Research that makes a positive difference to the transportation system in Iowa

IHRB IOWA HIGHWAY RESEARCH BOARD

MITIGATION OF SEDIMENTATION AT MULTI-BOX CULVERTS

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RESEARCH PROJECT TITLE
MITIGATION OF SEDIMENTATION AT MULTI-BOX CULVERTS
(IHRB RESEARCH PROJECT TR-665)

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We created a web-platform that uses a data-driven approach for providing the critical information needed for designing and maintaining culverts operational and free of sedimentation.

BACKGROUND

While there are no concerns with conveying high flows, many multi-box culverts in Iowa have a significant problem with formation of sediment deposits at culverts. The highly erosive Iowa soils can easily cause silt-in and barrels can become partially filled with sediment in just a few years. Silting can considerably reduce the capacity of the culvert to handle larger flow events leading to hazards for the structure and flooding upstream the culvert.

There are considerable knowledge gaps in addressing the sedimentation at culverts as an end-to-end process, especially in connecting the upland with in-stream processes and simulating the sedimentation at culverts in non-uniform, unsteady flows while also taking into account vegetation growth.

OBJECTIVES

The overall project objective is the systematic identification of the likelihood of culvert sedimentation degree as a function of the stream and culvert geometry as well as of the watershed and stream characteristics in the culvert drainage area. The establishment of the functional relationship is made through the usage of Multi-Criteria Decision Analysis, a tree-based analytic technique popular in computer-based classification and prediction applications. The method is popular because the decision trees are intuitive and, therefore, easy to explain outside the software developer community.

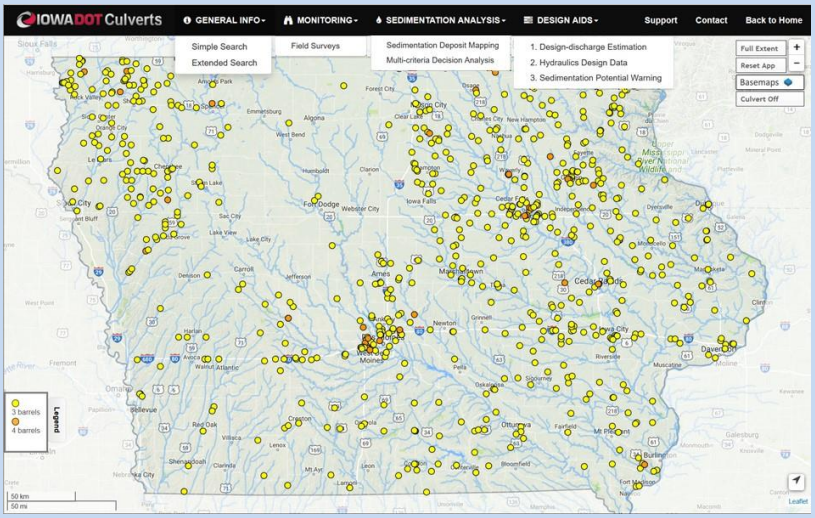
IOWA DOT CULVERTS PLATFORM

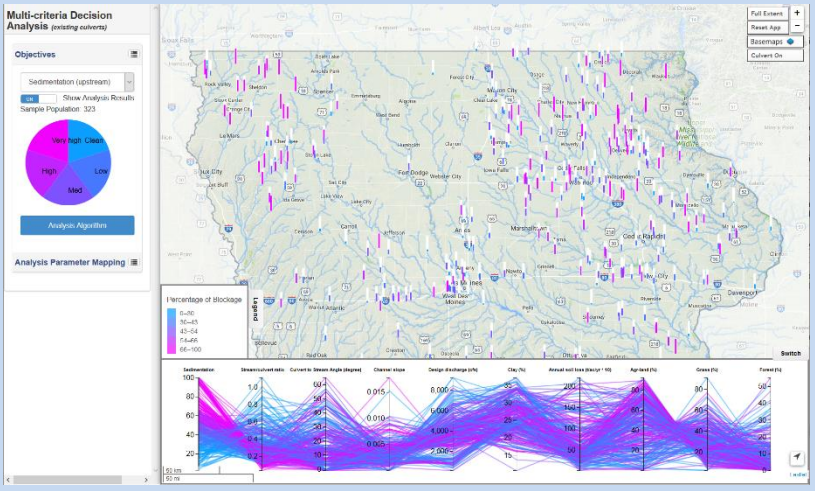
(iowawatersheds.org/idotculverts)

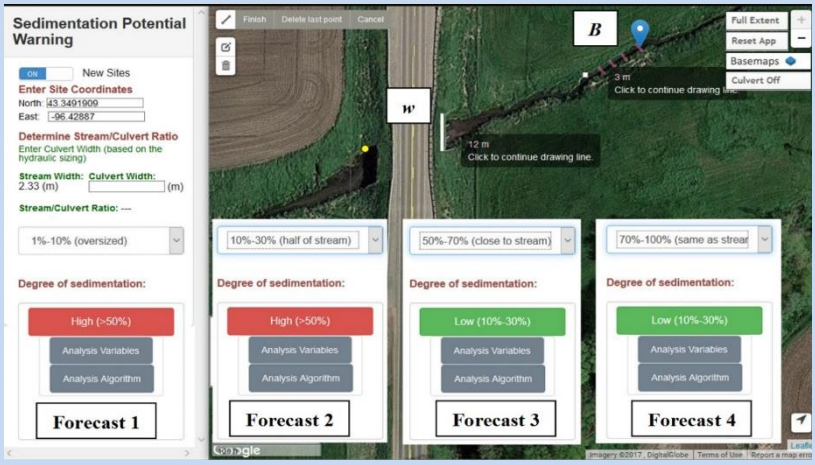
The portal enables four workflows:
(1) storage and query of culvert and drainage area characteristics;
(2) monitoring of sedimentation at culverts using in-situ or remote sensing technologies;
(3) analysis of the sedimentation at culverts; and
(4) support of culvert design by forecasting the sedimentation potential for existing or new culvert sites.

The core of the Iowa DOT Culverts platform is a Multiple-Criteria Decision Analysis (MCDA), a data-driven engine that uses quantitative and qualitative data, along with expert judgment, to develop quantitative relationships between the degree of culvert sedimentation and the key process drivers within the drainage area of the culvert, using the power of machine-learning and visual-analytics techniques.

The forecasting of the degree of sedimentation at culverts is the premier product of this study as it embeds all the artificial intelligence tools developed for the Iowa DOT Culverts platform. The tool provides the degree of sedimentation for existing or new culvert sites. The degree of sedimentation is defined as the ratio of the total area of the expansion upstream from the culvert divided by the area covered by sediment deposits.







TECHNOLOGY TRANSFER: During 2017, the prototype Iowa DOT Culverts platform has been presented in several national, state, and regional: Transportation Research Board 2017 Meeting (Washington D.C.), AASHTO TC on Hydrology & Hydraulics (Des Moines, Iowa), State Transportation Innovation Councils dissemination workshops (5 Iowa locations), MINK Local Roads Meeting (St Joseph, MO).