Figure 1. The interannual variability of African climate and hydrology (computed from 1960 to 1995 monthly time series) as indicated by a) the coefficient of variation (CV) in the Climate Moisture Index (CMI), and b) the CV of river flow ($Q_c$). Source: Vörösmarty et al., 2004.
Figure 2: Water stress computed with increasing resolution. The relative water stress index (RWSI) was computed as the percent of annual average renewable water resources used by humans at:

(a) **Country-scale.** RWSI between 20 and 40 is moderate water stress, RWSI > 40% stress (annual human water use represents more than 40% of average annual renewable water resources) is considered to indicate severe water.

(b) **30-minute (0.5 degree) grid scale.** RWSI was computed for each grid cell and then the number of people exposed to severe water stress (RWSI > 40%) under mean annual conditions was tabulated. Source: Vorosmarty et al., 2000.

(c) **6-min (0.1 degree) grid scale.** Number of people (in thousands) exposed to severe water stress under 30-year drought conditions. Source: Vorosmarty et al., 2004.
Figure 3: Change in the percent of African population under severe water stress with increasing resolution. When the RWSI is computed at the country scale, only 4% of the population appear to suffer from water stress. However, when water use statistics are geospatially distributed based on population and compared to geospatially modeled water resources, the number of people exposed to water stress increases 6-fold.
Figure 4a. Lake Victoria and the major sub-basins within the drainage basin.

Figure 4b. Simulated river networks defined at a 1.5 minute (approximately 2.5 km) resolution for the river basins of Lake Victoria. The river networks were first derived from a high resolution elevation digital elevation model and then corrected using maps and basin attributes from local river gaging stations.
Figure 5. Monthly Climate Moisture Index (CMI) computed for the Lake Victoria basin once again shows the defining influence of the ITCZ migration on local climate. For instance, the northeastern portion of the basin varies from wet to dry in the course of an average year while just the opposite occurs in the southwestern portion of the basin.
Figure 6: Comparison of water stress analysis for the Lake Victoria basins at 1.5 minute and 6 minute resolutions. The finer resolution (1.5-min) analysis shows a slightly lower proportion of population (3.5%) under severe water stress (DIA/Q > 40%) than does the coarser (6-min) resolution analysis (4.8%). But, the proportion of the population exposed to moderate water stress (DIA/Q between 20 and 40%) in the 1.5 min analysis (4%) is double that (2%) shown in the 6-min analysis. However, both analyses indicate that the number of people exposed to water stress is low in the Lake Victoria basin. The number of people exposed to low or no water stress is just over 90% in both cases. The difference in results between the two analyses is due to two major factors: 1) the 6-minute network was derived to represent continental scale basins while the 1.5 minute resolution river network was constrained by basin attributes from Lake Victoria catchments, making it more locally representative, and 2) precipitation, river discharge and population datasets were validated with finer resolution (administrative level) information.
Table 1: Water reuse indices computed on an average annual basis for Kenyan rivers within the Lake Victoria Basin. Note that the highest value (South Awach) is only about 1.5% of the available river discharge, indicating that, on average, the quantity of water is adequate for meeting human demand within the Lake Victoria basin and that river water may be under utilized. However, this index does not account for the reduction in utilizable water due to poor access and poor water quality.

<table>
<thead>
<tr>
<th>River</th>
<th>Water Reuse Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sio</td>
<td>0.0093</td>
</tr>
<tr>
<td>Nzoia</td>
<td>0.0079</td>
</tr>
<tr>
<td>Yala</td>
<td>0.0055</td>
</tr>
<tr>
<td>Yala</td>
<td>0.0083</td>
</tr>
<tr>
<td>Nyando</td>
<td>0.0035</td>
</tr>
<tr>
<td>Nyando</td>
<td>0.0040</td>
</tr>
<tr>
<td>North Awach</td>
<td>0.0082</td>
</tr>
<tr>
<td>South Awach</td>
<td>0.0148</td>
</tr>
<tr>
<td>Sondu</td>
<td>0.0073</td>
</tr>
<tr>
<td>Gucha-Migori</td>
<td>0.0108</td>
</tr>
<tr>
<td>Gucha-Migori</td>
<td>0.0052</td>
</tr>
<tr>
<td>Mara</td>
<td>0.0026</td>
</tr>
</tbody>
</table>

Figure 7: Monthly water reuse index for the Yala River in Kenya. Although the seasonal demand of water increases nearly 3-fold between July and January, water use relative to the available supply is still quite low.
Figure 8: Distribution of population within Kenyan catchments with distance from third order or greater stream at 1.5 min resolution.
Figure 9: Risk to human well-being due to a) poor access to safe water and b) access to adequate sanitation facilities as defined in the text. Because the population density varied between districts, risk factors combined both population density and quality of access, as shown in Table 2. In aggregate, nearly 85% of the population has inadequate access to safe water in this region, which is in stark contrast to published country-level estimates of access. By contrast, approximately 70% of the region has good access to sanitation facilities.

Table 2: Definition of risk highlighted in Figure 9, combining influence of population density with access to water and sanitation.

<table>
<thead>
<tr>
<th></th>
<th>Low Pop Density &lt;250 persons/km²</th>
<th>High Pop Density &gt;250 persons/km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Access</td>
<td>Medium risk 1</td>
<td>Big risk</td>
</tr>
<tr>
<td>Good Access</td>
<td>Small risk</td>
<td>Medium risk 2</td>
</tr>
</tbody>
</table>
Figure 10a. Number of cholera cases in Nyanza Province, Kenya for 1997 through 2001. Note the high incidence in the El Nino years of 1997 and 1998.

Figure 10b. Cholera cases per thousand people in Nyanza Province, Kenya for 1997 through 2001. The two districts with the highest occurrence of cholera also have 30% of their population living within 2 km of Lake Victoria.
Figure 11: The relationship between cholera outbreaks and proximity to Lake Victoria. Shapiro et al. (1999) showed that drinking Lake Victoria water increases the risk of contracting cholera. Our study also indicates that people living within close proximity to the lake are at a greater risk of contracting cholera, especially in El Nino years.
Figure 12. The intersection of human health (represented by cholera cases/1000 people) and access to water and sanitation. Risk categories are defined in Table 3. Virtually all of the districts reporting cholera cases are shown to have moderate (yellow) to high (red) risk due to poor access to both safe water and sanitation.

Table 3. Risk categories based on thresholds of access to safe water and sanitation as discussed in the previous section of this paper.

<table>
<thead>
<tr>
<th>Poor Sanitation (&lt;70%)</th>
<th>Big risk</th>
<th>Medium risk 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Sanitation (&gt;70%)</td>
<td>Medium risk 1</td>
<td>Small risk</td>
</tr>
</tbody>
</table>