**Water Security Dashboard Edits**

April 23, 2015

**Dan** – we would like to preserve one version of the existing dashboard (which is oriented towards the LACC audience) and have you make a duplicate copy and then incorporate the changes below.

* **Title (at the top by the trend icon):** Change to “Supplementary Material: Tellman *et al.*, in review”
* Remove the WATER QUANTITY RISK data throughout, which has two indicators: annual water stress index, seasonal water stress index
* On the left panel, Change WATERSHED CONSERVATION SOLUTIONS to SOURCE WATERSHED CONSERVATION SOLUTIONS
* On the left panel, add new major headings and indicators for FLOOD MITIGATION section, as described below.

**MAJOR HEADER: Flood Mitigation**

Minor Header: **Riverine Flood Mitigation**

### Note: Keep the first three metrics already there:

### Riverine Flood Mitigation City Ranking

### Urban Population Exposed to Riverine Flooding

### Biophysical Opportunity to Mitigate Riverine Flooding\*

### \*Change this metric to read: Opportunity to Mitigate Riverine Flooding

Subheader (Under Opportunity to Mitigate Riverine Flooding): **Watershed Response Sensitivity**

Pop-up: *Five physical watershed characteristics that represent a watershed’s natural propensity to respond to investments in natural infrastructure.*

1. Shape (Unitless)

Watershed shape is captured by the Gravelius Index, G (Gravelius 1914), a metric of how circular a watershed is. A value of one represents a perfectly circular watershed. Rounder watersheds can be more sensitive to land cover changes (Bhagwat et al. 2011) and therefore be more responsive to natural infrastructure interventions. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

*🡪 Reverse axis – lower values are better.*

1. Slope (degrees)

The average slope in degrees was computed for each watershed. Watersheds with lower slope are more sensitive to changes in land cover (Bhagwat et al. 2011). Slope was derived from the SRTM Digital Elevation Model and converted to slope with the Jenness DEM Surface Tool (Jenness 2012) to preserve slope calculations over a continental area. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

*🡪 Reverse axis – lower values are better.*

1. Size (km2)

The area of each watershed was calculated in km2 in a GIS based on the HYDROSHEDS drainage basins (Lehner et al. 2008). Smaller watersheds can be more effective for restoration, as a smaller investment in land area is needed to change a given percentage area in the watershed. For example, often a 10-20% change in land cover in a watershed is required to detect a measureable or significant change in discharge in a storm event (Bathurst et al. 2011a, Bathurst et al. 2011b). A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

*🡪 Reverse axis – lower values are better.*

1. Drainage Density (km/km2)

Drainage Density is the total length of all channels in a watershed divided by the basin area. High drainage density is related to a lower “length of overland flow” as defined by Horton (1945). Basins with less overland flow have more water filtrating though the subsurface than rejected in overland flow (Harlin 1984). Thus, basins with a higher drainage density have a higher portion of water that could potentially be infiltrated, especially in protected areas and on soils with high infiltration capacity. Watersheds with higher drainage density are likely to be more sensitive to land use changes in terms of increasing infiltration to reduce flood peaks. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

1. Flood Discharge Sensitivity (unitless)

Flood discharge sensitivity is a metric to identify watersheds where a marginal change in discharge is likely to lead to the largest change in flood exposure. This is captured by the equation, where *Ix* is the inundated area (in km2) within the city limits in month *x*, *Acity* is the area of the city (in km2), *Qx* is the average discharge in month *x* (in liters/second), and *MQ* is the long-term average discharge (in liters/second). The flood discharge sensitivity metric shows the relative change in inundated area (percent of total city area) between the highest and second highest flood months of the year, months 12 and 11 (data from Fluet-Chouinard et al. 2014), while the denominator shows the relative change in discharge (percent of MQ) between months 12 and 11 (discharge estimates from Lehner and Grill 2013). An index of 1 means a certain percentage change of discharge leads to the same percentage change in inundated area, a value larger than 1 means that the relative change in discharge leads to a larger change in inundation, and a value smaller than 1 means that a certain relative change in discharge leads to lower change in inundation (e.g., 10% more discharge means 5% more inundation). As natural infrastructure interventions often aim to reduce discharge, watersheds with a higher index are places where the efforts to reduce discharge could most mitigate flooding.

Sub-subheading (under Riverine Flood Mitigation): **Scope of intervention**

*Six indicators that represent availability of restoration and preservation activities that mitigate flooding*

1. Preserve Infiltration (unitless)

Infiltration potential of a watershed is represented by the estimated “Curve Number,” which represents the rainfall-to-runoff ratio for a unique land use / land cover (using GlobCover 2009) and soil type (FAO 2007) based on USDA-NRCS (2004) lookup tables. Low curve numbers indicate higher infiltration capacity. For cities with multiple flood watersheds, a weighted average curve number was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

*🡪 Reverse axis – lower values are better.*

1. Increase Infiltration (%)

Estimate of the percent increase in infiltration from restoring non-urban land areas for each watershed. We assume that restoring degraded lands will increase infiltration capacity, with the greatest expected potential on already naturally permeable soils (Ilstedt et al. 2007, Giambelluca 2002, Godsey et al. 2004). Infiltration gain is estimated for each pixel by assuming a new Curve Number (CN) as a 10% reduction of the previous CN on all agricultural and barren land. The percent difference in current versus new CN is an estimate of potential increase in infiltration capacity if restoration activities are applied to all “recoverable” land in a watershed. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

1. Preserve Riparian Buffer (%)

Riparian areas around a stream are important to keep undeveloped to allow natural channel and geomorphic adjustments. Thus, all non-urban land that is spatially connected to a stream is considered a riparian buffer. These areas can be an important barrier between high velocity urban runoff and the stream. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

1. Disconnect Effective Impervious Area (km2)

“Effective” impervious area refers to urban areas spatially connected to perennial streams. Disconnecting this effective impervious area would require reclaiming a 500 m buffer area around the river anywhere that urban land touches a perennial stream. This buffer prevents urban runoff from entering the stream as overland flow, reducing the flow velocity via the rougher friction of vegetation (Shuster et al. 2005). This metric estimates the buffer area (in km2) required to disconnect effective total impervious area for each basin. Thus, lower values represent less effort required to disconnect urban land from the stream. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

*🡪 Reverse axis – lower values are better.*

1. Preserve Wetland Storage (%)

Preserving wetland storage was calculated as the percent of wetland area in a watershed according to annual flooded areas from the GIEMS-D15 dataset (Fluet-Chouinard et al. 2015). Wetlands can store large amounts of water and play an important role in flood mitigation (Mitsch and Gosselink 2000). The wetland floodplain area for all natural areas (defined as areas of land cover that are not bare, agricultural, pastoral, or urban in the GlobCover data set) was computed for each watershed. This metric is reported as percentage of “natural” wetland for each watershed area. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

1. Increase Wetland Storage (%)

The increase in wetland storage was calculated as the potential increase in wetland area as a percent of the watershed. This potential “recovered” wetland (areas that could be wetland but are currently bare, agricultural, or pastoral) is added to the area of “existing” wetlands (wetlands currently in “natural” land covers) to estimate the total possible wetland area as a percent of each watershed. The potential percent increase in wetland storage represents the gain if all wetlands are restored. A weighted average was calculated for each city using the proportion of people exposed to flooding in each watershed as weights.

Minor Heading (Under FLOOD MITIGATION and equivalent heading level to “Riverine Flooding Mitigation”): **Stormwater Flood Mitigation**

*Note: Move the stormwater city ranking metric here that is already on the dashboard*

*Add:* **Stormwater Flood Mitigation Opportunity Index**

*This represents an index comprised of five indicators (comprising both stormwater risk and mitigation opportunity) to assess where natural infrastructure could be most readily sited and effective in mitigating stormwater flooding for each city.*

Subheader: **Stormwater Flood Risk**

1. Relative storm intensity (# annual dry days/(kg/m2)/yr )

Relative storm intensity is calculated as the average number of dry days divided by the average annual precipitation using precipitation data from The University of East Anglia’s Climate Research Unit (2005). Higher precipitation intensity can lead to overwhelmed drainage systems and localized flooding.

1. Soil Permeability (unitless)

Soil permeability was assessed using FAO soil data and USDA hydrologic soil groups. Each soil group was assigned a value from 1-4 with higher values indicative of lower permeability soils. The percentage of each soil group was used to determine a weighted score for each city. Cities with high soil scores are more suceptible to urban flooding.

Sub-Subheading (Under **Stormwater Flood Mitigation Opportunity Index**): **Effectiveness of Green Infrastructure Interventions**

1. Percent Open Space (unitless)

Impervious area estimates were derived from binary classification via thresholding of multispectral imagery provided by Hansen et al. (2013). Any non-impervious land areas were considered “open space.” Cities with 40-50% open space were considered optimum and scored highest with a value of 4. This optimum represents a mix of imperviousness that causes flooding and open space to easily site natural infrastructure. Cities with higher or lower percentages of open spaces were scored from 0-3 as they departed from this optimum.

1. Distribution of Open Space (unitless)

Dispersion of open space was calculated using nearest neighbor spatial statistics. Evenly distributed open space indicates higher likelihood of mitigating potential stormwater flooding. Cities with more distributed open space across the city score higher.

1. City Slope Score (unitless)

Average city slope was calculated using 90-m SRTM elevation (Farr et al. 2007). Natural infrastructure for flood mitigation is assumed to be easier to implement on lower, but not flat, slopes. Cities with slopes 2-4% received the highest score of 4, slopes 4-6% a 3, slopes 6-8% a 2, and slopes 8-10% a score of 1. Slopes outside of this range were assigned a 0.

* Dan – That’s everything for the flood indicators. One last edit is to put this text at the bottom of the left-side panel, which is just a note to readers: “**References:** Please refer to the Works Cited section in the main text.”