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Integration with the Tucson Case Study:

"Tucson GW dynamics. How is it affected by natural drought?"

swan
Sustainable Water ActioN

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PREVIOUS RESEARCH: PhD THESIS

Hydrological drought in the Spanish Mediterranean domain

Objectives

1º- To analyse the existing **connections and causalities between meteorological drought and drought in water tables**. Some relationship between the two is expected, but not a perfectly linear one

2º- To **link the results to the different managerial circumstances** taking place in the catchment to forecast a pattern of hydrological response to meteorological drought for each situation

Definitions of Drought

The WCP → **rainfall drought** if precipitation is significatively below the normal values

The UNESCO (1992) → **hydrological drought** is a dry period that causes a significant **decrease in** flows or **water tables**

Why studying drought in Tucson´s water tables?

A certain **knowledge gap** about GW dynamics is identified by the water managers

It will help to explain the dynamics of the basin´s **water resources during scarcity**

There is literature that says that the aquifer dynamics is not linked to rainfall but we still need to check what happens now that groundwater is less overexploited (CAP)

Work plan

1º- Collection of **bibliography** about GW in the Tucson basin and the models implemented and **identification of the main gaps**

2º- Collection of **historical data** on precipitation, surface runoff, water use, recharge to the aquifer, population, land use, water tables

3º- Comparison of the **regimes** and the cycles of all these variables

4º- Comparison of the historical **dry periods** of the variables and test their linkages

First steps and preliminary results

Time series selection and download:

- CRU monthly **precipitation** (1901 – 2012),
- Upper Santa Cruz monthly **water table depth** (1980 – 2012) in three drillings

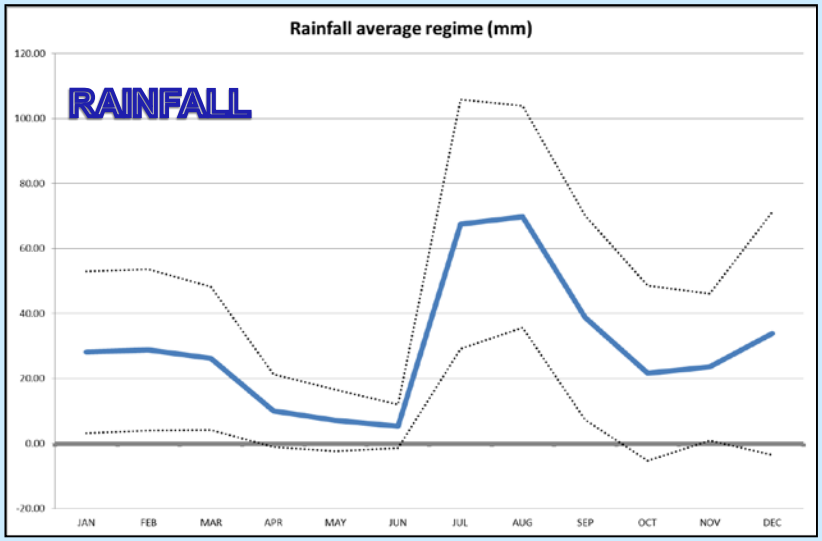
Preliminary characterization of the series: regimes, time series evolution

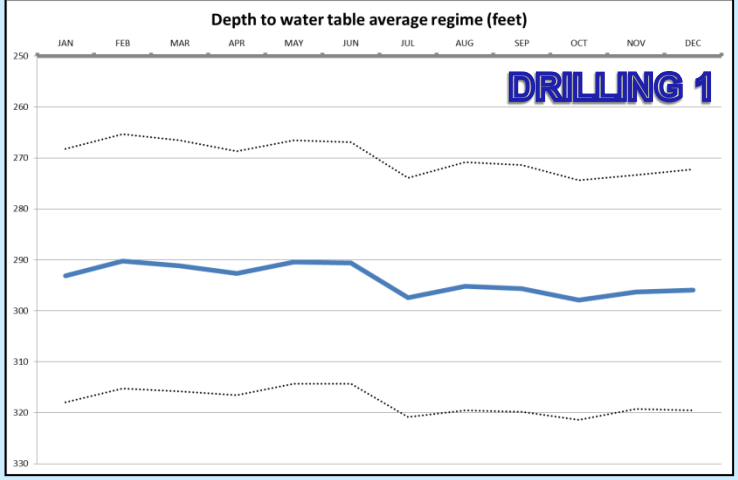
Preliminary drought comparisons

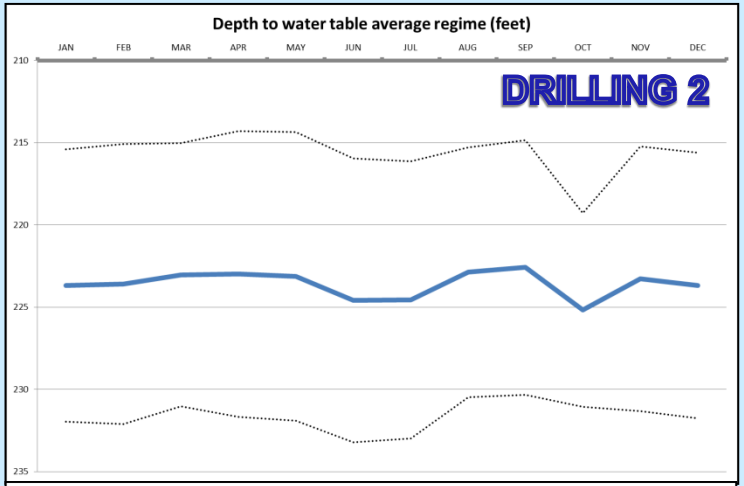
Regimes

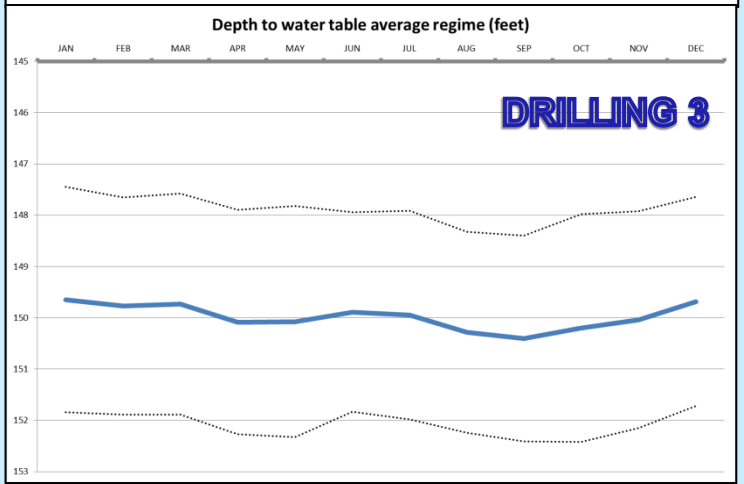
Differences in precipitation and water table monthly regimes: no coincidence of the peaks or the valleys

No coincidence among the different drillings (points of abundant extraction?)







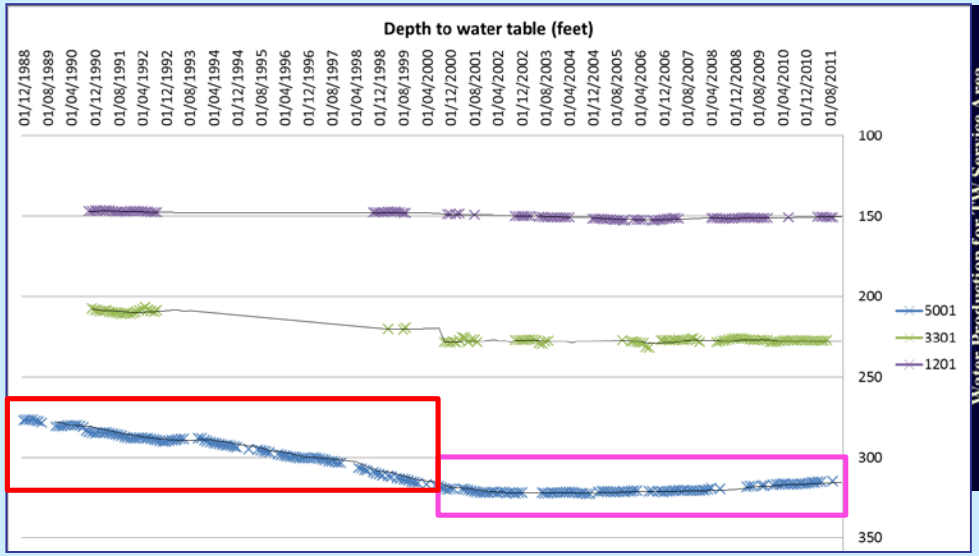


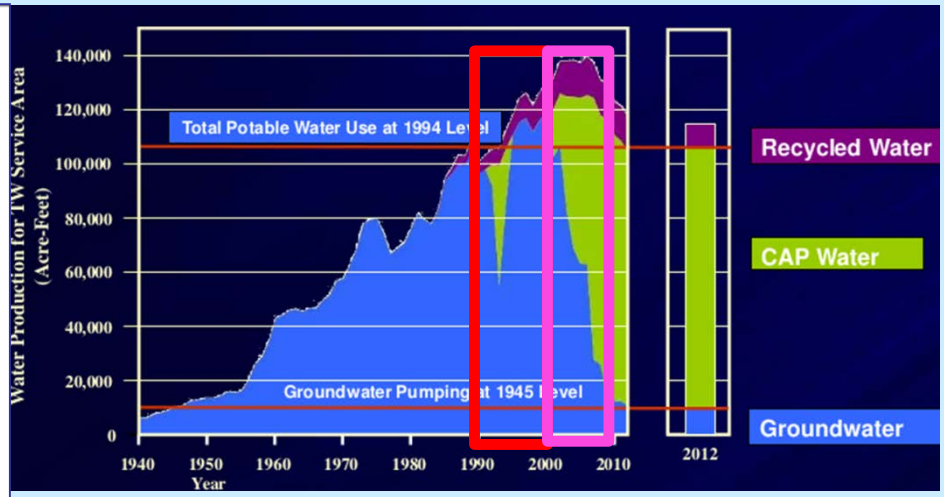
Time evolution

Identification of a decrease in the water levels. It is not a continuous drop but a shift, there is a specific and very **quick inflection point around y. 2000**

That could be caused by **overexploitation** → the 90´s were humid years in general, but more than 100.000 AF were taken from GW per year in that decade (more than ever)

Also, **from y. 2000 the values stabilise**, the decrease does not continue because of **CAP** Supply





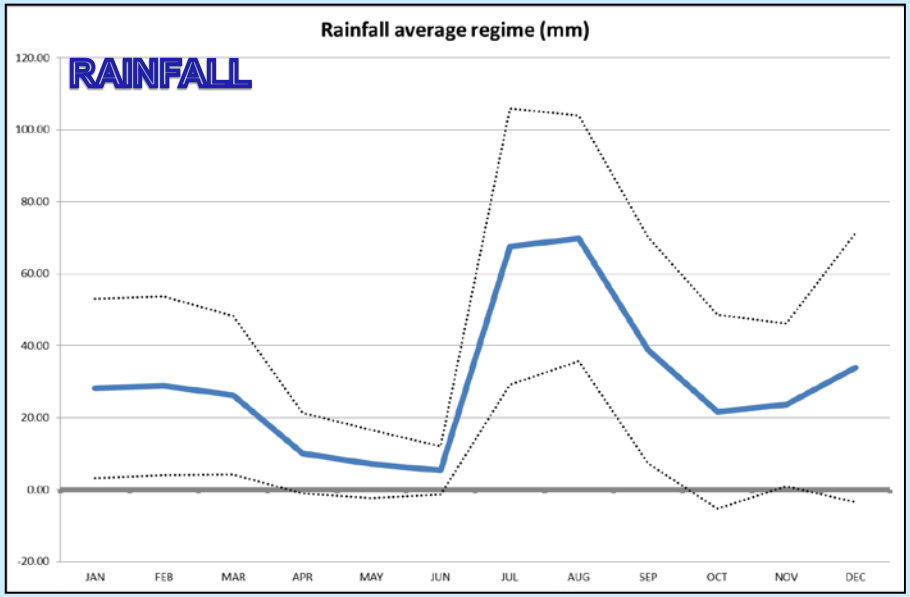
Methodology split in two: before and after y. 2000 because there are two different supply conditions and **two different water table conditions** (maybe as a result!)

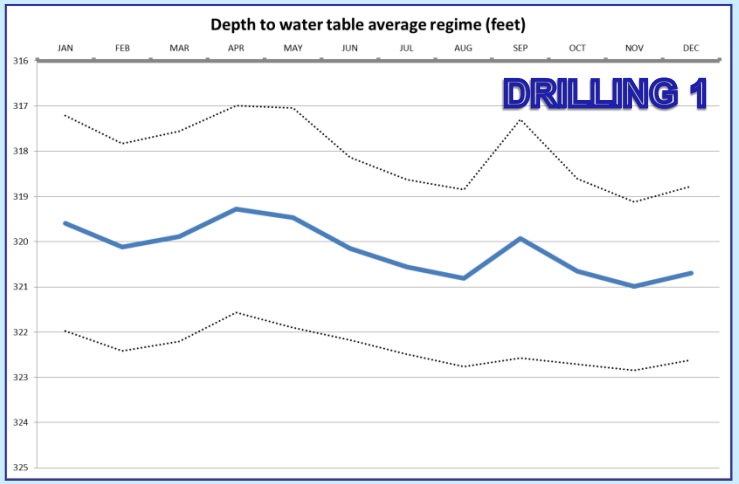
Thus, we built the hypothesis that maybe **after y. 2000 the system restores its natural behaviour**

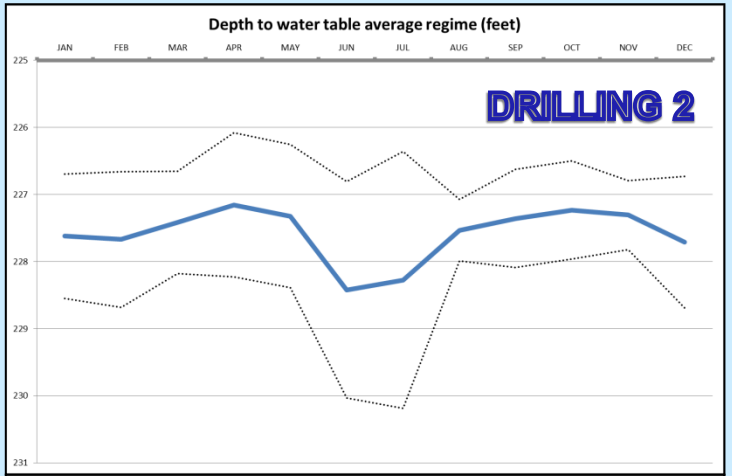
Regimes after y. 2000

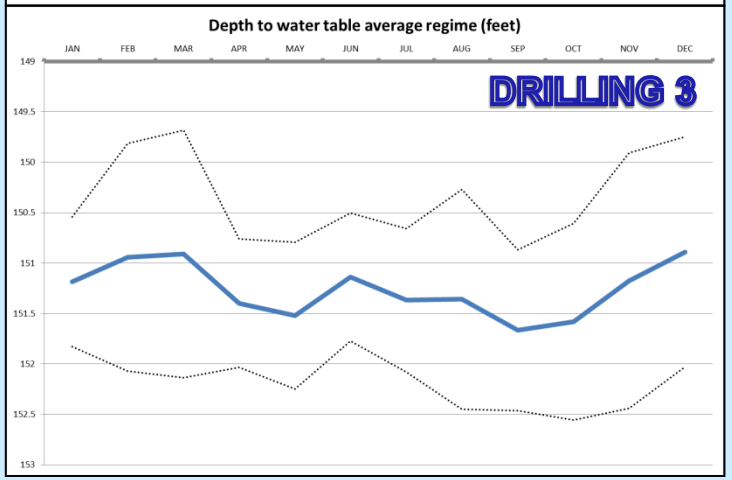
After 2000 the water table regimes start to follow the precipitation regimes (≈2 months delay of peaks & valleys)

More similarities among the oscillations and peak & valleys of the different drillings





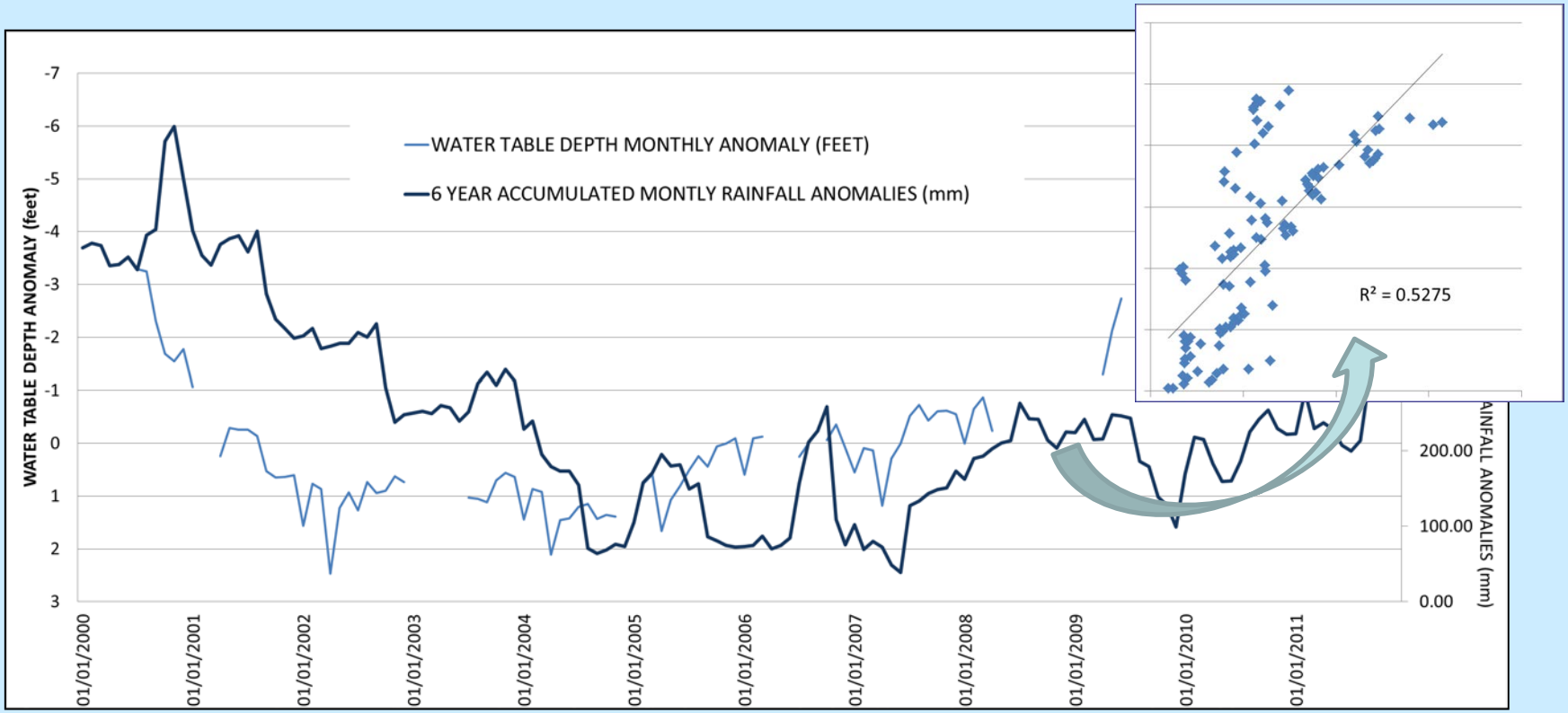




Preliminary drought types comparison

We calculated **anomalies** as a first approach to drought→ monthly deviation compared to the median of the month

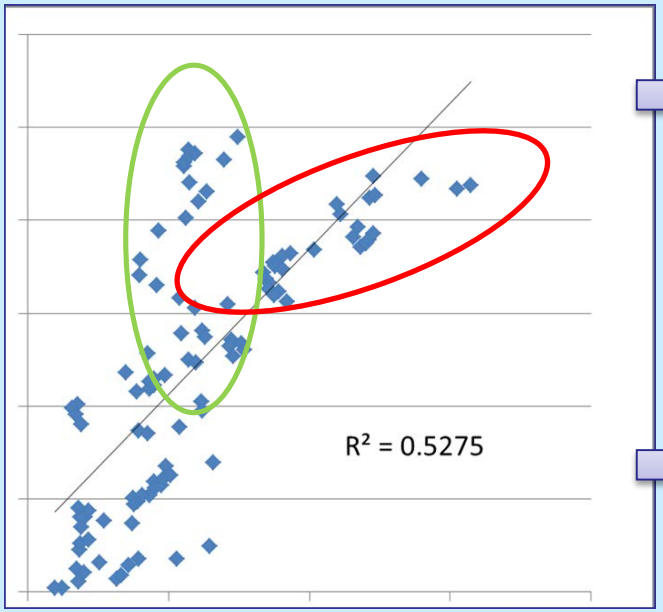
Rainfall anomalies and water table anomalies do not have an immediate connection, but we tried **time lag analysis and accumulations**

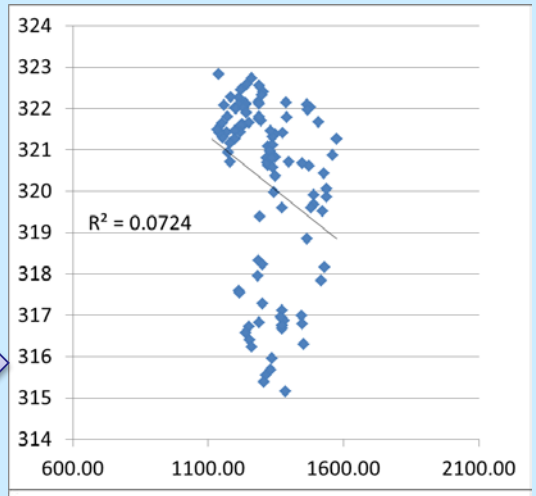


After y. 2000, **if we accumulate the previous rainfall anomalies** and compare them with monthly anomalies in water tables, **we find a great increase in correlations**, specially when we accumulate up to 6 years (72 months) → each value of hydrological anomaly depends on how anomalous were the previous 6 years

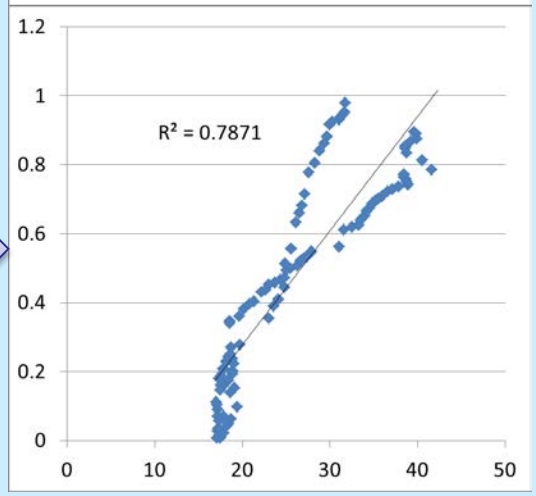
Preliminary drought types comparison

If we check the scatterplots, the connections and trends are not exactly the same when drought is settling and when it is recovering





If we just accumulate the original variables instead of the anomalies the patterns are not identified



As a first approach, we also applied the *IESP Drought Index* to the series and repeated the analysis, finding that the correlations are perfect when we apply the same accumulation patterns

Before y. 2000 all these patterns are not found, so this is a “new” phenomenon

Some preliminary ideas/ conclusions

The aquifer dynamics could depend on rainfall more than expected, now that it seems to be more "naturalized" as a result of a shift to CAP

It is important to extend this study to present

Aquifer dynamics could be perfectly predicted, according to the big correlations found, specially during dry periods

Next steps

We should add more drillings

We should use outputs from water table models, there are several

We should add more variables such as streamflows and artificial recharges, to account for other variables of the Tucson water cycle

We plan to use long term drought indexes (SPI48), as we saw that the connection is more evident in the long term

THANKS FOR YOUR ATTENTION!!!