Urban Flood Demo Program & Southwest Demo Program

US Army Corps of Engineers®

Wildland Fire Effects on Infiltration and Hydrologic Processes

Products

Develop a new guidance document for conducting post-fire hydrology assessments using existing tools. Develop an infiltration model that accounts for multilayer soil structure, and an infiltration function for post-fire infiltration recovery process. Design and implement a new infiltration module in the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) specific to modeling the post-fire environment.

Benefits

The new document will provide interim guidance for conducting post-fire hydrology assessments using the current available modeling tools. The new module in HEC-HMS will give flood and debris control managers a means to rapidly and quantitatively project the effect of wildland fires on flooding potential.

Issue

Wildland fires burn on average 4.2 million acres annually in the United States with the majority of the affected acreage in the arid west. In 2006, wildland fires affected 9.8 million acres in the continental United States with over 96,000 wildland fires. As of August 2007, six of the ten worst fire seasons since 1960 (measured in terms of acres burned) had occurred in the last seven years. Federal agencies spent $890 M on fire suppression in 2004. In addition, fire can dramatically affect the nature and mobility of surface debris and runoff characteristics of forested watersheds. As development pressure continues, these western fires are increasingly found at the urban–forest interface, with the result that the Corps is being called upon more often to assist state, tribal, and local entities in dealing with the hydrologic consequences of wildland fires. The Corps has limited planning tools for wildland fire response and few technical or watershed-modeling capabilities to describe post-fire hydrology.

Description

This work unit is a collaborative effort between the Corps and the Desert Research Institute. In the current phase of this project, basic research on the effects of wildland fires in the environment is being reviewed. A draft document has been prepared that provides an introduction to fire effects on watershed hydrology for engineers and hydrologists, discussing impacts to the environment from both views of the watershed. Particular attention is paid to changes in soil surface cover and infiltration capacity caused by the fire that may increase the risk of flooding, debris flow, and landslides. In the next phase of this

project, the Corps will develop a new infiltration module in HEC-HMS specifically for modeling infiltration in the post-fire environment. The module will take account of several key factors including: (1) soil organic matter content, (2) soil texture and structure, (3) intensity and duration of wildland fire, (4) length of time and number of rainfall events after the wildland fire. The module will be developed in conjunction with on-going research at Desert Research Institute (DRI) on general infiltration in a layered sloping soil. As part of the DRI work, analytical tools are being developed to characterize water infiltration into fire-burned soil surfaces. An analytical infiltration model for layered soil generated from the fire will be developed to account for the layering effects. An empirical function will be proposed to describe the infiltration recovery with time after individual wildfire events. These tools will allow physically-based analyses of post-fire infiltration and help correlate infiltration properties of post-fire soil to pre-fire soil. The major tasks include: (1) development of an analytical model for infiltration into multi-layered soil; (2) extension of the model to sloping surfaces, and design of an algorithm for model implementation in HEC-HMS; (3) performance of a literature search on water infiltration into wildfire affected soil, and subsequent restoration efforts/monitoring regarding fire-induced layer persistency; and, (4) proposal of an infiltration recovery function (IRF) based on literature data, and to test the concept on wildfire data from fire-affected lands in the Los Angeles District. A key component of the research is developing a quantitative description for the formation and subsequent breakdown of impermeable layers on or within in the soil. Research has shown that impermeable layers form during the wildland fire, and that the depth and thickness of these layers is a function of the intensity and duration of the fire. These layers break apart over time due to biological activity, leaching, and plant regeneration. Knowledge of these processes will be incorporated into the general infiltration model for application to post-fire assessments. Adding the module to HEC-HMS will enhance an already-recognized tool for flood assessments, and extend its usage to the post-fire environment. Under proposed future work, research and development will shift to other hydrologic processes, including surface erosion and debris flows.

Sponsors

Urban Flood Damage Reduction and Channel Restoration Development and Demonstration Program for Arid and Semi-Arid Regions (UFDP).

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