Overview of the Automatic Overland Flow Delineation Tool (AOFD)

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Dual-drainage concept: Sewer Network + Overland Network
(Djordjević et al., 2005)

- **Sewer system** (manholes and pipes): 1D
- **Overland system** (depressions and flow paths): 1D or 2D:
  - **2D overland flow modelling**: Surface divided into small elements (squares or irregular triangles). In general, long computational time, not suitable for real time forecasting.
  - **1D overland flow modelling**: Overland system consists of nodes (ponds) and links (flow paths). It can be created manually or using the AOFD tool, based upon an accurate DEM (Digital Elevation Model) of the area. Fast, suitable for real time applications.
2D model of the surface

1D model of the surface
HYBRID MODELS:
1D overland model in most part of the catchment with nested 2D overland model in areas more prone to flooding and where more detail is needed.
Automatic Overland Flow Delineation (AOFD) Tool

- GIS tool which automatically analyses and generates 1D model of the overland network based on DEM
- Takes into account processes such as pond forming, flow through preferential pathways and surface drainage capacity
- Takes into account interactions with sewer system
Inputs of AOFD

- DEM
- Slope
- Aspect
- Boundary
- Buildings
- Manholes
Output of AOFD

• Set of shapefiles which contain the information about the elements that constitute the 1D model of the overland network:
  • Ponds (local depressions) = nodes with associated storage capacity
  • Flow pathways = links with computed geometry

• These files can be imported into several hydraulic simulation software and can be easily coupled with 1D models of the sewer system, thus allowing for the creation of 1D-1D dual drainage models
AOFD is not a hydraulic simulation engine!
AOFD Algorithm

Start

Input file reading

Pond delineation

Pond filtering?

yes

Pond filtering (volume and depth)

Flow paths delineation

Flow paths cross-section definition

Generation of hydraulic model input files

End

No

Elimination of duplicate flow paths

1. **Pond delineation:**
   - Identification of sinks
   - Quantification of surface storage (depth-volume relationship)
   - Determination of natural exit point of pond
   - Based on DEM, using iterative “grow-up” method

**Pond filtering?**
- It is advisable to remove small ponds
- User may define filtering threshold.
2. Pathway delineation

- Connection between nodes (ponds & manholes) is identified
- Based on DEM, using “rolling ball” algorithm

Elimination of duplicates / merging of pathways:
If two or more pathways are closer than a given value (normally grid size), they are merged
3. Estimation of pathways’ cross-section

- Geometry of the open channel (user can choose between trapezoidal and arbitrary cross-section)
- Upstream/downstream elevations
- Actual length of the pathway
- Average slope

Methodology:
- Equi-distant cross sections are drawn along each pathway
- Arbitrary shape: elevation at each offset distance from centre
- Trapezoidal shape: find geometry of trapezoid that fits $H(m)$-$A(m^2)$ curve
4. **Creation of surface flow network and generation of hydraulic model input files**

- Parameters regarding interaction between sewer system and overland network are established by user
- Pathway roughness is assigned by user
- AOFD generates shapefiles of ponds and pathways
1D Overland Network of Cranbrook Catchment
Exercise

Executing the AOFD tool and creating a 1D1D dual-drainage model
STEP 1: Checking input data

• You have been provided with the following input dataset:
  - TestData_Victoria_5m
  - InputData
  - Project File: VS5.pro
  - DEM
  - Terrain slope
  - Terrain aspect
  - Catchment boundary
  - Cover layer
  - Buildings
  - Manholes
STEP 2: Launching the AOFD tool

- You have been provided with a folder that contains the AOFD software:

  SurfaceAnalysis
  - Conversion
  - CrossSection
  - DepLes
  - DSD
  - PathDel
  - pondDel
  - SIPSON
  - SurfFlowNetwork.exe
STEP 3: Executing the AOFD tool
1. Pond delineation

No. Pond Removed/Total = 268/2957
Total Volume = 727790.253242000200000
Loss Volume = 228026.775827000000000
Loss = 31.331%
2. Flow path delineation

- Start
- Input file reading
- Pond delineation
- Pond filtering (volume and depth)
  - yes
  - Pond filtering?
  - no
  - Flow paths delineation
  - Flow paths cross-section definition
  - Generation of hydraulic model input files
- End

- Flow path delineation parameters
  - buffer radius (m): 40
  - number of iterations: 50
  - consider buildings in delineation
  - buildings file: D:\AOFD_Runs\VS\03_Victoria_5m\VS5.pro

- Surface junction parameters
  - grid size for analysis (m): 5
3. Pathways’ cross section
4. Creation of surface flow network and generation of hydraulic model input files
AOFD output files (in DSD folder)
STEP 4: Importing AOFD output files into InfoWorks CS

i. Open and checkout the model of the sewer network

ii. Open the Data Import Centre (under the Network menu)

iii. Import the output files of the AOFD tool taking into account the tables and corresponding object fields

iv. Checks and manual editing is needed (e.g. to remove lose paths and make sure the connection with the sewer system is correct).
Limitations of 1D overland flow models

- Data preparation and model setup is time-consuming
- 1D model of the surface may be inaccurate in areas with multi-directional flow paths (i.e. flat areas and areas where expected flow depths are high)
- Visualisation – this can be improved by post-processing data
- As any other models, 1D models need calibration (especially of manholes and gullies, the parameters of which determine the volume of water that is exchanged between the surface and sewer system)