



# New Technique to Enhance Health Care Accessibility Mapping in Yemen

Mark Landry<sup>1</sup>, Carleen Ghio<sup>1</sup>, Andreas Maier<sup>1</sup>,  
and Ahmed Attieg<sup>2</sup>

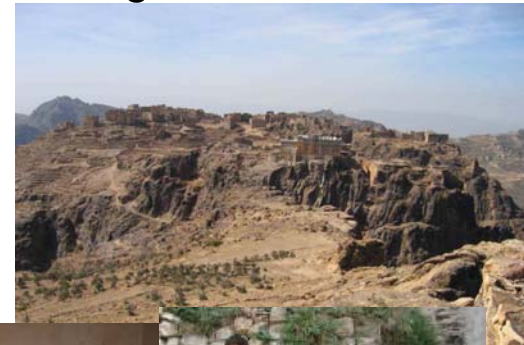
<sup>1</sup> *Abt Associates Inc., USAID-funded Health Systems 20/20 Project*

<sup>2</sup> *USAID/Yemen*

ESRI Health GIS Conference  
Denver, Colorado, October 25, 2006

# Health Information System (HIS) Challenges in Yemen

- ▲ **Inaccurate data collection** and health indicators due to lack of uniform statistical registers and collection tools
- ▲ Current data collections are **used for reporting purposes only**—as only 36% of facilities use data for decision-making
- ▲ Weak and unreliable health information systems contribute to misinformed decisions and **poor quality** of health care services
- ▲ **Lack of incentives** to maintain data for the many vertical programs or share data across Ministries



# Ongoing HIS/GIS Technical Support

- ▲ Instituted **National Health Accounts (NHA)** to track expenditures
- ▲ Conducted comprehensive **health facility survey** (data instrument, GPS coordinates, digital photographs)
- ▲ Synthesized, cleaned, and georeferenced the best available **GIS base map data**
- ▲ Coordinated with Central Statistical Organization on **2004 Census**
- ▲ Standardized **coding lists** for geographic units (settlements, districts, governorates) to increase compatibility and acceptance among all stakeholders
- ▲ **Building capacity** for District, Governorate, and National utilization of HIS with health GIS tools and applications scaled to each level
- ▲ Improved **transparency and accountability** of HIS resources, data sources, and indicators





# Governorate-Level HIS/GIS Support

- ▲ Simple, elegant, novel eHealth solutions
  - ▲ *Health Facility Viewer* (Internet Explorer enabled)
  - ▲ *Health Sector Analyzer* (MapObjects tool)
- ▲ **Target Audience:** Director-General of Health, Health Officials/Managers, Statisticians, Hospital Administrators
- ▲ Benefits anyone who can access a computer
- ▲ Easy-to-use **health care planning, targeting, management, budgeting, evaluation tools** in a GIS environment
- ▲ **Easy-to-understand analyses and maps**
- ▲ **Basic training, user's manual support, and evaluation**



HEALTH FACILITY VIEWER  
*Shabwah*



**VIEW INFORMATION FOR:**

Governorate:  Go >>

District:  Go >>

**Health Facility:**

- Mawqes Health Center
- Mawqes Health Unit
- Mawsatat Al Ain Health Unit
- Nakhl Health Unit
- Neqaq Health Unit

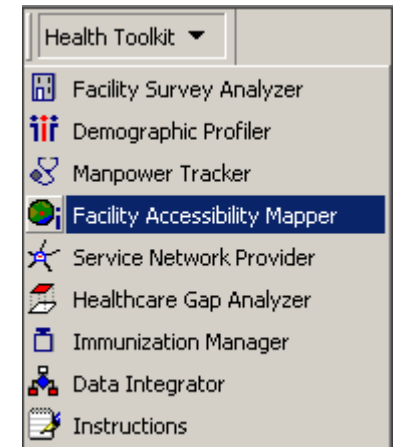
Go >>

- General
- Infrastructure
- Services
- Health Cadre
- Equipment
- Drugs
- Photos



# National-Level Health GIS Support

- ▲ **Health GIS Toolkit** for **ESRI ArcView 9.x ArcMap** environment
- ▲ **Target Audience:** Ministry of Health, other ministries, USAID/Yemen (all sectors), WHO, World Bank, Social Fund for Development, others
- ▲ **Mechanism** for accessing HIS databases for analyzing, visualizing, and reporting health information for decision-making and performance tracking
- ▲ **Rapid assessment** of health care gaps
- ▲ **Evidence-based planning** for meeting needs
- ▲ Reducing or **avoiding duplication** of service coverage by type
- ▲ **Targeting** limited resources
- ▲ Improving **effectiveness, efficiency, and equity** of health services
- ▲ CD-ROM contents: toolkit, base map data, and health facility survey data



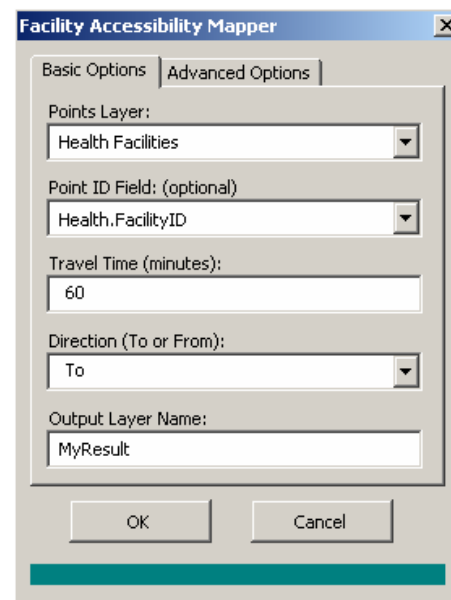
# Yemen Health GIS Toolkit

- ▲ **Version 1.0 (September 2006)** contains eight customized tools designed specifically to address the needs of the Yemeni Ministry of Health
  - ▲ **Facility Survey Analyzer:** Query/analytical tool using the health facility survey data
  - ▲ **Demographic Profiler:** Generates density maps based on key demographics
  - ▲ **Manpower Tracker:** Profiles health occupations using pie charts and bar graphs
  - ▲ **Facility Accessibility Mapper:** Calculates and displays the area surrounding a health facility that meets a user-defined time-travel accessibility criteria.
  - ▲ **Service Network Provider:** Illustrates health care service networks
  - ▲ **Health Care Gap Analyzer:** Identifies gaps in health care coverage according to user specifications
  - ▲ **Immunization Manager:** Time series analysis of routine immunization coverage and vaccine wastage
  - ▲ **Data Integrator:** Rapid integration of user data into HIS database
- ▲ **Next steps?**
  - ▲ Enhance existing tools
  - ▲ Add new modules to address health finance, resource tracking, disease surveillance, monitoring and evaluation, and integration of other health indicators



# Facility Accessibility Mapper

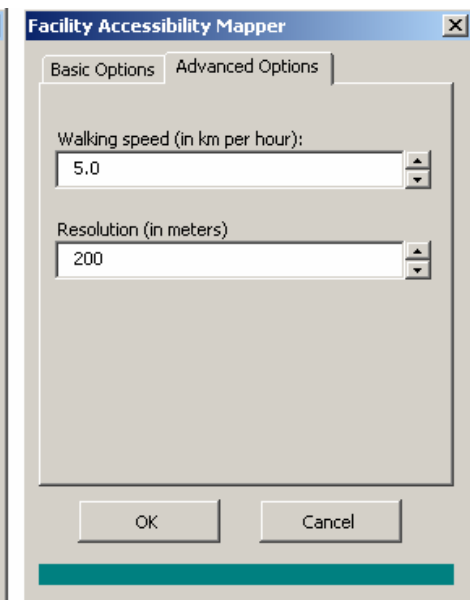
- ▲ Calculates the area surrounding a facility that can be reached by walking within a user-defined time frame.
- ▲ Anisotropic cost-distance approach:
  - ▲ Time
  - ▲ Distance
  - ▲ Walking speed
  - ▲ Topography (slope and direction)
- ▲ Pre-tested considerations
  - ▲ DEM vs. contour map inputs
  - ▲ Use/attraction of roads for walking
  - ▲ Raw vs. smoothed results
- ▲ Next steps:
  - ▲ Integrate vehicular accessibility
  - ▲ Interface with ArcView 9.2



The screenshot shows the 'Basic Options' tab of the Facility Accessibility Mapper dialog box. It contains the following fields:

- Points Layer: Health Facilities (dropdown menu)
- Point ID Field: (optional): Health.FacilityID (dropdown menu)
- Travel Time (minutes): 60 (text input)
- Direction (To or From): To (dropdown menu)
- Output Layer Name: MyResult (text input)

Buttons for 'OK' and 'Cancel' are located at the bottom.



The screenshot shows the 'Advanced Options' tab of the Facility Accessibility Mapper dialog box. It contains the following fields:

- Walking speed (in km per hour): 5.0 (spin box)
- Resolution (in meters): 200 (spin box)

Buttons for 'OK' and 'Cancel' are located at the bottom.

Search

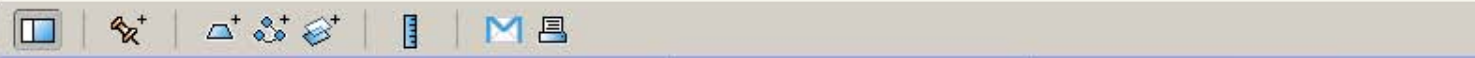
Fly To Find Businesses Directions

e.g., 94043

Places

- My Places
- Yemen Health GIS
- Yemen Health GIS
- Layers
- Tutorial
- Sightseeing
- default
- Temporary Places

Layers



2.71 mi

Image © 2006 TerraMetrics  
 Image © 2006 DigitalGlobe  
 © 2006 Europa Technologies

© 2005 Google™

Streaming ||||| 93% Eye all 38458 ft

Search

Fly To Find Businesses Directions

e.g., 94043

Places

- My Places
  - Yemen Health GIS
  - Yemen Health GIS
    - Governorate
    - District
    - Health Facilities
  - Layers
  - Health Facilities
  - Tutorial
  - Sightseeing
    - Select this folder and click on the 'Play' button below, to sta
    - default
  - Temporary Places
  - Yemen Health GIS
    - Governorate
      - Abyan
      - Al Bayda
      - Al Dhale'e
      - Al Hudaydah

Layers

Navigation icons: Home, Pegman, Fly, Rotate, Tilt, Street View, Print, Link, Full Screen, Refresh, Close



Facility Name (English):	Harib Hospital
Facility Name (Arabic):	مستشفى حريب
Facility Type:	Hospital
Location:	Rural
Governorate:	Marib
Operating since:	1972
Working Hours:	5
Total Rooms:	20

Search

Fly To Find Businesses Directions

e.g., 94043

Search input field with magnifying glass icon

Places

- My Places
  - Yemen Health GIS
  - Yemen Health GIS
    - Governorate
    - District
    - Health Facilities
  - Layers
    - Health Facilities
    - Tutorial
    - Sightseeing
  - default
- Temporary Places
  - Yemen Health GIS
    - Governorate
      - Abyan
      - Al Bayda
      - Al Dhale'e
      - Al Hudaydah

Layers

Navigation toolbar with icons for pan, fly, home, and other controls.



AUG 1954

	
Facility Name (English):	Al Ragheel Health Unit
Facility Name (Arabic):	الوحدة الصحية بالرغيل
Facility Type:	Health Unit
Location:	Rural
Governorate:	Amran
Operating since:	2004
Working Hours:	6
Total Rooms:	1

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 Image © 2006 DigitalGlobe  
 Image © 2006 TerraMetrics

© 2006 Google

520 ft

Streaming 12% Eye all 4899 ft

Search

Fly To Find Businesses Directions

e.g., 94043

Places

- My Places
    - Yemen Health GIS
    - Yemen Health GIS
    - Layers
    - Tutorial
    - Sightseeing
    - default
    - Temporary Places
- Select this folder and click on the 'Play' button below, to sta



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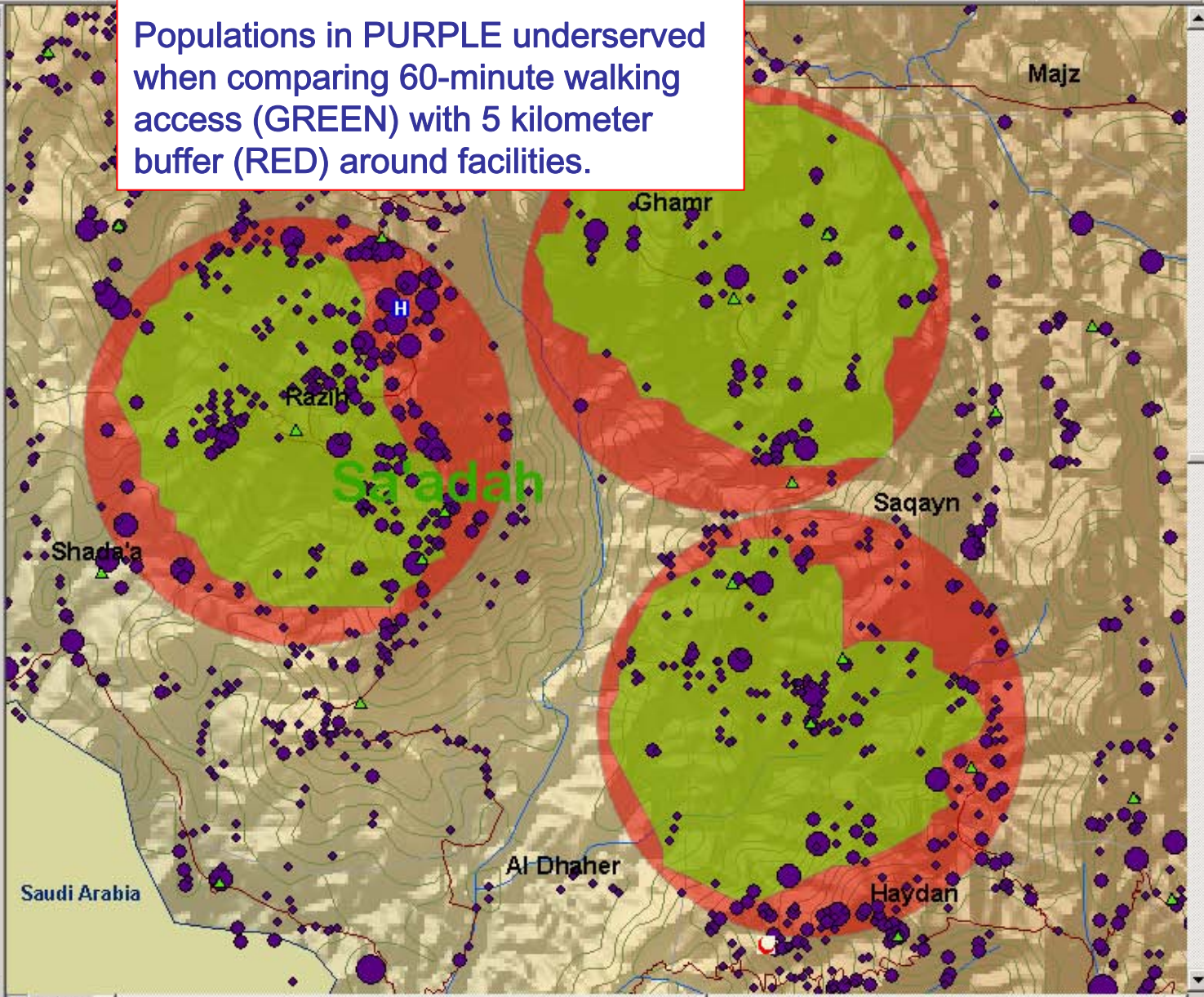
© 2006 Google™

Pointer 16°52'39.48" N 43°20'59.43" E elev 5434 ft Streaming 100% Eye alt 5809 ft

**Example: Accessibility Gap**

Populations in PURPLE underserved when comparing 60-minute walking access (GREEN) with 5 kilometer buffer (RED) around facilities.

- Yemen Health GIS**
- Health Facilities
    - Unverified Facilities
    - H Hospitals
    - C Health Centers/Clinics
    - ▲ Health Units
  - Village Population
    - Total (1994 Census)
    - ◆ < 100
    - 100 - 250
    - 251 - 500
    - 501 - 1,000
    - > 1,000
  - Example: 60-minute access ■
  - Example: 5km buffer ■
  - Governorate
  - District
  - Immunization Accessibility
  - Targeted Facilities
  - New Facilities
  - Immunization Gap
  - Immunization Network
  - Roads
    - TYPE
    - Asphalt Road
    - Unpaved Road
  - 100m Contours
  - Wadies
  - Yemen
  - Elevation
  - Countries
  - hillshade\_0008deg
    - Value
    - High : 181

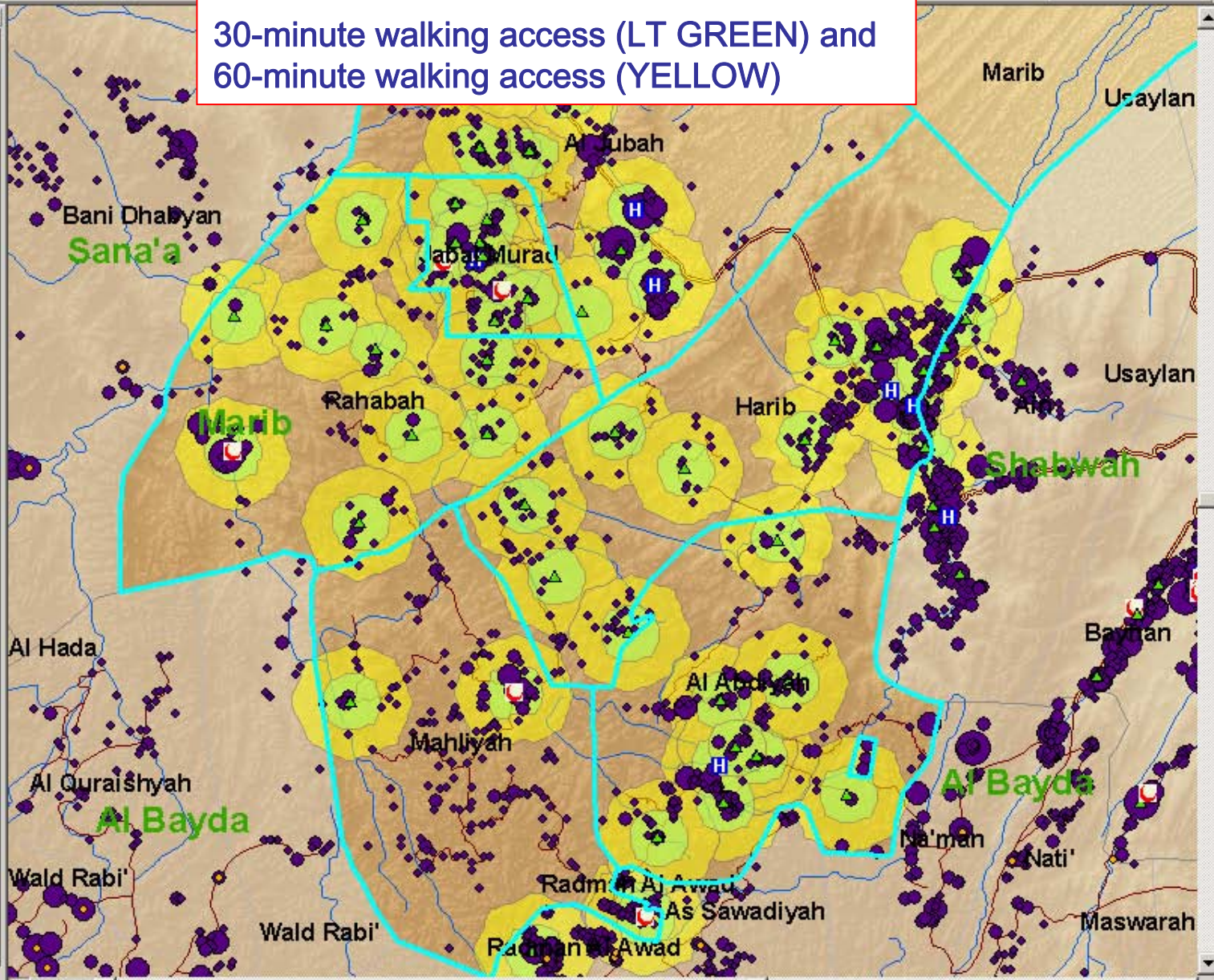


Example: Accessibility Coverage  
30-minute walking access (LT GREEN) and  
60-minute walking access (YELLOW)

**Yemen Health GIS**

- Health Facilities
  - Unverified Facilities
  - H Hospitals
  - C Health Centers/Clinics
  - ▲ Health Units
- Village Population
  - Total (1994 Census)
  - < 100
  - 100 - 250
  - 251 - 500
  - 501 - 1,000
  - > 1,000
- fam\_marib\_access240
- 100m Contours
- fam\_marib\_onefacaccess240
- 30-minute accessibility
  -
- 60-minute accessibility
  -
- 90-minute accessibility
  -
- Roads
  - TYPE
  - Asphalt Road
  - Unpaved Road
- Wadies
- Governorate
- District
- Yemen
- Elevation
- Countries
- Elevation (m)
- hillshade\_0008deg

Display Source Selection

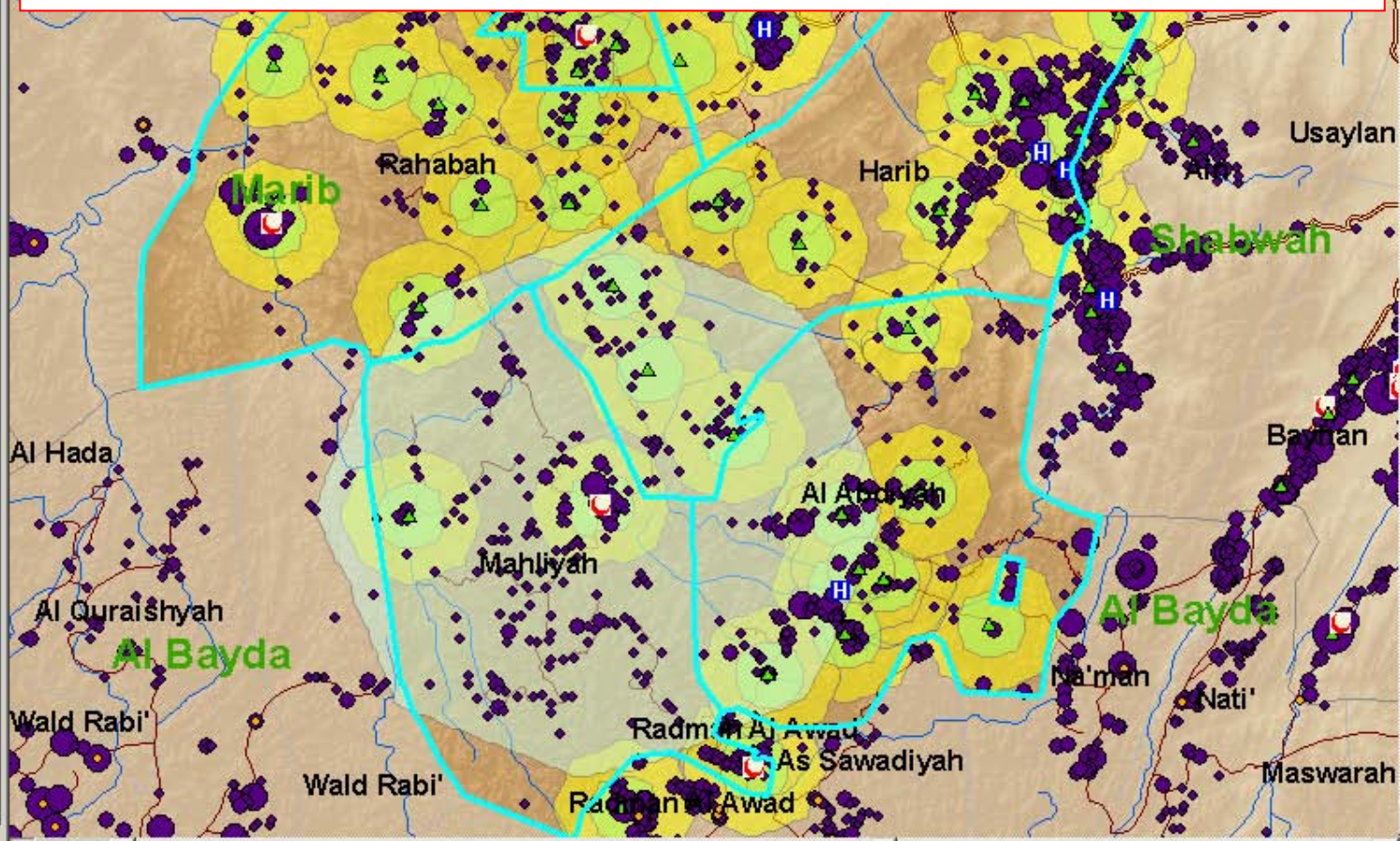



**Yemen Health GIS**

- Health Facilities
  - ◆ Unverified Facilities
  - H Hospitals
  - C Health Centers/Clinics
  - ▲ Health Units
- Village Population
  - Total (1994 Census)
  - ◆ < 100
  - 100 - 250
  - 251 - 500
  - 501 - 1,000
  - > 1,000
- fam\_marib\_access240
- 100m Contours
- health clinic - 3-hour network
  -
- 30-minute accessibility
  -
- 60-minute accessibility
  -
- 90-minute accessibility
- Roads
  - TYPE
  - Asphalt Road
  - Unpaved Road
- Wadies
  -
- Governorate
- District
- Yemen
- Elevation
- Countries
- Elevation (m)

Example: Evaluation of Health Clinic Network based on 3-hour walking coverage (LT BLUE)

Evidence-based visual inspection highlights: (1) importance of proximity, (2) establishing health care referral network for District health clinics, (3) overcoming political barriers associated with District boundaries, (4) inducing outreach campaign to educate citizens of availability of closest services, and (5) targeting locations for sending mobile health teams





# Example: Model Builder Approach

- ▲ Target health facilities meeting or not meeting user-defined criteria
- ▲ Assess the health service network coverage based on proximity
- ▲ Determine the level of accessibility (e.g., 30-, 60-, 90-minutes or other)
- ▲ Identify the gaps in health care services coverage
- ▲ Inform health planning decisions
  - ▲ Reallocation of resources
  - ▲ Identification of new points of service to be initiated
- ▲ View the results
- ▲ Track performance over time
  
- ▲ See example analysis on the following five slides...



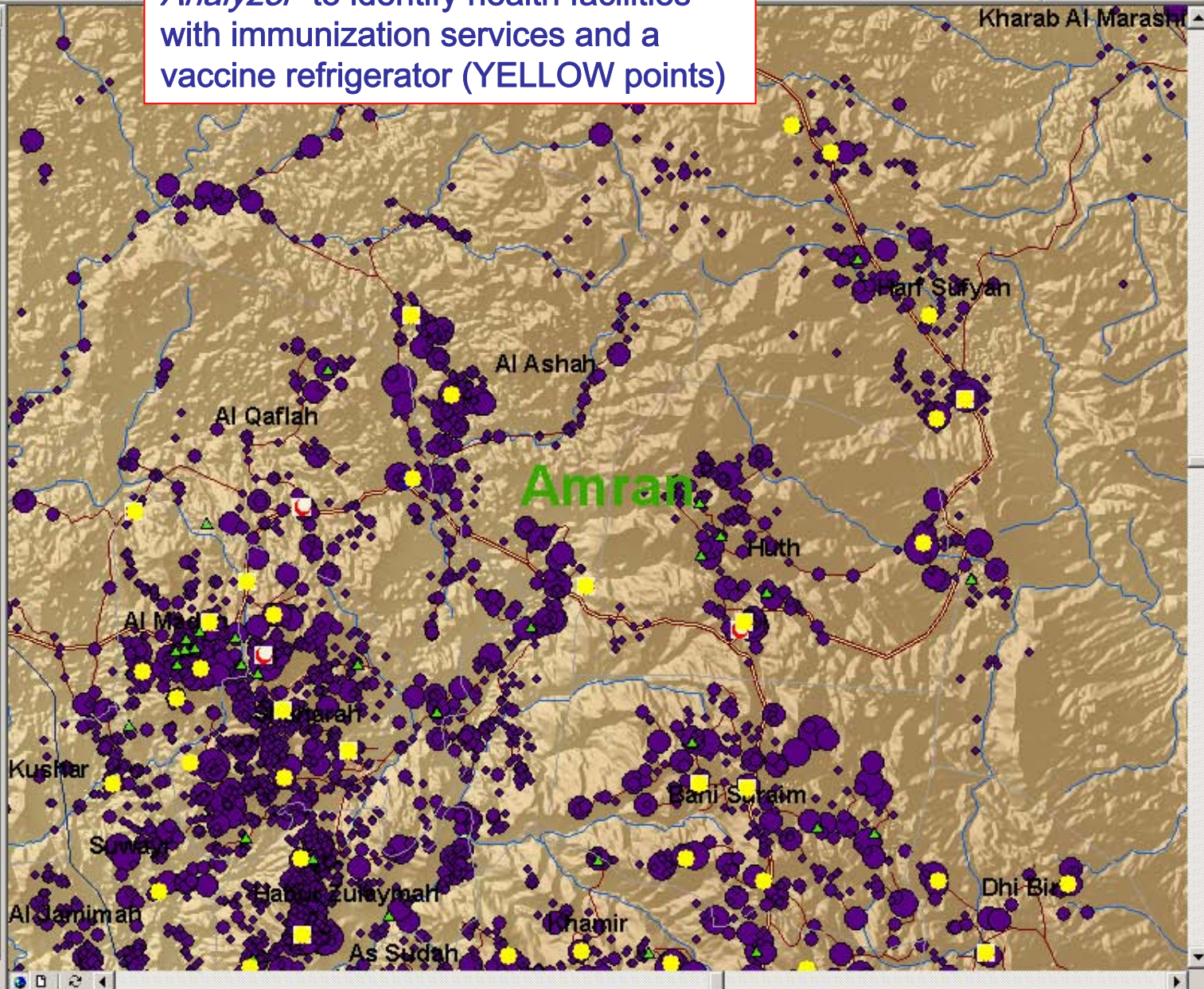


Step 1: Use the *Facility Survey Analyzer* to identify health facilities with immunization services and a vaccine refrigerator (YELLOW points)



**Yemen Health GIS**

- Governorate
- District
- Health Facilities
  - Unverified Facilities
  - Hospitals
  - Health Centers/Clinics
  - Health Units
- Immunization Accessibility
- Village Population
  - Total (1994 Census)
  - < 100
  - 100 - 250
  - 251 - 500
  - 501 - 1,000
  - > 1,000
- Targeted Facilities
- New Facilities
- Immunization Gap
- Immunization Network
- Roads
  - TYPE
  - Asphalt Road
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- 100m Contours
- Wadies
- Yemen
- Elevation
- Countries
- hillshade\_0008deg
  - Value
  - High : 181
  - Low : 1
- Elevation (m)







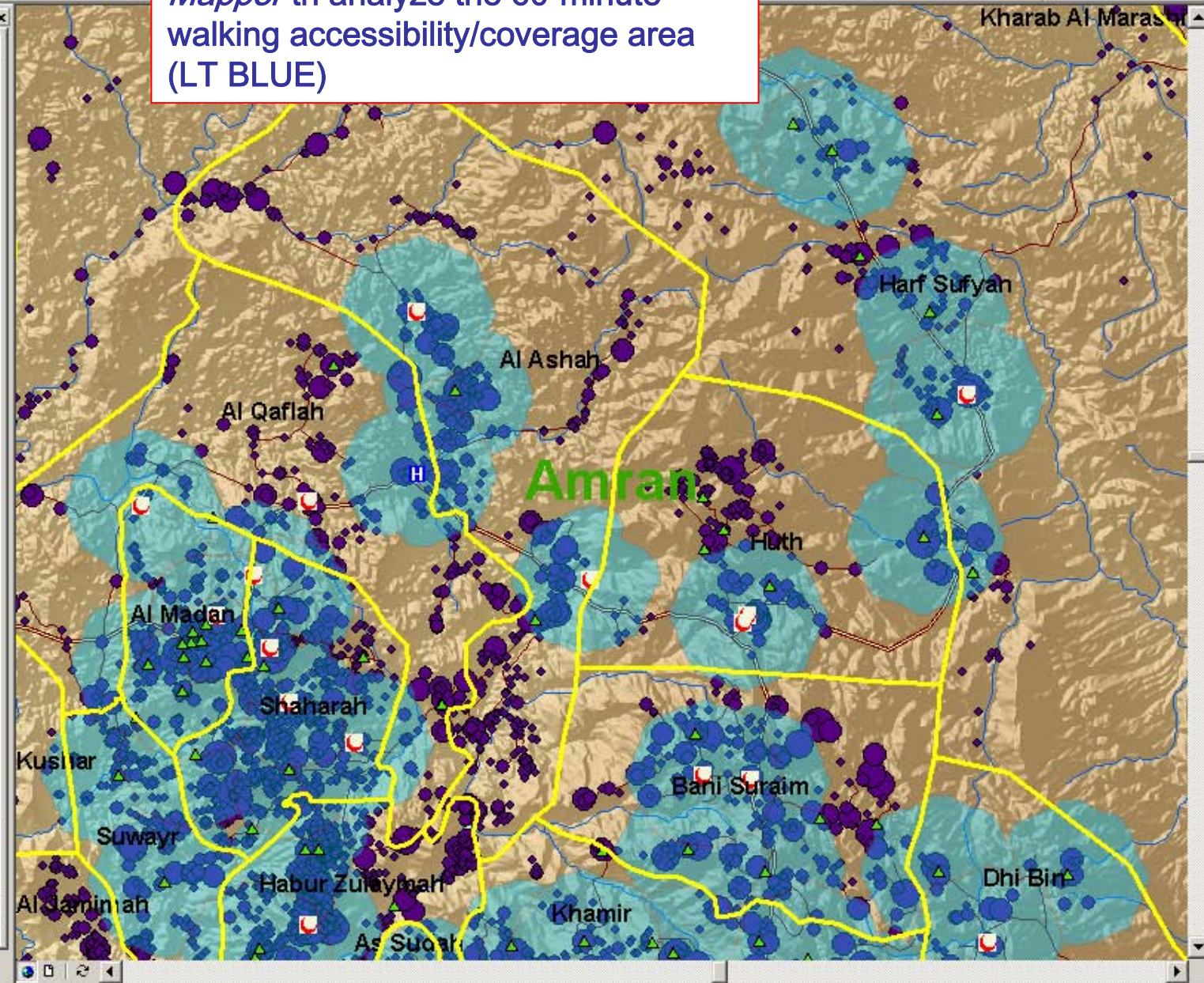
Step 3: Use the *Facility Accessibility Mapper* to analyze the 60-minute walking accessibility/coverage area (LT BLUE)



**Yemen Health GIS**

- Governorate
- District
- Health Facilities
  - Unverified Facilities
  - Hospitals
  - Health Centers/Clinics
  - Health Units
- Immunization Accessibility
- Village Population (Total (1994 Census))
  - < 100
  - 100 - 250
  - 251 - 500
  - 501 - 1,000
  - > 1,000
- Targeted Facilities
- New Facilities
- Immunization Gap
- Immunization Network
- Roads
  - TYPE
  - Asphalt Road
  - Unpaved Road
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- hillshade\_0008deg
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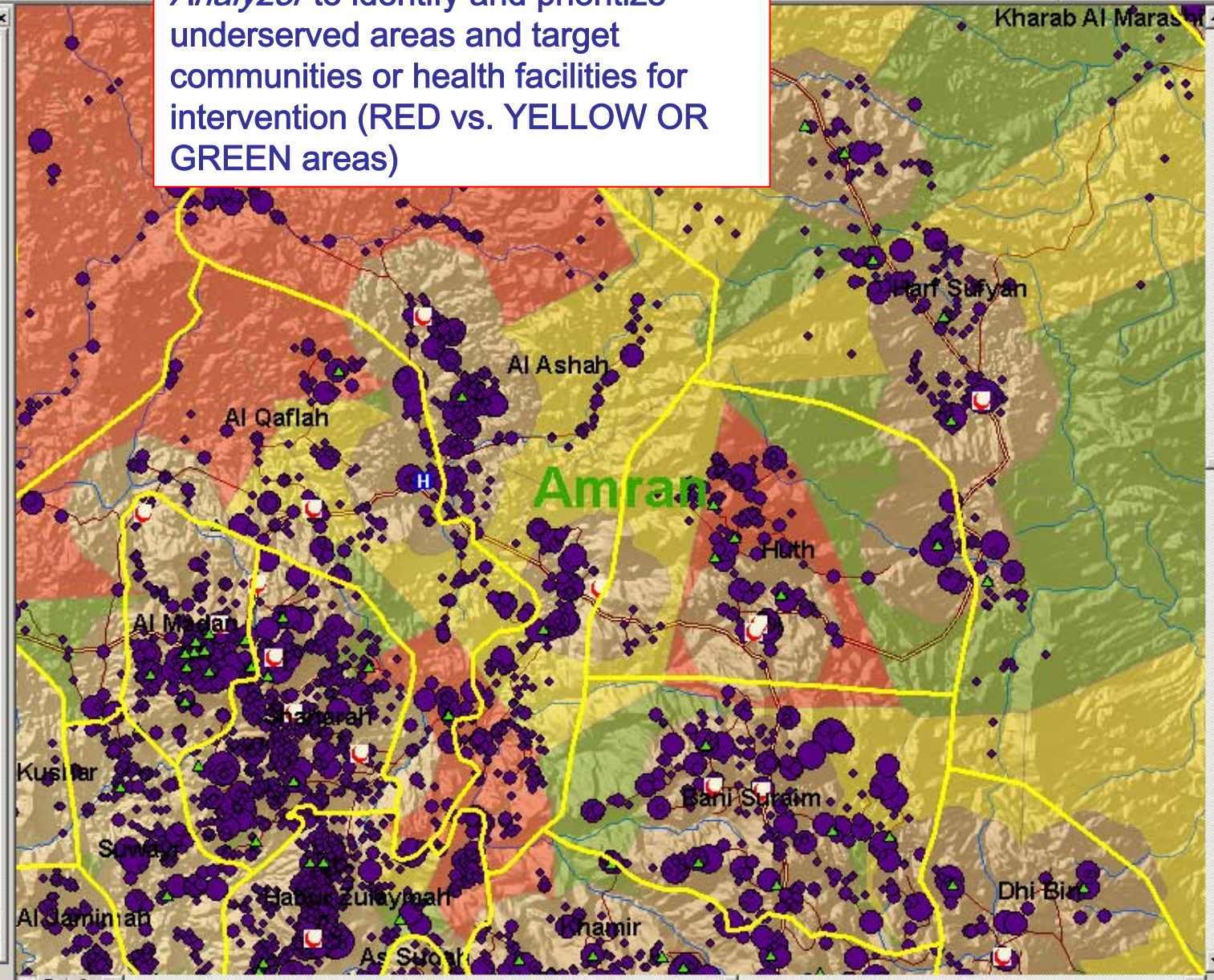
Display Source Selection

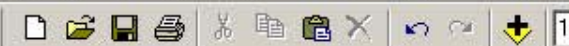




- Yemen Health GIS
  - Governorate
  - District
  - Health Facilities
    - Unverified Facilities
    - Hospitals
    - Health Centers/Clinics
    - Health Units
  - Immunization Accessibility
  - Village Population
    - Total (1994 Census)
    - < 100
    - 100 - 250
    - 251 - 500
    - 501 - 1,000
    - > 1,000
  - Targeted Facilities
  - New Facilities
  - Immunization Gap
    - Population
    - 0 - 1350
    - 1351 - 4704
    - 4705 - 9801
  - Immunization Network
  - Roads
    - TYPE
    - Asphalt Road
    - Unpaved Road
  - 100m Contours
  - Wadies
  - Yemen
  - Elevation

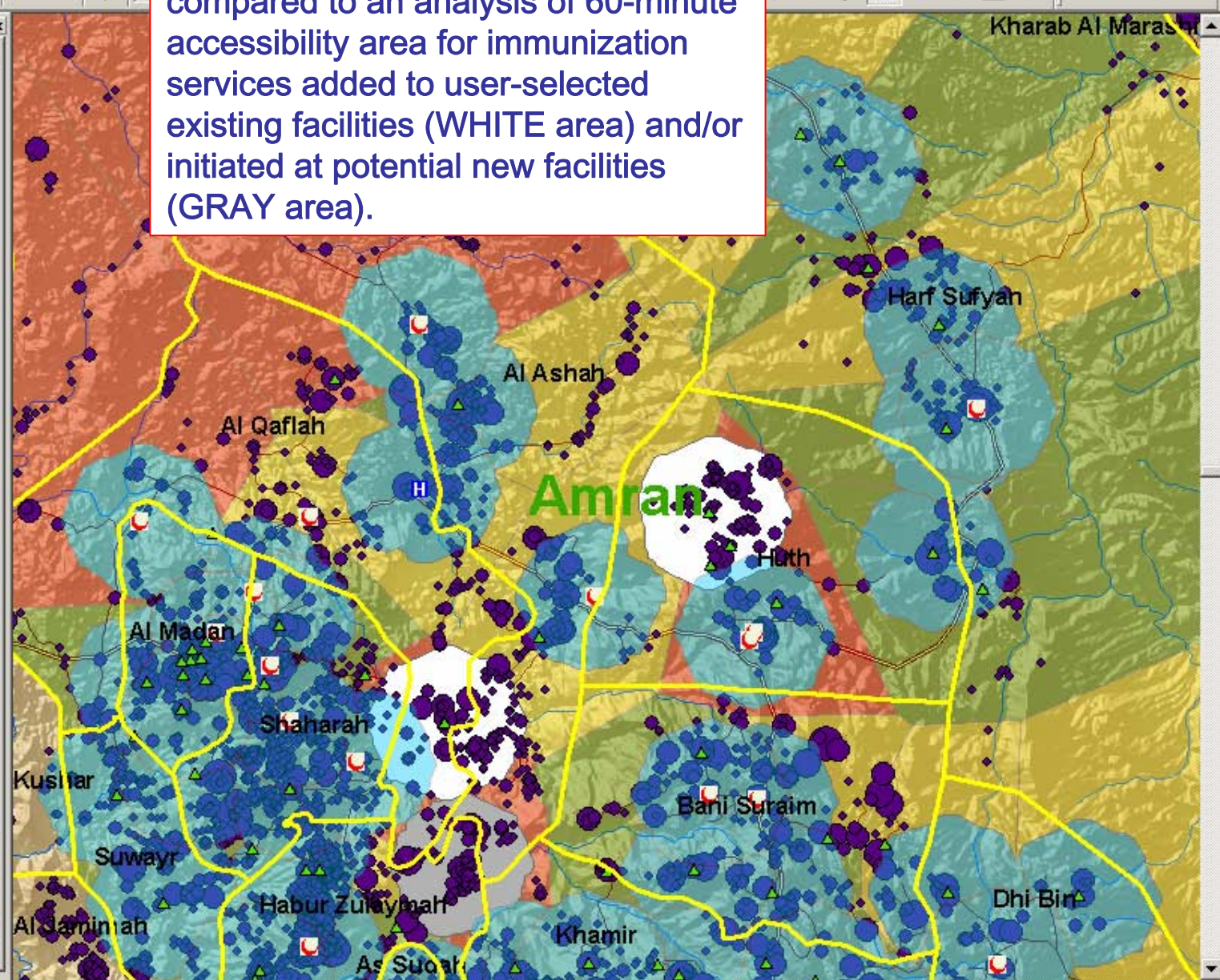
Step 4: Use the *Healthcare Gap Analyzer* to identify and prioritize underserved areas and target communities or health facilities for intervention (RED vs. YELLOW OR GREEN areas)





**Yemen Health GIS**

- Governorate
- District
- Health Facilities
  - Unverified Facilities
  - Hospitals
  - Health Centers/Clinics
  - Health Units
- Immunization Accessibility
- Village Population (Total (1994 Census))
  - < 100
  - 100 - 250
  - 251 - 500
  - 501 - 1,000
  - > 1,000
- Targeted Facilities
- New Facilities
- Immunization Gap
- Immunization Network
- Roads
  - TYPE
  - Asphalt Road
  - Unpaved Road
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- Wadies
- Yemen
- Elevation
- Countries
- hillshade\_0008deg
  - Value
  - High : 181



# Example Health Care Decision Support Results to Date

- ▲ **Targeting:** Midwives Association is using atlases to prioritize deployment of the newly trained
- ▲ **Assessment:** District health officials are using atlases, maps, and *Health Facility Viewer* to justify (re)allocation of resources
- ▲ **Planning:** Governorate health officials are using health GIS to consider health care equity by analyzing catchment populations by accessibility zones
- ▲ **Gap Analyzing:** Governorates used health GIS to identify and prioritize rural facilities in need of electricity to support cold chain
- ▲ **Collaborative Solutions:** Ministry of Local Authority used the USAID-enhanced GIS to support Fall 2006 elections



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