Do Bigger Storms Mean Bigger Losses?

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Wisconsin Agribusiness Classic

Madison, WI

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UW Extension University of Wisconsin-Extension

MAWRC MINNESOTA AGRICULTURAL WATER RESOURCE CENTER

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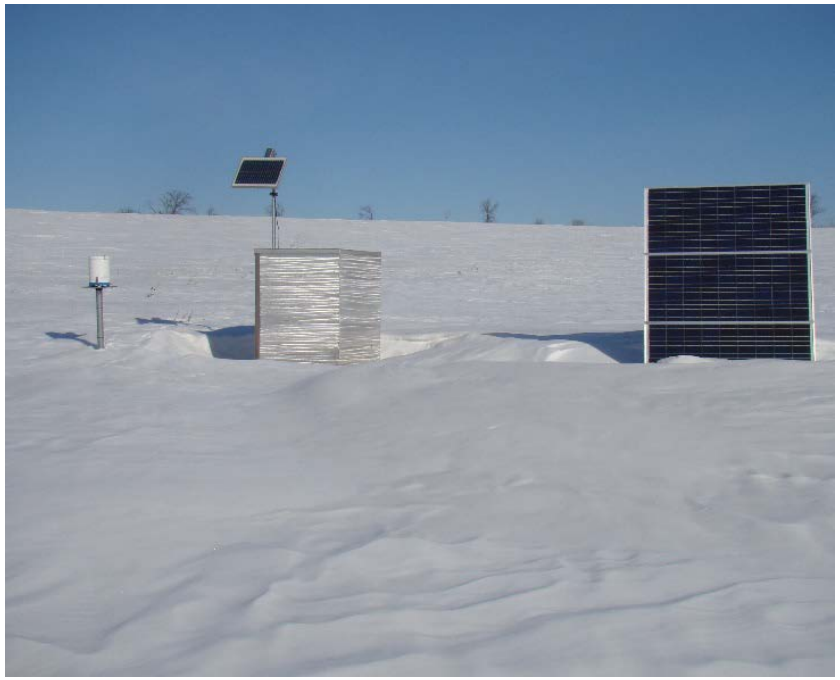
Discovery Farms collects edge-of-field surface runoff data is 365 days a year.

Weather • Soil

Flow • Sediment

Nitrogen • Phosphorus



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USGS science for a changing world

MINNESOTA DEPARTMENT OF AGRICULTURE

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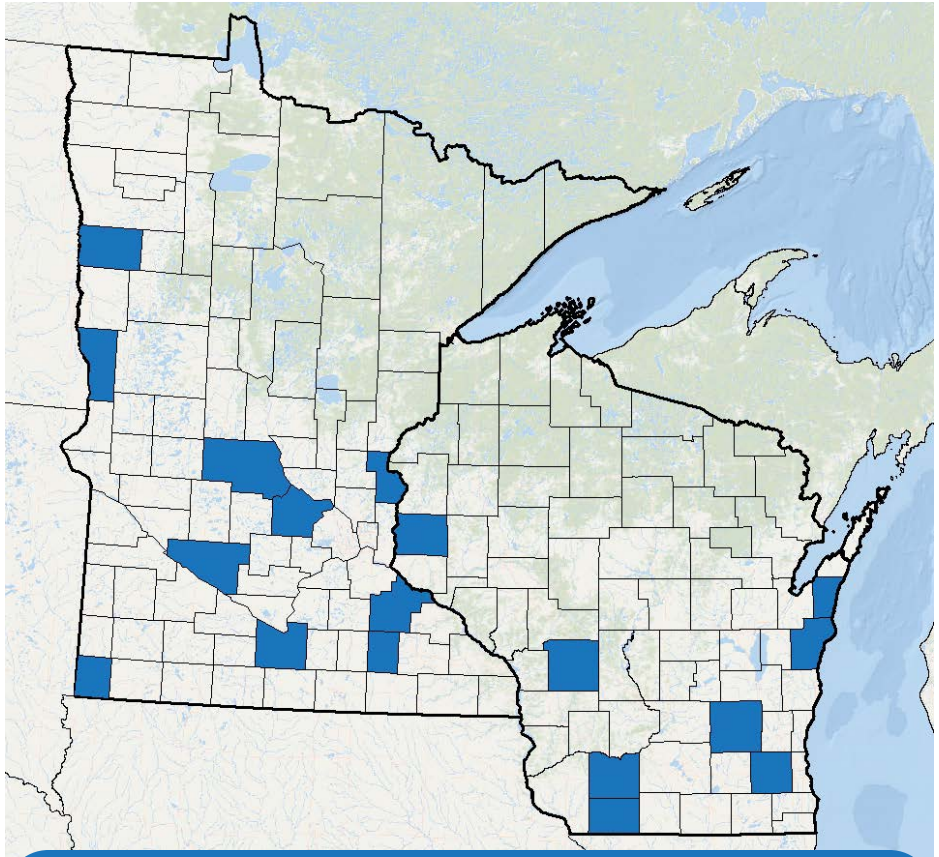
Discovery Farms has a large dataset with diverse farm systems and locations.



Surface Runoff
19 Farms
27 Fields
127 Surface Site Years

Diverse farm systems and landscapes across MN and WI

- Data collected from 2004-2016
- No tile, pattern and random tile at different spacing and depths
- Drainage areas from 5 to 42 acres
- Average field slopes 2% to 9%
- Well drained to poorly drained soils
- Dairy, beef, swine, and grain operations
- Crops ranging from corn, soybean, alfalfa, pasture

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Precipitation and runoff are defined as:

Precipitation: rain, snow, sleet, or hail that falls to the ground

Runoff: the draining away of water from the surface of an area of land

- Not all rain events cause runoff
- Not all runoff is a direct result of an individual rain event (snowmelt)

How do we determine the “size” of a storm?

Rainfall Frequency Atlas of the United States

- Hershfield, 1961

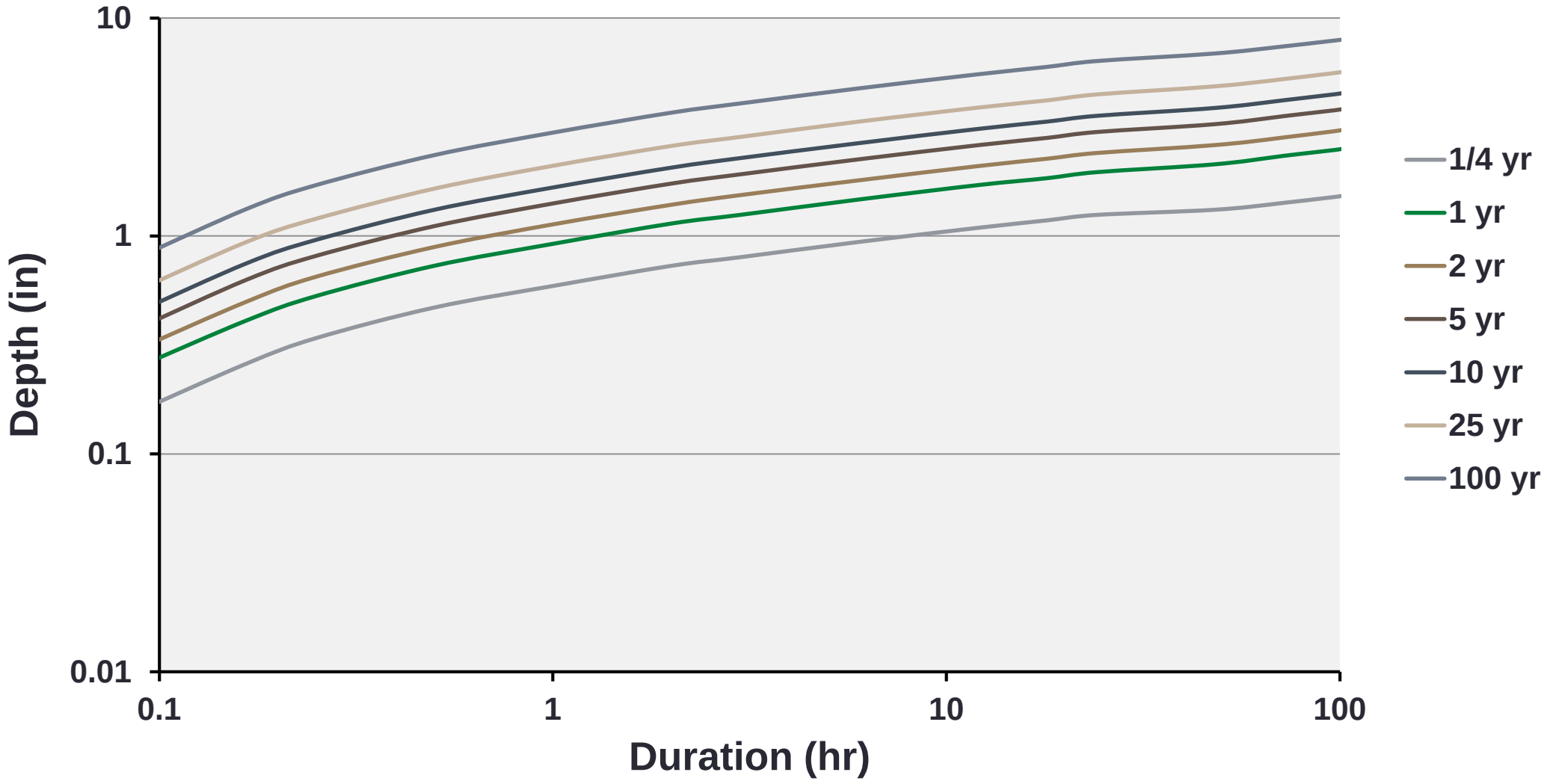
Rainfall Frequency Atlas of the Midwest

- Huff and Angel, 1992
- NOAA Atlas 14 for Midwestern States, 2013

Divided by regions within states: Depth-Duration-Frequency tables

	2 mos	3 mos	4 mos	6 mos	9 mos	1 yr	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
10 day	1.85	2.23	2.57	3.02	3.48	3.78	4.88	6.19	7.16	8.45	9.49	10.6
5 day	1.56	1.87	2.11	2.45	2.82	3.06	3.92	5.04	5.91	7.22	8.29	9.52
3 day	1.4	1.65	1.86	2.16	2.48	2.7	3.42	4.43	5.23	6.43	7.49	8.68
2 day	1.31	1.53	1.7	1.98	2.27	2.47	3.12	4.05	4.82	5.91	6.88	7.95
24 hr	1.24	1.44	1.57	1.82	2.07	2.25	2.82	3.6	4.31	5.29	6.17	7.15
18 hr	1.17	1.36	1.48	1.72	1.95	2.12	2.65	3.38	4.05	4.97	5.8	6.72
12 hr	1.08	1.25	1.37	1.59	1.8	1.96	2.45	3.13	3.75	4.6	5.37	6.22
6 hr	0.93	1.08	1.18	1.37	1.55	1.69	2.12	2.7	3.23	3.97	4.63	5.36
3 hr	0.79	0.92	1.01	1.17	1.32	1.44	1.8	2.3	2.76	3.39	3.95	4.58
2 hr	0.71	0.83	0.91	1.05	1.2	1.3	1.64	2.09	2.5	3.07	3.58	4.15
1 hr	0.58	0.68	0.74	0.86	0.98	1.06	1.33	1.69	2.03	2.49	2.9	3.36
30 min	0.46	0.53	0.58	0.67	0.76	0.83	1.04	1.33	1.59	1.96	2.28	2.65
15 min	0.34	0.39	0.43	0.49	0.56	0.61	0.76	0.97	1.16	1.43	1.67	1.93
10 min	0.26	0.3	0.33	0.38	0.43	0.47	0.59	0.76	0.91	1.11	1.3	1.5
5 min	0.15	0.17	0.19	0.22	0.25	0.27	0.34	0.43	0.52	0.63	0.74	0.86

Depth-Duration-Frequency tables



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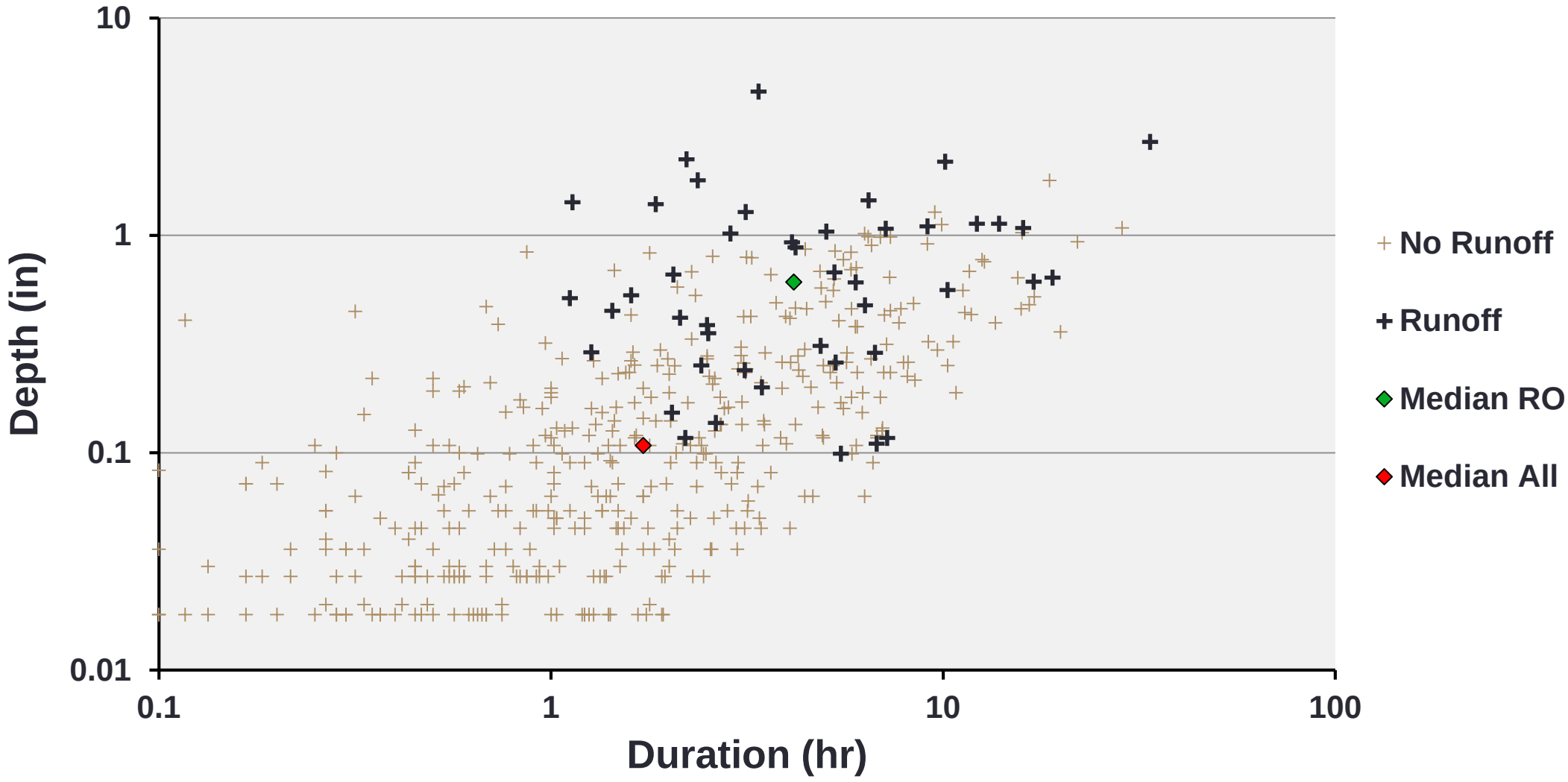
Example farm rain events with medians



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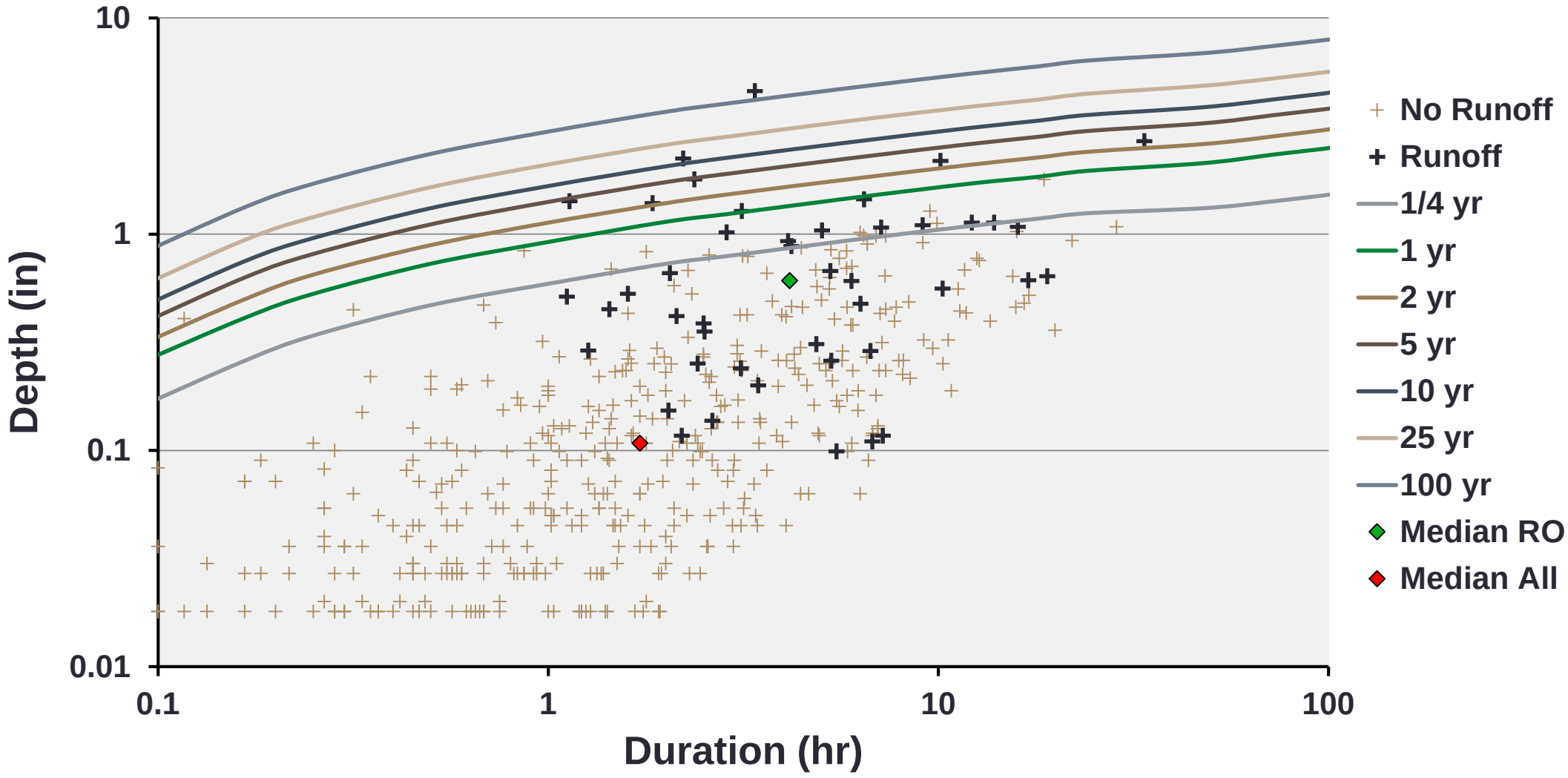
Example farm rain events with medians and “size”



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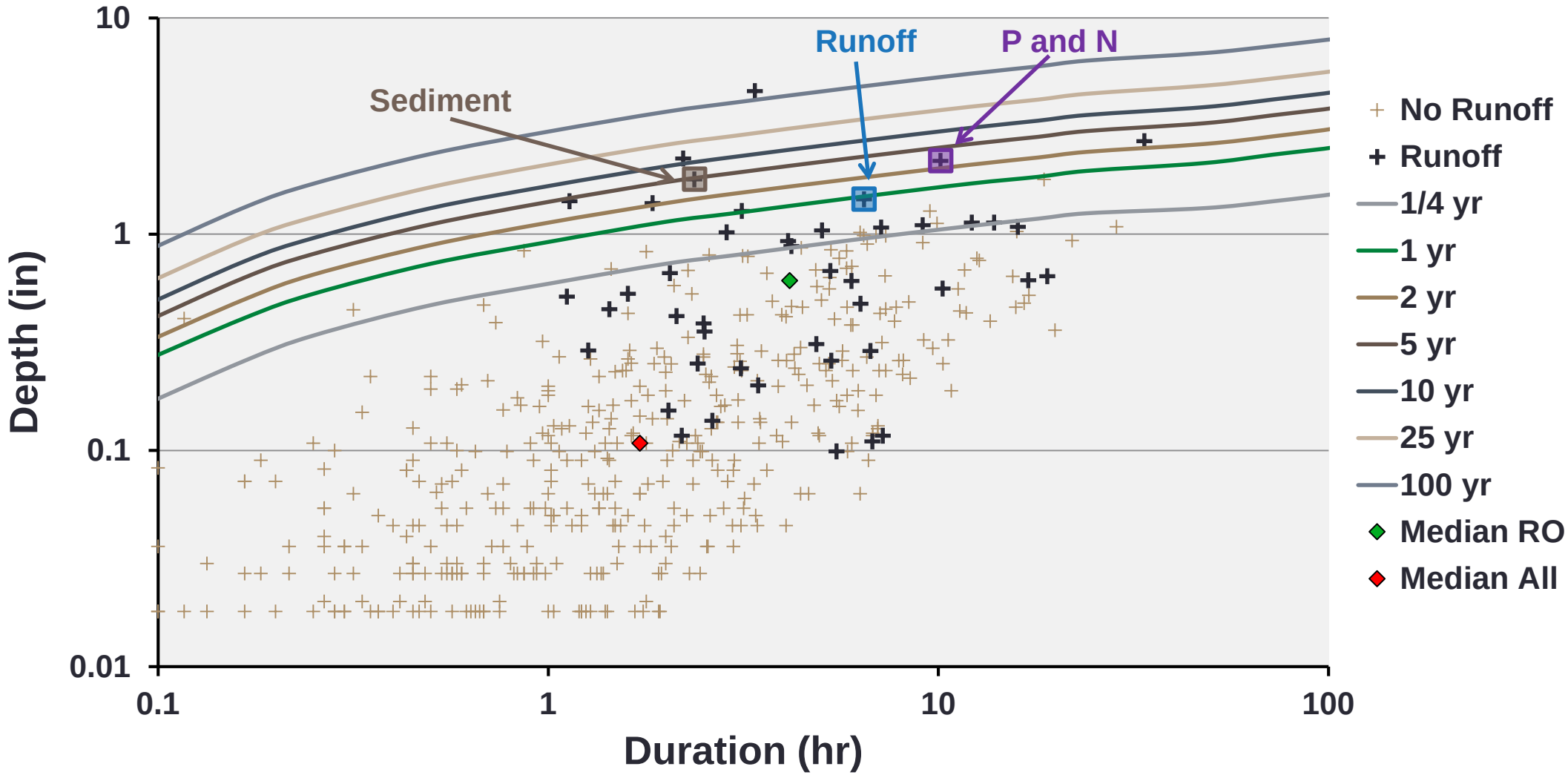
Example farm rain events with medians, “size” and greatest losses



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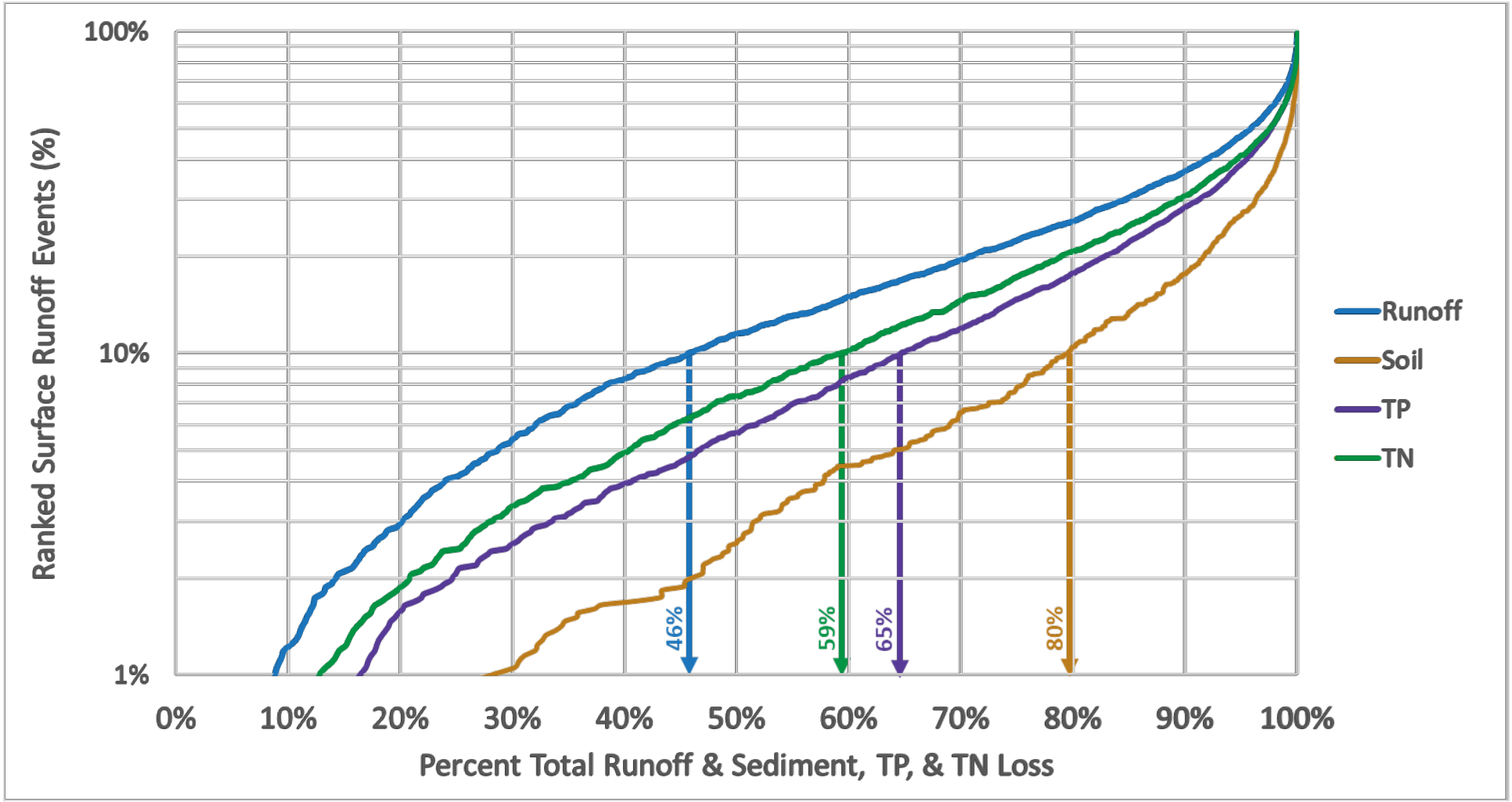
2184 runoff events at Discovery Farms locations in 127 site years

- Flow over the soil surface from snowmelt or rainfall
- Defined by start and stop of flow
- Runoff and sediment, phosphorus, and nitrogen concentrations and losses for each event
- On average, 17 runoff events per site year
- Events ranked for runoff and sediment, phosphorus, and nitrogen loss and the ranks were averaged

Most of the surface runoff losses happen in few of the largest runoff events



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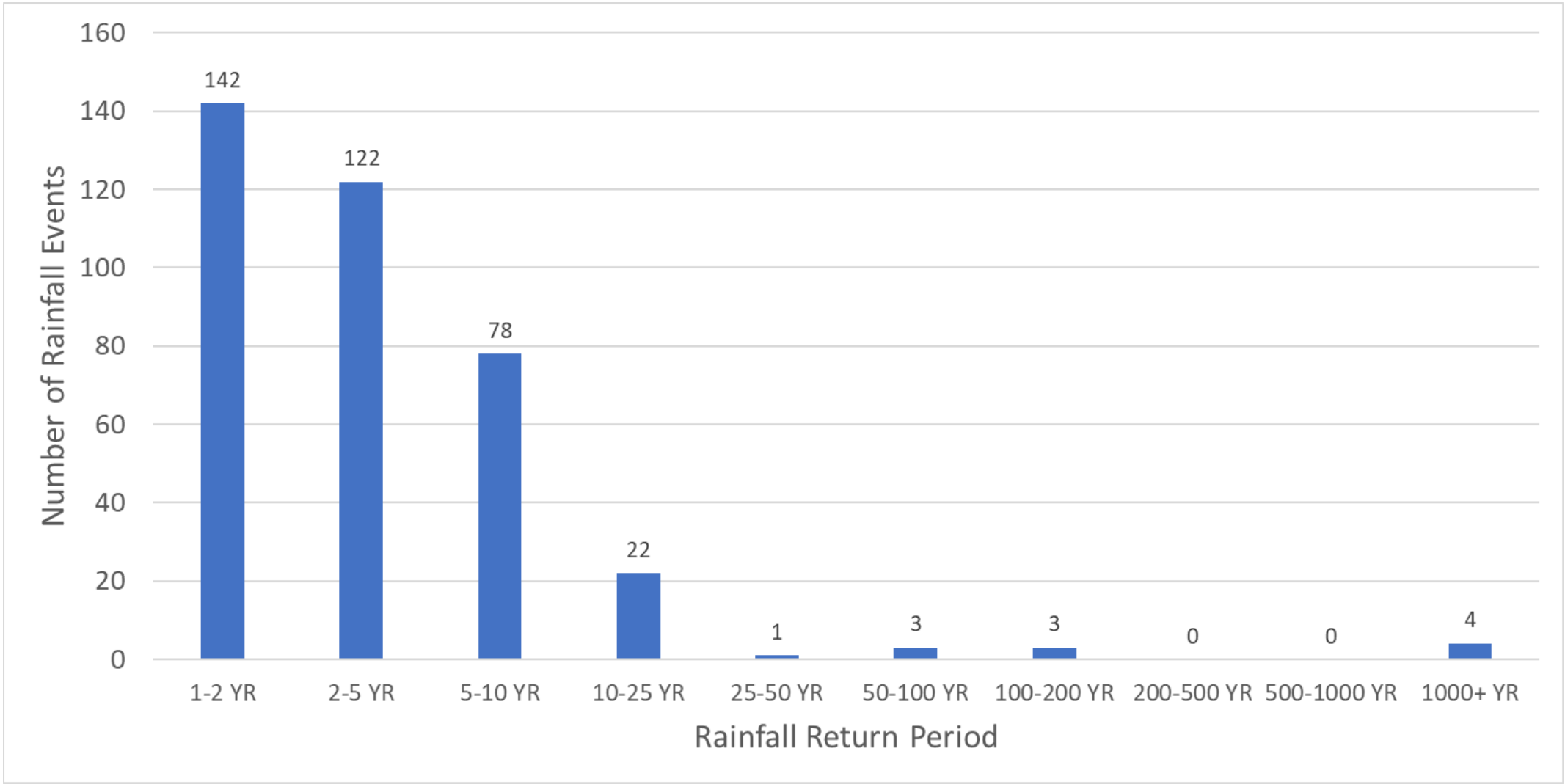
Are these high loss runoff events driven by extreme rainfall events?

Will an increase in extreme rainfall events lead the substantial changes in surface runoff from the edge-of-field?

375 rainfall events with a rainfall return period greater than 1 year.



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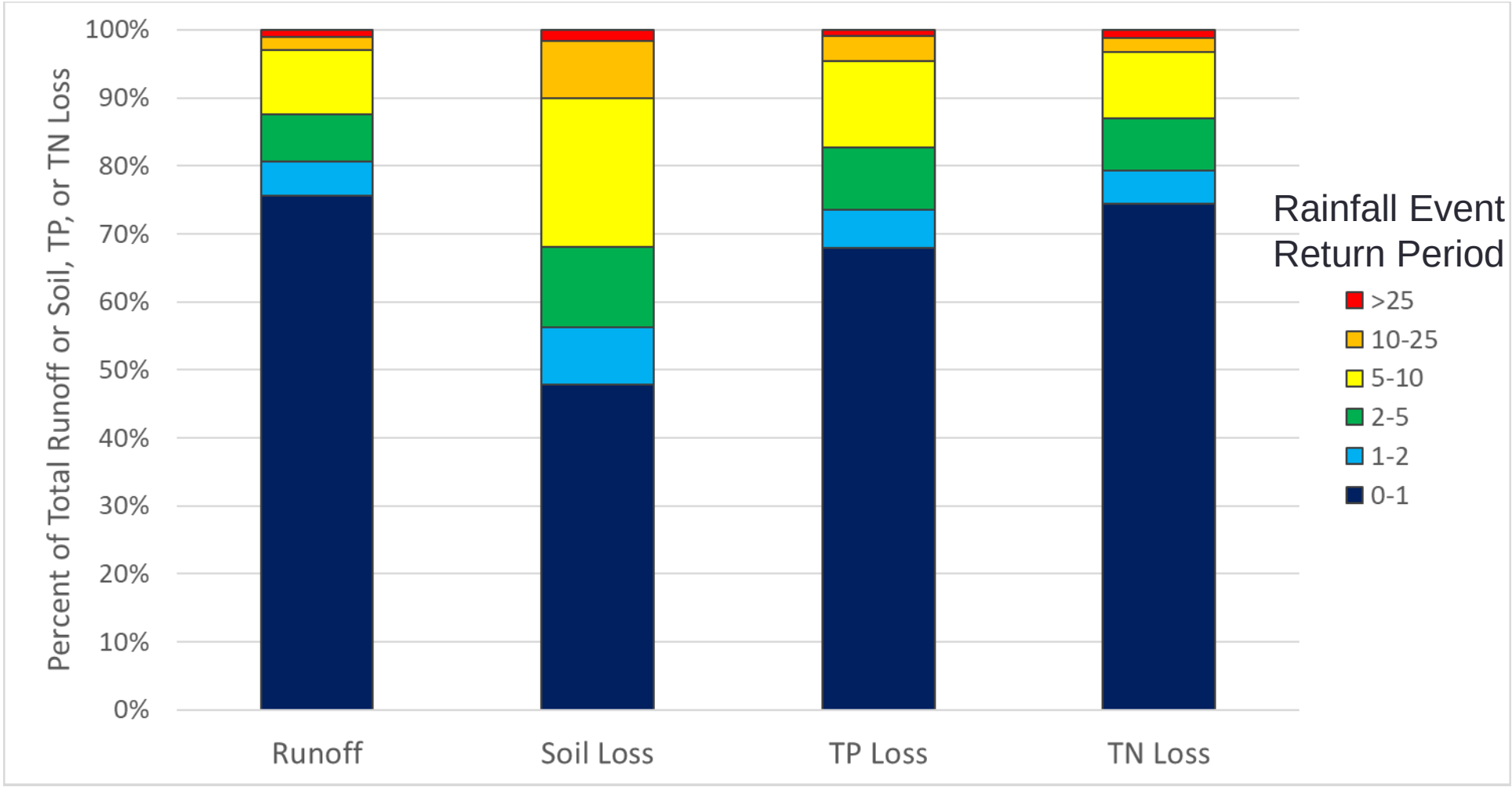
A majority (70-75%) of runoff, TP, and TN losses were driven by runoff where the rainfall return period was less than 1 year.



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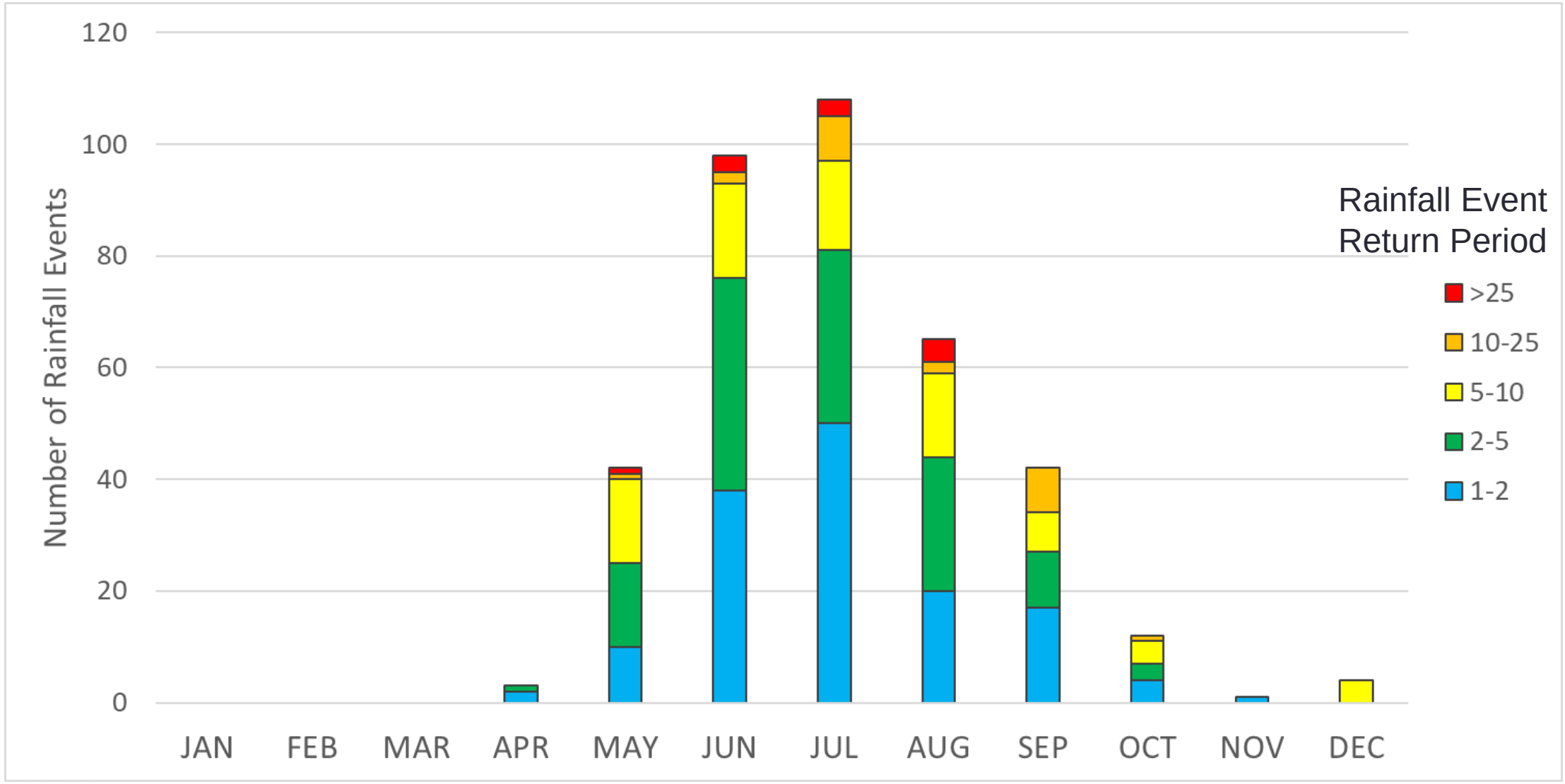
Timing of extreme rainfall matters.



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Timing of extreme rainfall matters.

Precipitation details

Return Period	Site	Start	End	Precipitation (in)	Duration (hr)	Average Intensity (in/hr)	5 Min Max Intensity (in/hr)	10 Min Max Intensity (in/hr)	15 Min Max Intensity (in/hr)	30 Min Max Intensity (in/hr)	60 Min Max Intensity (in/hr)
1000	ST1	5/31/2014 17:13	5/31/2014 21:14	5.10	4.02	1.27	7.80	6.60	5.72	5.50	4.70
1000	P1	8/18/2005 18:40	8/18/2005 22:03	4.59	3.38	1.36	7.04	6.68	6.24	5.19	4.03

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Timing of extreme rainfall matters.

ST1 5/31/2014

P1 8/18/2005

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Timing of extreme rainfall matters.

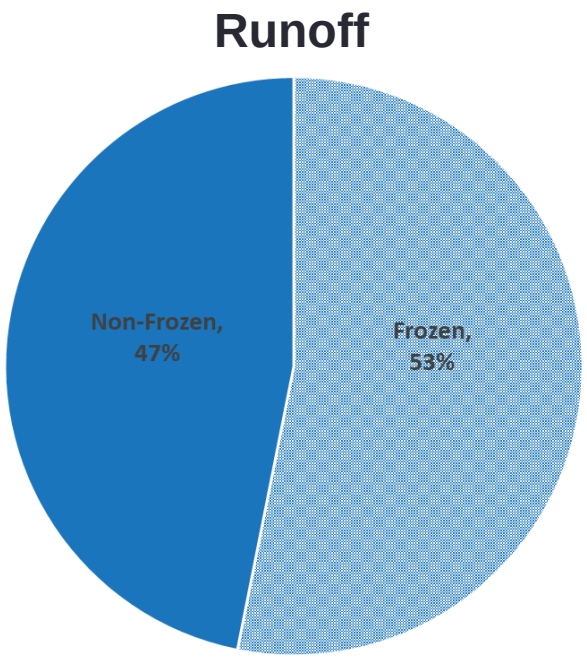
Precipitation details

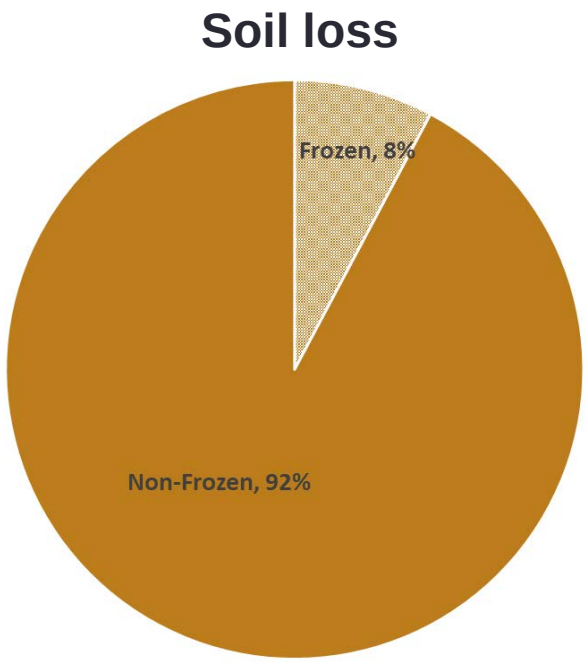
Return Period	Site	Start	End	Precipitation (in)	Duration (hr)	Average Intensity (in/hr)	5 Min Max Intensity (in/hr)	10 Min Max Intensity (in/hr)	15 Min Max Intensity (in/hr)	30 Min Max Intensity (in/hr)	60 Min Max Intensity (in/hr)
1000	ST1	5/31/2014 17:13	5/31/2014 21:14	5.10	4.02	1.27	7.80	6.60	5.72	5.50	4.70
1000	P1	8/18/2005 18:40	8/18/2005 22:03	4.59	3.38	1.36	7.04	6.68	6.24	5.19	4.03

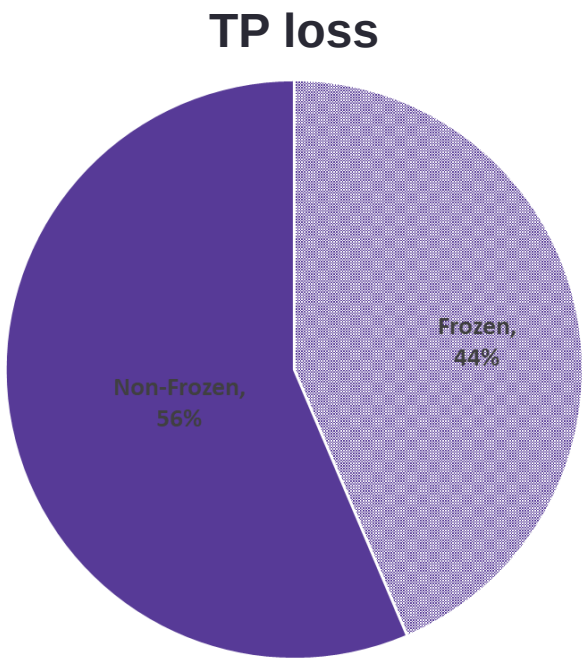
Runoff details

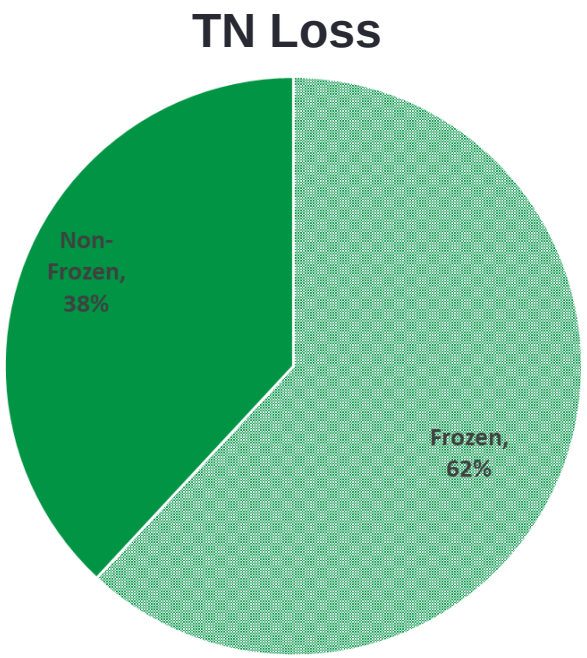
Site	Start	End	Runoff (in)	Soil (lb/ac)	TP (lb/ac)	TN (lb/ac)
ST1	5/31/14 16:19	6/1/14 3:05	1.18	880.59	0.85	8.80
P1	8/18/05 22:00	8/18/05 23:17	0.01	0.50	0.01	0.04

Snowmelt is a significant part of the water budget in Wisconsin and Minnesota.









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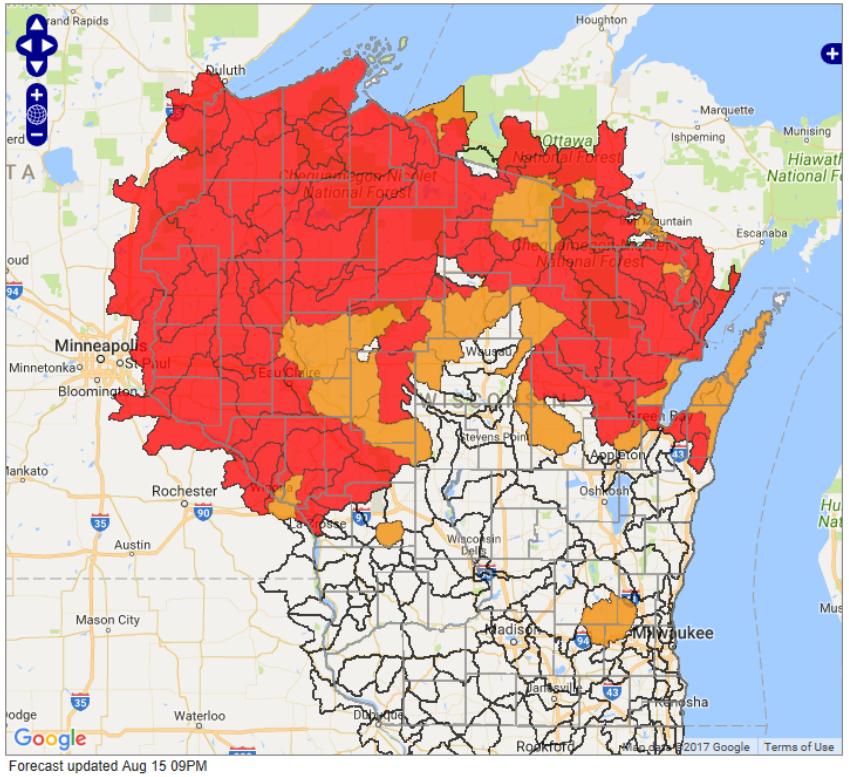
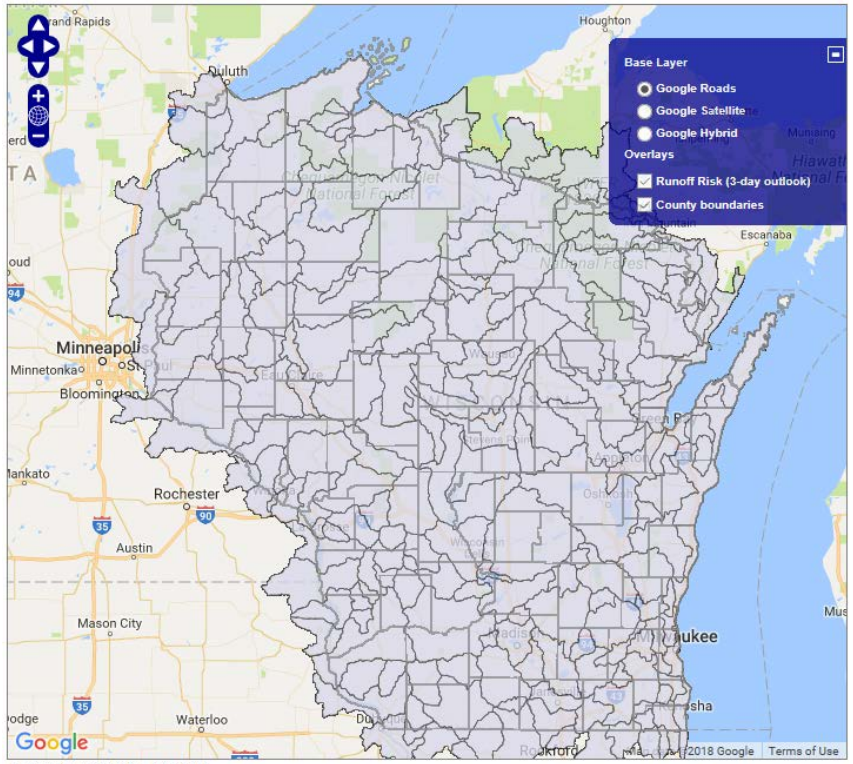
Tool – Runoff Risk Advisory Forecast map

Runoff Risk (3-day)			Winter Risk (10 day)		
Low	Moderate	High	Frozen/snow-covered soil	Runoff	Snowmelt Runoff



Forecast updated Aug 15 09PM



Forecast updated Jan 05 11AM

www.manureadvisorysystem.wi.gov

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Conclusions

- Most surface runoff losses happen in a limited number of runoff events
- Extreme rainfall events did not significantly impact edge-of-field surface runoff losses for the Discovery Farms dataset
- Timing of extreme precipitation events is important
  - A shift earlier in the year (April-May) would likely increase impact
- Influence of snowmelt diminishes impact of extreme rainfall events

Questions for the future

- Will timing of extreme precipitation events change?
- Will influence of snowmelt increase or decrease?
- Is there a need to assess differences by site - impact of conservation practices?
  - Soils, slope, etc
- Is there a way to assess longer durations (multiple day cumulative effects)?

Thank you!

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