POTENTIAL TANKER EXPLOSION SCENARIO IN VANCOUVER HARBOUR

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Abstract

Background Information

In 2016, the Government of Canada granted approval for the expansion of the Trans Mountain Pipeline known as the The Trans Mountain Expansion Project. The pipeline was initially built in 1953 and the expansion project looks to ensure Canada would be able to maximize its oil revenue. With the expansion project moving forward, Vancouver will see a seven-fold increase in tanker traffic. This increase in tanker traffic can lead to many negative impacts to fisheries, local marine wildlife, but also to the environment and atmosphere. An increase in tanker traffic would also increase the probability of tanker spills and explosions. A tanker ship can carry a large amount of oil at once, and therefore an explosion can cause a massive release of pollutants (CO_2, SOx, NOx, etc.) and particulate matter (PM) into the atmosphere leading to serious implications for local air quality and visibility.

Why are we concerned?

Ship transport contributes to air pollution via emissions of CO_2, NOx, SOx and PM via fuel burning. 80% of all cargo and goods are moved via ship transport. Currently in Canada, ship movement accounts for 1.6% of all CO_2 emissions. With the risk of spill or explosions, we can expect an additional release of pollutants thus affecting air quality, visibility and induce health concerns. A potential explosion of an oil tanker in transport can release pollutants into the atmosphere with the possibility smog and smoke lasting for days. Other effects include:

- Decrease in local air quality due to the suspension of pollutants
- Decrease in visibility due to the suspension of pollutants
- Create health problems such as difficulty breathing or impaired vision
- Enhance health risks such as asthma, hospital admissions, bronchitis, and possible death
- Cause damage to environments, crops and wildlife

Trans Mountain Pipeline Vancouver Harbour/Burrard Inlet Map

Figure 1: Current oil tanker route (Trans Mountain Pipeline) through Burrard Inlet.

Where is ship movement occurring and how much oil is moved?

Ship transport occurs along the Port of Vancouver Area with 15% of total Canadian ship transport (3000 oil tankers) being moved out of the Vancouver port per year. Each tank can carry up to 850 000 barrels of oil (up to 120 000 DWT). Currently tankers carrying oil represent 2% (5 tankers per month) of all ship movement in Vancouver. This number is expected to increase with the expansion project to about 14% of total ship traffic (up to 34 tankers per month).

Methodology

Consider a worst-case scenario where the largest possible oil tanker ship entering the Vancouver Port were to explode with its oil burned and released as CO_2. Details of the initial conditions used and meteorology conditions are listed below:

Date chosen: June 12th 2018 @ 2:00 PM - this date was chosen because Vancouver experienced a surface high pressure system and 2:00PM is the hottest time of the day. June 12th, 2018 was partly sunny with light rain and alternating wind patterns.

Release Duration: 5 hours, with a 1-hour averaging time

Release top: 15m (ASL)

Top of averaged layer: 3000m - within the boundary layer

Lat/Lon Location of explosion: 49.300128 -123.094425 (Burrard Inlet) - this location was chosen to simulate a worst case scenario explosion inside the Metro Vancouver area.

Total oil carried: 850 000 barrels (maximum per oil tanker ship)

1 barrel of oil = 160L x 0.85g/cm3 = 135 kg oil per barrel x 850 000 barrels = 114 750 000 kg oil moved

Total CO_2 Released if all the oil were burned:

- 1 barrel of oil = 160L x 0.85g/cm^3 density = 135 kg oil per barrel
- 135 kg oil per barrel x 850 000 barrels = 114 750 000 kg oil moved per ship x 3.15 = 361 462 500 kg CO2 gas if burned
- 361 462 500 kg CO_2 = 0.36 Mt CO_2 = 0.05% of Canada's Annual CO_2 Emissions.

Results

What Meteorology Affected the Trajectory and Dispersion?

- Atmospheric stability: weather conditions of that day were stable causing the trajectory to sit over Vancouver for long periods of time. These effects have been seen with regards to wildfire smoke, creating a positive feedback mechanism thus further exacerbating the impacts.
- Local winds of 8-13 km/hr (calm and light)
- Land-sea breeze
- Anticyclonic weather was present and is associated with a high pressure system and stable air parcel movement
- Seasonal & diurnal radiation patterns: summer time at 2:00pm is the hottest time of day during the hottest season which gives the high possibility of small temperature gradients and atmospheric stability to be present

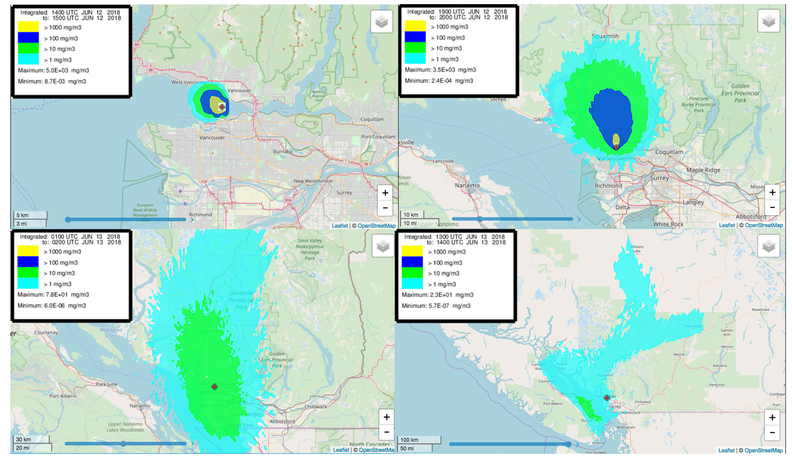

Figure 2: Results of the HYSPLIT Dispersion Model at 1-hour (top left), 7-hours (top right), 11-hours (bottom right) and 24-hours (bottom right).

Conclusions

The HYSPLIT dispersion model showed concentrations of >1000 mg/m3 and over a 24-hour period the pollutant remained airborne over Metro Vancouver with concentrations >1 mg/m3. These concentrations are extremely high, well exceeding the Canada Wide Standards (CWS) for PM2.5. Concentrations were able to travel quite far, affecting Vancouver Island and the Okanagan area. The potential tanker explosion resulted in pollutants to remain airborne throughout the 24-hour period and thus being a notable effect to air quality, visibility and health concerns. While this type of event is relatively unlikely to occur due to the assumption that all the oil on board would be burned within 5-hours. Nonetheless, it shows shocking results, where even if 10% of the oil on board were burned concentrations would still exceed the CWS of PM2.5 over a 24-hour period and cause significant health and visibility issues. Therefore, stakeholders of the Trans Mountain Expansion Project should be aware of this dramatic worst-case scenario analysis still and include it in the Environmental Impact Analysis.

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