Puget Sound High Resolution Change Detection, Phase 1 - C1300047

Final Completion Summary

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# Overview

Phase 1 of the Puget Sound High Resolution Change Detection project mapped land-cover changes related to urbanization, forestry and natural disturbances for the time period 2006-2009 using 1-m aerial imagery acquired from the National Agriculture Imagery Program (NAIP). The map depicts 86,097 acres of change distributed across 35,340 locations. Each mapped location includes the boundary of the change location plus the following visually estimated attributes: initial (2006) land cover, % change within the polygon, % reduction in tree canopy/shrub cover, % increase in impervious surface and % increase in semi-pervious surface.

The map is intended to inform questions about the causes and consequences of land cover change by providing detailed information about the locations and changes occurring at all scales throughout the Puget Sound basin. The major goal of land-use planning and natural resource management with regards to urbanization is to influence the locations of new development and maintain ecosystem services in support of the community. Measuring the effectiveness of these endeavors requires fine-scale information at extents covered by their associated legislative jurisdictions. The map represents changes as small as new single family residences, providing detailed data when assessing urbanization within specific zones, such as riparian corridors or along shorelines.

Creation of the change map included a hybrid approach to change mapping combining traditional remote sensing methods with manual photo interpretation methods. The initial phase employed remote sensing techniques, image segmentation and statistical modeling to tessellate the high resolution raster images into statistically homogenous regions (polygons) each with an associated probability of containing a change event. The polygons were partitioned into change-candidates and non-change polygons based on a change probability being >= 25% for change candidates and < 25% for non-change polygons. The candidate polygons were then submitted to the photo-interpretation phase. The proportion of polygons in the two fractions was usually about 1:50. Because of the relatively small portion in the change-candidate fraction, all change candidates were subjected to accuracy assessment providing the opportunity to verify change and attribute the change events with additional data. The polygons which were verified as having changes make up the change map. A large sample (the greater of 5,000 or 1% of all non-change polygons) was taken from the non-change polygons and subjected to the same photo interpretation analysis. Locations in that sample that were observed as containing changes were attributed accordingly and added to the map product. The areal proportion of these “omitted” changes was divided by the total area of the sample to derive an omission rate for the non-change polygons. This rate was multiplied by the area of the non-change polygons to produce an estimate of unmapped change (labeled Omission Estimate in Table 1) within each watershed resource inventory area (WRIA).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Area | Funding Source | Area (ac) | Change Locations | Change Area (ac) | Development Change Locations | Development Change Area (ac) | Mapped % | Omission Error Rate | Omission Estimate | Total Change Estimate |
| *WRIA 01* | *Remodel\** | *816,007* | *2,213* | *7,588* | *764* | *1,386* | *71%* | *0.38%* | *3,072* | *10,689* |
| **WRIA 02** | **LO Phase 1** | **128,288** | **812** | **227** | **315** | **62** | **50%** | **0.19%** | **243** | **456** |
| *WRIA 03* | *Remodel\** | *366,833* | *1,192* | *5,793* | *685* | *1,200* | *79%* | *0.44%* | *1,589* | *7,349* |
| **WRIA 04** | **LO Phase 1** | **1,573,836** | **1,168** | **2,174** | **30** | **12** | **47%** | **0.16%** | **2,515** | **4,666** |
| **WRIA 05** | **LO Phase 1** | **452,538** | **1,840** | **4,434** | **334** | **118** | **80%** | **0.24%** | **1,075** | **5,529** |
| **WRIA 06** | **LO Phase 1** | **141,591** | **2,076** | **1,043** | **930** | **346** | **57%** | **0.57%** | **801** | **1,838** |
| *WRIA 07* | *Remodel\** | *1,193,286* | *2,523* | *10,032* | *1,534* | *2,307* | *67%* | *0.34%* | *4,023* | *14,880* |
| *WRIA 08* | *Remodel\** | *410,871* | *1,596* | *2,247* | *1,524* | *1,951* | *73%* | *0.20%* | *817* | *3,069* |
| **WRIA 09** | **LO Phase 1** | **346,438** | **2,821** | **3,289** | **1,085** | **844** | **78%** | **0.27%** | **927** | **4,217** |
| **WRIA 10** | **LO Phase 1** | **671,143** | **3,826** | **11,226** | **1,733** | **1,583** | **86%** | **0.27%** | **1,769** | **13,025** |
| **WRIA 11** | **LO Phase 1** | **491,916** | **3,199** | **7,502** | **833** | **400** | **77%** | **0.45%** | **2,180** | **9,683** |
| **WRIA 12** | **LO Phase 1** | **106,580** | **1,658** | **1,415** | **762** | **1,092** | **81%** | **0.31%** | **326** | **1,744** |
| *WRIA 13* | *Remodel\** | *172,109* | *1,968* | *5,005* | *2,107* | *1,814* | *94%* | *0.18%* | *301* | *5,315* |
| **WRIA 14** | **LO Phase 1** | **219,570** | **1,363** | **4,777** | **433** | **225** | **75%** | **0.71%** | **1,525** | **6,356** |
| *WRIA 15* | *Remodel\** | *424,237* | *1,750* | *5,420* | *1,433* | *1,449* | *65%* | *0.68%* | *2,848* | *8,292* |
| **WRIA 16** | **LO Phase 1** | **390,910** | **756** | **3,969** | **108** | **43** | **84%** | **0.19%** | **735** | **4,718** |
| **WRIA 17** | **LO Phase 1** | **264,357** | **1,622** | **4,693** | **466** | **163** | **88%** | **0.25%** | **649** | **5,358** |
| **WRIA 18** | **LO Phase 1** | **459,921** | **1,590** | **2,105** | **757** | **349** | **85%** | **0.08%** | **366** | **2,470** |
| **WRIA 19** | **LO Phase 1** | **250,363** | **1,101** | **8,553** | **62** | **13** | **95%** | **0.17%** | **411** | **8,978** |
| Overall |  |  |  | 91492 |  |  |  | 78% | 26172 |  |

Table 1: Summary statistics for the 19 Puget Sound WRIAs

The current grant funded mapping 13 of the 19 WRIAs which are in bold. Some values from the six previously mapped WRIAs represent older protocols which are in the process of being updated. The development categories only include changes explicitly labeled as development. Additionally many “tree removal” changes are also due to urbanization.

## Innovations and new techniques

There are several unique aspects to this project that have not previously been used or are rarely used for mapping change. They were:

1. Eliminating commission through observing all change predictions.
2. Using probability thresholds to search beyond “predicted changes” for change events.
3. Reported change agents for each location.
4. Estimating unmapped change area.
5. Encapsulating the accuracy assessment environment for repeatability.

## Areas for improvement/expansion

1. Improve segmentation algorithms to more closely approximate human pattern recognition.
2. Improve statistical modeling to better discriminate false positives, thereby minimizing analyst time rejecting commission errors.
3. Improve the analyst viewing app to more efficiently enable processing. This can improve speed and reduce repetitive motions. Ease of use also aids transferability, reproducibility and minimizes human errors.
4. Expand reporting capability through land-cover modeling.
5. Creating web accessible use-case scenarios to facilitate local and regional analyses.

## Data Distribution

The change polygons (~ 100 mb) are currently available upon request but will be hosted on the internet by spring 2014. Website development is under way. Segmentation polygons can also be obtained along with modeling data but will remain restricted to requests due to very large ( > 1 gb) file sizes. Detailed method descriptions will be available on the web site. For further information, contact

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