Using GIS Technology to Mitigate Climate Related Risk to Water Infrastructure in Rural Ghana

October 31, 2023

https://www.safewaternetwork.org/sign-gis-program

Agenda

- Introduction
- The Need for Efficient & Accurate Feasibility Assessments
- The Need for Risk Awareness During the Planning Process
- Building Resiliency Through Geographic Information Systems (GIS)
- Walkthrough the Toolkit Apps
- Plans for Replication & Scale
- Flood Demo with Q&A

Innovation is a key part of our mission and our success in community safe water supply

About Safe Water Network

133	452 COMMUNITIES WITH SAFE WATER ACCESS *(CUMULATIVE)*	319
421,000	1.6 MILLION PEOPLE WITH SAFE WATER ACCESS *(CUMULATIVE)*	1,170,000
629	1,529 PEOPLE EARNING LIVELIHOODS *(CUMULATIVE)*	900
470	701 WOMEN ENGAGED WITH SKILLS AND JOBS *(CUMULATIVE)*	231
$321,645	$1.4 MILLION USD LOCAL WATER REVENUE	$1,087,790

The Safe Water Resiliency Toolkit

1. **Feasibility Tool**: Pre-Screen & Assess Optimal Communities
2. **Risk Assessment Tool**: Explore Local & Regional Hazards & Risks
3. **EPANET+ Tool**: Plan Optimal Infrastructure Design
4. **Mitigation Tool**: Creating Infrastructure and Community Resilience
5. **Field Sales Tool**: Building Sustainability and Growth

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What happens when we don't plan for climate shocks?

RISK AND HAZARDS TO STATIONS' OPERATIONS

- Limited evaluation of climate change and/or disaster risk metrics in station design
- Flooding and drought impacts stations operations
- Flooding in communities along Lake Volta
  - Inability to access control equipment;
  - Longer pumping hours;
  - Operations shut down for 1-2 months;
  - High expense on maintenance reserves to relocate panels and cables;
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  - Low production volumes and water sales;
  - High operational cost

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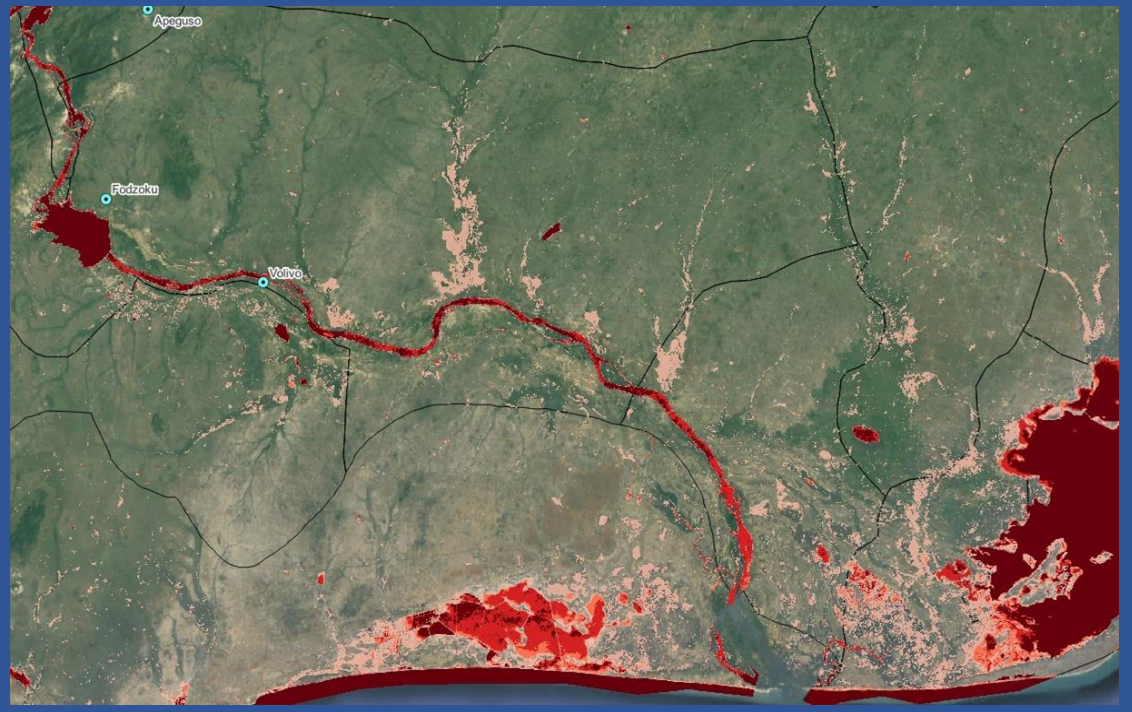
What happens when we don’t plan for climate shocks?

Flooding at water treatment facilities leads to direct and indirect costs

Total Cost of Flood Damage at Station in Volta Region, Ghana

- **$615** Lost Revenue
- **$3,000** Equipment Repair
- **$3,250** Benefits Lost

The risk assessment tool identifies areas at risk for flood and displays data visually to improve site planning and mitigate the impact of environmental hazards.



Flood Risk Zones in Volta Region, Ghana

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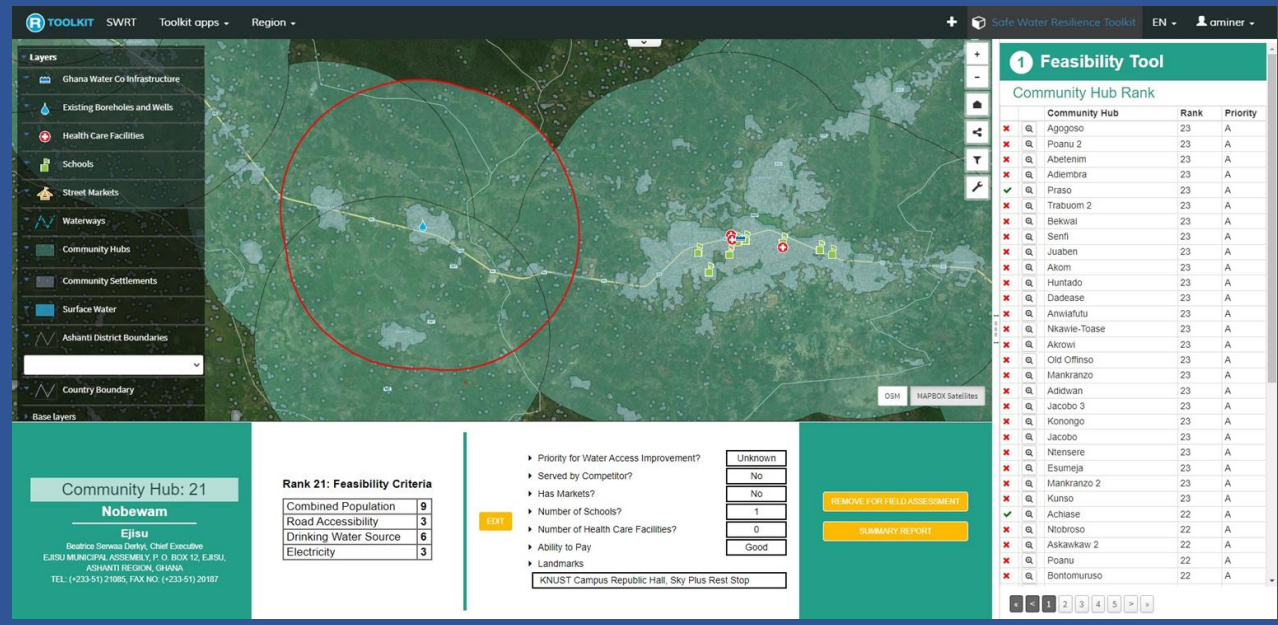
How can site planning technology optimize impact?

- Identify current and potential hazards and incorporate them into station design
- Assess risk on stations' design and make changes
- Assess the suitability of locations for infrastructure
- Prioritize intervention locations based on a more comprehensive assessment of risk factors



Planning Data Visualization for Nobewam, Ghana

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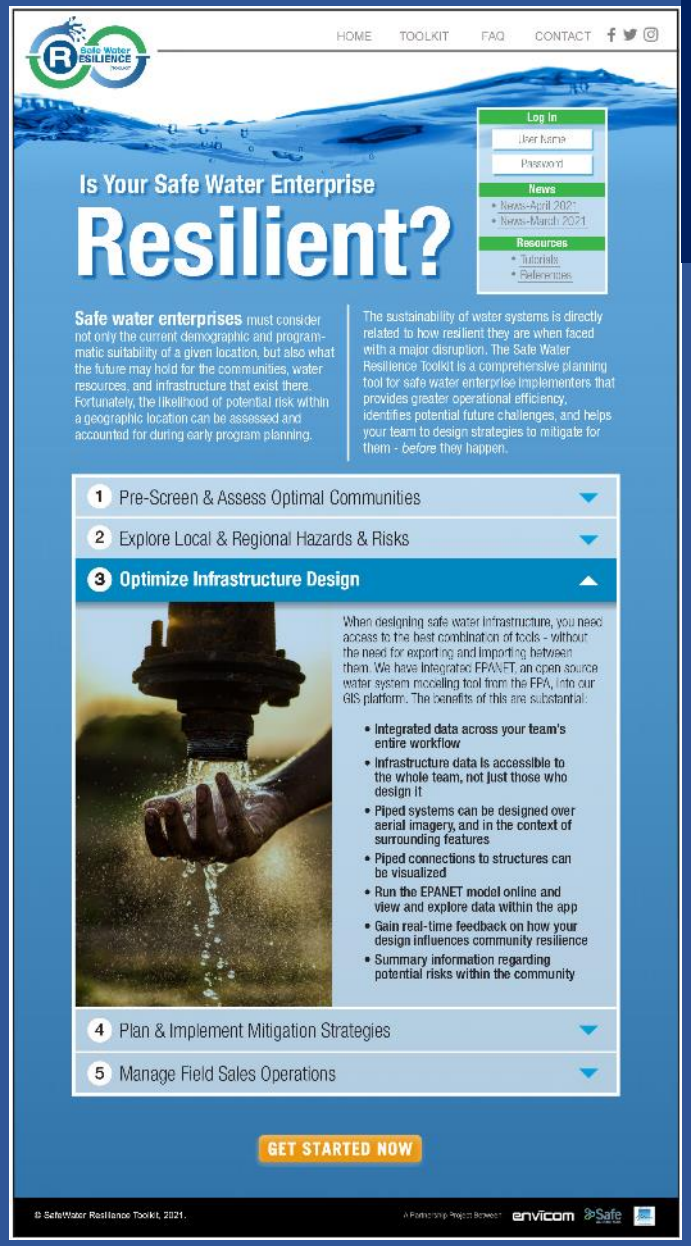
THE SAFE WATER RESILIENCE TOOLKIT:

WALKTHROUGH OF THE TOOLKIT APPS



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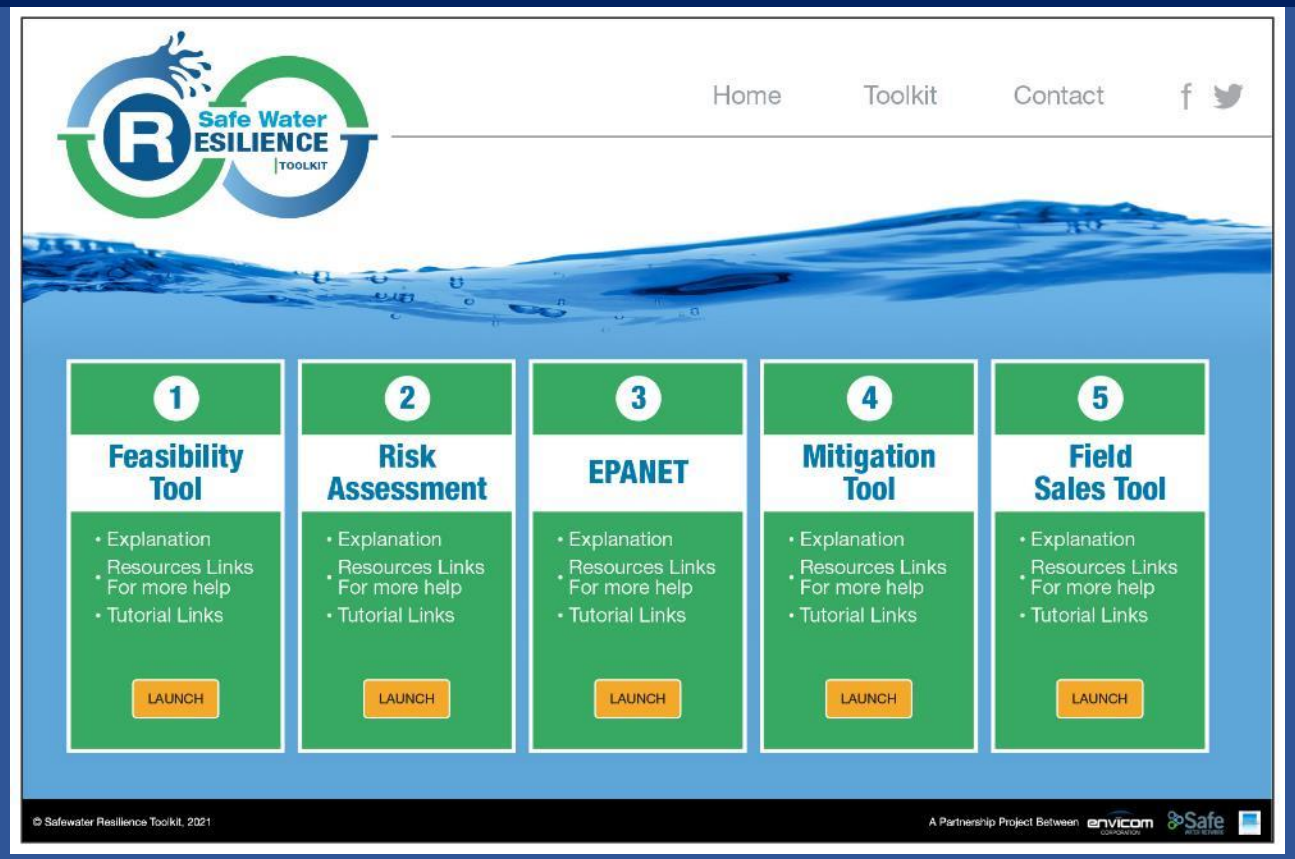

Toolkit Page

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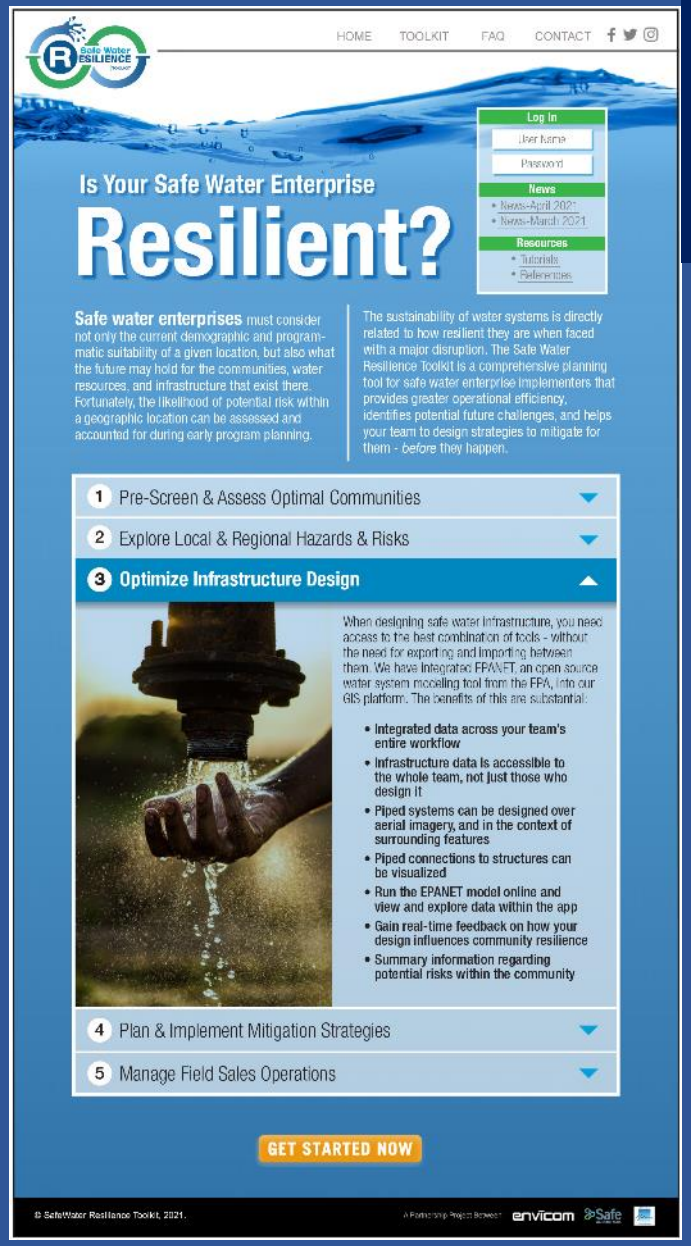

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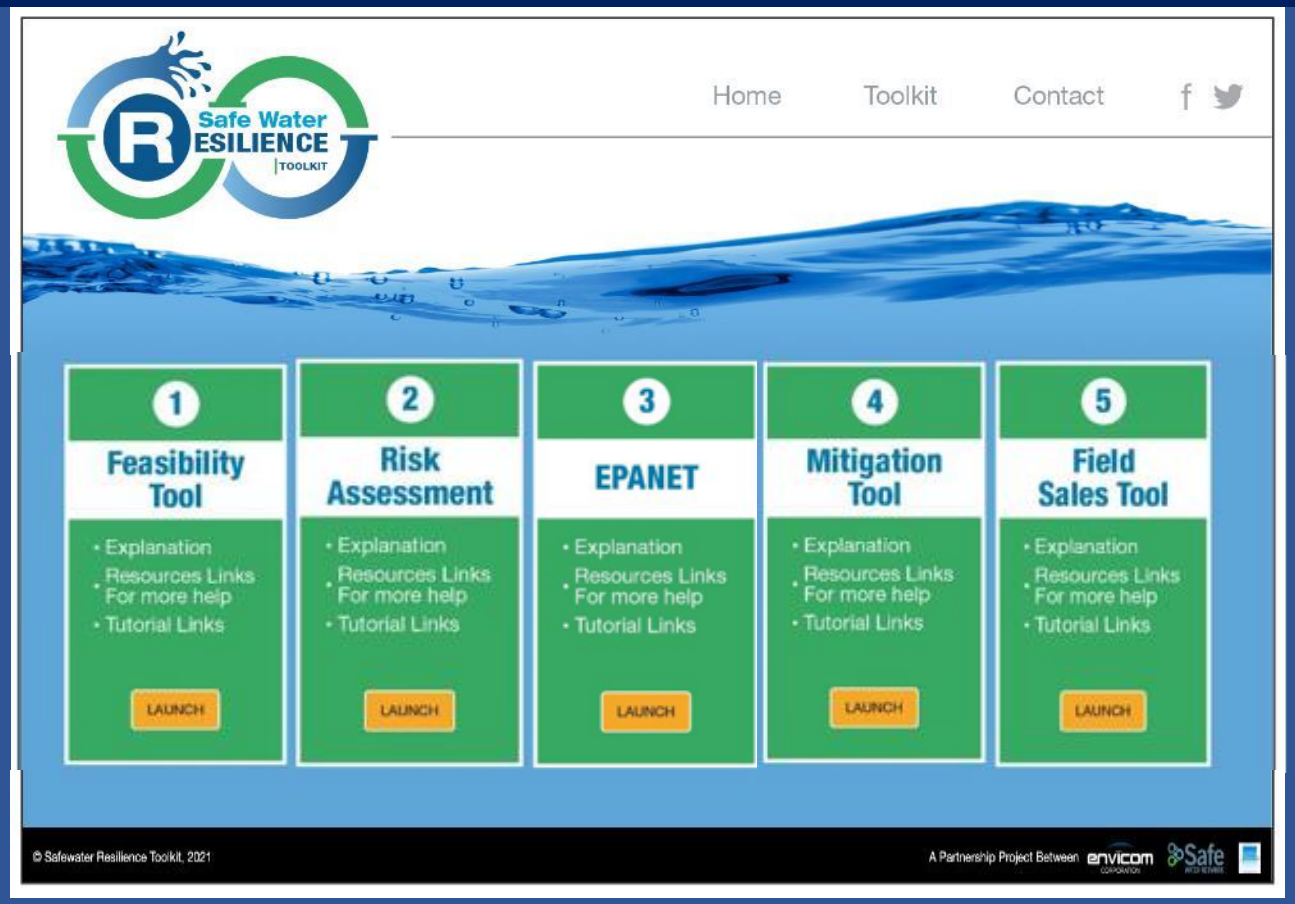

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App 1: Feasibility Tool

Prescreening for Optimal Site Selection

FEASIBILITY CRITERIA

Critical Criteria	Definition	Rank
Combined Population	Population of the community and surrounding communities less than 4km away	3
Drinking Water Source	The major sources of water for the community	2
Road Accessibility	The community's accessibility by road in all seasons	1
Access to Electricity	Availability of electricity in the community	1

Additional Criteria:

- People's Ability to Pay
- Priority for Water Access Improvement
- Is Area Served by Competitor?
- Proximity to Markets
- Existing Infrastructure

Current Data Collection Method:

- Physical visit to every community
- Paper data collection form, hand drawn maps
- Manual analysis of results

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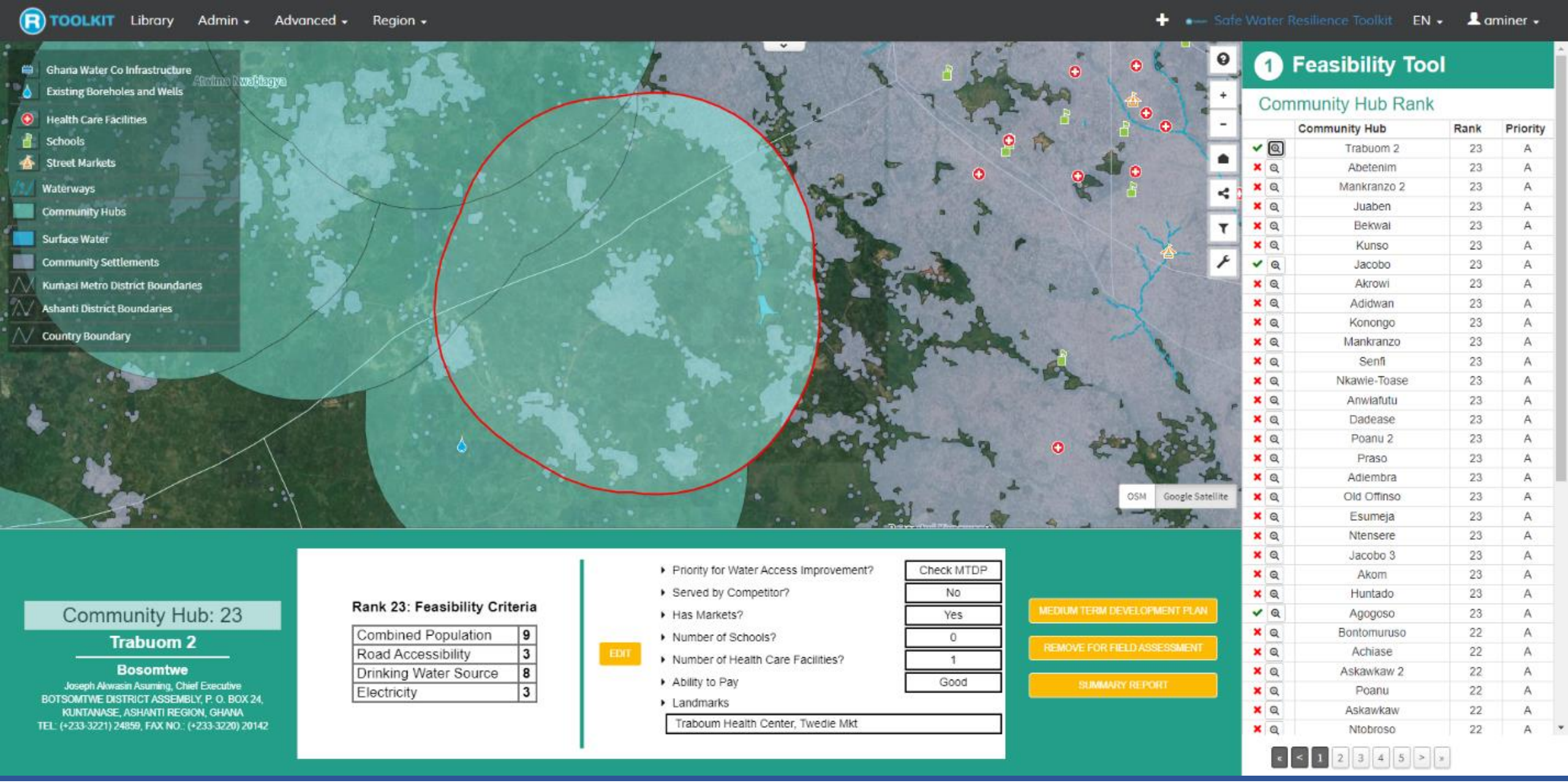

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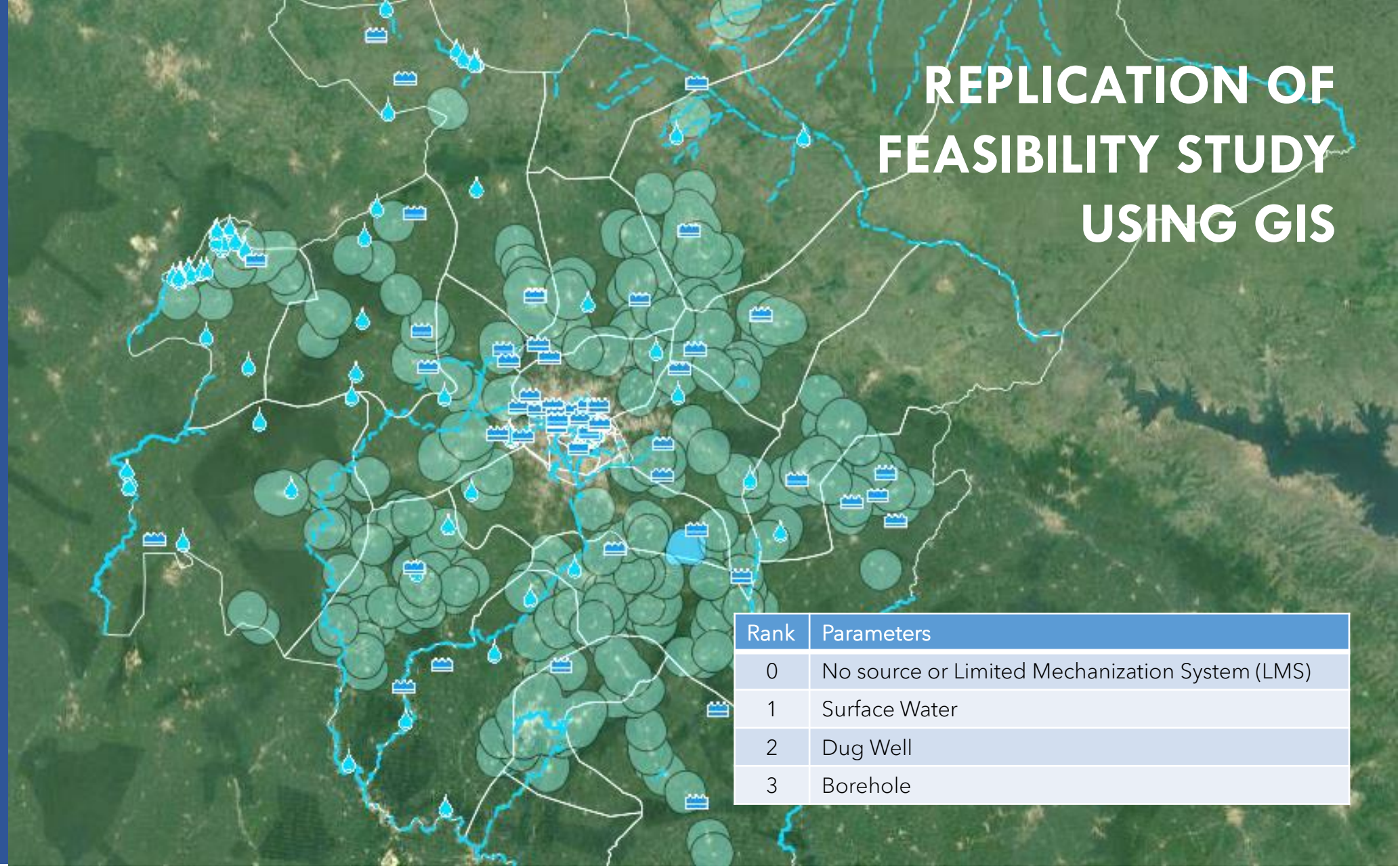
Safe Water RESILIENCE TOOLKIT

1 Feasibility Tool

REPLICATION OF FEASIBILITY STUDY USING GIS

Drinking Water Source



Rank	Parameters
0	No source or Limited Mechanization System (LMS)
1	Surface Water
2	Dug Well
3	Borehole

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App 2: Risk Assessment
Risk Awareness from the Outset

2 Risk Assessment

RISK ASSESSMENT

Why Assess Risk?

If current global patterns of increasing exposure, high levels of inequality, rapid urban development and environment degradation grow, then disaster risk may increase to dangerous levels.
CRED, UNDRR, 2020

Global average annual loss is estimated to increase up to US$415 billion by 2030.
UNDRR, 2015

INFORM RISK

INFORM Risk Index

The INFORM Risk Index is a global, open-source risk assessment for humanitarian crises and disasters. It can support decisions about prevention, preparedness and response.

https://drmkc.jrc.ec.europa.eu/

How?

- Many great frameworks and manual guides exist, but they are not digital or geospatial tools
- A few digital tools exist that either
  - a) display coarse-scale data (appropriate to Global/Regional/Country-level) **or**
  - b) only focus on one type of hazard (e.g. floods).
- Safe Water Resilience Toolkit is based on the INFORM Risk Index (Joint Research Center of European Commission), and translated into a geospatial application that is similar in concept to FEMA's Resilience Analysis and Planning Tool (RAPT). The data selected for use in the model is appropriate for use at sub-national and local levels.

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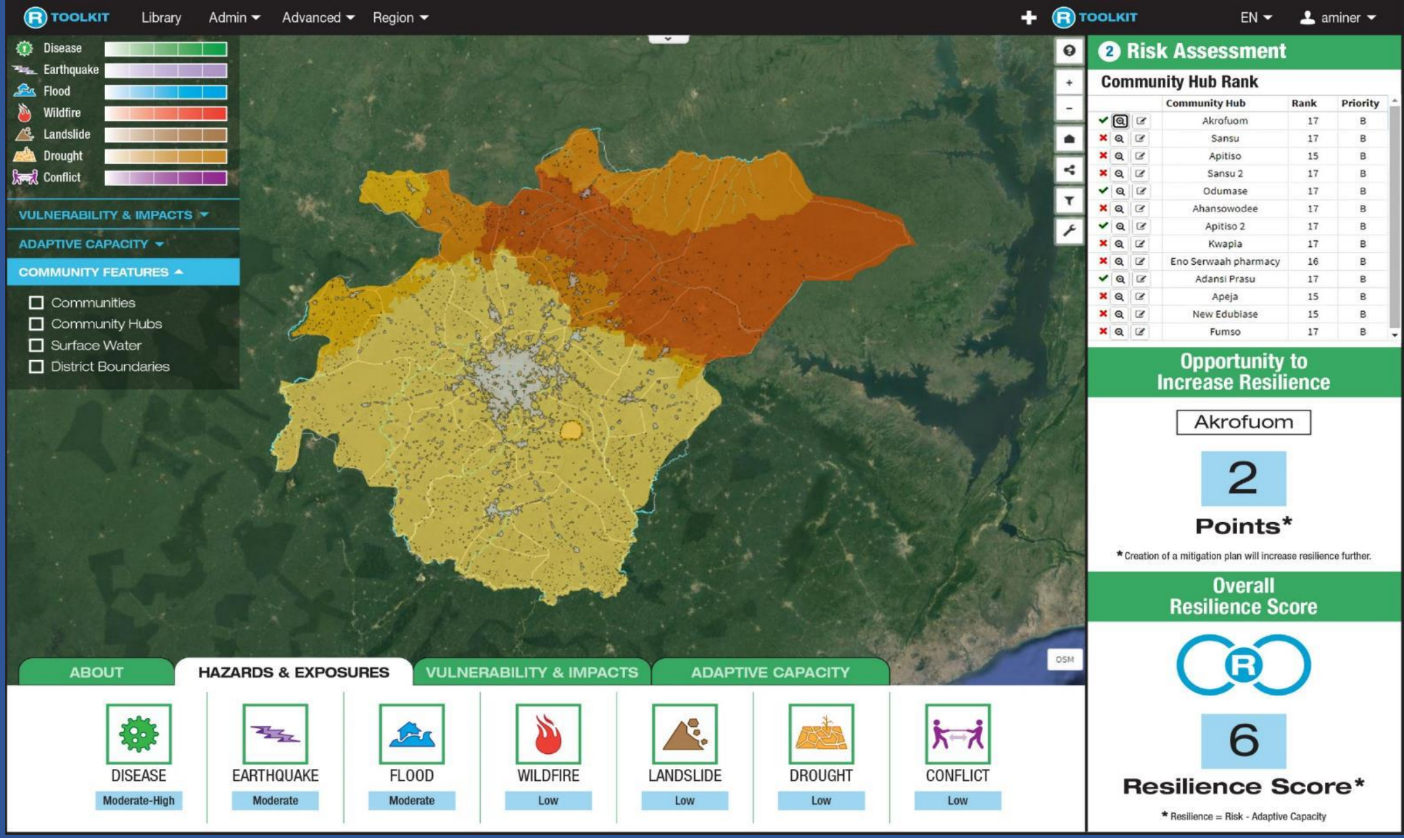
Safe Water RESILIENCE TOOLKIT

2

Risk Assessment



2 Risk Assessment

Community Hub Rank

Community Hub	Rank	Priority
Akrofuom	17	B
Sansu	17	B
Apitiso	15	B
Sansu 2	17	B
Odumase	17	B
Ahansowodee	17	B
Apitiso 2	17	B
Kwapia	17	B
Eno Serwaah pharmacy	16	B
Adansi Prasu	17	B
Apeja	15	B
New Edubiase	15	B
Fumso	17	B

Opportunity to Increase Resilience

Akrofuom

2

Points*

* Creation of a mitigation plan will increase resilience further.

Overall Resilience Score

6

Resilience Score*

* Resilience = Risk - Adaptive Capacity

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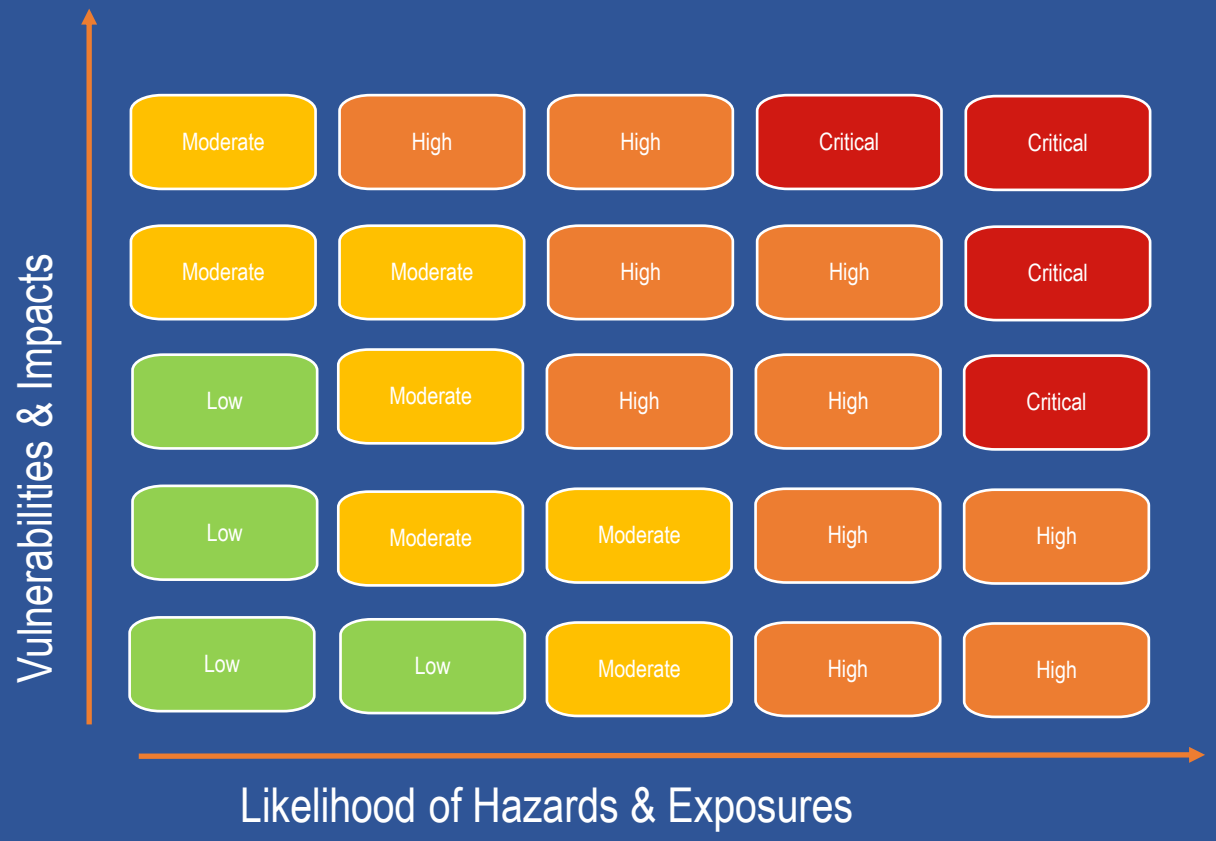
2

Risk Assessment

RISK ASSESSMENT



What is Risk?

Risk = Hazards ✖ Vulnerability ➗ Capacity

Inter-Agency Task Force on Climate Change and Disaster Risk Reduction

What is Resilience?

The goal of a system to continue to function to the fullest possible extent in the face of stress to achieve its purpose; this is a function of both the vulnerability of the system and its adaptive capacity

(Dalziell & McManus)

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Safe Water RESILIENCE TOOLKIT

2 Risk Assessment

RISK ASSESSMENT

RISK & RESILIENCE INDEX (INFORM Model)

HAZARDS & EXPOSURES

- Human-Derived (frequency)
  - Conflict (Intensity & Risk)
  - Disease
- Natural & Climate-Related (frequency)
  - Flood
  - Drought
  - Earthquake
  - Wildfire
  - Landslide

VULNERABILITY & IMPACTS

- Socio-economic
  - Development & Deprivation (GDP/HDI)
  - Dependent Males
  - Dependent Females
- Vulnerable Groups
  - Populations > 2km from Roads
  - Population Living in Poverty
- Water Resource Vulnerabilities
  - Groundwater Productivity & Storage
  - Depth to Groundwater

ADAPTIVE CAPACITY

- Institutional
  - Governance
  - Mitigation Planning & Activities
- Infrastructure & Services
  - Improved Housing
  - Access to Roads (<2km)
  - Access to Healthcare
  - Access to WASH Services
  - Access to Electricity

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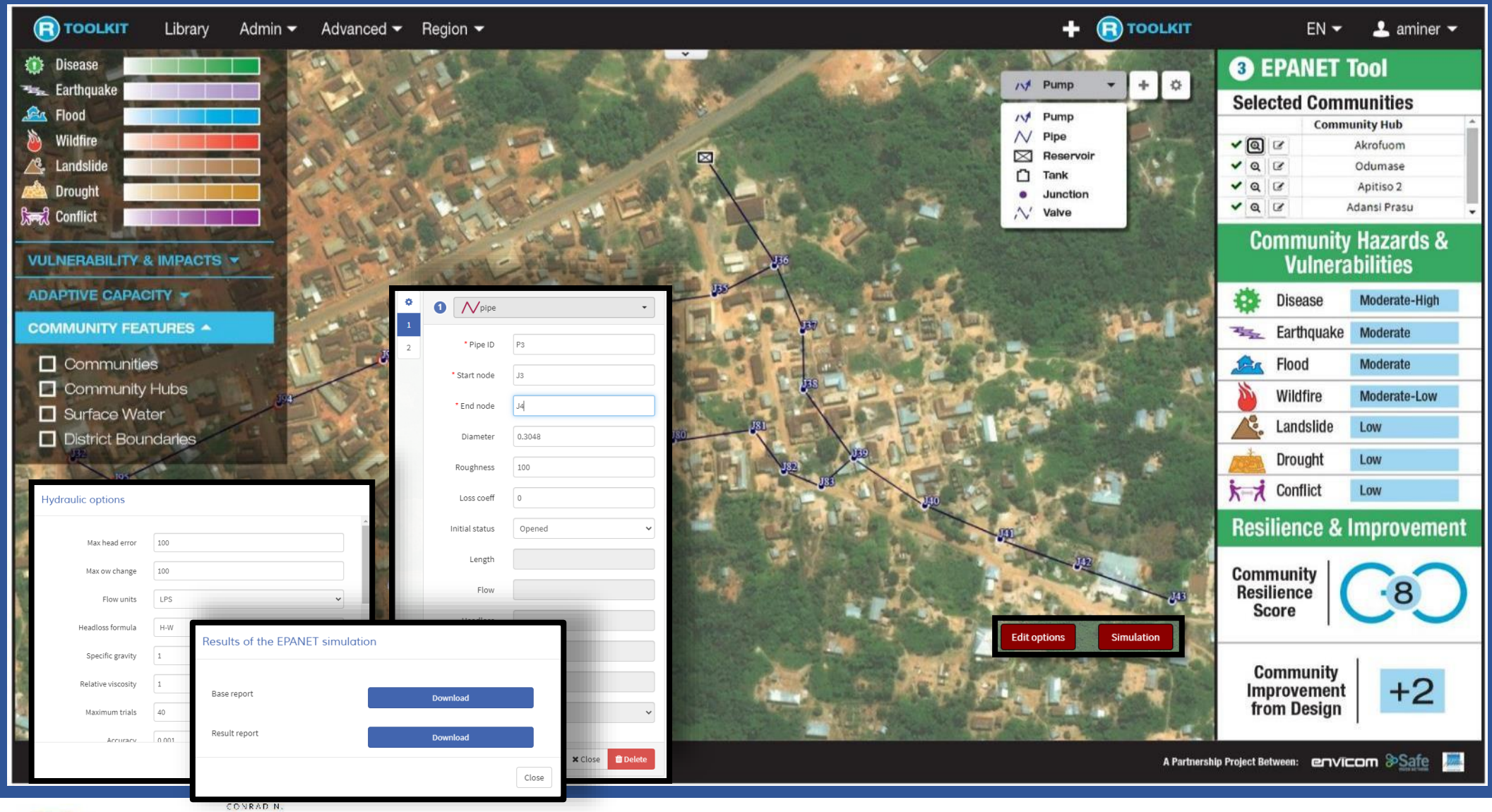
App 3: EPANET - *Engineering in the Cloud*

Benefits of EPANET in the Cloud:

- Whole team has access to infrastructure data
- Systems are designed in their 'true' location - over georeferenced aerial imagery & in the context of other geographic data
- Piped connections to structures can be visualized
- Inclusion of risk data informs decisions for system placement



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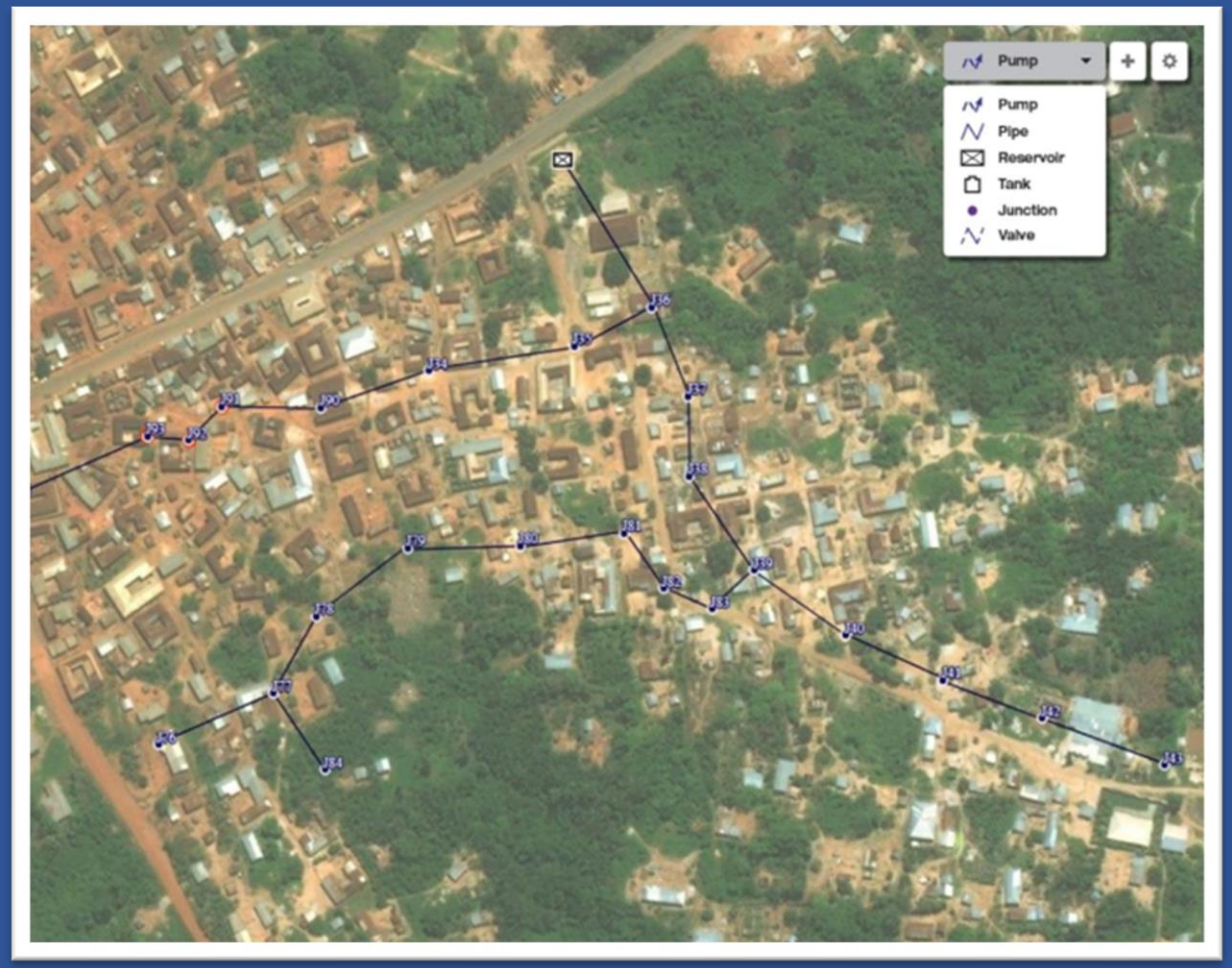
3

EPANET Assessment



BETA TESTER INPUT from Professional Users of EPANET

- Engineers Without Borders
- UNDP Crisis Center
- Private Company
- Engineer from Water4

- <u>Updating to assist novice users based on their recommendations</u>:
- Integrating costing
- Integrating design criteria
- Automating all IDs

- <u>Additional integrations:</u>
- High resolution elevation data
- Pre- and Post- Disaster imagery
- Water Safety Plan to be integrated with the system design

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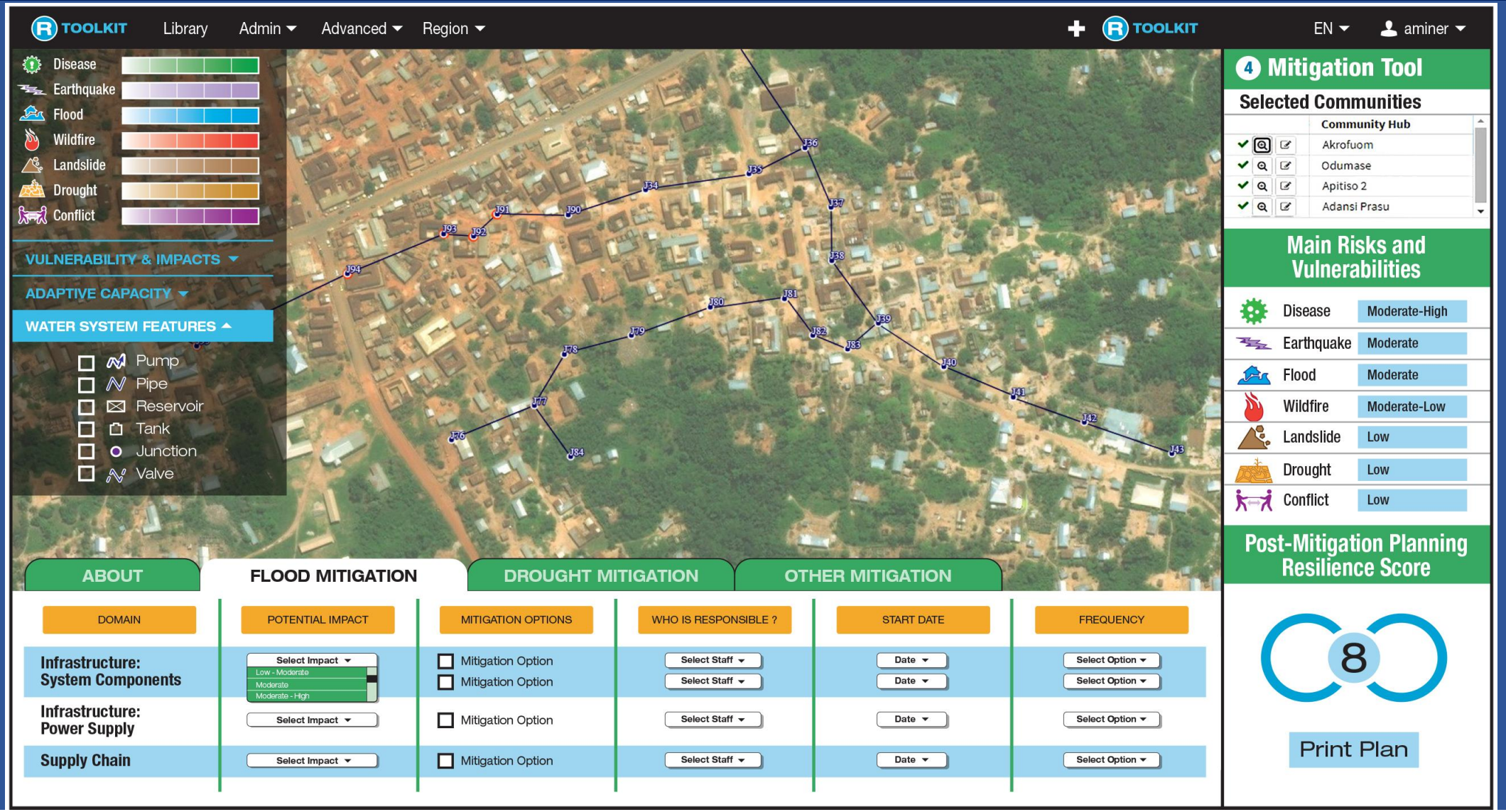
App 4: Mitigation Planning - *Creating Program Resilience*

4 Mitigation Tool 2 Risk Assessment



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App 5: Field Sales Tool - *Building Sustainability & Growth*

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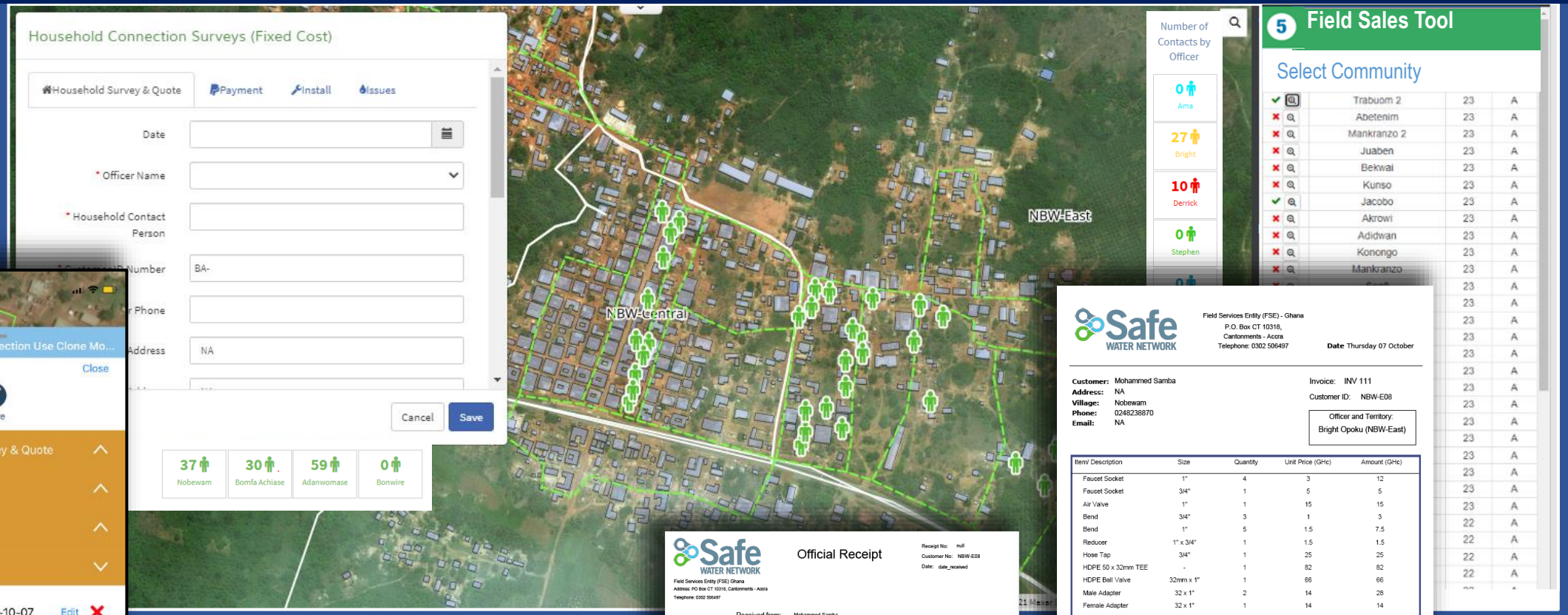
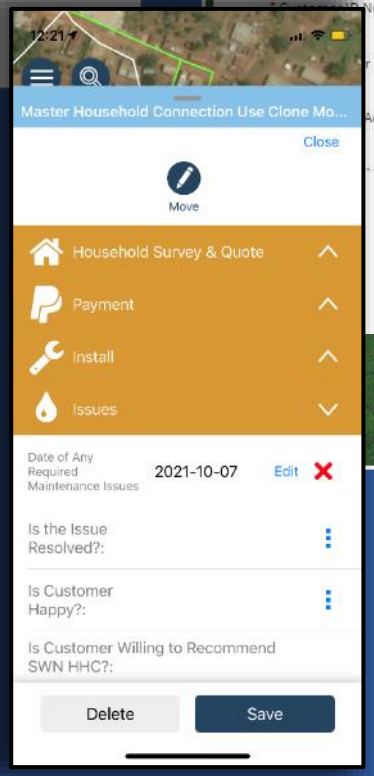
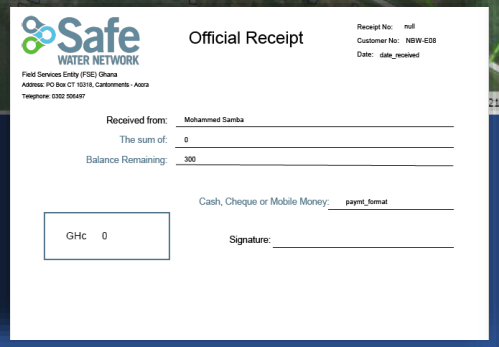
5 Field Sales Tool Assessment



Web Interface



Mobile Interface



Receipt

Invoice

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USER FEEDBACK – How Useful Has this Tool Been for the Sales Team?

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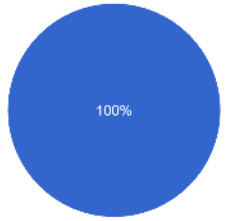
Field Sales Tool

Is the app easy to use and understand?

How helpful is it to see the customers on a map in the field?

How helpful was the app for managing contacts and customers throughout the sales process?



App Features & Details

Select the level of value that each aspect of the app provides to you for your work: *

	Low Value	Moderate Value	High Value	Very High Value
Seeing where my customer are	○	○	○	◉
App layout/ ease of use	○	○	◉	○
Symbology (icons/colors/labels)	○	◉	○	○
Clarity of data visualization	◉	○	○	○
Different sections in form	◉	○	○	○
Automatic calculations (dates, money)	○	◉	○	○
Reminders	○	◉	○	○

What would make the app better? (optional)

- The moment one log in there is no need for that person to select his name again
- It will be cool when the field officer log in it automatically provides the field officer name
- I think the moment you log in it should automatically know the field officer.

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PLANS FOR REPLICATION & SCALE UP

- Actively seeking funding partnerships as well as aerial imagery partnerships as we look to scale this Toolkit to assist other users world-wide.

- **Current roadmap seeks to:**
  - Modify the Toolkit to be accessible for more Safe Water Enterprise and Safe Water Infrastructure Programs
    - e.g. build in parameters that can be modified according to address each teams' program criteria, as well as improving location-based market data (proxies)
  - Develop a 'ticketing system' for maintenance (request from other SWEs)
  - Potentially integrate our IoT platform into the Toolkit (e.g. monitor functionality, water quality, etc)

- **Future Roadmap:**
  - We have had some interest in expanding the Toolkit to provide Post-Disaster Assessments for Infrastructure
    - Incorporate AI to improve speed of conducting rapid damage assessments using before and after imagery
    - Add additional engineering software alongside EPANET
  - Generate and integrate feasibility, risk, engineering and marketing data with this level of granularity for greater geographic locations (Ghana? West Africa?)
  - Since the risk and resiliency assessments are relevant to any subject or location, the resilience toolkit is adaptable (e.g. agriculture, conservation/eco-tourism, fishing, sanitation/waste management)

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Thanks for Your Attention!

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Back Up Slides

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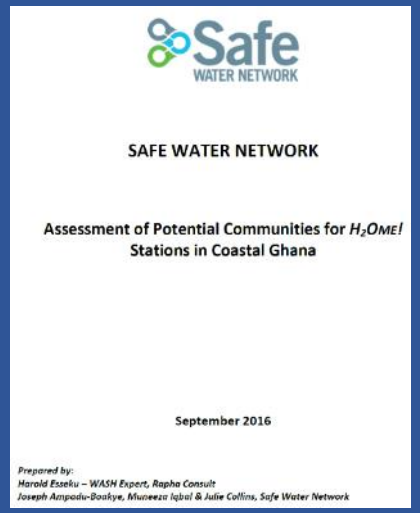
The Need for Efficient & Accurate Feasibility Assessments

EXISTING METHODS OF FEASIBILITY ANALYSIS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Assessment of Potential Communities for $H_2OME!$ Stations in Coastal Ghana

September 2016

Prepared by:
Harold Esseku – WASH Expert, Rapha Consult
Joseph Ampadu-Boakye, Muneeza Iqbal & Julie Collins, Safe Water Network

- Desk review
- Physical visit to Local Government Authorities
- Physical visit to communities
- Complete forms and maps
- Manual analysis of results

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The Need for Efficient & Accurate Feasibility Assessments Continue….(1)

CHALLENGES WITH EXISTING METHOD

- Non existent data
- Inaccurate data
- Difficult to collect data
- Resource intensive
- Limited integration of variables

THE SOLUTION – FEASIBILITY TOOL

- Digitize feasibility assessment;
- Time and cost savings
- Flexibility in applying multiple variables;
- Granularity in analysis

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The Need for Risk Awareness During the Planning Process

RISK AND HAZARDS TO STATIONS' OPERATIONS

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The Need for Risk Awareness During the Planning Process

BENEFITS OF RISK ASSESSMENT TOOL

- Identify potential hazards
- Assess risk on stations' design
- Ensure stations are designed with consideration of current and potential risk factors
- Assess the suitability of communities for infrastructure
- Prioritize intervention locations based on comprehensive factors
- Determine optimal locations for stations.

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THE SAFE WATER RESILIENCE TOOLKIT:

WHAT IS IT & HOW DOES IT SUPPORT THE TEAM?

- Workflow driven set of tools that translate paper workflow into a digital process

  - Creates cost effectiveness and efficiency
  - Non-resource intensive (pre-screens optimal locations)
  - Assimilates multiple variables into usable intelligence
  - Provides granular data for better decision-making and spatial planning
  - Incorporates risk into the planning process
  - Easily scalable for use in different geographic areas