Towards Land Use Dynamics Investigation

A case study of the Democratic Republic of the Congo

Jean-Paul Kibambe & Pierre Defourny

Dpt. of Environmental Sciences and Land Use Planning,
Université catholique de Louvain

Stocks et Flux de Carbone Forestier dans le Bassin du Congo
Février 2010 - Brazzaville

UCL Université catholique de Louvain

Outline

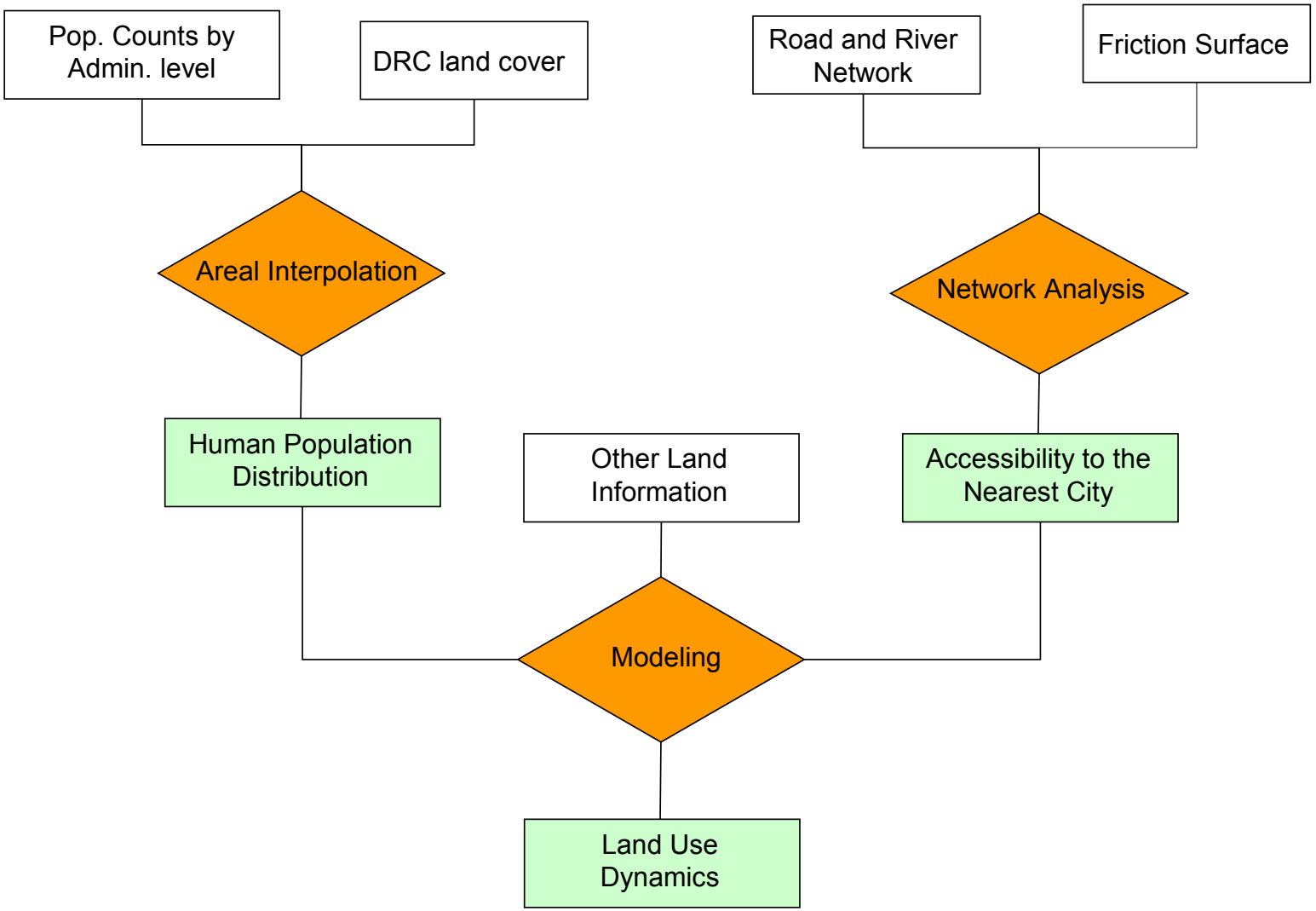
Introduction

Demographic growth and accessibility to main cities/markets are considered as important factors of land use dynamics

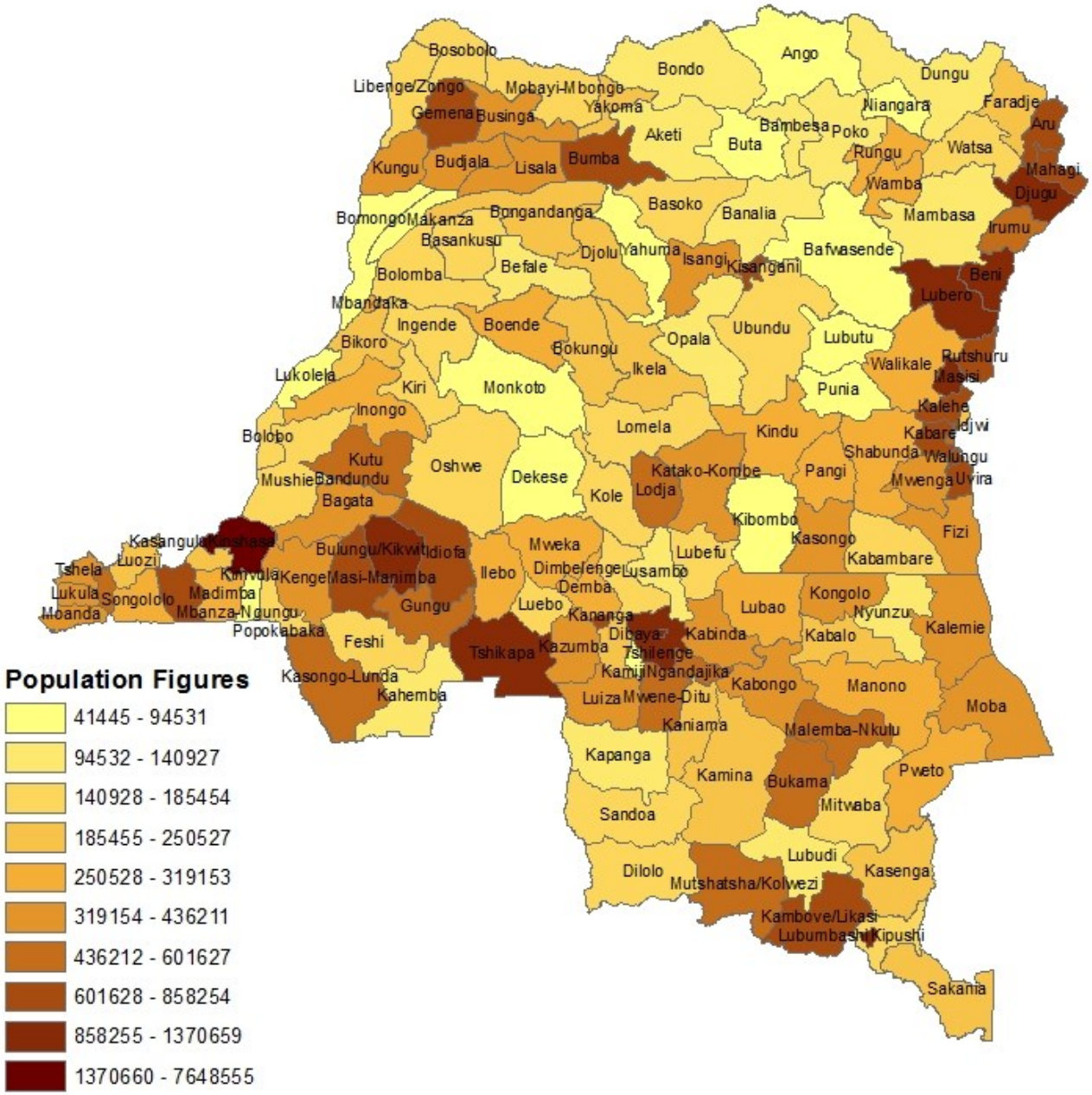
These factors are however inaccurately estimated for many countries (in the Congo Basin region) due to many factors: data availability, scarcity and coarse spatial of network datasets at the national scale, etc.

The current research illustrates how **the population distribution** and **accessibility** could be estimated using spatial modeling techniques

Modeling Process



DRC Population Figures



Regression Weighted Areal Interpolation

Population (y_i) as a function of land cover composition (x_{ik}) and considering population densities (β_i) as spatially invariant:

$$y_i = \underbrace{\beta_1 x_{i1} + \cdots + \beta_k x_{ik}}_{\widehat{y_i}} + \varepsilon_i \qquad \forall i = 1, \ldots, n$$

Where ε_i refers to the corresponding error in terms of population

Or using standard matrix notations:

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon} \quad \Longrightarrow \quad \widehat{\boldsymbol{\beta}} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{y} \quad \text{where } \mathbf{X} = \begin{pmatrix} x_{11} & \cdots & x_{1k} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nk} \end{pmatrix}$$

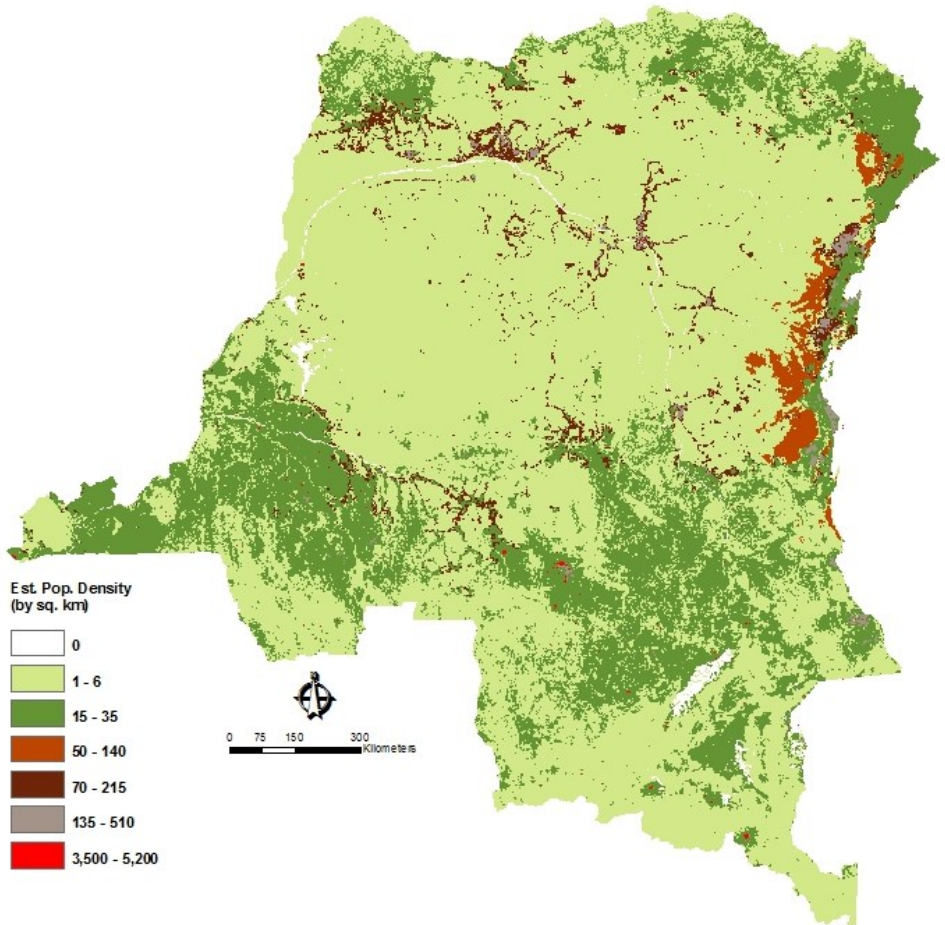
Constrained Regression

Using alternative information to reduce discrepancies between observed and predicted population (e.g. DRC urban population is about 30% of the total population)

$$\begin{pmatrix} \mathbf{X}'\mathbf{X} & \mathbf{s}_a & \mathbf{s}_b \\ \mathbf{s}'_a & 0 & 0 \\ \mathbf{s}'_b & 0 & 0 \end{pmatrix} \begin{pmatrix} \beta \\ \lambda_a \\ \lambda_b \end{pmatrix} = \begin{pmatrix} \mathbf{X}'\mathbf{y} \\ (0.3)y_T \\ (0.7)y_T \end{pmatrix}$$

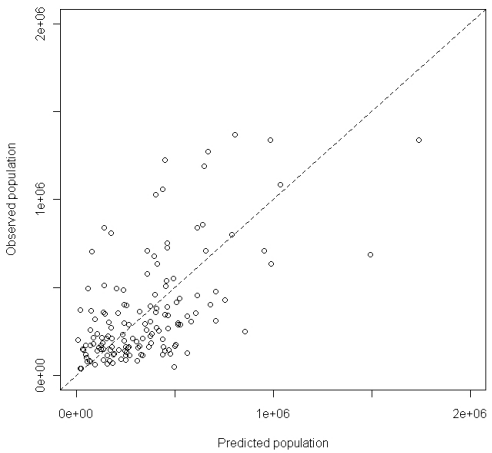
with y_T = the total population, $\mathbf{s}'_a = (s_1, 0, \ldots, 0)$ and $\mathbf{s}'_b = (0, s_2, \ldots, s_k)$, where s_1 denotes the total urban area, respectively, whereas $s_2, \ldots, s_k$ refer to total areas for the various other classes.

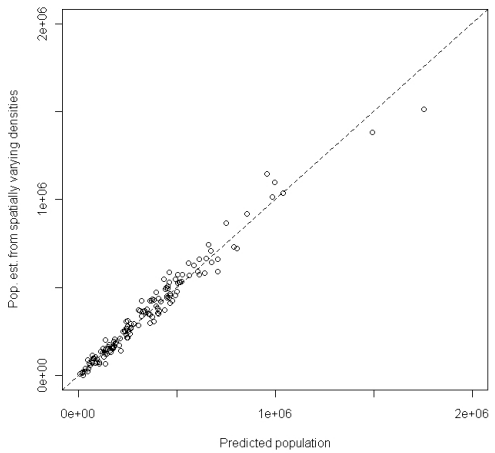
Estimated Sp. Distribution of Human Population

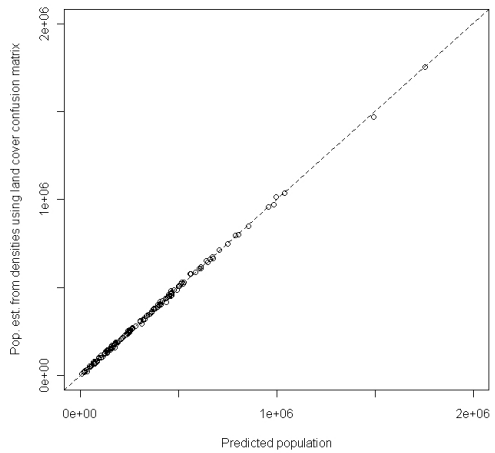


Assessing Sources of Errors

Confusion matrix and simulation of spatially varying densities



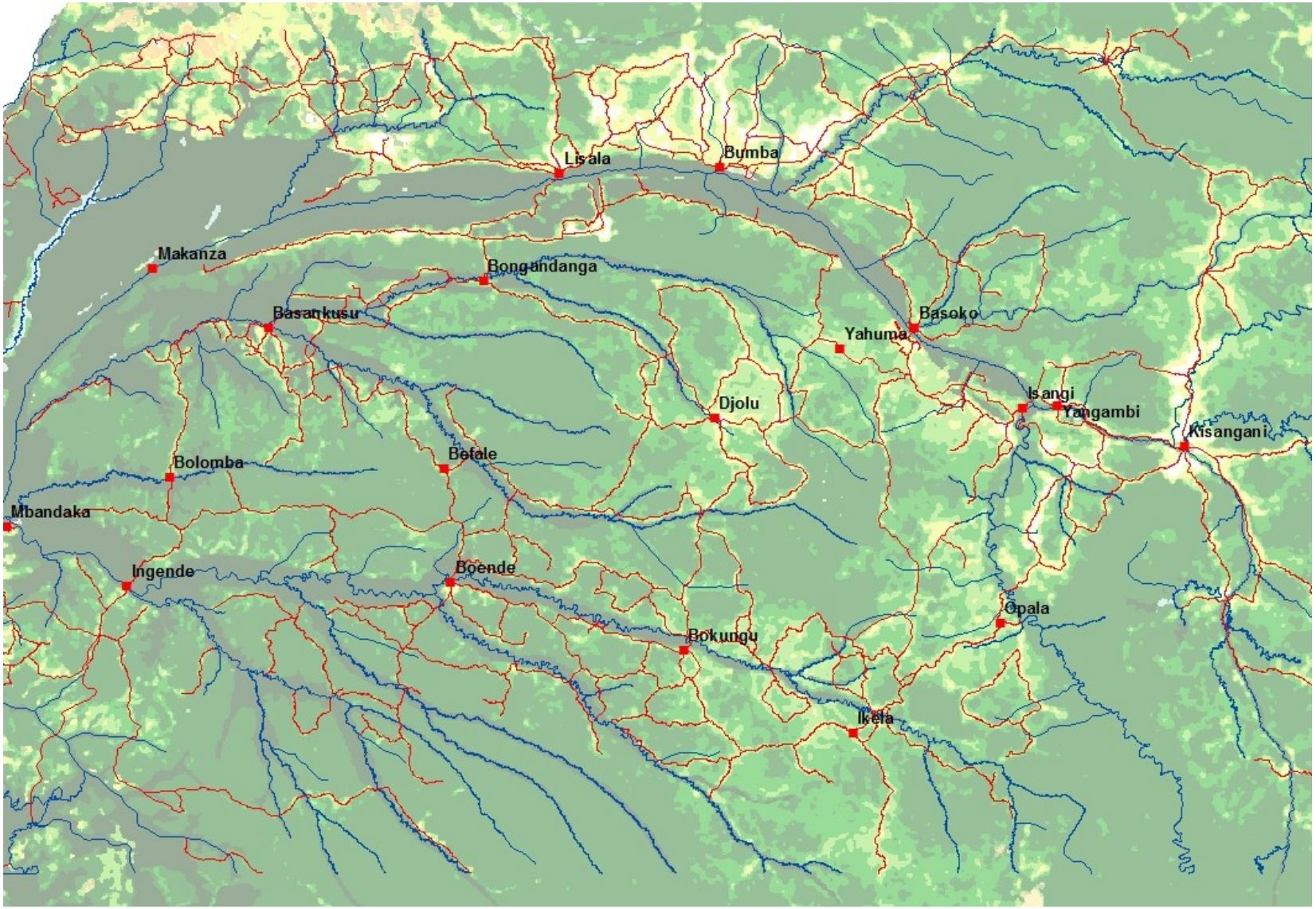




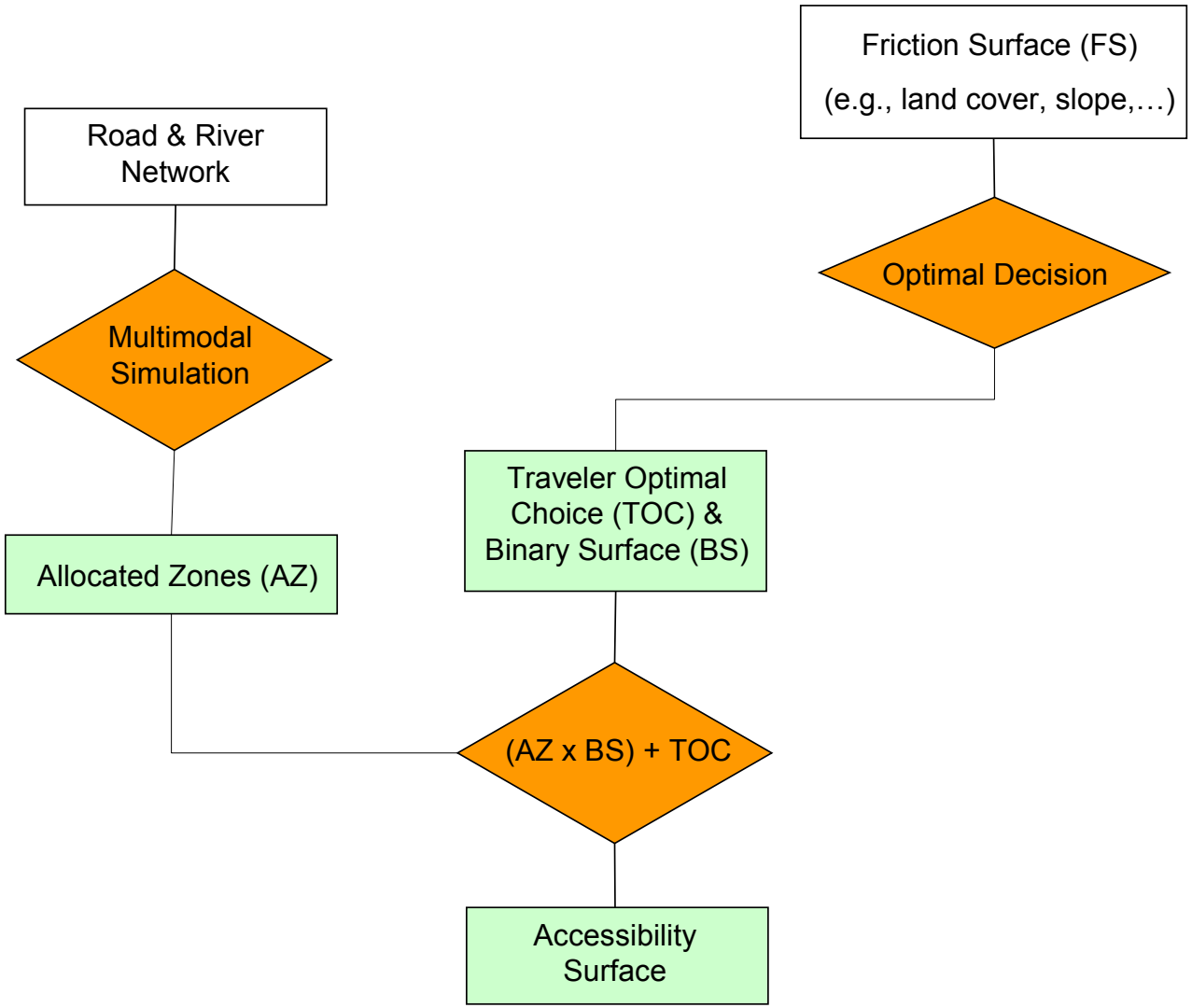
Framework

- LU Dynamics models tend to use euclidean distances as an accessibility indicator
- However a reliable accessibility model must integrate multimodal aspects as well as transport capacities
- Need to overcome limitations of a scarce and coarse network dataset

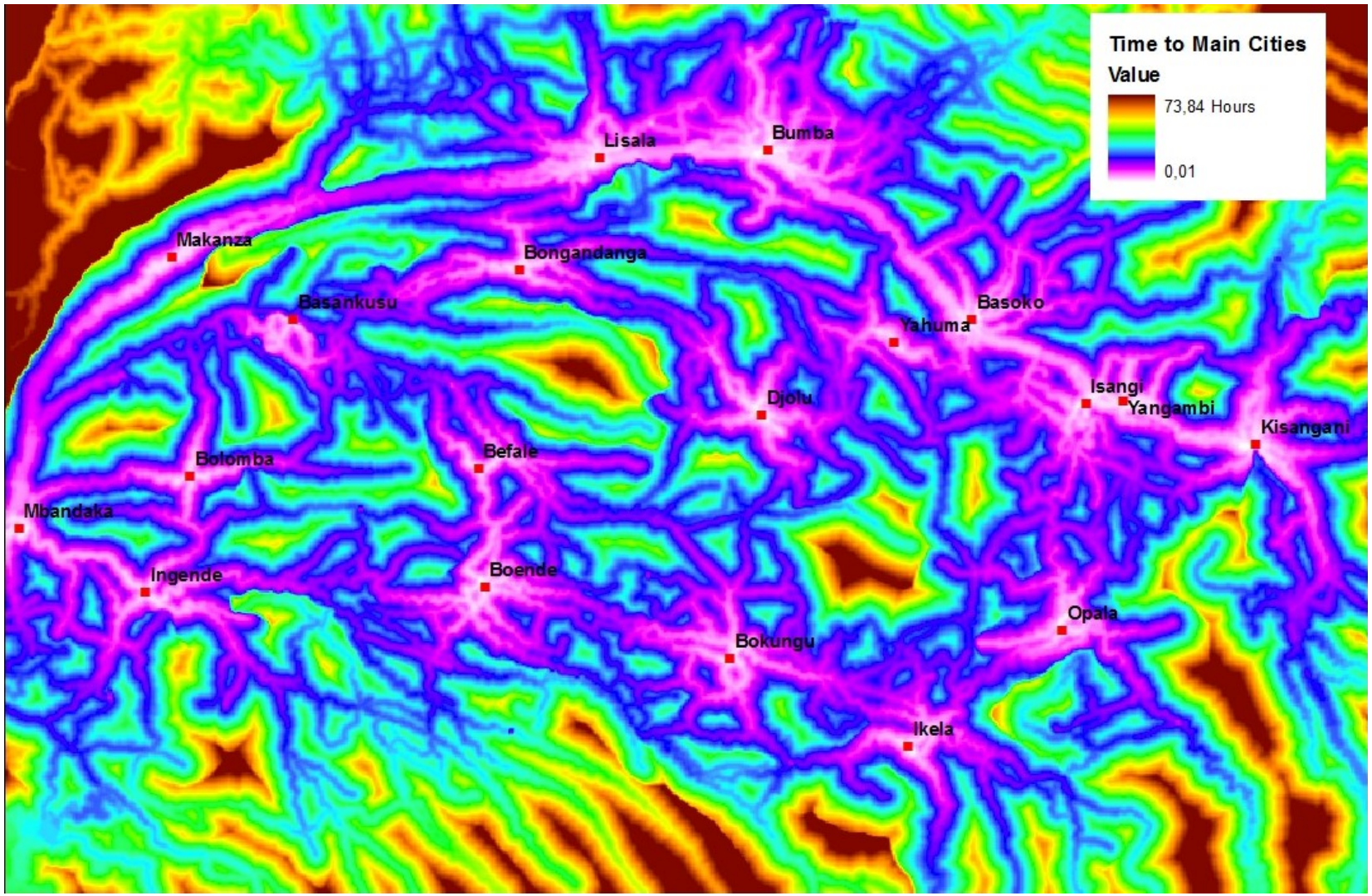
Illustration of DRC road and river dataset



Accessibility Simulation Process



Accessibility to Main Cities



MLW Case Study - Previous Presentations

- Janet Nackoney (UMd)
- Jef Dupain (AWF)
- MLW Consortium activities

Summary

- Results of human population distribution and accessibility modeling are promising
- Need for an external validation of derived population densities estimates
- Better characterization of markets' roles
- Better calibration of the model

THANKS FOR YOUR ATTENTION...