Water Management and the Irrigation Water Requirement Estimation Decision Support System (IWREDSS)

Denise Tu, Hydrologist
Commission on Water Resource Management (CWRM)

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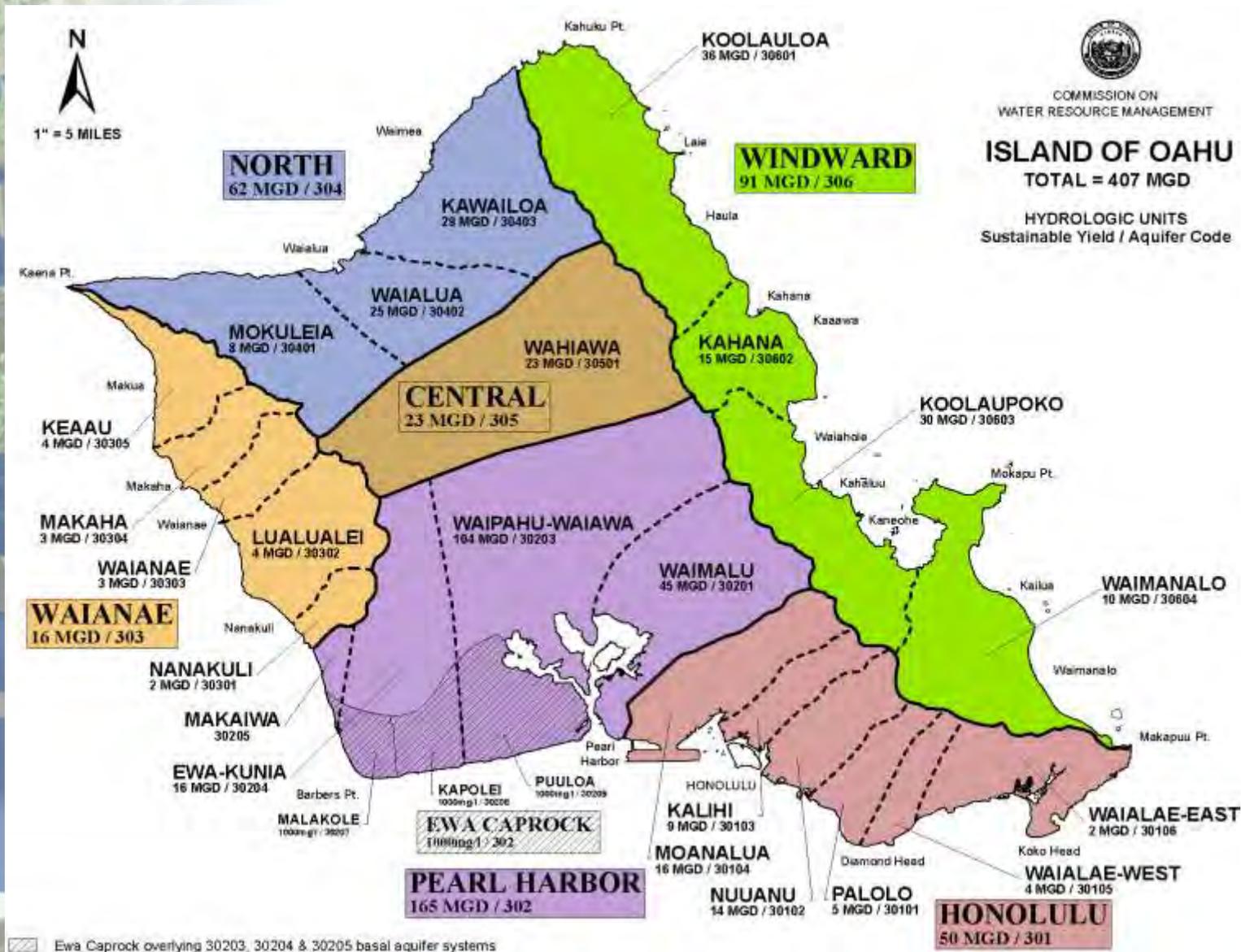# *CWRM Goals and Principles*

Protection of Public Trust

4 Public Trust Purposes

- Maintenance of Water in its Natural State
- Domestic use (individuals)
- Traditional and Customary Rights
- DHHL Reservations

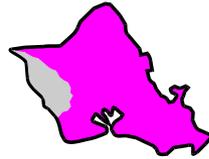**Ensure Reasonable and Beneficial Uses**

Ground Water Regulation Branch
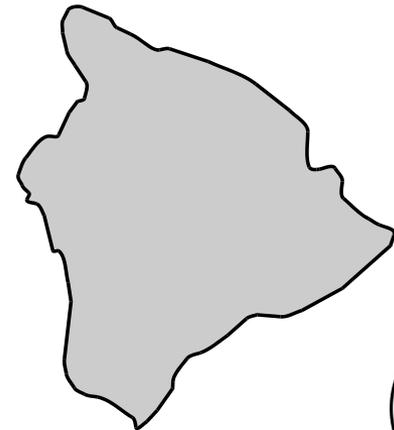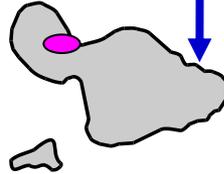
Ground Water Management Areas

Molokai

Maui

Oahu
(excluding Waianae)

Commission on Water Resource Management — State of Hawaii

Stream Protection and Management Branch

- Protect, enhance and reestablish practicable, beneficial instream use of water while seeking to obtain maximum reasonable and beneficial offstream uses.

- Regulate stream channel alterations and stream diversion works statewide via permits

- Manage using measurable interim instream flow standards watersheds statewide

Irrigation Water Requirement Estimation Decision Support System (IWREDSS)

Purpose

- Management tool
- To determine if water use request is reasonable.
- Comparative Analysis.

Water Use Permit (WUP)

Surface water or groundwater use permit for existing and new uses.

Irrigation Water Requirement Estimation Decision Support System (IWREDSS)

- GIS based soil water budget model
- Current plugin for ArcMap 9.3
- Uses climate, soil and crop databases
  - Evapotranspiration (ET) and rainfall weather stations throughout Hawaii
  - State soil layers and properties
  - Growing parameters for commercial and domestic crops
  - Common irrigation methods
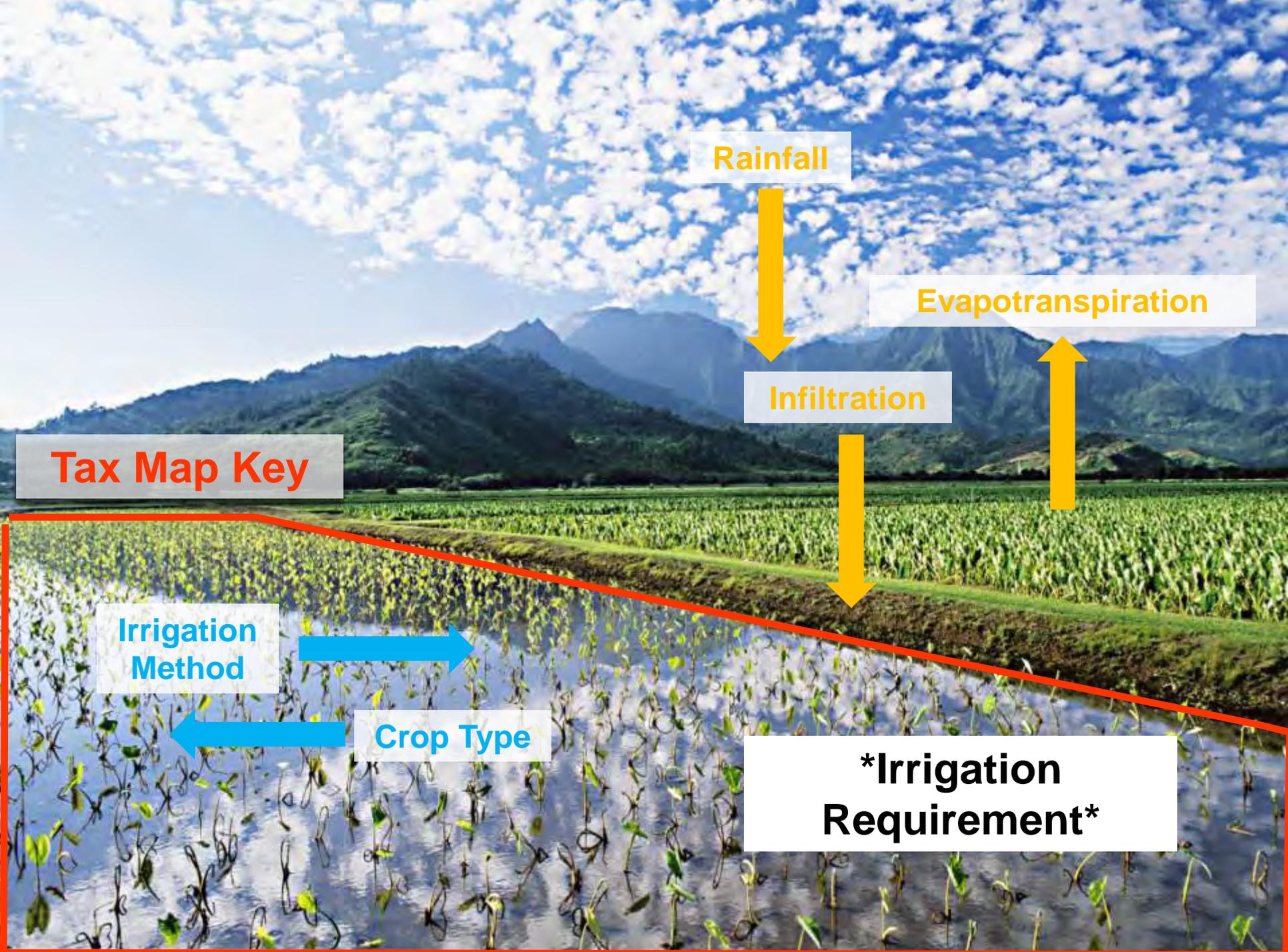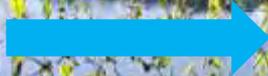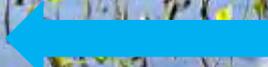
Permitting Decision Making

When the **Total Use** requested [MGD] > then the modeled **Irrigation Requirement** then

- The requested amount is **not** reasonable
- The modeled **Irrigation Requirement** is recommended

When the **Total Use** requested [MGD] < then the modeled **Irrigation Requirement** [MGD] then

- The requested amount is **reasonable**
- The requested **Total Use** [MGD] is recommended

Model Mechanics

- Select Property of interest by Tax Map Key (TMK)

- Using drop down options:
  - Crop/ Leaf Area Index
  - Irrigation Period
  - Irrigation System
  - SCS curve number
  - Depth to water table

IWREDSS Crop Types

IWREDSS Leaf Area Index

Crop Name	LAI	Source
Coffee	7.5	Malavolta, 2007
Citrus	7.0	Cohen et al. 1987
Papaya	4.0	Aiyelaagbe and Jalaoso, 1992
Eucalyptus	6	Steven & Toit 2006
Guava	6.5	Corea et al., 2004
Kikuyu Grass	2.0	(Suggested)
Dillisgrass	2.0	(Suggested)
Bermudagrass	2.2	Kiniry et al., 2007
St. Augustina	2.0	(Suggested)
Zoysiagrass	2.0	Agata et al., 1989
Alfafa	2.99	Sanpedro et al., 2007
Sudan Grass	3.25	Denson & Russotti, 1997
Banana	4.0	Demrati, et al., 2007
Cabbage	7.50	Gimenez et al., 2002
Onion	2.30	Sanpedro et al., 2007
Ginger, Potato	7.30	Wu et al., 2007
Lettuce	1.40	Gimenez et al., 2002
Other melon	2.70	Orgaza et al., 2005
Pineapple	7.5	Bartholomew & Malézieux, 1994
Seed Corn	4.93	Sanpedro et al., 2007
Sugar Cane	5.5	Teruel, et al., 1997
Sweet Potato	5.40	Sanpedro et al., 2007
Taro	0.49	Sanpedro et al., 2007
Tomato	3.00	Scholberg et al., 2000

IWREDSS Irrigation Systems

- Trickle, drip
- Trickle, spray
- Multiple sprinkler
- Sprinkler, container nursery
- Sprinkler, large guns
- Seepage, sub-irrigation
- Crown flood
- Flood (taro)

IWREDSS Soil Conservation Service (SCS) runoff curve number

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{1000}{CN} - 10$$

Q= runoff (in)

P= rainfall (in)

S= max retention

- Coefficient of runoff potential (after processes such as evapotranspiration and surface storage are accounted for)

- Higher CN value = High Runoff potential.

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

Example Groundwater Permit

Requested amount: 0.032 MGD

Item	Wahiawa Aquifer System (MGD)
Sustainable Yield	23
Existing Water Permits	22.4
Subtotal	**0.602**
Other completed applications	0
Example Application	0.032
Subtotal (potential available or deficit)	**0.57**

Example Groundwater Permit

Agricultural Water use request: 26,000 gpd

Crops	Irrigation Requirement/Acre (gpd)	Irrigated acreage (acres)	IR (gpd)
Citrus	2,805	2.25	6,311
Mango	2,862	2.25	6,440
Avocado	2,907	2.25	6,541
Coconut	2,983	2.25	6,712
		Crop IR	**26,003**

Agricultural Water Use Decision

When the **Total Use** requested [MGD] > then the modeled **Irrigation Requirement** then

- The requested amount is **not** within reason
- The modeled **Irrigation Requirement** is recommended

When the **Total Use** requested [MGD] < then the modeled **Irrigation Requirement** [MGD] then

- The requested amount is **reasonable**
- The requested **Total Use** [MGD] is recommended

Agricultural Water Use Decision

Agricultural water use request: 26,000 gpd

Modeled irrigation requirement: 26,003 gpd

Water use request < Modeled irrigation requirement

Therefore:

- Water use request is reasonable
- 26,000 gpd is recommended

Example Groundwater Permit

Approved Water Use amount: 29,000 gpd

Item	Requested (gpd)	Recommended (gpd)
Domestic	400	400
Livestock	300	75
Farm building	400	400
Crops	26,000	26,000
Reservoir Evaporation	1,666	1,666
Initial Reservoir Filling	2739	0
Total	**31,505**	**28,541**

Water Management and IWREDSS Conclusions

- IWREDSS is one component helping to manage and sustain water resources.

- Modeled irrigation requirements are used for comparative analysis.

- IWREDSS helps determine if **agricultural** water withdrawal/use are reasonable.

Website: http://www.hawaii.gov/dlnr/cwrm
E-mail: dlnr.cwrm@hawaii.gov

IWREDSS Model Validation
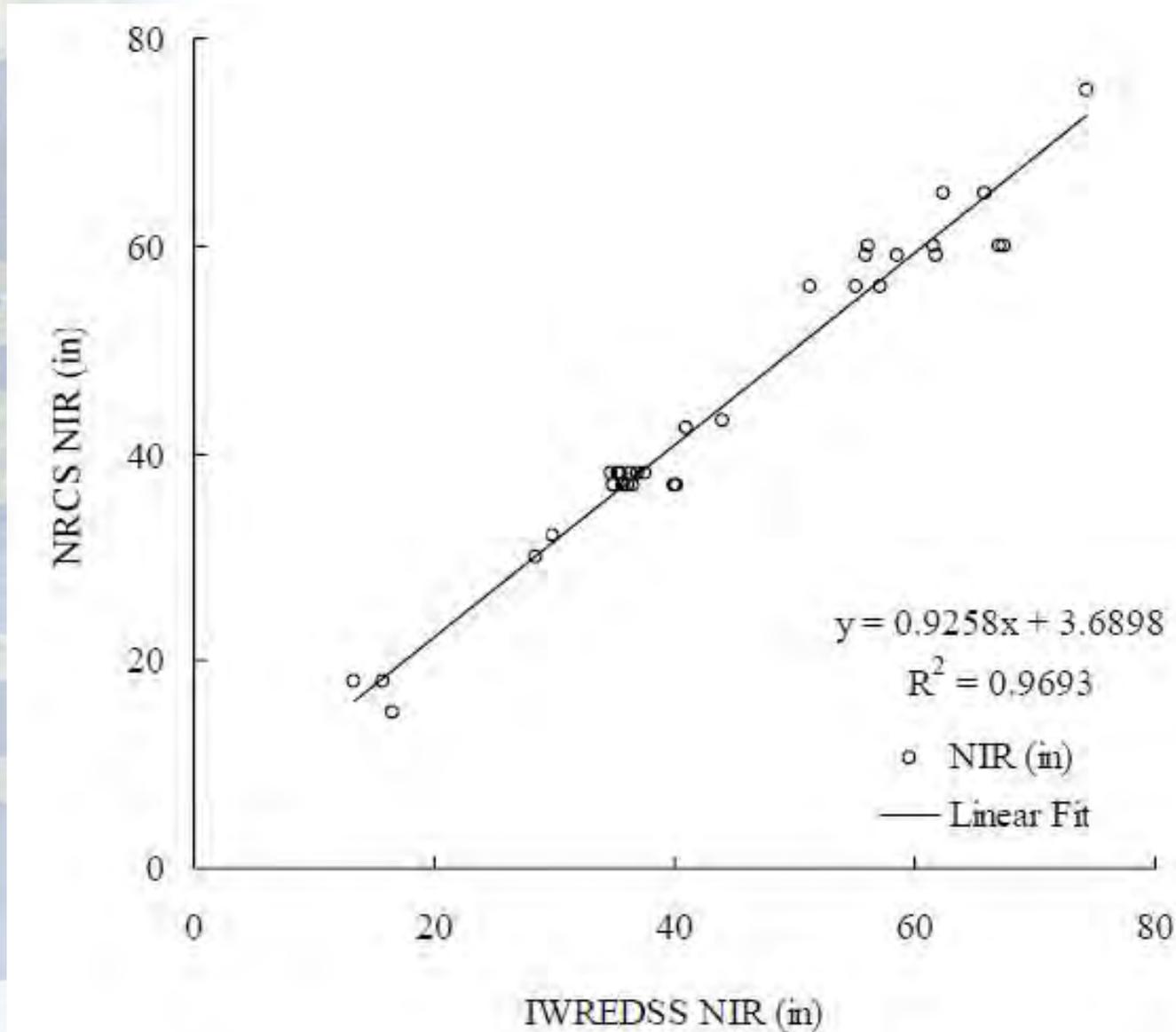
Surface Water Management Example

Item	TMK	Requested Quantity (gpd)	Net Acreage
Agriculture	015	80,590	0.15
Agriculture	016	177,300	0.33
Agriculture	017	214,909	0.4
Domestic	017	1,200	0.4
	Total AGR	**472,799**	
	Total Requested	**473,999**	

Surface Water Management Example

Tax Map Key (TMK)	Crop	Net Irrigated Acreage	IR/ Acreage (GPD)	IR (GPD)
015	Wetland Kalo	0.15	8,260	1,270
016	Wetland Kalo	0.33	8,040	2,650
017	Ti	0.13	5,960	790
017	Banana	0.13	4,500	600
017	Papaya	0.13	2,530	340
017	Wetland Kalo	0.4	6,200	2,480
			Total IR	8,130