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The Use of LiDAR Elevation Data and Satellite Imagery to Locate Critical Source Areas to Diffuse Pollution in Agricultural Watersheds

Ariane Drouin (1), Aubert Michaud (1), Georges Thériault (2), Isabelle Beaudin (1), Jean-François Rodrigue (3), Jean-Thomas Denault (2), Jacques Desjardins (1), and Noémi Côté (1)

(1) Institut de recherche et de développement en agroenvironnement inc. (IRDA), Québec, Canada (ariane.drouin@irda.qc.ca), (2) Agriculture et Agroalimentaire Canada (AAC), Québec, Canada , (3) Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ), Québec, Canada

In Quebec / Canada, water quality improvement in rural areas greatly depends on the reduction of diffuse pollution. Indeed, point source pollution has been reduced significantly in Canada in recent years by creating circumscribed pits for manure and removing animals from stream. Diffuse pollution differs from point source pollution because it is spread over large areas. In agricultural areas, sediment loss by soil and riverbank erosion along with loss of nutrients (phosphorus, nitrogen, etc.) and pesticides from fields represent the main source of non-point source pollution.

The factor mainly responsible for diffuse pollution in agricultural areas is surface runoff occurring in poorly drained areas in fields. The presence of these poorly drained areas is also one of the most limiting factors in crop productivity. Thus, a reconciliation of objectives at the farm (financial concern for farmers) and off-farm concerns (environmental concern) is possible. In short, drainage, runoff, erosion, water quality and crop production are all interconnected issues that need to be tackled together.

Two complementary data sources are mainly used in the diagnosis of drainage, surface runoff and erosion : elevation data and multispectral satellite images. In this study of two watersheds located in Québec (Canada), LiDAR elevation data and satellite imagery (QuickBird, Spot and Landsat) were acquired.

The studied territories have been partitioned in hydrologic response units (HRUs) according to sub-basins, soils, elevation (topographic index) and land use. These HRUs are afterwards used in a P index software (P-Edit) that calculates the quantities of sediments and phosphorus exported from each HRUs. These exports of sediments and phosphorus are validated with hydrometric and water quality data obtain in two sub-basins and are also compared to soil brightness index derived from multispectral images. This index is sensitive to soil moisture and thus highlights areas where the soil is more humid. A variety of other indices are used to explain the sediments yields. These indices, such as the average percentage of slope, the distance to the stream, the relative position in landscape, the position to the water table, etc. are mainly derived from high precision elevation data.

All these data are used to locate critical source areas that generally correspond to a restraint part of the territory but account for the principal amount of sediments exports. Once the critical source areas are identified, best management practices (BMPs) (per example : contaminant source control practices, conservation cropping practices and surface runoff control structures) can be planned. This way, money and energy are used where it really counts.

In this presentation, the complete methodology including LiDAR data processing will be explained. The results and the possibility to reproduce the developed method will be discussed.