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Link:

The goal of this analysis was to analyze the possible variability of water pollution accumulation in the streams and rivers of the Port of Tacoma and immediately surrounding areas, starting from a LiDAR point cloud. The pollution of local water resources has implications at multiple levels, from ecological concerns in the Puget Sound to the possible spread of pollution during flood events to the possibility of an interruption to normal water supplies resulting in people attempting to drink from local streams. Because of these various concerns, it is worth investigating the accumulation patterns in play. To this end, 2020 Pierce County point cloud data were acquired from the Washington LiDAR portal covering the Port of Tacoma area and processed into a bare earth DEM using a combination of python and ArcGIS Pro, before being used to predict the locations and shapes of distinct watersheds using QGIS’s hydrology tools followed, tools which rely upon precise elevation data (as is provided by LIDAR-derived DEMs) to estimate the area over which rainwater will flow into a given drainage channel, such as a river, rather than any other. These polygons were then subjected to zonal statistics to produce pollution scores based on the five-class equal interval ranking of each watershed in four characteristics – average number of EPA designated toxic release facilities within one mile across the area of the watershed, average number of highways and highway ramps within one mile across the area of the watershed (as based on City of Tacoma data), average number of non-highway roads with speed limits above thirty five miles per hour within one mile across the area of the watershed (likewise), and portion of the watershed within one mile of the Puget Sound (as based on Pierce County data). These results were used to construct a zero to nine index where zero represents no pollution being predicted to enter the water in the area and nine represents an area with essentially maximal scores in all categories.

Equal interval classification was used to normalize the scores of the watersheds in each category due to ongoing technical difficulties preventing the use of Z-Scores or other more statistically meaningful normalizers. All qualities were not ranked equally – toxic release sites were estimated as more individually impactful on water quality than the automotive traffic highways, which were estimated as more pertinent than high speed non-highways, which were estimated as more meaningful than proximity to the shipping traffic of the port of Tacoma. As such, in that order, they represent three, two and a half, two, and one and a half points out of a total nine.

A toxic release site was seen as likely to produce the most concentrated and localized pollution in the form of leaked gasses and contaminated water, justifying its high score. Automotive pollution from highways was seen as being both consistently produced by the traffic and relatively concentrated, thus taking the second spot. High speed roads were similar, but less so. Proximity to the Puget Sound, and thus shipping, while likely a source of considerable pollutants during some times of the day that might then enter the water, was judged as more intermittent in nature and likely to only apply to a full extent at low altitudes, more in line with the port itself, thus receiving the lowest rank.

The results suggest, perhaps unsurprisingly, that the most polluted water enters the Puget Sound within around the center of the Port of Tacoma itself, and to a lesser extent in New Tacoma. While it might be tempting to suggest that these results are originated by the use of some data originating from city of Tacoma itself, with regards to the roads, the data layer actually extended a notable degree outside of the city itself, while the toxic release data points were sourced from the entirety of Pierce County. This is not to say that the resultant index map should, in any way, be relied upon though. This map does not consider the possibility of residential runoff from lawn care or already contaminated soil, nor does it account for actual traffic loads beyond those produced from a given sort of road. Furthermore, the watersheds produced did not provide the means to account for downstream accumulation and, indeed, were fragmentary and error-ridden due in large part to the urban character of the study area. Many of the supposed river channels identified were, in fact, streets, with their watersheds being much the same, while the actual rivers and streams of the area were by and large ignored due to the presence of bridges and other infrastructure that fragmented their channels in the DEM, since lidar is collected from high altitudes by planes and as such cannot fully see under bridges. In a sense, though, we can understand a real problem in modern cities due to this misidentification of roadways as streams, even if it hinders the actual purpose of the analysis – by filling a hilly, high elevation, rainy area like Tacoma with sunken-in roads made of water-impervious materials, artificial watersheds which entirely encompass roadways might be formed, resulting in fast moving stormwater picking up large amounts of automotive pollutants and carrying them to the coast. For these reasons, it is difficult to draw any firm conclusion from this analysis beyond that it would probably make a sizable difference for the better if toxic releases in the port area were better controlled, and if highway traffic were reduced – things which were already known, to some extent. An improved version of this analysis would also benefit from the use of a more nuanced way of estimating the pollutant impacts of various features. An analysis based on the observation that roadways can become drainage channels in their own right, which seeks to investigate the degree to which a ‘watershed’ is composed of roadways and other paved surfaces might be more useful and achievable as a basis for urban watershed health research than this one was.