Green/Blue Metrics Meeting June 20, 2017 Summary

Short round table introductions of participants

- Paul Villenueve, Carleton, Co-lead Green/Blue,
- Matilda van den Bosch, UBC, Co-lead Green/Blue
- Dan Crouse, UNB
- Lorien Nesbitt, UBC
- Audrey Smargiassi , Uof Montreal
- Andy Hong, UBC
- Perry Hystad, Oregon State University
- Patrick Kinney, Boston U
- Eleanor Setton, CANUE Managing Director
- Evan Seed, CANUE Geospatial Data Lead
- Mahdi Shooshtari, CANUE Data Scientist, Lead Developer

Green/blue function-based metrics: Co-leaders (Paul Villeneuve and Matilda van den Bosch) supervising scoping reviews for metrics that consider type of green space, accessibility, tree canopy datasets etc., with plans to complete in Fall 2017.

Satellite-based metrics: CANUE is currently expanding Normalized Difference Vegetation Index (NDVI) (annual mean and growing season mean, as well as mean and max of 100, 250, 500 and 1km buffers) and indexing to postal codes for:

- 30m resolution from Landsat 5 and Landsat 8 (1985 to present)
- 250m resolution from MODIS (2004 to present)
- 1km resolution from AVHRR (1979 to present)

Discussion: How can we create the most flexibility for NDVI metrics, given possible requirements for many different buffer sizes and temporal averages, and long export times from Google Earth Engine?

CANUE proposes to:

- Use Google Earth Engine to produce cloud free water masked composites and export summary stats per pixel (min, max, mean, others?) for each month of each year.
- Develop a python script that allows user to calculate temporal and spatial aggregations as needed.
- Monthly may be difficult, some challenges with winter images , so there should be a quality field (i.e., count of pixels that contribute to monthly composite value)

- UPDATE – since the meeting, CANUE has explored this avenue and monthly data will require partnering with Google Street View to complete given extensive processing requirements. CANUE will pursue and update if/when this work begins.

Discussion: The sensors for measuring near infrared and infrared (used to calculate NDVI) are different on Landsat 5 and Landsat 8. How should we handle this?

- There are no Landsat data for 2012, so no overlap between sensors and cannot directly compare.
- Literature suggests difference is not large, but Enhanced Vegetation Index (EVI) was found to be more comparable between Landsat 5 and Landsat 8 than NDVI – Perry suggests EVI may be more spatially smooth, thus may seem more comparable.
- Others have used MODIS data as the standard for comparison – differences very small.
- NDVI may not change that much on an annual basis, so general agreement that researchers could viable interpolate missing 2012 data from 2011 and 2013 data, or create running means using multiple years.
- CANUE will leave it to researchers to decide how they want to handle this for NDVI from Landsat.

Discussion: There are many other satellite-based metrics available, i.e., enhanced vegetation index, soil moisture index, tasselcap brightness, leaf on/leaf off index, normalized difference water index, etc. - is there interest in pursuing?

- Yes, may link to pollen counts
- Noise-reducing aspect of leaf on/leaf off is also of interest
- Scoping review will be looking to organize by biological pathways, so hope that these kinds of metrics will be identified as applicable to certain health outcomes.
- CANUE will focus on completing NDVI and Green View Index until scoping reviews are complete.

Google Street View metrics: CANUE is exploring methods for using Google Street View to measure metrics from images:

- % green, based on RGB value of pixels as per MIT method (http://senseable.mit.edu/treepedia)
- % green and others, based on machine learning to identify green vegetation
- Developing a method for creating training data (possibly using Amazon Turk)
- Getting access to large amount of Google Street View images is a barrier, CANUE is currently working with Google reps to resolve.

Perry Hystad, OSU is actively working on this as well:

- Neural network machine learning using Google Street View in Portland, OR (paper soon to be published) comparing greenspace metrics: green view index; ratio of green view index to NDVI (seems to be a good measure of vertical greenspace/tree canopy)
- Assessed how including non-vegetation green biased results (very little – under 2% on average was a non-vegetation green item)
- Pilot $ to use deep learning, have developed method that counts number of trees,
- Hope to have a number of look at number of indices, including tree canopy coverage to types of trees to streetscapes restorative potential – will be done next summer.
- Collaborating with Oregon State computer science group, but lack of training data for environmental metrics is a big barrier; maybe use GIS/satellite data to develop first set, then refine with Amazon Turk? Will be looking at this in the Fall using a smart phone app to help create training data.

Discussion: Google Street View images are refreshed at different times and may not always be during greenest periods.

- May not be looking at same image when you recalculate, may have been updated (thought to be based on density, i.e., more frequent updates in cities. We need to consider this in terms of reproducibility (will have to archive the images used for CANUE metric).
- OSU (Perry/Andy) looked at seasonality of images, finding the majority (80%) were taken in summer, at least in Portland, OR.
- Google's Tile API allows for selecting images by year and date, and this might help with selecting images from key seasons. Could enable looking at the same location in winter and summer to better identify deciduous/evergreen trees. OSU (Perry/Andy) found the Tile API to be very slow.
- How often would we recalculate green view index? Every 5 years perhaps, as it is not expected that greenness will change that much (in general) from one year to the next.

Bluespace metrics: Dan Crouse (UNB) is working on bluespace metrics:

- For all postal codes in 30 largest Canadian cities, combined with Statistics Canada digital hydrology data developed in 2011 (coded as ocean, large lakes, med/small lakes, rivers)
  - Straight line distance to water by water type
  - Area of water/presence of water in 50m 100m 250m 500m 1km buffers
  - Expected to complete in 2017 and use for health analysis.

Future/other work:

- Matilda van den Bosch is beginning to work with the Landscape Ecology Lab at UBC, using Landsat 8, and other algorithms to get to 2-5m resolution to create detailed vegetation

inventory for Metro Vancouver (coniferous/deciduous, grass, mixed trees, shrubs) with plans to link to CCHS data. Also looking to map ecosystem services across Metro Vancouver.

- Lorien suggests exploring ways to combine Google Street View with satellite data to improve spatial accuracy of metrics, etc. Also looking at getting higher resolution satellite data (Planet) to further increase accuracy.
- Important questions include how greenspace relates to health:
  - Is a location that is green all year round better than one that is green only in summer?
  - Is greenness simply a surrogate for impervious/non-impervious surface? How does this relate to urban/rural spaces?
  - Associations with greenspace are stronger in cities than rural areas – how to standardize the amount of greenspace by pop density (ratio does not work – high/high and low/low would be same ratio) How do we deal with population density (urban/rural), stratify study by population density?
  - In reality, most studies will be focusing on urban areas that have enough population to support epidemiological studies, so looking at difference between metrics should focus on urban areas.
- Urban planners are interested in what attributes of greenness makes it useful , i.e., trees may have a different function than other vegetation. How do people use greenspaces - varies by region and demographics as well, pathway dependent, reducing harm, environmental stressors, restoring capacities, encouraging physical activity, social interaction, broad influences of greenspace.
- Can we classify the restorative potential of Google Street View images? Perry ordered mobile EEG, walk different routes and seeing cortisol and EEG, continuous measures, and GPS and will add other sensors to look at effects of built environment, will follow up with Matilda,
- Matilda is involved in a survey measuring how participants respond to/behave in different bluespace settings (blue health survey). Just starting now, so results 6 months/1 year away. These results might be useful to validate exposure metrics being developed by Dan Crouse, or inform new metrics.

General Discussion

- A comparison of how the many different indices relate to each other would be very useful, using test areas in representative areas across Canada (i.e., western forest, prairies, etc). Perry notes that some previous work suggests differences across spatial resolution may be more important

than differences between indices at the same resolution. Paul V. suggested earlier to focus on urban areas for these analyses.

- Make sure to have detailed standardized methods for calculating so able to reproduce, documenting the process is as important as the metric.
- Audrey – have NDVI maps, happy to apply some of algorithms, estimating vegetation measures, tree inventories,
- Patrick Kinney – previously working in climate change/health, now moving into urban interventions – involved in team funded by NASA to increase use of satellite data, focus mostly on air pollution, but sees that green/blue could also be integrated into this – has a bit of funding.