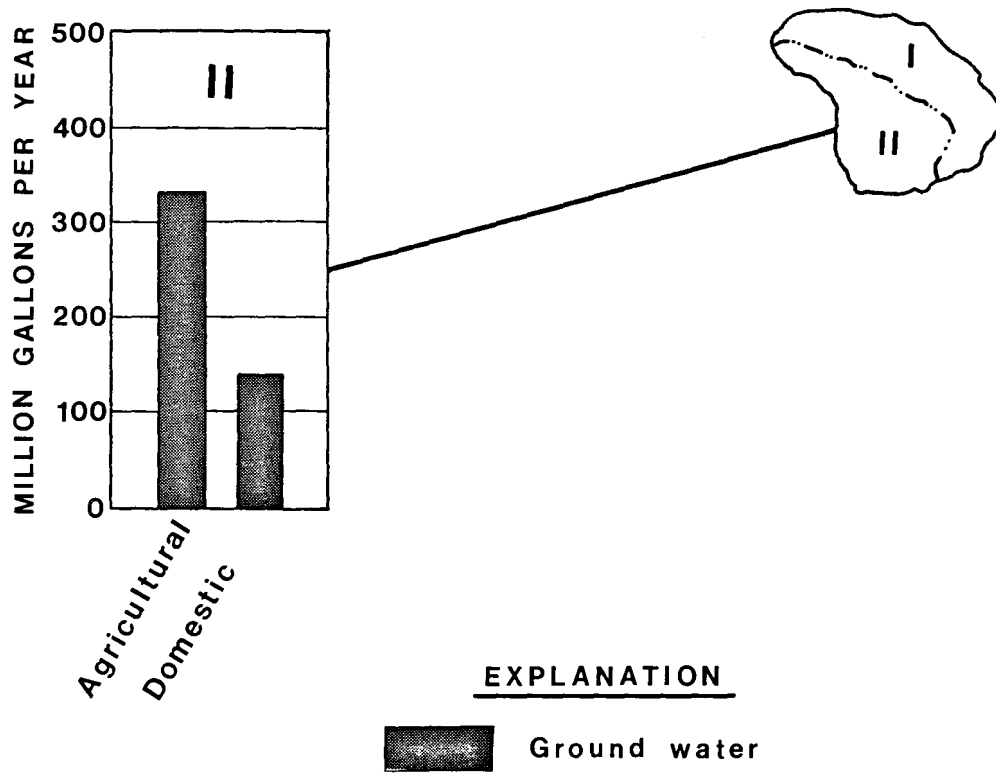


Figure 6. Water use for hydrographic areas by type and source, Island of Lanai.

Table 7. Water use for hydrographic areas by type and source,
Island of Molokai

Hydrographic areas ^{1/}	Water use	Quantities, in million gallons per year		
		Ground water	Surface water	Recycled water
I	Domestic -----	30	---	-----
II	Agricultural -----	140	10	-----
	Domestic -----	140	---	-----
III	Agricultural -----	---	980	-----
	Domestic -----	100	80	-----
	Industrial:			
	Thermoelectric -----	10	---	-----
	Other uses -----	---	30	-----

^{1/} See figure 7.

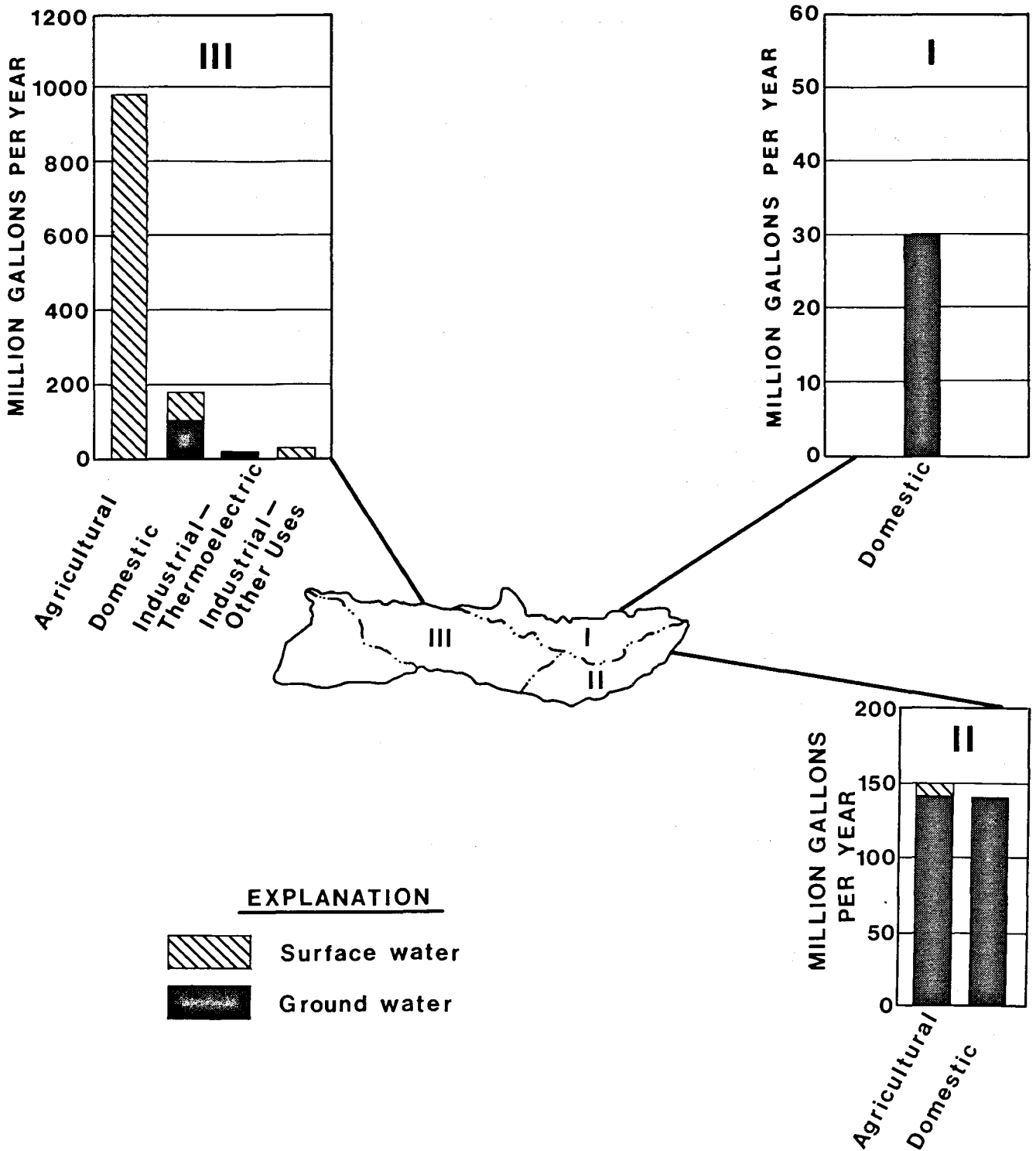


Figure 7. Water use for hydrographic areas by type and source, Island of Molokai.

Table 8. Water use for hydrographic areas by type and source,
Island of Oahu

Hydrographic areas ^{1/}	Water use	Quantities, in million gallons per year		
		Ground water	Surface water	Recycled water
I	Agricultural -----	560	-----	-----
	Domestic -----	2,200	-----	-----
II	Agricultural -----	90	80	-----
	Domestic -----	4,770	-----	-----
III	Agricultural -----	250	-----	-----
	Commercial -----	410	-----	-----
	Domestic -----	13,830	-----	-----
	Industrial:			
	Thermoelectric -----	-----	-----	180
		<u>2/</u> 51,310	-----	
	Other uses -----	1,220	-----	-----
IV	Agricultural -----	54,530	2,030	-----
	Domestic -----	36,990	-----	-----
	Industrial:			
	Thermoelectric -----	280	-----	20
		<u>2/</u> 374,590	-----	
	Other uses -----	4,410	-----	-----
V	Agricultural -----	750	-----	-----
	Domestic -----	1,550	-----	-----
VI	Agricultural -----	14,130	14,040	3,350
	Domestic -----	3,910	-----	-----
	Industrial:			
	Thermoelectric -----	2,230	-----	-----
	Other uses -----	1,710	-----	-----

1/ See figure 8.

2/ Seawater.

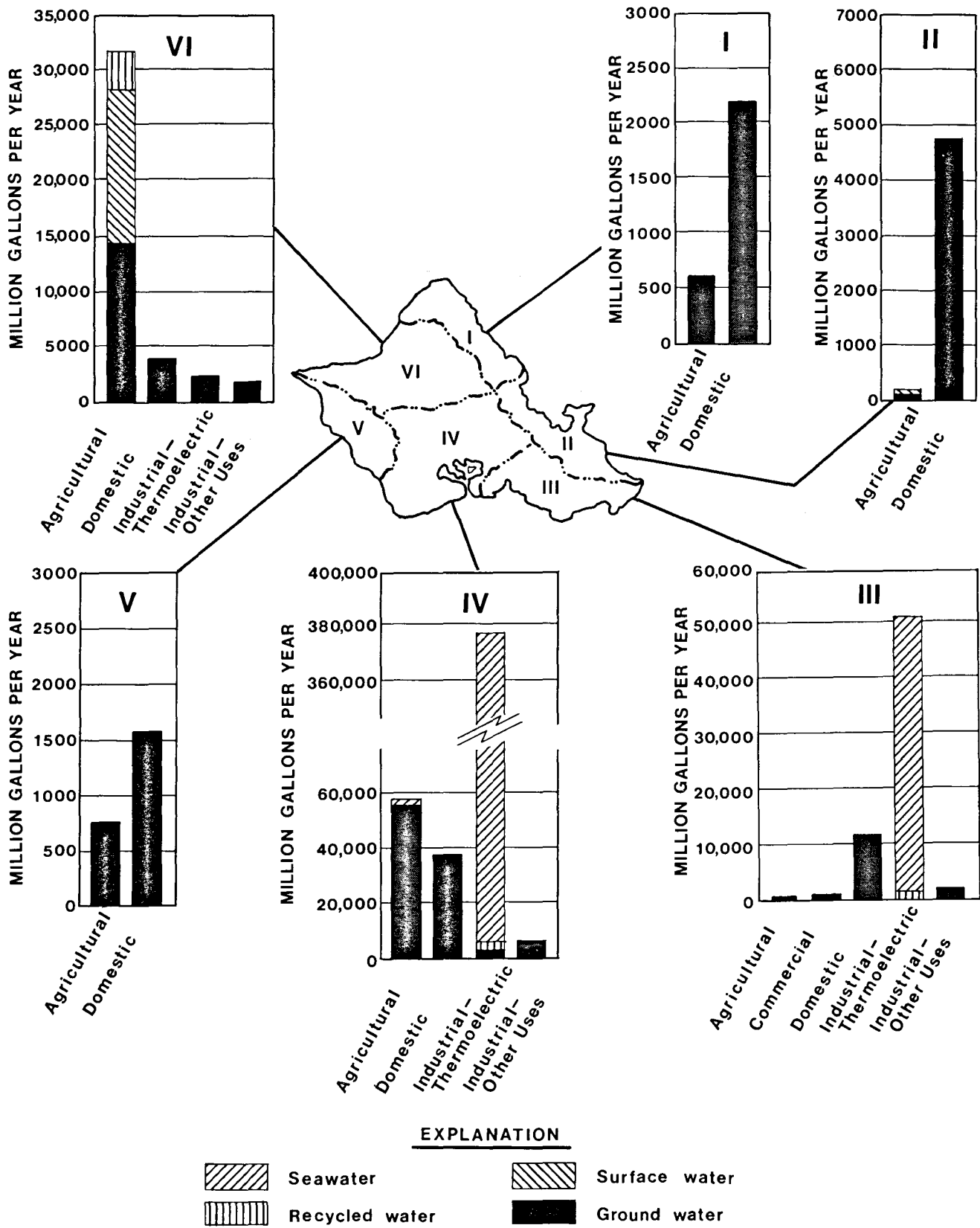


Figure 8. Water use for hydrographic areas by type and source, Island of Oahu.

Table 9. Water use for hydrographic areas by type and source,
Island of Kauai

Hydrographic areas ^{1/}	Water use	Quantities, in million gallons per year		
		Ground water	Surface water	Recycled water
I	Agricultural -----	160	2,370	-----
	Commercial -----	20	-----	-----
	Domestic -----	210	20	-----
	Hydroelectric -----	-----	12,000	-----
	Industrial:			
	Other uses -----	10	-----	-----
II	Agricultural -----	100	34,880	1,940
	Commercial -----	620	-----	-----
	Domestic -----	650	-----	-----
	Hydroelectric -----	-----	11,730	-----
	Industrial:			
	Thermoelectric -----	100	2,170	-----
Other uses -----	<u>2/3,950</u>	-----	-----	
III	Agricultural -----	9,660	8,790	3,120
	Commercial -----	200	-----	-----
	Domestic -----	380	-----	-----
	Hydroelectric -----	-----	1,630	-----
	Industrial:			
	Other uses -----	190	3,120	1,870
IV	Agricultural -----	40	21,460	510
	Commercial -----	20	-----	-----
	Domestic -----	60	150	-----
	Industrial:			
	Other uses -----	20	-----	-----
	V	Agricultural -----	6,690	20,530
Commercial -----		900	-----	-----
Domestic -----		690	-----	-----
Hydroelectric -----		-----	11,380	-----
Industrial:				
Thermoelectric -----		1,790	-----	-----
Other uses -----	6,040	1,080	-----	

1/ See figure 9.

2/ Seawater.

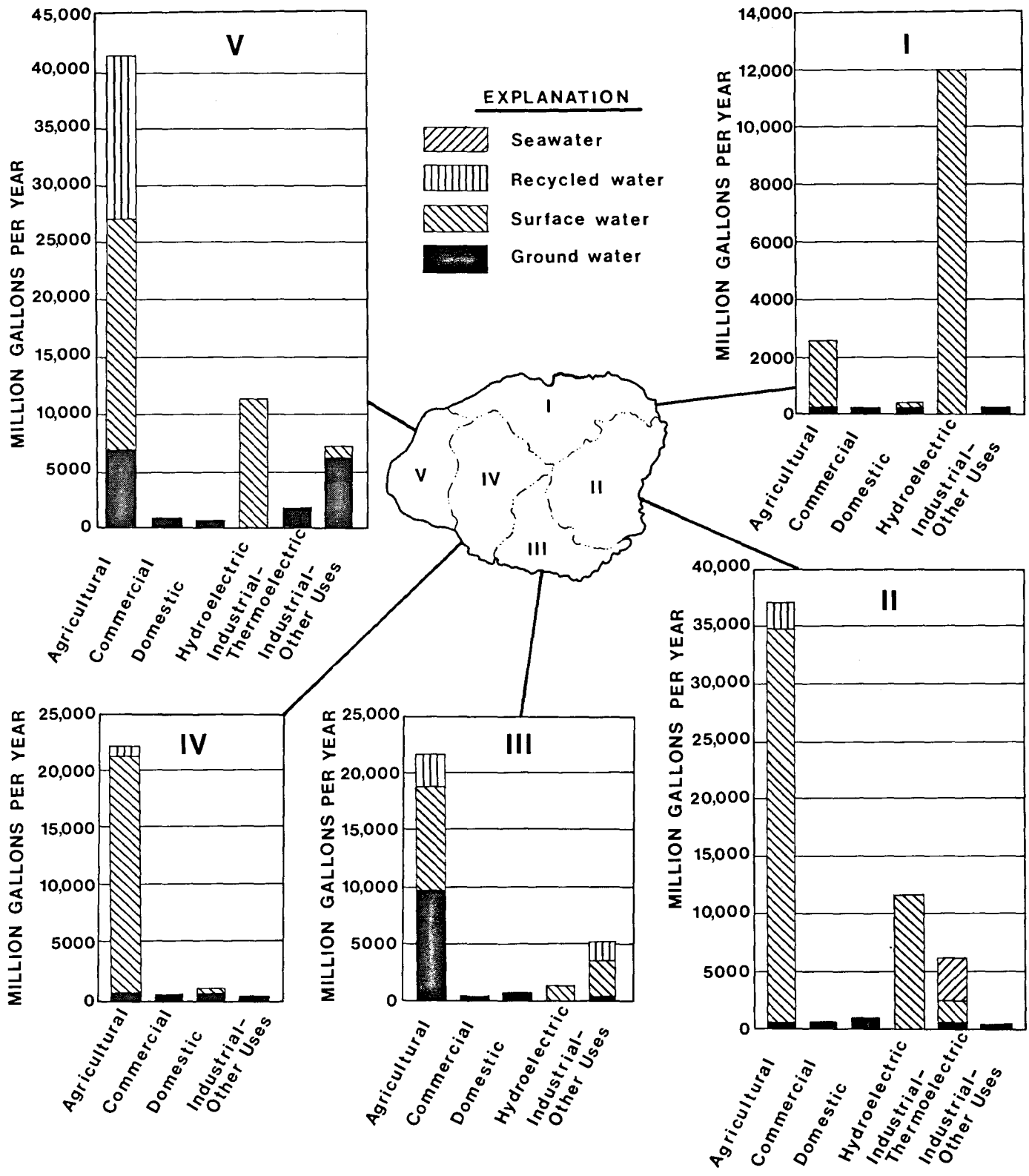


Figure 9. Water use for hydrographic areas by type and source, Island of Kauai.

Table 10. Water use by type and source, Island of Niihau

Island ^{1/}	Water use	Quantities, in million gallons per year	
			Ground water
Niihau	Agricultural -----		10
	Domestic -----		10

1/ See figure 10.

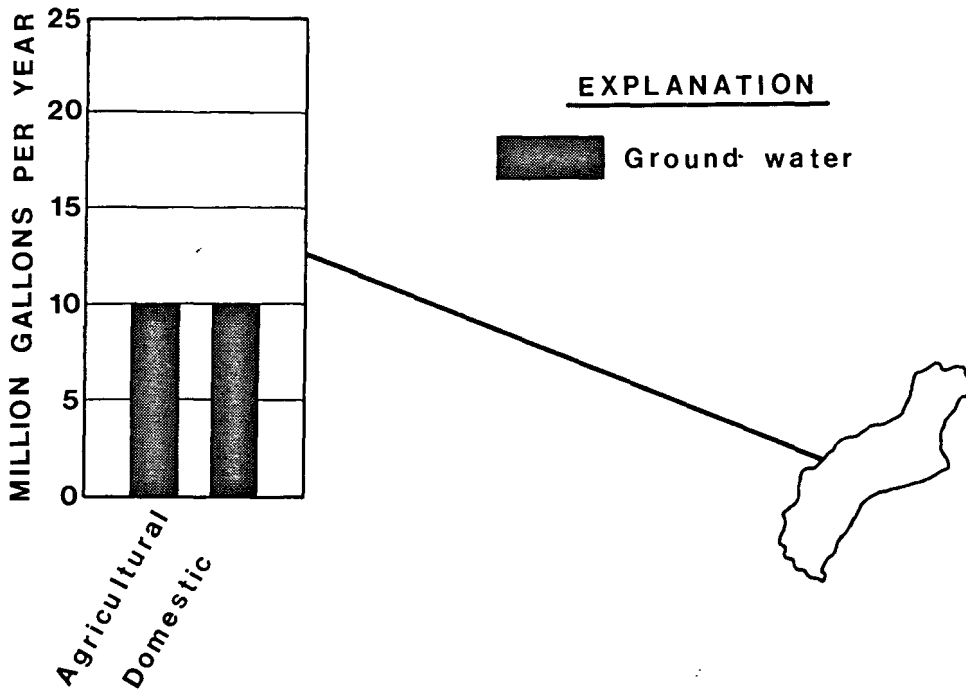


Figure 10. Water use by type and source, Island of Niihau.



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