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Placement of Coastal Embankment and Monitoring using IoT

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Learning Objectives

- Learn how to position embankment in InfraWorks
- Learn how to simulate, visualize, and analyze 2D flood simulations in the model
- Learn how to create detail design using Civil 3D
- Learn about an IoT-based flood embankments monitoring system

Description

Learn the workflow to place embankment around the coastal regions by using InfraWorks software to create a conceptual design. Use Flood Simulation to simulate, visualize, and analyze 2D flood simulations in the model and export from InfraWorks to Civil 3D software for the detailed design, with all the model information. Finally, use IoT to monitor the embankment after construction. This system will enable early detection of disturbing phenomena or events occurring in the flood embankments, thus enabling early response and prevention of crisis.

Speakers

Thandavan Boobalan (Technical Specialist, Autodesk) carries 9 years of Experience in Pre-sales, Training & Technical Support on BIM for MEP Products, and our manufacturing product portfolio. In his earlier assignments he worked as BIM Implementation Engineer & BIM Coordinator for projects across Middle East region.

Prabhu Gunasekaran (Technical Specialist, Autodesk) works to bring every person on every team, in the construction industry, closer together, to help them win in the future of connected construction. A Civil & Structural Engineer, with over 8 years of experience in the Engineering Procurement & Construction Industry, working in multiple project execution teams, driving them towards technology adoption and digital transformation.

Position Embankment in InfraWorks

A vital step in constructing an embankment is to understand the terrain in terms of elevation, slope, and other parameters. This information is important to position the embankment and its alignment. Terrain Themes in Autodesk InfraWorks allows you to visually classify the terrain based on Elevation, Aspect, or Slope. Once inside the InfraWorks model,

1. Click Manage ➤ Display ➤ [icon] to open the Terrain Themes Palette.
2. In the Terrain Shading palette, click ➕ (Add a New Theme).
3. In the Theme Parameters area, do the following:

a. Enter a name for the theme.
b. For Analysis Type, select Elevation, Aspect, or Slope.
c. Specify the Minimum and Maximum values.
d. Use these values to constrain the theme to specific areas. For example, when theming by elevation, enter a Minimum of 100 meters and a Maximum of 1000 meters to omit elevations at sea level and those above 1000 meters.
e. For Distribution, indicate the method used to determine the theme range.
f. Indicate the Number of Rules.
g. If you are theming by aspect, for Minimum Horizontal Slope, indicate the lowest slope degree value to consider in the theme.

4. Under Color Range, specify the following:

a. Transparency: Use the slider to indicate how much of the underlying styling you can see once the theme is applied. A higher setting makes the theme more transparent.
b. Color from and Color To: InfraWorks creates a color ramp between the first color in the theme (Color From) and the Color To selection. The Preview area displays the color ramp.
c. Palette Type: For details, see the "Advanced Tips" section below.

5. Click OK to apply the theme.

Figure 2 displays the terrain, visually classified by elevation, highlighting the high points and low points within the geographical selection. (See the section ‘Autodesk Screencast Links’ to access recorded video workflows)

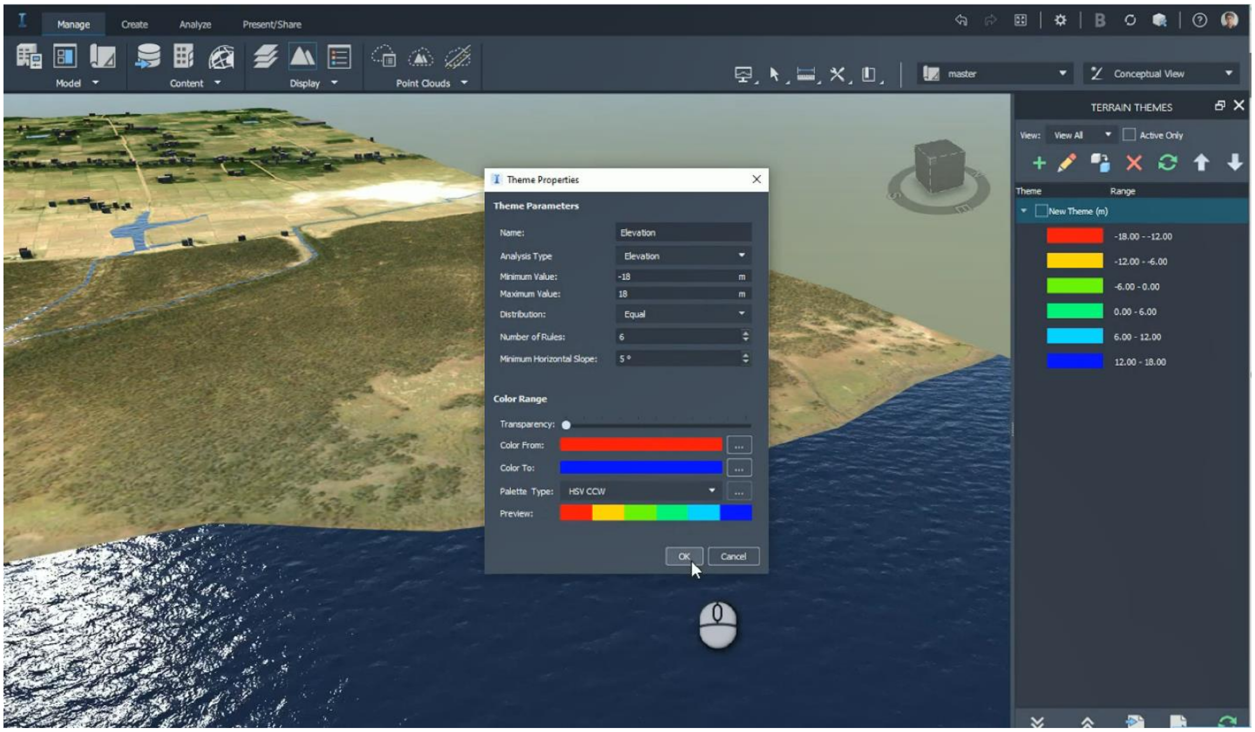

FIGURE 1TERRAIN THEMES IN INFRAWORKS

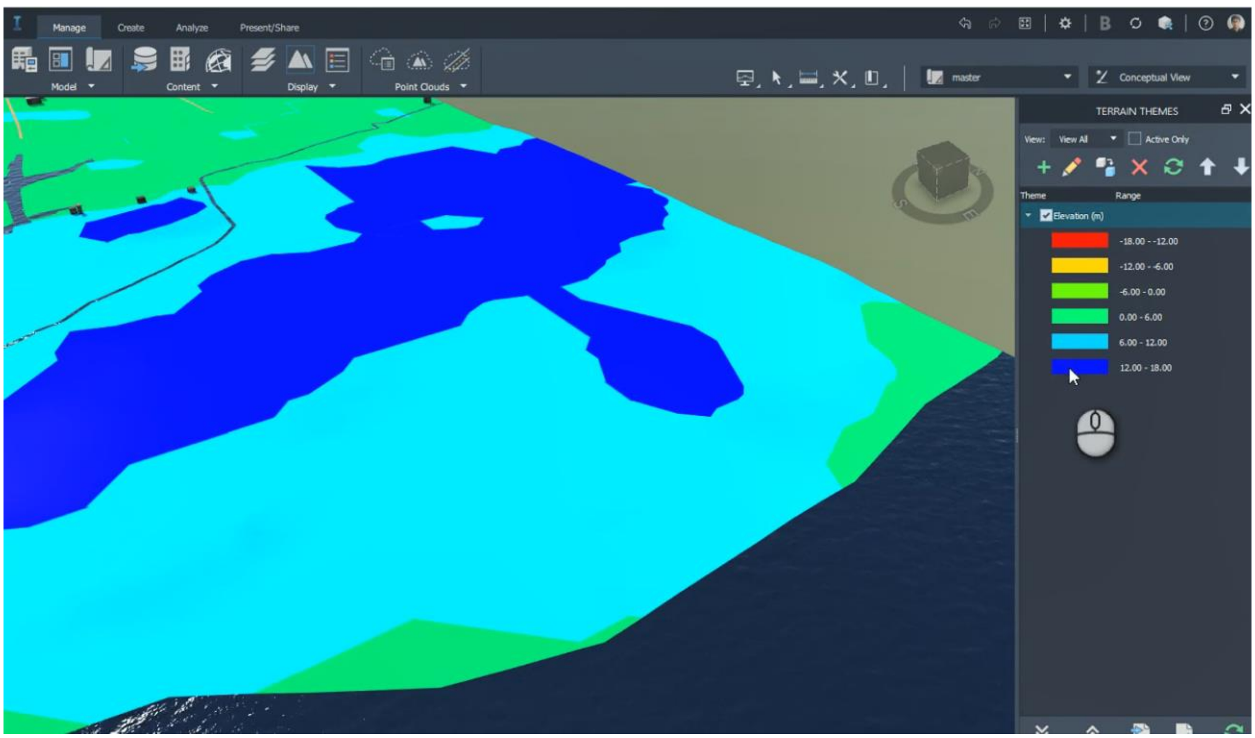

FIGURE 2 TERRAIN THEMES IN INFRAWORKS - ELEVATION

Simulate, Visualize & Analyse Flood Simulations

InfraWorks users can also use Flood Simulation to simulate, visualize, and analyze 2D flood simulations in your model. Flood simulation can be used for inland and coastal flooding projects depending on the parameters you define. InfraWorks only supports flood simulation capabilities for users who have purchased and installed the third-party RiverFlow2D plugin available from Hydronia, LLC.

Flood simulation uses a shallow water equation model. Given rainfall and/or tidal shift parameters that you define, the model can accurately predict and simulate inland or coastal flooding. It can do so combined with modeling hydraulic routing of the flooding.

Start by defining a boundary for your flood simulation study area. InfraWorks will re-mesh the terrain surface for the specified area. Once you assign the inflow and outflow boundaries and define parameters for your simulation, InfraWorks will pass this information to Hydronia RiverFlow2D for computation.

- Create simulation area and model inflow and outflow.
- Assign single or multiple inflow locations.
- Use Discharge v. Time hydrograph inflows, or Elevation v. Time stage hydrograph inflows.
- Automatic creation of simplified surface mesh.
- Establish a uniform or distributed Manning's n value for the model.
- Determine the simulation time and intervals.
- Utilize the Hydronia RiverFlow2D model to perform the simulations.
- Animate the resulting flood surface by elevation, depth, or velocity in the model.
- Create 2D snapshots at any point in your flood simulation
- You can play the flood simulation animation in-canvas once your simulation has finished generating.

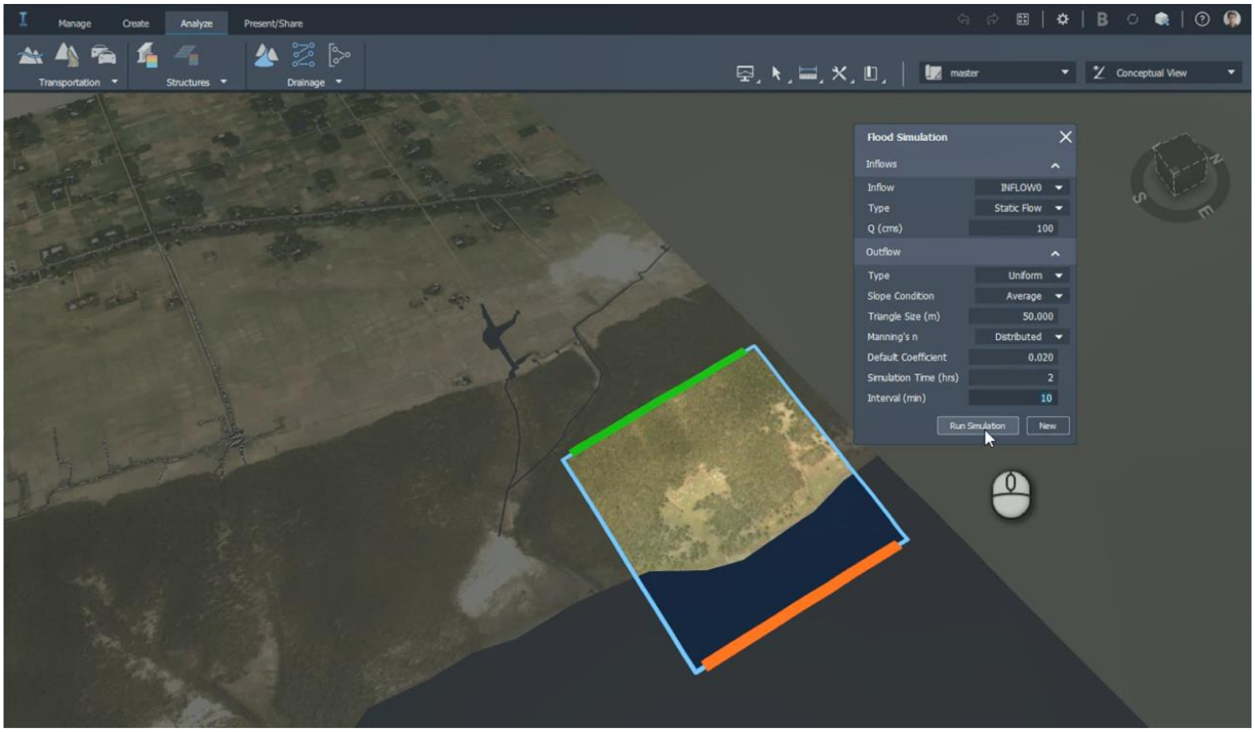

FIGURE 3 FLOOD SIMULATION IN INFRAWORKS - INPUT PARAMETERS

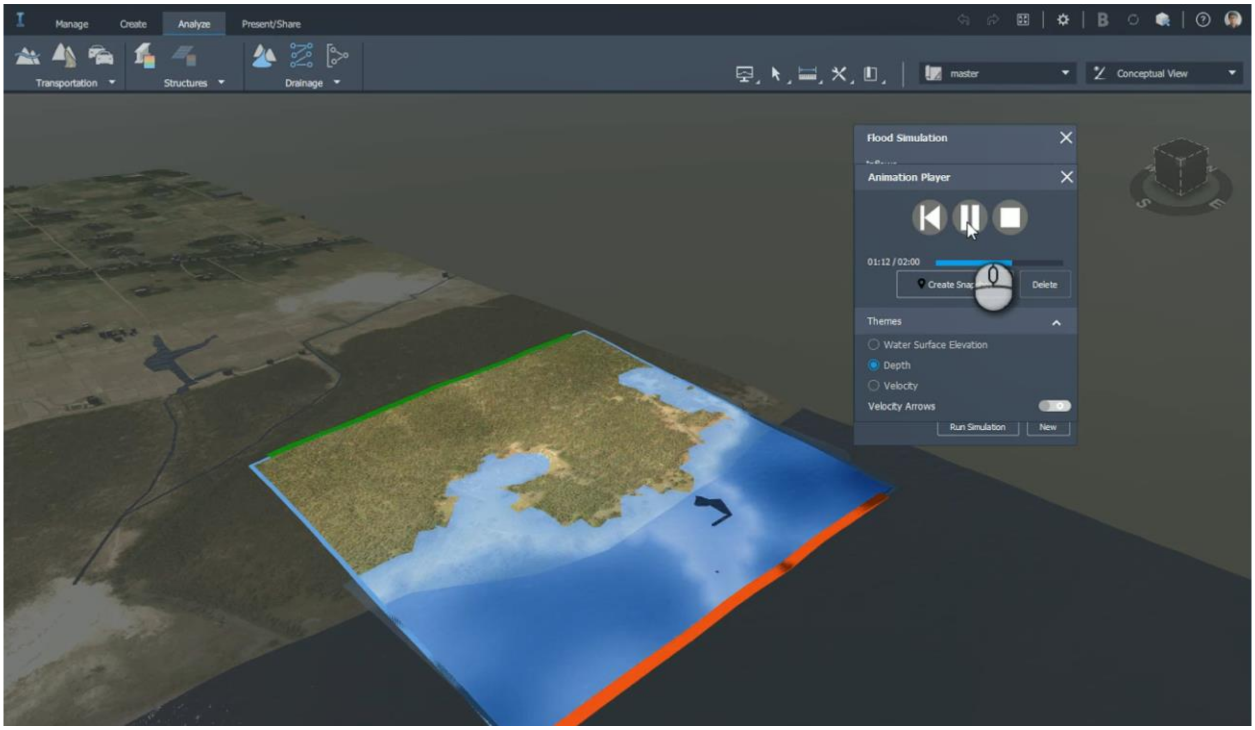

FIGURE 4 FLOOD SIMULATION - SIMULATION ANIMATION

Running Flood Simulation with the Embankment

Creating the Embankment

An embankment can be created in InfraWorks, using the Component Road feature, and then modifying the parameters to suit an embankment. Refer the Screencast video attached below for more details. The alignment and profiles can be modified to suit the existing conditions, explored through the previous sections.

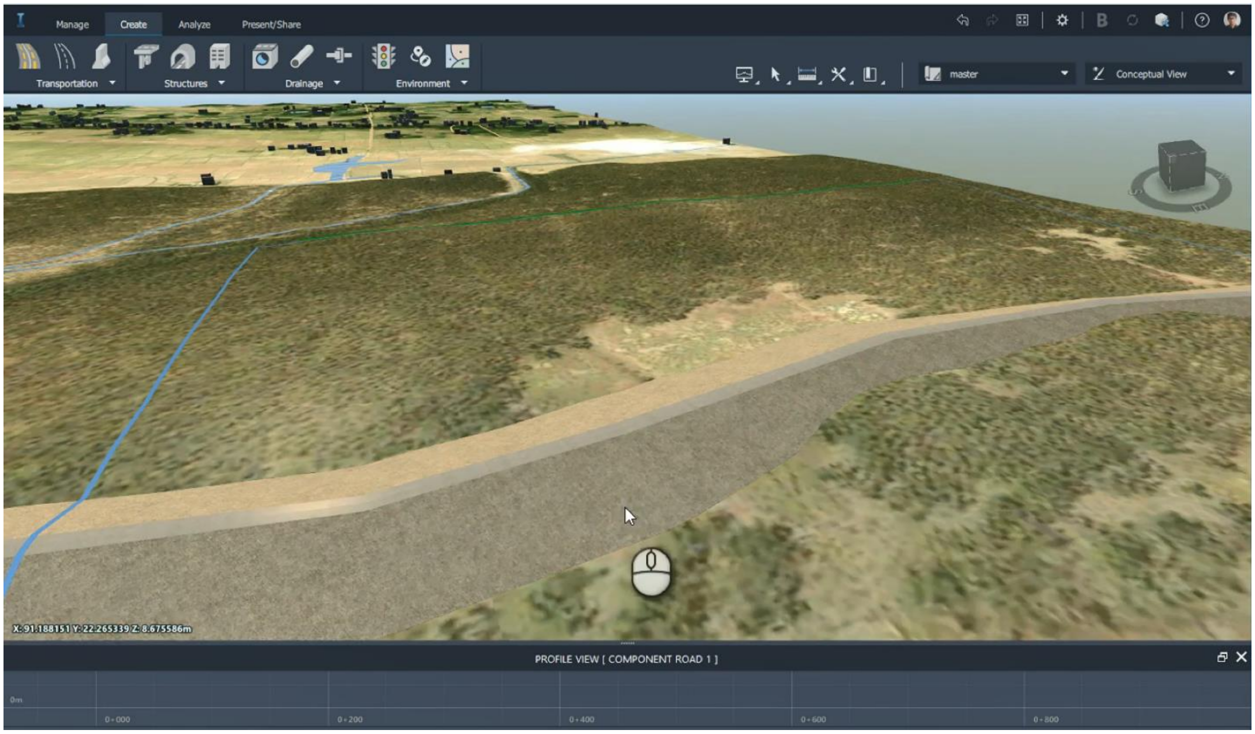

FIGURE 5 MODELLING EMBANKMENT IN INFRAWORKS

Once the embankment is modelled, re-run the flood simulation to understand the impact of flood on the embankment and the areas protected by the environment. Modify alignment and profile based on acceptable flood impact levels.

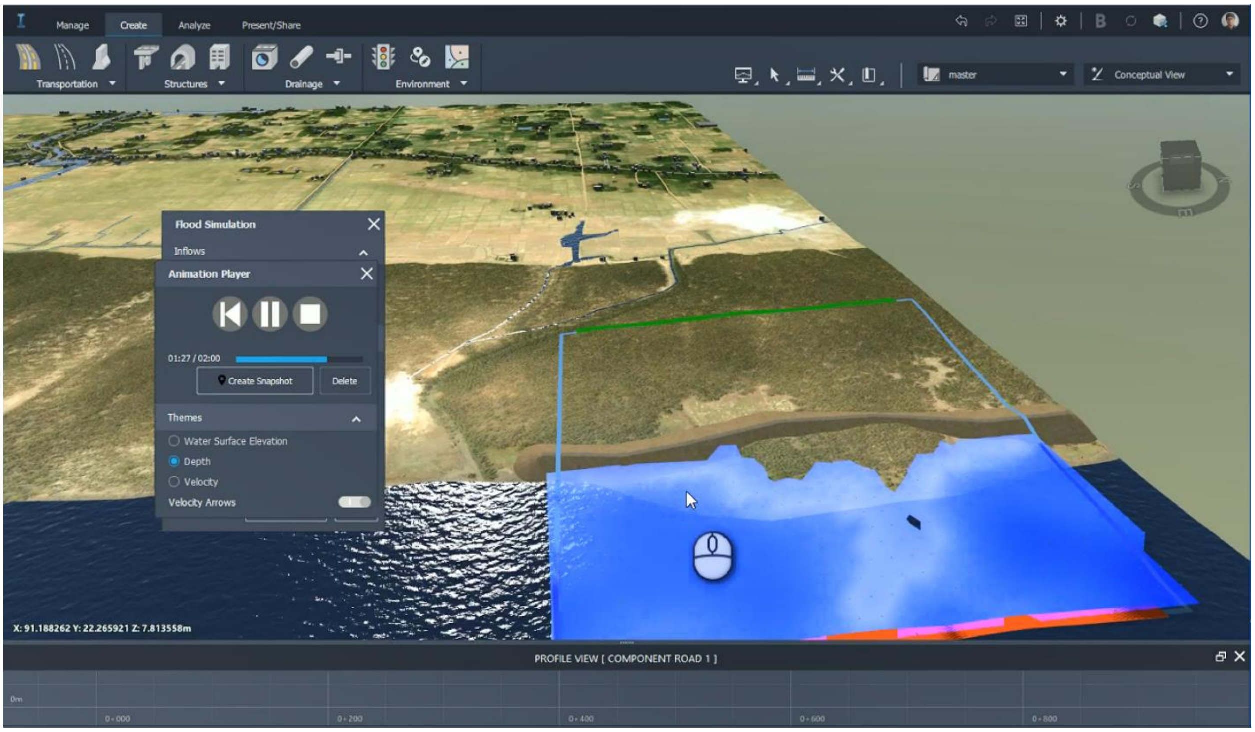

FIGURE 6 FLOOD SIMULATION - RUN SIMULATION WITH EMBANKMENT

Create Detailed Design Using Civil 3D

You begin by preparing a proposal in InfraWorks, and then import into Civil 3D.

1. In InfraWorks, select the proposal that you want to import into Civil 3D from the Proposal list.
2. Click the Settings and Categories icon on the flyout menu. Click the Model Properties icon to copy the exact UCS name (for example, GA83-WF) to the clipboard. You will later paste into Civil 3D, for an exact match.
3. Save the model and exit InfraWorks.
4. In Civil 3D, open a standard template file.
5. In the Tool space window, right-click the drawing name and select Edit Drawing Settings. Paste the UCS code into the Selected Coordinate System Code box.
6. In the InfraWorks tab, click Open Model. In the Open InfraWorks Model dialog box, browse to specify the InfraWorks SQLITE model to import.
7. Click Open Model to import the InfraWorks model into the Civil 3D drawing.

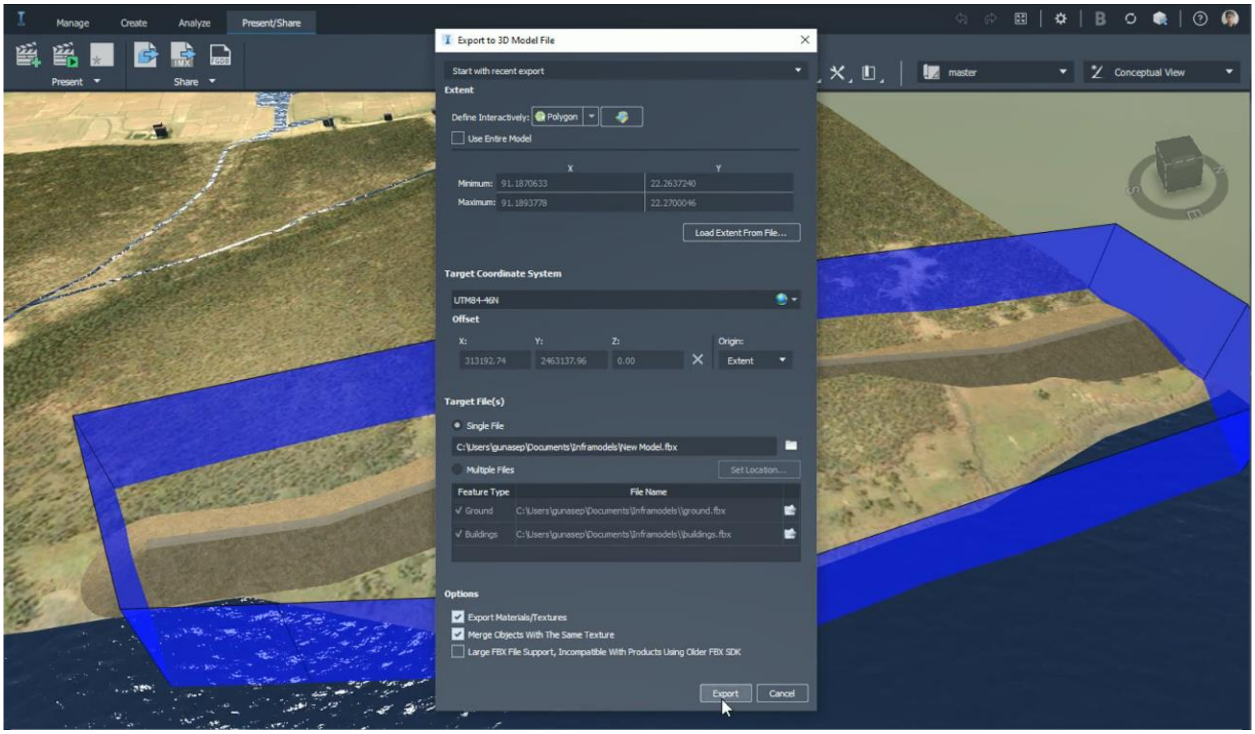

FIGURE 7 EXPORT INFRAWORKS MODEL TO CIVIL 3D

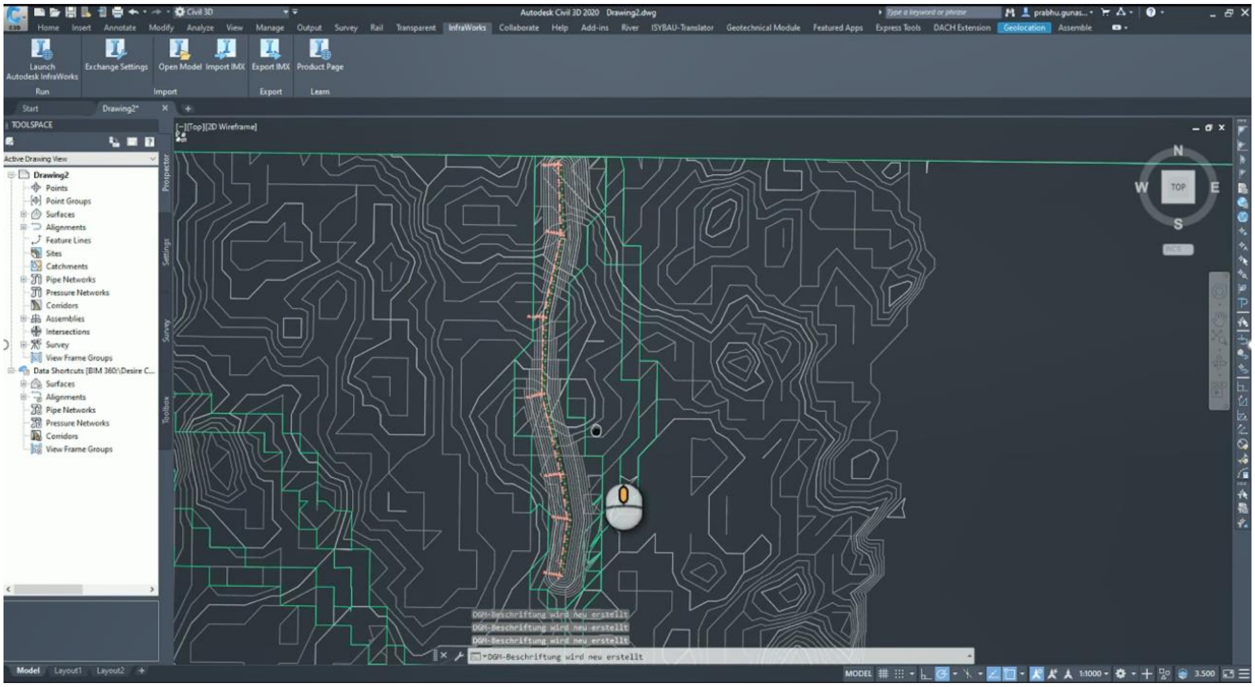

FIGURE 8 IMPORT SURFACE TO CIVIL 3D

IoT Based Flood Embankment Monitoring System

E. Michta, R. Szulim, A. Sojka - Piotrowska, K. Piotrowski University of Zielona Góra, prof. Szafrana 2, Zielona Góra, PL IHP Im Technologiepark 25, 15236 Frankfurt (Oder), Germany, propose the following concepts behind setting up an IoT based flood embankment monitoring system.

A flood embankment monitoring system based on using IoT and cloud computing technologies can be done using a system consisting of sensors, IoT nodes, Gateways and Cloud based services. Nodes communicates with the sensors measuring certain physical parameters describing the state of the embankments and communicates with the Gateways. Gateways are specialized active devices responsible for direct communication with the nodes, collecting sensor data, preprocess the data, applying local rules and communicate with the Cloud Services using communication API delivered by cloud services providers.

These systems will enable early detection of disturbing phenomena or events occurring in the embankments, thus enabling early response and prevention of crisis situations. In this area of applications where there are large construction spaces, the location of damage is a big challenge. The use of distributed wireless sensor technology and Internet of Things technology (IoT) offers the ability to monitor multi-kilometer structural and functional behavior of the structure at defined measuring ranges and set spatial resolution at economically justified limits.

IoT Architecture

IoT opens new opportunities for the operation of measuring and control systems, their integration, especially if they are distributed. The IoT thing can be any autonomous device with an IP address and a wireless transmitter, equipped with measuring and/or control systems, connected to the Internet. Within the IoT, all connected devices become more than a single set of devices, creating so-called Cloud. IoT is the intelligent environment in which data can be merged from different devices or different systems.

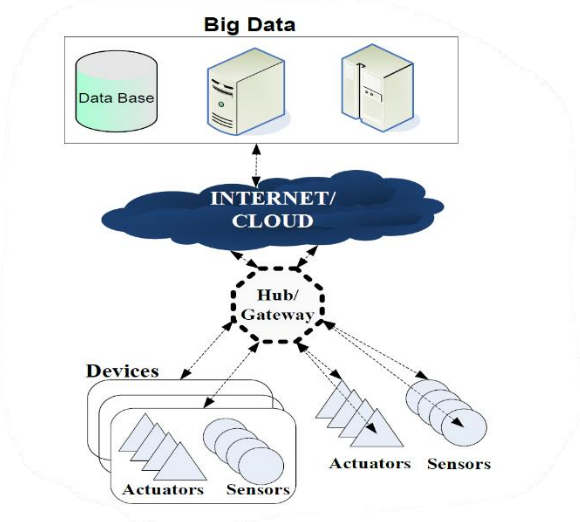

FIGURE 9 GENERIC IOT ARCHITECTURE

A key component in IoT is the creation of intelligent applications that can collect data from multiple endpoints, and then based on their analysis, act based on previously defined parameters or algorithms. Intelligent applications will be dedicated to specific applications and will vary from one application to another. They can work in a hierarchical system, what means, that in a IoT hub/gateway that simultaneously serves as a gateway to the Internet, an intelligent application analyzing data from the local network and working with a smart application working in the so- Big Data. A cloud-based application will creatively analyze data from multiple devices and multiple networks and will generate global requests that can be sent to devices or used by other applications. For IoT to be of value, processes must be created to search large amounts of data to discover relationships and correlations that leads to intelligent decisions that would be difficult or impossible to make in a different situation. The Big Data process involves the following tasks: data acquisition, data storage, and data analysis. Data acquisition is most often a multi-stage process that involves gathering data by individual devices and then transferring them to a central database through a hierarchical structure of the Internet. Storing data in the cloud seems easy, but it is just an illusion. One of the preferred ways to solve this problem is to use DBAaS (Database as a Service) with analytics platforms currently offered in the cloud by several database management vendors. Figure 10 shows the Intel reference model developed in 2015.

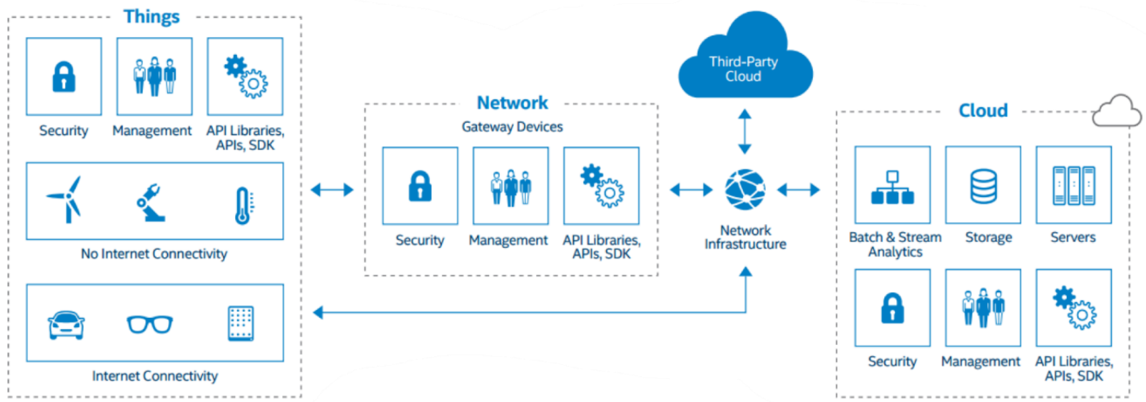

FIGURE 10 INTEL IOT REFERENCE MODEL

Cloud Computing

The Cloud Computing (CC) is a technology of building distributed system based on shared components located on servers on the Internet. There are many so called Public Cloud Services providers like Microsoft Azure, Amazon Web Services, Google Cloud etc. Building systems with the use of CC services can be much faster and cost effective then organizing all of the necessary infrastructure like servers, operating systems and software on the premises. IoT technology assumes using CC services in the Data Centers. CC technology can be used to monitor objects and devices.

Flood Embankments Monitoring System

The system Architecture can consist of sensors, two types of active devices like IoT Nodes and Gateways and Cloud Services.

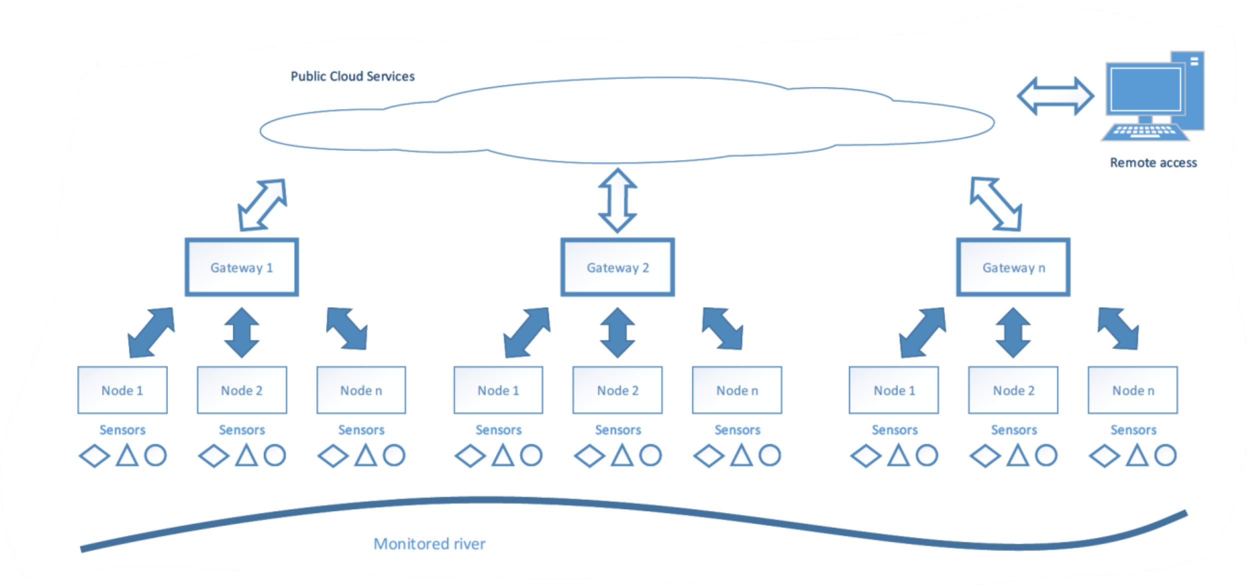

FIGURE 11 PROPOSED SYSTEM ARCHITECTURE

Nodes can be distributed in critical points of the river. Sensors can be distributed in any density over a large area. The data from these sensors can then be analyzed (by the algorithms system), which allows for the transmission of relevant information and messages to the flood protection unit, but also to the owner of the flood embankments. The system can react directly to changes in observed phenomena. For example, it can automatically increase the frequency of the measurement if it identifies something disturbing. The system works in real time. Such a system is fully automated, non-invasive, wireless and energy saving. Devices can be programmed to charge as little power and operate without replacing the batteries as long as possible, depending on the frequency of measurements, it is even a few years.

IoT technology, along with available cloud computing platforms, enables the construction of a real-time flood monitoring system. The flood monitoring system will inform emergency management centers of impending hazards, and residents of the state of the river, or the entering ban on flood embankments. Units managing the flood embankments will be informed in real time about changes in the structure of the embankments and damages. This will allow for quick intervention and possible removal of the damage which will prevent from bigger flood disaster, which in turn will influence the safety of the residents.

Autodesk Screencast Links

1. Terrain Themes
2. Flood Simulation before embankment
3. Modelling Embankment
4. Flood Simulation after embankment
5. Transfer model from InfraWorks to Civil 3D

References

1. IoT based flood embankments monitoring system, E. Michta, R. Szulim, A. Sojka - Piotrowska, K. Piotrowski University of Zielona Góra, prof. Szafrana 2, Zielona Góra, PL IHP Im Technologiepark 25, 15236 Frankfurt (Oder), Germany