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Evaluating the effect of rainfall variability on vegetation establishment in a semidesert grassland

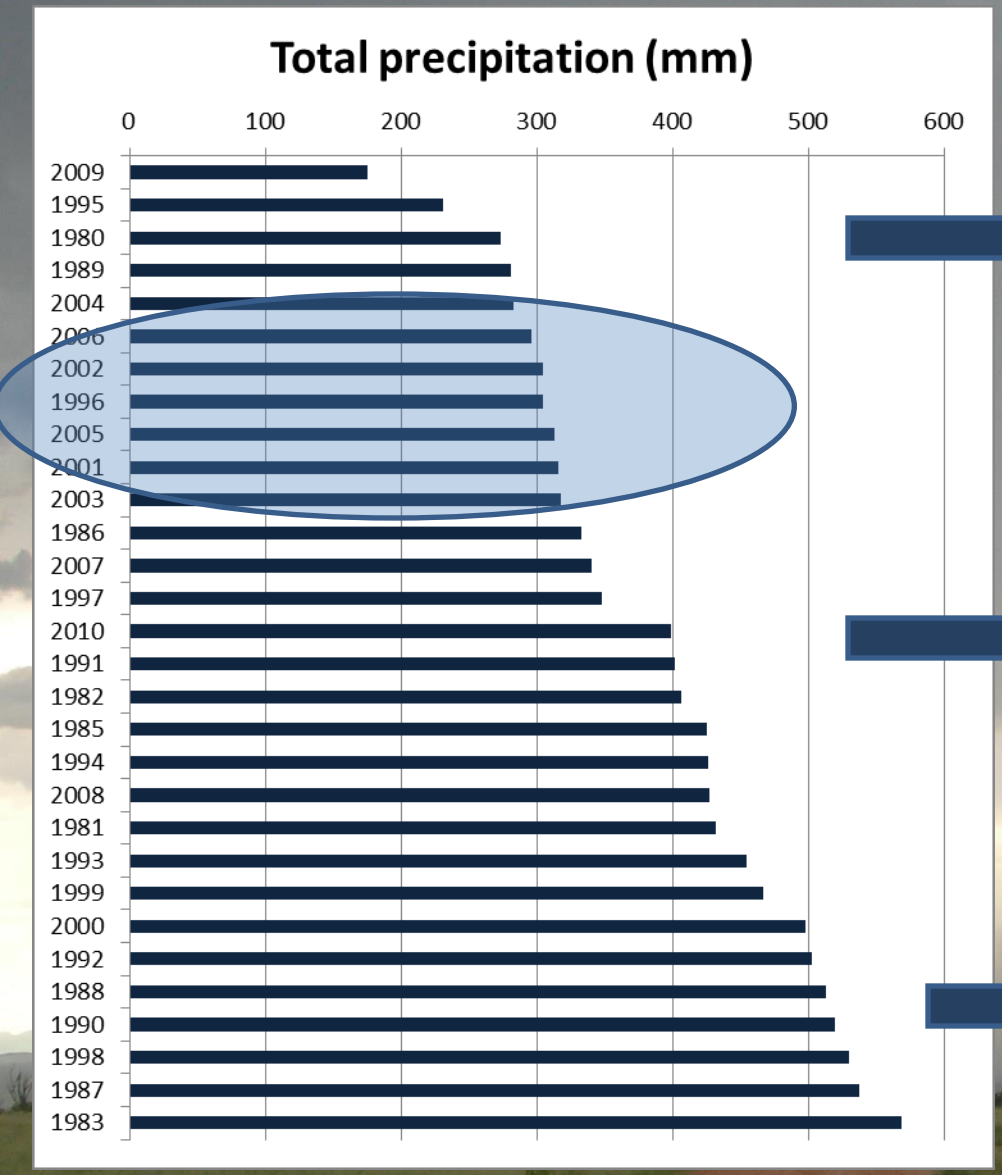
Jeffrey S. Fehmi · Guo-Yue Niu · Russell L. Scott · Andrea Mathias

Revegetation research results from southern Arizona

Speaker: Jeffrey S. Fehmi
School of Natural Resources and Environment
University of Arizona

With substantial contribution by: Guo-Yue Niu, Russell L. Scott, & Andrea Mathias

My old explanation



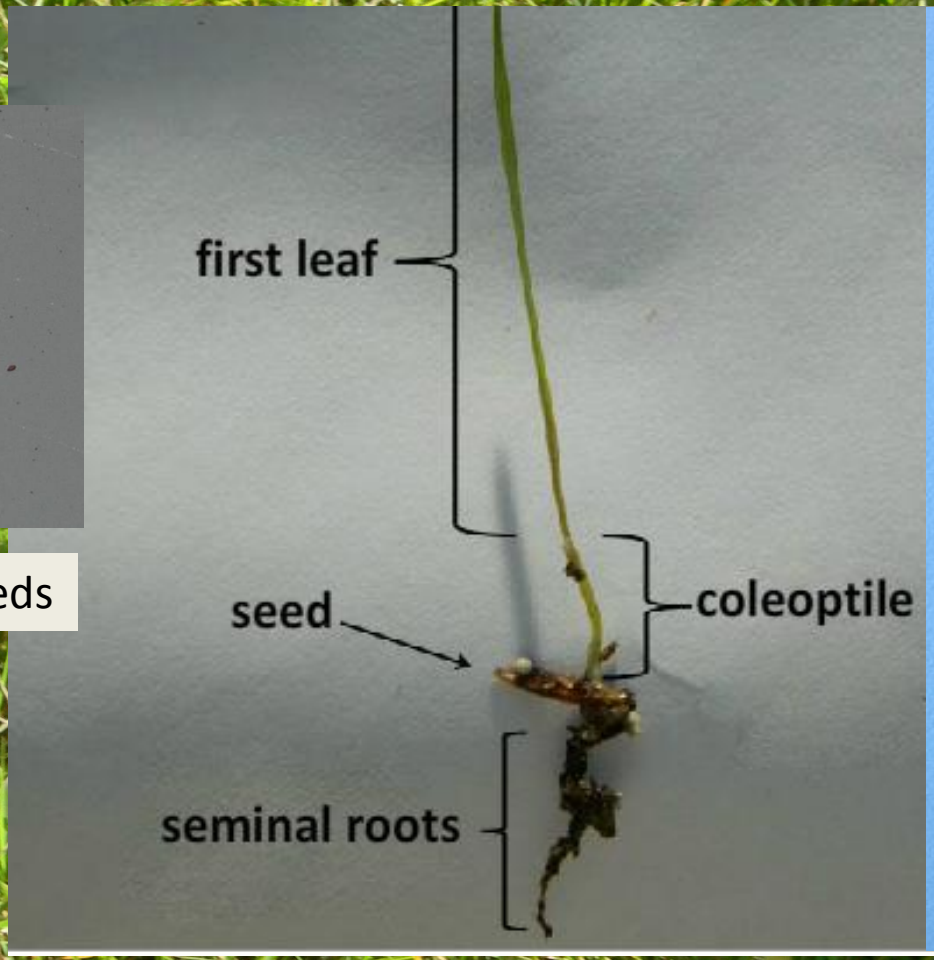
Too dry

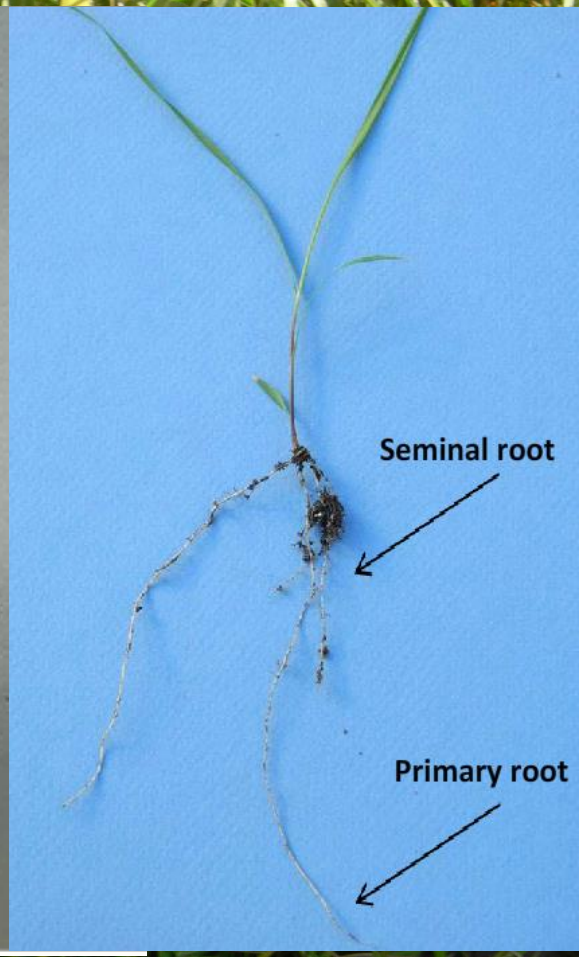
Average

Wet

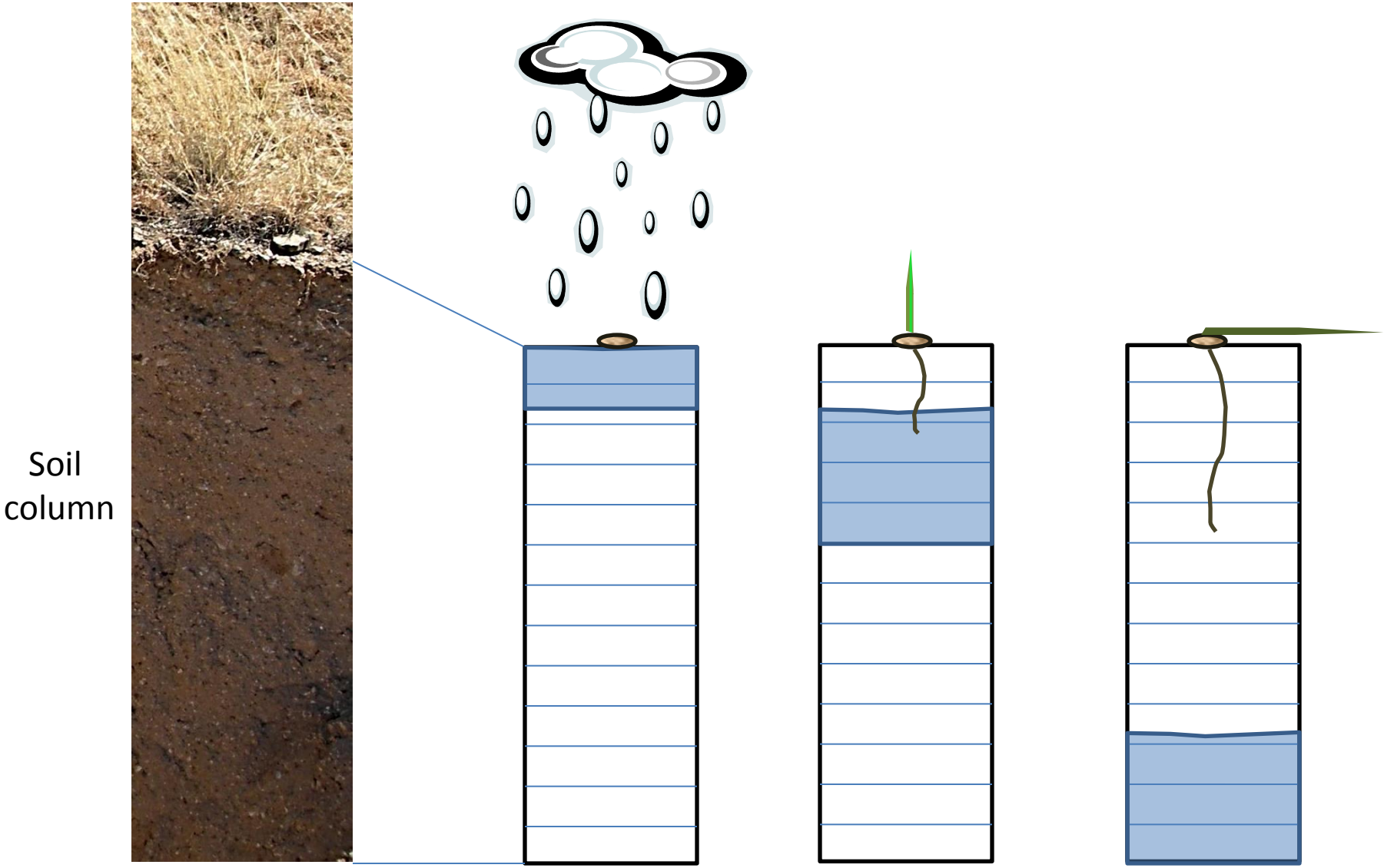
The beginning of a grass plant

Plains lovegrass seeds





http://passel.unl.edu/animation/0cc39838e6ff74ddf333e948bf9975d3-NSE_seed_structure_emergence.swf



Germinated plants die when root growth does not keep up with the drying front in the soil

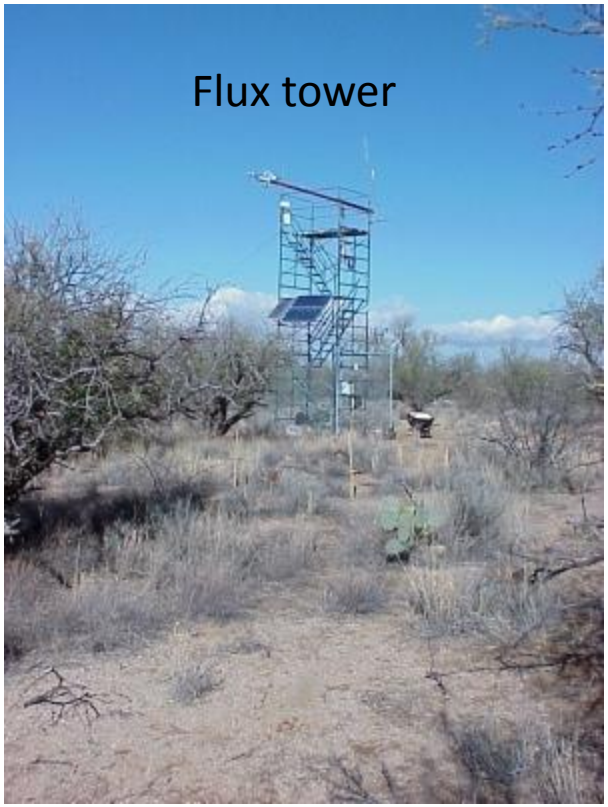
Model effects of Rainfall

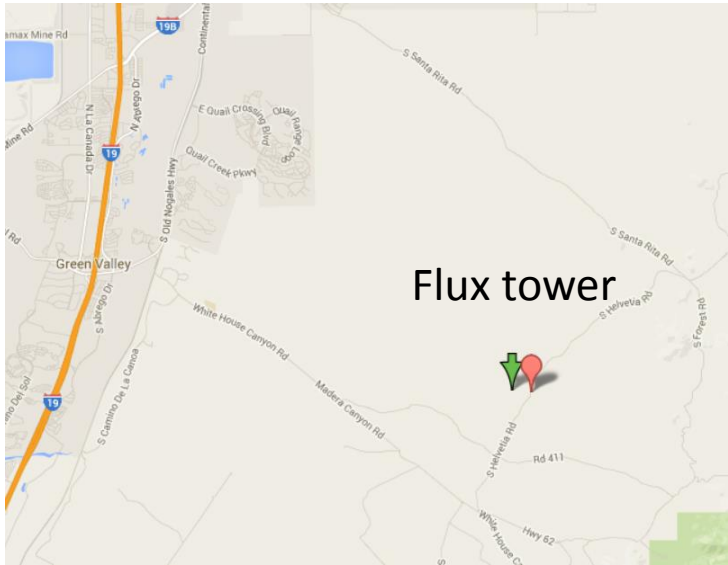
- Rainfall data (1980–2010, 31 years) from Santa Rita Experimental Range
  - gage 5 (31.8152 N, 110.8516W, 1,163 m asl, 398 mm average annual precipitation)
  - gage 6 (31.8137 N, 110.8544 W, 1,215 m asl, 405 mm average annual precipitation).
  - The gages are 311 m apart.

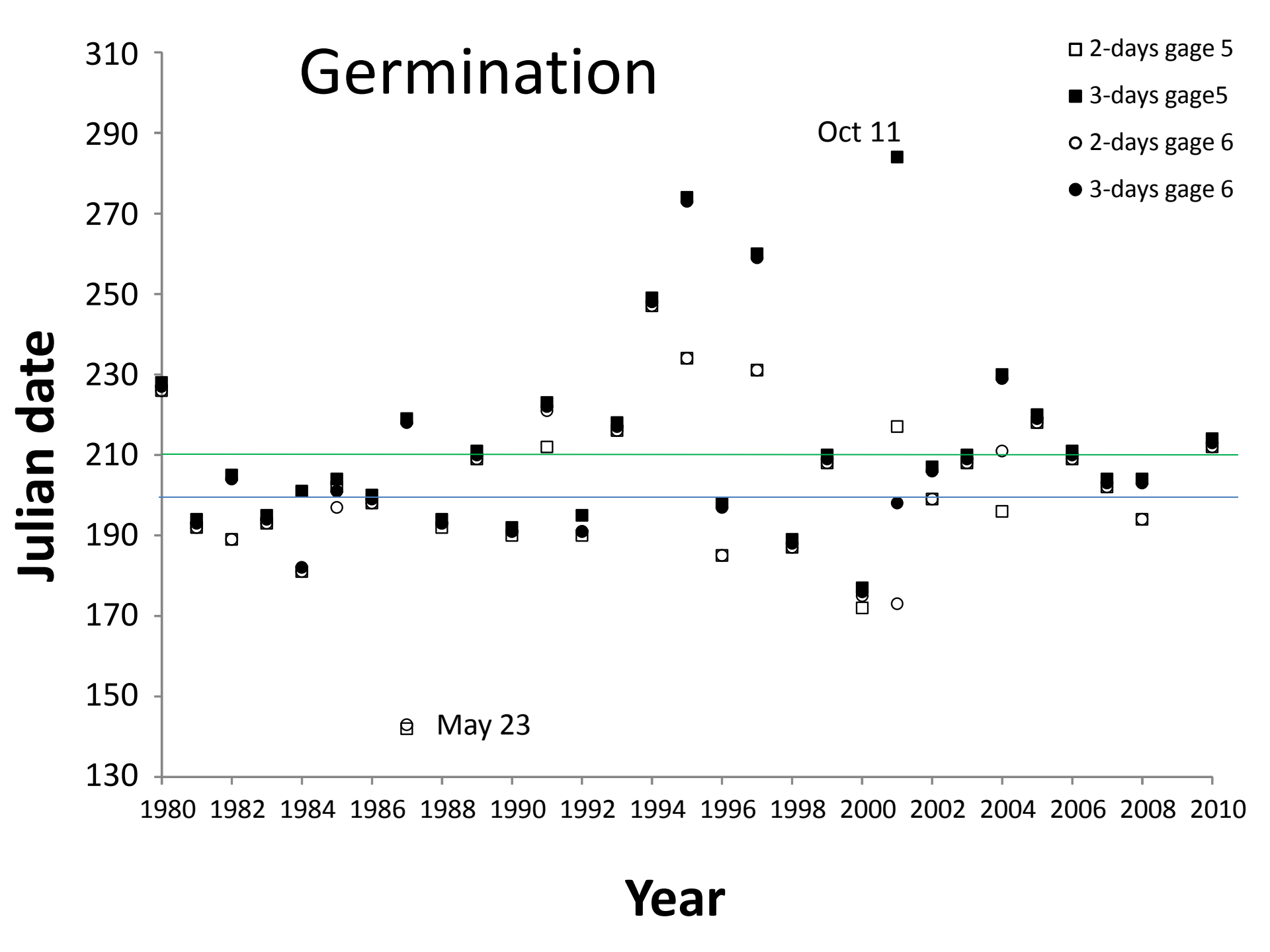
http://water4life-water4life.blogspot.com/

Model integrating precipitation and eddy flux data to obtain soil moisture

- Seven years of eddy flux data (6 January 2004–31 December 2010). Santa Rita Mesquite Savanna site (31.8214 N, 110.8661 W, 1,120 m). Uniform sandy loam.
- Made a land surface model with hourly atmospheric forcing data
  - shortwave and longwave radiation fluxes,
  - 31-year precipitation data,
  - air temperature, humidity, pressure, and wind speed.





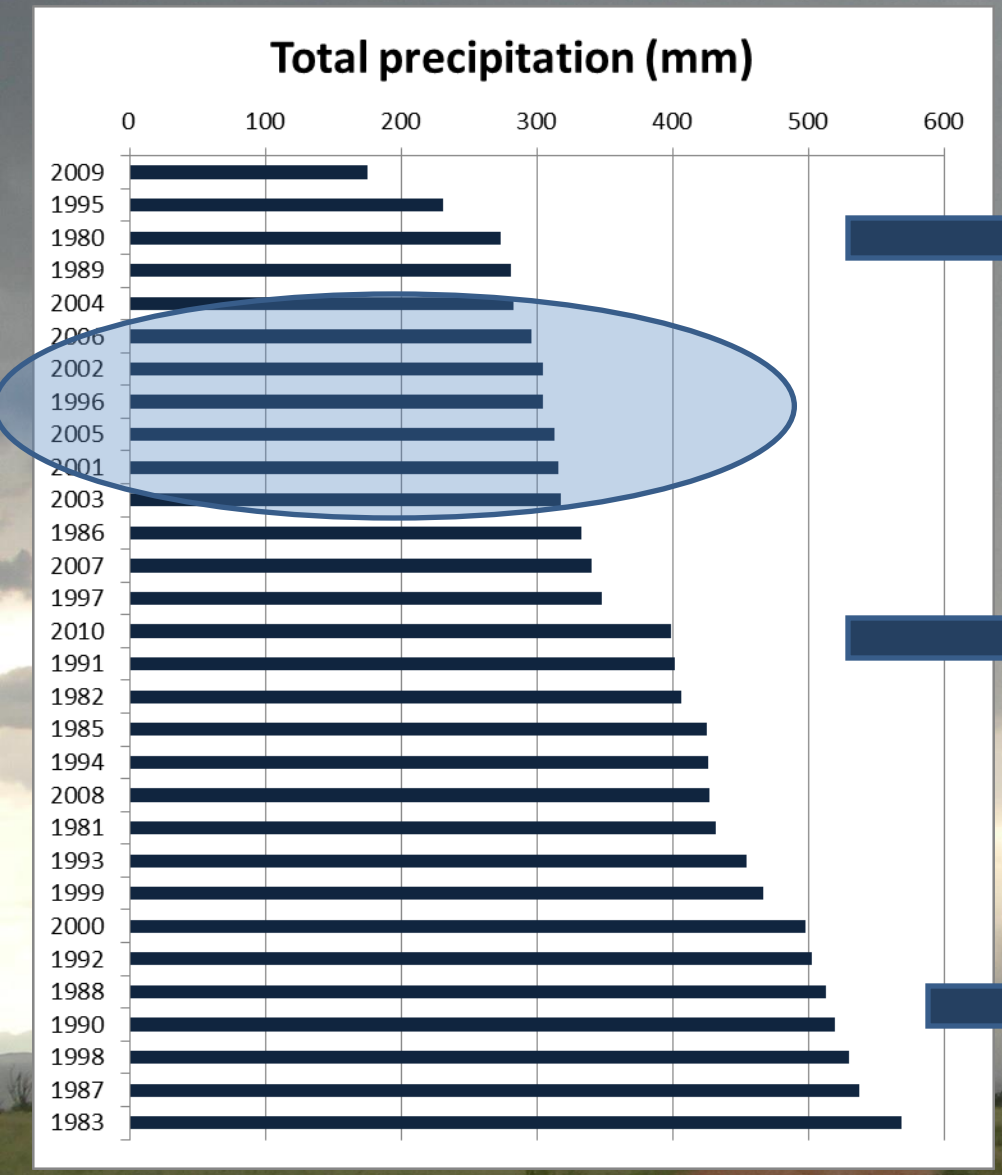

Germination
2-days gage 5
3-days gage5
2-days gage 6
3-days gage 6
Oct 11
May 23
Julian date
Year
310
290
270
250
230
210
190
170
150
130
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

Chance of success

- Two-day scenario:
  - Gage 5 - 35 % of the years failed to have successful establishment,
  - Gage 6 - 29 % of the years failed
- Three-day scenario:
  - Gage 5 - 29 % failed
  - Gage 6 - 35 % failed

Year	Gage 5 2D	Gage 6 2D	Gage 5 3D	Gage 6 3D
1980	1	1	0	0
1981	1	1	1	1
1982	0	0	1	1
1983	1	1	0	0
1984	1	1	1	1
1985	1	1	1	1
1986	0	0	0	0
1987	0	0	1	1
1988	0	0	0	0
1989	1	1	1	1
1990	1	1	1	1
1991	0	1	1	1
1992	0	0	0	0
1993	1	1	1	1
1994	1	1	1	1
1995	0	0	1	0
1996	1	1	0	0
1997	1	1	1	0
1998	1	1	1	1
1999	1	1	1	1
2000	1	1	1	1
2001	0	0	0	1
2002	0	0	1	1
2003	1	1	1	1
2004	0	1	0	0
2005	1	1	1	1
2006	1	1	1	1
2007	1	1	1	1
2008	1	1	1	0
2009	0	0	0	0
2010	1	1	1	1

My old explanation

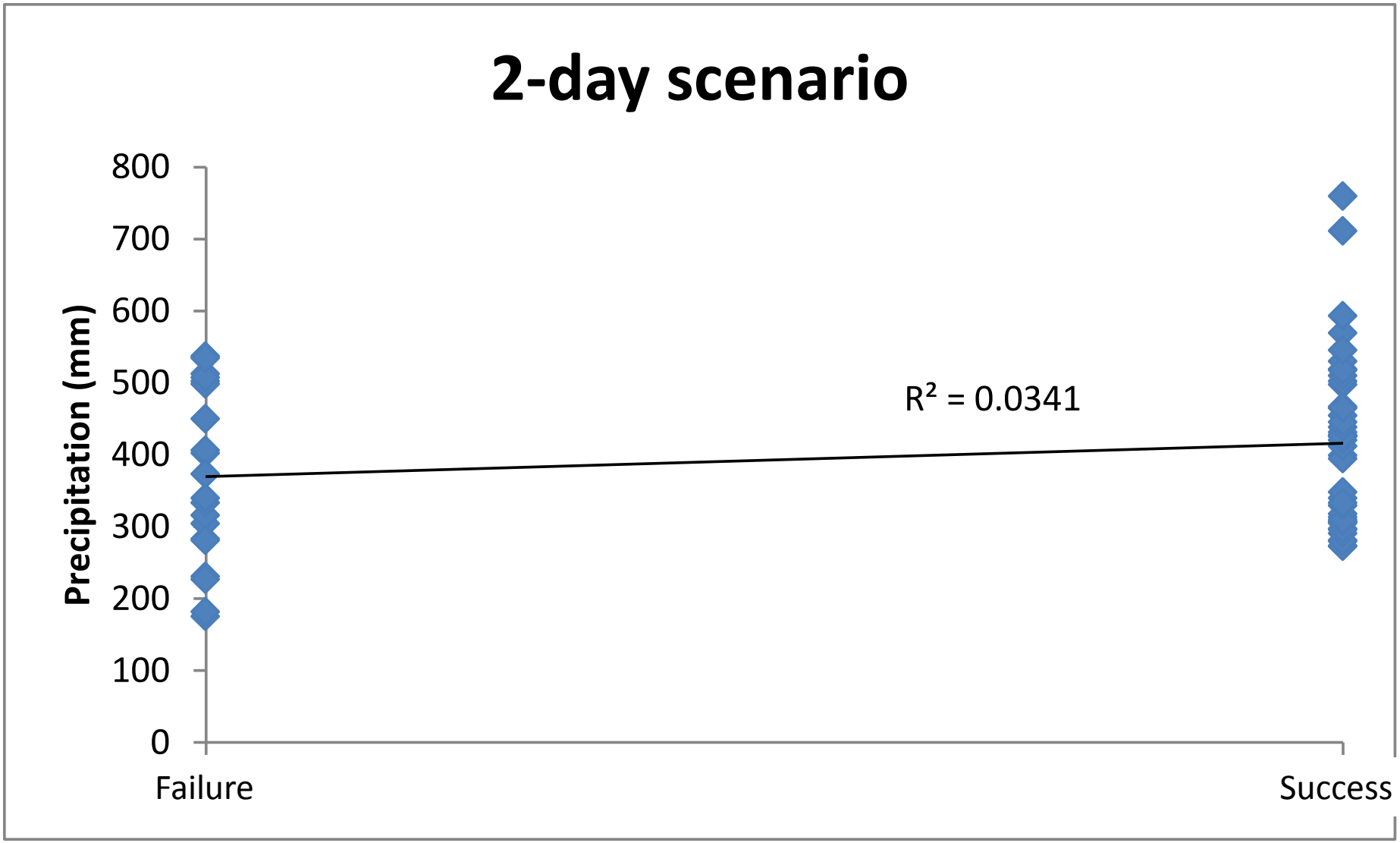


Too dry

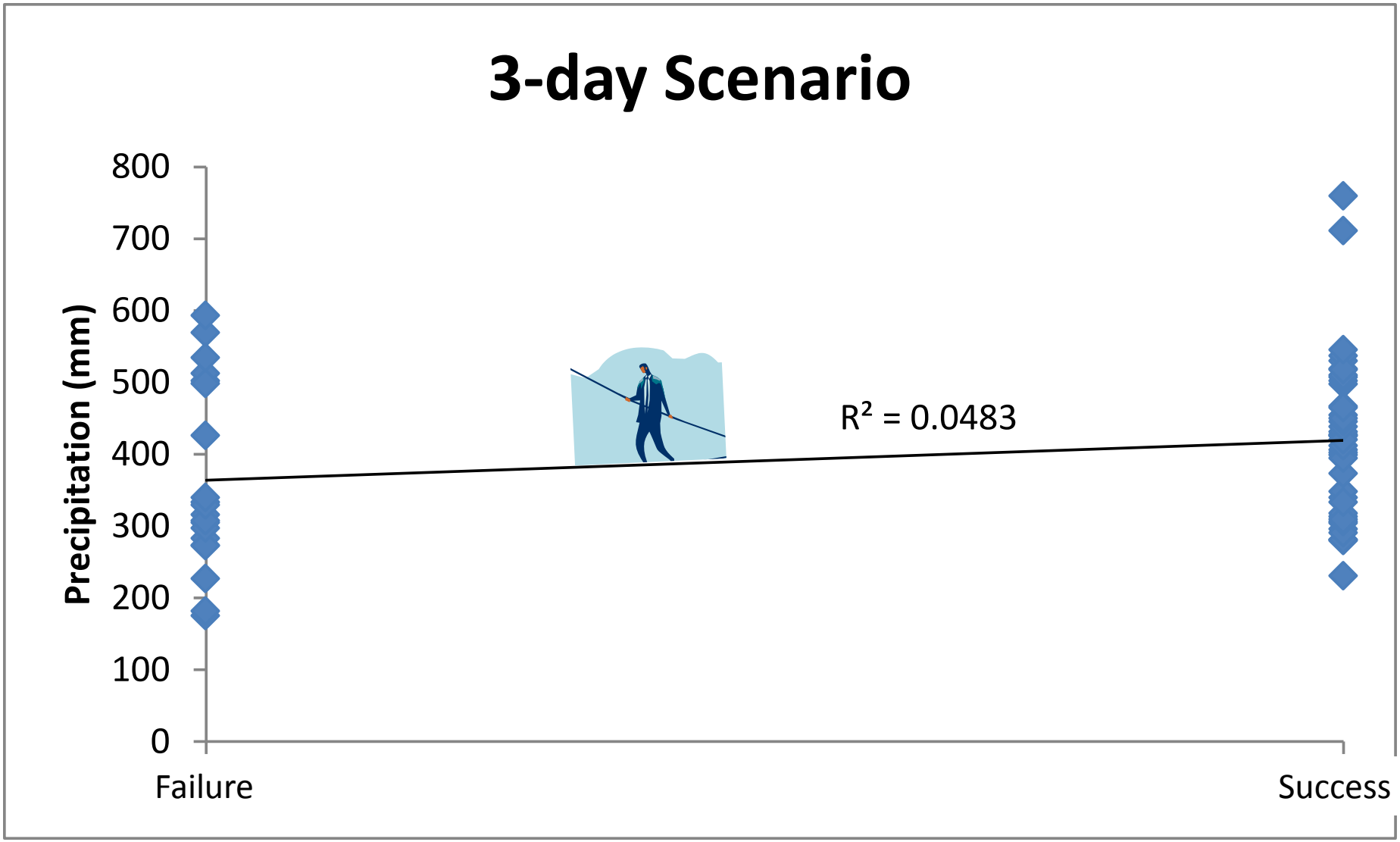
Average

Wet

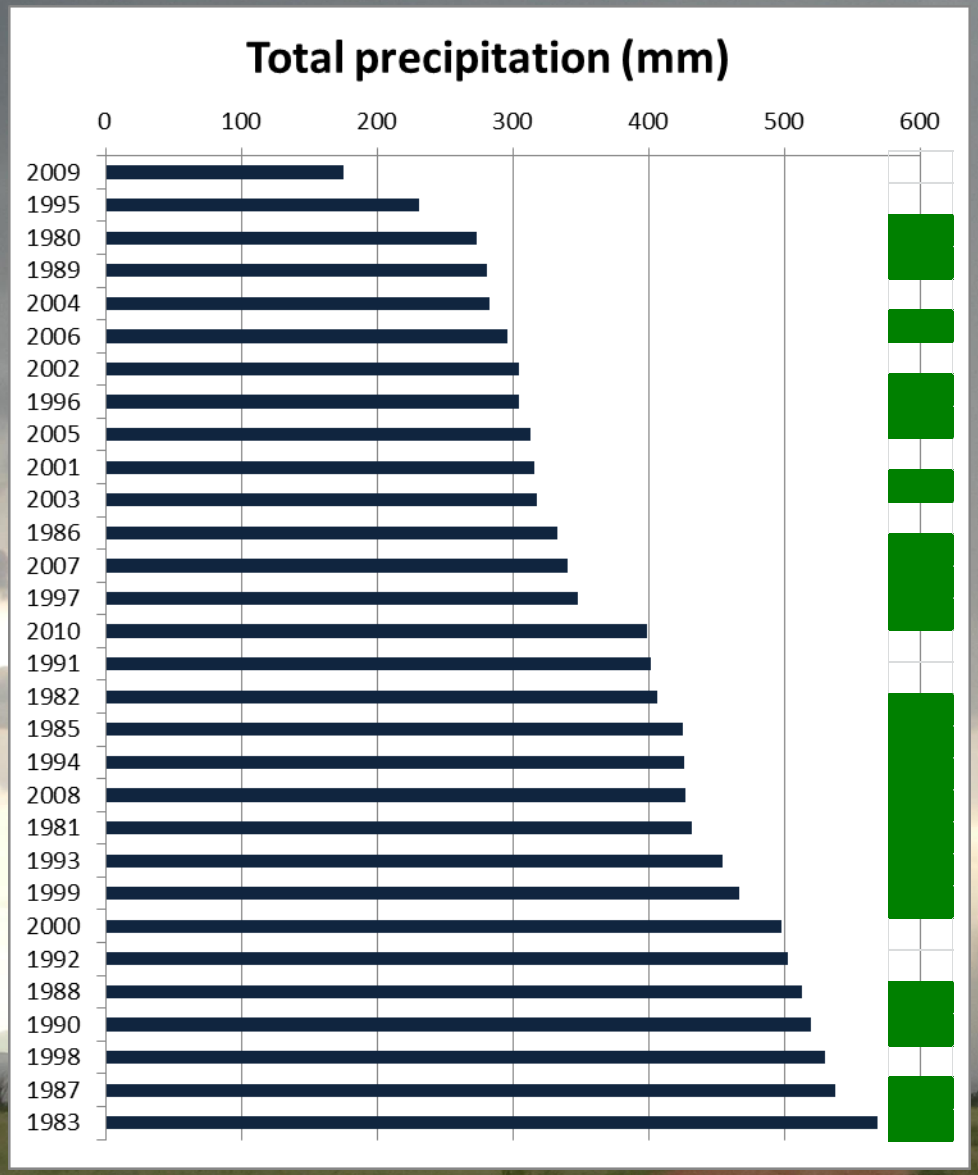
Optimistic scenario



Pessimistic scenario



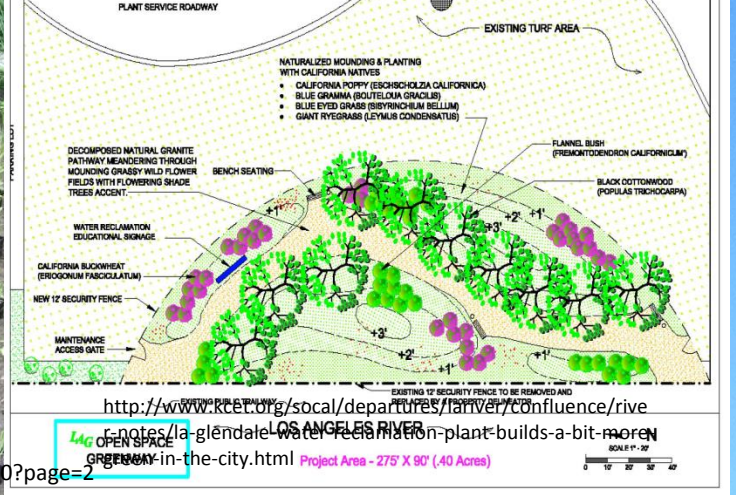
My new explanation?



Average annual precipitation does not matter for germination and establishment?!?

Intersection between planting and nature

http://www.thesca.org/greencities2010?page=2



http://www.kcet.org/socal/departures/lariver/confluence/river-notes/la-glendale-water-reclamation-plant-builds-a-bit-more-green-in-the-city.html

Landscaping

Sculpt site/soil ripping

Plant and water

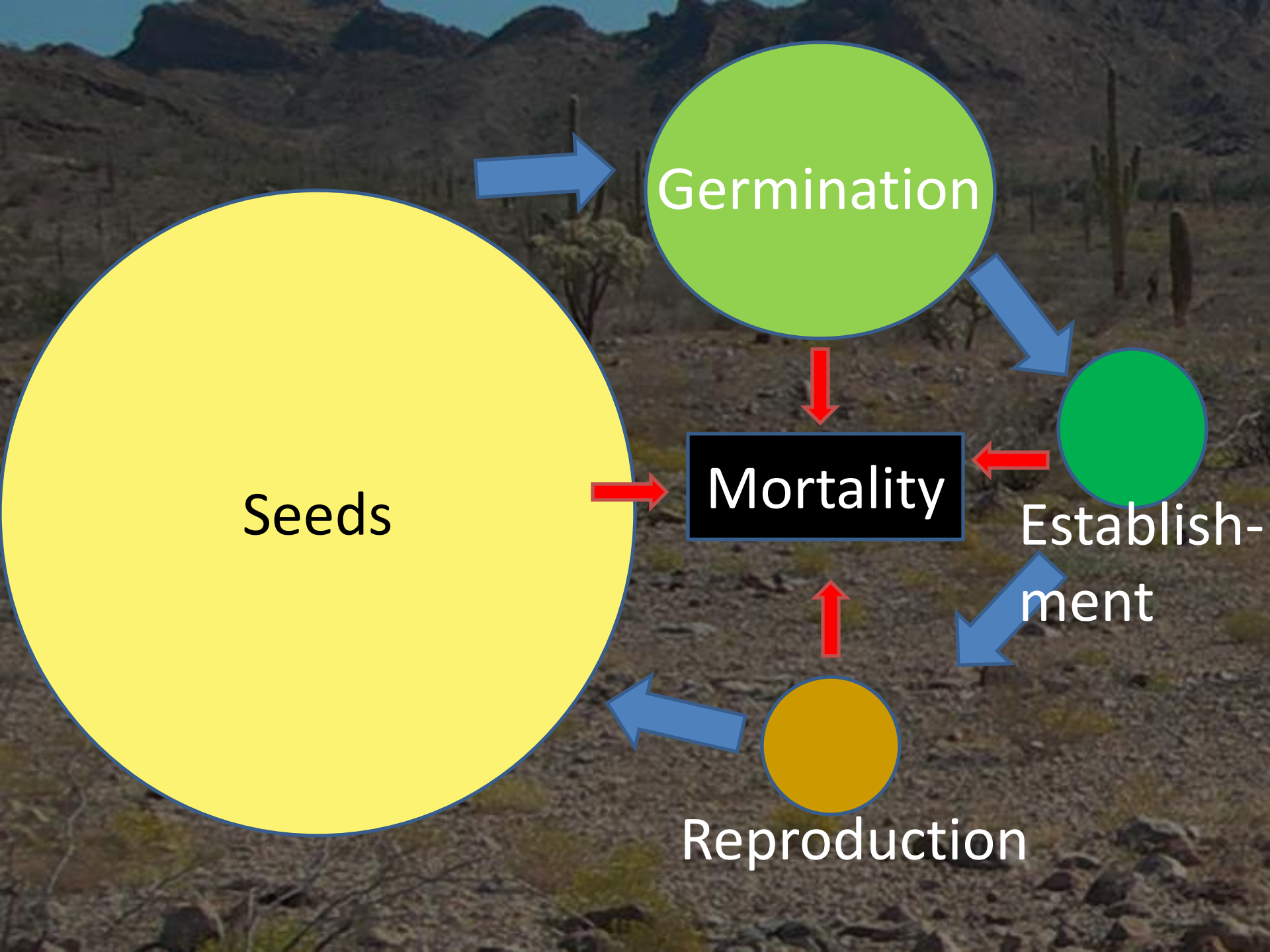
Fertilize

Drill seed

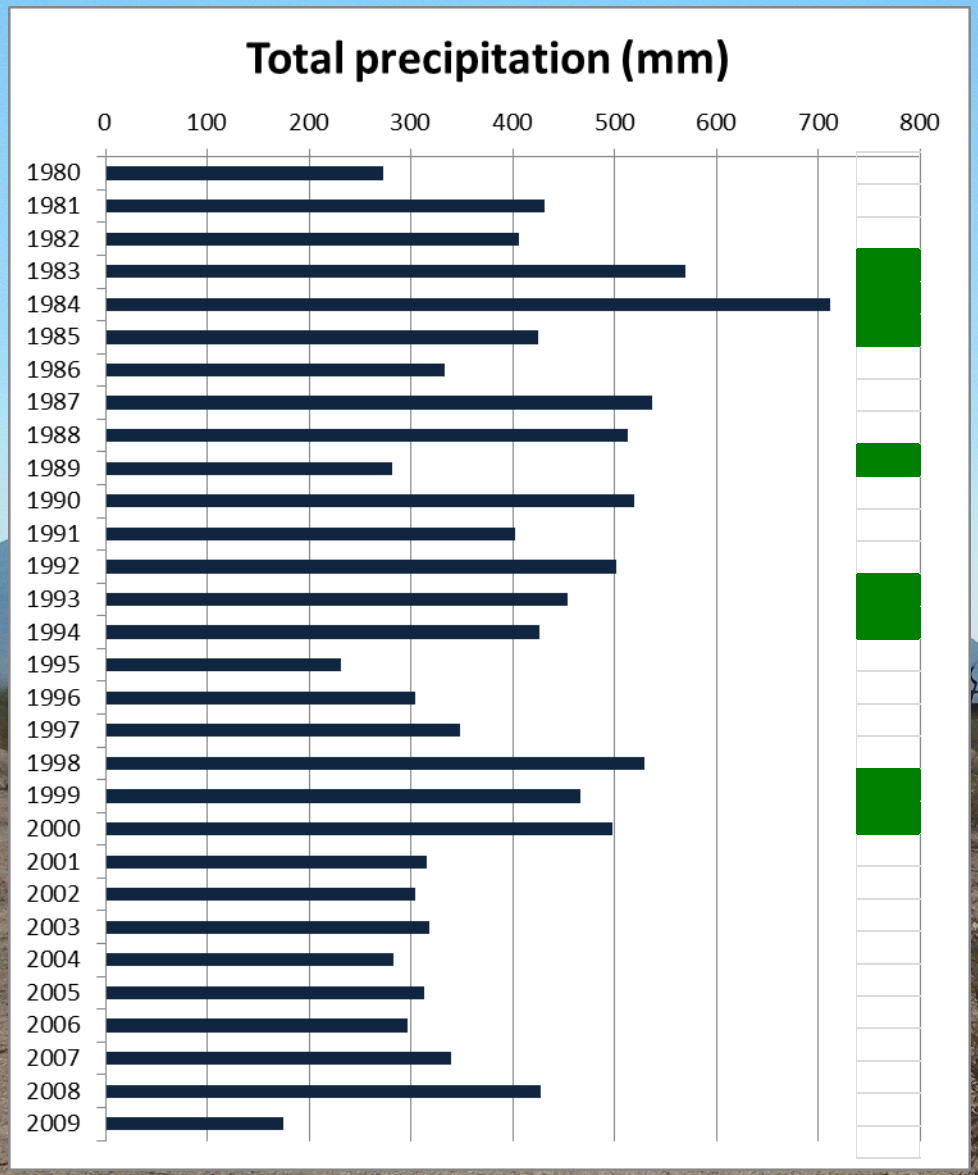
Broadcast seed and wait for rain

Natural recruitment from seed

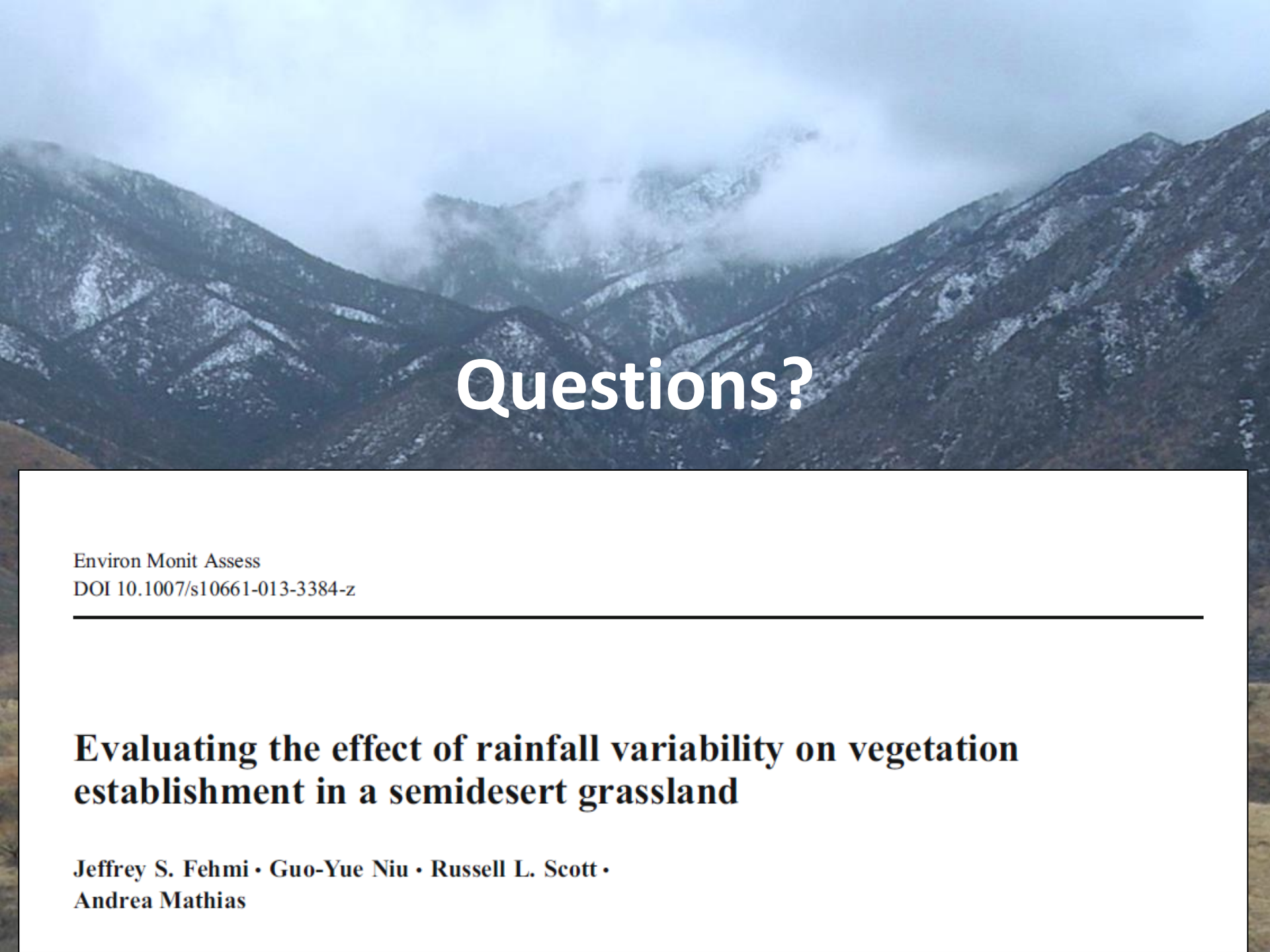
Do nothing


Germination
Seeds
Mortality
Establish-
ment
Reproduction

Natural recruitment from seed



If 400 mm is required the previous year for good seed set, then only 8 years of 31 (26%) have success.



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