Vulnerability of surface water bodies to potential contamination by ammunition residues from military training ranges

André G. T. TEMGOUA, Richard MARTEL, Uta GABRIEL and Marie-Juliette Jouveau, INRS-ETE, 490 Rue de la Couronne, Quebec (QC) G1K 9A9, Canada, Andre_Guy_Tranquille.Temgoua@ete.inrs.ca

Abstract

Over the last decade, a major effort has been made by Canadian Forces to understand the hydrodynamic of groundwater flow on range training areas (RTA). However, there is also a need to study surface water bodies and especially their vulnerability to potential contamination by ammunition residues. In this work, the developed methodology allows determining the hydrologic network with potential accumulation areas. The main objective is to identify areas where surficial geology, topography and hydrological properties are favorable to rainfall-runoff and to establish if the quality of surface water may be altered by training activities and subsequently if potential ammunition residues may migrate to receptors such as lakes and rivers.

Introduction

Digital Elevation Models (DEMs) are being increasingly used in hydrology (Wilson and Gallant, 2000). The rapid ongoing improvement of available DEM data is due to the evolution of DEM acquisition techniques such as LIDAR (Light Detection And Ranging) that are producing high resolution DEM data. Under certain circumstances (low resolution of the DEM), softwares (Global Mapper, ArcGis) can moderately help to upscale the resolution of DEM. Researchers actually stand at a threshold of improvement in surface topography precision that provides opportunities and computing challenges. This situation is also driven by the available performance in personal computers with the capability to speedily process DEM data and use topographic attributes extracted from DEMs in hydrology models (Tarboton, 1997).

Topography defines watersheds which are fundamentally the most basic hydrologic landscape elements (runoff characteristics). In this project, the derived topographic quantities are coupled to a hydrologic model using the Soil Conservation Method SCS (1978,1968) that defined rainfall-runoff (part of precipitation that flows in streams, lakes, wetlands and rivers). The applied method determines accumulation areas and contributes to surface water bodies assessment to potential contamination by ammunition residues from range training areas (RTA).

Methodology

The methodology is shown on the chart below :

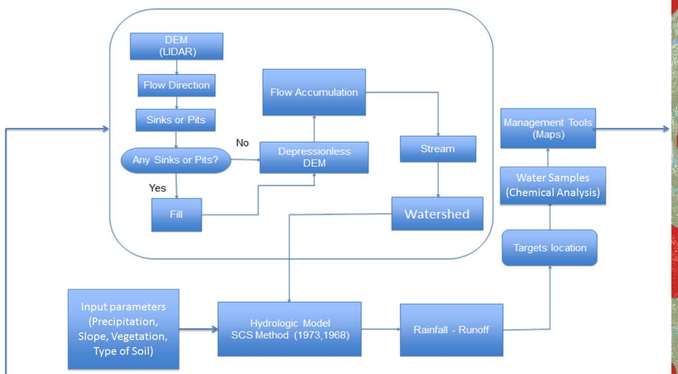


Figure 1 : Hydrological modeling flowchart

DEM Preprocessing

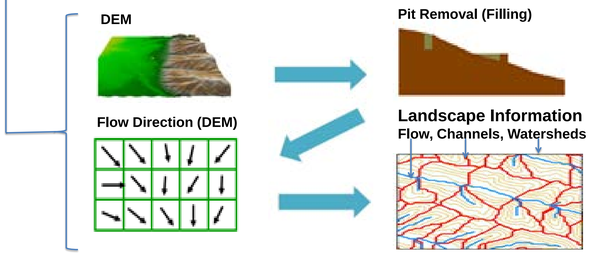
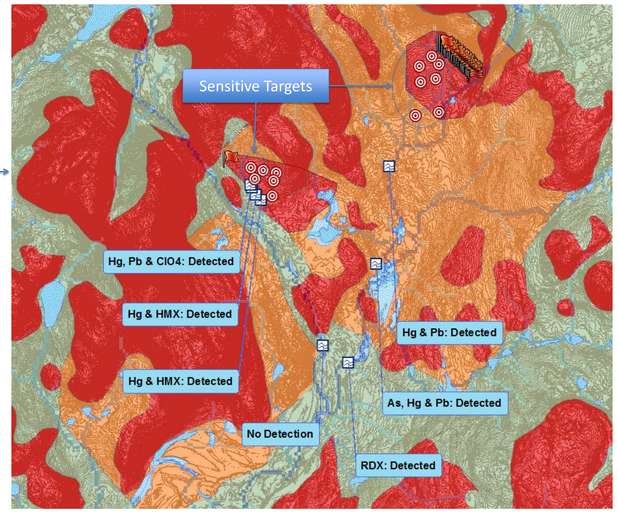


Figure 2 : The DEM water flow information model for deriving channels, watersheds, catchments and flow accumulation areas (Taboton, 1997)

Results



Legend

Rainfall-Runoff Index
- 0 Very Low
- 0-1 Low
- 1-3 Moderate
- 3-4 High
- 4-5 Very High

Flow Accumulation Index
- High : 6 (Permanent streams)
- Low : 2 (Intermittent streams)

- Targets
- Firing Position
- Surface_Water_Analytes

Figure 3 : Surface water vulnerability map of the studied site

Conclusion

Topographic attributes extracted from DEMs are useful in hydrologic modeling. DEM quality is important for the development of surface water bodies assessment mapping. Errors from the DEM may bias the surface flow direction and change slightly the local outputs of the hydrologic model. However, the provided map may help to decide if the location of targets and impact areas need to be moved in relationship to surface water quality. However, aquifer vulnerability must also be considered to have a more integrated management tool.

References

1. Soil Conservation Service (1973), ''A Method for Estimating Volume and Rate of Runoff in Small Watersheds, ''Technical Paper No. 149, USDA-SCS, Washington, D.C.

2. Soil Conservation Service, (1968), After ''Hydrology'', Suppl. A to Sec. 4, Engineering Handbook, U.S. Department of Agriculture.

3. Tarboton, D. G., R. L. Bras and I. Rodriguez-Iturbe, (1991), "On the Extraction of Channel Networks from Digital Elevation Data," Hydrologic Processes, 5(1): 81-100.

4. Wilson, J. P. and J. C. Gallant, (2000), Terrain Analysis: Principles and Applications, John Wiley and Sons, New York, 479 p.