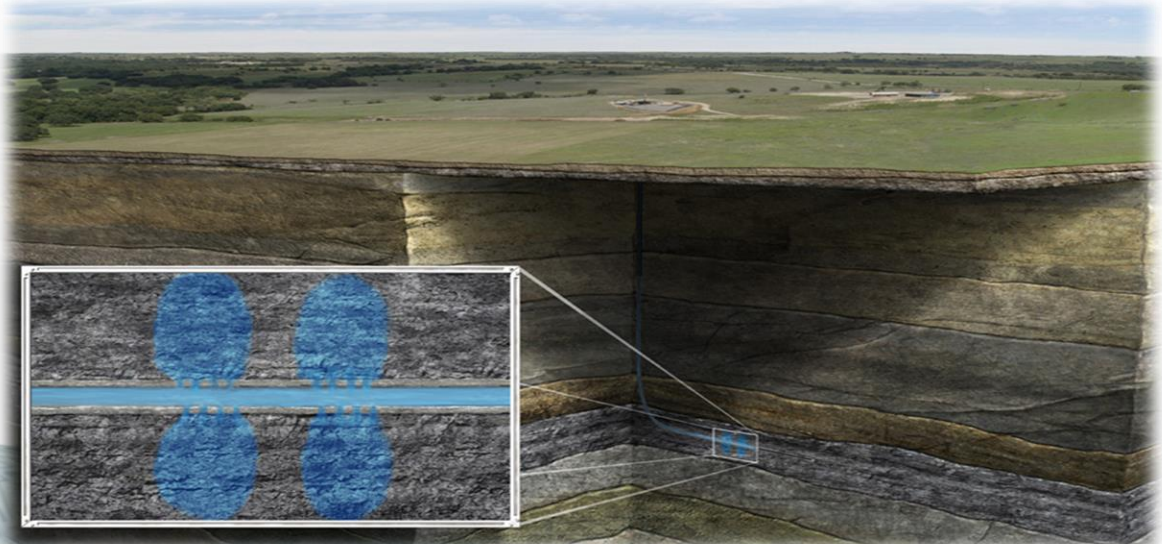
Baseflow recession analysis across the Eagle Ford gas play (Texas, USA)



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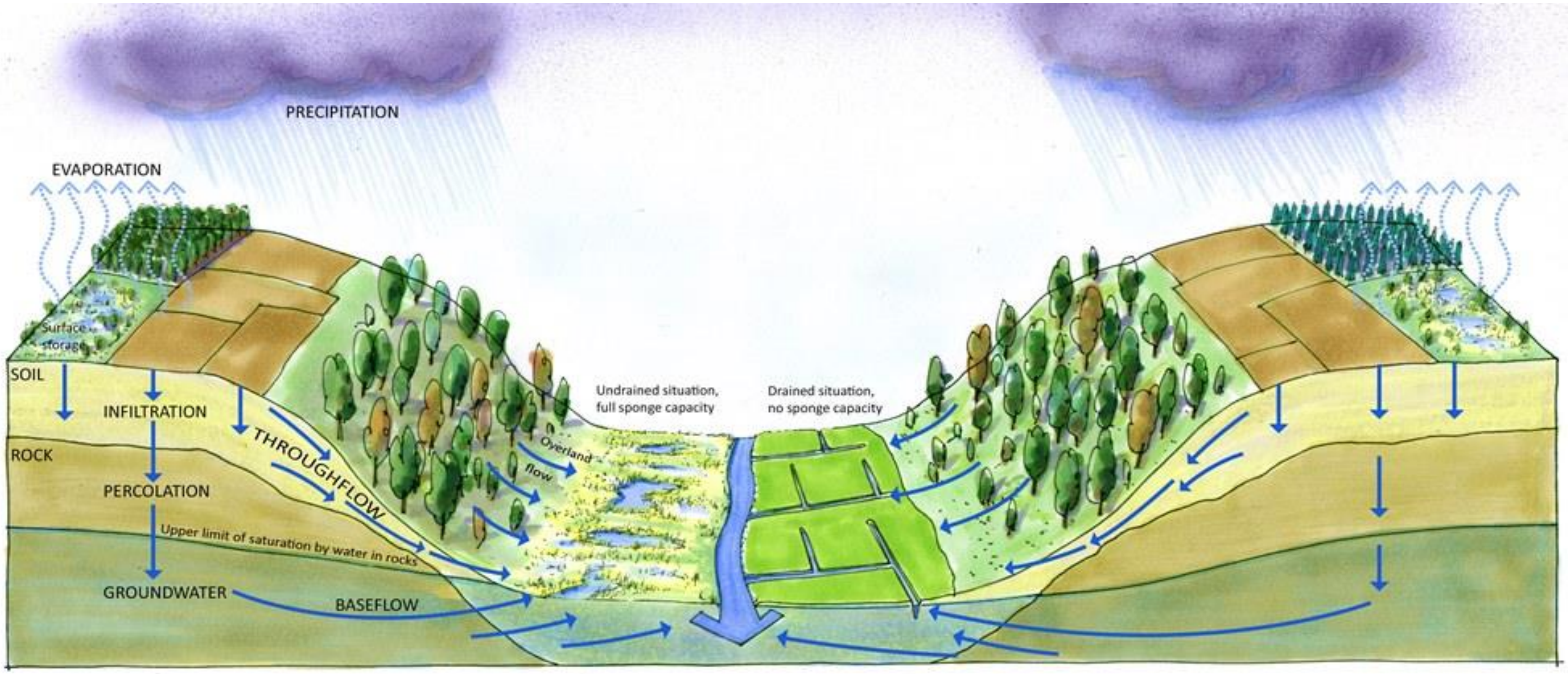
INDEX

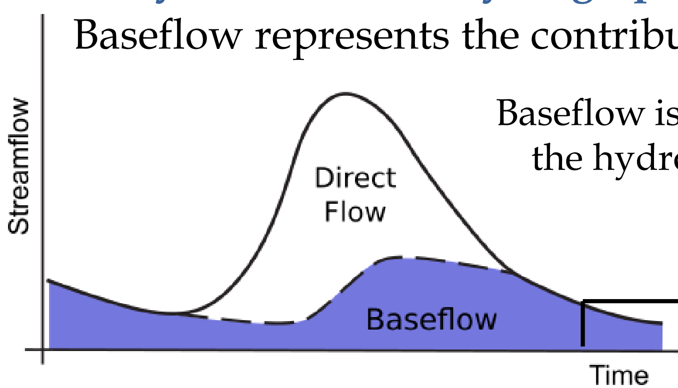
INTRODUCTION

Baseflow generation

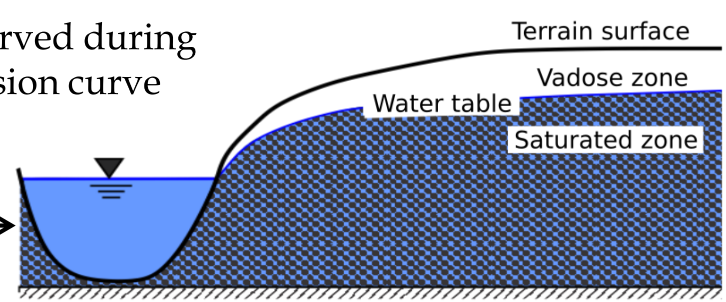


Usually derived from hydrographs

Baseflow represents the contribution of shallow aquifers to the river streamflow

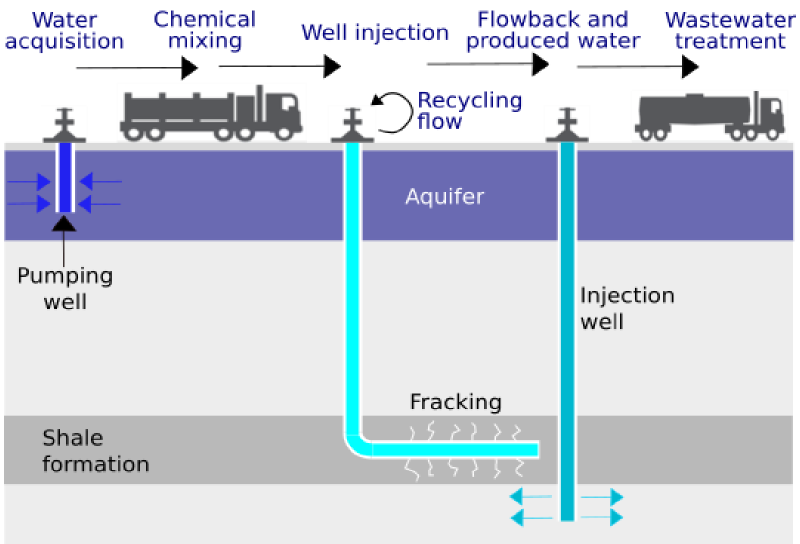


Baseflow is mainly observed during the hydrograph recession curve

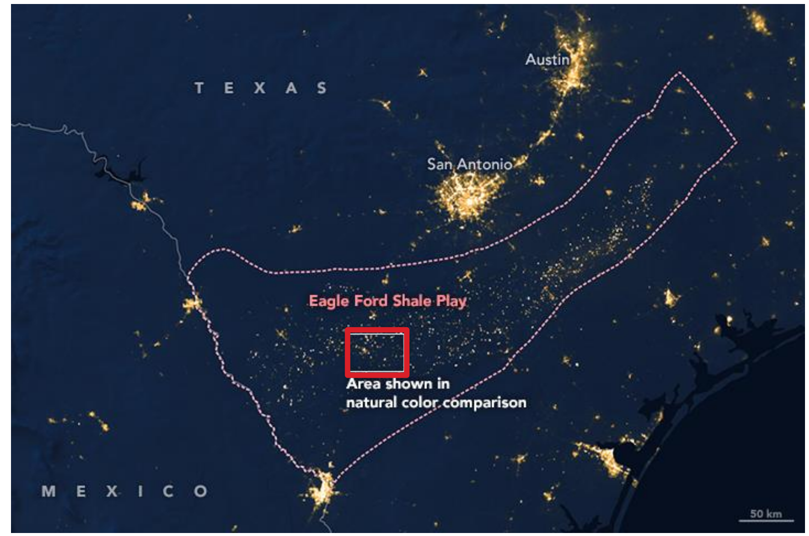


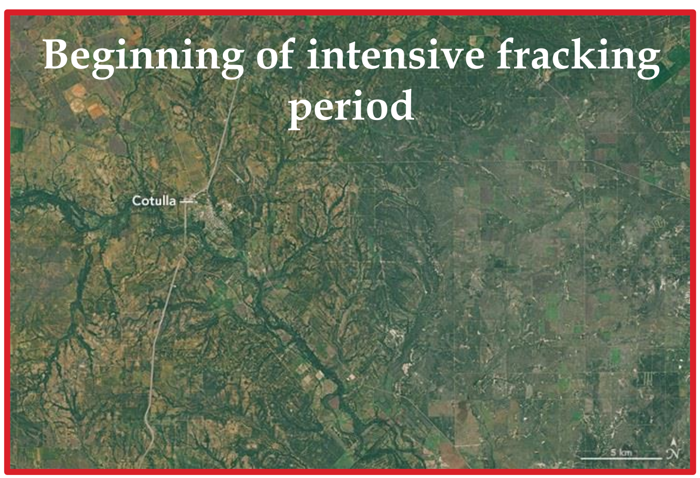
INTRODUCTION

Water use for fracking



Eagle Ford play





17/12/2000

18/12/2015

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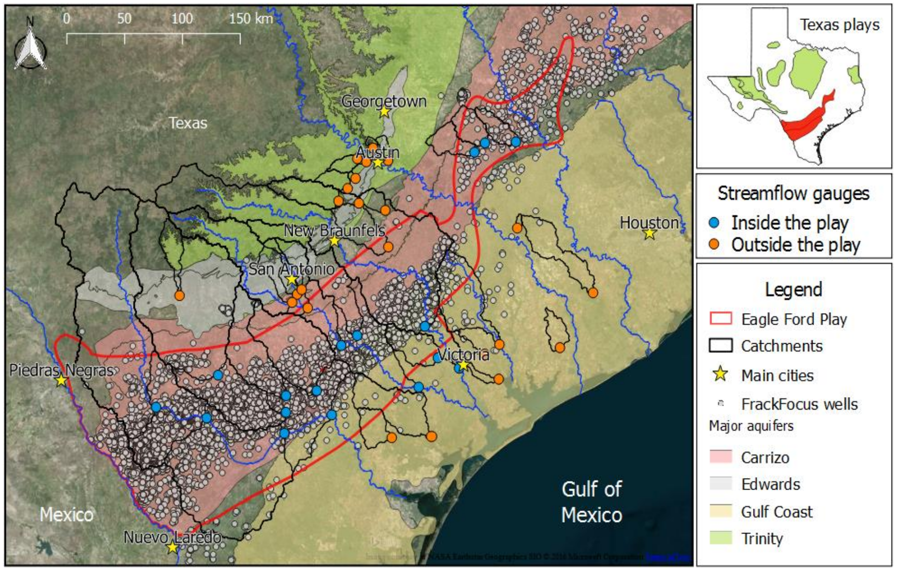
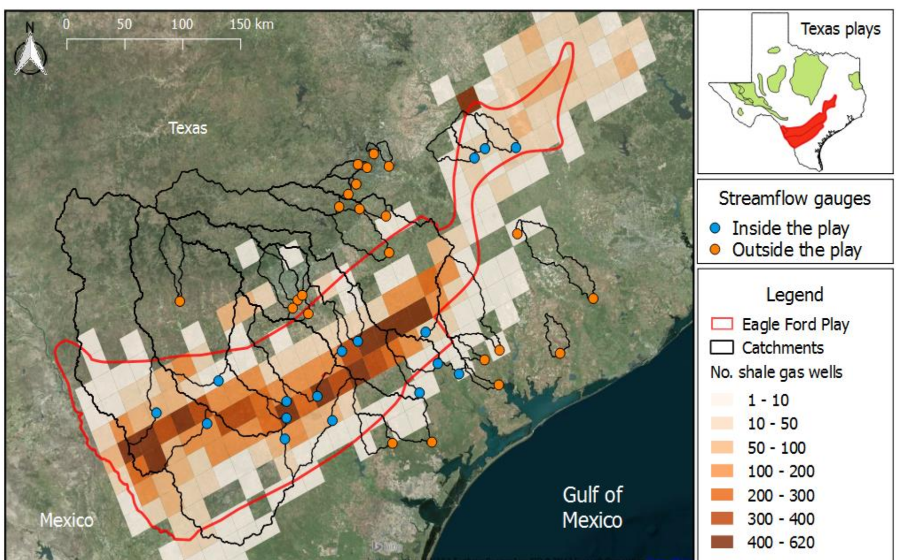
STUDY ZONE AND DATA

Streamflow and watersheds location

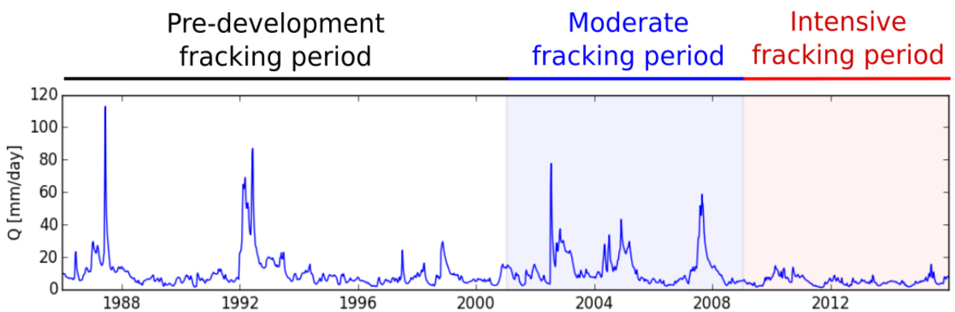


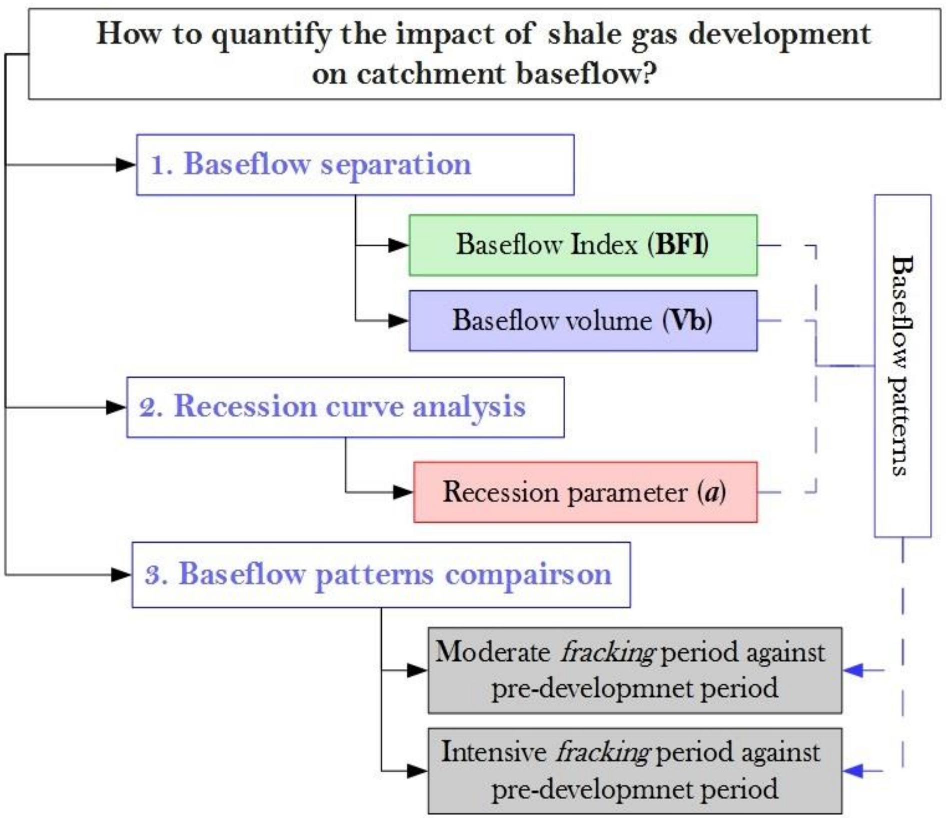
Frac wells density across the play



- 17 streamflow gauges inside the play (analysis watersheds)
- 23 streamflow gauges outside the play (control watersheds)
- Streamflow data from 1986 to 2015, obtained from the USGS Water of the Nation
- Wells for fracking were obtained from FracFocus data for the period 2011 to 2014
- Groundwater consumption and groundwater levels were obtained from TWDB

OBJETIVE AND METHODS

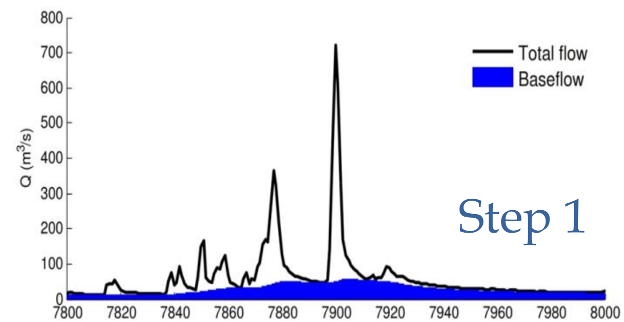


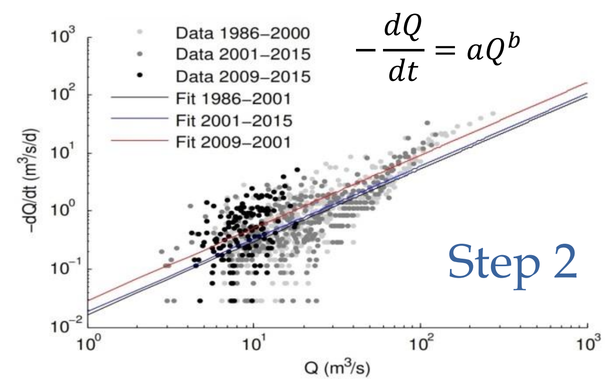


Objective

Analyze baseflow recession time-space patterns of 40 catchments, located across the Eagle Ford shale gas play in Texas (USA).

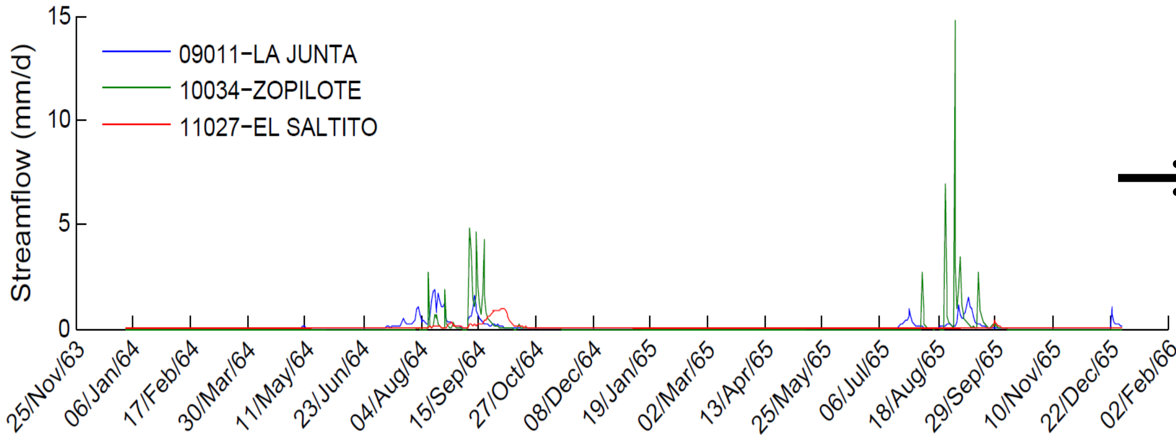
Methods

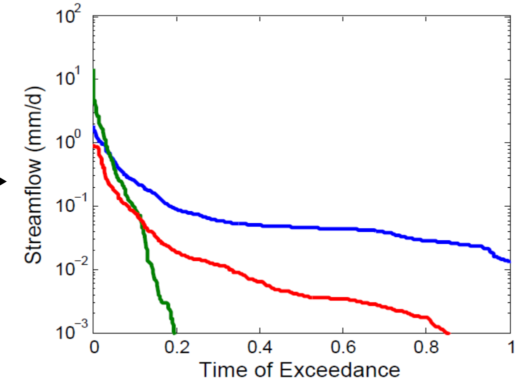




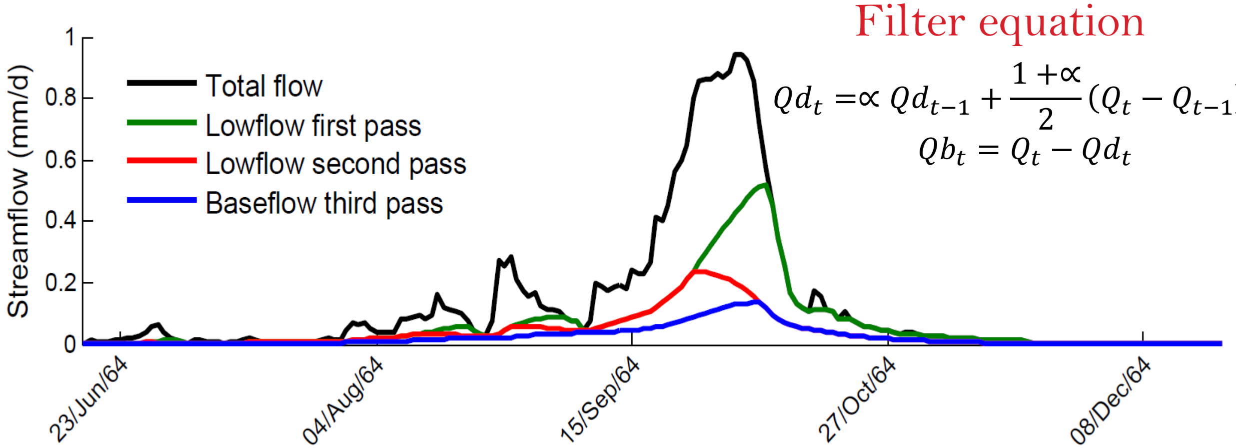
METHODS

Analysis of changes in streamflow through the flow-duration curve (FDC)





Baseflow separation though a Recursive Digital Filter (Lyne and Hollick, 1979)



Filter equation

$$Qd_t = \propto Qd_{t-1} + \frac{1+\propto}{2}(Q_t - Q_{t-1})$$

$$Qb_t = Q_t - Qd_t$$

Baseflow volume (Vb)

$$Vb = \int_0^t Qb\, dt$$

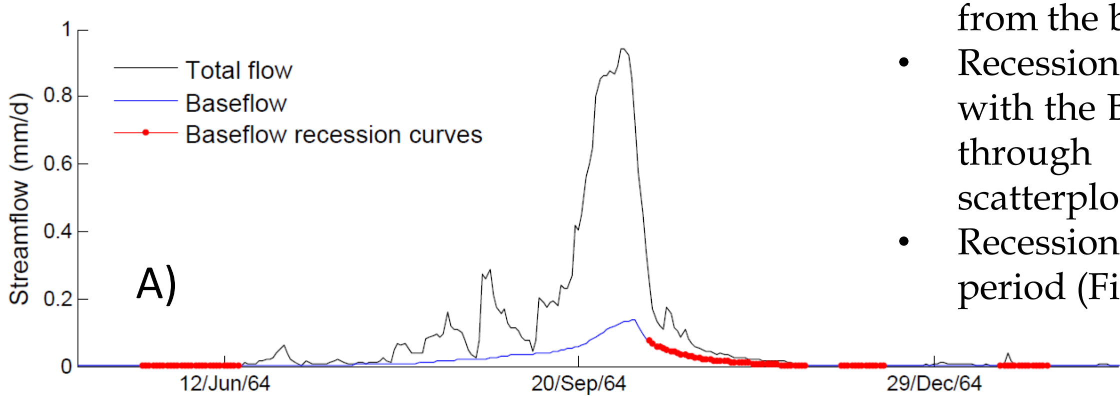
Baseflow Index (BFI)

$$BFI = \frac{\sum_0^{365} Q_b}{\sum_0^{365} Q} = \frac{V_b}{V_t}$$

METHODS

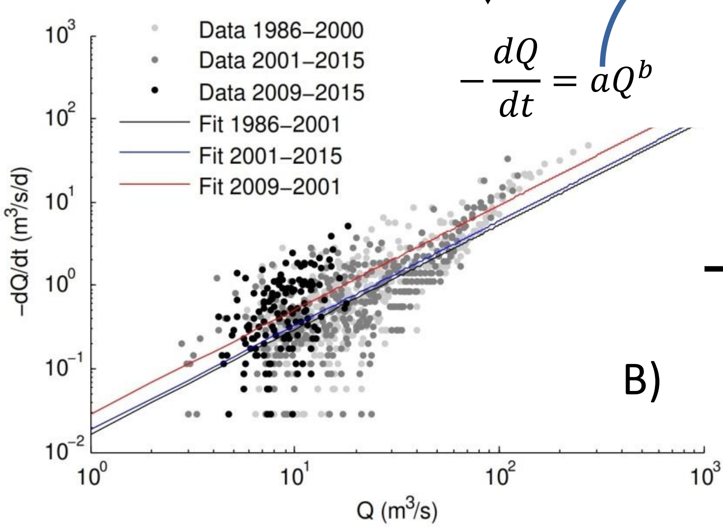
Baseflow recession analysis

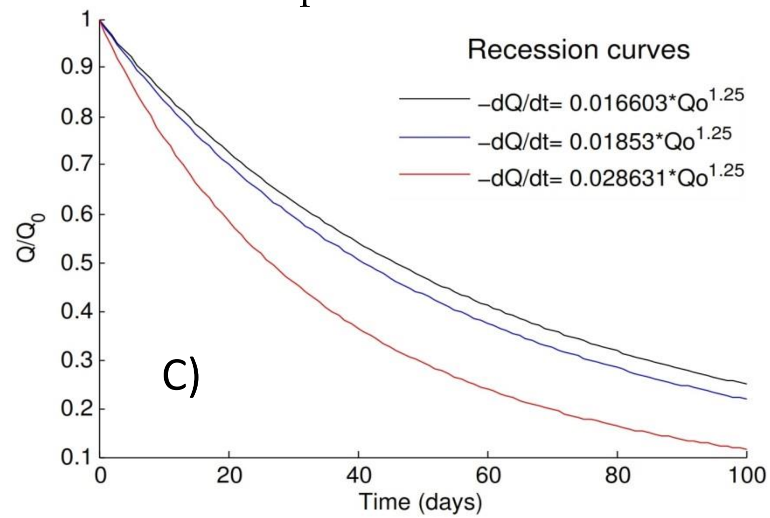
- Baseflow recession curves were extracted from the baseflow hydrograph (Fig. A).
- Recession curves for a period were analyzed with the Brutsaert and Nieber (1977) method through the log(-dQ/dt) vs log(Q) scatterplot (Fig. B).
- Recession parameter was estimated for each period (Fig B and C).



$$-\frac{dQ}{dt} = aQ^b$$

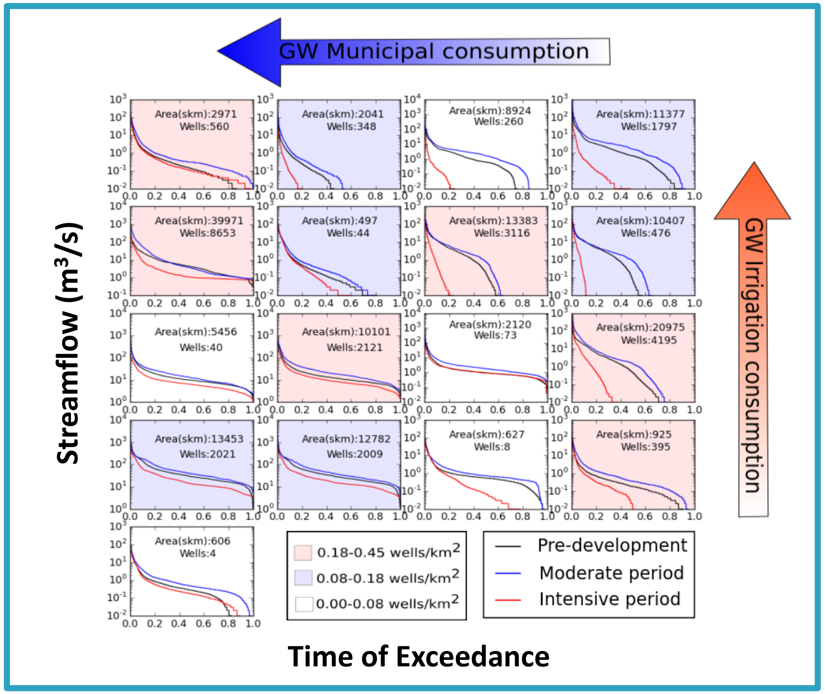
Recession parameter: As bigger recession parameter, as steeper the recession curve



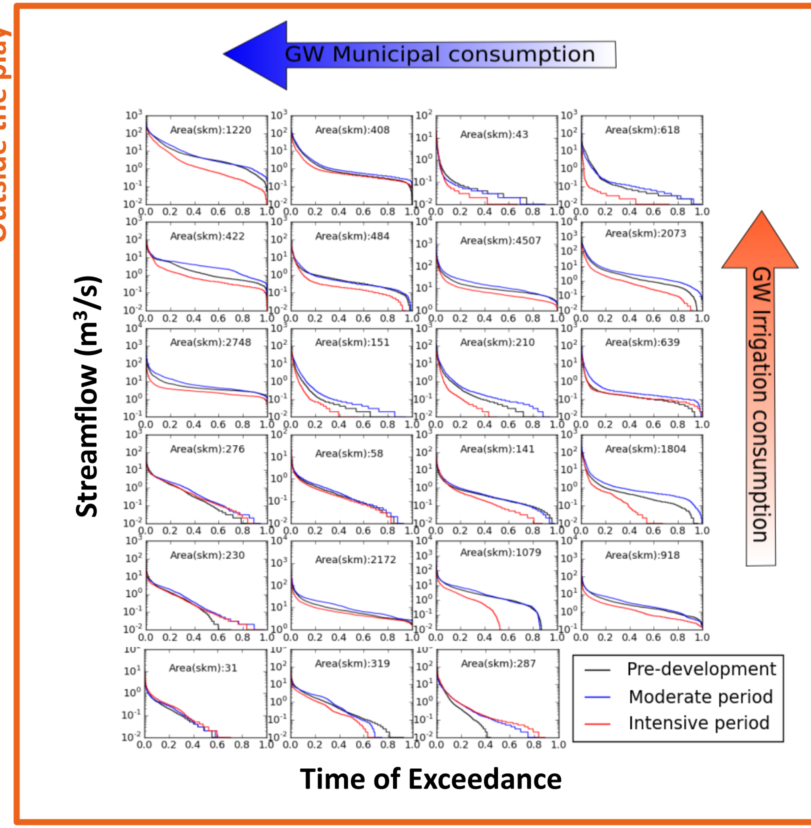


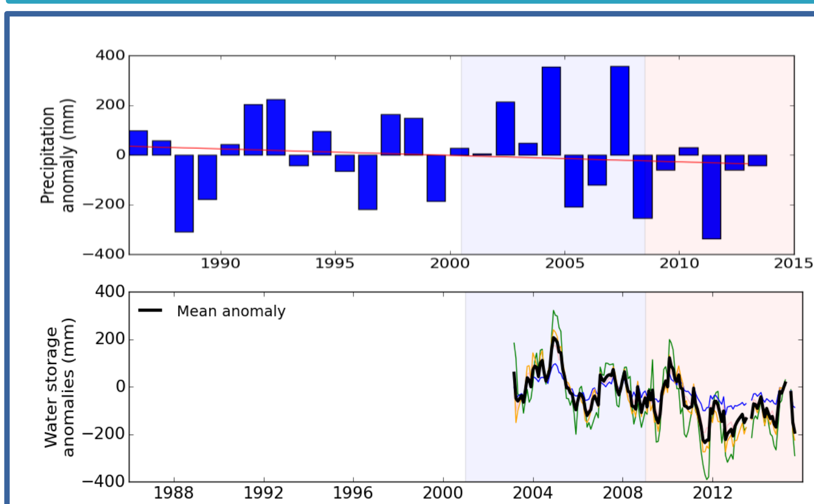
RESULTS: streamflow duration curves and anomalies

Inside the play

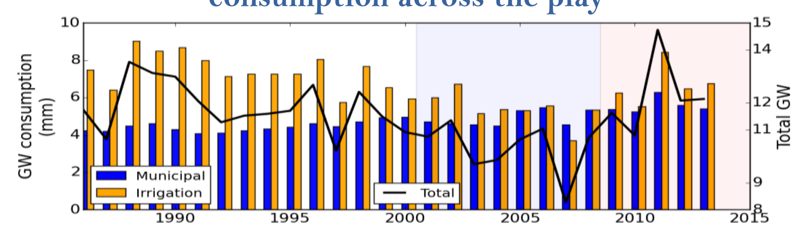


Outside the play





Precipitation and water storage anomalies and GW consumption across the play



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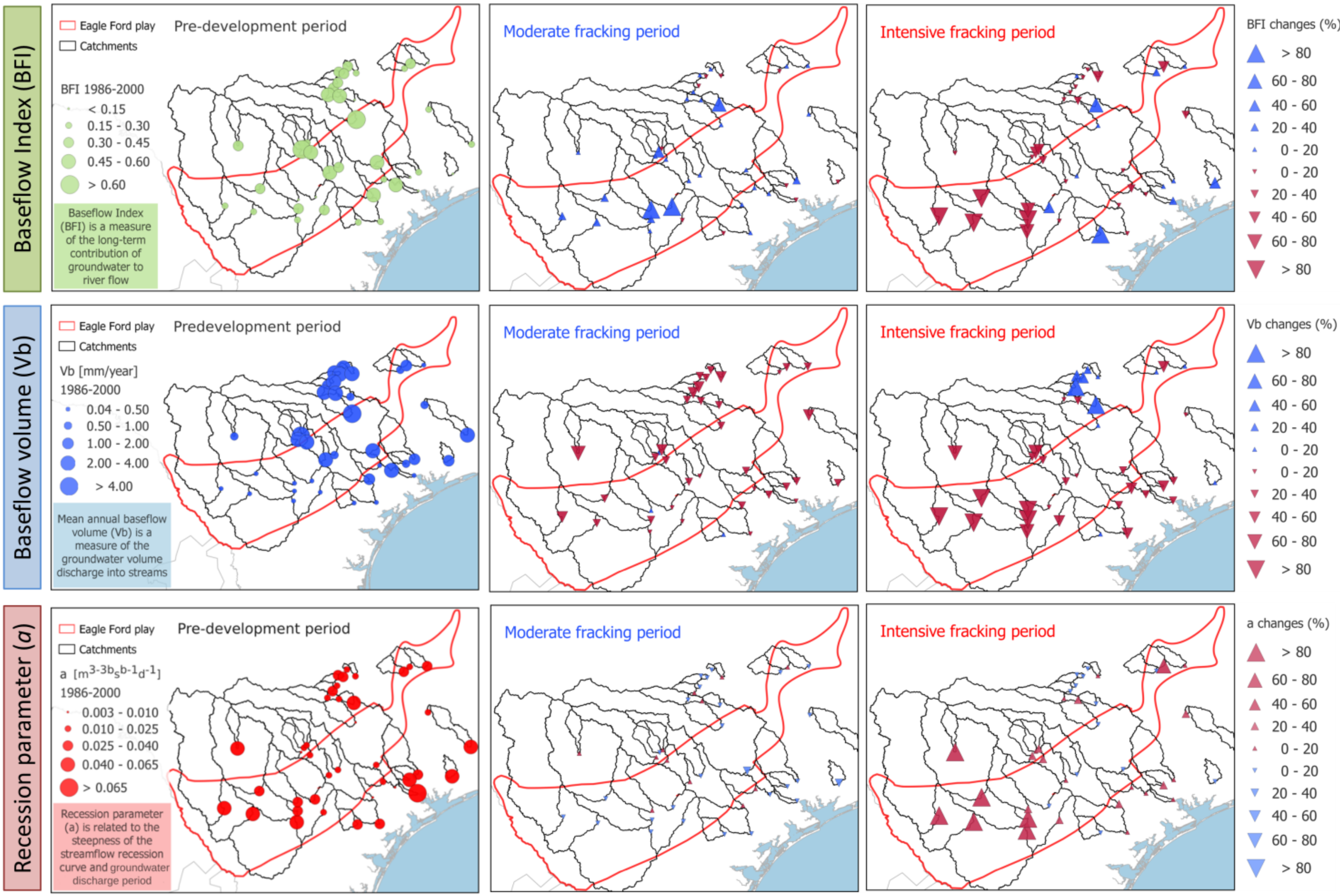
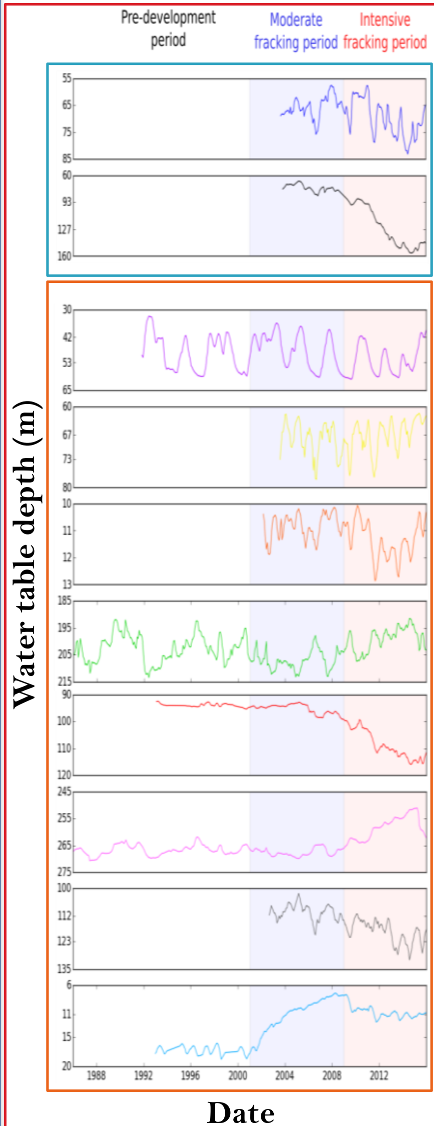
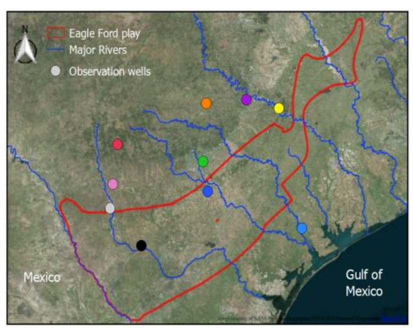
RESULTS: baseflow patterns comparison



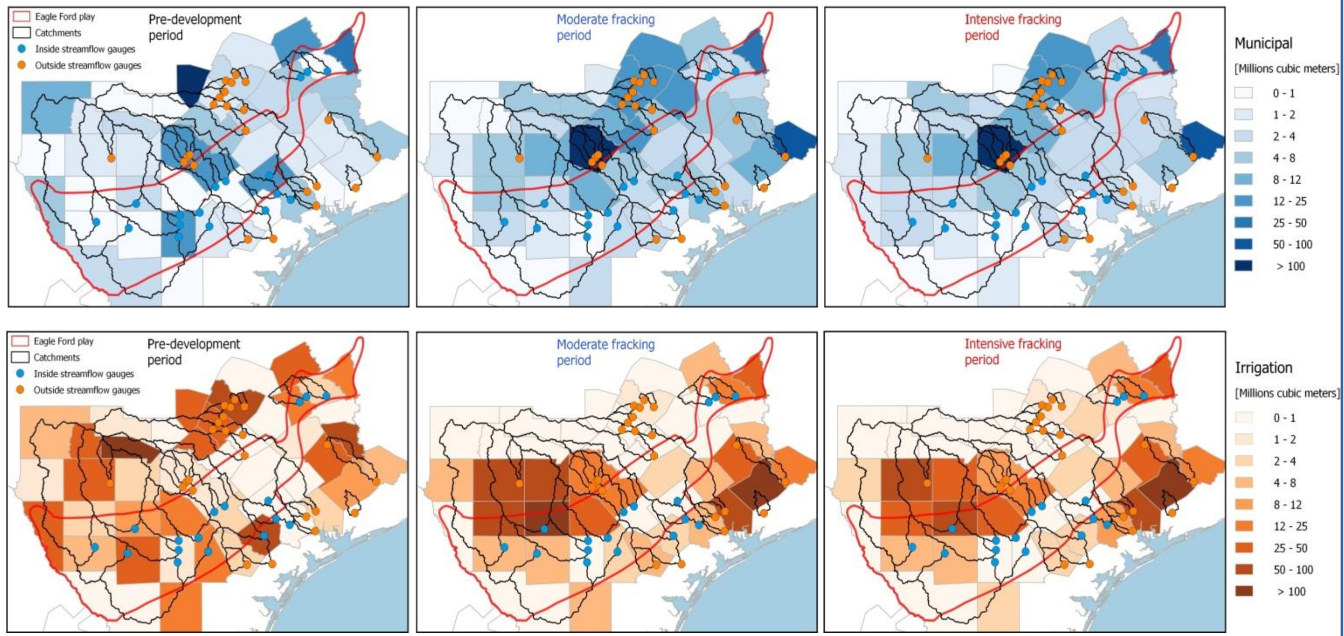
RESULTS: groundwater consumption



Piezometers located inside and outside the play



Municipal (blue) and Irrigation (orange) groundwater consumption across the play



- The majority of the watersheds inside the play showed higher GW consumption for irrigation
- The majority of the watersheds outside the play showed higher GW consumption for municipal uses
- High water table decreases were shown during the intensive fracking period in some wells

CONCLUSIONS

Period	Watersheds	Negative changes in baseflow patterns (>40 %)		
		BFI	Vb	*a*
Moderate fracking	Inside the play	0	1	0
	Outside the play	0	7	0
Intensive fracking	Inside the play	7	13	6
	Outside the play	3	13	2

- Higher negative changes were detected in baseflow patterns ***inside the play*** during the ***intensive fracking period***.
- Effects in watersheds ***inside*** the play were associated with an ***intensive fracking activity*** and ***higher irrigation rates***.
- However, it should be noted that the ***intensive fracking period*** is also linked to ***high water stress conditions*** generated by depletion in groundwater storage and low precipitation/recharge rates; which are associated to an exceptional drought.
- Results show that the observed decline in baseflow patterns are more significant in ***intermittent streamflow regimes***.

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