



## Meander Migration Rate: Evaluation of Some Existing Methods

Rivers are dynamic systems. The action of the flowing water can change the elevation and the lateral location of the riverbed and the riverbanks. Meanders are particularly prone to changes in lateral location because of the centrifugal force that increases the shear stress at the interface between the water and the soil.

Predicting the movement of a meander is both difficult and necessary. It is difficult because many factors influence the process and necessary because such a movement may create expensive maintenance

problems for nearby bridges.

During the first year of this research, a comprehensive review of the literature was undertaken on this broad topic and summarized in a report (Report 2105-2). During the second year, a narrower topic was selected and is reflected in the title of this project summary report.

### *What We Did...*

There are three general approaches to predicting the migration rate of meanders: 1) the empirical approach,

2) the time-sequence maps and extrapolation approach, and 3) the fundamental modeling approach.

In a first part of the project, we studied two of the three major approaches. In a second part, we assembled data on the migration of six meanders on four Texas rivers. In a third and last part, we compared the migration rates predicted by the two approaches with the migration rates measured at the sites.

The empirical approach is based on correlation equations derived from databases of observed meander behavior. The time-sequence approach uses the previously observed movement of a given meander to predict its future migration. The fundamental modeling approach consists of modeling the erosion process at the water-soil interface and projecting it into time by using future hydrographs (water velocity versus time).

We selected four empirical



Figure 1. Nueces River flood in 1998.



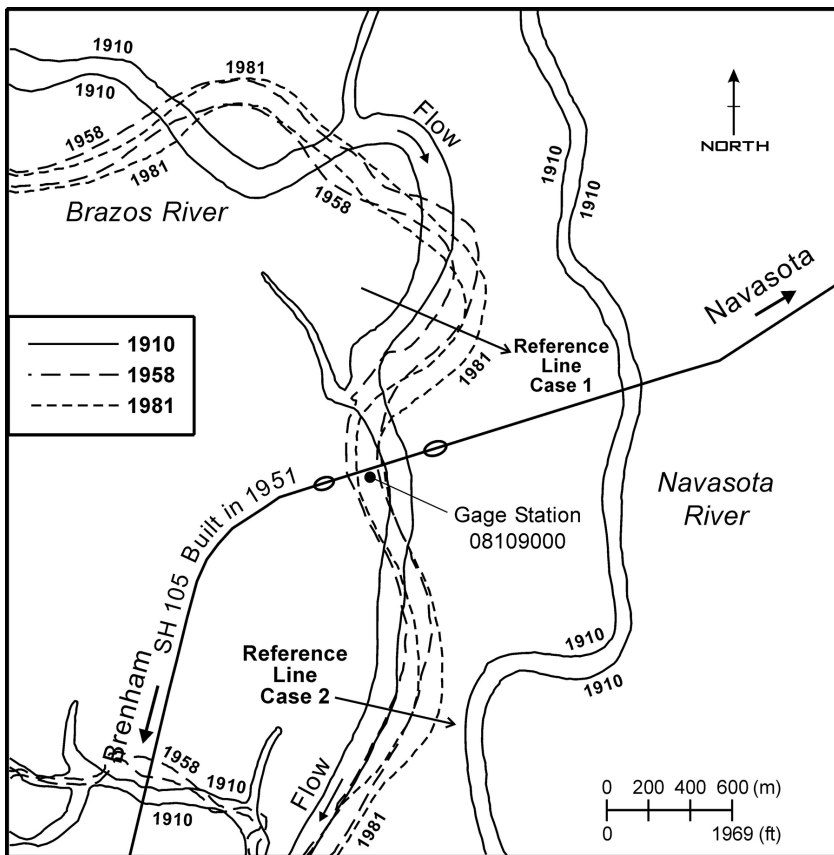


Figure 2. Meander Migration for the Brazos River at SH 105

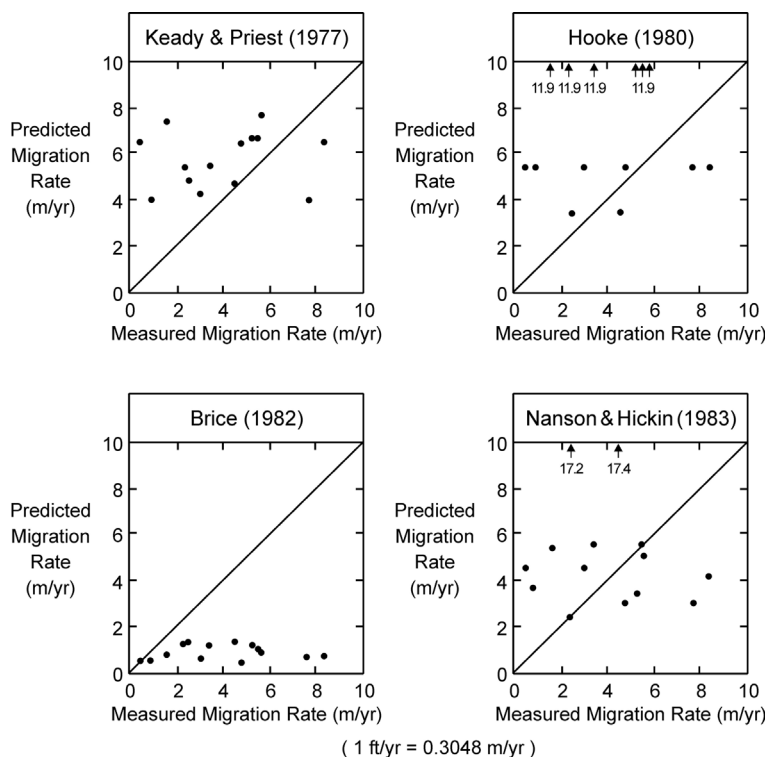


Figure 3. Predicted versus Measured Migration Rates for Four Empirical Methods

equations: the Keady and Priest (1977) method, the Hooke (1980) method, the Brice (1982) method, and the Nanson and Hickin (1983) method. We also selected and described the time-sequence maps and extrapolation approach. We did not select the fundamental modeling method because it is not completed but is in development at Texas A&M University.

We selected six meander migration case histories on four Texas rivers. TxDOT suggested these sites as sites where migration had been significant and had led to major maintenance problems. The sites are:

- Brazos River at SH 105 (Figure 1),
- Nueces River at US 90,
- Trinity River at FM 787,
- Guadalupe River at US 59.

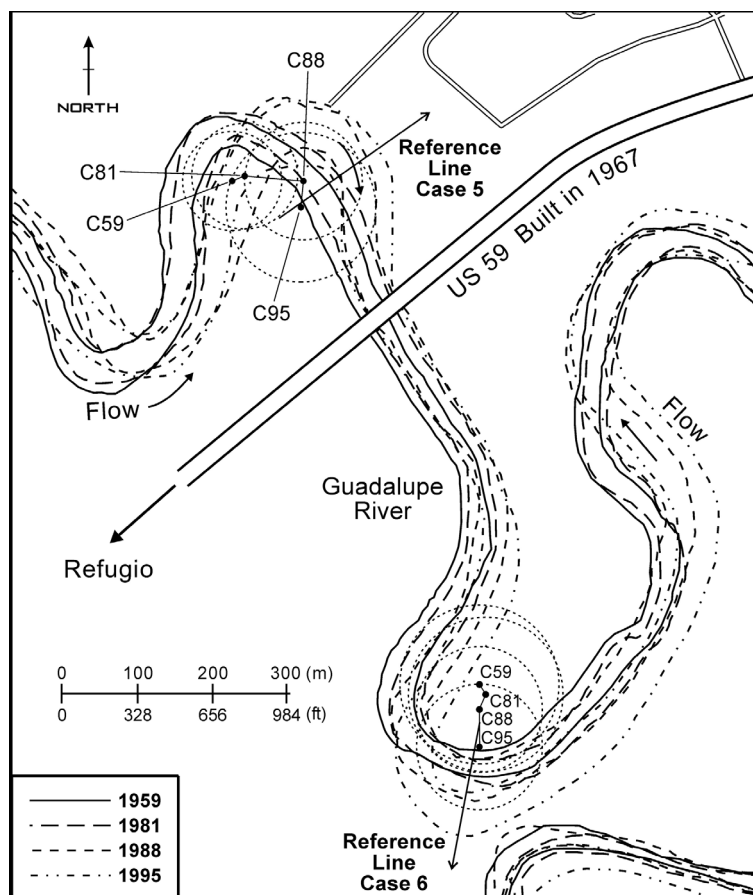
For each site we collected many topographic maps and aerial photographs indicating the migration of the meanders over many decades. We then superimposed the river locations as a function of time on the same graph and measured the migration of the meander over time.

We compared the values predicted by the empirical equations with the measured values of the migration rates and concluded on the accuracy and precision of the methods studied.

### What We Found...

For the empirical methods, the comparisons are shown in Figure 2. The figure indicates that the Keady and Priest method





**Figure 4.** Meander Migration and Time-Sequence Method for the Guadalupe River at US 59

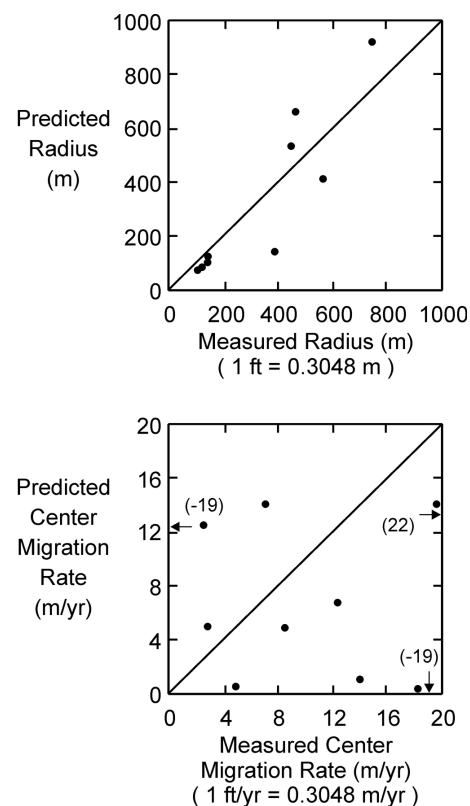
is reasonably conservative, that the Hooke method is overly conservative, that the Brice method seriously underpredicts the measurements, and that the Nanson and Hickin method splits the measured data with significant scatter. On the basis of these data alone, the Keady and Priest method appears to be a reasonably safe method to use keeping in mind that the scatter is significant.

For the time-sequence and extrapolation method (Figure 3), the comparisons indicate (Figure 4) that this method gives a reasonably satisfactory prediction

of the radius of the meander but not of the center migration rate. In some cases, the predicted movement of the center of the circle is in the opposite direction to the measured movement. This method is much more operator-dependent than the empirical methods; however, it is superior to the empirical method in that it gives a much more complete position of the meander.

### *The Researchers Recommend...*

While waiting for the results of the current research effort dedicated to the development of the fundamental modeling



**Figure 5.** Predicted versus Measured Migration Parameters for the Time-Sequence Maps and Extrapolation Method

approach, the case histories analyzed indicate that the Keady and Priest empirical method is reasonably conservative and that the time-sequence and extrapolation method gives a reasonably satisfactory prediction of the evolution of the radius of curvature of the meander, but not of the migration rate of the center of the best fit circle.



## *For More Details . . .*

The research is documented in the following reports:

Report 2105-1 *Predicting Meander Migration: Evaluation of Existing Techniques*. February 2002.

Report 2105-2 *Guidelines for Bridges over Degrading and Migrating Streams, Part 1: Synthesis of Existing Knowledge*. September 2001.

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**To obtain copies of the reports, contact Dolores Hott, Texas Transportation Institute, Information & Technology Exchange Center, (979) 845-4853, or e-mail d-hott@tamu.edu. See our on-line catalog at <http://tti.tamu.edu>.**

## *TxDOT Implementation Status April 2002*

The research evaluated empirical methods, the time-sequence map, and extrapolation methods of determining stream meander migration rates. The research indicated that some of the empirical methods may produce conservative results regarding the meander migration rate. The research indicated that the time-sequence maps and extrapolation method give a reasonably satisfactory prediction of the radius of the meander but not of the center migration rate. The research will serve as a benchmark for a follow-up research project that will attempt to establish a soils properties-based prediction of meander migration rate.

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## *DISCLAIMER*

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