

Applying Predictive Analysis to Optimize Location of Food Distribution Sites

Session

Advancing Humanitarian and
Peacekeeping Operations with GIS

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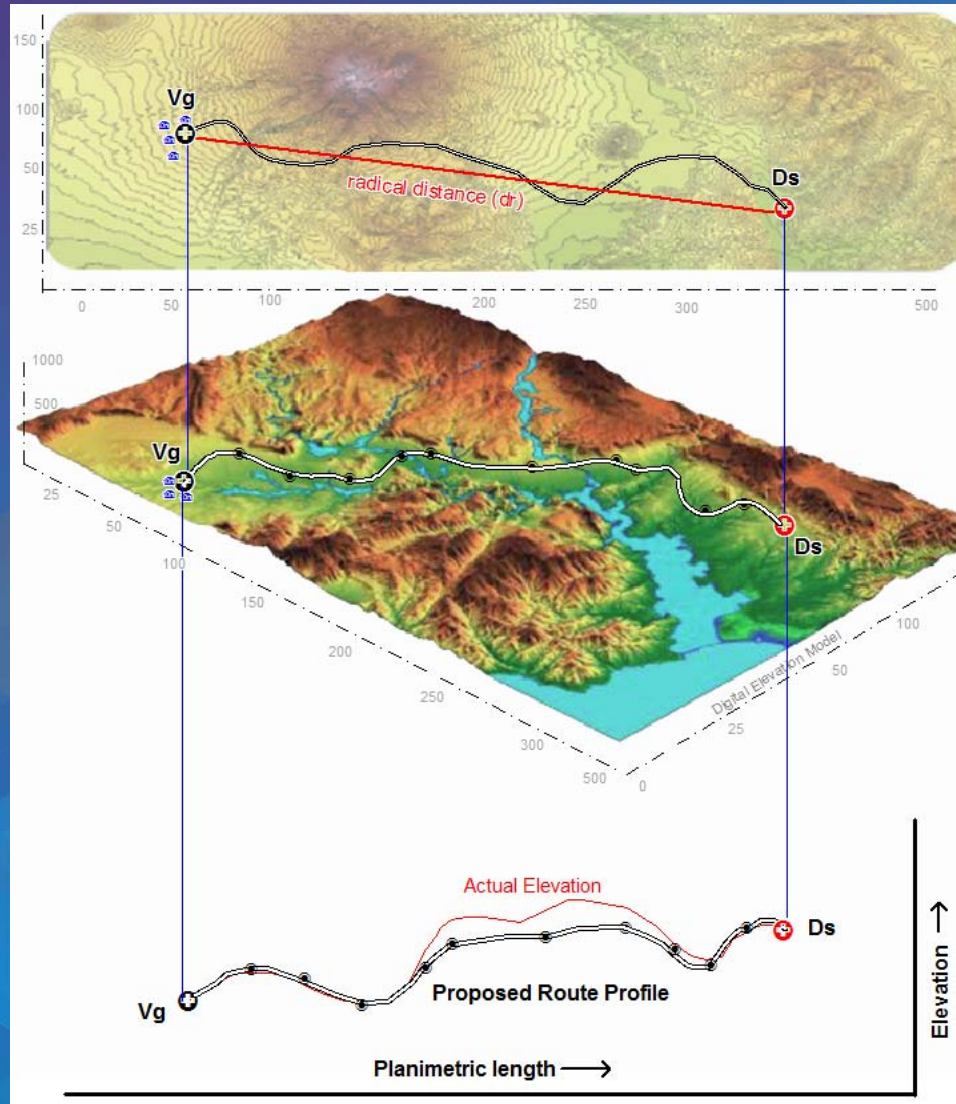
Esri User Conference – San Diego – June 2016

Predictive Analysis : Optimize the Food Distribution Site

Within our presentation the following questions should be addresses:

- What is Predictive Analysis (PA)?
- What types of geospatial analysis used at PA?
- How do these tools work?
- What problem did we solve with PA?
- How to implement this solution?
- What advantage did PA give us?

Predictive Analysis Toolset: Properties

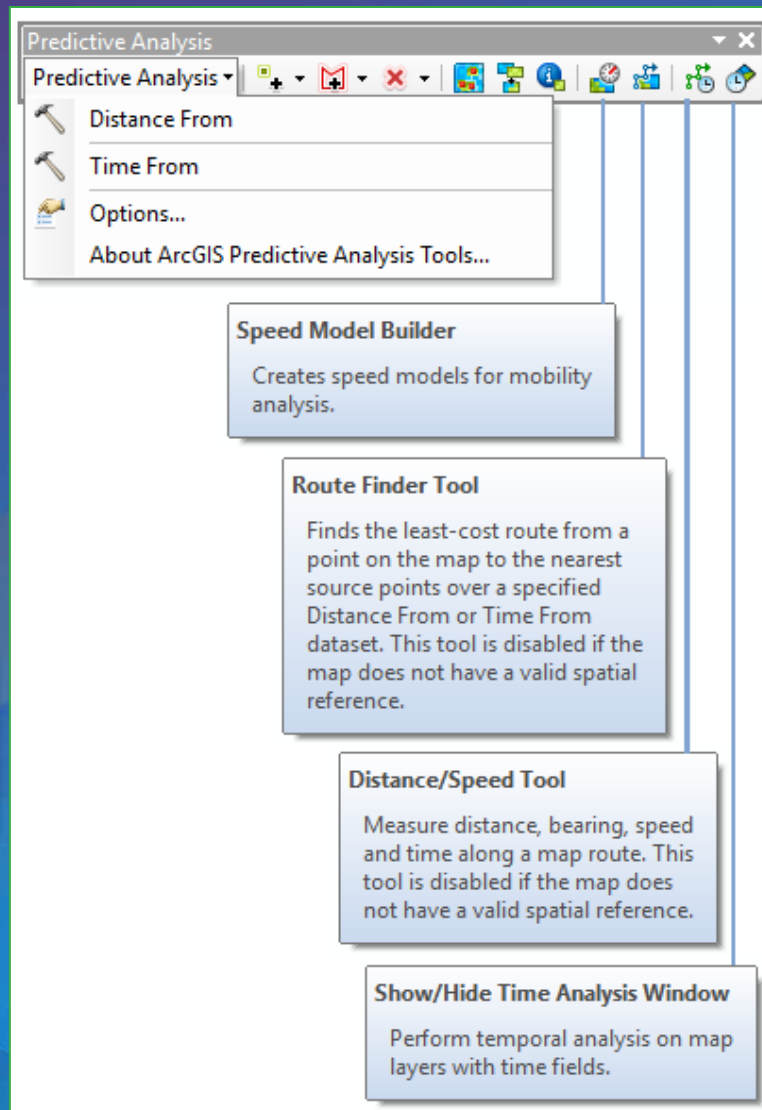


- PA is **Spatial tools Add-In** at ArcGIS Desktop
- PA is a **set of tools** used by analysts to **build models** to **predict the location** of moving or stationary objects or events.

The Predictive Analysis Tools allow to :

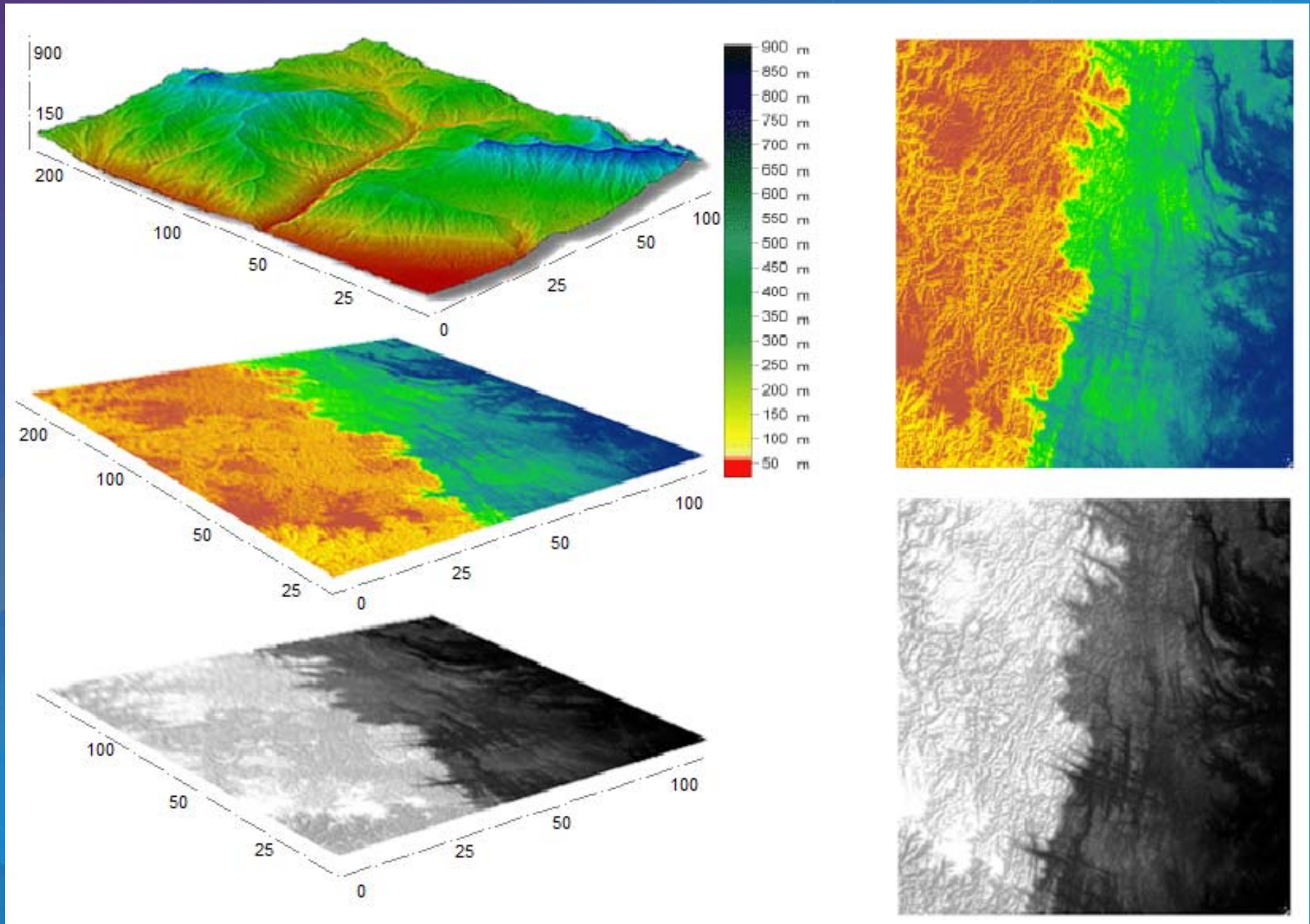
- calculate the walking distance between two points
- estimate the time needed (or duration) for walking between two points
- find theoretically the route or track between two points
- PA tools work using the raster model of spatial data (DEM)

Predictive Analysis Toolset: Components



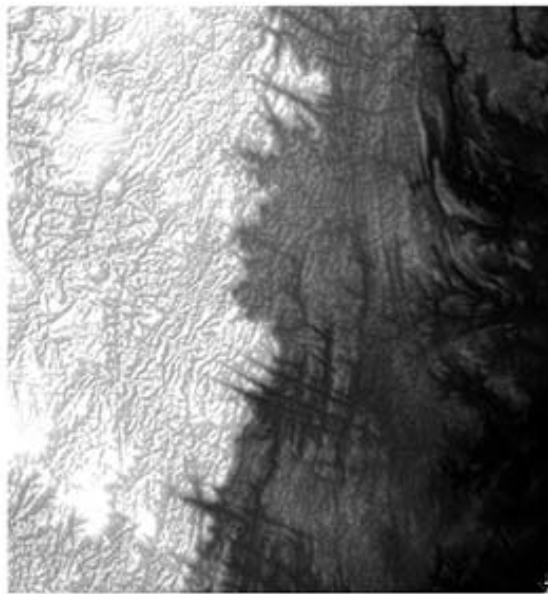
- PA includes the Speed Model Builder, Route Finder Tool, Distance/Speed Tool, Distance From and Time From
 - **Speed Model Builder:** apply estimates (or assumptions) about movement speeds and conditions.
 - The modeling uses the **Naismith's rule** that provides a **model for walking speed** based on topography (Digital Elevation Models)
 - **Distance from:** estimates the linear distance from points, main roads
 - **Time from:** use the SpeedModel and Distance Model to derive a **Time raster layer**
 - **Route finder:** evaluates distance and time of travel under various SpeedModel iterations, It is a tools for finding shortest paths between locations

<http://appsforms.esri.com/products/download/index.cfm?fuseaction=download.main&downloadid=1747>



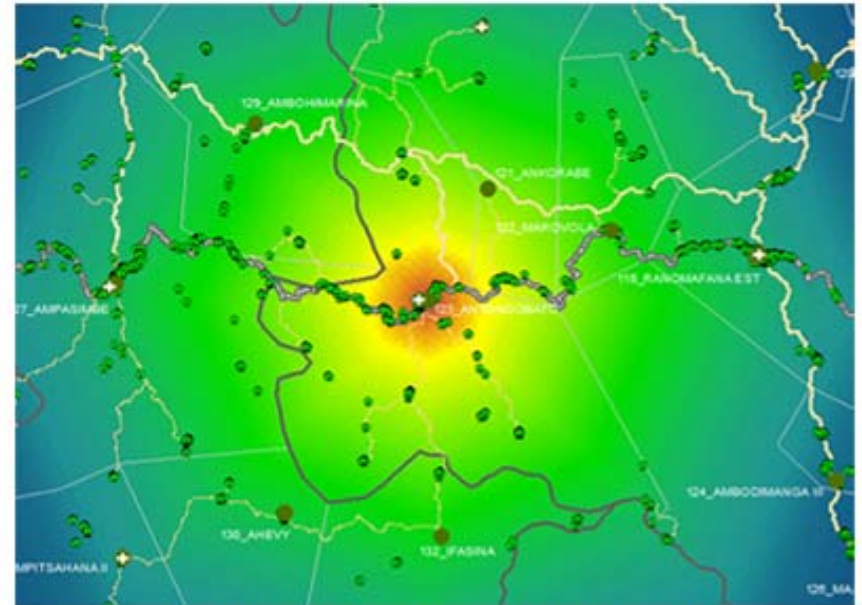
Digital Elevation Models

Predictive Analysis Toolset: Distance From



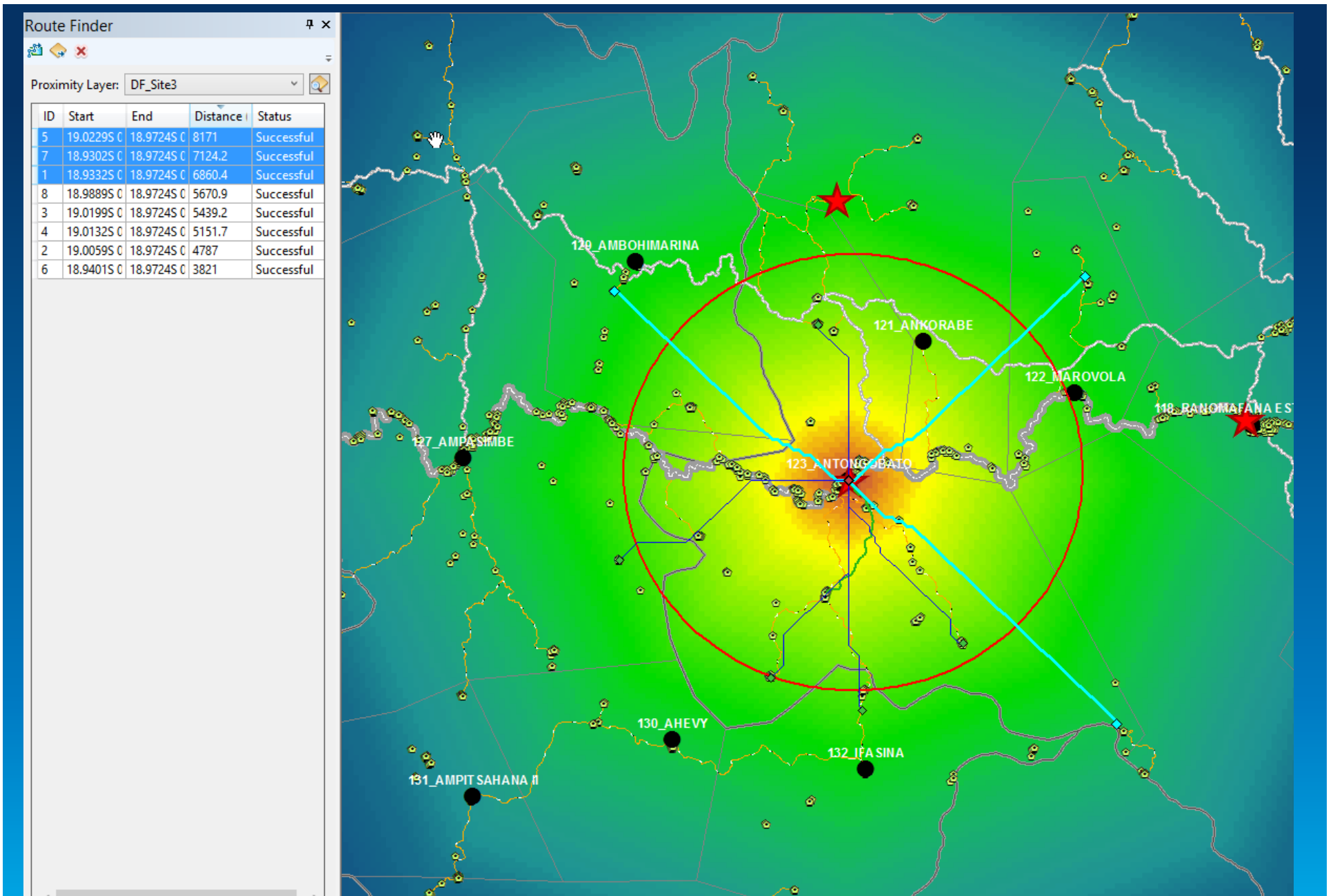
Surface Raster

Distance
From Point



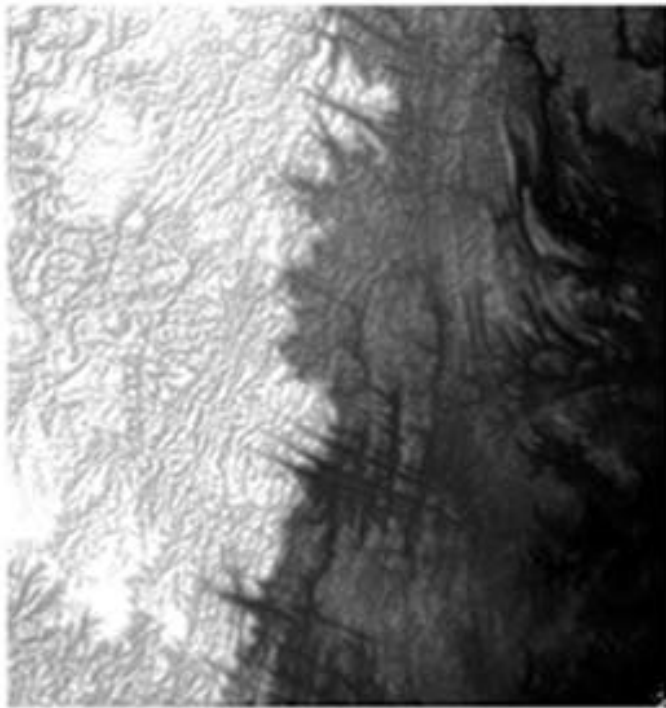
Distance Model Raster

Each raster cell is coded with the distance from the nearest distribution center. The default symbolization shows “nearby” in red and “far away” in blue, with intermediate values in yellow and green. Other symbol renderings are available.

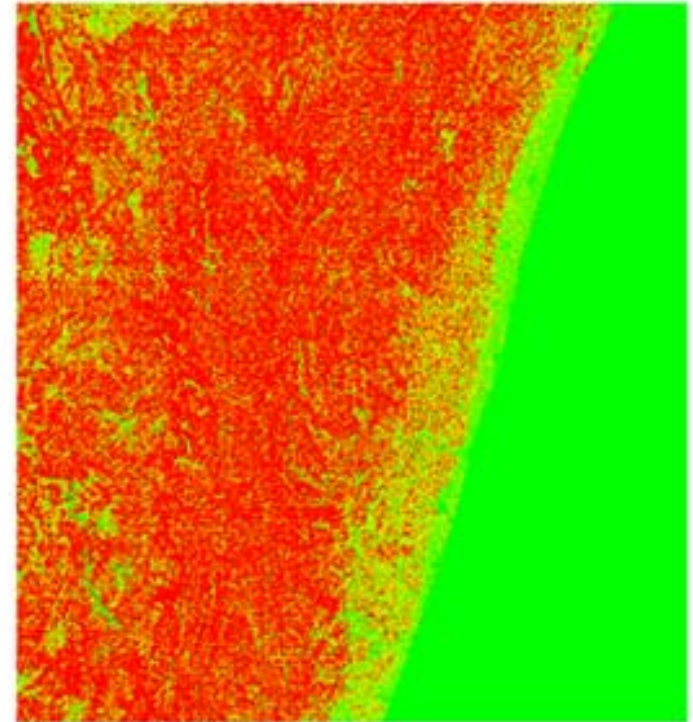


Predictive Analysis Toolset: Distance Analysis

Predictive Analysis Toolset: Speed Model Builder



Surface raster



SpeedModel Raster

The Speed Model Builder develops **sophisticated travel-speed models** that account for multiple environmental variables. We used the general principle of **Naismith's Rule** for estimating speed that people can walk over different slope.

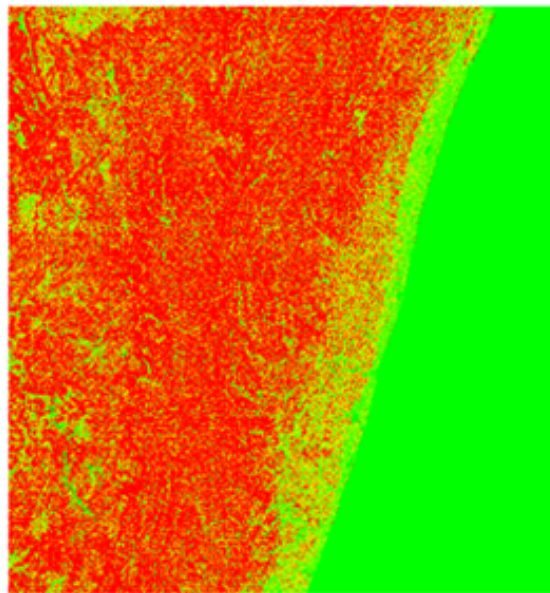
Naismith's rule

The Naismith assumption is that people can walk relatively quickly over flat terrain but more slowly over hilly terrain.

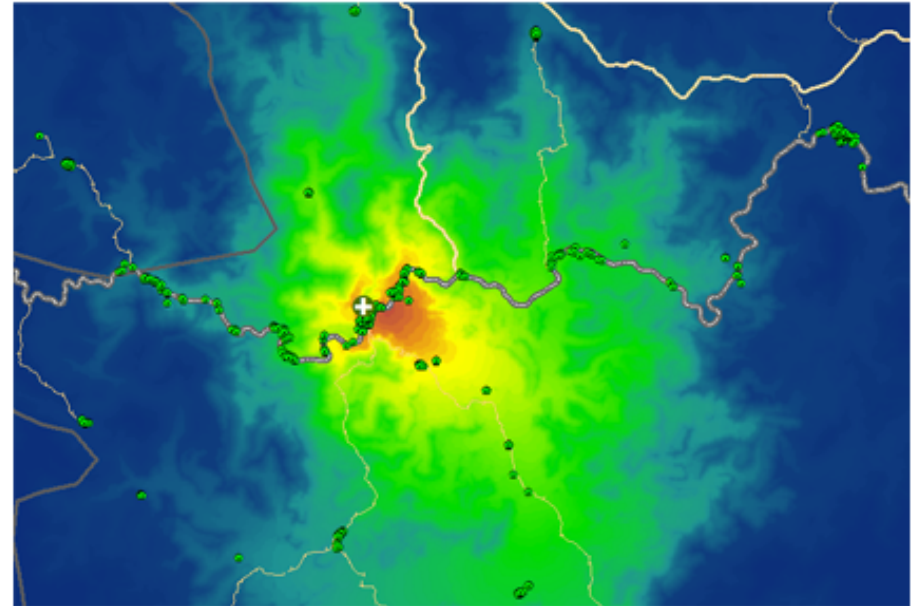
https://en.wikipedia.org/wiki/Naismith's_rule

Slope Type	Slope (Degrees)	Speed (km/hour)
Flat	0-0.1	4.5
Low	0.1 – 2.5	4
Moderate	2.5 – 5	3
High	5-7.5	2.5
Very High	7.5 – 10	2
Impassably high	≥ 10	0.4

Predictive Analysis Toolset: Time From



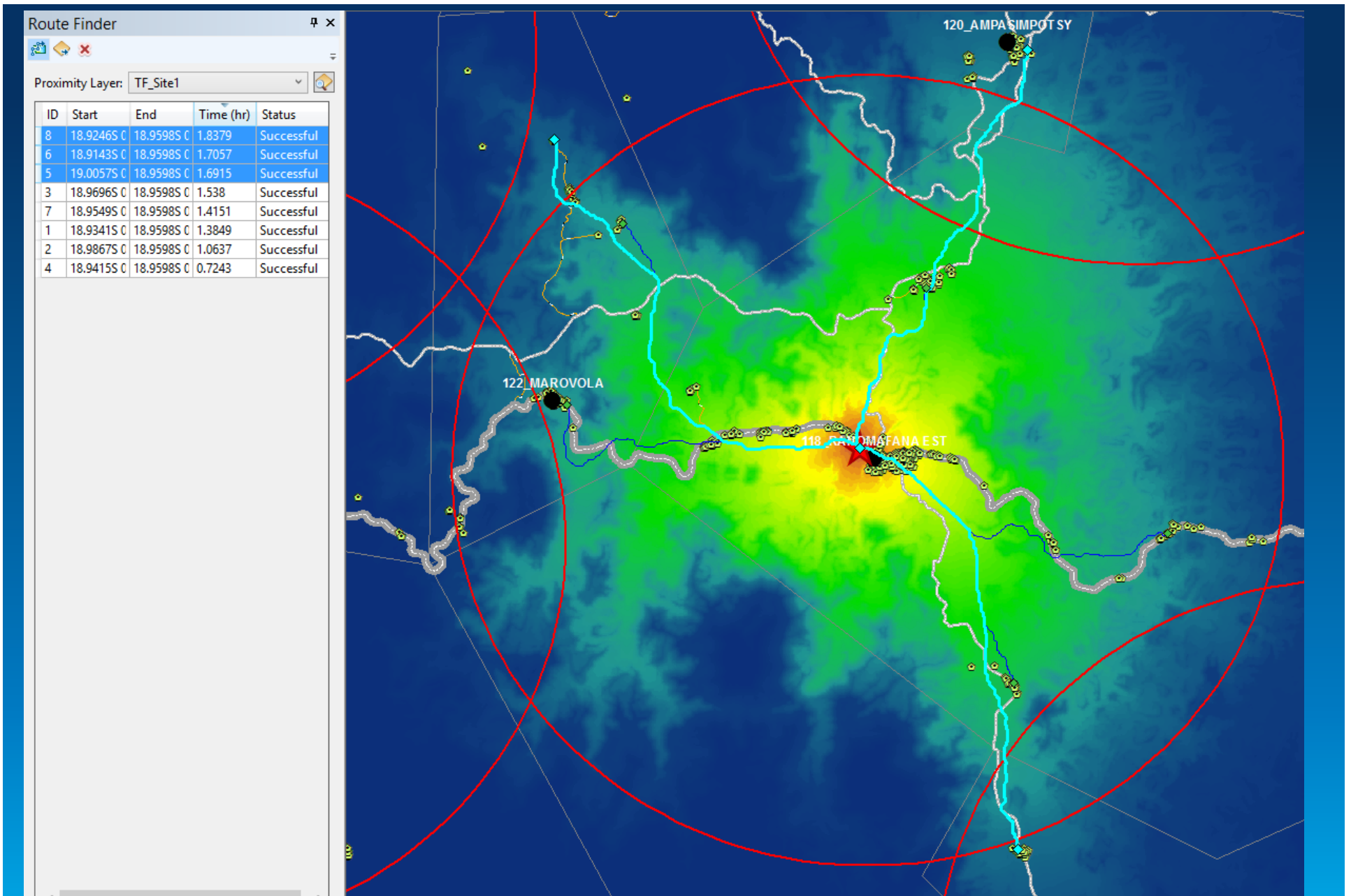
SpeedModel Raster



Time Raster layer

The Time From layer is **calculated from the distance raster and the speed model raster**. This layer intersects the distance model and the speed model for every cell in the raster layers.

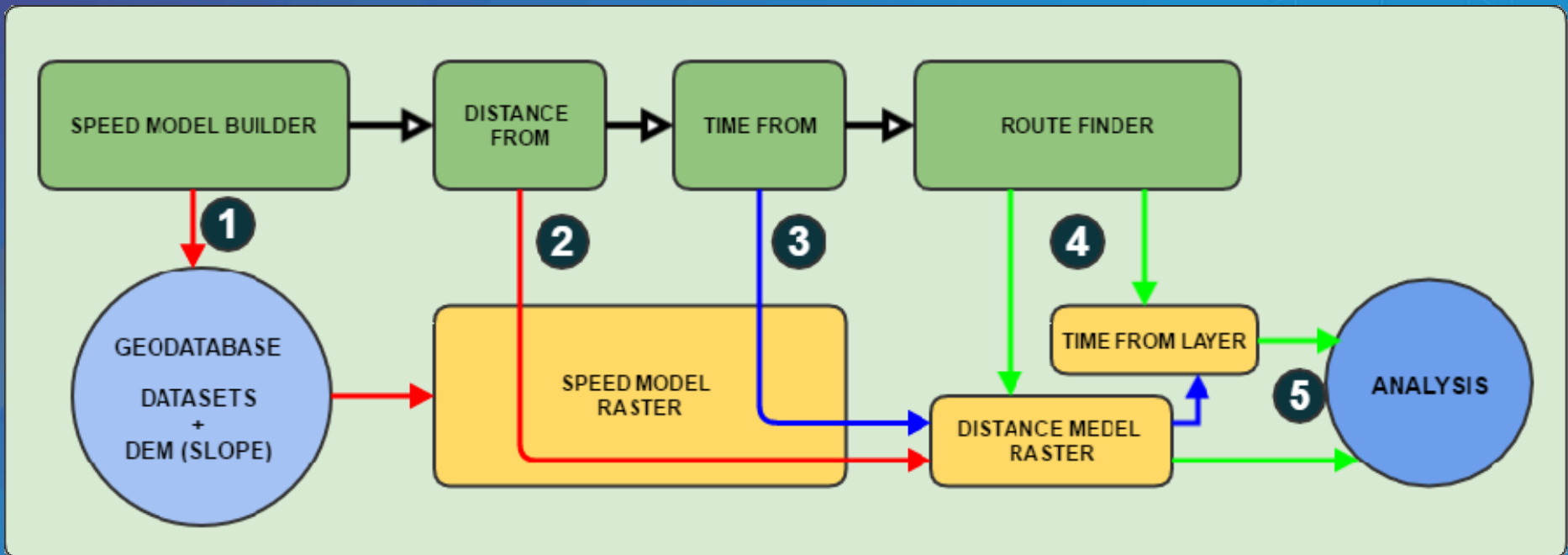
In the symbol, the **light colors** (green, yellow, red) are **areas with short time to point** (distribution center) and the **darker color** (blue) represents **longer time**.



Predictive Analysis Toolset: Time Analysis

How does the Predictive Analysis Toolset work

The Predictive Analysis is a series of analysis steps used to build models that can predict the location of moving objects or events



How to apply this process in the Fararano project?



Fararano Project

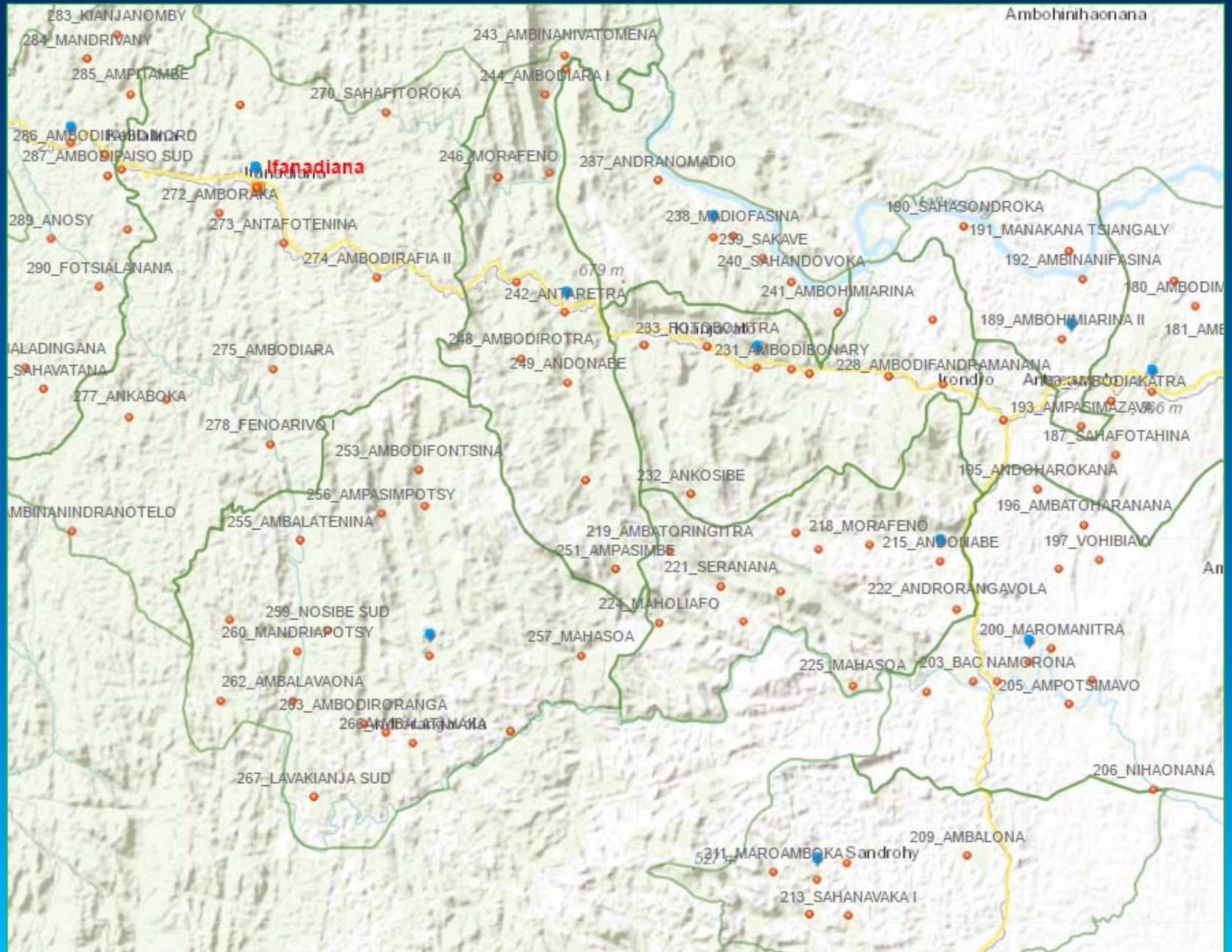
- Country : Madagascar
- Project Goal : Food insecurity is reduced in 48 communes in rural Madagascar.
- **Purpose: Health/Nutrition – Ag/Livelihoods-Resiliency**
- **Donor: USAID/Food for Peace (FFP)**
- Project Budget: 138 M USD (Cash) **16,150 MT (Food)**
- Implementing Period : 5 years
- Partners: BDEM, ODDIT, CDD,CMB
- Implementing Area: 3.Regions – 7 Districts, 48 Communes – 464 Fokontany (Community)
- Beneficiaries Targets: 72 800 HH - 364.000 Population
- **Technology: iFormBuilder – Zoho - GIS**



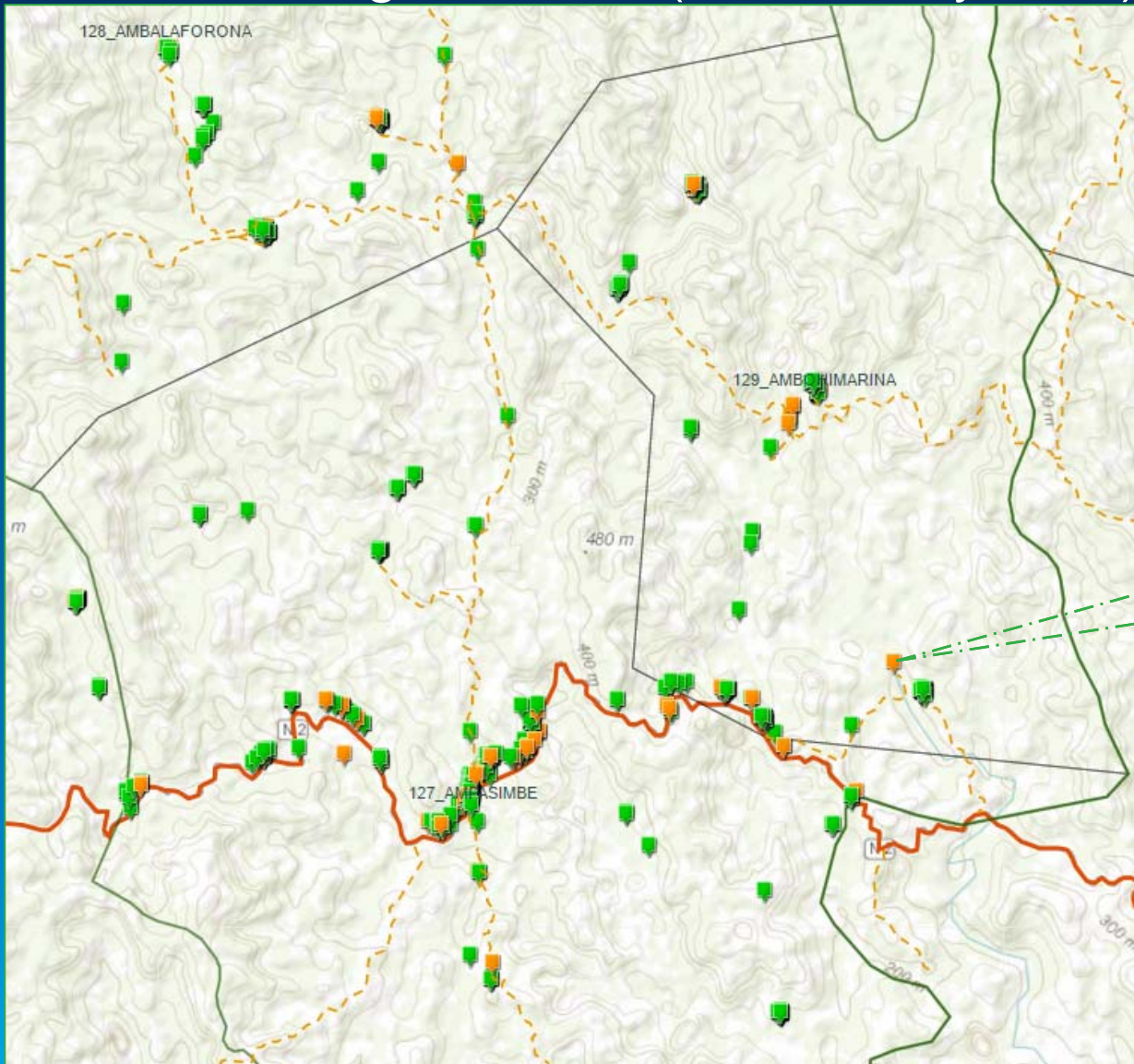
<http://arcg.is/1VT2IH0>

Fararano Project: Targeted area (Commune level)

48 Communes - 464 Fokontany (Community)
Fararano works in all of communities for each Commune




Fararano: Targeted area (Community level)



(1 of 10)

Household ODDIT-127/0A9C
CRS_Benefi ODDIT-127/0A9C-67a



First_Name SABOTSIVAVY
Last_Name Clarisse
gender Female
age 44.00
Marital_St Widowed
Level_of_E Primary level
Phone_Numb
longitude 48.67
latitude -18.96
region AT SINANANA
district BRICKAVILLE
commune Ampasimbe

Zoom to

464 Communities – 72 800 Households
Each Household is located by its GPS coordinates

Fararano Project : Food Distribution Context

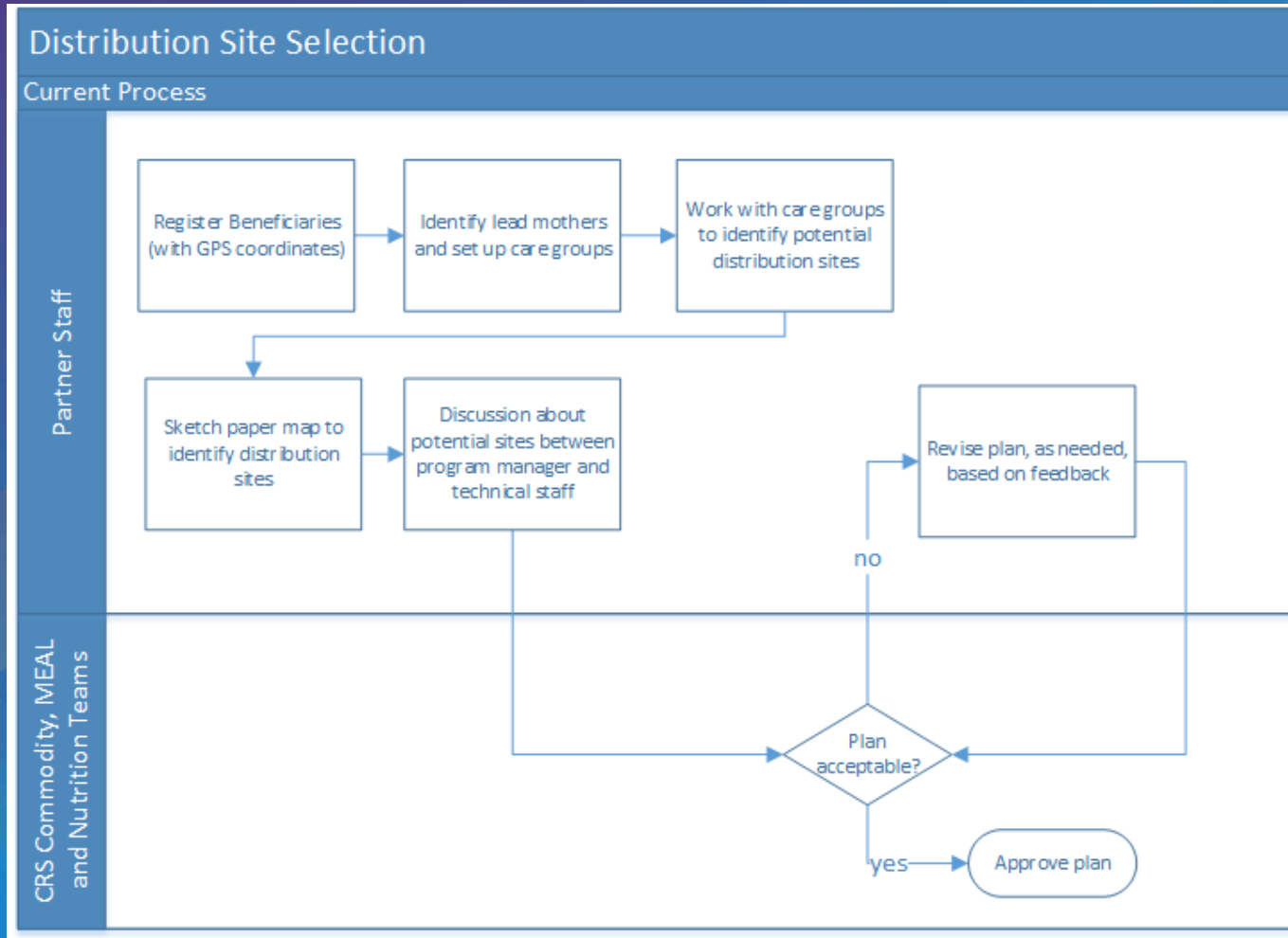


Fararano project will provide food rations to pregnant/lactating women and children under 2 using the First 1000 days approach:

- Fararano plans to target 42,000 mother-child pairs by distributing food rations on a monthly basis
- Fararano implements approximately 200 distribution sites
- Recipients typically travel on foot to join the distribution centers.
- At an early distribution site, some individuals having to walk 18 km (one way) from village to the distribution site

Based on a nutritional analysis of need for women and children, each mother will receive 5kgs of CSB+ and 0.75kgs of Vegetable oil (VO) per month and children 3kg of CSB+ and 0.3 kg of VO.

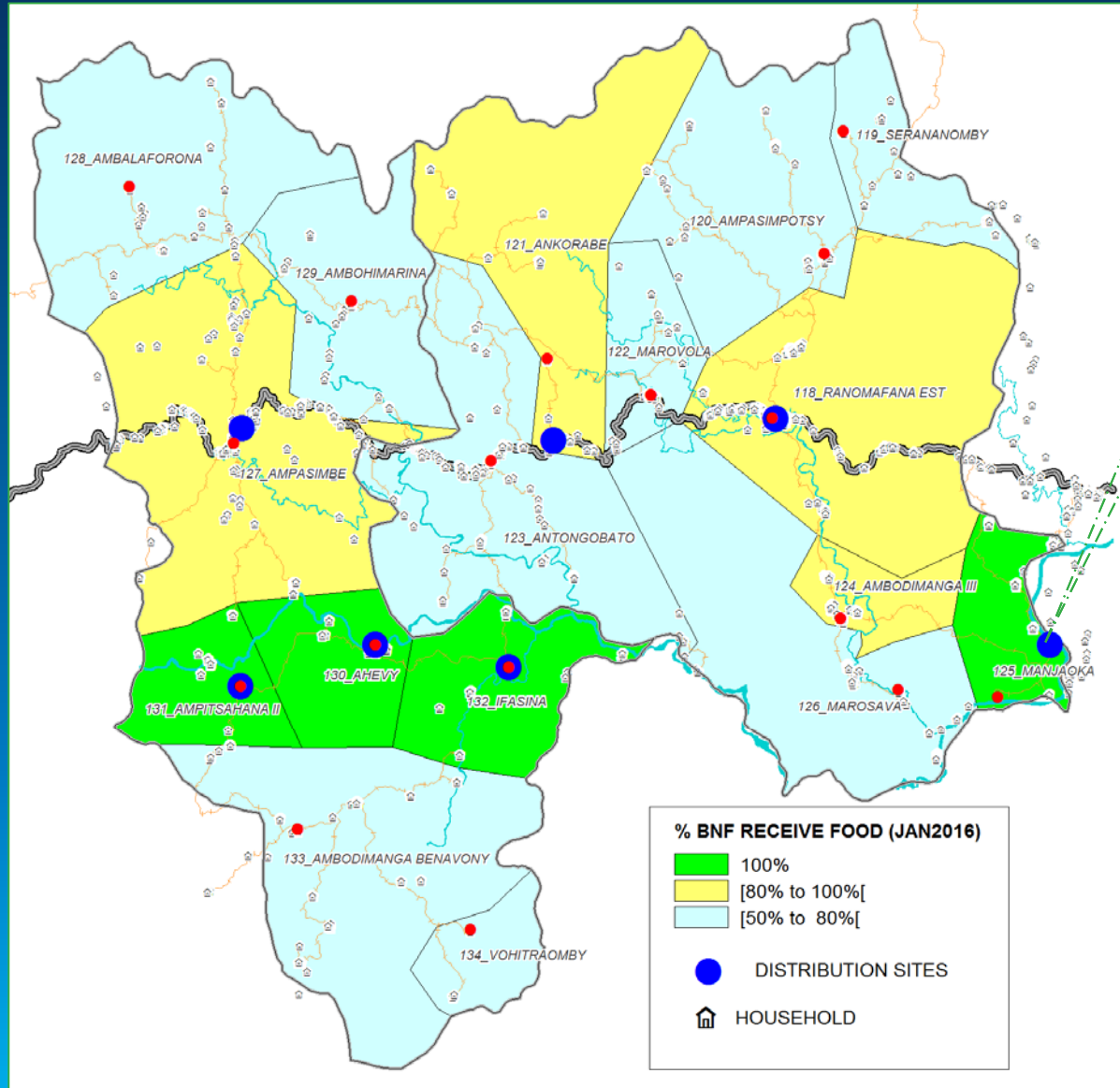
Fararano Project : Food Distribution Site Selection



Initially, distribution site identification is typically based on local context in respecting basic criteria defined by the project .

- existence of large space
- shelter,
- water supply
- large coverage of beneficiaries.
- distribution sites must also be accessible by 6 ton trucks

Fararano Project : Food Distribution Context

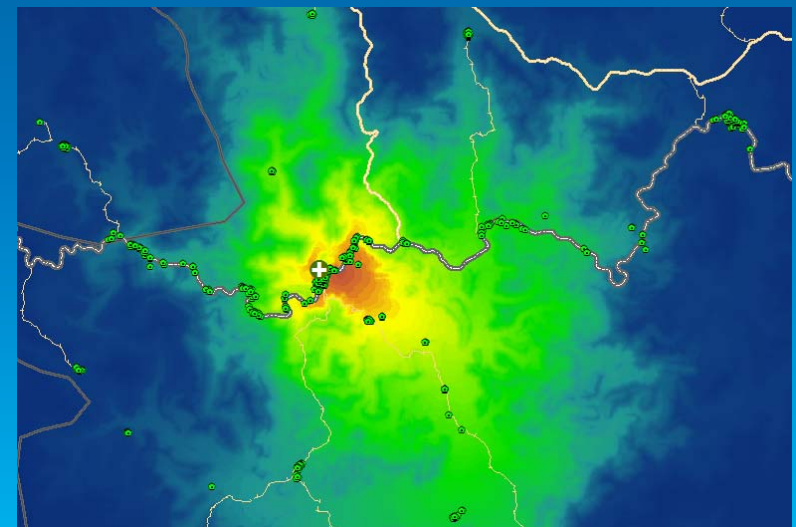
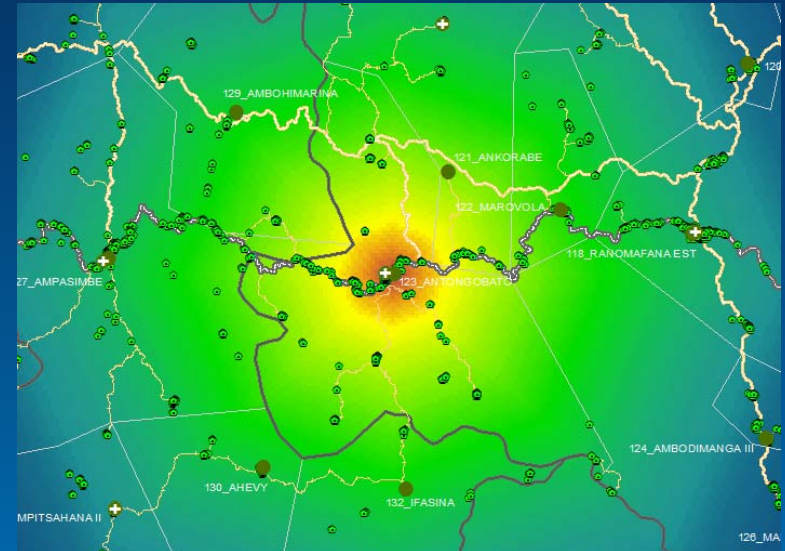


Faced for these issues, CRS proposed applying Geospatial analysis to optimize site selection

GIS solution proposed: Apply Predictive Analysis

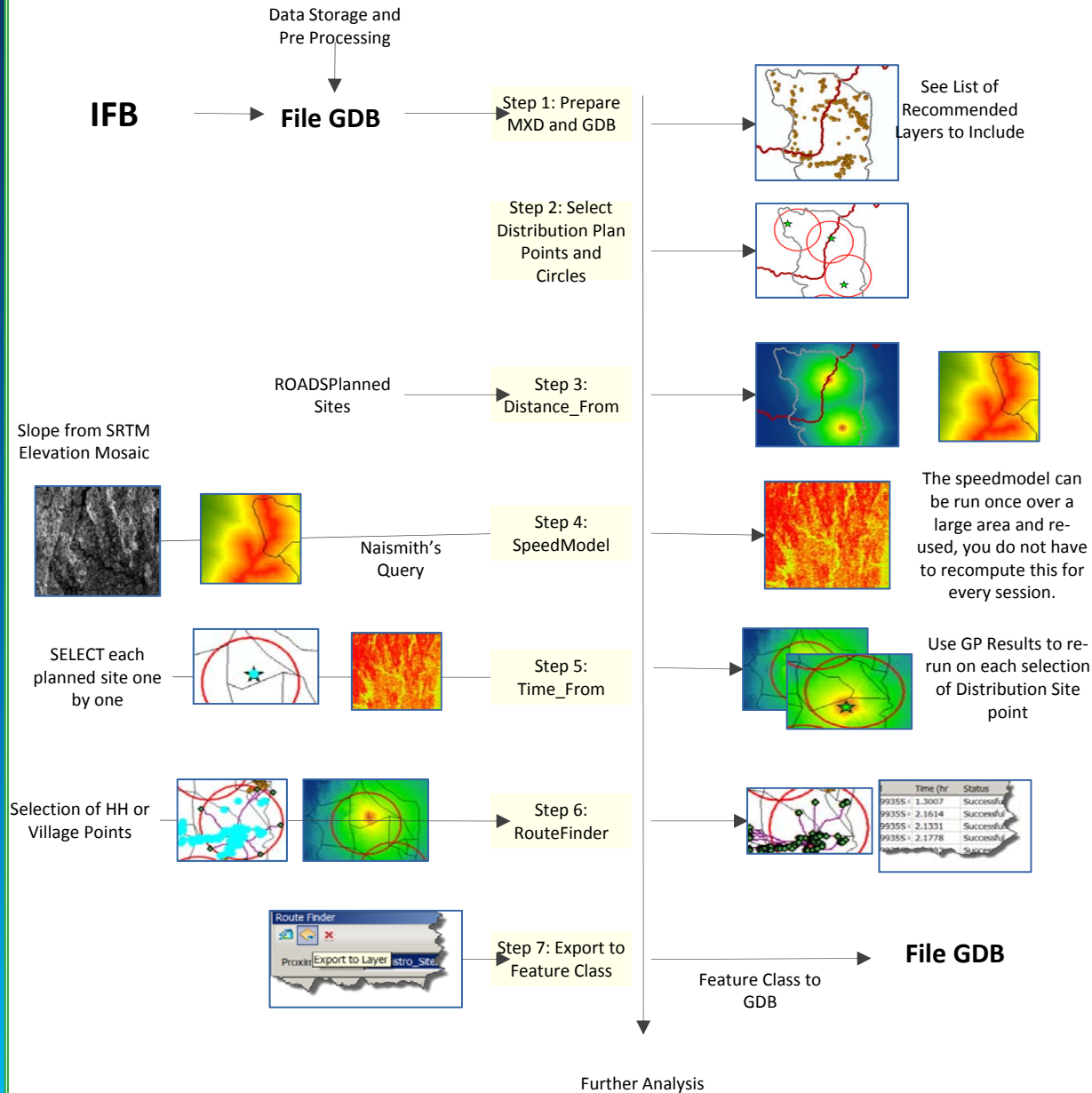
The goals for this solution were:

- To optimize the placement of distribution sites based on a maximum walking distance 5km for beneficiaries
- To optimize the routes traveled by delivery trucks to the distribution sites.
- To increase the efficiency of all operations and transport
- To improve and develop the best intervention strategy for managing the food distribution



The technical guide is available for this workflow

PA (Predictive Analysis) Workflow



Inputs & Planning

Fararano uses the **eValue platform** based on iFormbuilder for data collection, while capturing GPS coordinates

Esri provides **iForm tools** to connect iFormbuilder data to ArcGIS Desktop

Datasets preparation: Location of beneficiaries, Fokontany heads, rivers, roads and satellite imagery aids selection of potential sites

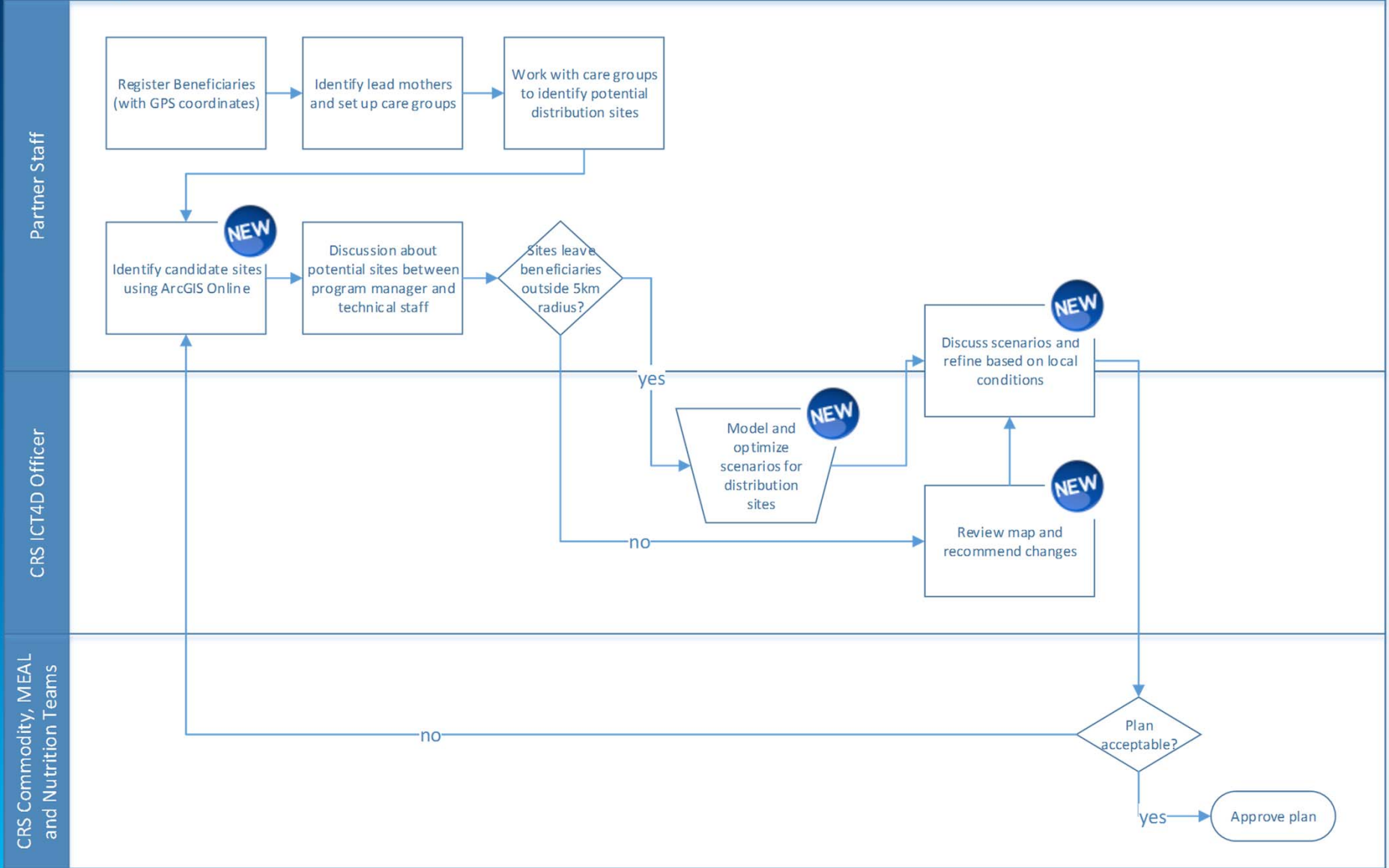
Buffers 5km radius to estimate number of beneficiaries that would be near potential distribution sites

Local knowledge of the area is critical to understand constraints

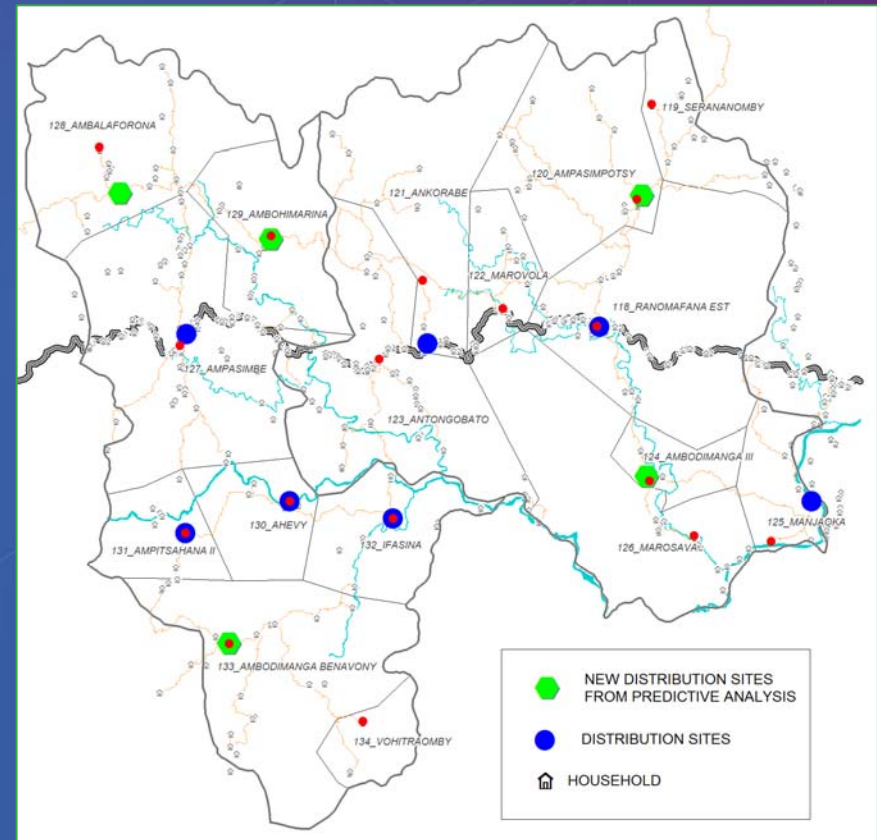
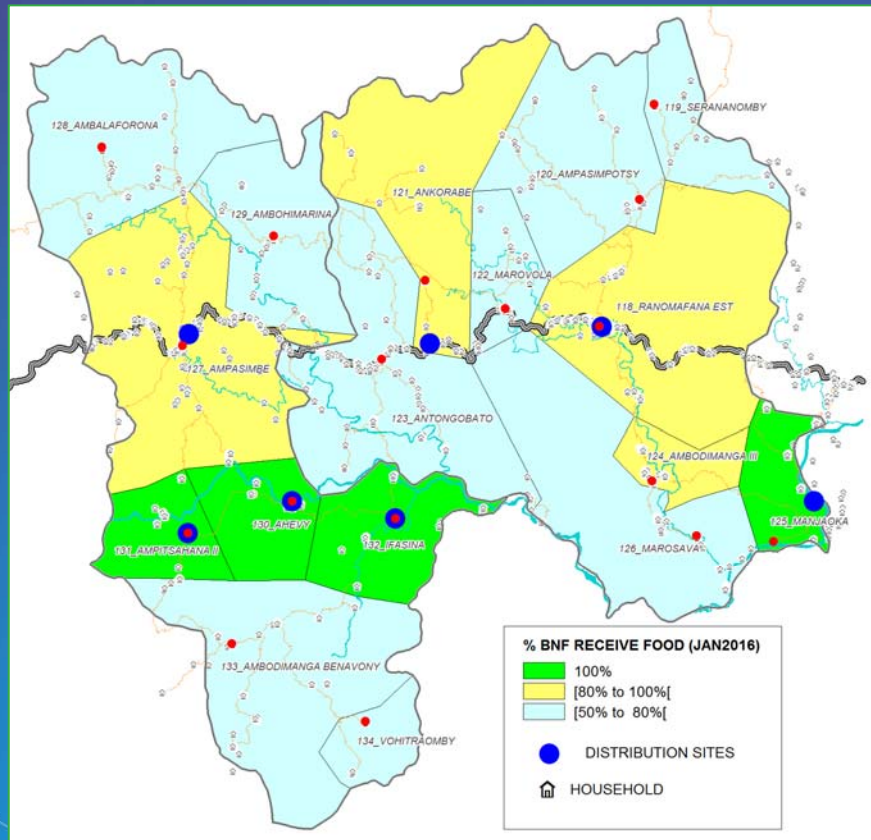
PA-Enabled Process to Select Distribution Sites

Distribution Site Selection

Process using GIS



Food Distribution: New Sites implemented



12 new sites proposed by predictive analysis algorithm

- 8 are created with 98% presence rate,
- 4 others are at implementation phase

The transport cost for these 8 sites are optimized because they are located on the food track itinerary

Predictive Analysis : Lifecycle with Role

PROGRAM MANAGER

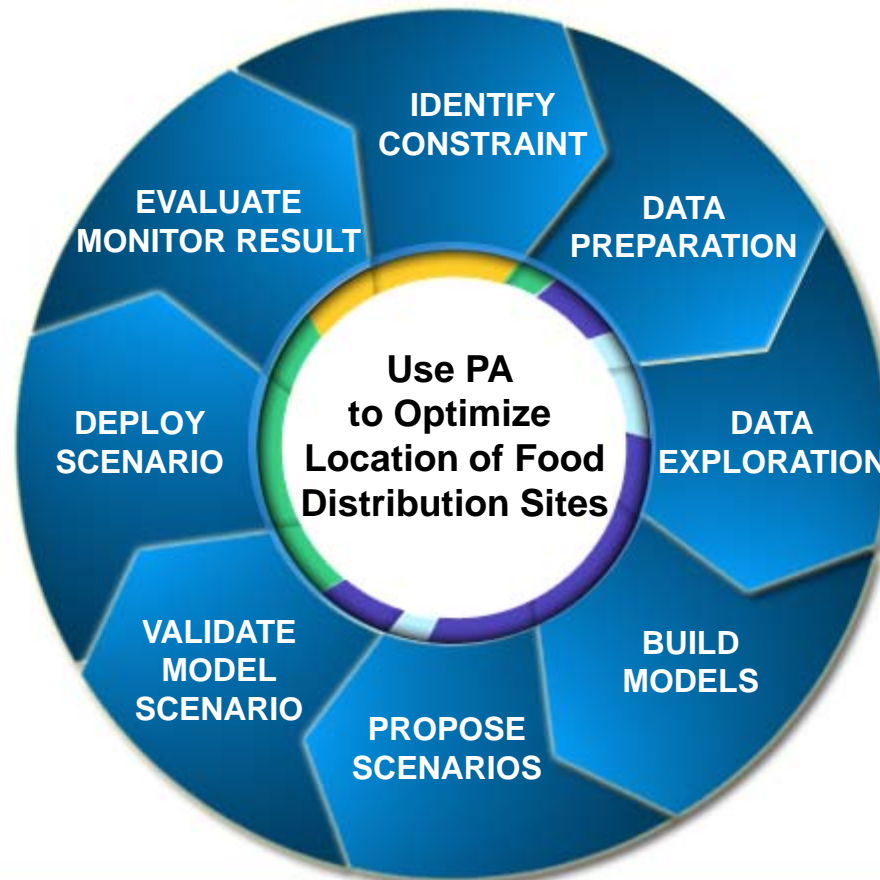


Makes Decisions
Evaluates Processes
Implements

MEAL OFFICER PARTNER



Data Preparation
Scenario Validation
Deploy Scenario



DATABASE ANALYST

Data Cleaning
Data Analysis
Data Visualization
Report Creation



GIS SPECIALIST

Exploratory Analysis
Prepare Geodatabase
Descriptive Segmentation
Predictive Modeling



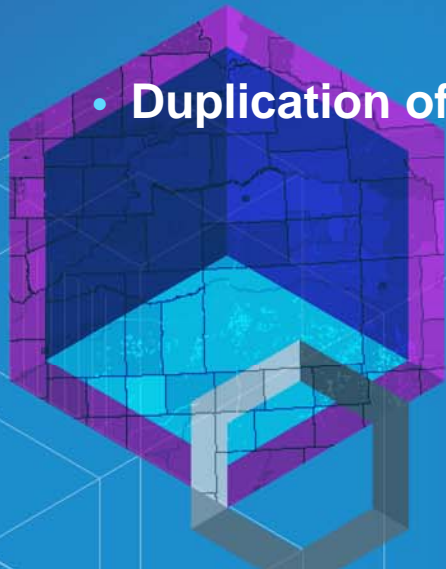
Key Successes

- PA-enabled maps precisely identify beneficiary walk times
- PA allows staff to model and optimize multiple planning scenarios
- Web-based maps enable collaboration and effective management across organizations
- Improve business performance in term of Food distribution
- Drive strategic decision making.



Challenges on implementing and scaling innovation

- Assure the availability of the referential datasets.
- Build the capacity on GIS, Data management for the technical staff
- Clarify Role and responsibility at all level
- Sustainability of this solution (License, Training,)
- Duplication of this solution in the another Project /Activities:

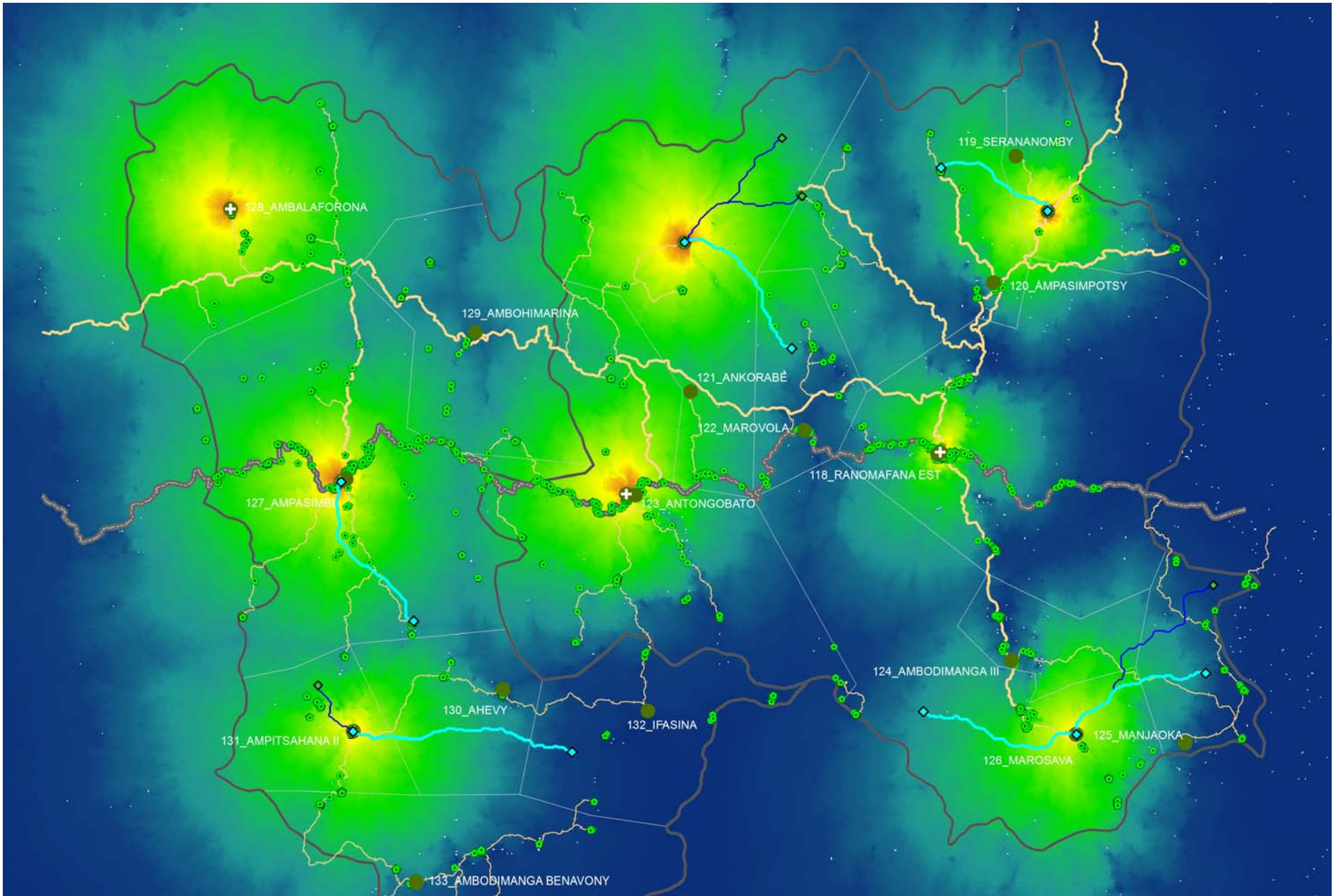


Summary

This solution is powerful in term of spatial analysis, the models provided for this solution are less expensive, scalable and sustainable could be readily adapted by Humanitarian Aid and Facilities Program.

The Implementation of this solution has

- **Increased the mechanism for fostering Innovation in the different sectors in Madagascar**
- **Increased CRS visibility and its leadership in program Area**
- **Improved approach to manage the Food Distribution within 1000Days approach**
- **Improved the efficiencies in project operation.**



THANK YOU