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Effect on rivers of massive changes in hydrologic regime due to human intervention

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Before Eurafrican settlement, much of the more humid areas of the Great Plains of the United States were unsuitable for intensive agriculture due to the prevalence of a high water table. During the growing season, a substantial fraction of the land in question would consist of intermittent marshland. In order to enable intensive agriculture, an intensive network of buried drainpipes (“drain tiles”) was built. These drain tiles flow into irrigation ditches, which then lead the water, and the sediment it carries, to rivers. The result is a massively modified hydrologic regime. Characteristics of this regime are greatly shortened times of concentration and flood hydrograph length, and greatly increased peak flows. Intensive plowing of Great Plains farmland has likely increased the sediment delivery to the adjacent networks. There is, however, another way in which the sediment transport rate in the river networks can increase. The sediment transport rate depends nonlinearly on flow discharge. A shorter hydrograph with a higher peak can cause a higher sediment transport rate. As a result, the river may go into degradation. This degradation can in turn mobilize more sediment from terraces in the floodplain and valley wall bluffs against which the river impinges. Here a simplified model is used to discuss the effect of modification of hydrologic regime on river morphodynamics and sediment delivery. The results are discussed in the context of the drainage basin of the Minnesota River, Minnesota, USA.