Validation of a New GIS Tool to Rapidly Develop Simplified Dam Break Models

NWS and Dam Breaks

NWS Responsibility: Issue accurate and timely forecasts for floods resulting from dam failures to protect lives and property.

NWS has developed a new tool called GeoSMBK, which is designed to build a SMPDBK model in less than 30 minutes. This tool is used to rapidly develop simplified (SMPDBK) dam break models.

Simplified Dam Break (SMPDBK)

SMPDBK is simple to use but the underlying algorithms are not so simple:

1. Complete new flow at dam break with optional flow routing.
2. Compute local flow from routing across cross-section and below dam.
3. Use full dynamic stages in Manning's equation.
4. Compute stage at cross-section or downstream boundary section.
5. Compute stage from headwaters.
6. Compute stage at cross-section, downstream boundary section.
7. Compute flow at cross-section and downstream boundary section.

SMPDBK Features:

- Provides peak flows, peak depths, and time-to-peak at any downstream point.
- Simpler to use than dynamic 3D models.
- Guarantees stability.
- Does not require explicit upstream and downstream boundary conditions.
- No backwater.
- No reservoir inflows during an event.
- Cannot model dams in series or downstream levees.

Validation Method:

- Hindcasts used only for North Dakota failures.
- Breadth parameters computed from empirical models.
- Only readily available DEM data.
- Compared GeoSMBK to rules of thumb and observed data.
- No calibration against high water marks or other observed data.

Summary:

- GeoSMBK is a new tool for flood forecasting.
- Excellent after-event validation
- Provides accurate estimates of peak flow, peak depth, time to peak.
- Improved over HEC-RAS in accuracy
- Non-intrusive, quick to develop

GeoSMBK Model Development

6. Generate SMPDBK input file
7. Execute SMPDBK

GeoSMBK Features and Inputs:

- Designed to build a SMPDBK model in less than 30 minutes.
- Requires ArcGIS desktop with spatial analyst extension.
- Requires 10 m DEM.
- Has no calibration parameters.
- Hypothetical dam break.
- Hydrologic Atlas, USGS.
- NWS Rule of Thumb.
- NHDPlus 30-m DEM.
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- NID
- NWS
- Imagery
- DEM
- M DEM can be used; more accurate DEM preferred when available.
- Imagery from NED might be used.
- M DEM can be used; more accurate DEM preferred when available.

Hindcast Validation

For comparison, detailed post-event analysis for Big Bay using HEC-RAS (Yochum et al. 2008) resulted in an average error of 0.8 ft.

Conclusions:

- GeoSMBK is a new tool for flood forecasting.
- Excellent after-event validation.
- Provides accurate estimates of peak flow, peak depth, time to peak.
- Improved over HEC-RAS in accuracy.
- No calibration parameters.
- Hypothetical dam break.
- Non-intrusive, quick to develop

Recommended Future Work:

- Add fixed modeling capability to GeoSMBK.
- Devote more toward version of GeoSMBK.
- Reduce reliance on old SMPDBK science by partnering with FEMA, USACE, and others on dam break modeling and model building.