BhOOmi

Cristián Garay

Brian Goodness

Eric Hagen

Deepa Kalpathi

Surendran Subbiah

Faculty Advisor: Joshua Blumenstock

Problem space

- Information void in developing world
- Governments in many developing countries lack the resources to produce reliable data about their citizenry
- Policy makers and aid organizations are forced to make decisions based on incomplete information

Blumenstock, J. E. "Fighting Poverty with Data." Science 353.6301 (2016): 753-54. Web.

Current Approaches for Measuring Wealth

Surveys

The DHS Program
Demographic and Health Surveys

- Expensive, costly
- Infrequent

Night Lights

- Can serve as proxy for economic indicators
- Performs poorly in *low-lit* areas; hard to differentiate at extreme levels of poverty

Jean et al (2016)

- Used *daytime* satellite imagery to train model vs. nightlights and wealth
- Leverages computer vision; e.g., can distinguish between the type of building
- Validated on Rwanda and four Sub-Saharan African nations
- Served as an inspiration/foundation for our project

Science AAAS

Jean, N., Burke, M., Xie, M., Davis, W.M., Lobell, D.B., Ermon, S., 2016. Combining satellite imagery and machine learning to predict poverty. Science 353, 790–794. doi:10.1126/science.aaf7894.

Research & Data

Takeaways from User Research

“Surveys are expensive; and the reliability of this data is questionable”

“Quantifiable metrics is a challenge in International Development.”

“Today we use an opportunistic approach, based on what data we have access to”

Ann Blake, 28 years

Education: London School of Economics

Employment: Project Analyst with International Monetary Fund, Financial analyst at Morgan Stanley

Role / Activities: Data Guru; Mixes & matches reports

Primary tool: Microsoft Excel

The Data

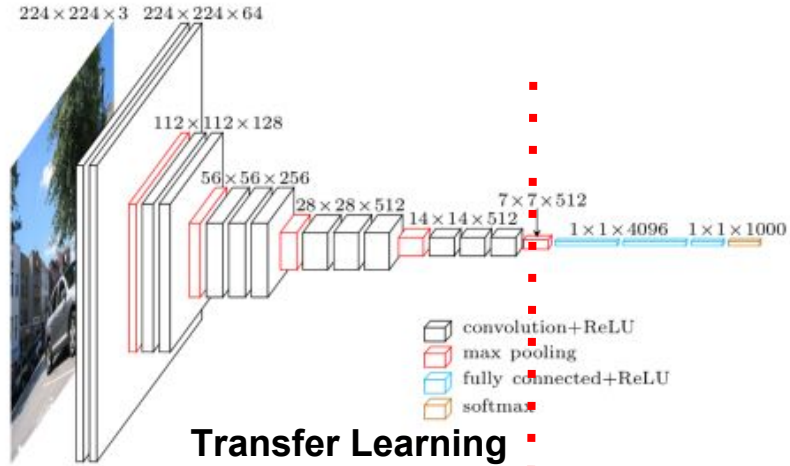
(1) Nightlights satellite imagery: NOAA

(2) Daylight satellite imagery: Google Static Maps API

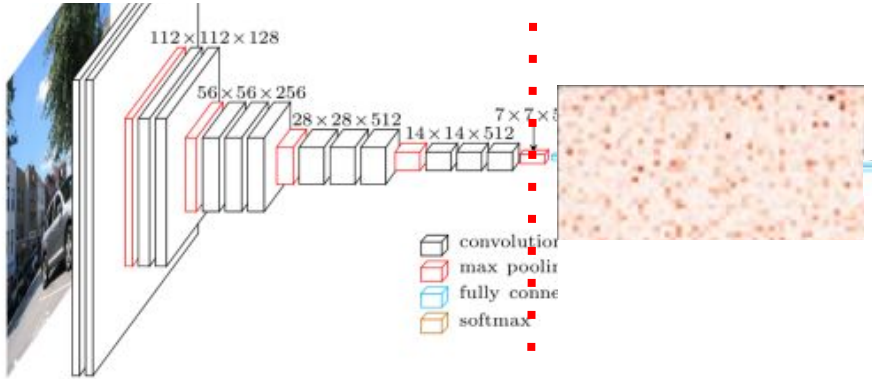
(3) DHS surveys

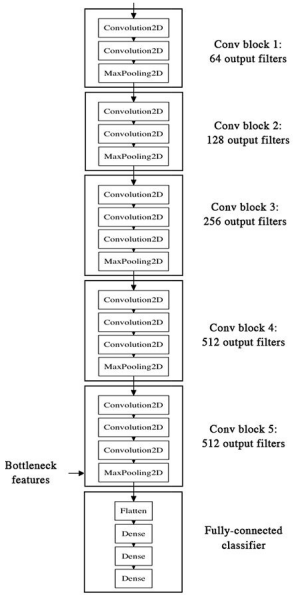
Machine Learning

Deep Neural Nets -
Learning features from daylight satellite imagery using Deep Learning tools



Transfer Learning

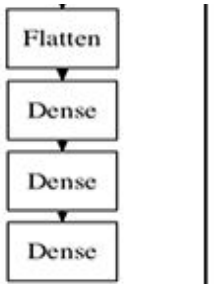




Fine Tuning

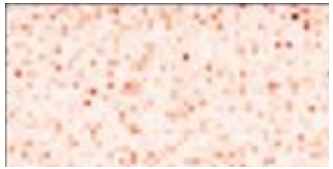
K. Simonyan, A. Zisserman. "Very Deep Convolutional Networks for Large-Scale Image Recognition." 2015.

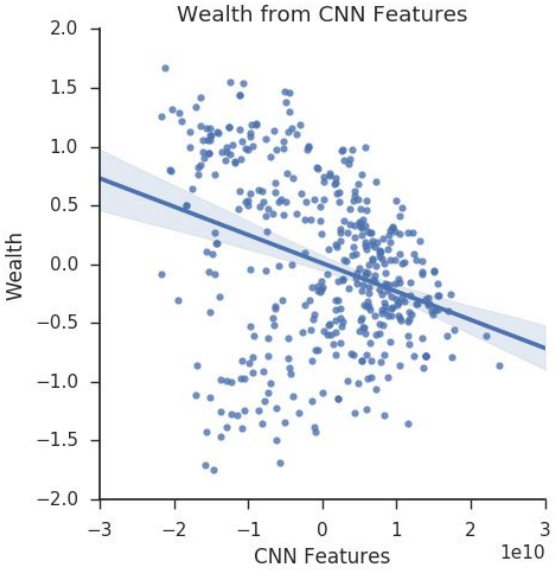
Wealth Prediction



Fully-connected classifier

Extract a representation of Daylight





Build a Regression Model

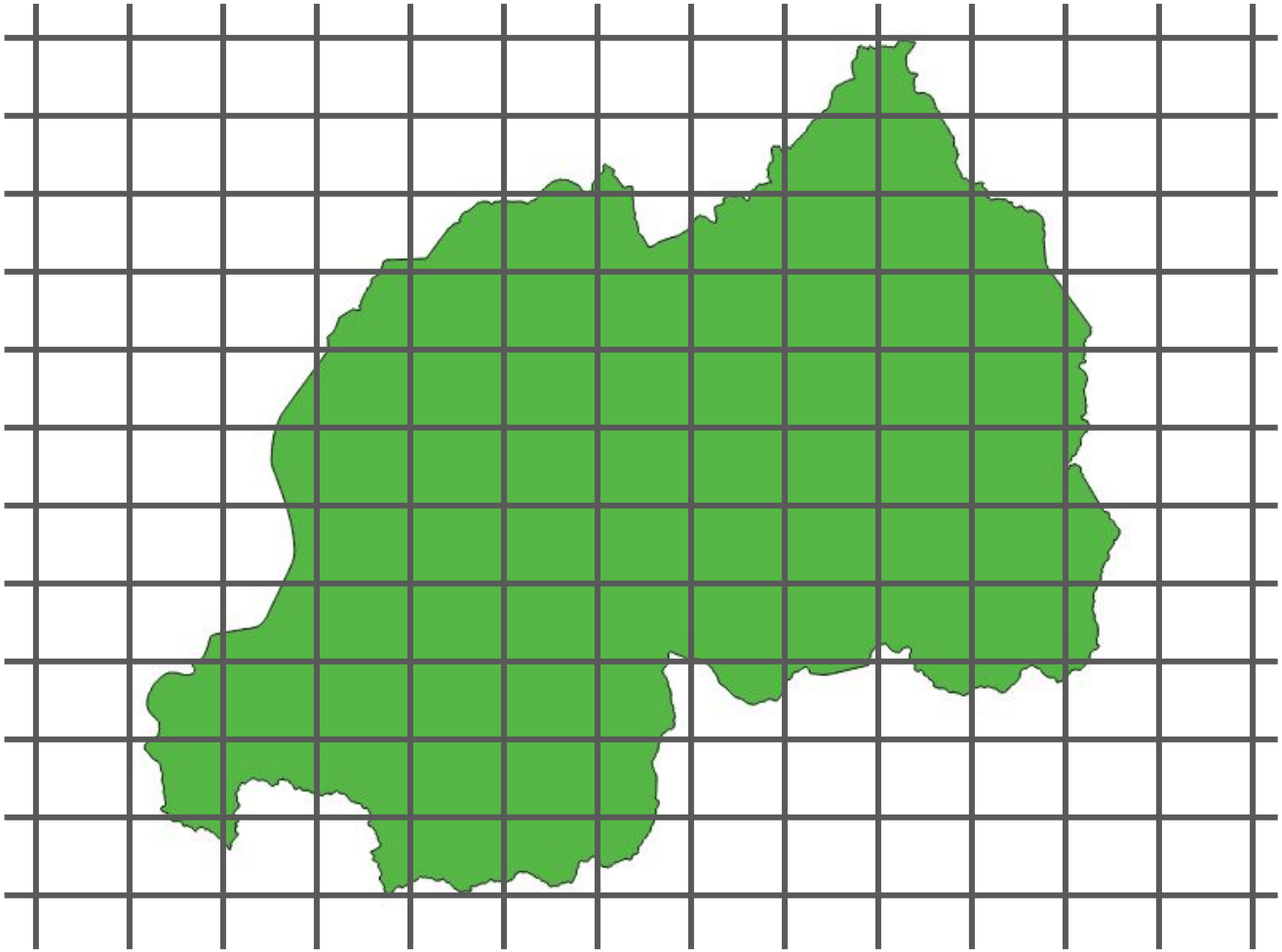
R^2 = 0.672

Data Management

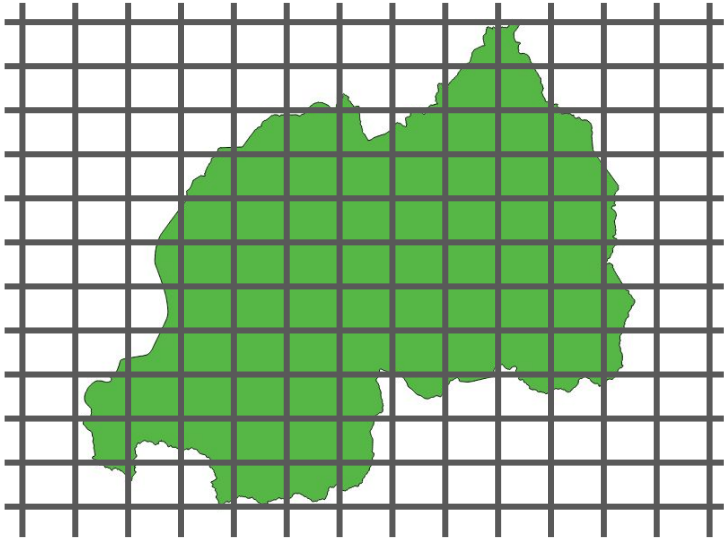
Built a Pipeline for Four Countries

2.7 Million Images

Partitioned Each Country into Latticed Grid of 1km x 1km cells



Wealth predictions for
each 1km x 1km cell



Spatially joined cells and aggregated to
regions at 3 different levels within country

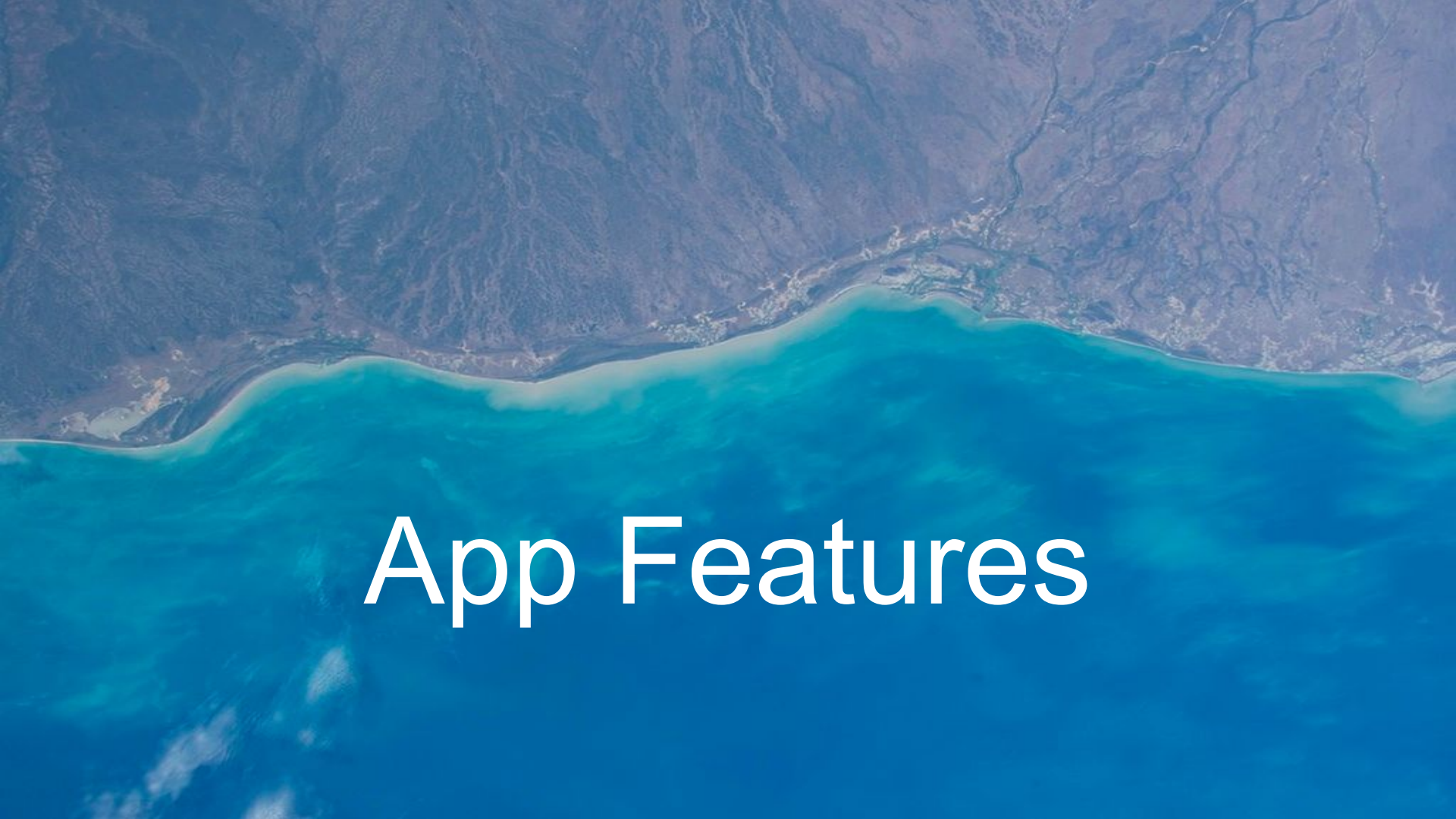
Web Architecture

Web Architecture

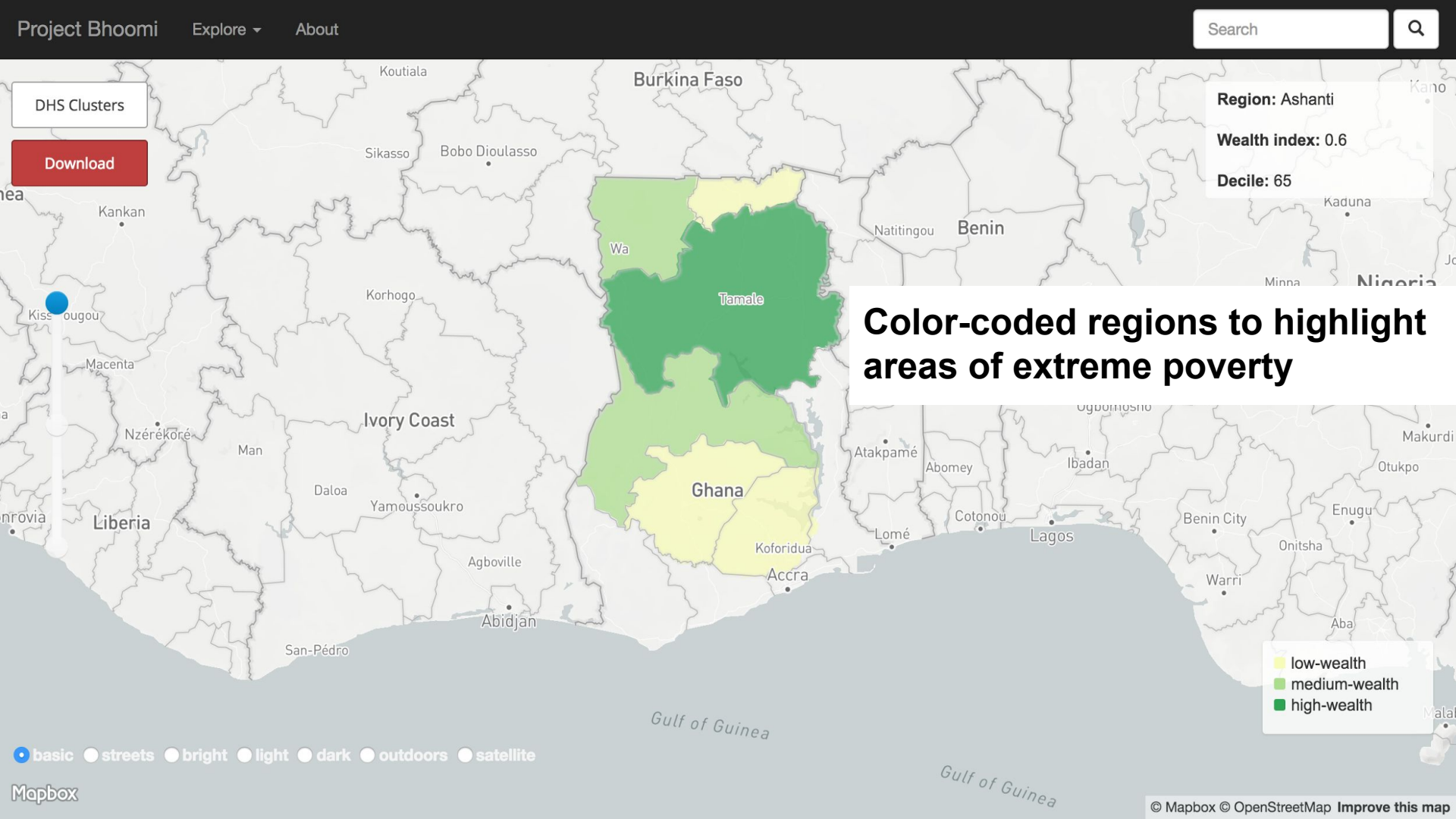
Fast concept to completion.
“Batteries included” modules to handle common web tasks.
Scalable

GeoJSON allows encoding a variety of geographic data structures in JSON objects.

Responsive design.
Consistent styles.
Maps with easy to use API and design tools.



App Features


Project Bhoomi
Explore
About
Search
DHS Clusters
Download
Region: Ashanti
Wealth index: 0.6
Decile: 65
Color-coded regions to highlight areas of extreme poverty
Burkina Faso
Koutiala
Sikasso
Bobo Dioulasso
Kankan
Kissidougou
Korhogo
Macenta
Nzérékoré
Man
Ivory Coast
Daloa
Yamoussoukro
Liberia
Monrovia
Agboville
Abidjan
San-Pédro
Wa
Tamale
Ghana
Koforidua
Accra
Natitingou
Benin
Atakpamé
Abomey
Lomé
Cotonou
Lagos
Ibadan
Ogbomosho
Kaduna
Kano
Minna
Nigeria
Makurdi
Otukpo
Enugu
Benin City
Onitsha
Warri
Aba
Gulf of Guinea
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medium-wealth
high-wealth
basic
streets
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light
dark
outdoors
satellite
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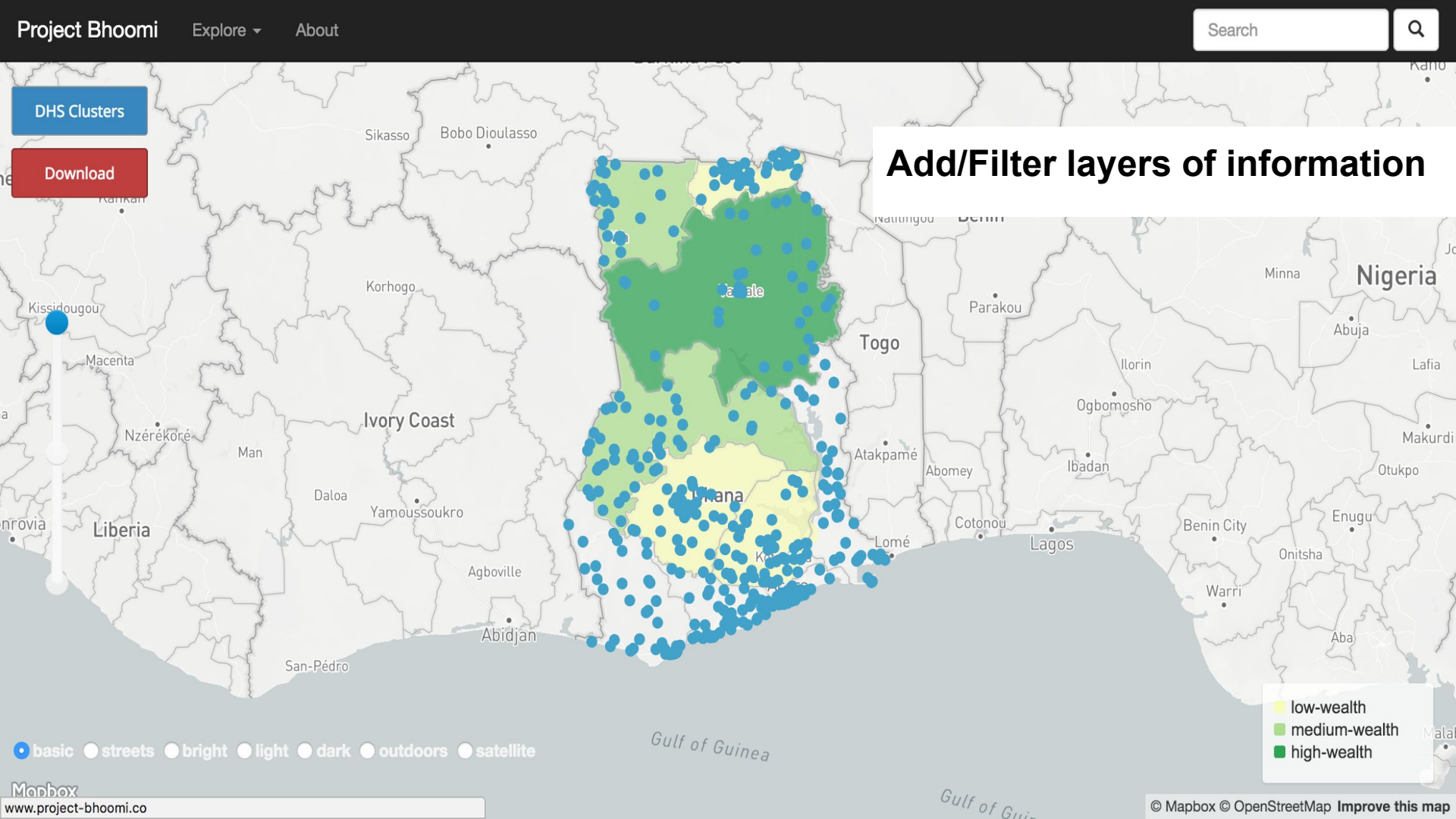
Project Bhoomi
Explore
About
Search
DHS Clusters
Download
Add/Filter layers of information
Sikasso
Bobo Dioulasso
Korhogo
Kissidougou
Macenta
Nzérékoré
Man
Ivory Coast
Daloa
Yamoussoukro
Liberia
Agboville
Abidjan
San-Pédro
Togo
Parakou
Atakpamé
Abomey
Lomé
Cotonou
Lagos
Ilorin
Ogbomosho
Ibadan
Abuja
Minna
Nigeria
Lafia
Makurdi
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DHS Clusters

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Browse across countries and regions

Kamina
Kolwezi
Likasi
Lubumbashi
Kasama
Mbeya
Selous Game Reserve
Songea
Mtwara
Mzuzu
Niassa National Reserve
Comoros
Pemba
Malawi
Lichinga
Chipata
Lilongwe
Zambia
Nacala
Kafue National Park
Lusaka
Nampula
Zomba
Blantyre
Tete
Mulilo
Livingstone
Kadoma
Mozambique
Quelimane

low-wealth
medium-wealth
high-wealth

Mapbox

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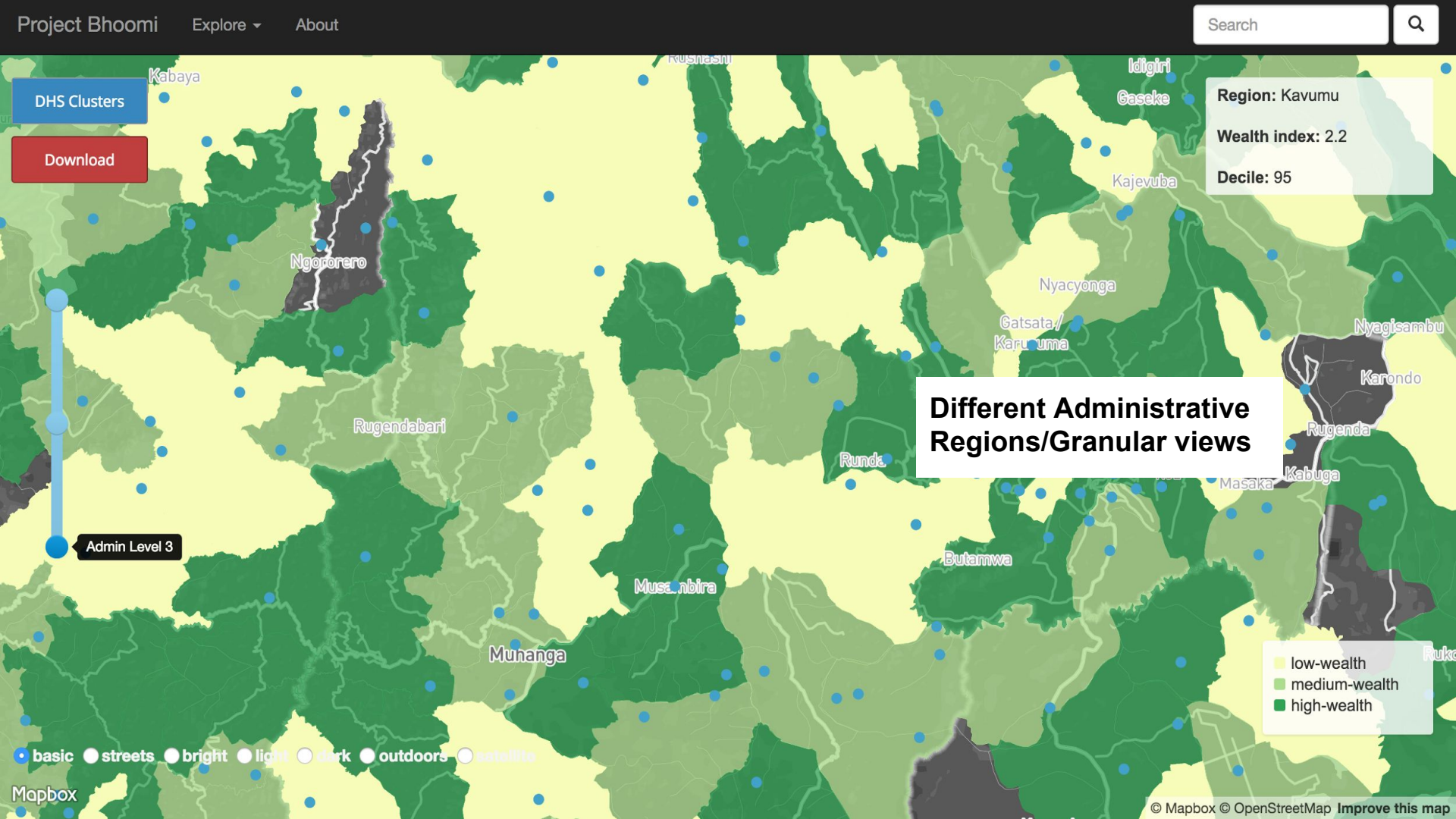
Project Bhoomi
Explore
About
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DHS Clusters
Download
Region: Kavumu
Wealth index: 2.2
Decile: 95
Admin Level 3
Different Administrative Regions/Granular views
Kabaya
Idigiri
Gaseke
Kajevuba
Ngororero
Nyacyonga
Gatsata/
Karuruma
Nyagisambu
Karondo
Rugendabari
Rugenda
Runda
Masaka
Kabuga
Butamwa
Musambira
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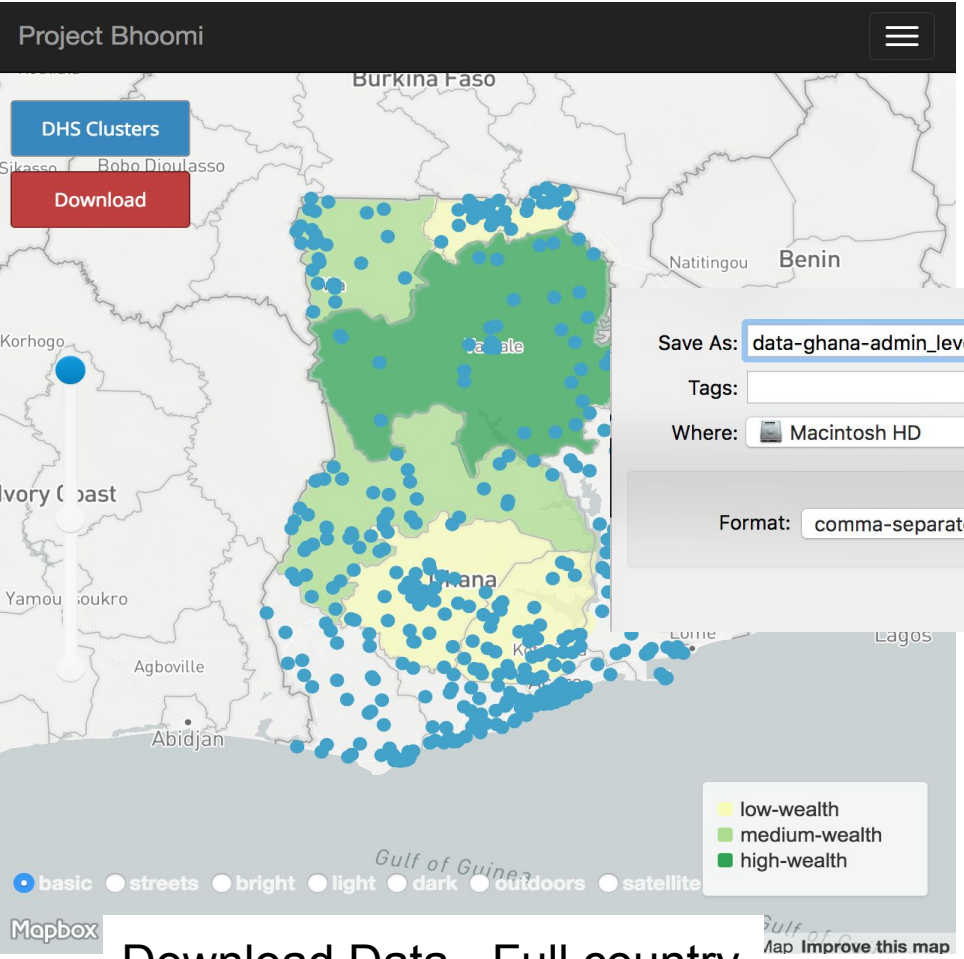
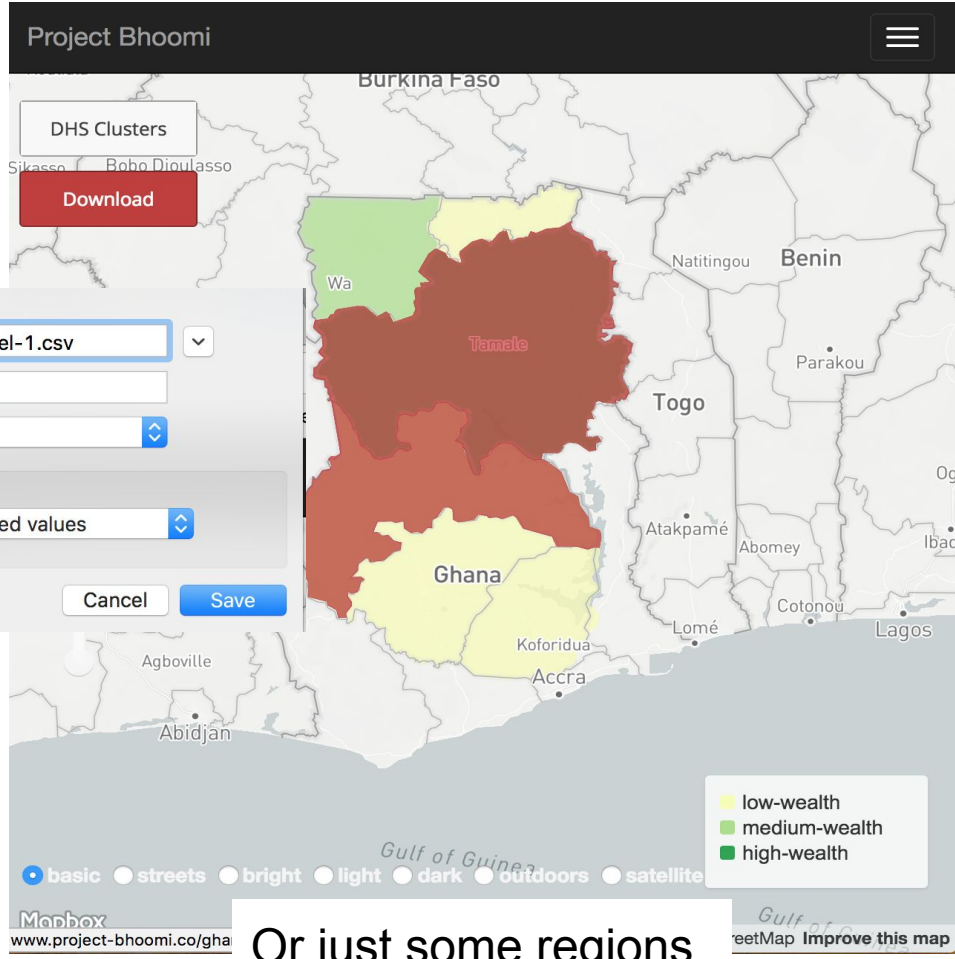


Download Data - Full country



Or just some regions

Special Acknowledgments

Joshua Blumenstock - Faculty Advisor

Guanghua Chi


Questions?