The effect of river training structures on flood heights on the Middle Mississippi River

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ABSTRACT: The U.S. Army Corps of Engineers (Corps) uses river training structures in the Middle Mississippi River to accomplish their mission of providing a safe and dependable navigation channel. The Corps continues to monitor the physical effects of these structures on bathymetry, velocity and water surfaces. This paper discusses the research conducted to further the understanding of the effect of river training structures on water surfaces. This comprehensive study conducted by both the Corps and external experts from other federal agencies and academia in the fields of river data collection, river engineering, geomorphology, hydraulics and statistics, included an analysis of past research, all available gage data, historic measurement techniques and instrumentation and their effect on the rating curve and specific gage analysis. These studies all lead to the conclusion that river training structures do not have an effect on water surfaces at higher flows.

1 INTRODUCTION

1.1 *Introduction*

Two interconnected missions of the U.S. Army Corps of Engineers (Corps) are maintaining a safe and dependable navigation channel, and providing flood protection. On the Middle Mississippi River (MMR), the reach between its confluence with the Missouri and the Ohio Rivers, the navigation channel is maintained primarily through the use of river training structures (also known as dikes, groynes and navigation structures) and dredging. On the MMR, training structures have been designed and constructed in many different shapes and elevations to achieve desired outcomes. River training structures redistribute the rivers energy to achieve a desired result, including a deeper navigation channel and/or to increase environmental habitat.

Dating back to the construction of the first river training structures in the early nineteenth century, engineers have persistently sought to fully understand their physical effects on the bathymetry, velocity patterns and water surfaces. As part of the navigation project, the Corps has continuously monitored the river's response to river training structures, and has found no effect on water surface elevations at higher flows. However, through the use of specific gage analysis and numerical modeling, some researchers have recently expressed concerns that the historical construction of river training structures on the MMR has significantly increased flood stages.

1.2 *Background*

River training structures constructed for navigation purposes divert flow towards the navigation channel. Initially, this diversion of flow reduces the cross sectional area resulting in an increase in velocity. The higher velocities increase the sediment transport capability of the channel, thus causing the riverbed to scour. Over time, the channel reaches a state of dynamic equilibrium resulting in a narrower but deeper and more hydraulically efficient navigation channel. In most cases studied, the channel cross sectional area remained constant. River training structures on the MMR are generally constructed to an elevation of one half bankfull and are submerged by over five meters at flood flows. Generally, the construction of navigation structures does not have an effect on the cross section of the overbank area.

There have been many other changes in the Middle Mississippi River basin. The MMR has undergone major natural planform changes including the capture of the Kaskaskia River resulting in a reduction in length of 8 kilometers. Other man-made changes have occurred in the floodplain that has had major effects on the Middle Mississippi River. The construction of levees has disconnected the river from its floodplain, and reservoirs on the mainstem tributaries have decreased the available sediment for transport (Dyhouse 1995).

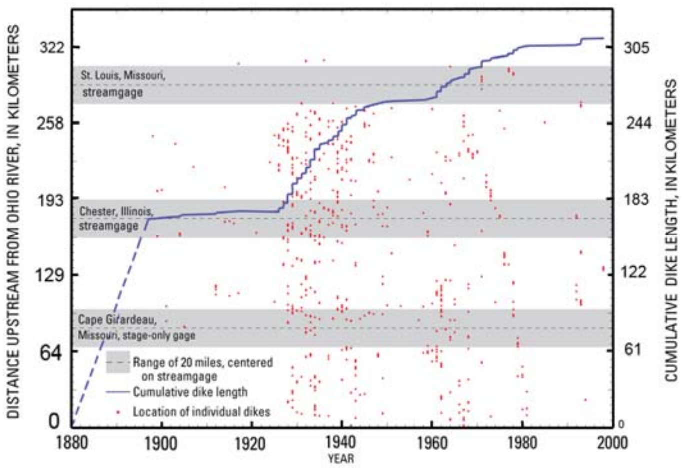

Figure 1. Distance upstream from the Ohio River and cumulative length of dikes built on the Middle Mississippi River since 1880 (Huizinga, 2008)

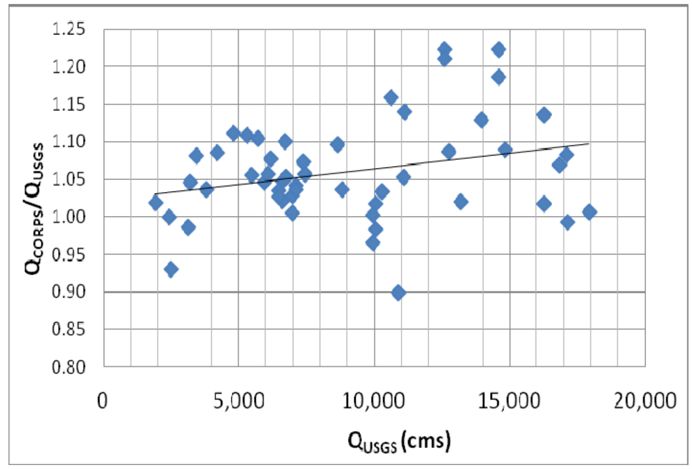

Figure 2. Comparison of Simultaneous Discharge Measurements, St. Louis 1935-1939

2 PREVIOUS RESEARCH

The first study specifically addressing the effect of river training structure construction on water surfaces was conducted during the extreme high water of June and July 1935 (Ressegieu 1952). This study was prompted by the differences in observed streamflow for equal stages following the transfer of streamgaging responsibility from the Corps to the United States Geological Survey (USGS) in March 1933. The study addressed the accuracy of the standard equipment and method of observation between the two agencies. Similar simultaneous streamflow studies were conducted between 1935 and 1948. In 1952, the results of all of the studies were analyzed and it was concluded that, on average, the discharges measured by the Corps generally exceeded those measured by the USGS by zero percent at mean stage to slightly more than ten percent at high stages. Another conclusion of Ressegieu (1952) was that "the reduction in floodway capacity was not an actual physical reduction but an apparent reduction caused by a discrepancy in the accuracy of measuring streamflow by older methods and equipment'.

The first study proposing a link between the construction of river training structures and an increase in water surface elevations was Stevens et al. (1975) who proposed that the combination of river training structures constricting the main channel and levees isolating the main channel from its floodplain resulted in increased stages for flood discharges.

Through the use of historic streamgage data, Belt (1975) arrived at the same conclusion. The source data, methodology and analysis used by these studies was questioned by Stevens (1976), Dyhouse (1976) Strauser & Long (1976) and Westphal & Munger (1976).

Munger et al. (1976) studied the changes in hydraulics on the Mississippi River resulting from river confinement by levees and the construction of river training structures. As was the case in previous studies using gage data, the reliability of early discharge data collected by the Corps was brought into question. In a study of velocity, stage and discharge data, Munger et al. (1976) concluded that "generalizations about the effect of dikes on stage-discharge relations are not justified". When examining cross section shape and velocity distributions at the St. Louis gage it was observed that there had been no striking changes in cross-section shape or velocity distributions at the section between 1942 and 1973.

Dyhouse (1985, 1995) found through numerical and physical modelling that published discharges for historic floods, including 1844 and 1903, were greatly overestimated. Dyhouse concluded that the use of early discharge data collected by the Corps including historic peak flood discharges in conjunction with streamflow measurements by the USGS will result in incorrect conclusions.

By comparing the trends in stage and streamflow measurements for rivers with and without river training structures Criss & Shock (2001) concluded that stages have increased over time on rivers due to the construction of river training structures.

Pinter et al (2001) used specific gage analyses to study the changes in stage and discharge relationships on the Middle Mississippi River and concluded that the presence of river training structures has increased roughness and resulted in an increase in flood stages.

One limitation of specific gage analysis is that it can only be performed on gages with a discharge record. Jemberie et al (2008) developed a refined specific gage approach to overcome this limitation by developing "synthetic discharges" at stage only gages. The synthetic discharges are created by interpolating discharge values at nearby gages to create a stage-discharge relationship at stage only gages. Jemberie et al (2008) also formulated a continuous specific gage time series for large, rare discharges by using “enhanced interpolation”. The results of the refined specific gage study were that stages that correspond to flood discharges increased substantially at all stations consistent with what was documented by Pinter (2001).

Remo & Pinter (2007) used a 1-D unsteady HEC-RAS model (“retro-model”) to assess the magnitude and type of changes in flood stages associated with 20th century river engineering. The “retro-model” used historic hydrologic and geospatial pre-USGS data to establish baseline roughness conditions. The baseline was then compared to present day hydraulic conditions to determine the changes in roughness as a result of engineering modifications. The results from the “retro-model” showed an increase in flood stages similar to those observed by Pinter (2001) and Jemberie et al (2008).

The increase in water surfaces found by Stevens et al. (1975), Belt (1975), Criss & Shock (2001), Pinter et al (2001) and Jemberie et al (2008) are all driven by the difference in measured discharges between the Corps and USGS. The increase in roughness found by Remo & Pinter (2007) was a consequence of comparing the roughness calculated using early Corps discharges from the 1900’s to those calculated using USGS discharges.

3 AVAILABLE STREAMFLOW DATA

There exist only three rated streamgages on the MMR; St. Louis, Missouri (USGS streamgage station 07010000) located at River Mile (RM) 179.6, Chester, Illinois (USGS streamgage station 07020500) located at RM 109.9 and Thebes, Illinois (USGS streamgage station 07022000) located at RM 43.7. In addition to the rated streamgages there exist a number of stage only gages on the Middle Mississippi River. Streamflow is not collected at these gages and therefore it is impossible to compile a meaningful specific gage record.

Stage and streamflow data on the MMR has been collected at the St. Louis, Chester and Thebes gages since 1861, 1891 and 1932 respectively (Reinecke, 1935). The early streamgage data was collected by numerous agencies including the Corps, local governments, local water departments etc. The USGS has collected continuous streamflow data at St. Louis and Thebes since 1933 and Chester since 1942.

As described in the previous section, a discrepancy exists in early streamflow measurements for similar stages between measurements made by the Corps and the USGS. The two agencies used different instruments and methodology to estimate streamflow. The Corps used a variety of different instruments to measure streamflow dating back to 1866. These instruments include ice cakes, surface floats, double floats, rod floats, early current meters and large and small Price Current Meters. The USGS used one small Price Current Meter exclusively to measure streamflow until converting to the use of Acoustic Doppler Current Profiler (ADCP) in the 1990’s.

Other differences in measurement instrument and methodology between the Corps and USGS was the shape and size of the weights used, type of line used, type of counter, amount of spin time, spacing between velocity stations, number of vertical measurements and measurement platform. The USGS measured streamflow from fixed, stationary platforms such as bridges whereas the Corps measured streamflow from floating platforms such as small boats and barges. Simultaneous streamflow studies between the Corps and USGS found that the discharges collected by the Corps were overestimated on average by 10.5% (Ressegieu 1952). It was determined that this overestimation was mostly due to the lateral movement of the boat during periods of observation by the Corps. When emphasis was put on reducing the boat’s lateral movement, the difference between the Corps and USGS measurements was reduced to less than 2.5%. Collecting data from fixed platforms such as bridges eliminated the problem of lateral movement for the USGS. Another conclusion of the studies was that the equipment used by the Corps was obsolete.

The overestimation of early discharge measurements was revisited by Stevens (1979). An analysis of the data collected by Stevens (1979) revealed that floats overestimated streamflow measured by the USGS by up to 15% for surface floats, 17% for double floats and 6% for rod floats. Consistent with previous studies, the amount of overestimation increased with increasing streamflow. Stevens (1979) also conducted simultaneous streamflow measurements using 24”, 36” and AA current meters. The streamflow measured with meters from a boat was up to over 5% higher than that measured from a bridge. The maximum discharge observed during the field tests was 16,990 cubic meters per second (cms). The results obtained by Stevens (1979) represented a conservative estimate. By using fathometers and modern surveying techniques, Stevens (1979) was unable to account for the variability in cross sectional area found in the early measurements. Early cross sectional measurements were collected using rods and later lines and weights.

Pinter (2010) analyzed historic discharge measurements collected by the Corps and concluded that float based and meter based streamflow measurements made prior to the transfer of streamgaging responsibility to the USGS are comparable to each other at the same stage. By not including USGS measurements in his analysis Pinter (2010) was unable to determine how discharges measured by the USGS compare to those measured by the Corps. The conclusions by Pinter (2010) help explain why questions about the accuracy of streamgaging instruments and techniques were not raised until after the change to USGS instruments and methodology for streamflow measurement.

Another difference between the Corps and USGS that can affect analysis of historic data is the way rating curves were developed. The Corps developed rating curves for specific time periods using streamflow measured during that time. At the St. Louis gage, the Corps created rating curves for the time periods 1861-1871, 1872-1881, 1882-1895, 1896-1915, 1916-1918, 1919-1928 and 1929-1934. The USGS continually updates their rating curves by making periodic adjustments based on measurements that are systemically off the rating indicating a change in the controlling flow condition.

As shown by the limited number of discharge measurements taken before 1933, Figure 3, streamflow measurements used to develop the Corps rating curves were not taken consistently during the rating periods. For example, for the St. Louis rating curve covering the period 1861-1881, of the 181 discharge measurements used to create the rating curve, 177 were collected between 1879-1881.

4 CONTEMPORARY RESEARCH

To update ongoing evaluations of the physical effects of river training structures, the Corps initiated a new study on the possible effect of these structures on water surfaces. This series of studies included an analysis of past research, an analysis of the available gage data on the MMR, an analysis of historic measurement technique and instrumentation and its effect on the rating curve, specific gage analysis and physical modelling. In addition to the research conducted by the Corps, the St. Louis District engaged with external technical experts in the fields of river data collection, river engineering, geomorphology hydraulics and statistics.

4.1 *Specific Gage Analysis*

A tool that has often been used to study the stability of the MMR is specific gage analysis (Munger et al 1976, Pinter 2001, Brauer 2009, Watson & Biedenharn 2010). Specific gage analysis is a plot of stage over time for fixed discharges at a particular gage location. There are two methods for developing specific gage records; the rating curve method and direct step method. In the rating curve method, discharges measured within a chosen year are plotted against stage. A regression curve is then fitted to the data either by eye or through the use of a curve fitting program. The stage for selected fixed discharges is then selected from the regression curve. This process is repeated for each year studied and the stages are plotted over time on a specific gage plot.

In the direct step method (Figure 3) direct streamflow measurements within chosen flow ranges are plotted against time. Unlike the rating curve method, the direct step method can have multiple values or (if a discharge is not observed) no values for a particular year.

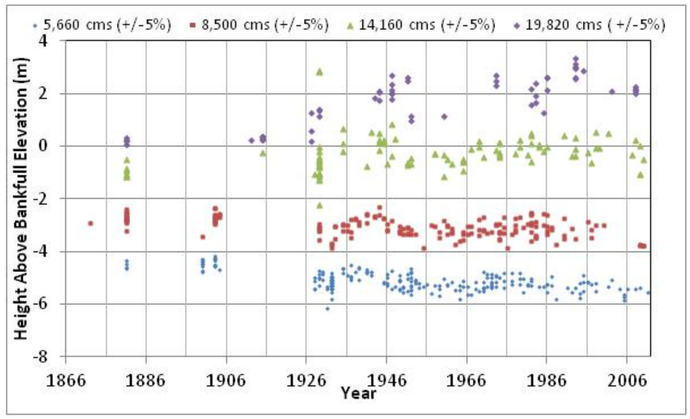

Figure 3. Specific Gage Analysis at the St. Louis Gage, 1866-2011. Height above bankfull elevation of zero corresponds to a stage of 9.14 meters on the St. Louis Gage.

4.2 *Watson and Biedenharn (2010)*

Due to their reputation as experts in geomorphology, river engineering and the use of specific gage analysis, the Biedenharn Group, which consists of David Biedenharn and Chester Watson, was selected to evaluate the use of specific gage analysis in previous studies and to conduct a specific gage study using the most updated available gage data to determine if the construction of river training structures on the Middle Mississippi has caused an increase in flood heights.

In a review of historic streamflow data collected prior to the USGS, Watson & Biedenharn (2010) determined that pre-USGS data should be omitted for the following reasons (1) It has been confirmed through simultaneous measurement comparisons that there is much uncertainty in the historic data due to differences in methodology and equipment (2) there is much uncertainty with respect to the location of the discharge range (3) there is insufficient measured data at the higher flow ranges to produce reliable specific gage records (4) the homogeneous data set containing all discharges collected by the USGS provides an adequate long-term, consistent record of the modern-day river system including periods of significant dike construction.

In their analysis, Watson & Biedenharn (2010) studied the specific gage records at the three rated gages on the MMR; St. Louis, Chester and Thebes. The analysis for Thebes was omitted in this paper due to the effect of backwater from the Ohio River. For each streamgage studied, the specific gage record was analyzed and compared with a record of river training structure construction for a reach extending 20 river miles downstream. All data used in their study was collected by the USGS and retrieved from their website.

Bankfull stage at the St. Louis gage is 9.1 meters with a corresponding discharge of approximately 14,160 cms. Flows below 11,330 cms are contained within the top bank and flows above 19,820 cms are well above the top-bank elevation. The time period 1933-2009 was studied. The top elevation of training structures in this reach was between 4.6-5.5 meters and all structures are completely submerged at discharges exceeding 7,930 cms. In their analysis, Watson and Biedenharn (2010) found a statistically significant slightly decreasing trend in streamflows below 5,660 cms. In streamflows between 8,500 cms and 14,160 cms a statistically significant horizontal trend in stages was observed. At 19,820 cms there was a trend in stages that was not statistically significant. The slight upward trend in stages at 19,820 cms had considerable variability in the data and was strongly influenced by the 1993 flood.

Bankfull stage at the Chester gage is 8.2 meters with a corresponding discharge of approximately 11,900 cms. The time period 1942-2009 was studied. The top elevation of navigation structures in this reach was 5.2-5.8 meters and all structures are completely submerged at discharges exceeding 7,930 cms. The only statistically significant trend found was a statistically significant slightly decreasing trend for streamflows below 2,830 cms. There was no trend for 5,660 cms and 11,330 cms. There was a slightly increasing trend at 8,500 cms. For both overbank flows, 14,160 cms and 19,820 cms, there were slight increasing trends.

After a closer examination of the specific gage trends it was apparent that the long term trends for both St. Louis and Chester were not continuous and there was a shift in stages that occurred in the early 1970's. When the record was broken into pre- and post – 1973 sections different trends were observed. Prior to 1973 at all gages studied, there were no increasing trends for any of the flows. Post-1973 there were no increasing stage trends for within-bank flows at any of the gages. A slightly increasing stage trend occurred for overbank flows of 14,160 cms and 19,820 cms at the Chester gage. A majority of the construction of river training structures on the Middle Mississippi was performed prior to 1973.

In conjunction with the specific gage record, Watson & Biedenharn (2010) analyzed the record of training structure construction including an analysis of the top elevation of the structures. The typical top elevation of the structures was between 3-4.9 meters below the top bank. Since the top elevation is so far below top-bank elevations, the most dramatic impacts of the structures should be in the low to moderate stages below top bank where the specific gage analysis revealed decreasing or no trends.

Watson & Biedenharn (2010) concluded that, "based on the specific gage records, there has been no significant increase in stages for within-bank flows that can be attributable to river training structure construction. Any increase in overbank flood stages may be the result of levees, floodplain encroachments, and extreme hydrologic events; and cannot be attributed to river training structures based solely on specific gage records".

4.3 *USGS, Huizinga (2009)*

The USGS is the primary collector of streamgage data on the MMR. A majority of the available hydrologic data for any type of study (specific gage analysis, numerical modelling etc.) was collected and verified by the USGS. The USGS was selected to examine all available data from the rated streamgages on the MMR and determine stage-discharge relation changes through time and to investigate cause-and-effect mechanism through evaluation of hydraulic geometry, channel elevation and water-surface elevation data.

When compiling specific gage records it is important to have an understanding of the various factors that can affect stage and discharge at streamgages. These factors have a greater effect on the stage-discharge relationship for higher flows. Higher flows are infrequently observed and therefore observations affected by the aforementioned factors are not averaged out as is the case with lower flow observations. Huizinga (2009) found that there are both natural and man-made factors that can have an impact on the stage (both an increase and decrease) for a constant discharge. The man-made factors include in-channel structures (i.e. river training structures) and floodplain structures (i.e. levees, floodwalls, roadways). Natural factors include water temperature, seasonal variations in vegetation thickness, suspended sediment load and hysteresis.

All of the natural factors can be observed in the specific gage records. For example, cold water passing at a lower stage compared to a similar discharge of warm water. This is observed through higher stages for late summer floods (i.e. 1993, 1973). Also contributing to higher stages for late summer floods is the effect of seasonal variations in vegetation thickness. The increased roughness due to thicker bankline vegetation results in higher stages. Suspended sediment load is particularly important on the Middle Mississippi River due to the combination of flows from the sediment laden Missouri River and the relatively clear Upper Mississippi River. Floodwaters originating from the Missouri River pass at a higher stage compared to those originating from the Upper Mississippi River. Hysteresis combined with the timing of measurements has a large effect on a specific gage analysis. The rising limb of the hydrograph has a higher discharge for a given stage compared to the falling limb.

Huizinga (2009) conducted a specific gage analysis using the direct step method on only data collected by the USGS for the gages at St. Louis and Chester. Similar to Watson & Biedenharn (2010), Brauer (2009) and Pinter et al. (2001), an apparent decrease of stage with time for smaller, in bank discharges was observed at both the St. Louis and Chester gages. This decrease in stage was attributed to the construction of river training structures and/or a decrease in sediment load available for transport on the Mississippi River due to the construction of reservoirs on the main stem tributaries of the Mississippi River, particularly the Missouri River.

Huizinga (2009) found a slight increase in stage over time for higher flows at both St. Louis and Chester over the entire period of record. The transitional discharge was 11,330 cms and 8,500 cms for the St. Louis and Chester gages respectively. These discharges correspond to stages of 7.6 meters at St. Louis and 6.7 meters at Chester. At these stages the navigation structures are submerged by between 2.1-3.1 meters. Huizinga (2009) attributed the slight increase in out of bank flows to the construction of levees and the disconnection of the river to the floodplains. Similar to Watson & Biedenharn (2010), Huizinga (2009) observed a shift occurring in the out of bank flows in the mid-1960's and attributed it to the completion of the Alton to Gale levee system which paralleled the entire Middle Mississippi River.

In an analysis of cross sectional data collected at the St. Louis and Chester gages it was found that although the shape of the cross section had changed, the cross sectional area for moderate (11,330 cms)

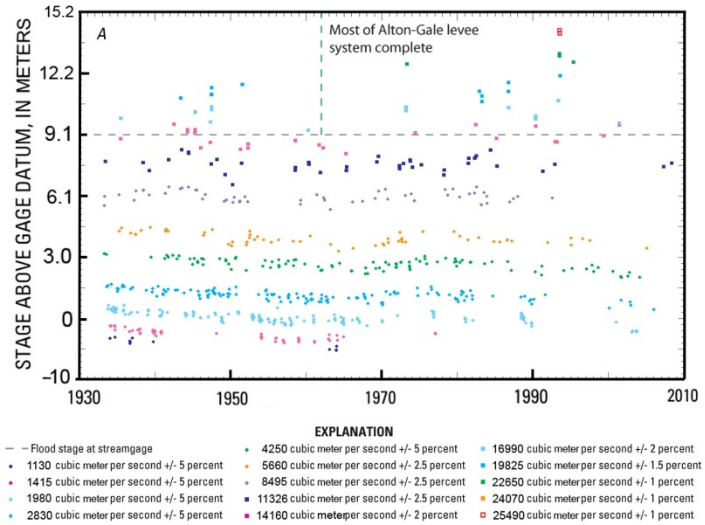

Figure 4. Stage for a given discharge range with time from measurements made at the streamgage at St. Louis (Huizinga, 2009)

and high (16,990 cms) flows remained relatively constant throughout the period of record. The construction of river training structures immediately upstream of the Chester gage provided a case study on the effect of the absence and construction of structures on the cross section over time. Prior to the construction of the structures, the channel thalweg repeatedly shifted between the left and right banks. Following the construction of the structures, the cross sections displayed much less variability. An overall stabilizing effect of the structures was seen on the cross section for discharges of 2,830 cms and 11,330 cms. The cross sectional area for the first and last measurements of the period of record remained similar despite the river training structure construction upstream for all discharges

Huizinga (2009) conducted a study of all rating curves developed for St. Louis and Chester, including those developed prior to 1933 by the Corps. When comparing daily values from the Corps from 1861-1927 to the original USGS rating in 1933 there appeared to be an abrupt change in the upper end of the ratings used before 1933. When these daily values developed by the Corps were "adjusted" to compensate for the overestimation of Corps discharge measurements detailed in the simultaneous discharge measurement studies between the Corps and USGS the adjusted daily discharge values plotted in line with the original USGS rating (A).

4.4 *Statistical Evaluation*

A critical review of the statistical analysis used to support specific gage analyses by Pinter (2001, 2003, 2009) and Brauer (2009) was conducted by V.A. Samaranayake (2009) from the department of

Mathematics and Statistics at Missouri University of Science and Technology. In his report, Samaranayake (2009) concluded that the analysis presented by Pinter (2001, 2003, 2009) did not support the conclusions that river training structures are increasing stages for higher discharges.

Samaranayake (2009) also evaluated the two types of specific gage analysis, rating curve and direct step methods, to determine which is more appropriate in this case. Samaranayake (2009) concluded that the direct step method was the most appropriate. This is due to the data points being more homogeneous than those obtained from the rating curve method as far as variance is concerned and therefore can be considered devoid of simultaneity bias and other such artifacts.

Samaranayake (2009) also concluded that, when using computed daily discharge values, the researcher is essentially recreating the original USGS rating curves used to obtain the daily discharges. The computed daily discharge data lacks the natural variability found in measured streamflow and can lead to conclusions that are due to artefacts created by errors in the original rating curves. This error is compounded by the fact that the USGS uses the same rating curves for several years producing results that, rather than being independent, are correlated across several years.

4.5 *Ongoing Research*

In addition to the ongoing monitoring of the physical effects of navigation structures on the MMR, two major research efforts are in progress. One study is a series of numerical simulations of recently constructed river training structures. The other is a generic 1:400 scale physical sediment transport model to study the effect of river training structures on water surfaces. By modelling a non-specific, straight reach of river, the study analyzes the changes in water surfaces in response to changes in structure length and the number of structures in the structure field. Both research efforts are ongoing and results will be posted on the Corps website at the time of completion.

5 DISCUSSION

A body of research showing that river training structures do not impact water surfaces at high flows exists. In contrast, there exists a series of journal articles that claim the contrary; that the construction of river training structures has led to an increase in flood stages. The dramatic upward trends in water surface concluded in these studies are all driven by the use of early discharge data. Numerous studies, including simultaneous discharge studies conducted by the Corps and USGS dating back to the 1930's, have determined that early Corps streamflow data is inaccurate and unreliable due to differences in instrumentation and methodology. Analyses performed using the long term homogeneous data set containing all discharges collected by the USGS have led to the conclusion that river training structures are not increasing flood heights. When early discharge measurements are omitted from the analysis, all studies (both that do and do not conclude river training structures increase water surfaces) exhibit the same trends.

Through the use of a fixed bed physical model, Azinfar and Kells (2007) found an inverse relationship between the backwater effect of a submerged river training structure and the submergence ratio. It would be expected that the effects of river training structures on water surfaces would be observed at stages immediately above the top elevation of the structures (or at the lowest submergence) and decrease with an increase in discharge (and submergence). The trends observed in specific gage analysis, including those conducted by Pinter (2001, 2003) and Jemberie (2008), show that there is no effect on stages for flows between the top elevation of the structures and bankfull.

Huizinga (2009), Watson & Biedenharn (2010) and Brauer (2009) all concluded that a major driver of the "step –up" in the highest flows was the result of changes in the floodplain, particularly the construction and raising of levees. This is confirmed by the increase in stages for the highest discharges that coincided with the construction of major levee systems (Alton to Gale). This conclusion is consistent with the conclusions of previous studies on the topic including Munger et al. (1976).

6 CONCLUSIONS

Research studying the physical effects of river training structures on the MMR has been ongoing by the Corps since the implementation of the Corps' navigation program. Throughout this time, a number of studies have been performed by the Corps, other federal agencies and external technical experts to determine the effect of river training structures on water surfaces. This includes recent analysis performed by the Corps and other river engineering and statistics experts. The results of these studies have all to the conclusion that the construction of river training studies in the MMR has not resulted in an increase in water surface elevations, particularly at higher flows.

The Corps will continue to monitor the effects of river training structures through the analysis of hydrographic, velocity and water surface surveys and stage and streamflow records. The Corps will also continue to conduct additional research efforts as new data becomes available and when additional research is necessary.

7 DISCLAIMER

The views expressed in this article are those of the author and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.

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