Application of urban growth modelling to project slum development and its implications on sanitation planning

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MEGATROPOLIS
50 km
30 km
10 km
HOME SWEET HOME
"We're waiting for the city to come to us..."

Urban growth and Sanitation

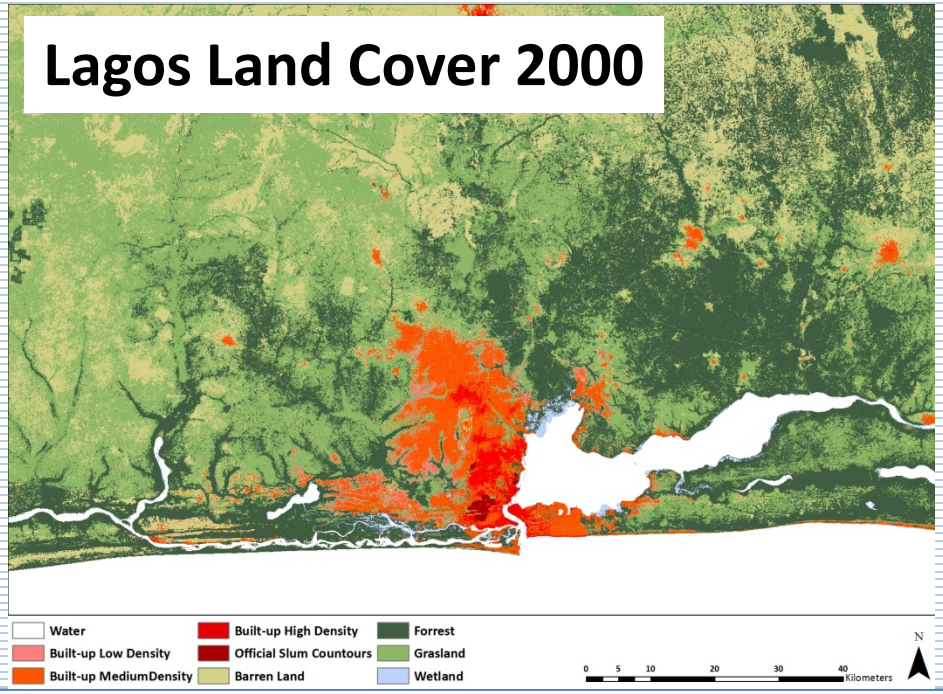
- In fast growing megacities, urban growth has a large impact on water cycle;
- Most research related to flooding;
- Waste water (management) largely affected;
- Proof of Concept;
- Lagos, Nigeria

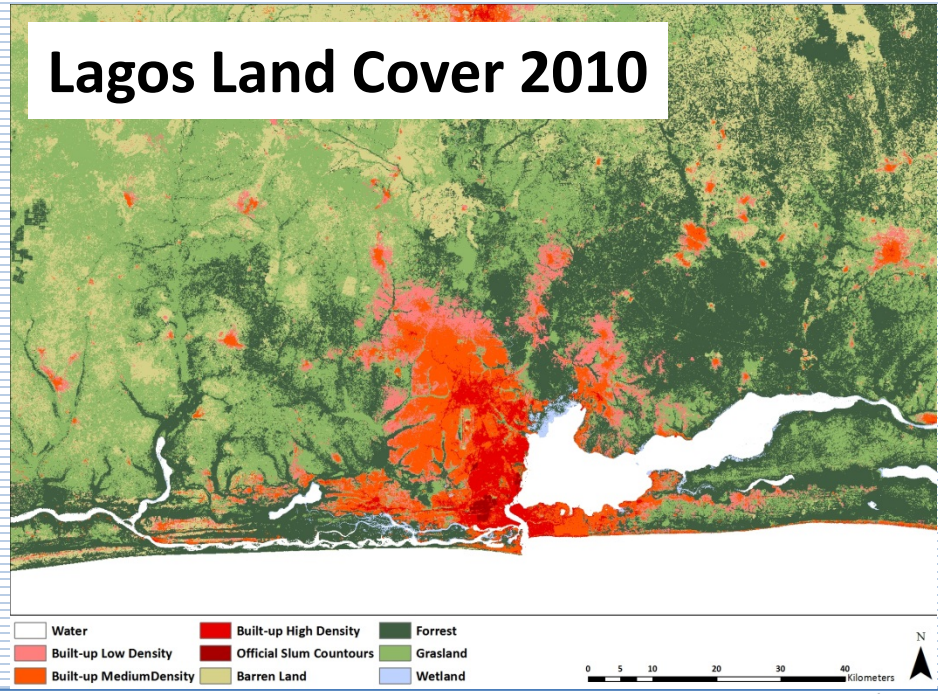
What can be the potential consequences of future urban growth on wastewater management?

Business As Usual in UGM

UGM: Dinamica-Ego (CSR-UFMG) dynamic GIS platform

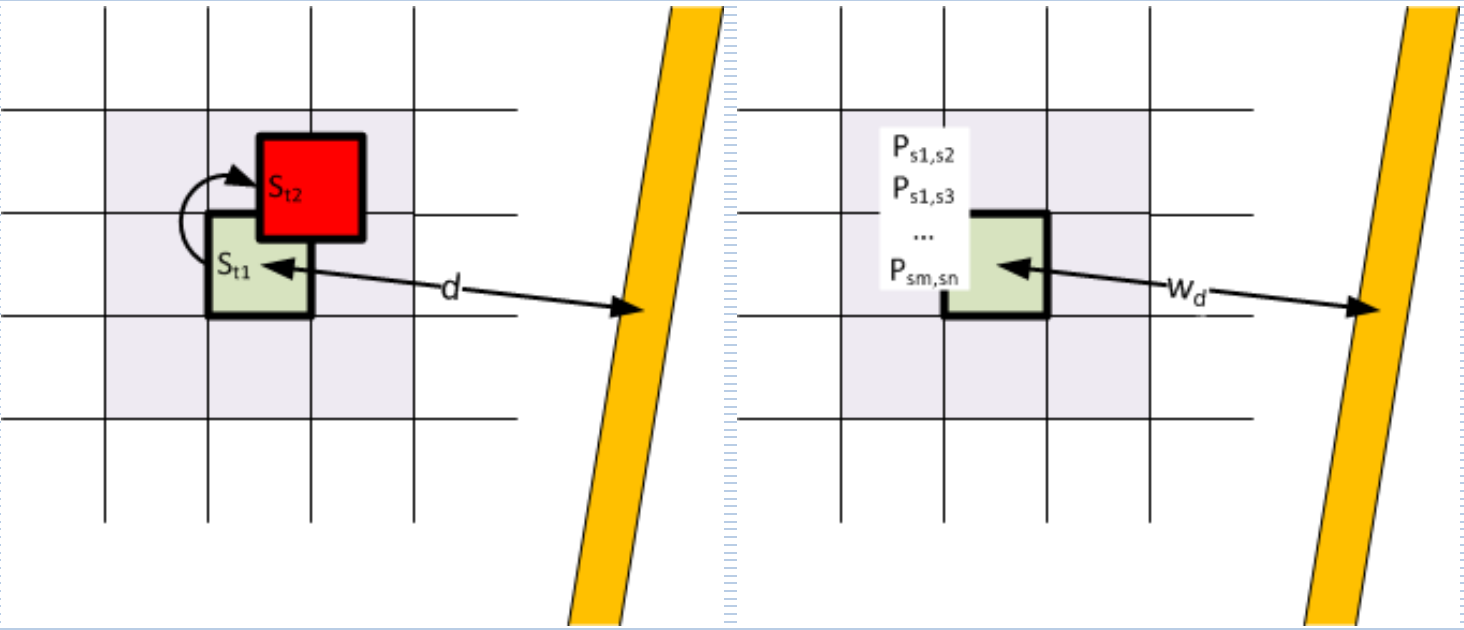
- Constrained stochastic CA;
- Weight-of-Evidence method (Bonham-Carter, 1994);
- Performance evaluation based on Kappa index;
- Projections are extrapolation of LULC differences between baseyears





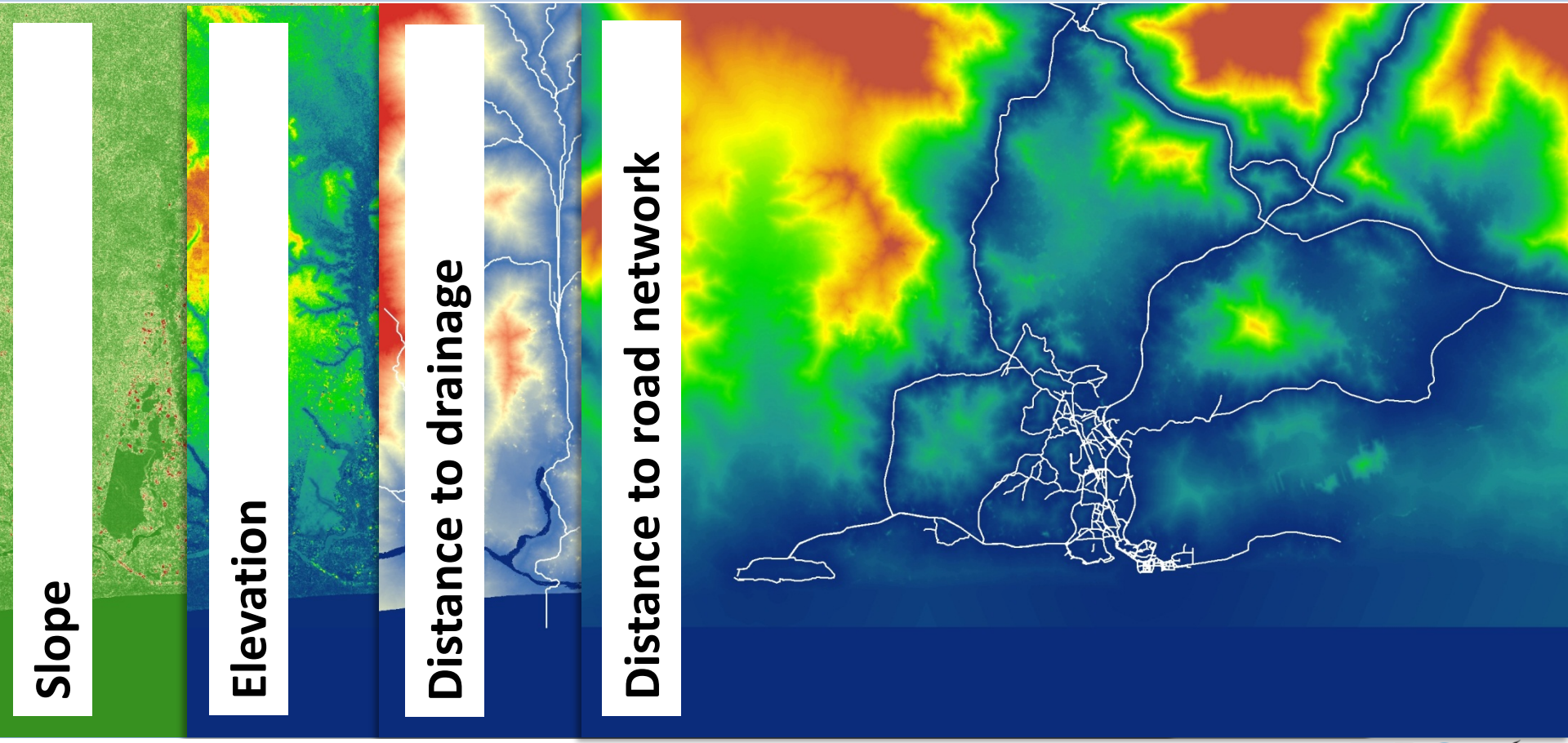
Weight of Evidence

- Determine set of LULC transitions;
- Assign weights to discrete ranges (e.g. distance) for a set of themes;
- Develop 'suitability map' (i.e. probability matrix);



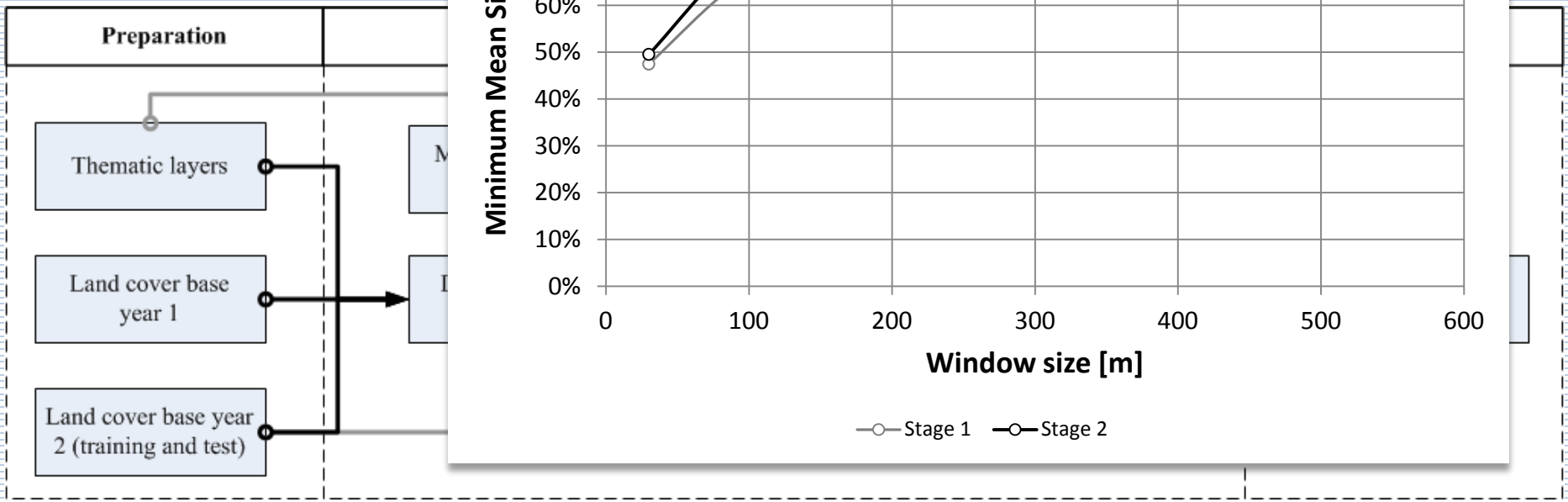
UGM: Thematic maps

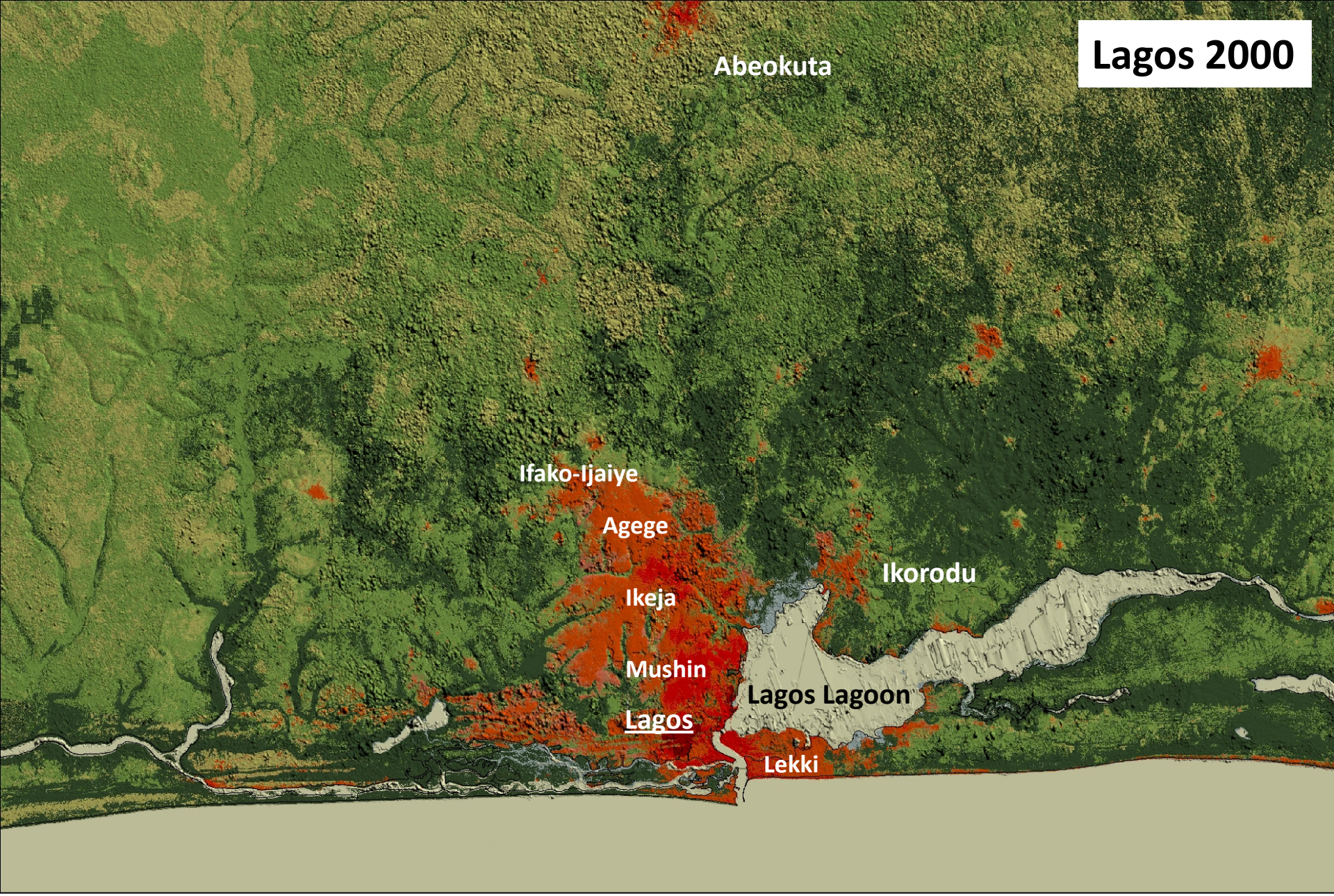
- Evaluating the importance of physical and proximity based factors;
- Arbitrary set, yet agreement in UGM literature

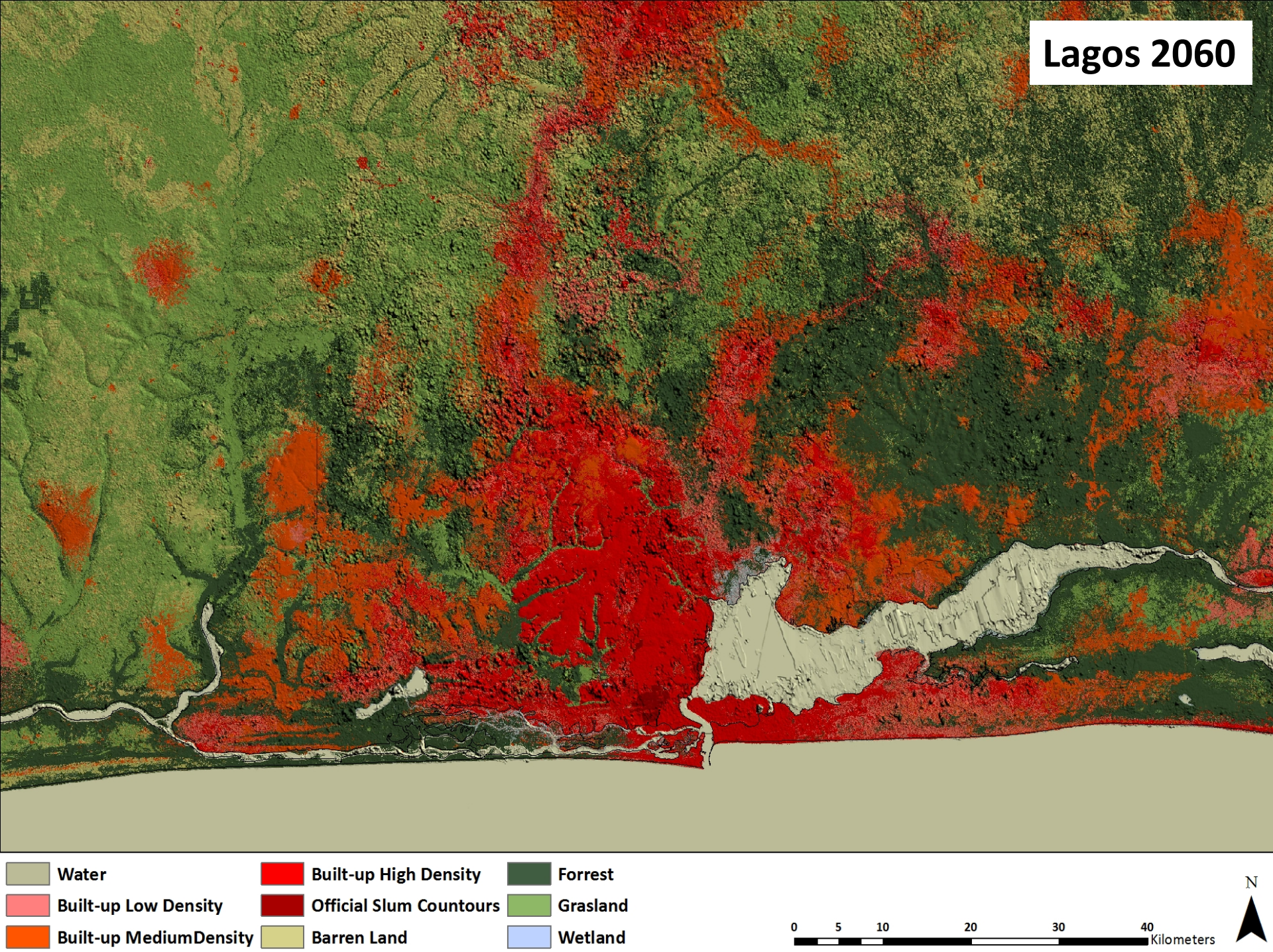


UGM: Methdology

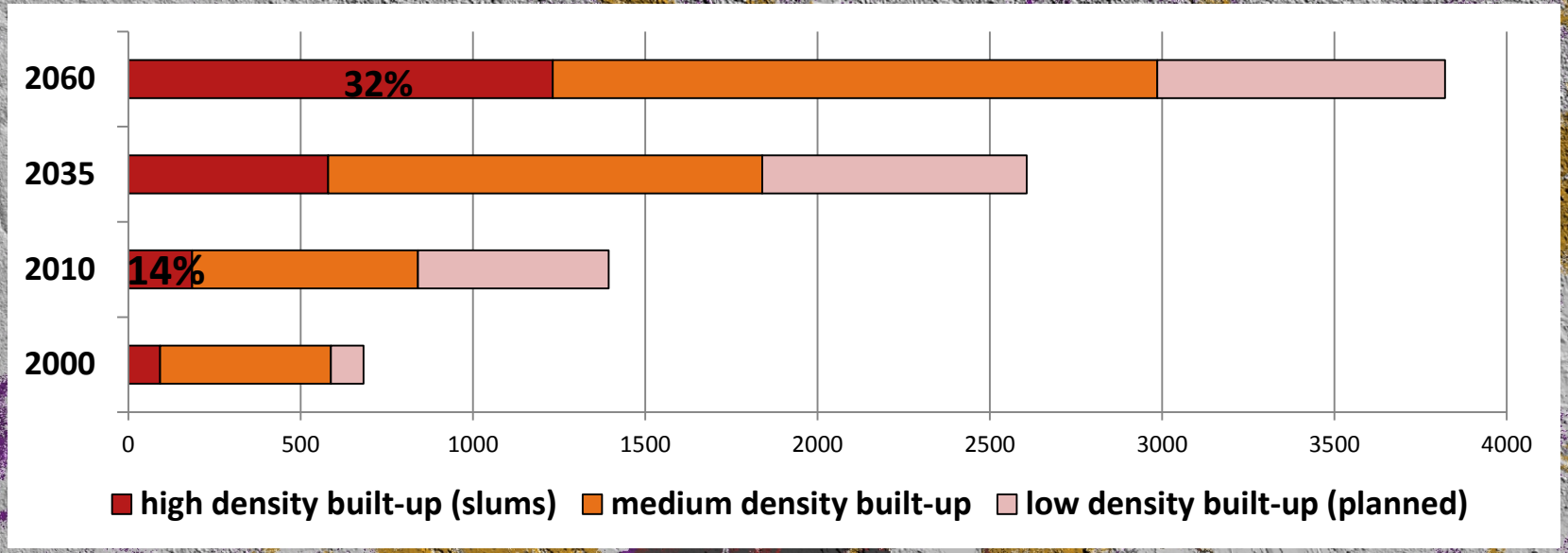
- Preparation phase: LULC base years, thematic layers;
- Validation phase: Optimizing predicted-observed similarity base years
- Projection: Applying transition rules for n increments




Lagos 2000
Abeokuta
Ifako-Ijaiye
Agege
Ikeja
Mushin
Lagos
Ikorodu
Lagos Lagoon
Lekki
Water
Built-up Low Density
Built-up MediumDensity
Built-up High Density
Official Slum Countours
Barren Land
Forrest
Grasland
Wetland
0 5 10 20 30 40
Kilometers
N


Lagos 2060
Water
Built-up Low Density
Built-up MediumDensity
Built-up High Density
Official Slum Countours
Barren Land
Forrest
Grasland
Wetland
0
5
10
20
30
40
Kilometers
N

Lagos Urban Growth 2000-2060



Existing
Expansion
Infill
Leapfrog

0 5 10 20 30 40 Kilometers

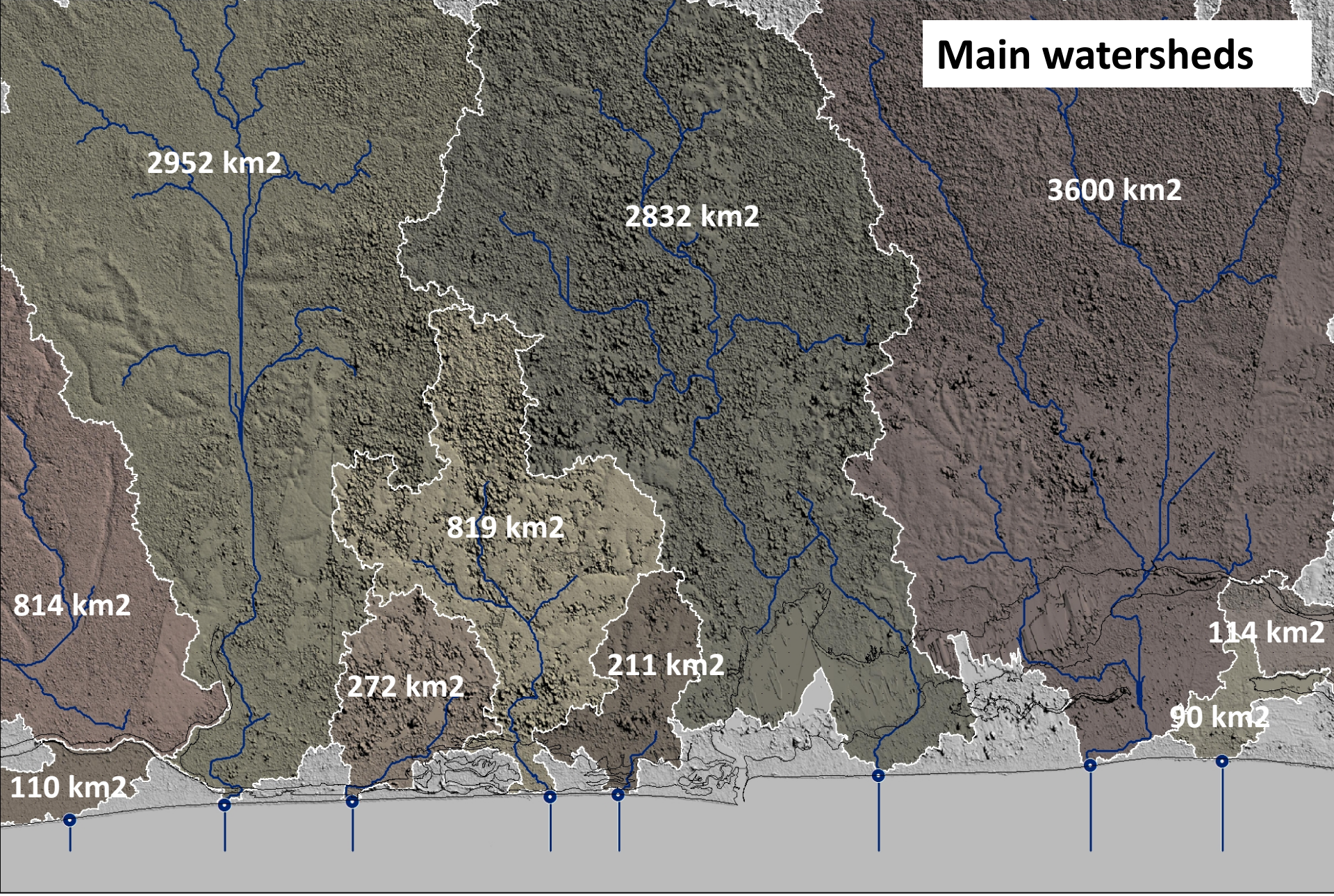
N

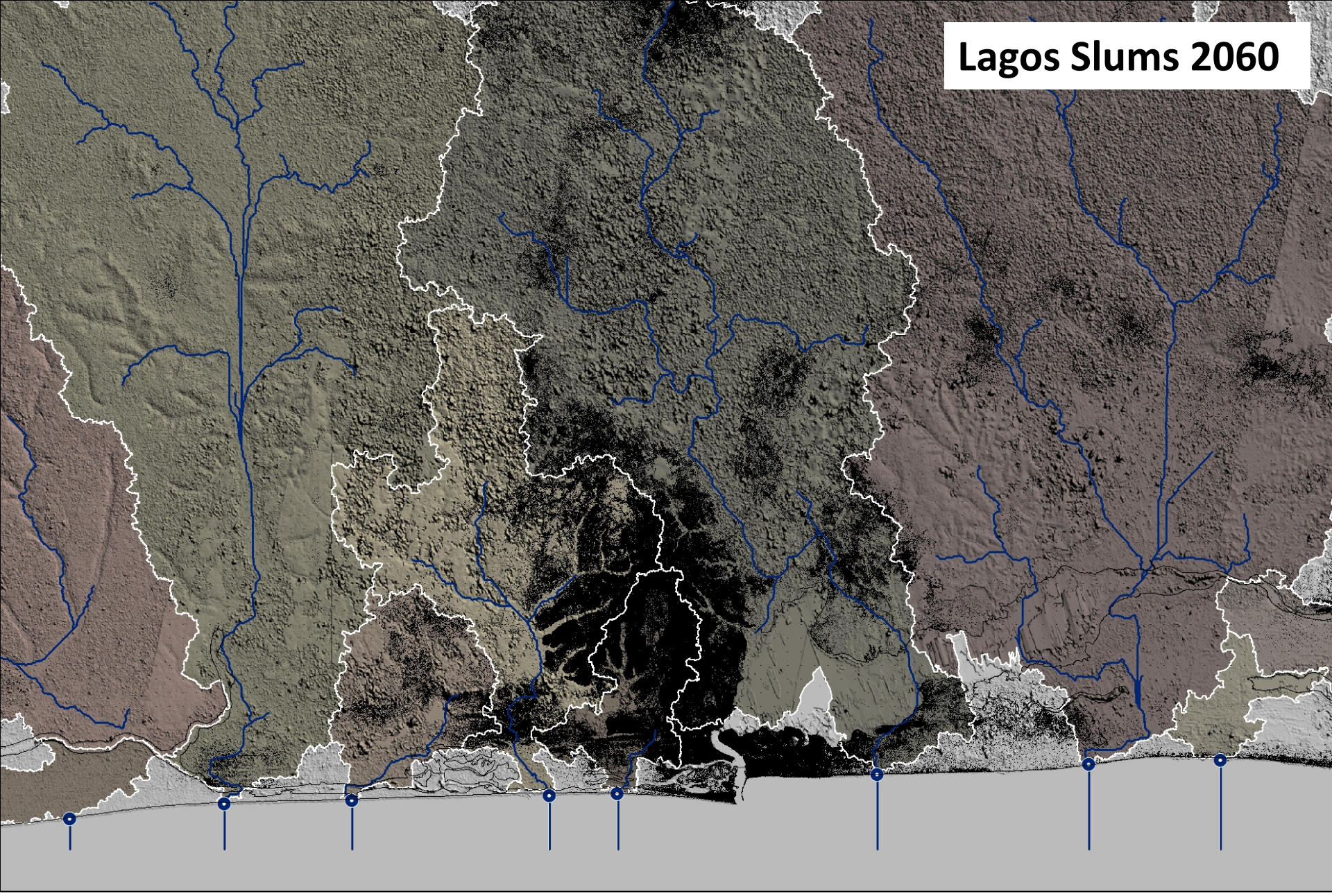
Lagos: High density built-up area
Lagos: Medium density built-up area
Lagos: Low density built-up area
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Sanitary pollution loads

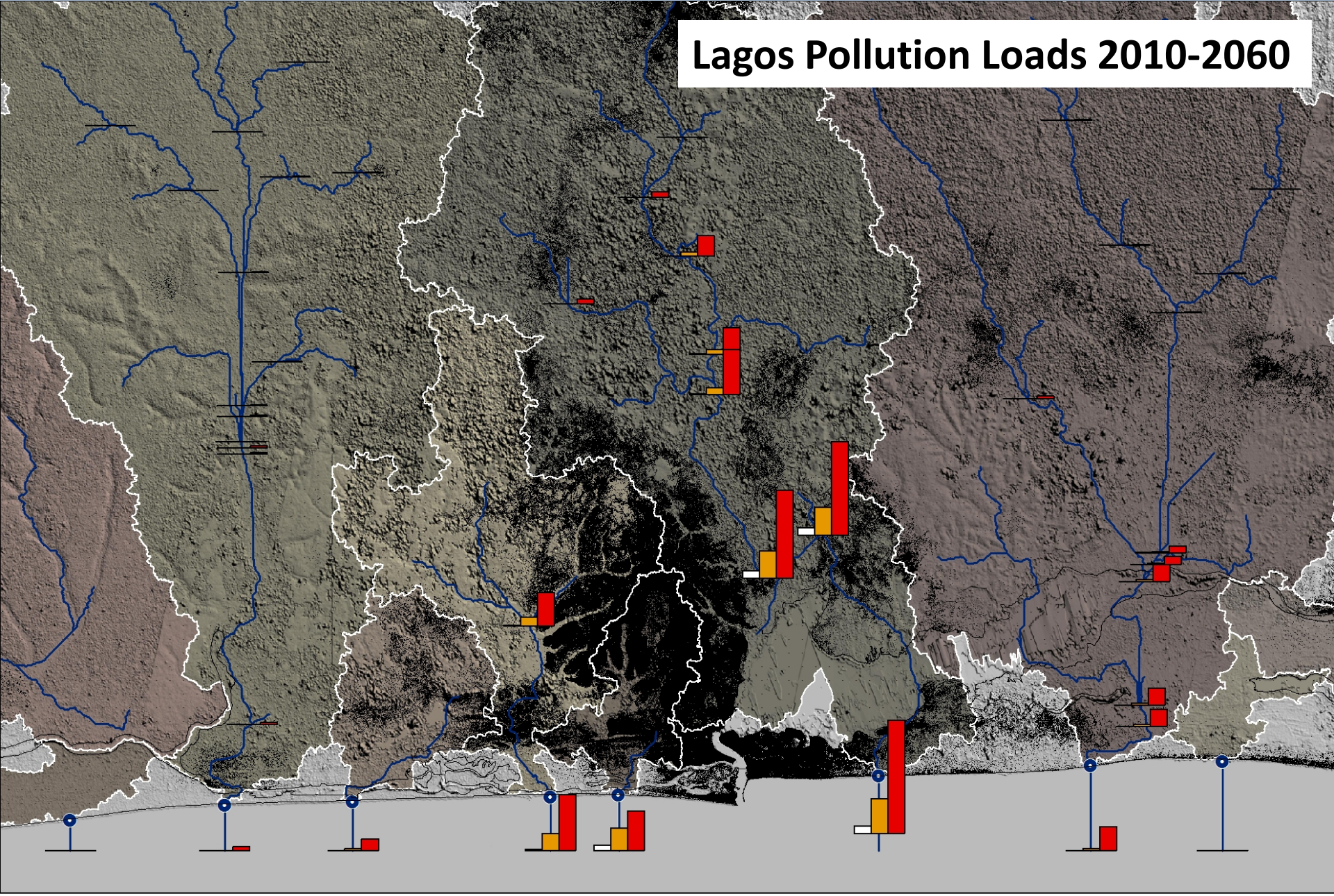
- Delineate watersheds and slum areas;
- Associate population densities to the delineated slum areas;
- Assign baseline loads (Organics, Solids, Nutrients) based on Heinzel et al (2001) for base year 2010;
- Assess increased loads by distributing urban growth (population densities) over watersheds (2035, 2060);

COD	90 l/c/d
BOD	60 l/c/d
Nitrogen	5 l/c/d
Phosphorus	2 l/c/d
TSS	60 l/c/d


Main watersheds
2952 km2
2832 km2
3600 km2
819 km2
814 km2
114 km2
211 km2
272 km2
90 km2
110 km2
Outlets
Streams
0
5
10
20
30
40
Kilometers
N


Lagos Slums 2060
Outlets
Streams
Slum Countours
0
5
10
20
30
40
Kilometers
N

Lagos Pollution Loads 2010-2060



Main Observations

- Overall: severe increase in pollution loads;
- Some currently unaffected streams will face serious future contamination;
- Big impact on the Laguna and livelihood (fishery, etc.);
- Outcomes could provide base for pro-active policy (slum formation, sanitation, etc.)

Big Uncertainties

- Actual discharge into streams;
- Slum delineation;
- Future growth rates and development

CONCLUSIONS

- New application of UGM;
- Outcomes suggest a ecologic disaster with severe consequences for the current downtown areas (downstream) and Laguna;
- Pro-active growth containment and slum management is necessary;