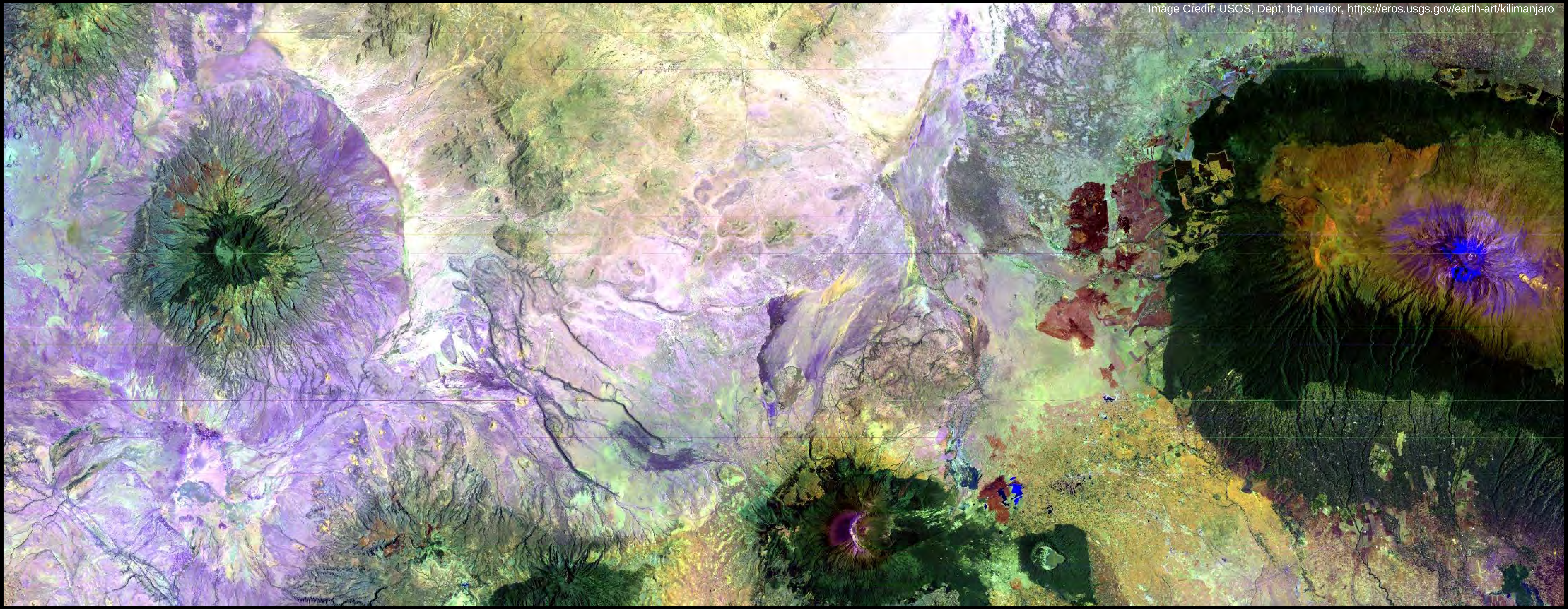
Designing Applications to Foster the Health of Terrestrial and Wetland Ecosystems in the Coastal Zone of West Africa



Danielle Wood (MIT), David Lagomasino (ECU), Ufuoma Ovienmhada (MIT), Abigail Barenblitt (NASA), Amanda Payton (ECU),

Jack Reid (MIT), Seamus Lombardo (MIT), Eric Ashcroft (Blue Raster), Temilola Fatoyinbo-Agueh (NASA)


1 NO POVERTY
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5 GENDER EQUALITY
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7 RENEWABLE ENERGY
8 GOOD JOBS AND ECONOMIC GROWTH
9 INNOVATION AND INFRASTRUCTURE
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15 LIFE ON LAND
16 PEACE AND JUSTICE
17 PARTNERSHIPS FOR THE GOALS
THE GLOBAL GOALS
For Sustainable Development

1. Earth Observation (EO) System Design and Implementation
2. EO System Operation, Data Retrieval, Calibration & Validation
3. EO Data Correction and Processing
4. Earth Science Modeling and Assimilation of Earth Observations
5. EO Data Discovery & Visualization: Providing interface to find and explore data
6. EO Data Transformation: Creating data interface based on user needs
7. Knowledge Integration: Combining physical, social, economic and other data
8. Decision Support: Providing recommendations for action

Hakimdavar, Raha, Danielle Wood, John Eylander, Christa Peters-Lidard, Jane Smith, Brad Doorn, David Green, Corey Hummel, and Thomas C. Moore. "Transboundary Water: Improving Methodologies and Developing Integrated Tools to Support Water Security." (2018). https://ntrs.nasa.gov/search.jsp?R=20180002176

Designing a Decision Support Tool to support Integrated Water Resource Management and Biodiversity in Lake Nokoue, Benin

US Co-Investigators: Space Enabled Research Group @ MIT Media Lab, NASA Goddard Space Flight Center, Blue Raster

Benin Co-Investigators: Green Keeper Africa

Additional Scientific Input: National Institute of Water, Benin

frontiers in Climate

ORIGINAL RESEARCH
published: 09 September 2021
doi: 10.3389/fclim.2021.717418

Inclusive Design of Earth Observation Decision Support Systems for Environmental Governance: A Case Study of Lake Nokoué

Ufuoma Ovienmhada[1*], *Fohla Mouftaou*[2] *and Danielle Wood*[1]

[1] *MIT Media Lab, Space Enabled Research Group, Massachusetts Institute of Technology, Cambridge, MA, United States,*
[2] *Green Keeper Africa, Cotonou, Benin*

Earth Observation (EO) data can enhance understanding of human-environmental systems for the creation of climate data services, or Decision Support Systems (DSS), to improve monitoring, prediction and mitigation of climate harm. However, EO data is not always incorporated into the workflow for decision-makers for a multitude of reasons including awareness, accessibility and collaboration models. The purpose of this study is to demonstrate a collaborative model that addresses historical power imbalances between communities. This paper highlights a case study of a climate harm mitigation DSS collaboration between the Space Enabled Research Group at the MIT Media Lab and Green Keeper Africa (GKA), an enterprise located in Benin. GKA addresses the management of an invasive plant species that threatens ecosystem health and economic activities on Lake Nokoué. They do this through a social entrepreneurship business model that aims to advance both economic empowerment and environmental health. In demonstrating a Space Enabled-GKA collaboration model that advances GKA's business aims, this study first considers several popular service and technology design methods and offer critiques of each method in terms of their ability to address inclusivity in complex systems. These critiques lead to the selection of the Systems Architecture Framework (SAF) as the technology design method for the case study. In the remainder of the paper, the SAF is applied to the case study to demonstrate how the framework coproduces knowledge that would inform a DSS with Earth Observation data. The paper offers several practical considerations and values related to epistemology, data collection, prioritization and methodology for performing inclusive design of climate data services.

Keywords: earth observation, water hyacinth, climate data services, decision support systems, design

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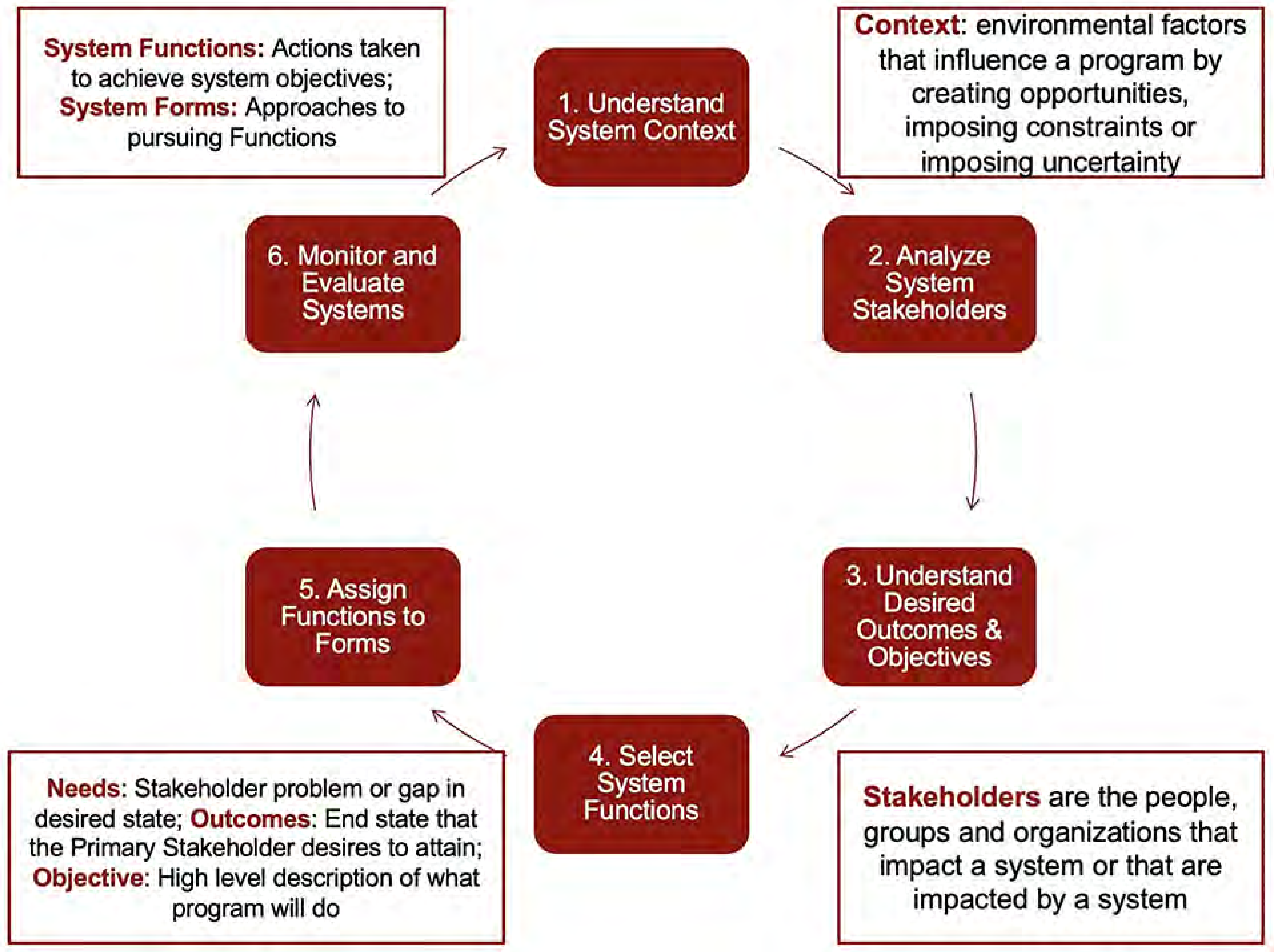
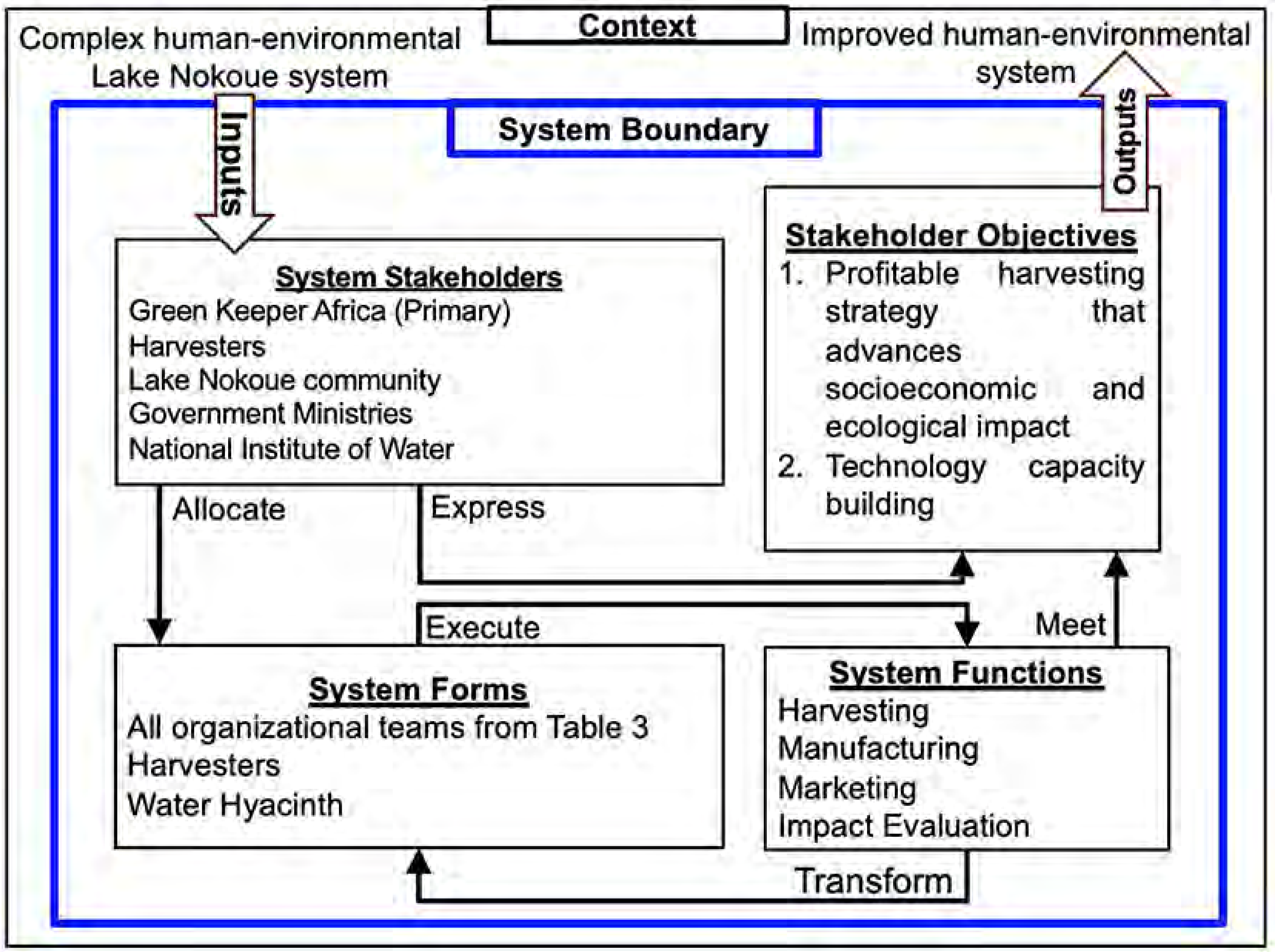
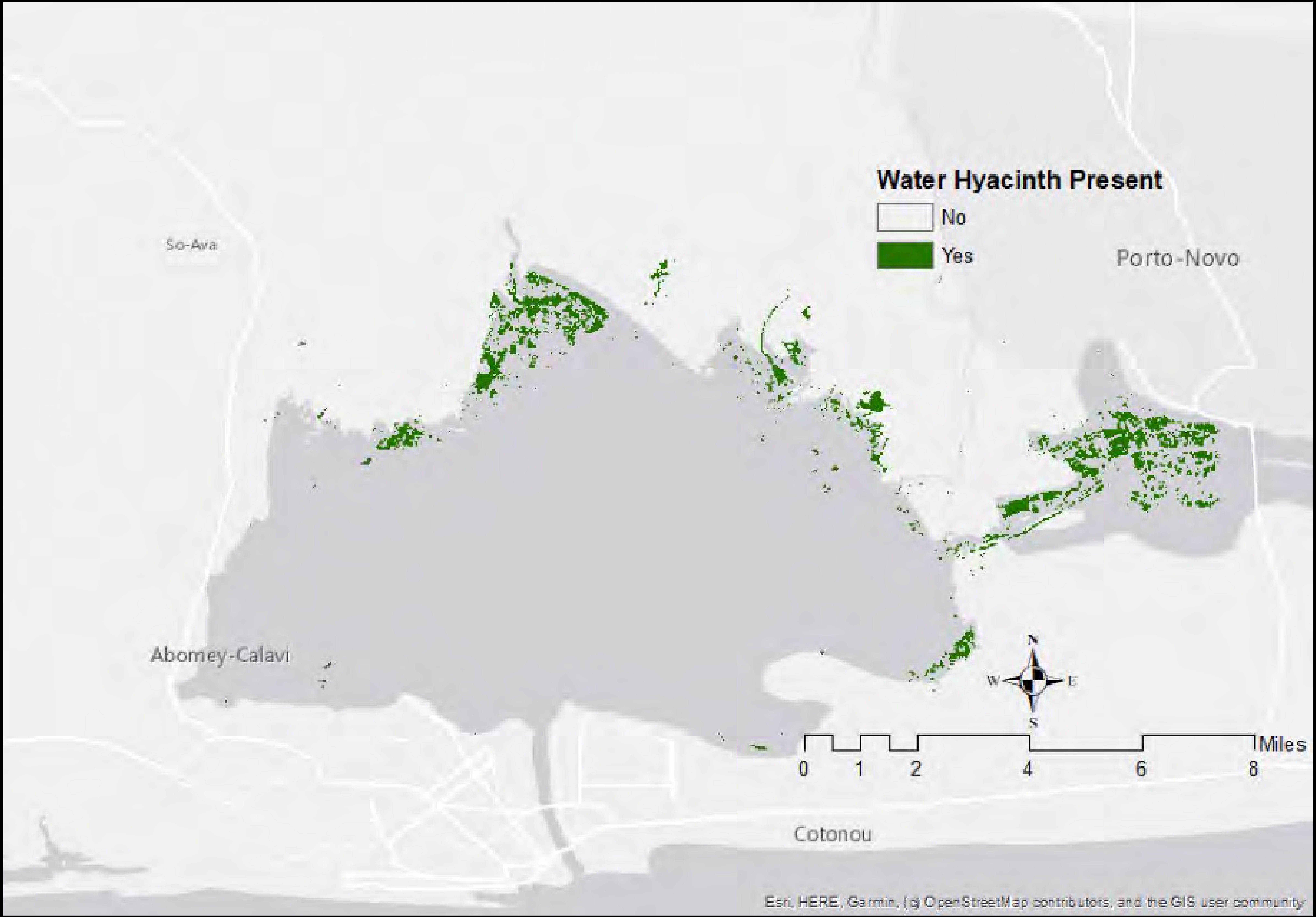

System Functions: Actions taken to achieve system objectives;
System Forms: Approaches to pursuing Functions
1. Understand System Context
Context: environmental factors that influence a program by creating opportunities, imposing constraints or imposing uncertainty
6. Monitor and Evaluate Systems
2. Analyze System Stakeholders
5. Assign Functions to Forms
3. Understand Desired Outcomes & Objectives
4. Select System Functions
Needs: Stakeholder problem or gap in desired state; Outcomes: End state that the Primary Stakeholder desires to attain; Objective: High level description of what program will do
Stakeholders are the people, groups and organizations that impact a system or that are impacted by a system

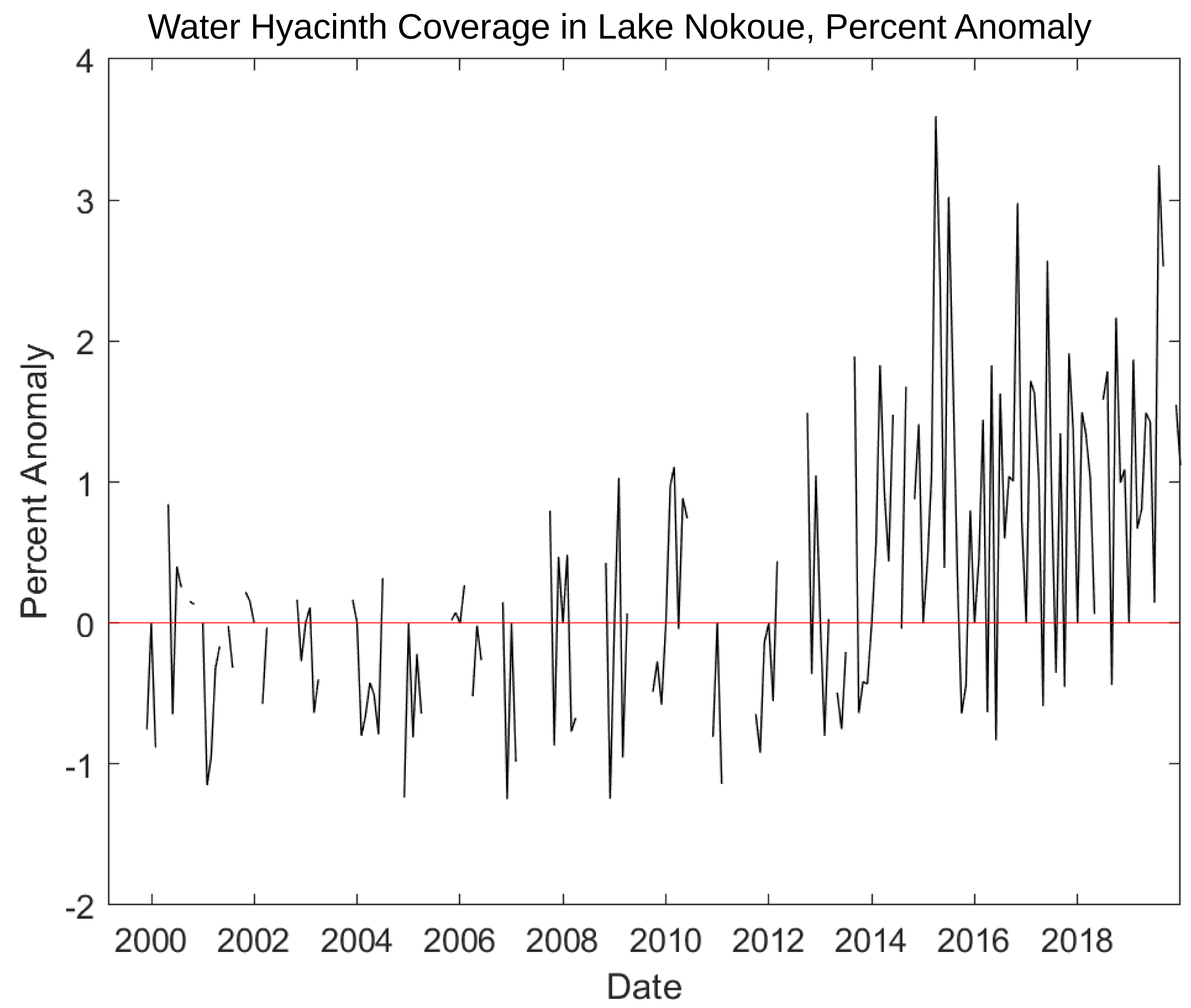
Ecotechnology firm Green Keeper Africa is a co-Investigator focused on invasive species management in Benin (SDG 15.8). Photo from August 2019 visit.

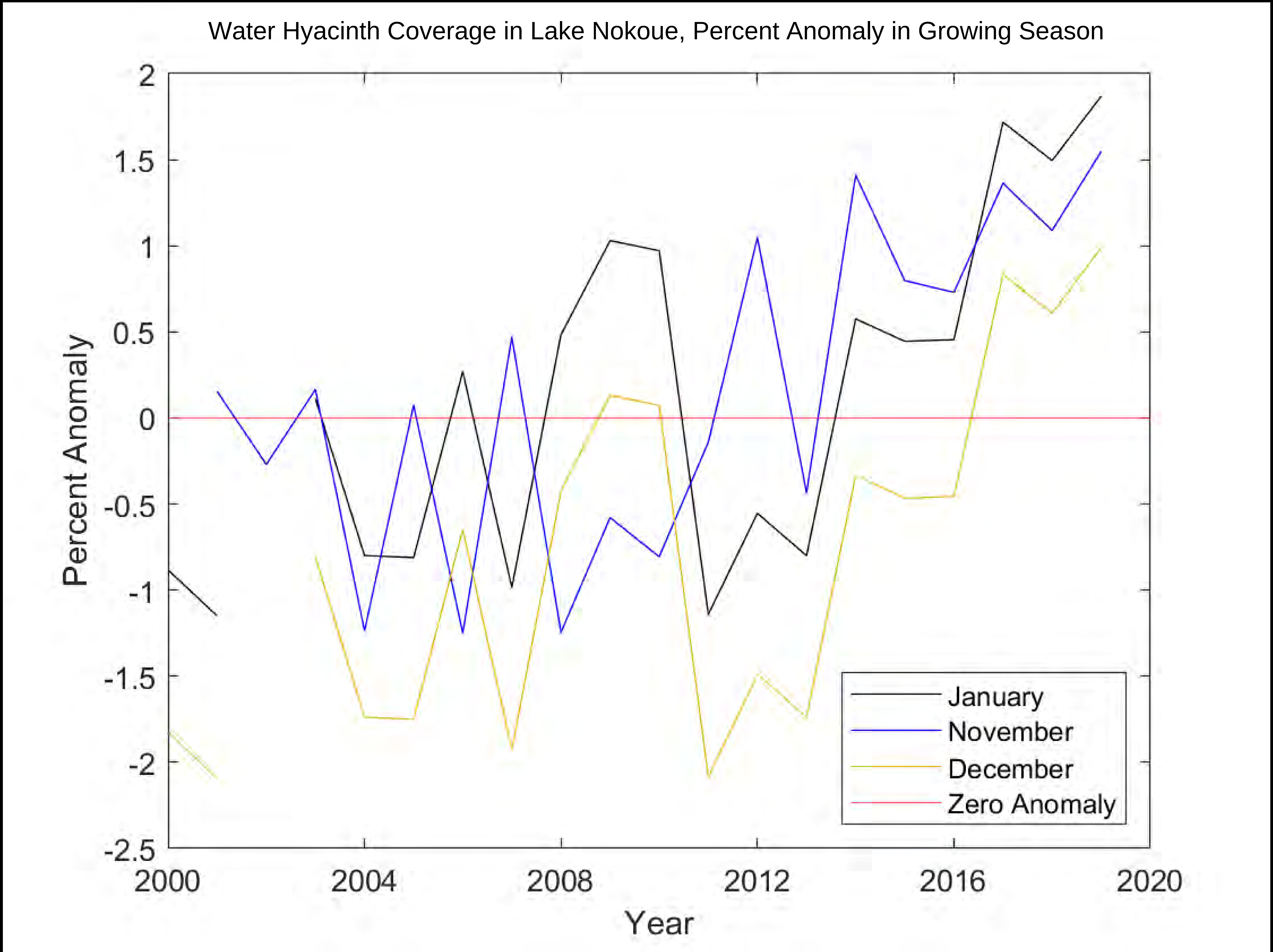

440000
460000
720000
700000
Sô RIVER
SO-AVA
Ouémé
ABOMEY CALAVI
NOKOUE LAKE
PORTO NOVO
LAGOON PORTO-NOVO
SEME
COTONOU
ATLANTIC OCEAN
N
S
E
W
0 3 6 12 Km
Legend
Main town
Local government
Stream
Water body

Lake Nokoue

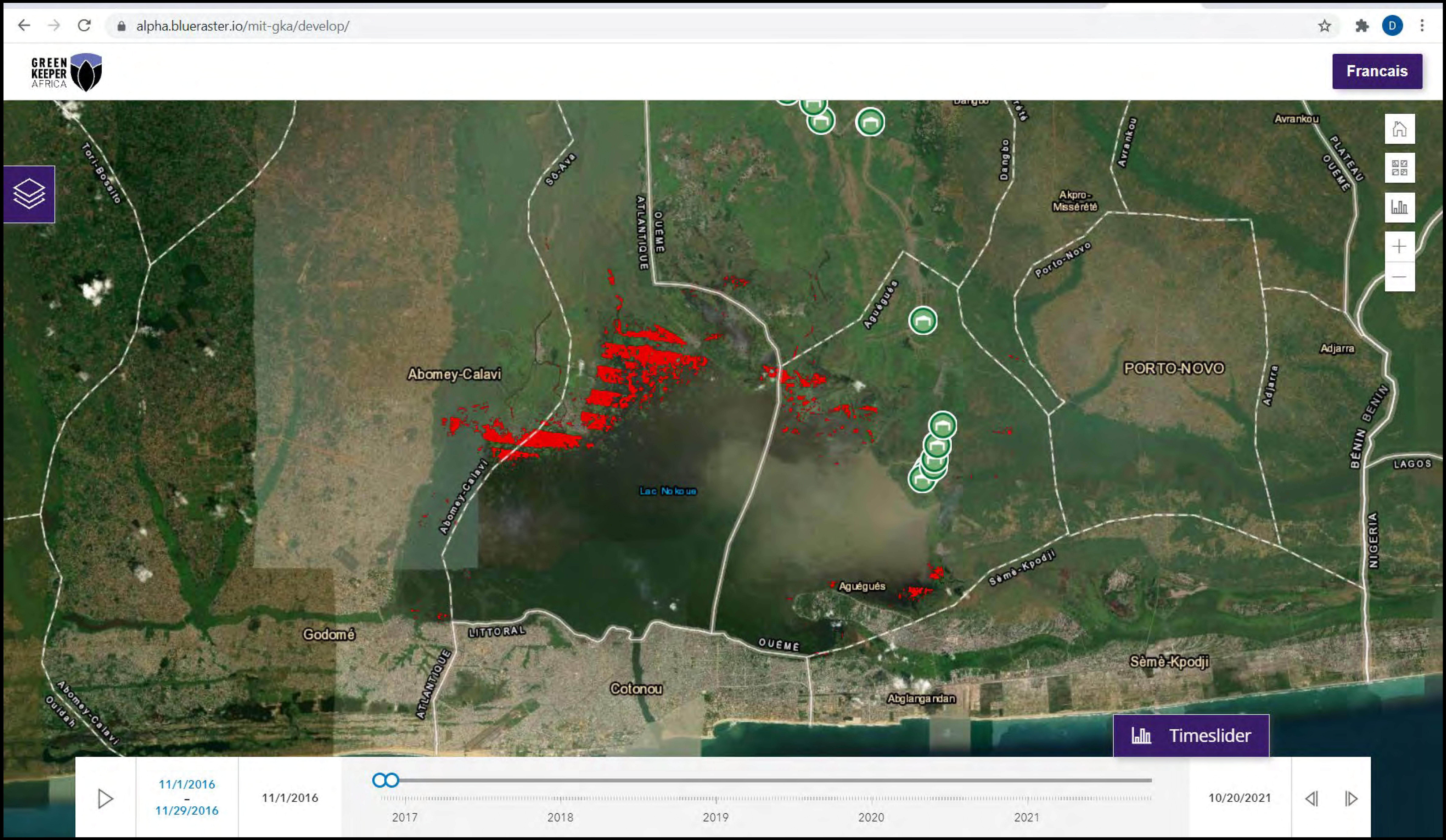

Context
Complex human-environmental Lake Nokoue system
Improved human-environmental system
System Boundary
Inputs
Outputs
System Stakeholders
Green Keeper Africa (Primary)
Harvesters
Lake Nokoue community
Government Ministries
National Institute of Water
Stakeholder Objectives
1. Profitable harvesting strategy that advances socioeconomic and ecological impact
2. Technology capacity building
Allocate
Express
Execute
Meet
System Forms
All organizational teams from Table 3
Harvesters
Water Hyacinth
System Functions
Harvesting
Manufacturing
Marketing
Impact Evaluation
Transform


Water Hyacinth Present
No
Yes
So-Ava
Porto-Novo
Abomey-Calavi
Cotonou
N
W
E
S
0
1
2
4
6
8
Miles
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community


Water Hyacinth Coverage in Lake Nokoue, Percent Anomaly
Percent Anomaly
4
3
2
1
0
-1
-2
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date



Water Hyacinth Coverage in Lake Nokoue, Percent Anomaly in Growing Season
Percent Anomaly
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
2000
2004
2008
2012
2016
2020
Year
January
November
December
Zero Anomaly



alpha.blueraster.io/mit-gka/develop/
GREEN KEEPER AFRICA
Francais
Abomey-Calavi
Lac Nokoue
PORTO-NOVO
Godomé
Cotonou
Aguégués
Sèmè-Kpodji
Abglangandan
Akpro-Missérété
Avrankou
Adjarra
LITTORAL
OUEME
ATLANTIQUE
NIGERIA
LAGOS
Timeslider
11/1/2016
-
11/29/2016
11/1/2016
2017
2018
2019
2020
2021
10/20/2021


Earth Engine Apps
Experimental
Search places
Layers
Map
Satellite
Burkina Faso
Ghana
Nigeria
Landcover Classes
Waterbodies
Mangrove/Forested Wetlands
Wetland
Mining
Artificial Surfaces
Closed Forest
Open Forest
Woody Crops
Agriculture
Grassland/Shrubland
Mixed Vegetation
Bare
Disclaimer: Please note that the data presented here is preliminary and subject to revision.
Map data ©2021 Google
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Analysis of deforestation due to mining in Southwestern Ghana

US Co-Investigators: Space Enabled Research Group @ MIT Media Lab, NASA Goddard Space Flight Center

West African Co-Investigators: Ghana Statistical Service, Ghana Space Science and Technology Institute

The Ghana Space Science and Technology Institute is also a Co-Investigator on the project. They are contributing to the develop methods to map mining and mangroves.

GHANA SPACE
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journal homepage: www.elsevier.com/locate/scitotenv

The large footprint of small-scale artisanal gold mining in Ghana

Abigail Barenblitt [a,c,*], Amanda Payton [b], David Lagomasino [b], Lola Fatoyinbo [c], Kofi Asare [d], Kenneth Aidoo [d], Hugo Pigott [e], Charles Kofi Som [e], Laurent Smeets [e], Omar Seidu [e], Danielle Wood [f]

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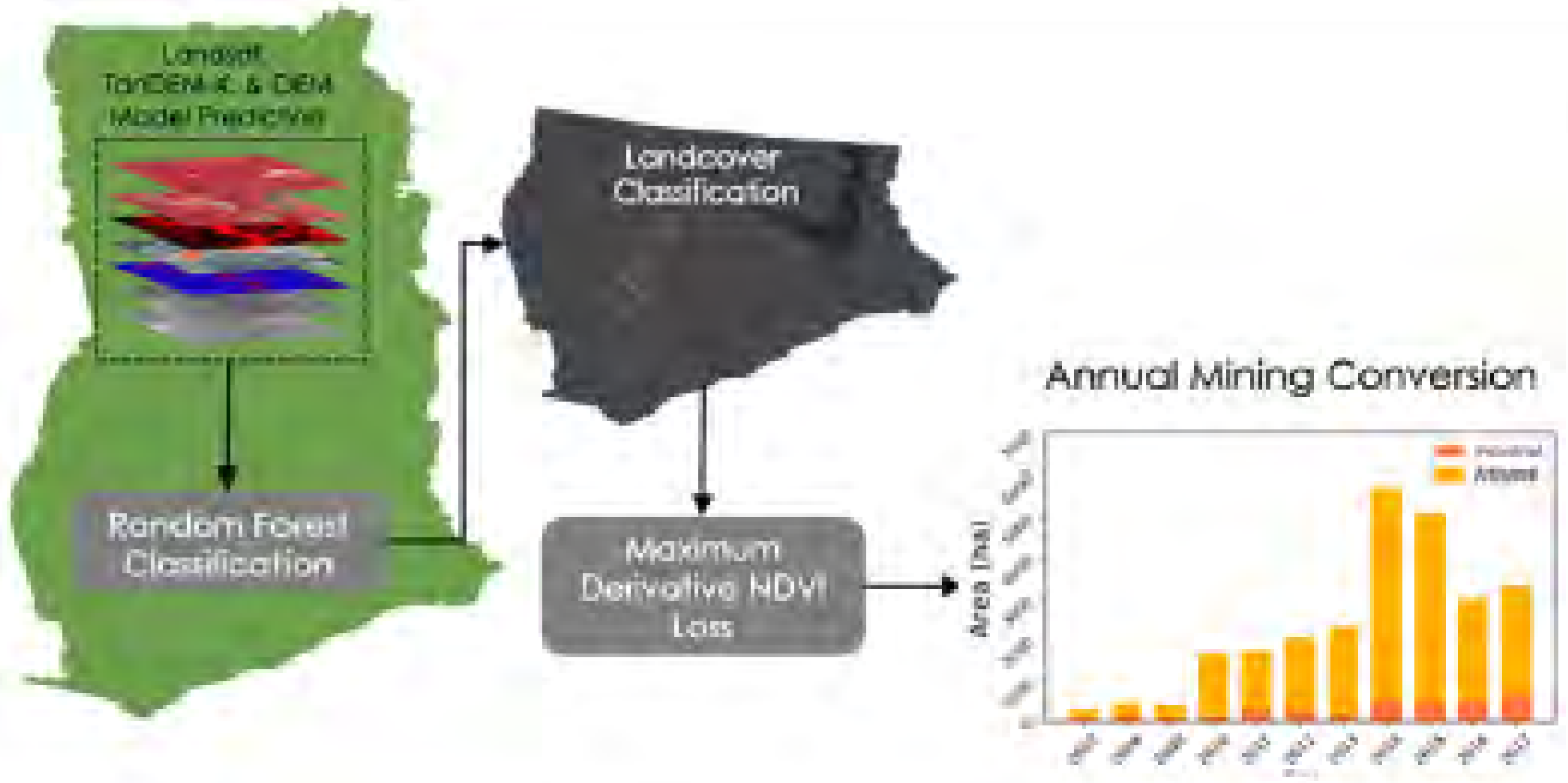
[d] Ghana Space Science and Technology Institute, Accra, Ghana
[e] Ghana Statistical Service, Accra, Ghana
[f] Space Enabled Research Group, Massachusetts Institute of Technology, Cambridge, MA, United States

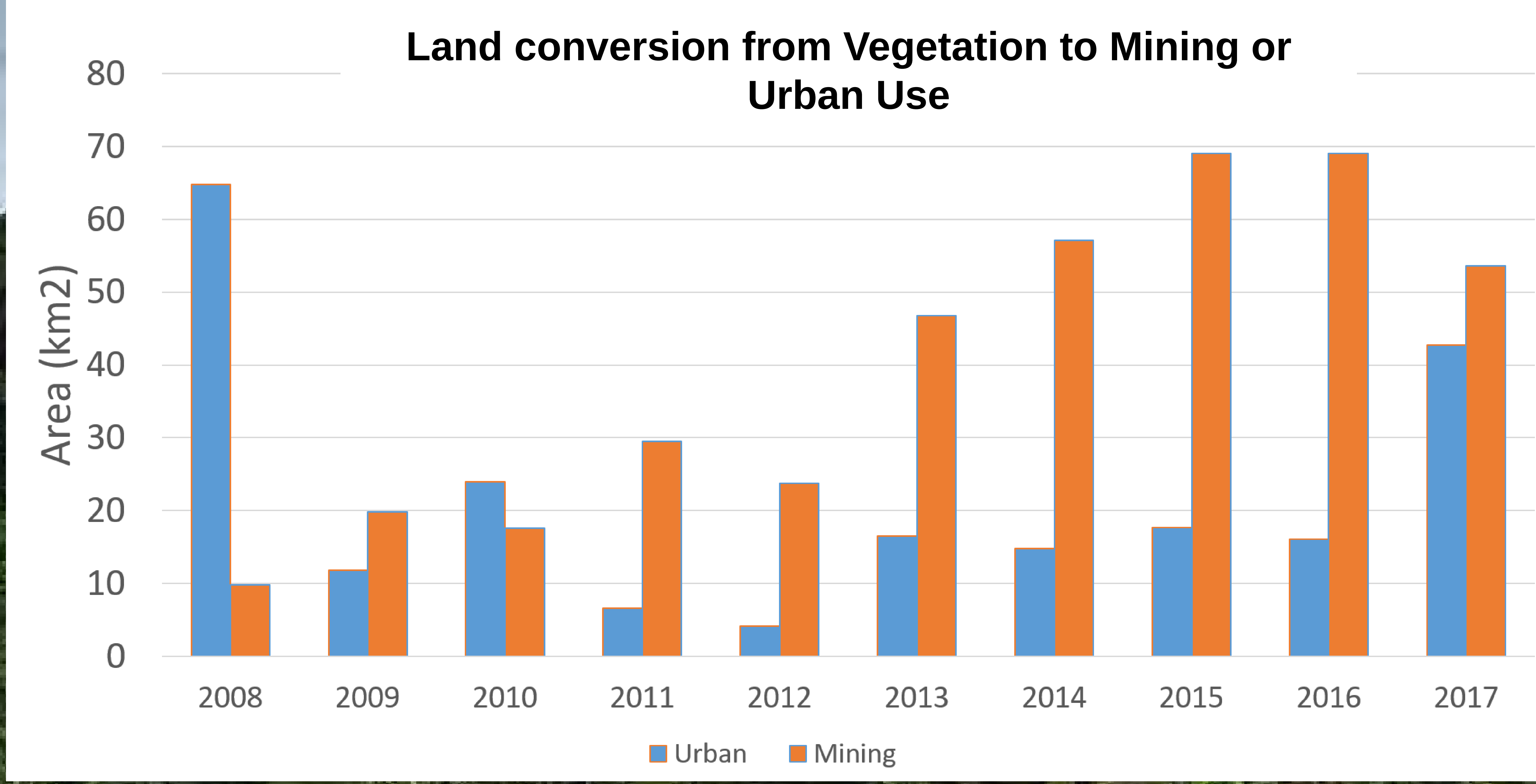
HIGHLIGHTS

- Land conversion in due to artisanal gold mining = that of urban expansion.
- New mining extent (2005 and 2019) was dominated by artisanal mining (~89%).
- Over 700 ha of artisanal mining was detected in protected areas.
- This mining is degrading and destroying forested ecosystems.

GRAPHICAL ABSTRACT




Google Earth
Training Data
Reference Landsat
(2002-2005)
Observation Landsat
(2010-2019)
Timestack
Differencing
Anomalous
NDVI Loss
Random
Forest
Classification
Landcover
Classification
Mining
Landcover Class
Landsat 8
NIR Entropy
TanDEM-X
(2015)
DEM (2000)
Random
Forest
Classification
Small vs
Large Scale
Mines
NDVI
Derivative
Model
Annual
Mining Gain
(2007-2017)

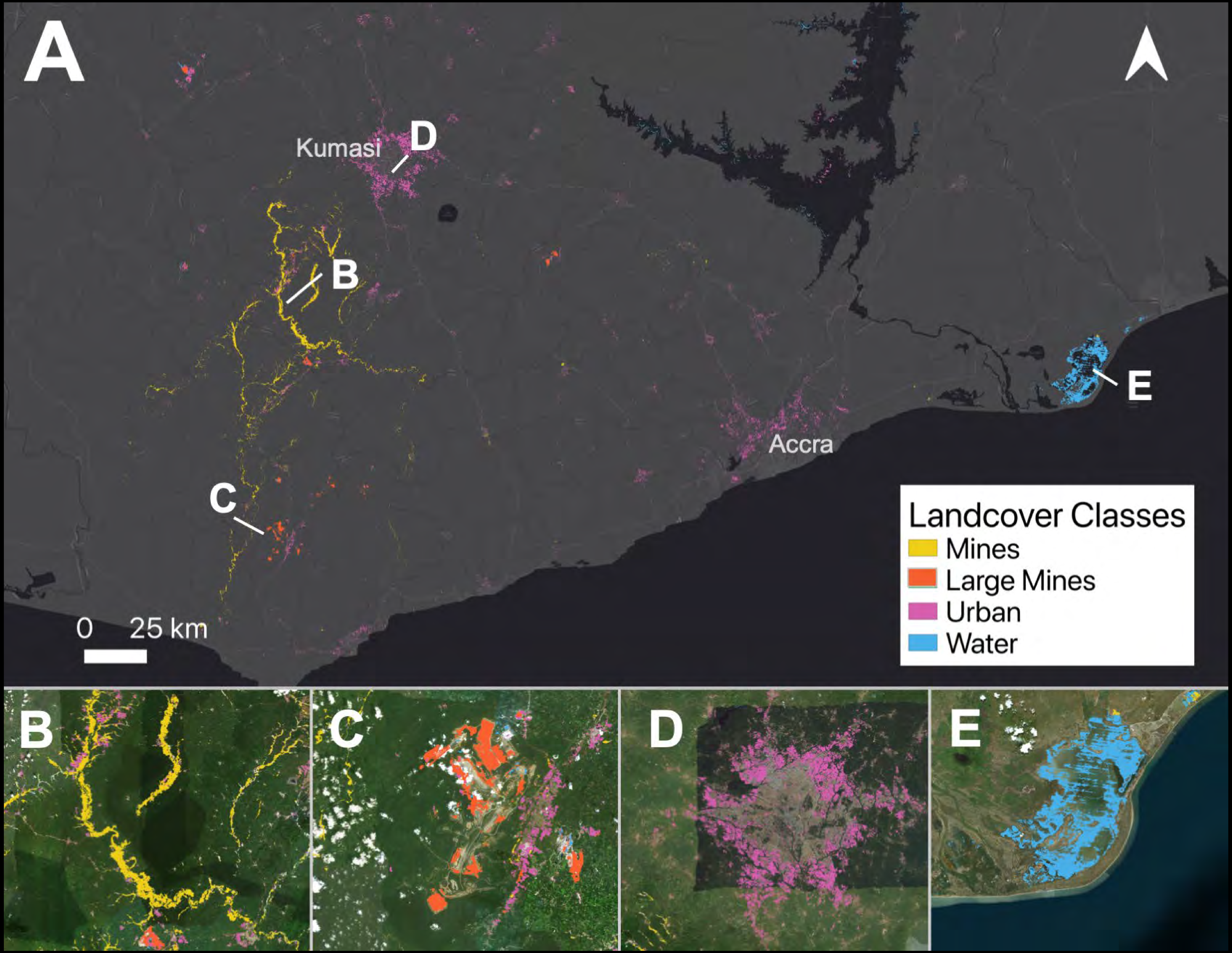


The analysis used Landsat 7 and 8 Imagery (Bands 4 to 7). The observational period was 2008-2017. Land was classified into four classes: Water, Urban, Mine and Vegetation

https://assets.bwbx.io/images/users/iqjWHBFdfxIU/iCk5guosUGns/v2/1000x-1.jpg

Supervised Random Forest Classification

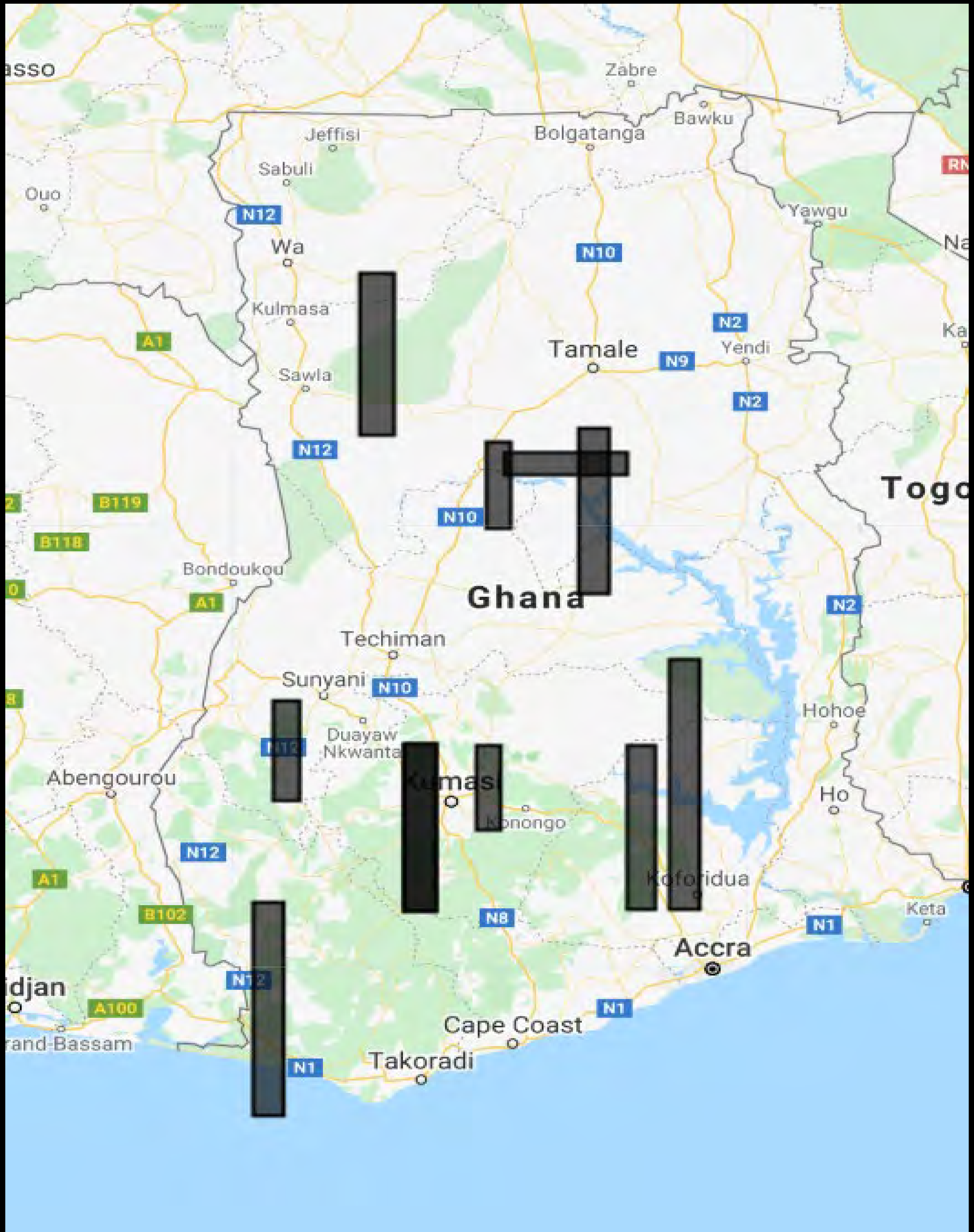
- Landsat 7 and 8 Imagery
- Used bands 1-7
- Observation period: 2007-2017
- 4 landcover classes
  - Water
  - Urban
  - Mines
  - Vegetation

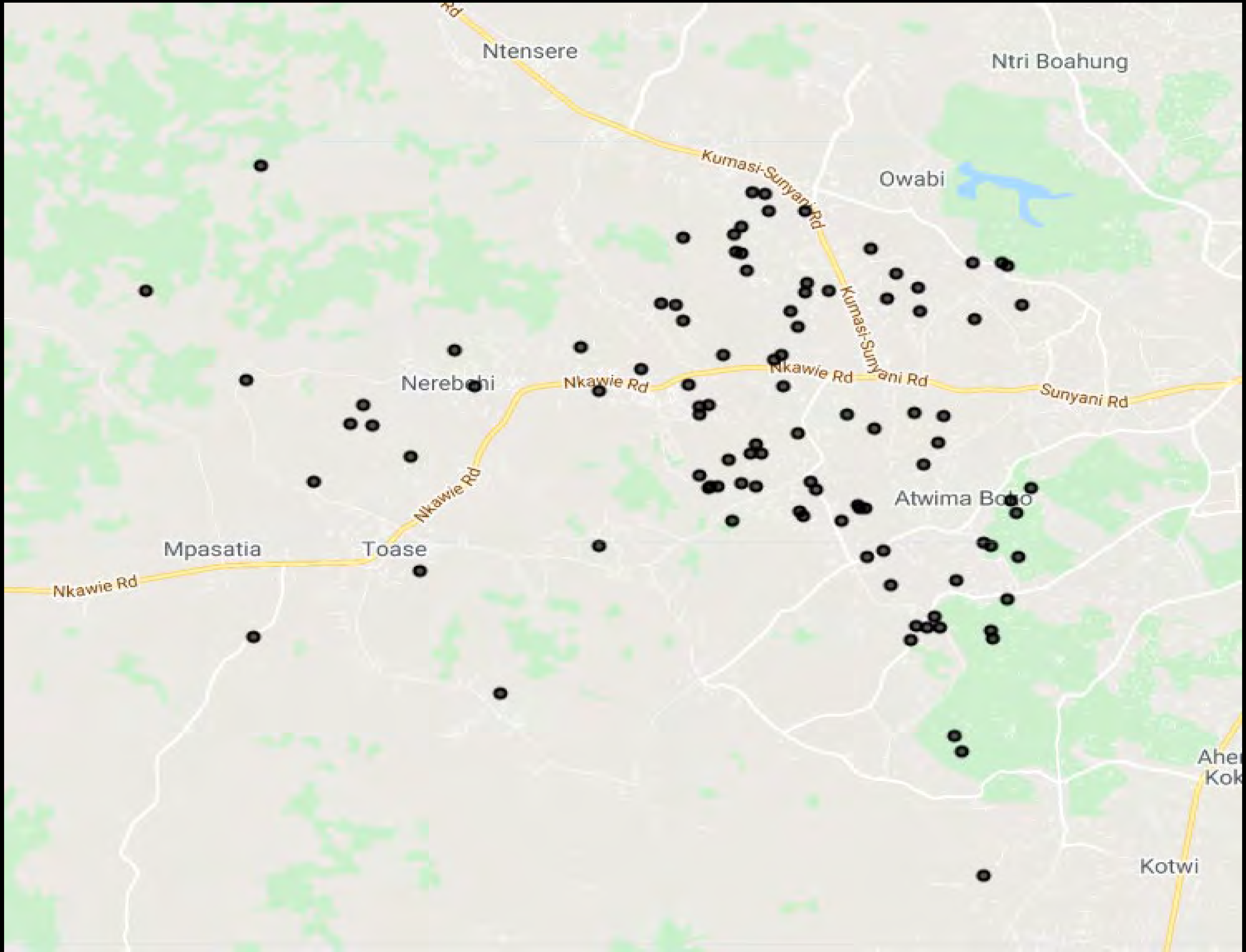


A
Kumasi
D
B
C
E
Accra
0
25 km
Landcover Classes
Mines
Large Mines
Urban
Water
B
C
D
E


A
B
0 2 km
Kumasi
C
0 2 km
D
0 2 km
Accra
0 25 km
Year of Loss
2007
2017

Accuracy Assessment Using Worldview Data






mangrovescience.earthengine.app/view/miningresults
Earth Engine Apps
Experimental
Search places
Layers
Map
Satellite
Select layers to display.
2007
2017
Mining Conversion Year
2016
Annual Mining Conversion
Total Mining Area
Artisanal
Industrial
World Database Protected Areas
Visit Example Locations
Select
Graphs of Results
Total Mining Area by Year
Industrial
Artisanal
6,000
4,000
2,000
0
Area in Hectares
2,010

2002-2005
2019-2020
Red Band Change
Ankobra River
Pra River
Volta River
Asanta
Axim
Big Ada
Agbletokwei
Ada Foah
Agbledo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UNIVERSITE D'ABOMEY - CALAVI
Institut National de l'Eau (INE)
Rez-de-chaussée: Laboratoire d'Hydrologie Appliquée (LHA)
1er Etage: Formation doctorale Wascal
2ème Etage: Salles de cours
neo


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