Channel Morphology, Streamflow Patterns, and Sediment Transport of Two Intermittent Rivers Along the Balcones Fault Zone in San Marcos, Texas

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Introduction: San Marcos, Texas is located along the Balcones Escarpment in central Texas which lies directly on the boundary between two physiographic provinces, the Gulf Coastal Plain and the Edwards Plateau (Fig. 1). The Balcones escarpment is characterized by a series of en echelon faults within the Balcones Fault Zone (Maclay & Small, 1986) (Fig. 2); making it a region prone to severe flooding due to this sharp rise in topography, climate, and urbanization (Baker, 1975; Caran & Baker, 1986). This study was conducted within two intermittent rivers (IRs) located in Schulle Canyon and Spring Lake Preserve; both of which belong to the San Marcos Greenbelt Alliance park system. The proximity of these study sites allow us to focus on the topographic effects of streamflow as the climate and underlying geology remain consistent.

The purpose of this project is to assess the channel morphology, surface water flow, and sediment transport of two intermittent rivers along the Balcones Fault Zone. Largely, we are asking:

1. How often do these two intermittent rivers flow?
2. When they do flow, what is the cause of that flow?
3. During rainfall events, what grain sizes are transported?
4. What relationships can be determined bewteen these two intermittent rivers?

Methods: Several techniques are being used in this study to quantify the hydrology, sediment transport, and channel morphology (Fig. 3):

1. Stream, temperature, intermittency, and conductivity sensors (STiCs) (Fig. 4)
   a. Deployed longitudinally down each stream
   b. 60 sensors in total, stacked atop each other to obtain a relative depth estimate.
   c. Determines when and where these streams are flowing

2. Passive integrated transponder tags (PITs) (Fig. 5)
   a. 23 mm in length
   b. 60 in total inserted into D16, D50, and D84 grain sizes.
   c. Tracks how far different grain sizes travel after rainfall events.

3. Field measurements such as slope, bankfull width, and bankfull depth show how the stream's morphology changesover time.

References:

Caran, S. C., Tx, A., & Baker, V. R. (1986). Flooding along the Balcones Escarpment, Central Texas. Geological Society of America, 1(14), 11.

Chapin, T. P., A. S. Todd, and M. P. Zeigler (2014), Robust, low-cost data loggers for stream temperature, flow intermittency, and relative conductivity monitoring, Water Resour. Res., 50, 6542–6548, doi:10.1002/ 2013WR015158.

Maclay, R. W., & Small, T. A. (1986). Carbonate Geology and Hydrology of the Edwards Aquifer in the San Antonio Area, Texas. Texas Water Development Board, (November).

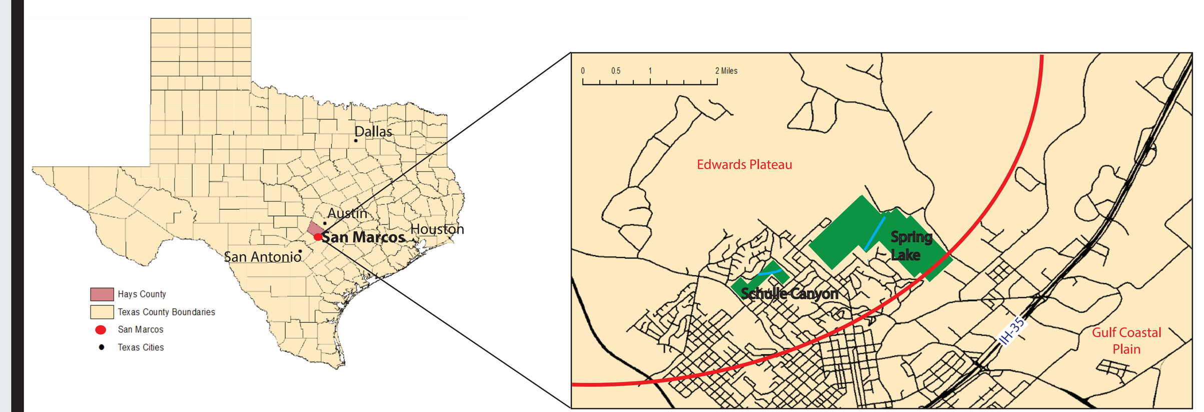

Fig. 1: Location of both study sites in central Texas, red line indicates the boundary between the Gulf Coastal Plain and the Edwards Plateau. As you move North into the plateau we see a change in geology and the topography becomes much steeper.

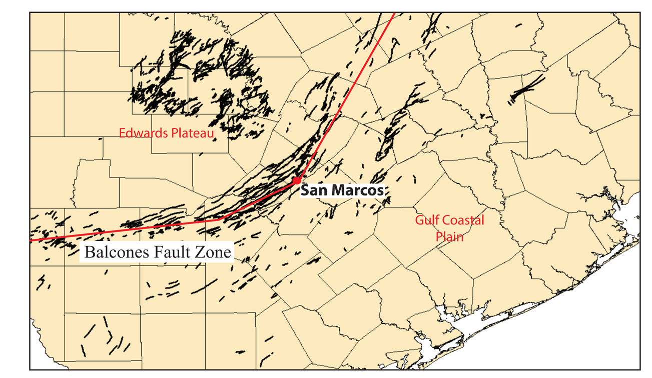

Fig. 2: Location of the Balcones Fault Zone in central Texas and two of the state's physiographic boundaries. San Marcos, Texas lies directly on the boundary between the Gulf Coastal Plain and Edwards Plateau and is the beginning of the Texas Hill Country.

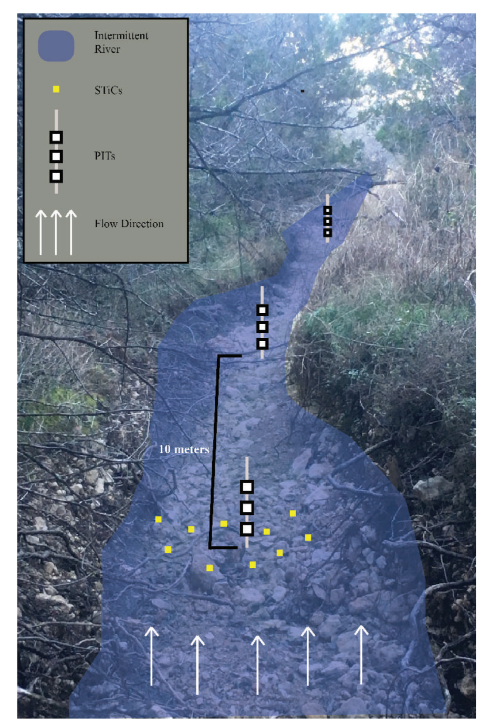

Fig. 3: Field set-up of both the PITs and STiCs. PITs are inserted into varying grain sizes. STiCs are stacked on top of each other with three on each rebar when able. Rebar spacing is on stack per 10 meters

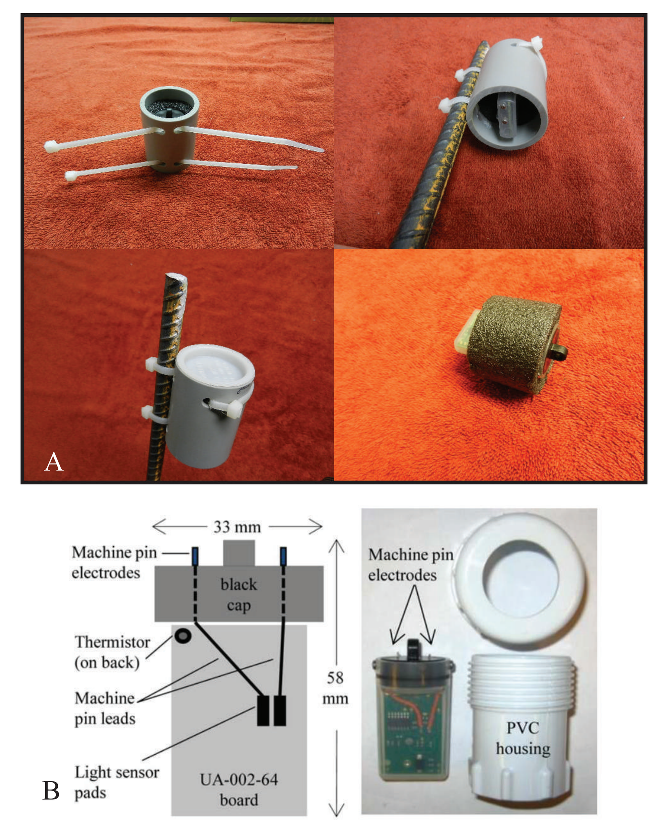

Fig. 4: (A) Attachment of STiCs inside PVC housing, (B) Electrical modification of STiCs. The light sensor is rewired to measure conductivity (Chapin et al.)

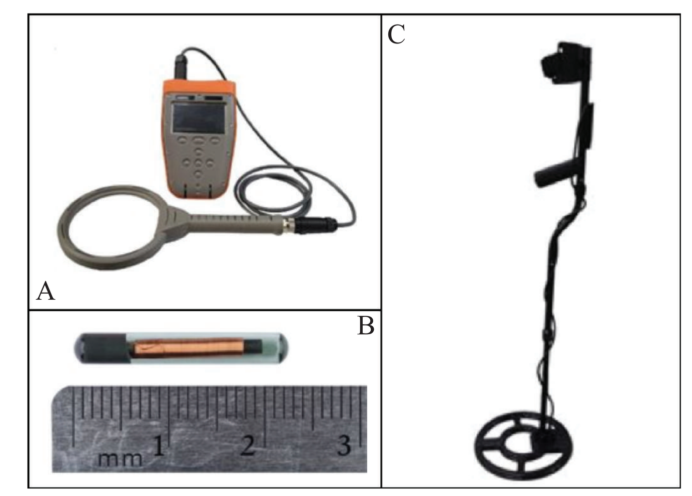

Fig. 5: Equipment needed to track PIT tags. Includes, A: HDR Plus Reader, B: HDX23 (23 mm tag), C: BP Plus Lite antenna

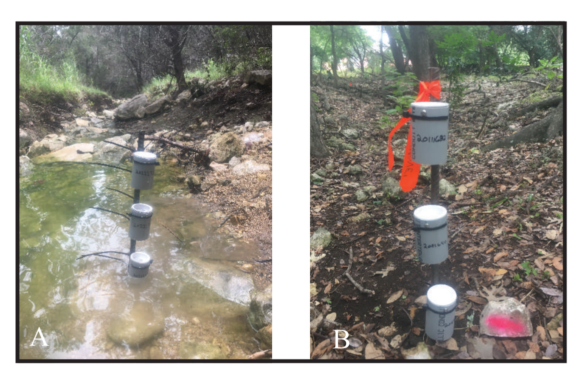

Fig. 6: Deployment of STiCs. (A) IR in Spring Lake that appears to flow for most of the year. (B) IR in Schulle Canyon that seems to only flow during and shortly after rainfall.

Fig. 7: A 23mm PIT tag with drill hole. PIT tag was then inserted into the drill hole and sealed with clear stonework silicon.

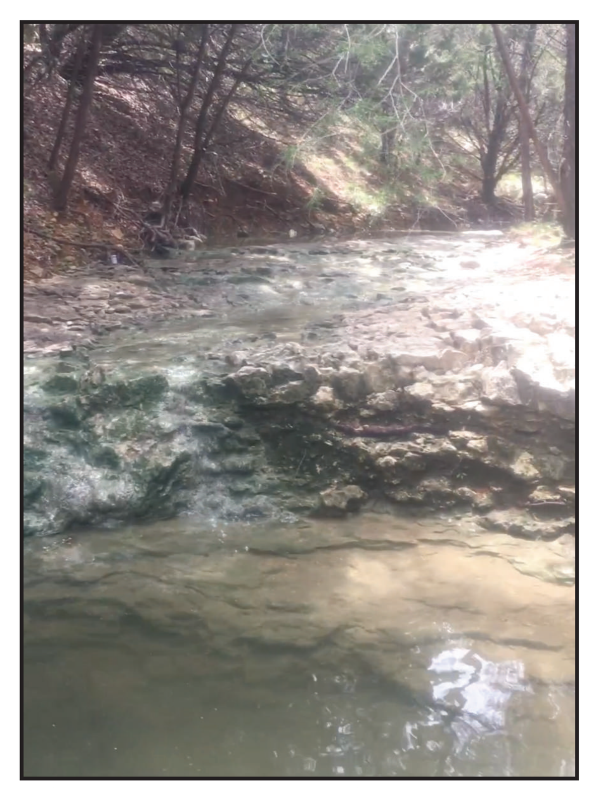

Fig. 8: IR present within Spring Lake Preserve. In the foreground there is a 3.5 foot depression that collects water from upstream. Just upstream of this depression, the bed is primarily limestone bedrock. After this depression, the streambed becomes more gravelly with varying grain sizes. Not pictured is the IR within Schulle Canyon. The Schulle Canyon stream is made up of limestone gravel with no exposed bedrock.

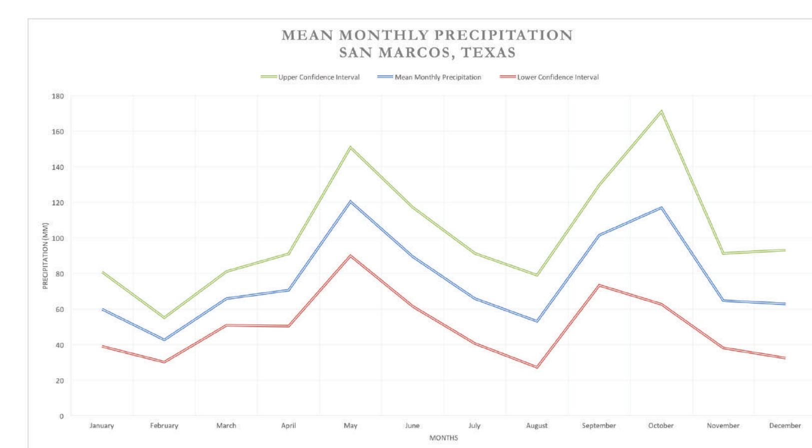

Fig. 9: Figure 2: SMTX monthly precipitation (1990-2016) graph. The green and red lines represent the upper and lower 95% confidence intervals, respectively, from January 1990 to December 2016. The blue line represents the mean monthly precipitation from January 1990 to December 2016.Data from NOAA

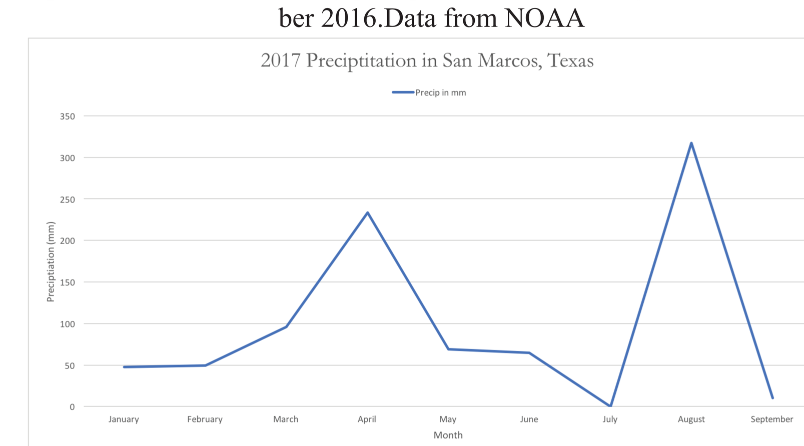

Fig. 10: SMTX precipitation from January-September 2017. Blue line represents the total precipitation for a given month. We again see the two distinct precipitation peaks throughout the year. Data from NOAA

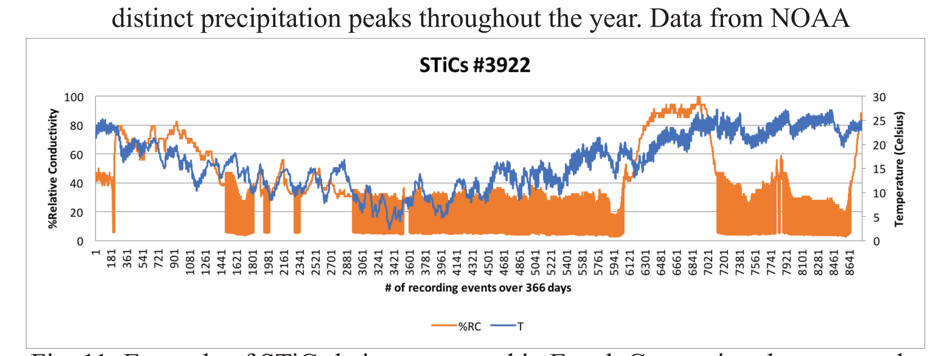

Fig. 11: Example of STiCs being processed in Excel. Converting the raw conductivity into percent relative conductivity helps noramalize the differences in low and high conductivity readings on each sensor

Results and Conclusions (so far...): The similar characteristics within each IR, along with analogous ecosystems and underlying bedrock led us to think that the two rivers would behave similarly. This has not yet been confirmed in terms of their sediment transport. After several rainfall events (the most occurring during a time span of 2 days during Hurricane Harvey of 151 mm), we observed little sediment transport in each river as measured by 60 embedded Passive Integrated Transponders into various grain sizes from 40-120mm. The IR present in Schulle Canyon has a much steeper gradient compared with Spring Lake. Of the three times we have visited the sites to ensure the sensors were still in operation, all three showed flowing water within the IR in Spring Lake and none in the IR in Schulle Canyon. This has led us to think that Schulle Canyon behaves like a prototypical ephemeral river, while Spring Lake is a textbook IR.

Future Steps: In early January 2018, the final surveying will be completed in each IR with the measurements of bankfull width and depth, channel length, and slope being calculated. These will be compared to our initial measurements to show how quickly these rivers can change over the course of a year. PITs and STiCs will be retrieved and will immediately be processed and analyzed. For the PITs, their change in GPS coordinates will be input into ArcMap for easy interpretation. STiCs require much more processing primarily through Excel (Fig.11). These three methods will then be evaluated by using multiple linear regression, and principal component analyses to gain some insight into the sediment transport dynamics, channel morphology, and hydrology along the Balcones Fault Zone.

Extras: If you would like to download a PDF version of this poster, please scan the QR code below.

If you would like to know more about our research, please visit:

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