Levees and Floodplain Management

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At the turn of the century our riverine commercial fisheries were seen as resources to feed the nation; yet today most of these fisheries are either restricted or completely closed. This is in part due to contamination by both domestic and industrial wastes, but equally or perhaps more important, is the impact of channelization and impoundment to meet the needs of flood control, hydropower, water supply, and commercial navigation. In recent years, our society has made major strides in addressing serious water quality issues, but little has been done to restore the habitats lost to major water resource developments.

The Mississippi and Missouri rivers are two of the largest and most managed rivers in the United States, and both (Figure 1) are significantly impacted by development for hydropower, navigation and flood control. The impacts that occur are typical of those man has had on other rivers nationwide. In addition to the mainstem dams and levees shown in Figure 1, there are many more dams, levees, and channelization projects throughout the watersheds.

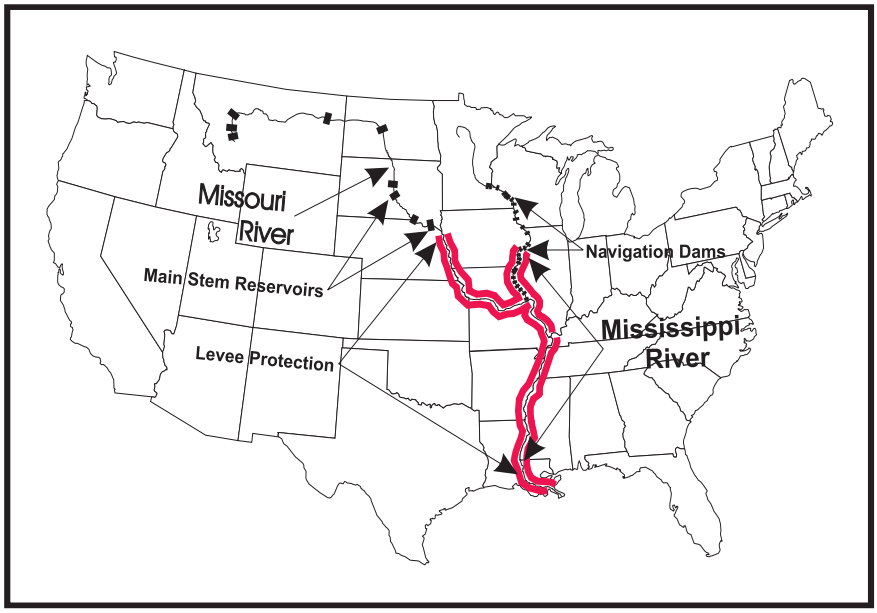

Figure 1. Mainstem flood control and navigation projects of the Mississippi and Missouri rivers.

During the first half of this century, rivers in the United States such as the lower Missouri River (Figure 2) were becoming little more than major sewer systems, seen only as mechanisms to carry away wastes, and as "common enemies" that had to be controlled, and if possible, harnessed for hydropower and navigation. In fact able bodied men were drafted, military style, to fight the river, our "common enemy" in the event of flooding. Little or no consideration was given to river ecology, to the importance of natural processes, or to man's connection to ecological integrity. These terms weren't even known, much less understood.

In the case of the lower Missouri River a federal program called Pick Sloan was used to place several major dams on the mainstem, and to channelize downstream reaches for commercial navigation. Development and draining of floodplain lands for agriculture came about as a result of both the Pick Sloan Program and something called the Swamp Act. Swamps, or wetlands as we know

Figure 2. Development of the lower Missouri River for commercial navigation and flood control. Photos courtesy of the Missouri Department of Conservation.

them today, were also considered common enemies. Our society, had little understanding of the role that these floodplain wetlands played in controlling floods; in serving as the "kidneys" of the landscape, cleansing runoff waters; or in maintaining ecological integrity. Our vision has been one of dominion over nature.

By the late 1970's the Missouri, the lower Mississippi, and many other rivers and tributaries in the United States had been totally channelized, and their natural floodplain ecosystems had been almost totally converted to farmland or other purposes. In the process, we lost many of our commercial fisheries, many sport fisheries are threatened, and today we face growing lists of threatened and endangered aquatic species.

In terms of numbers, on the lower Missouri River alone (Table 1), just in conversion of what was former river channel and erosion zones (not the entire floodplain) we lost over 100,000 acres of aquatic habitats, over 65,000 acres of island sandbars, over 114,000 acres of wetlands, over 190,000 acres of woodlands, and over 127 miles

Table 1

Missouri River Habitat Lost to Channelization 1912-1980*

Aquatic Habitats	**100,000 Acres**
Island Sandbars	**65,000 Acres**
Wetlands	**114,000 Acres**
Woodlands	**190,000 Acres**
Shorelines	**127 Miles**

***Includes only the former natural river channel and meander belt, not the entire river floodplain.**

Source: U.S. Fish & Wildlife Service, 1980

of shorelines. The result of this basinwide development and channel straightening became evident on the lower Missouri and parts of the Upper Mississippi river basins after the high water event, or flood of 1993. The Missouri River flooded bluff to bluff on two different occasions, pretty much having its own way, recovering or recreating many new or former aquatic and floodplain habitats. Wet areas on the floodplain left by the flood were a mix of newly scoured areas and old depressions or channels where prior wetlands had been drained for farming. Some floodplain farmlands were left covered with sands ranging from a few inches up to ten feet deep (Figure 3), and many floodplain homes were destroyed (Figure 4). Depending on point of view, this can either be considered tremendous destruction of farmlands, or from the river's point of view as tremendous rehabilitation of former aquatic habitats — the river's natural method of restoring its biological systems.

Figure 3. Former Missouri River floodplain farmlands impacted by the 1993 floods. Photo courtesy of the Missouri Dept. of Conservation.

Figure 4. Floodplain farm house destroyed by the 1993 floods. Photo courtesy of the Missouri Dept. of Conservation.

The flood fight during the 1993 flood was largely unregulated, with each landowner or group of landowners fending for themselves. In fact some federally sponsored levees were raised as much as two feet higher than their authorized level (Figure 5). One such levee near Quincy, Illinois blocks off over 100,000 acres of floodplain, or put another way over 150 mi^2 of floodplain. It seemed that,

Figure 5. The raising of this federal agricultural levee during the 1993 "flood fight" threatened neighboring lands by further constricting the floodplain and forcing flood waters to higher elevations. Photos courtesy of the U.S. Fish and Wildlife Service.

during the flood, all previous agreements were off and farmers could raise their levees as high as they thought necessary to protect their crops. Public funding assisted in many ways in helping to raise these levees, and then paid to reconstruct them once they failed — and many levees did fail in several places. This despite the fact that the taxpayers had originally paid to construct the levees only to a specified elevation. Also by raising these large agricultural levees, nearby developed lands as well as cities and towns in the area, on both sides of the river, were faced with increased flood levels.

Nearly the entire Mississippi River floodplain downstream from Rock Island, Illinois, the Missouri River downstream from Sioux City, Iowa, and the Illinois River have been isolated from the river by levees and converted to agriculture (Figure 1). This problem occurs to a lesser extent on many of the smaller tributaries. These isolated floodplains are areas that the river once had not only as part of its Aquatic Terrestrial Transition Zone **(See Natural Floodplain Ecosystems)**, but also for use in flood water storage and conveyance. Water from all of these rivers ultimately ends up at St. Louis, where the Illinois, Upper Mississippi, and Missouri rivers merge.

In essence, while destroying prime riverine and floodplain habitats, our society has created many of our own flooding problems. Figure 6 shows the relationship between flood elevation and discharge at St. Louis, Missouri between 1844 when flood control developments first began and 1993 when our last great high water event or flood occurred. As we have continued to build levees over time, and blocked off floodplains, flood elevations have risen accordingly. You will note in Figure 6, comparing discharge to flood elevation, that discharge was actually higher than flood elevation in 1844, and then over time, flood elevation has risen disproportionately to discharge as the river lost its floodplain to development. In 1993 when many of the levees broke, you will note that the two once again rose in concert, in a more natural way.

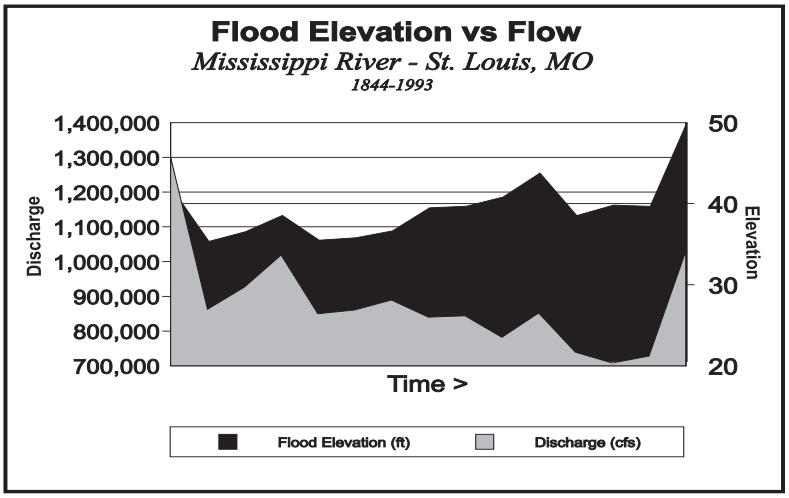

Figure 6. The relationship between discharge or flow and flood elevation, as impacted by isolation of river floodplains with levees.

Looking at levees in cross section (Figure 7) you can see how these high levees cause water levels to rise. As long as they hold, the water has no place to go but up, essentially forcing flood waters to pass through a narrow funnel-like opening between the levees. Waters impounded upstream cause rapidly rising, higher than normal flood elevations, and people who may never have been flooded before, now find their homes under water. In self defense these newly flooded people now face the need to build their own levees and floodwalls (Figure 8), usually through taxpayer assistance. And so it goes upstream, until virtually everyone has a levee, and virtually the entire floodplain is isolated from the river.

When these levees break, because the water is stacked so high, a tremendous amount of energy is

released. This energy is released in the form of what hydrologists call a “dam break floodwave”, creating huge scour holes adjacent to the channel as diagramed in the river cross section shown in Figure 9 and in the photo shown in Figure 10. Sands from these holes are then scattered about across the floodplain, as shown in Figure 3, to depths of up to ten feet. Damages caused by the 1993 flood cost the American taxpayer somewhere between $14 and $16 billion. Aquatic organisms, on the other hand, regained access to their historic floodplain habitats and enjoyed a banner year, with production levels up across the board (Sparks 1995).

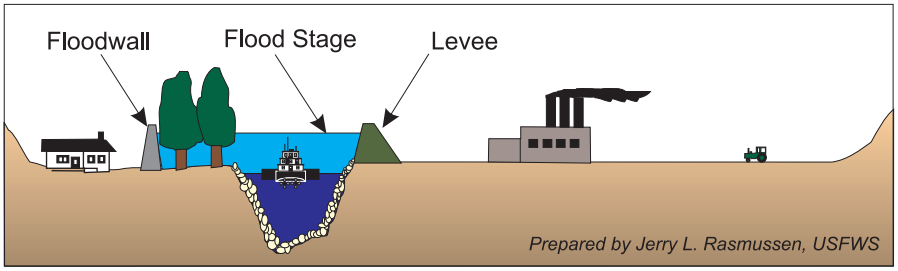

Figure 7. Flood control levees isolate river floodplains; increase flood stage; impact water qualtiy, and destroy wetland, riparian, and instream habitats.

Figure 8. The floodwall at Cairo, IL isolates the city from the Mississippi River - the very reason for its establishment in the first place.

As noted previously, most of the levees on the Upper Mississippi River occur downstream from Rock Island, Illinois. Upstream from that point the floodplain is kept largely intact by the Upper Mississippi River National Wildlife and Fish Refuge which stretches over a distance of 285 miles from Rock Island upstream to Wabasha, Minnesota. Flood damages in areas adjacent to that refuge were minimal during the 1993 flood.

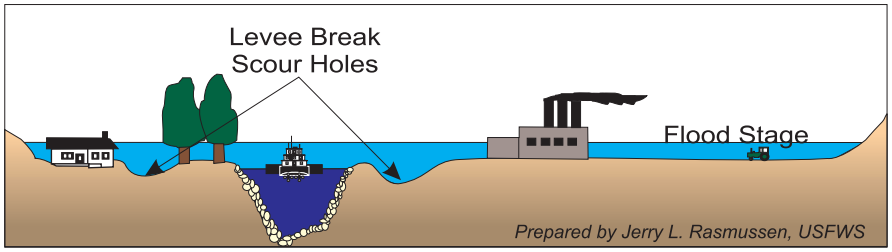

Figure 9. Broken flood control levees cause increased flood damages and floodplian scour because flood heights are increased and induced developments are not protected from flooding.

Unfortunately, a slackwater navigation project is layered over the top of that refuge. The navigation project isn’t designed to provide for flood protection, and may actually reduce it by keeping the floodplain partially inundated. But the presence of the Upper Mississippi River National Wildlife and Fish Refuge still provides flood protection by keeping the floodplain largely undeveloped and open (Figures 11 and 12).

Figure 10. Missouri River levee break.

Such refuges placed on other rivers can be

very effective in reducing flood damages to neighboring lands, while assisting in restoring ecological integrity to the river ecosystems **(See Ecosystem Restoration and 21st Century Floodplain).**

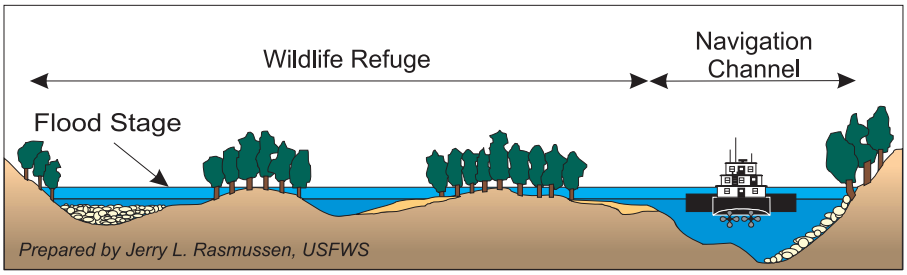

Figure 11. Floodplain wildlife refuges provide significant space for conveyance and storage of

References

Sparks, R. E. 1995. The Great Flood of 1993: Environmental Effects and Recommendations. In: *The Upper Mississippi River: Sustainable Redevelopment Alternatives*. Northeast-Midwest Institute. 218 D. Street S.E., Washington, D.C. pp. 5-9.

Figure 12. View of the Upper Mississippi River floodplain overlooking Prairie du Chien, WI

Jerry L. Rasmussen, March 9, 1999