Philosophy of globally customizable ES models
Towards globally customizable ecosystem service models

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A user friendly access to ES modelling

1. ES-related user queries in a user-selected spatial and temporal context.
2. Queries can be entered in the Explorer interface as English sentences (or keywords)
3. Keywords call on logical statements (ontologies) that are conceptual models *resolved* with the data and algorithms available in the ARIES semantic web
Why are they needed?

- A conceptualization of ES supply and demand
- Rapid assessment
- No input/data preparation needed
- Models can run in any spatial context of the Earth with seasonal to annual temporal scale
- Customization of data, models and scenarios is currently possible using the k.LAB Modeler
  - soon with ARIES Explorer too
Current Contents

Fully specified model content concerning the following ES problem areas:
• Carbon storage
• Outdoors recreation
• Pollination
• Sediment retention
• Riverine flood regulation

Areas in development for a forthcoming release in the short term include:
• Mariculture suitability
• Water availability (based on hydrological calculations)
• Biodiversity value (based on machine learning of expert opinion)
• Crop yield production
• Forest timber production
• MicroHydro renewable energy production
What they are now

- Ready to use as a baseline but likely delivering a rough picture
- For all the queries, ARIES will build a spatially explicit observation,
  - mostly raster GIS coverage of user-selected resolution.
- The results will reflect the contents of the ARIES semantic web at the time of query
  - nearly all supporting data are currently available at spatial resolution ranging between 1km and 90m.
- Not complexity oriented
  -> static and aggregated: as per InVEST/Estimap approaches
Global ES models

Carbon storage
Key methods: Ruesch & Gibbs 2008

Riverine flood regulation
Key methods: Di Leo et al. 2011

Pollination
Key methods: Zulian et al. 2013

Recreation
Key methods: Paracchini et al. 2014
Scalability, Context Awareness and Crowd-sourced Data

• Waterways

```plaintext
@color(blue)
model each corth:Waterway

"Automatically scales to find the types of settlements most relevant to each scale of observation."
using

gis.osm.query(
  feature-type="line",
  equal=["waterway", "river"],
  if [space.scale <= 11],
  gis.osm.query(
    feature-type="line",
    equal=["waterway", ("river", "stream")],
    if [space.scale > 11];
```

• Human Settlements

```plaintext
@color(blue)
model each Infrastructure:HumanSettlement

"Automatically scales to find the types of settlements most relevant to each scale of observation."
using

  gis.osm.query(
    feature-type="point",
    equal=["place", "city"],
    if [space.scale <= 5],
    gis.osm.query(
      feature-type="point",
      equal=["place", ["city", "town"]],
      if [space.scale > 5 & space.scale < 9],
      gis.osm.query(
        feature-type="point",
        equal=["place", ["city", "town", "village"]],
        if [space.scale >= 9];
```

9
e.g. Zoom Level

### Zoom levels

<table>
<thead>
<tr>
<th>Level</th>
<th># Tiles</th>
<th>Tile width (° of longitude)</th>
<th>m / pixel (on Equator)</th>
<th>– Scale (on screen)</th>
<th>Examples of areas to represent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>360</td>
<td>156,412</td>
<td>1.50 million</td>
<td>world</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>180</td>
<td>78,206</td>
<td>1.25 million</td>
<td>continent</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>90</td>
<td>39,103</td>
<td>1.10 million</td>
<td>large country</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
<td>45</td>
<td>19,551</td>
<td>1.00 million</td>
<td>largest country</td>
</tr>
<tr>
<td>4</td>
<td>256</td>
<td>22.5</td>
<td>9,775</td>
<td>0.95 million</td>
<td>large African country</td>
</tr>
<tr>
<td>5</td>
<td>1,024</td>
<td>11.25</td>
<td>4,096</td>
<td>0.80 million</td>
<td>large European country</td>
</tr>
<tr>
<td>6</td>
<td>4,096</td>
<td>5.625</td>
<td>2,444</td>
<td>0.75 million</td>
<td>small country, US state</td>
</tr>
<tr>
<td>7</td>
<td>16,384</td>
<td>2.913</td>
<td>1,222</td>
<td>0.70 million</td>
<td>small area, city</td>
</tr>
<tr>
<td>8</td>
<td>65,536</td>
<td>1.406</td>
<td>610,984</td>
<td>0.65 million</td>
<td>wide area, large metropolitan area</td>
</tr>
<tr>
<td>9</td>
<td>262,144</td>
<td>0.703</td>
<td>305,492</td>
<td>0.60 million</td>
<td>world, large urban area</td>
</tr>
<tr>
<td>10</td>
<td>1,048,576</td>
<td>0.352</td>
<td>152,746</td>
<td>0.50 million</td>
<td>metropolitan area</td>
</tr>
<tr>
<td>11</td>
<td>4,194,364</td>
<td>0.176</td>
<td>75,373</td>
<td>0.45 million</td>
<td>city</td>
</tr>
<tr>
<td>12</td>
<td>16,777,216</td>
<td>0.088</td>
<td>38,187</td>
<td>0.40 million</td>
<td>town, city district</td>
</tr>
<tr>
<td>13</td>
<td>67,108,864</td>
<td>0.044</td>
<td>19,093</td>
<td>0.35 million</td>
<td>village, suburb</td>
</tr>
<tr>
<td>14</td>
<td>268,435,456</td>
<td>0.022</td>
<td>9,547</td>
<td>0.30 million</td>
<td>street</td>
</tr>
<tr>
<td>15</td>
<td>1,073,741,824</td>
<td>0.011</td>
<td>4,773</td>
<td>0.25 million</td>
<td>small road</td>
</tr>
<tr>
<td>16</td>
<td>4,294,967,296</td>
<td>0.005</td>
<td>2,387</td>
<td>0.20 million</td>
<td>street</td>
</tr>
<tr>
<td>17</td>
<td>17,179,069,184</td>
<td>0.003</td>
<td>1,193</td>
<td>0.15 million</td>
<td>block, park, addresses</td>
</tr>
<tr>
<td>18</td>
<td>66,719,476,736</td>
<td>0.001</td>
<td>596</td>
<td>0.10 million</td>
<td>some buildings, trees</td>
</tr>
<tr>
<td>19</td>
<td>274,877,906,944</td>
<td>0.0005</td>
<td>296</td>
<td>0.10 million</td>
<td>local highway and crossing details</td>
</tr>
</tbody>
</table>

- The "# Tiles" column indicates the number of tiles needed to show the entire world at the given zoom level. This is useful when calculating storage requirements for pre-generated tiles.
- The "Tile width" column gives the map width in degrees of longitude, for a square tile drawn at that zoom level.
- Values listed in the column "m / pixel" gives the number of meters per pixel at that zoom level. These values for "m / pixel" are calculated with an Earth radius of 6372,792 km and hold at the Equator; for other latitudes the values must be multiplied by the cosine (approximately assuming a perfect spherical shape of the geoid) of the latitude.
- "– Scale" is only an approximate size comparison and refers to distances on the Equator. In addition, the given scales assume that 256-pixel wide tiles are rendered and will be dependent on the
What they can become

● The model content does not implement monolithic "models" of ES
● Starting point for improvement, also conceptual improvement
● Capture more complexity, including multi-agents networks and dynamic transitions
  → this is the real PTB framework implementation
● We envision a critical role of remotely sensed data in the near future for real time and high frequency assessments