

This presentation premiered at WaterSmart Innovations

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Quantifying Effective Rain When Automating Landscape Irrigation Water Management



Steven E. Moore
Irrisoft, Inc.
smoore@irrisoft.net

Landscapes are Over Watered

- EPA \approx 50%
 - Example: 4' of water versus 8'

- Why?
 - Distribution efficiency
 - Schedules are not adjusted often enough.
 - Fear of killing plants.

- What are the implications?
 - Water is Wasted
 - Money is Wasted
 - Plants are Overwatered



Rain

□ Problem

- Don't water when its raining.
- When to resume watering after it rains?



□ Solve It

- Improve Irrigation Efficiency
 - Eliminate Wasted Water
 - Save Money
- Healthier Landscapes

Smart? Control

- Big on ET
- What about Rain?
 - Is a Rain Shut-off device good enough?



Measure ET and Measure Rain

ET – Rain = Irrigation



Many parts of the country receive more Rain than ET.

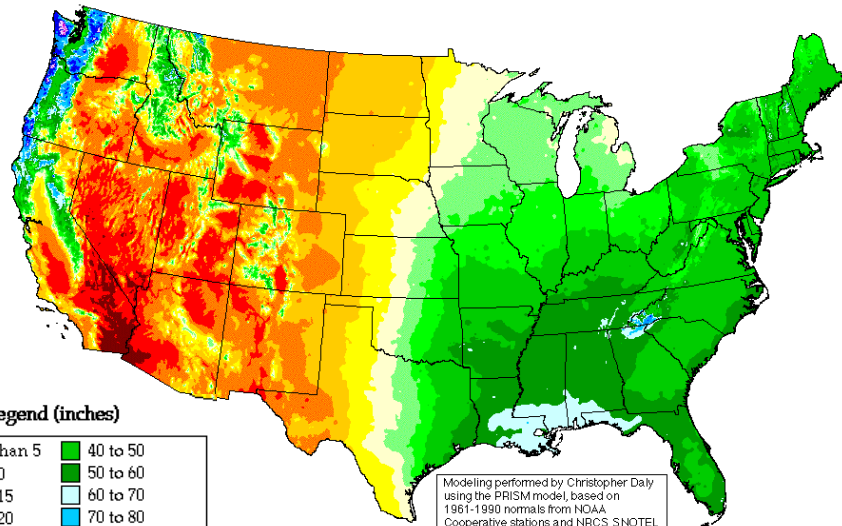
Rain

Annual

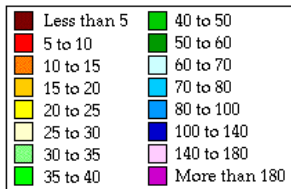
ET

Annual Average Precipitation

United States of America



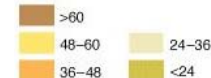
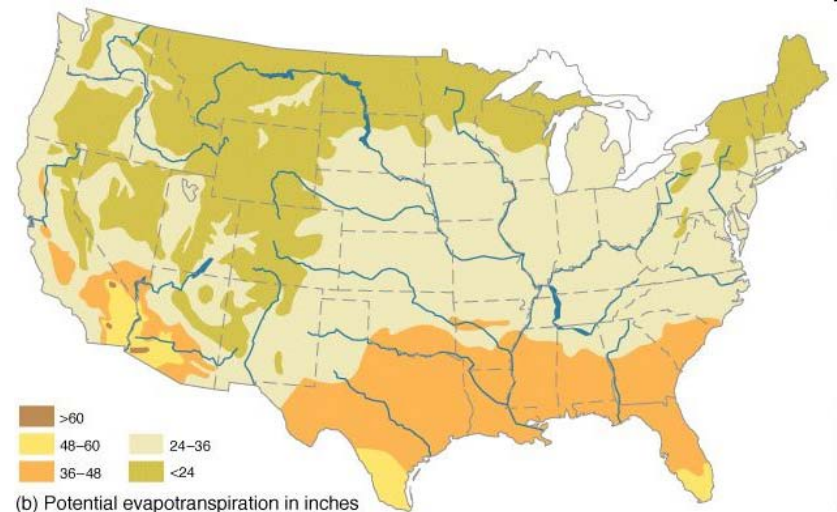
Legend (inches)



Modeling performed by Christopher Daly using the PRISM model, based on 1961-1990 normals from NOAA Cooperative stations and NRCS SNOTEL sites. Sponsored by USDA-NRCS Water and Climate Center, Portland, Oregon.

Oregon Climate Service
George Taylor, State Climatologist
(541) 737-5705

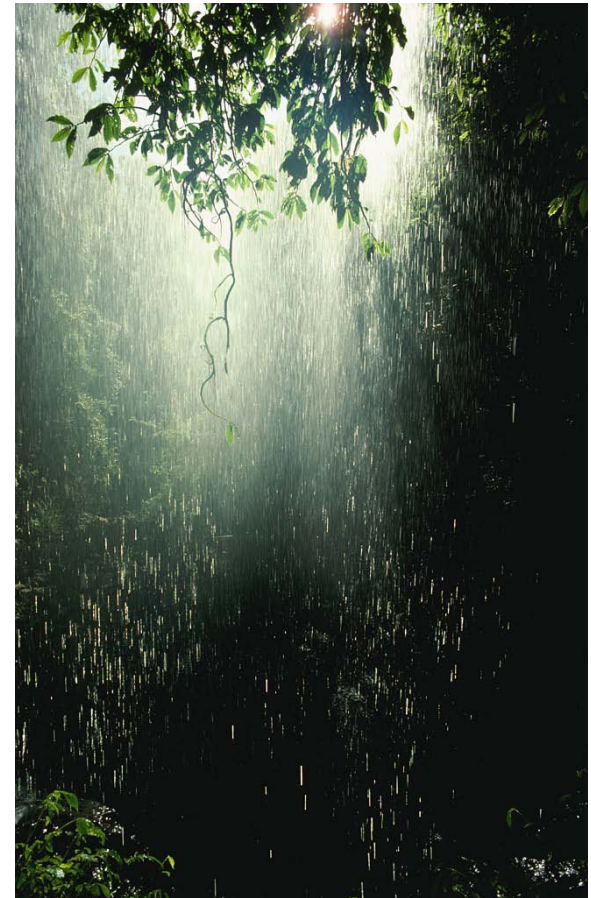
Period: 1961-1990



(b) Potential evapotranspiration in inches

Making the Most of Rain

- When?
- Where?
- How much?
- How fast?



What is Effective Rain?

- Rain that is beneficial to plants

- Soaks into the root zone

- Application of Effective Rain

- Real time water management



Quantifying Effective Rain

- Measure It

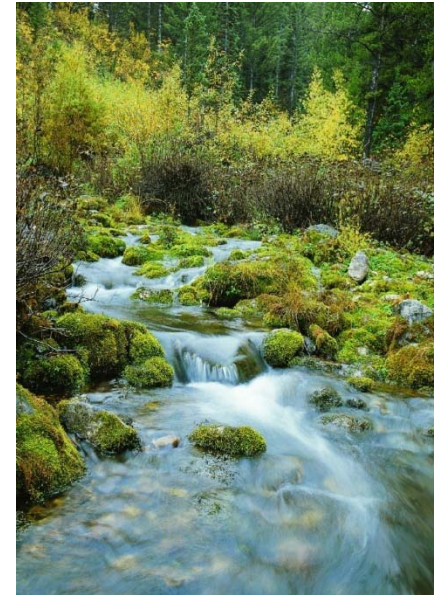


- Ignore rainfall faster than soil absorption

- Soil Intake Rate
- Potential to Run Off

- How much can the soil hold?

- Soil is a Reservoir
 - Current soil moisture content

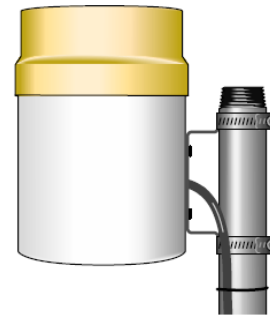
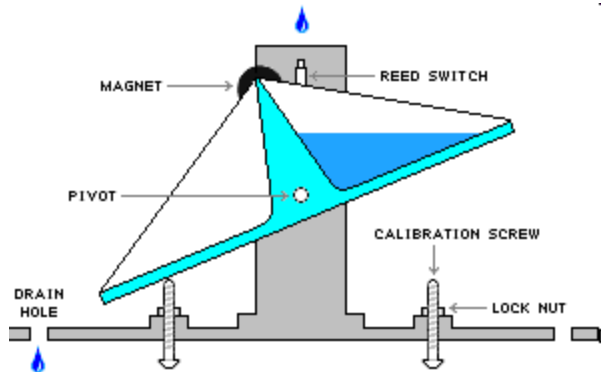


Measure Rain

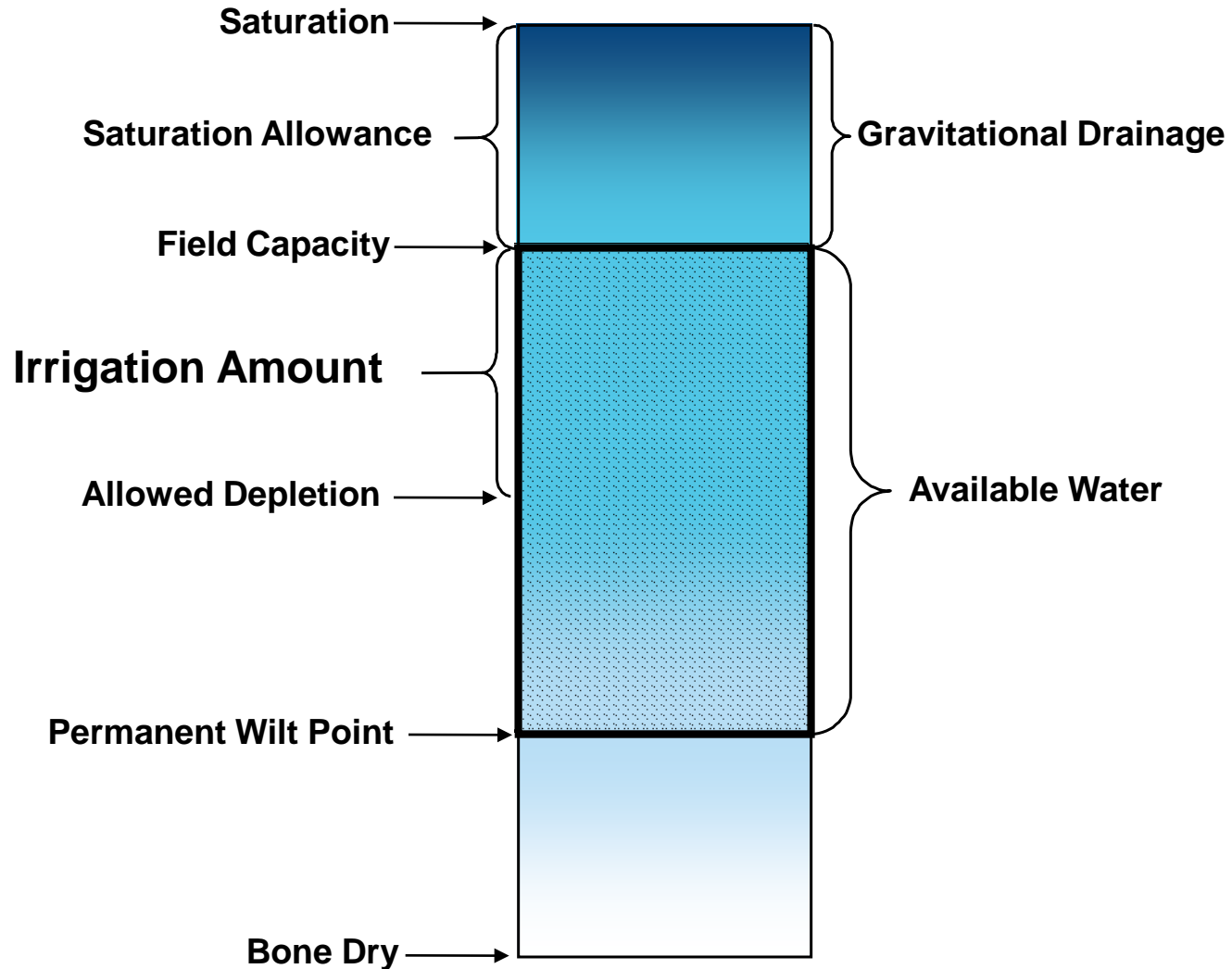
- Devices

- Tipping bucket
- Weight
- Impact

- Record at least hourly



The Soil Reservoir



Quantify Root Zone Capacity

- Variables
 - Soil Type
 - Available Water (AW) – Inch per Inch
 - Root Depth (RD) - Inches
 - Managed Allowed Depletion (MAD) - %
 - Saturation Allowance (SA) - Inches
 - Maximum Hourly Rain (MHR) - Inches per Hour
 - Infiltration Rate

- Resulting Limits
 - Root Zone Capacity (RZC) = AW x RD
 - Allowed Depletion (AD) = RZC x MAD%
 - Optimum Irrigation Amount = AD
 - Moisture Balance Limit = AD + SA



Soils Chart

Generalized Soil Water Characteristics

| Soil Texture | | AW range in./ft | AW in./ft | AW in./in. | I In./h | FC % vol | PWP % vol | SAT % vol | Sand % | Silt % | Clay % |
|--------------------------|------|--------------------|--------------|---------------|------------|-------------|--------------|--------------|-----------|-----------|-----------|
| Coarse | | | | | | | | | | | |
| Sand / Fine sand | Sa | 0.36-0.84 | 0.60 | 0.05 | 1.50-3.00 | 14 | 6 | 37 | 90 | 4 | 6 |
| Loamy sand | LSa | 0.56-1.12 | 0.84 | 0.07 | 1.00-2.00 | 15 | 7 | 38 | 83 | 10 | 7 |
| Moderately Coarse | | | | | | | | | | | |
| Sandy loam | SaL | 0.66-1.98 | 1.32 | 0.11 | .80-1.20 | 20 | 9 | 42 | 64 | 25 | 11 |
| Medium | | | | | | | | | | | |
| Loam | L | 1.06-2.78 | 1.92 | 0.16 | .40-.60 | 27 | 12 | 46 | 40 | 42 | 18 |
| Silty loam | SiL | 1.10-3.70 | 2.40 | 0.20 | .25-.40 | 28 | 10 | 46 | 21 | 66 | 13 |
| Silt | Si | 1.40-3.40 | 2.40 | 0.20 | .30-.50 | 30 | 10 | 44 | 10 | 82 | 8 |
| Moderately Fine | | | | | | | | | | | |
| Sandy clay loam | SaCL | 1.08-2.52 | 1.80 | 0.15 | .10-.30 | 29 | 18 | 44 | 54 | 19 | 27 |
| Clay loam | CL | 1.42-2.42 | 1.92 | 0.16 | .07-.25 | 32 | 18 | 50 | 33 | 34 | 33 |
| Silty clay loam | SiCL | 1.74-2.58 | 2.16 | 0.18 | .05-.12 | 35 | 18 | 52 | 12 | 55 | 33 |
| Fine | | | | | | | | | | | |
| Sandy clay | SaC | 1.05-1.83 | 1.44 | 0.12 | .08-.20 | 32 | 22 | 50 | 53 | 6 | 41 |
| Silty clay | SiC | 1.40-2.20 | 1.80 | 0.15 | .05-.15 | 43 | 27 | 54 | 6 | 47 | 47 |
| Clay | C | 1.44-1.92 | 1.68 | 0.14 | .05-.10 | 45 | 32 | 54 | 23 | 22 | 55 |

AW = Available Water measured in inches per foot or inches per inch of soil (average of sources)

FC = Field Capacity, percent water volumetrically

PWP = Permanent Wilting Point, percent water volumetrically

SAT = Saturation Point, percent water volumetrically

I = Infiltration rate on relatively flat ground, inches per hour

Sources of information:

1. *USDA/NRCS National Engineering Handbook*, Part 652 Irrigation Guide, Chapter 2
2. *Soil Water Characteristics, Hydraulic Properties Calculator*, Saxton, et.al. USDA-Agricultural Research Service
<http://hydrolab.arsusda.gov/soilwater/Index.htm>
3. *Ag Irrigation Management*, ITRC, California Polytechnic State University
4. Infiltration Rates are based upon the following sources:
NRCS Soil Quality Indicators,
New Mexico State University Climate Center,
<http://weather.nmsu.edu/models/irrsch/soiltype.html>
Hydrologic Soil Properties Classified by Soil Texture, Rawls, Brakensiek and Saxton 1982,
Rain Bird and Toro charts derived from USDA information,
Site Evaluation for Stormwater Infiltration, Wisconsin Department of Natural Resources,
P8 Urban Catchment Model, William W. Walker, Jr. prepared for US EPA, Minnesota PCA, Wisconsin DNR,
Infiltration Rate by Soil Group/Texture, Texas Council of Governments, 2003

Moisture Balance

Checkbook Method

- Input

- ET – Subtract
- Rain – Add
- Irrigation – Add
 - Irrigation Amount = Allowed Depletion

- Limits

- Maximum Hourly Rain
- Allowed Depletion
- Moisture Balance Limit



The Moisture Balance or Checkbook Method of Irrigation Scheduling

Hourly Moisture Balance

Variables

| | |
|---------------------------|-----------------|
| Soil Type | Sandy Clay Loam |
| Available Water in/in | 0.11 |
| Root Depth - Inches | 8.00 |
| Managed Allowed Depletion | 50% |
| Saturation Allowance | 0.22 |
| Maximum Hourly Rain | 0.35 |

Resulting Limits

| | |
|---------------------------|------|
| Root Zone Capacity | 0.88 |
| Allowed Depletion | 0.44 |
| Optimum Irrigation Amount | 0.44 |
| Moisture Balance Limit | 0.66 |

| Date | ETc | Total Rain | Rain Limited by Max Hourly Rate | Effective Rain | Irrigation | Moisture Balance |
|----------------|-------|------------|------------------------------------|-------------------|------------|---------------------|
| 6/5/2009 1:00 | 0.018 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| 6/5/2009 2:00 | 0.015 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| 6/5/2009 3:00 | 0.010 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6/5/2009 4:00 | 0.005 | 0.00 | 0.00 | 0.00 | 0.44 | 0.44 |
| 6/5/2009 5:00 | 0.002 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 |
| 6/5/2009 6:00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 |
| 6/5/2009 7:00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 |
| 6/5/2009 8:00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 |
| 6/5/2009 9:00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 |
| 6/5/2009 10:00 | 0.001 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 |
| 6/5/2009 11:00 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.43 |
| 6/5/2009 12:00 | 0.000 | 0.03 | 0.03 | 0.03 | 0.00 | 0.46 |
| 6/5/2009 13:00 | 0.000 | 0.03 | 0.03 | 0.03 | 0.00 | 0.50 |
| 6/5/2009 14:00 | 0.000 | 0.41 | 0.35 | 0.16 | 0.00 | 0.66 |
| 6/5/2009 15:00 | 0.001 | 0.01 | 0.01 | 0.00 | 0.00 | 0.66 |
| 6/5/2009 16:00 | 0.002 | 0.00 | 0.00 | 0.00 | 0.00 | 0.66 |
| 6/5/2009 17:00 | 0.006 | 0.00 | 0.00 | 0.00 | 0.00 | 0.65 |
| 6/5/2009 18:00 | 0.013 | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 |



Example Scenarios

Example 1

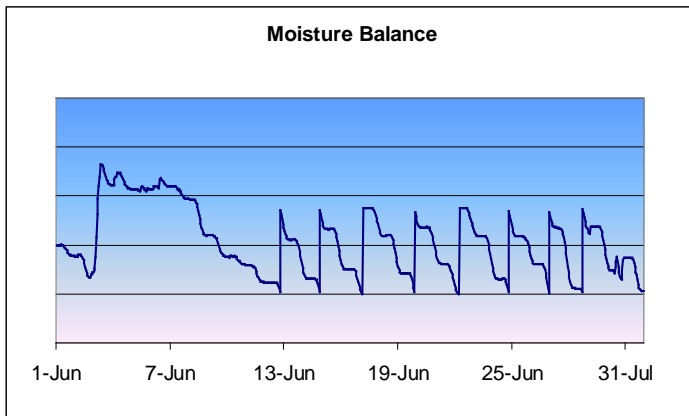
99% Rainfall Efficiency

Variables

| | |
|---------------------------|-----------------|
| Soil Type | Sandy Clay Loam |
| Available Water in/in | 0.11 |
| Root Depth - Inches | 8.00 |
| Managed Allowed Depletion | 50% |
| Saturation Allowance | 0.22 |
| Maximum Hourly Rain | 0.35 |

Resulting Limits

| | |
|---------------------------|------|
| Root Zone Capacity | 0.88 |
| Allowed Depletion | 0.44 |
| Optimum Irrigation Amount | 0.44 |
| Moisture Balance Limit | 0.66 |



Moisture Balance

| Date | ET | Total Rain | Effective Rain | Irrigation | Moisture Balance |
|--------------|-------------|-------------|----------------|-------------|------------------|
| 6/1/2008 | 0.06 | 0.00 | 0.00 | 0.00 | 0.19 |
| 6/2/2008 | 0.12 | 0.04 | 0.04 | 0.00 | 0.11 |
| 6/3/2008 | 0.12 | 0.58 | 0.57 | 0.00 | 0.56 |
| 6/4/2008 | 0.09 | 0.07 | 0.07 | 0.00 | 0.54 |
| 6/5/2008 | 0.06 | 0.06 | 0.06 | 0.00 | 0.53 |
| 6/6/2008 | 0.07 | 0.08 | 0.08 | 0.00 | 0.55 |
| 6/7/2008 | 0.07 | 0.01 | 0.01 | 0.00 | 0.48 |
| 6/8/2008 | 0.19 | 0.00 | 0.00 | 0.00 | 0.30 |
| 6/9/2008 | 0.11 | 0.00 | 0.00 | 0.00 | 0.19 |
| 6/10/2008 | 0.06 | 0.02 | 0.02 | 0.00 | 0.15 |
| 6/11/2008 | 0.10 | 0.01 | 0.01 | 0.00 | 0.06 |
| 6/12/2008 | 0.14 | 0.00 | 0.00 | 0.44 | 0.36 |
| 6/13/2008 | 0.21 | 0.00 | 0.00 | 0.00 | 0.15 |
| 6/14/2008 | 0.19 | 0.00 | 0.00 | 0.44 | 0.40 |
| 6/15/2008 | 0.21 | 0.00 | 0.00 | 0.00 | 0.20 |
| 6/16/2008 | 0.15 | 0.00 | 0.00 | 0.00 | 0.05 |
| 6/17/2008 | 0.13 | 0.00 | 0.00 | 0.44 | 0.36 |
| 6/18/2008 | 0.20 | 0.00 | 0.00 | 0.00 | 0.16 |
| 6/19/2008 | 0.21 | 0.00 | 0.00 | 0.44 | 0.40 |
| 6/20/2008 | 0.16 | 0.00 | 0.00 | 0.00 | 0.24 |
| 6/21/2008 | 0.17 | 0.00 | 0.00 | 0.00 | 0.07 |
| 6/22/2008 | 0.16 | 0.00 | 0.00 | 0.44 | 0.35 |
| 6/23/2008 | 0.19 | 0.00 | 0.00 | 0.00 | 0.16 |
| 6/24/2008 | 0.22 | 0.00 | 0.00 | 0.44 | 0.37 |
| 6/25/2008 | 0.16 | 0.00 | 0.00 | 0.00 | 0.22 |
| 6/26/2008 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6/27/2008 | 0.30 | 0.00 | 0.00 | 0.44 | 0.14 |
| 6/28/2008 | 0.24 | 0.00 | 0.00 | 0.44 | 0.34 |
| 6/29/2008 | 0.18 | 0.04 | 0.04 | 0.00 | 0.20 |
| 6/30/2008 | 0.28 | 0.26 | 0.26 | 0.00 | 0.18 |
| Total | 4.74 | 1.17 | 1.16 | 3.52 | |

99%

8 Water Days

Example 2

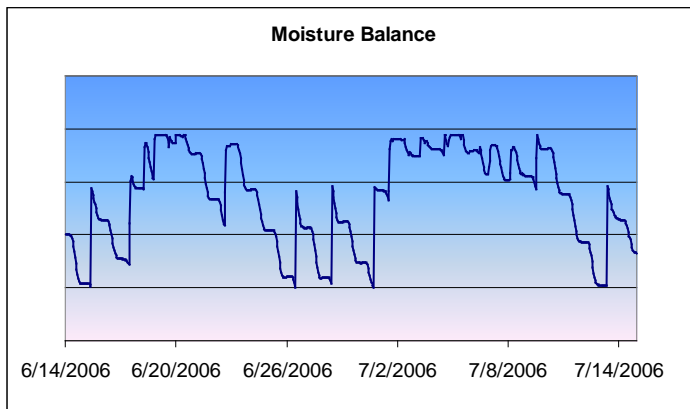
36% Rainfall Efficiency

Variables

| | |
|---------------------------|-----------|
| Soil Type | Clay Loam |
| Available Water in/in | 0.16 |
| Root Depth - Inches | 6.00 |
| Managed Allowed Depletion | 50% |
| Saturation Allowance | 0.24 |
| Maximum Hourly Rain | 0.20 |

Resulting Limits

| | |
|---------------------------|------|
| Root Zone Capacity | 0.96 |
| Allowed Depletion | 0.48 |
| Optimum Irrigation Amount | 0.48 |
| Moisture Balance Limit | 0.72 |



Moisture Balance

| Date | ET | Total Rain | Effective Rain | Irrigation | Moisture Balance |
|--------------|-------------|-------------|----------------|-------------|------------------|
| 6/14/2006 | 0.23 | 0.00 | 0.00 | 0.00 | 0.02 |
| 6/15/2006 | 0.18 | 0.00 | 0.00 | 0.48 | 0.32 |
| 6/16/2006 | 0.18 | 0.00 | 0.00 | 0.00 | 0.14 |
| 6/17/2006 | 0.09 | 1.13 | 0.42 | 0.00 | 0.47 |
| 6/18/2006 | 0.18 | 0.48 | 0.43 | 0.00 | 0.72 |
| 6/19/2006 | 0.10 | 0.94 | 0.06 | 0.00 | 0.68 |
| 6/20/2006 | 0.11 | 0.40 | 0.06 | 0.00 | 0.63 |
| 6/21/2006 | 0.22 | 0.00 | 0.00 | 0.00 | 0.42 |
| 6/22/2006 | 0.14 | 0.60 | 0.40 | 0.00 | 0.68 |
| 6/23/2006 | 0.22 | 0.00 | 0.00 | 0.00 | 0.46 |
| 6/24/2006 | 0.19 | 0.00 | 0.00 | 0.00 | 0.27 |
| 6/25/2006 | 0.22 | 0.00 | 0.00 | 0.00 | 0.05 |
| 6/26/2006 | 0.25 | 0.00 | 0.00 | 0.48 | 0.28 |
| 6/27/2006 | 0.24 | 0.00 | 0.00 | 0.00 | 0.05 |
| 6/28/2006 | 0.22 | 0.00 | 0.00 | 0.48 | 0.31 |
| 6/29/2006 | 0.19 | 0.00 | 0.00 | 0.00 | 0.12 |
| 6/30/2006 | 0.14 | 0.00 | 0.00 | 0.48 | 0.46 |
| 7/1/2006 | 0.07 | 0.55 | 0.31 | 0.00 | 0.70 |
| 7/2/2006 | 0.11 | 0.03 | 0.03 | 0.00 | 0.62 |
| 7/3/2006 | 0.08 | 0.11 | 0.11 | 0.00 | 0.65 |
| 7/4/2006 | 0.09 | 0.59 | 0.16 | 0.00 | 0.72 |
| 7/5/2006 | 0.11 | 1.34 | 0.04 | 0.00 | 0.65 |
| 7/6/2006 | 0.15 | 0.07 | 0.07 | 0.00 | 0.57 |
| 7/7/2006 | 0.16 | 0.10 | 0.10 | 0.00 | 0.51 |
| 7/8/2006 | 0.14 | 0.16 | 0.16 | 0.00 | 0.53 |
| 7/9/2006 | 0.14 | 0.68 | 0.26 | 0.00 | 0.66 |
| 7/10/2006 | 0.21 | 0.00 | 0.00 | 0.00 | 0.44 |
| 7/11/2006 | 0.23 | 0.00 | 0.00 | 0.00 | 0.22 |
| 7/12/2006 | 0.20 | 0.00 | 0.00 | 0.00 | 0.01 |
| 7/13/2006 | 0.17 | 0.00 | 0.00 | 0.48 | 0.32 |
| 7/14/2006 | 0.16 | 0.00 | 0.00 | 0.00 | 0.16 |
| Total | 5.09 | 7.18 | 2.61 | 2.40 | |

36%

5 Water Days

Example 3

45% Rainfall Efficiency

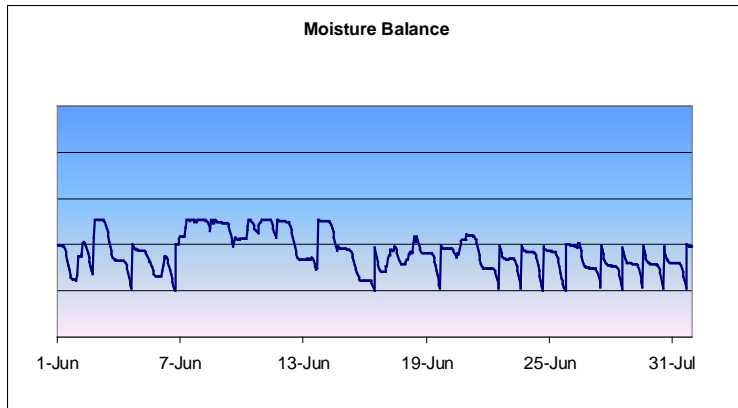
Variables

| | |
|---------------------------|-----------------|
| Soil Type | Silty Clay Loam |
| Available Water in/in | 0.17 |
| Root Depth - Inches | 3.00 |
| Managed Allowed Depletion | 50% |
| Saturation Allowance | 0.13 |
| Maximum Hourly Rain | 0.35 |

Resulting Limits

| | |
|---------------------------|------|
| Root Zone Capacity | 0.51 |
| Allowed Depletion | 0.26 |
| Optimum Irrigation Amount | 0.26 |
| Moisture Balance Limit | 0.38 |

| Moisture Balance | | | | | |
|------------------|-------------|-------------|----------------|-------------|----------------------|
| Date | ET | Total Rain | Effective Rain | Irrigation | Moisture Balance |
| 6/1/2009 | 0.19 | 0.03 | 0.03 | 0.00 | 0.09 |
| 6/2/2009 | 0.18 | 1.37 | 0.47 | 0.00 | 0.38 |
| 6/3/2009 | 0.22 | 0.00 | 0.00 | 0.00 | 0.16 |
| 6/4/2009 | 0.20 | 0.00 | 0.00 | 0.26 | 0.22 |
| 6/5/2009 | 0.15 | 0.01 | 0.01 | 0.00 | 0.08 |
| 6/6/2009 | 0.19 | 0.14 | 0.14 | 0.26 | 0.28 |
| 6/7/2009 | 0.06 | 0.97 | 0.16 | 0.00 | 0.38 |
| 6/8/2009 | 0.13 | 0.55 | 0.12 | 0.00 | 0.37 |
| 6/9/2009 | 0.15 | 0.06 | 0.06 | 0.00 | 0.28 |
| 6/10/2009 | 0.08 | 0.38 | 0.18 | 0.00 | 0.38 |
| 6/11/2009 | 0.11 | 0.39 | 0.11 | 0.00 | 0.38 |
| 6/12/2009 | 0.21 | 0.00 | 0.00 | 0.00 | 0.17 |
| 6/13/2009 | 0.09 | 0.33 | 0.30 | 0.00 | 0.38 |
| 6/14/2009 | 0.18 | 0.03 | 0.03 | 0.00 | 0.23 |
| 6/15/2009 | 0.17 | 0.00 | 0.00 | 0.00 | 0.06 |
| 6/16/2009 | 0.21 | 0.00 | 0.00 | 0.26 | 0.10 |
| 6/17/2009 | 0.13 | 0.17 | 0.17 | 0.00 | 0.15 |
| 6/18/2009 | 0.14 | 0.20 | 0.20 | 0.00 | 0.20 |
| 6/19/2009 | 0.23 | 0.00 | 0.00 | 0.26 | 0.23 |
| 6/20/2009 | 0.07 | 0.15 | 0.15 | 0.00 | 0.30 |
| 6/21/2009 | 0.18 | 0.00 | 0.00 | 0.00 | 0.12 |
| 6/22/2009 | 0.20 | 0.00 | 0.00 | 0.26 | 0.17 |
| 6/23/2009 | 0.22 | 0.00 | 0.00 | 0.26 | 0.21 |
| 6/24/2009 | 0.25 | 0.00 | 0.00 | 0.26 | 0.21 |
| 6/25/2009 | 0.22 | 0.00 | 0.00 | 0.26 | 0.25 |
| 6/26/2009 | 0.17 | 0.04 | 0.04 | 0.00 | 0.12 |
| 6/27/2009 | 0.24 | 0.00 | 0.00 | 0.26 | 0.14 |
| 6/28/2009 | 0.24 | 0.00 | 0.00 | 0.26 | 0.15 |
| 6/29/2009 | 0.26 | 0.00 | 0.00 | 0.26 | 0.14 |
| 6/30/2009 | 0.25 | 0.00 | 0.00 | 0.26 | 0.15 |
| 7/31/2009 | 0.17 | 0.00 | 0.00 | 0.26 | 0.24 |
| Total | 5.49 | 4.82 | 2.17 | 3.32 | |
| | | | 45% | | 13 Water Days |



Example 4

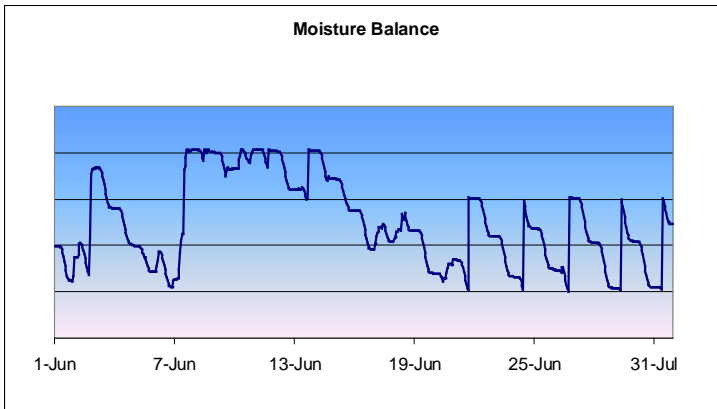
63% Rainfall Efficiency

Variables

| | |
|---------------------------|-----------------|
| Soil Type | Silty Clay Loam |
| Available Water in/in | 0.17 |
| Root Depth - Inches | 6.00 |
| Managed Allowed Depletion | 50% |
| Saturation Allowance | 0.26 |
| Maximum Hourly Rain | 0.35 |

Resulting Limits

| | |
|---------------------------|------|
| Root Zone Capacity | 1.02 |
| Allowed Depletion | 0.51 |
| Optimum Irrigation Amount | 0.51 |
| Moisture Balance Limit | 0.77 |



Moisture Balance

| Date | ET | Total Rain | Effective Rain | Irrigation | Moisture Balance |
|--------------|-------------|-------------|----------------|-------------|---------------------|
| 6/1/2009 | 0.19 | 0.03 | 0.03 | 0.00 | 0.09 |
| 6/2/2009 | 0.18 | 1.37 | 0.76 | 0.00 | 0.67 |
| 6/3/2009 | 0.22 | 0.00 | 0.00 | 0.00 | 0.45 |
| 6/4/2009 | 0.20 | 0.00 | 0.00 | 0.00 | 0.25 |
| 6/5/2009 | 0.15 | 0.01 | 0.01 | 0.00 | 0.11 |
| 6/6/2009 | 0.19 | 0.14 | 0.14 | 0.00 | 0.06 |
| 6/7/2009 | 0.06 | 0.97 | 0.77 | 0.00 | 0.77 |
| 6/8/2009 | 0.13 | 0.55 | 0.12 | 0.00 | 0.75 |
| 6/9/2009 | 0.15 | 0.06 | 0.06 | 0.00 | 0.67 |
| 6/10/2009 | 0.08 | 0.38 | 0.18 | 0.00 | 0.77 |
| 6/11/2009 | 0.11 | 0.39 | 0.11 | 0.00 | 0.76 |
| 6/12/2009 | 0.21 | 0.00 | 0.00 | 0.00 | 0.55 |
| 6/13/2009 | 0.09 | 0.33 | 0.30 | 0.00 | 0.76 |
| 6/14/2009 | 0.18 | 0.03 | 0.03 | 0.00 | 0.61 |
| 6/15/2009 | 0.17 | 0.00 | 0.00 | 0.00 | 0.44 |
| 6/16/2009 | 0.21 | 0.00 | 0.00 | 0.00 | 0.23 |
| 6/17/2009 | 0.13 | 0.17 | 0.17 | 0.00 | 0.27 |
| 6/18/2009 | 0.14 | 0.20 | 0.20 | 0.00 | 0.33 |
| 6/19/2009 | 0.23 | 0.00 | 0.00 | 0.00 | 0.10 |
| 6/20/2009 | 0.07 | 0.15 | 0.15 | 0.00 | 0.18 |
| 6/21/2009 | 0.18 | 0.00 | 0.00 | 0.51 | 0.50 |
| 6/22/2009 | 0.20 | 0.00 | 0.00 | 0.00 | 0.30 |
| 6/23/2009 | 0.22 | 0.00 | 0.00 | 0.00 | 0.08 |
| 6/24/2009 | 0.25 | 0.00 | 0.00 | 0.51 | 0.34 |
| 6/25/2009 | 0.22 | 0.00 | 0.00 | 0.00 | 0.12 |
| 6/26/2009 | 0.17 | 0.04 | 0.04 | 0.51 | 0.51 |
| 6/27/2009 | 0.24 | 0.00 | 0.00 | 0.00 | 0.26 |
| 6/28/2009 | 0.24 | 0.00 | 0.00 | 0.00 | 0.02 |
| 6/29/2009 | 0.26 | 0.00 | 0.00 | 0.51 | 0.27 |
| 6/30/2009 | 0.25 | 0.00 | 0.00 | 0.00 | 0.02 |
| 7/31/2009 | 0.17 | 0.00 | 0.00 | 0.51 | 0.37 |
| Total | 5.49 | 4.82 | 3.06 | 2.55 | |
| | | | 63% | | 5 Water Days |

Increasing Effective Rain

- Water Management based on Moisture Balance
 - Quantify Effective Rain
 - Each Hydro Zone
- Increase Soil Reservoir Capacity
 - Increase root depth
 - Water management
 - Soil preparation
- Current Moisture Content
 - Anticipate potential rain and delay watering
- Improve Permeability - Maximum Hourly Rate
 - Mulch
 - Cultivation
 - Soil Amendments



Conclusions

- Measuring Effective Rain is as important as measuring ET.
- Hourly Moisture Balance modeling quantifies Effective Rain.
- Rainfall Efficiency is not a simple % of total rain.
- With proper management rainfall effectiveness can be improved.
- Measuring Effective Rain improves irrigation control efficiency.
 - Reduce Wasteful Overwatering
 - Save Money
 - Improves Landscape Health



Improve Irrigation Efficiency

- Rain Shut-off Devices – Good
 - Don't suspend irrigation soon enough.
 - Allow watering to resume too soon.
- Turn off the sprinklers when it rains - Better
- Moisture Balance w/ Measured Effective Rain – Best
 - Suspends irrigation when needed.
 - Knows when to allow watering to resume.



Quantifying Effective Rain When Automating Landscape Irrigation Water Management

Thank You



watersmart⁰⁹
INNOVATIONS

Steven E. Moore
Irrisoft, Inc.
smoore@irrisoft.net