

Capturing Floods on River Plains with Textile Tubes

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Flood issues

People are running out of useable fresh water. Part of the cause is pollution of existing supplies. Part is increased human population. Part is the effect of Climate Change. Per a 2007 study by the Environment California Research and Policy Center, and numerous other climate studies, extreme 24-hour storm events (floods) are increasing. Also, a National Science Foundation study of 925 rivers found the total runoff has declined significantly in most rivers. The decline in total flow is also expected to increase with increasing greenhouse gas emissions. California will have less winter precipitation stored as snow. India and China will have seasonally dry rivers after Himalayan glaciers melt. Capturing floods with textiles is a crucial Climate Change adaptation.

Traditionally, dams have been employed to control floods and store water for use during droughts. The sites available for traditional dams have decreased. People have become more aware of the environmental and social impacts of flooding canyons. Water engineers have refocused their attention on groundwater storage. However, it is extremely difficult to store a flood in the ground without first capturing it. Otherwise, the water is gone before the relatively slow processes of injection or percolation can store a significant quantity in the ground.

The problem is one of flow rate. For example, the Los Angeles River is a concrete lined channel. The 100-year flood on the Los Angeles River is 175,000 cubic feet per second ($5,000 \text{ m}^3/\text{sec}$, 14,000 acre-feet per hour). The existing groundwater recharge basins along the route can hold about 1,000 acre-feet (1.2 million m^3) or 4 minutes of flood flow. This means Los Angeles captures less than 1% of the river runoff during a large 24-hour storm.

In all the situations listed below, the ideal is for the fresh water to remain captured in the textile structure for a relatively short time, a month or three. It should be conveyed from the textile structure into ground water storage or some beneficial use within the month. The more time it can be empty, the more opportunities for capturing a flood. While it is empty, it is also useful to be out of the way. That way, the land space covered by a full textile structure is available for agriculture between floods.

Particularly cost effective textile structures are obtained with strong porous textiles arranged as tubes with thin impervious liners. The porous textile tubes, such as the Miratec GeoTube and the Flint Industries TitanTube, can be filled about 6-foot (2 m) high with water for any width of tube. If the tube is supported by earth or other structures, the water can be deeper. Note that a single unsupported tube rolls relatively easily, if filled on a slope. The tube stress is similar for a tube 100 feet thick full of fresh water floating in sea water. It can be inexpensively lined with an impervious liner to hold water.

Flooding rivers generally carry sediments and perhaps trash. It may be necessary to remove the sediment from the textile structure. Tubes can be turned flushed or inside out to remove silt, but may need a new impervious liner on the outside which becomes the inside.

Over the last decade or two, plastic manufacturers have advanced the strength, durability, and cost effectiveness of textiles. Those advances can be exploited to capture floods in innovative and cost effective ways.

Capturing floods behind levees on rural plains

The best agricultural lands are often near rivers because the rivers meandered over the plains depositing fertile soils with each flood. Humans constrained the rivers behind levees in order to farm and live close to the river. In this situation, textiles can be used for the dual purpose of water storage and as a temporary containment for the river.

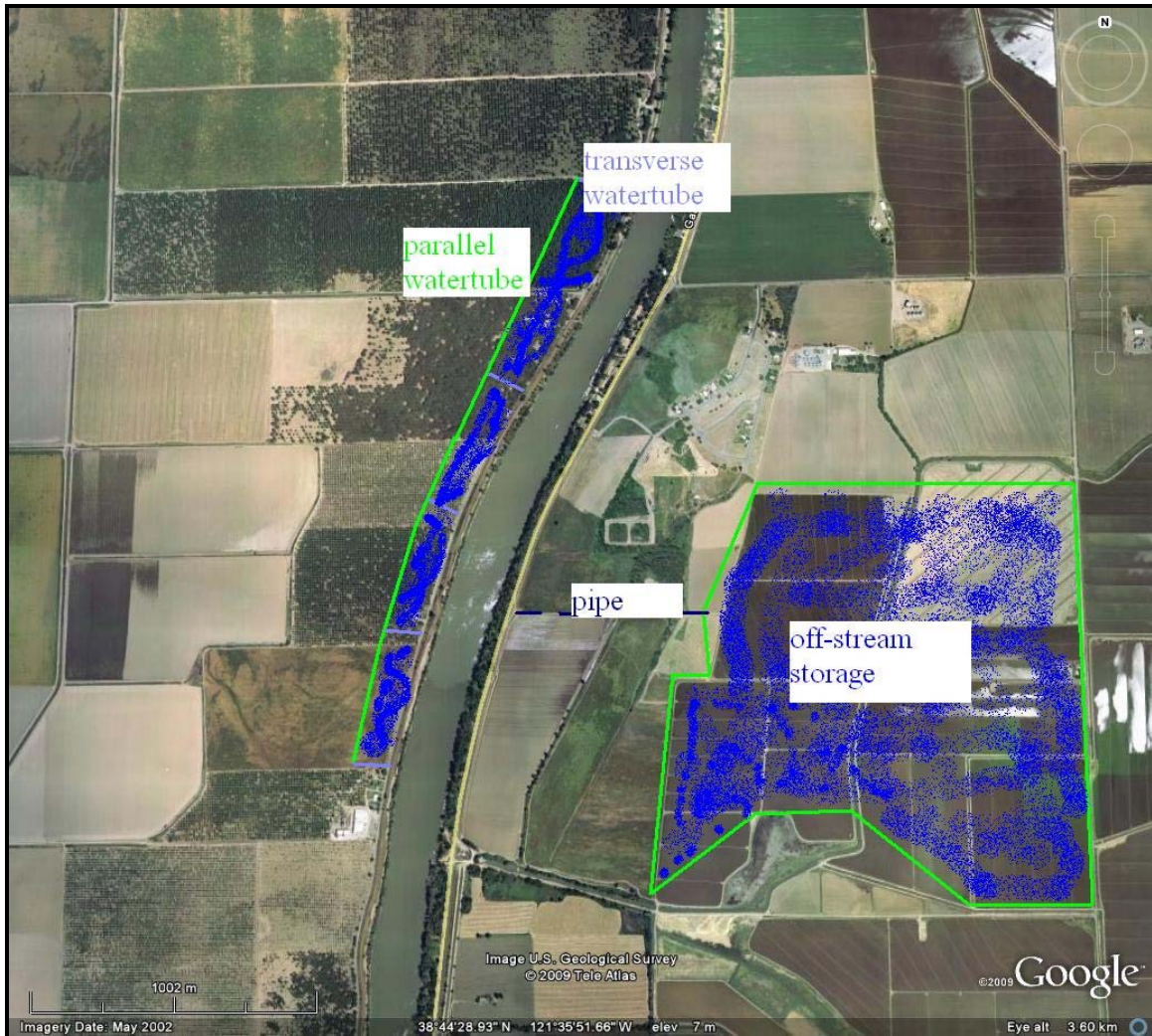


Figure 1 – Aerial view of flood capture on rural plain

Figure 1 is an aerial photo of a river plain. In this area the bottom of the river is about the same elevation as the surrounding agricultural land. The river flows between traditional earth levees. Two arrangements of temporary watertubes are shown. One side of the river has water capture and flood protection parallel to the river with parallel and transverse watertubes (shown in green). The other side of the river has watertubes arranged for temporary off stream storage (with the enclosing watertubes shown in green). Note that in both cases, the watertubes would have to be filled before allowing the water to flood the enclosed area.

Note that deflating the transverse watertubes would allow the flood water to drain parallel to the river. That is employing the parallel watertubes without the transverse watertubes widens the floodway and helps prevent flooding the area outside the parallel watertubes.

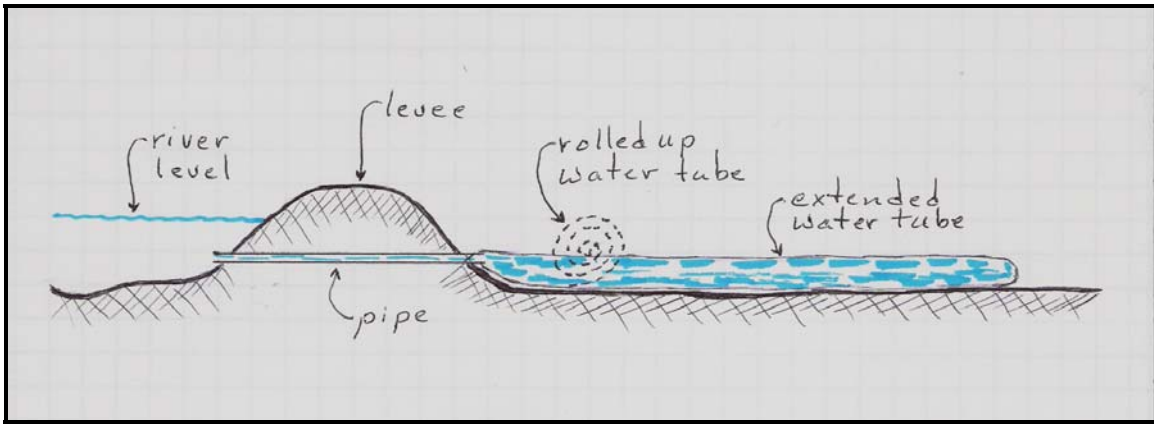


Figure 2 – Cross-section of rural plain flood capture system

Figure 2 shows cross-section of a typical watertube, shown perpendicular (transverse) to the river flow, as on cross-section A-A. The river is on the left and is flowing into the page. The levee is in the middle. Both the empty (rolled up) and the full extension of the watertube are shown.

Each watertube requires a stabilizing structure as shown in the cross-section of Figure 3. Without the stability tubes, the hydrostatic force from water in the rectangular storage area will roll the watertube. The stability tube can be on either or both sides. Alternatively an earth berm, at least a third the height of the full watertube, may be employed instead of the stability tubes to prevent rolling.

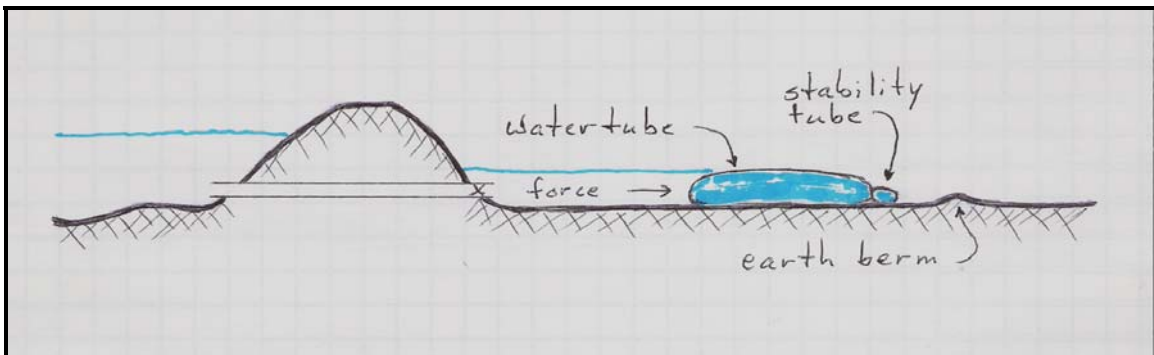


Figure 3 – Cross-section of stability tube and optional earth berm

Figure 2 shows a pipe through the levee that allows filling the watertubes and enclosed storage area during river levels that are far below flood stage. Where local topography prevents filling the tubes directly from the river, they can be filled with either a pipe from further upstream or with pumps.

Figures 1 and 2 do not present features familiar to water system engineers such as valves that would be normally closed to prevent inadvertent watertube or storage area filling, water spill systems that prevent over-filling the watertubes, systems to detect and minimize the effects of a watertube bursting, and pipes to remove the stored water.

The concept of flooding fields and secondary levees is ancient. One advantage of the watertube is that it only obstructs farming and transportation when protecting against additional flooding or when storing water, while awaiting its percolation into the ground. After percolation has occurred, the watertubes can be drained either into the percolation basin, used for irrigation or pumped to the local water treatment plant.

A rural river plain may employ watertubes which inflate to 6 feet (2 m) high by 33 feet (10 m) wide. Transverse watertubes may extend 6600 feet (200 m) from the levee and be spaced at 3,300 feet (1 km) intervals. Several parallel tubes may be needed to cover the 3,300 feet depending on shipping size limitations, how large the watertube will be when it is rolled up, and handling when removing sediment from inside the watertube. The transverse and parallel tubes form a rectangle capable of storing 300 acre-feet (330,000 m³) of stormwater per one-side kilometer of river length. The watertubes themselves store 50 acre-feet (22,000 m³) of stormwater.

If the above system extended over 60 miles (100 km) along both sides of a river, it would capture 95,000 acre-feet (100 million m³) per storm event. Both system cost and storage volume are strongly affected by height of the full watertube and the distance of the watertube from the river.