PAN TO PENMAN-MONTEITH

Transition of Irrigation Coefficients in Israel

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Agrometeorologists for Farmers
In Hotter, Drier, Wetter Future

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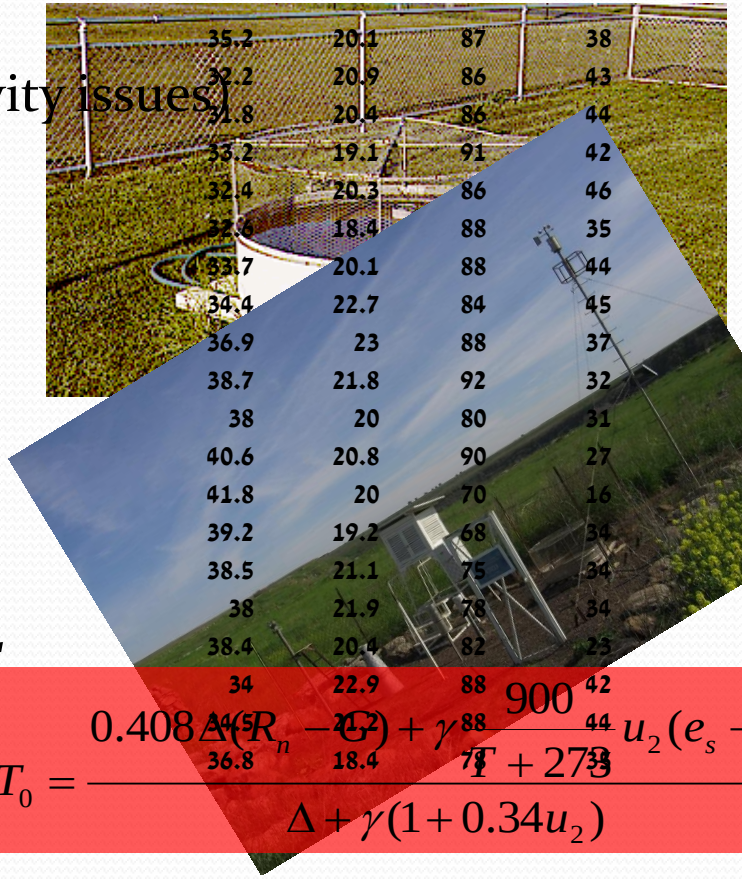
Pan to Penman-Monteith

- Motivations
- Making the change
- Conclusions

Motivations:

- **20th century:**
  - Widespread Pan-A use (Representativity issues)
  - Irrigation coefficients (late 1960's)
  - P-M equation growing use
- **21st century:**
  - AWS become wide spread
  - Automatic Irrigation systems
  - Abundance of data available to user (ASCE/FAO/PAN/Grass/Alfalfa)



$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s -}{\Delta + \gamma(1 + 0.34u_2)}$$

Tower of Babel

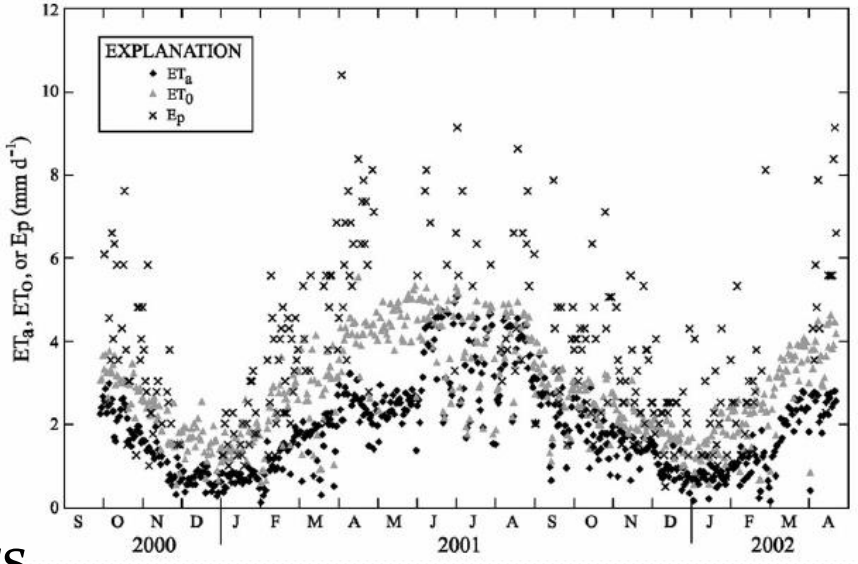
Making the change

- **Recognizing the confusion– Extension Service**
- **Commitment of all organizations to process:**
  - Ministry of Agriculture
  - Extension Service
  - ARO (Agriculture Research Organization)
  - Regional R&D Organizations
  - Academia
  - Farmers
  - Israel Meteorological Service (IMS)
  - Private Sector

UNIFORMITY

Making the change

- **Chosen ETo method – FAO-56**
  - International standard
  - Robustness
  - Easy transition –
    can be compared to the pan.
  - On line real time data.
  - Direct connection to computers and communication systems
  - Can be gridded and modeled – GIS, forecast



Sumner, D.M., and J. M. Jacobs, 2005. *J. of Hydrology,* 308, 81-104.

Making the change

- **Seamless transition – "transparent" to farmer**
- **Quick transition**
  - No time for new experiments
  - Use available data
  - Irrigation amounts not to be changed
  - Replace ETo ➔ Replace crop coefficients

Making the change - Technically

- Irrigation amounts – not to be changed
- Changing ETo and crop coefficients only:

$$I = K_{cpan} * ET_{pan} = K_{cpm} * ET_{pm}$$

$$K_{cpm} = K_{cpan} / Ratio_{ET}$$

- I – Irrigation under optimal conditions
- K_{cpan} – Pan irrigation coefficient
- E_{pan} – Pan evaporation
- K_{cpm} – Calculated PM coefficient.
- E_{pm} – Calculated PM evapotranspiration.
- $Ratio_{ET} – E_{pm}/E_{pan}$

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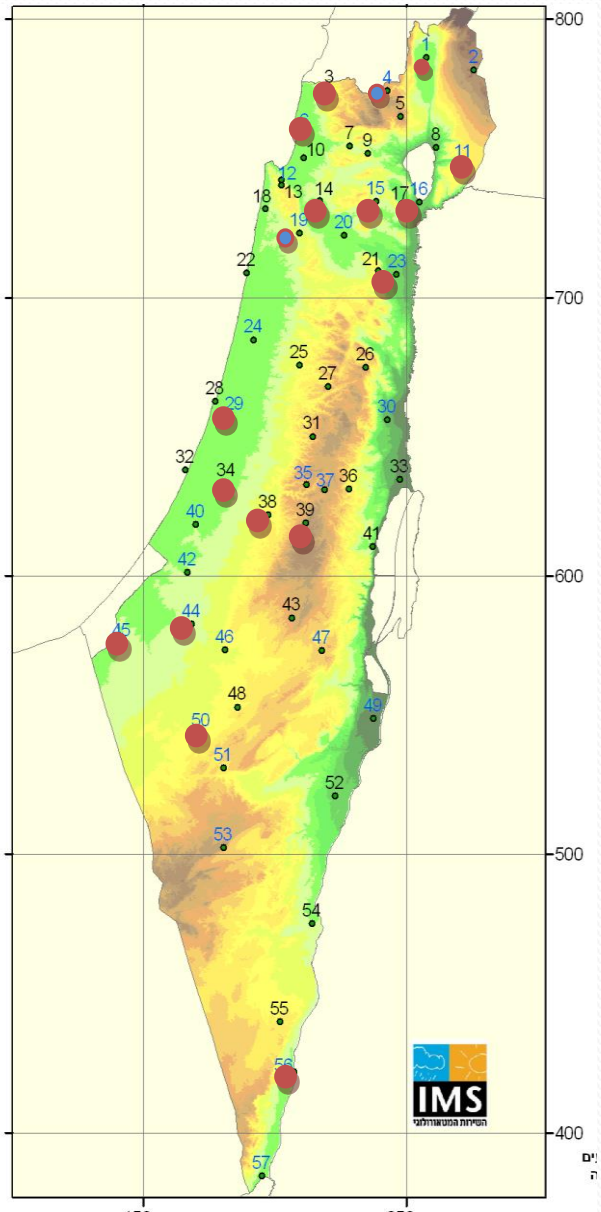
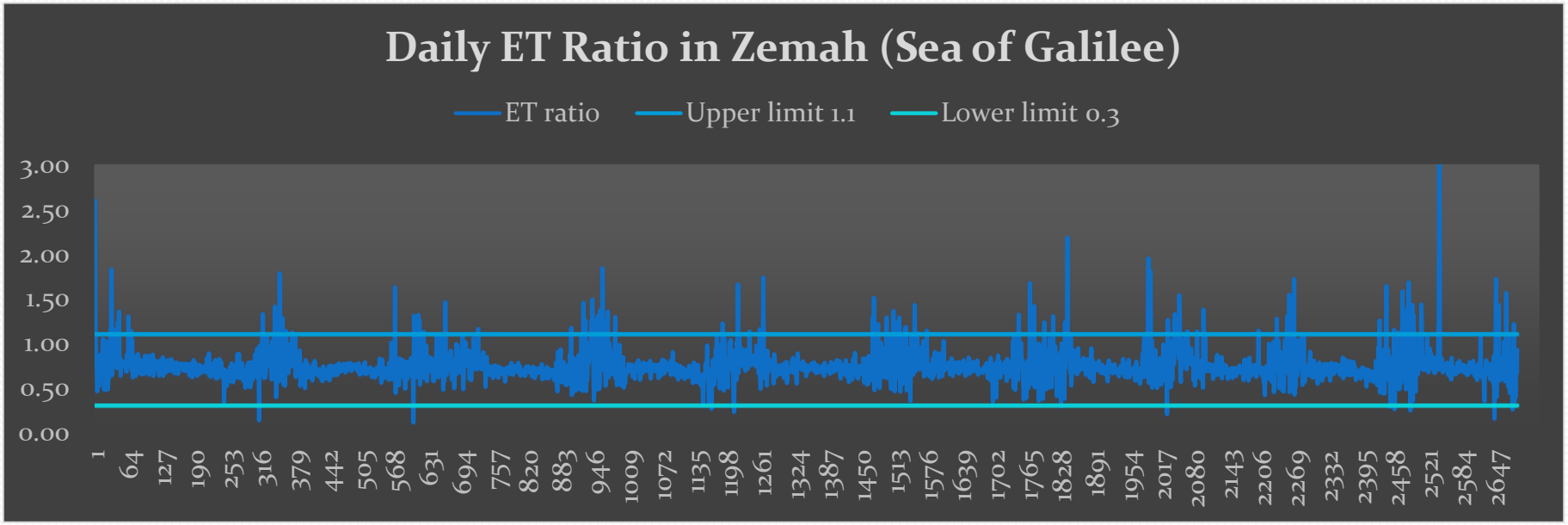
Making the change - Calculating ETo ratio

- Defining agro-climatic regions
- Sufficient PAN-A & AWS data
- 5-10 years data
- IMS & Ministry of Agriculture
- 57 AWS & 17 PAN-A sites
- Scrutinizing PAN-A data
- Averaging daily data over a month



Making the change - Calculating ETo ratio

- **Scrutinizing PAN-A data**
  - Missing data
  - Rain days
  - Accumulated data
  - Measurement errors



Making the change - Calculating ETo ratio

Acre	Newe Yaar	Gilat	Rosh Zurim	Yotvata	Eilon	Kefar Blum	Zemah	Eden Farm	Hafetz Hayim	Bet Dagan	Avne Etan	Negev Pl.	Besor	Month
	0.95	0.79	0.78	0.68	0.74	0.79	0.78	0.81	0.82	0.74	0.79	0.76	0.82	1
0.76	0.95	0.83	0.80	0.68	0.76	0.81	0.76	0.82	0.84	0.78	0.81	0.79	0.87	2
0.76	0.92	0.81	0.81	0.63	0.79	0.81	0.78	0.79	0.86	0.78	0.80	0.76	0.84	3
0.78	0.92	0.76	0.85	0.60	0.79	0.81	0.75	0.75	0.84	0.78	0.82	0.71	0.79	4
0.77	0.88	0.74	0.87	0.60	0.82	0.78	0.73	0.72	0.86	0.79	0.80	0.69	0.78	5
0.77	0.83	0.68	0.89	0.60	0.83	0.73	0.72	0.69	0.84	0.79	0.80	0.69	0.77	6
0.77	0.82	0.69	0.90	0.58	0.85	0.74	0.72	0.69	0.82	0.79	0.82	0.68	0.76	7
0.76	0.80	0.68	0.89	0.59	0.88	0.73	0.71	0.71	0.83	0.78	0.82	0.68	0.76	8
0.73	0.80	0.67	0.87	0.60	0.84	0.71	0.69	0.72	0.81	0.74	0.79	0.68	0.76	9
0.74	0.84	0.66	0.82	0.61	0.77	0.73	0.67	0.75	0.83	0.74	0.78	0.71	0.75	10
0.72	0.93	0.67	0.77	0.63	0.72	0.80	0.69	0.77	0.83	0.74	0.79	0.68	0.81	11
0.74	0.93	0.69	0.77	0.66	0.71	0.83	0.72	0.77	0.83	0.70	0.77	0.70	0.79	12

Making the change – Calculating ETo ratio

$$K_{cpm} = K_{cpan} / Ratio_{ET}$$

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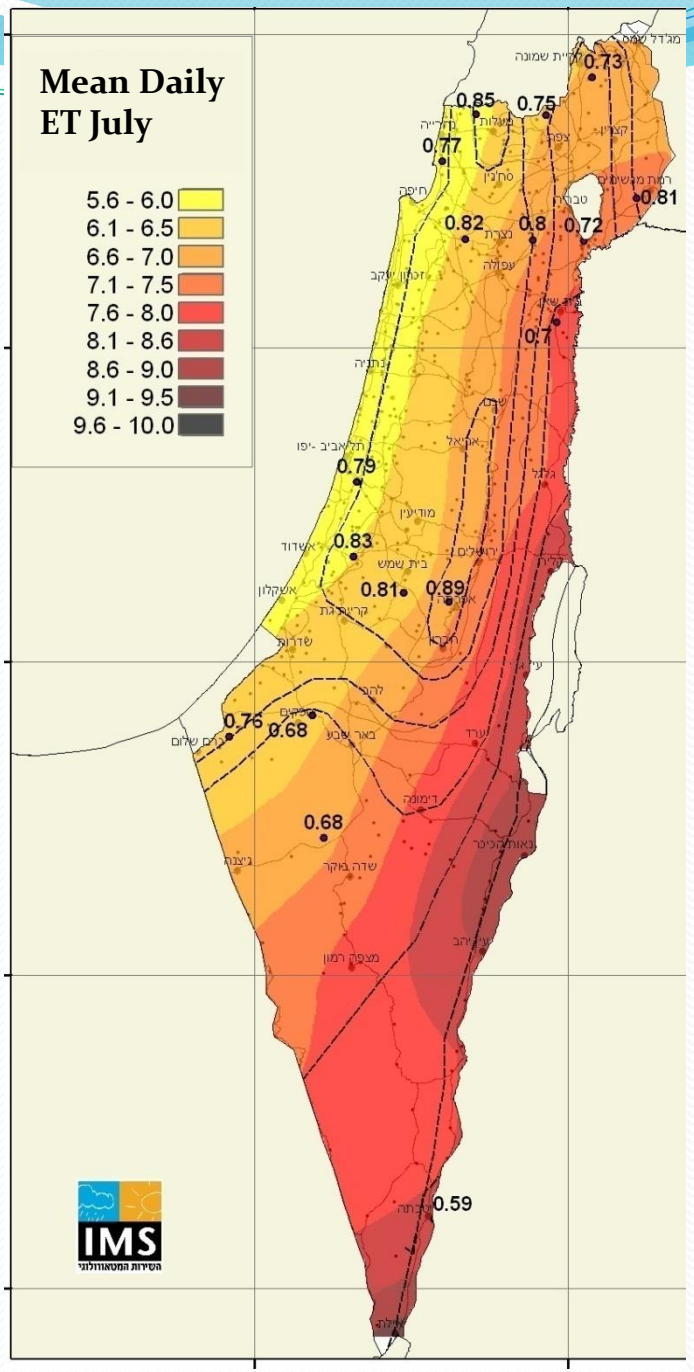
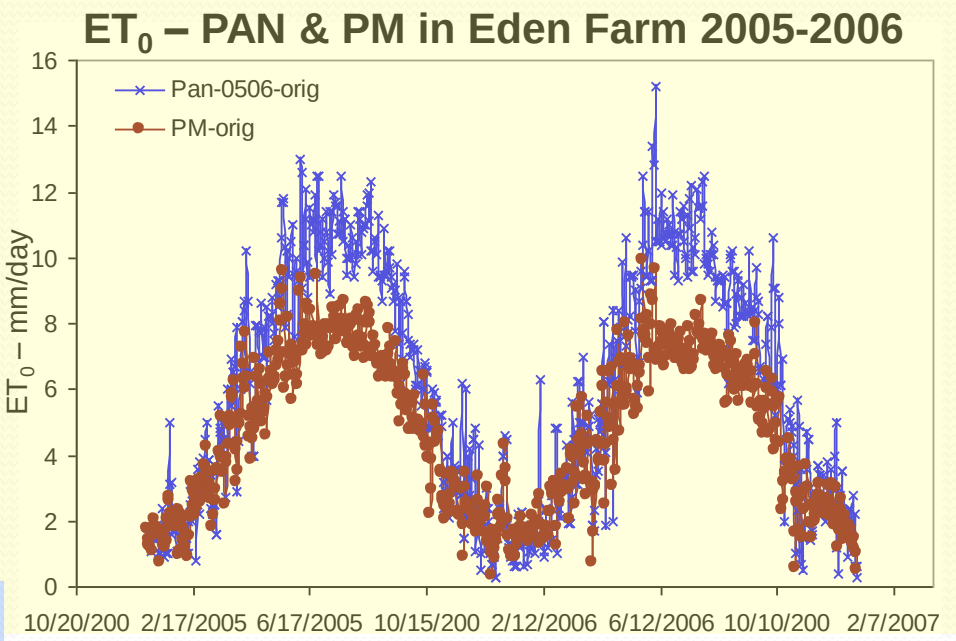
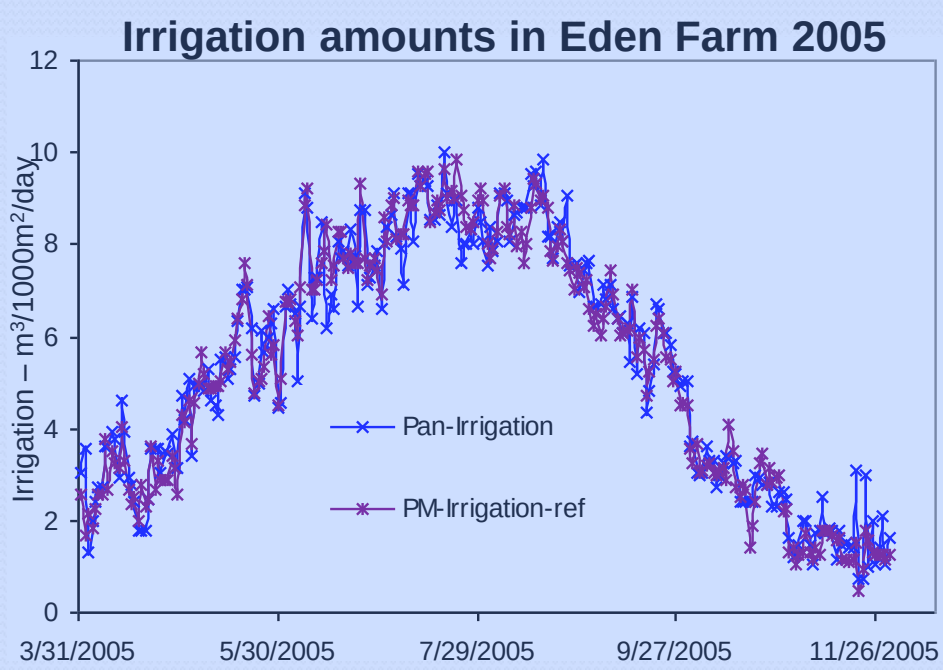


Making the change - Calculating crop coefficients

DATE	PAN COEFFICIENT	PM COEFFICIENT
1-15 APRIL	0.35	0.46
16-30 APRIL	0.4	0.53
1-15 MAY	0.45	0.56
16-30 MAY	0.5	0.67
1-15 JUNE	0.55	0.71
16-30JUNE	0.6	0.77
JULY	0.6	0.79
AUGUST	0.65	0.86
SEPTEMBER	0.65	0.94
OCTOBER	0.65	0.94
Coefficients for Irrigation of Banana in En Carmel		

Making the change – from ET_0 to Irrigation





Making the change - PM Based Water Chart

		Banana - Coastal	AWS	Total Irrigation (m^3/Season)	Banana Irrigation Chart	
				1158		
		Acre	Acre		Type in Weekly Calculated ET	Daily Irrigation Amount M^3/Dunam/Day
Month	Decada	PM Coefficient	Mean Daily ET	m^3/day mm		
March	1	0.00	3.40	0.0		0.0
	2	0.00	3.40	0.0		0.0
	3	0.55	3.40	1.9	12.0	0.9
April	1	0.50	4.30	2.2	10.0	0.7
	2	0.50	4.30	2.2	15.0	1.1
	3	0.55	4.30	2.4	23.0	1.8
May	1	0.65	5.00	3.3	29.0	2.7
	2	0.75	5.00	3.8	28.0	3.0
	3	0.80	5.00	4.0	30.0	3.4
June	1	0.90	5.50	5.0	32.0	4.1
	2	0.95	5.50	5.2		0.0
	3	1.00	5.50	5.5		0.0
July	1	1.15	5.60	6.4		0.0
	2	1.20	5.60	6.7		0.0
	3	1.30	5.60	7.3		0.0
August	1	1.35	5.40	7.3		0.0
	2	1.35	5.40	7.3		0.0
	3	1.40	5.40	7.6		0.0
September	1	1.35	4.80	6.5		0.0
	2	1.40	4.80	6.7		0.0
	3	1.40	4.80	6.7		0.0
October	1	1.35	3.60	4.9		0.0
	2	1.25	3.60	4.5		0.0
	3	1.15	3.60	4.1		0.0
November	1	1.20	2.70	3.2		0.0
	2	0.00	2.70	0.0		0.0
	3	0.00	2.70	0.0		0.0
December	1	0.00	2.10	0.0		0.0
	2	0.00	2.10	0.0		0.0
	3	0.00	2.10	0.0		0.0

Making the change – The real challenge

משרד החקלאות ופיתוח הכפר
שירות ההדרכה והמקצוע
The Agricultural Extension Service of Israel

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Irrigation coefficients

There are several methods for calculating potential evaporation from meteorological stations. FAO 56 Is the accepted method by the Israeli Meteorological Service and the Ministry of Agriculture and the World. At the same time, there is a method to calculate daily evaporation (or during the day) accepted by the Northern R & D. All irrigation coefficients accompanying Excel files relate to evaporate calculated accepted by the Meteorological Service and the Ministry of Agriculture.

Avocado irrigation coefficients
The author's name: which Eizenkot
Date of publication: 31/12/2012
Type of content: walling

Irrigation coefficients Bugs
The author's name: which Eizenkot
Date of publication: 01/02/2013
Type of content: walling

Irrigation coefficients peach
The author's name: which Eizenkot
Date of publication: 04/03/2013
Type of content: walling

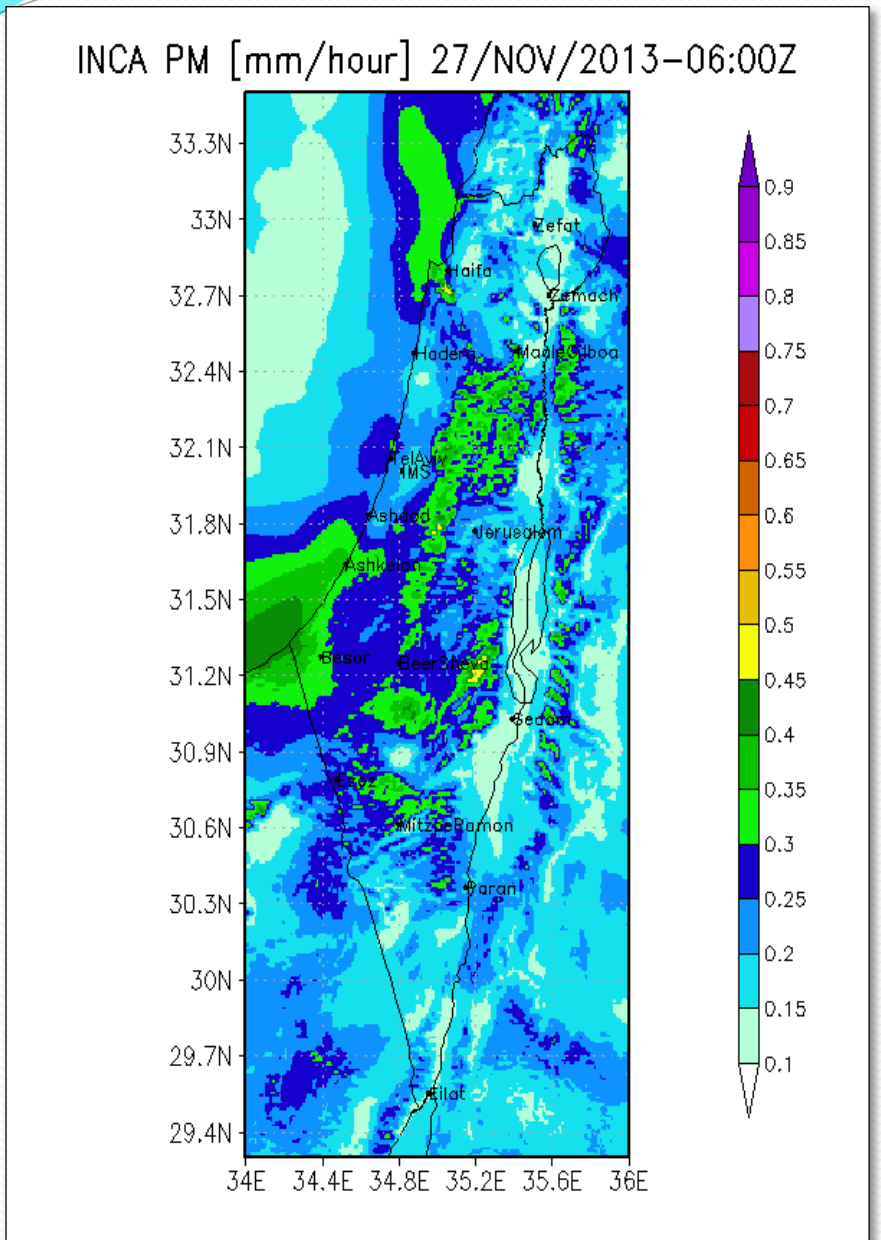
Professional information

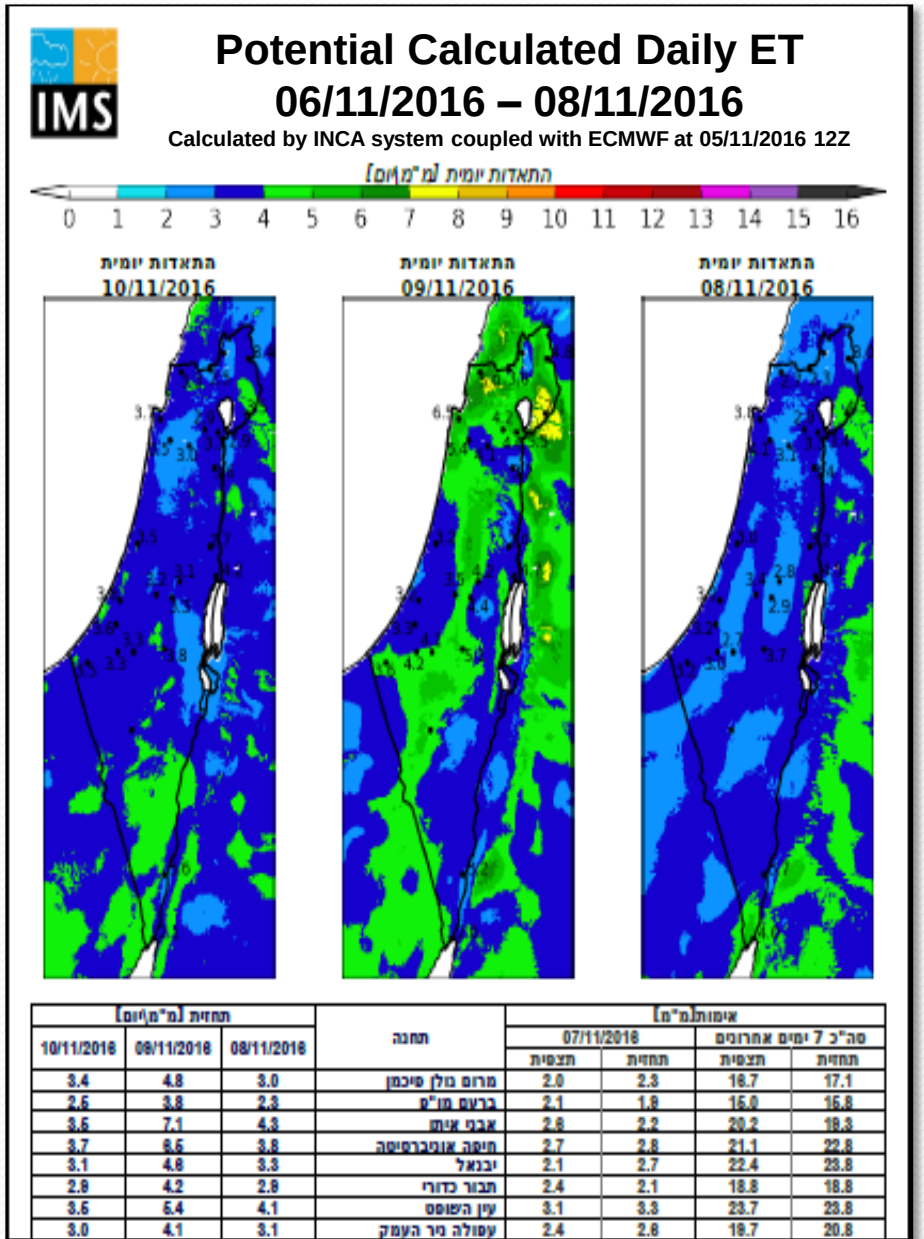
Professional publications farmers

Themes
Shaham Research Foundation
Irrigation coefficients
Flower industry newsletters
Fallow
Calculations

Selected sites

Further Utilizations:





תחזית [מ"מ/יום]			תחנה	אימות[מ"מ]			
				07/11/2016		סה"כ 7 ימים אחרונים	
10/11/2016	09/11/2016	08/11/2016		תחזית	תצפית	תחזית	תצפית
3.4	4.8	3.0	מרום גולן סיכמן	2.3	2.0	17.1	16.7
2.6	3.8	2.3	ברעם מו"פ	1.8	2.1	15.8	15.0
3.5	7.1	4.3	אבני איתן	2.2	2.6	19.3	20.2
3.7	6.6	3.8	חיפה אוניברסיטה	2.8	2.7	22.8	21.1
3.1	4.8	3.3	יבנאל	2.7	2.1	23.8	22.4
2.8	4.2	2.8	תבור כדורי	2.1	2.4	18.8	18.8
3.5	5.4	4.1	עין השופט	3.3	3.1	23.8	23.7
3.0	4.1	3.1	עמק יזרעאל	2.8	2.4	20.8	19.7

Conclusions:

- **Recognize a mal-practice**
- **Cooperation:**
  - All relevant sectors
  - Through entire product chain
  - Preliminary phase to final product
- **Seek how to contribute to the project:**
  - Be pro-active
  - Adjust to client needs
  - Professionalism
- **Reach End-User:**
  - Directly
  - Indirectly


IMS
THANK YOU

Water Management in Israel

Centralized Governance
Water Act (1951): All water resources belong to the people

Semi arid Climate

86%
Potable water recycled

~50%
Potable water from desalination

35%
Irrigation potable water

14%
Decrease per capita domestic use