Using Geospatial Tools to Enhance Response Mechanisms for Missing Children Cases in Jamaica

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Abstract

The Ananda Alert Programme developed in 2009 has seen an increased demand for the safe and speedy recovery of missing children, while simultaneously being criticized for its lack of effectiveness. Using geospatial and other IT technologies, missing children alerts were mapped as a means of enhancing the planning and recovery process, and geospatial web tools further utilized to disseminate information to various stakeholders.

It is shown that spatial tools can assist with the conduct of analyses and the visualization of trends and patterns associated with high clusters of missing children and empower the responders to make more efficient the mitigation and response exercises.

Key Words: Ananda alert, geospatial analysis, missing children

Introduction

Children continue to account for a large percentage of missing persons in Jamaica. According to the National Intelligence Bureau, 2012, in 2008, of the 1,446 persons reported missing across Jamaica, 960 were children. This figure increased to 1,770 in 2009, and to 2,126 in 2011. Some of these missing children are suspected victims of human trafficking and abduction and have not returned home.

The Ananda Alert Programme is a nationwide system developed in 2009 designed primarily to support the recovery of missing children in the unfortunate event that he/she is missing or abducted. The system involves the mobilization of stakeholders into getting the message of a missing child into the public domain the moment the matter is reported to the police. The aim is to create a rapid response from law enforcement and communities to help bring the matter to public attention with the aim of increasing the chances of the child's safe return.

In 2012, the programme saw an increased demand for the safe recovery of missing children. At the same time, it was being criticized as being largely ineffective. One study conducted by Gloria Thompson on the abduction alarm system, found it wanting and concluded that while Ananda Alert is a good initiative by policymakers, it has not lived up to its true potential (Gleaner, 2013). This when compared with the successes that have been realized from the implementation of the AMBER Alert Programme in the United States, which since its inception in 1996 has seen the successful recovery of 672 missing children who were abducted (AMBER Alert website, 2013) and has a high overall success and recovery rates of nearly 97%.

Grant, 2011 recommended that as it relates to missing children in Jamaica, technology needs to be implemented that would foster better communication between the police, school administrators, and parents of missing children, as with improvement in technology, immediate action may be taken to locate missing children. The use of Geographical Information Systems (GIS) is one technological resource that can be effectively utilized to enhance the Ananda alert programme.

GIS is a tool for comprehending geography and has traditionally been used to support businesses and initiatives by providing a spatial (geo-referenced) component to the decision making process. GIS organizes geographic data with computer software so that users can view and manage information about places, analyze spatial relationships and model spatial processes (A to Z GIS, 2001). This geographic information is organized in such a way that a person reading a map can select data necessary for a specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a base map of real-world locations. For example, a crime analyst might use a local base map and select datasets from the records management system to add data layers to a map that identifies crimes by type, date, time, and location. With the ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every aspect and function of law enforcement (ESRI, 2006) including the recovery of missing persons.

One unique component of GIS data is that it allows the researcher to create a fishnet grid over small areas of data, disassociating like areas and minimizing potential endogeneity (Lindsey, 2013).

The National Centre for Missing & Exploited Children (NCMEC), administrators of the AMBER Alert System in the United States, have been actively utilizing geospatial tools and other IT technologies to assist in missing children recovery from as far back as the year 2000. As **Kochan, 2001** outlines, NCMEC extensively uses MapObjects software to query each missing child's case for the geographic distribution of leads. All lead locations are mapped in conjunction with the last seen location of the child as well as any location to which the custodial parent believes the child may have gone. These leads are displayed against a variety of layers that include states, counties, roads, ZIP Code boundaries, train and bus stations, and telephone exchange boundaries. Additional layers, such as parks and campgrounds, are also mapped. The visual display of these leads is searched for patterns, and a cluster of high-ranking leads in a given area could warrant a targeted poster distribution to elicit additional leads. NCMEC also uses ArcIMS with a system called LOCATER, which was developed to provide law enforcement agencies with the ability to rapidly disseminate images and information about missing children.

Technology has therefore played a significant role in keeping AMBER Alert Plans viable within the NCMEC system. The presence of a favourable policy environment also supports quick action from responders. This includes the requirement by law (The Adam Walsh Child Protection and Safety Act of 2006) that within 2 hours of receipt of a report of a missing or abducted child, an entry must be made by law enforcement into the National Crime Information Centre database, which law enforcement uses to document and query activity and information about missing people.

Objectives

This paper examines how geospatial and other IT technologies can be utilized to enhance the planning and recovery process for missing children in Jamaica, thereby enhancing the Ananda Alert Programme. The paper will further explore the benefits of using geospatial web tools to disseminate information on missing children and how the local authorities can become empowered to make more efficient the mitigation and response exercises.

Methodology

Each descriptive Ananda alert is attached with a geographical location (X, Y coordinate) or is geo-referenced using the local addressing system. The information is tabulated in a Microsoft Excel spread sheet, to include, among others: date missing, name, gender, age, parish, address, complexion, height, dressTop, dressBottom, dressShoe, build, last seen location, assigned police station, time of day (***Figure 1***).

MissingDate	Name	Gender	Age	Parish	Latitude (X)	Longitude (Y)	Complexion	Dress Bottom	Build	LastSeen	TimeofDay
7/1/2013		Female	17	St Catherine	18.2133	-77.0167	Dark	Grey shorts suit	Medium Build	Home	Unknown
6/28/2013		Female	16	Kingston	18.0156	-76.7927	Dark	Unknown	Medium Build	Home	Unknown
6/30/2013		Male	15	St. Catherine	18.0715	-76.9259	Brown	Blue jeans pants	Medium Build	Home	a.m
7/3/2013		Male	15	St. Thomas	17.8861	-76.4167	Dark	Unknown	Slim Build	Home	p.m
7/1/2013		Male	15	Kingston	18.0271	-76.8485	Dark	Unknown	Stout Build	Home	p.m
6/30/2013		Female	13	St. Ann	18.4027	-77.1008	Brown	Black and blue	Slim Build	Home	p.m
7/7/2013		Female	17	Manchester	18.0173	-77.1667	Brown	Unknown	Slim Build	Home	p.m
7/6/2013		Male	11	St. Catherine	17.9767	-76.988	Brown	Black and white	Slim Build	Home	p.m
7/19/2013		Female	15	Kingston	18.0105	-76.8243	Dark	Red pants	Stout Build	Home	a.m
7/12/2013		Male	14	Kingston	17.9746	-76.8007	Dark	Blue jeans pants	Medium Build	Home	p.m
7/7/2013		Female	15	Kingston	18.029	-76.7083	Brown	Long white dress	Slim Build	Home	a.m
6/14/2013		Male	13	Kingston	17.9754	-76.7659	Dark	Orange shorts	Slim Build	Saunders Avenue	p.m
7/13/2013		Male	13	St. Catherine	17.9417	-77.0667	Dark	Grey shorts	Medium Build	Sun Beams Boys	p.m
7/14/2013		Male	12	St. Catherine	18.0125	-76.8429	Dark	Blue jeans pants	Medium Build	White Marl Primary	p.m
7/16/2013		Male	15	Kingston	18.0785	-76.793	Fair	Blue jeans pants	Slim Build	Home	p.m
7/15/2013		Female	16	Kingston	18.0062	-76.7950	Dark	Light blue jeans	Slim Build	Vicinity of [illegible]	p.m
7/2/2013		Female	17	Kingston	18.0037	-76.7217	Brown	Black pants	Slim Build	Unknown	p.m
7/14/2013		Female	16	St. Ann	18.4083	-77.1003	Dark	Red shirt	Slim Build	Home	p.m
7/22/2013		Male	17	St. Elizabeth	18.0788	-77.6998	Dark	Multi-coloured	Slim Build	Dry River District	p.m
7/15/2013		Male	13	St. Ann	18.3883	-77.1333	Dark	Black pants	Slim Build	Home	p.m
7/12/2013		Female	17	St. Catherine	17.9427	-76.8821	Brown	Unknown	Medium Build	Home	a.m
7/30/2013		Female	17	St. Catherine	17.9947	-76.9616	Brown	Blue stripped jeans	Slim Build	Home	unknown
Unknown		Female	15	St. Thomas	17.9617	-76.3603	Fair	Short blue jeans	Slim Build	Home	p.m
8/4/2013		Female	16	St. Catherine	18.0021	-76.9207	Dark	Black shirt with	Unknown	Home	p.m
8/3/2013		Female	15	Kingston	17.9987	-76.8139	Dark	Grey and black	Slim Build	Home	p.m
8/5/2013		Female	15	St. Andrew	18.0834	-76.8023	Fair	Blue skirt	Slim Build	Montgomery Road	p.m
8/5/2013		Female	14	Kingston	18.013	-76.8771	Dark	Floral dress	Slim Build	Kingston Public	a.m
7/16/2013		Female	16	St. Catherine	17.9787	-76.8787	Dark	Blue jeans shorts	Slim Build	Home	p.m
7/21/2013		Female	13	St. Andrew	17.9358	-76.6443	Dark	Unknown	Medium Build	Leaving home	unknown
8/6/2013		Female	Unknown	Kingston	18.0042	-76.8316	Dark	Yellow pants	Fat	Home	p.m
7/24/2013		Female	13	Manchester	18.2063	-77.5367	Brown	Unknown	Medium Build	Leaving home	unknown
8/7/2013		Female	16	St. Catherine	17.968	-76.8944	Dark	Orange and red	Medium Build	Home	p.m
8/4/2013		Male	17	Kingston	17.9974	-76.7822	Brown	Blue jeans pants	Medium Build	Home	unknown
8/6/2013		Female	12	Montego Bay	18.4748	-77.9028	dark	Blue jeans pants	Slim Build	Home	p.m
8/9/2013		Female	15	Kingston	18.0283	-76.8532	Light	Multi-colored tights	Medium Build	Mother	p.m

***Figure 1*: Snapshot of Geo-referenced Ananda Alerts**

The datasets in the Excel table are imported into an ArcGIS Desktop 10.2 environment and converted to a shapefile. These Ananda alert shapefiles (point features) are then overlaid with other geospatial datasets including the fundamentals (***Figure 2***). Data layers overlaid include base maps, road network and transportation routes (taxi, bus), cadastral (parcel) data, communities, addressing data, social infrastructure (schools, health centres, police stations, community centres, homework centres, malls), physical infrastructure, socio-economic data (poverty maps, living conditions, income distribution and demographic).

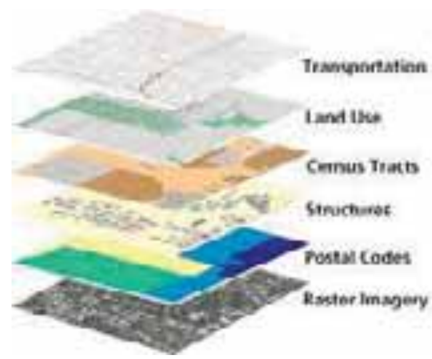


***Figure 2*: Overlay of GIS Data Layers**

Additional geospatial data relating to crime such as rape statistics, carnal /sexual/physical abuse, gang locations and specialization and other non-spatial information are also overlaid. This data overlay allows for visualization of datasets for the following analyses to be conducted:

1. Point Density Analysis

ArGIS Desktop Spatial Analyst extension is used to conduct point density analysis. Point density analysis may be defined as a calculation of the magnitude per unit area from point features that fall within a neighbourhood around each cell. Conceptually, a neighbourhood is defined around each output raster cell centre, and the number of points that fall within the neighbourhood is totalled and divided by the area of the neighbourhood (ESRI, 2006).

2. Google Fusion Tables and Network Graphs

Network graphs help visualization and support undirected and directed graph structures. This type of visualization illuminates relationships between entities. Entities are displayed as round nodes, and lines show the relationships between them. The vivid display of network nodes highlights non-trivial data discrepancies that may otherwise be overlooked (Google, 2013).

Network graphs are created by importing the geo-referenced table into the cloud and configuring each row of the table representing one relationship in the graph. The network graph shows each row as a line connecting a missing child with a particular attribute. If a missing child or a location is listed twice, that child or location is shown as an even bigger node. Multiple relationships between two nodes are summed into a thicker line. These visual relationships help to draw new conclusions or points of interest that were never discovered or approached before.

3. *Web Map*

In disseminating the information a web application is created using ArcGIS Explorer Online. ArcGIS Explorer is an application that lets you explore and present maps within an efficient and well-structured environment; create new maps; add and edit different types of map content; visually interpret data in the map using a dashboard and create and manage data and groups online.

The web map is created by importing the Ananda alerts shape files in a ZIP archive (.zip) on to a base map. (The ZIP archive must contain the *.shp, .shx, .dbf, and .prj* files). The Ananda alert shape files are then combined with other geospatial datasets. Features are imported to the map exactly as they are defined in the shapefile. Data are re-projected to the coordinate system used by the map. The layers are then configured with the appropriate standard symbology and the the web map is subsequently configured to share specific layers with different users or the general public.

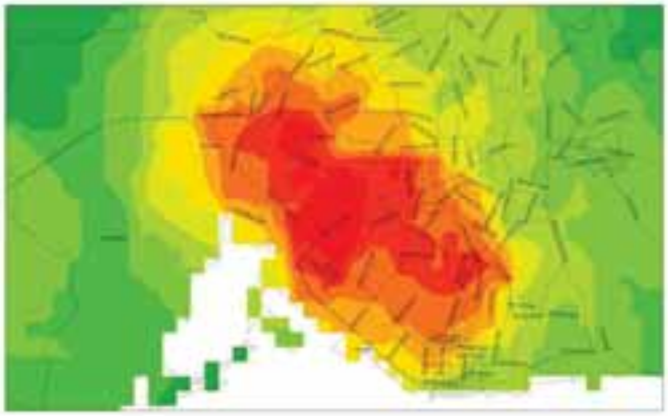
Analysis and Discussion

Hotspot Maps

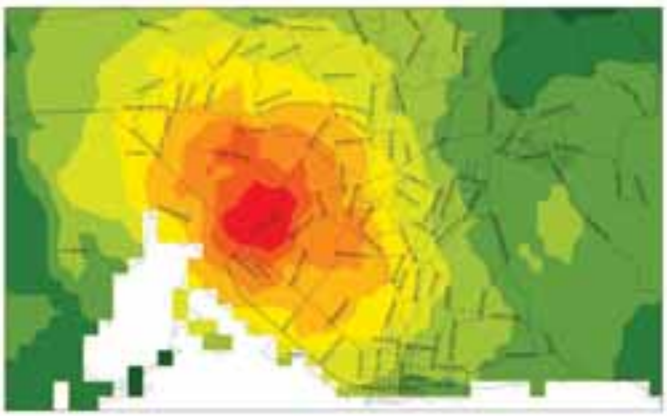
Data on missing children for the period 2011 to 2013 were captured and analysed using available geospatial tools and overlaid with several layers of relevant data. The Ananda alert cases were mapped and reports produced on: number of children missing per parish; number of children missing per community/area and their surroundings; missing children cases assigned per police station; time of day ratio for missing children for a period; last seen analysis; as well as description of missing children (build, complexion, clothing type).

The analysis shows that the highest number of alerts were for the parishes of Kingston and St Andrew in particular communities in the south of Kingston and south west St Andrew, which correlates with the challenging policing divisions in the Kingston Metropolitan Area. As indicated in ***Figure 3***, these hotspots are shown with an intense red colour. Outside of the KMA, urban areas in the parishes of St. James and St. Catherine feature as hotspot areas for high numbers of missing children.

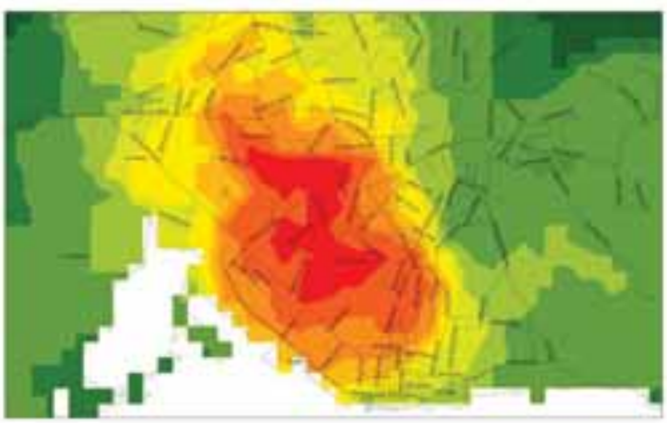
***Figure 3*: Point Density Analysis for the Kingston Metropolitan Area (2011-2013)**



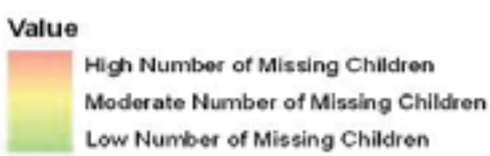
2011



2012



2013
Jan-Oct



When the socio-economic layers (poverty index, living conditions such as housing types, income, consumption, settlement types, crime, etc.) are digitally superimposed with the missing children datasets, registered to a common coordinate system, the relationship between both datasets occupying the same geographic space reveals that the areas of intensity overlap. In that, the areas with the highest number of missing children are also the more socially and economically vulnerable, located in the same areas in south west St. Andrew and the south of Kingston. (See ***Figure 4***).

The geometric intersection of other layers comprising multiple datasets including the parcel data, community layers (from Social Development Commission), schools, police stations, transportation network (bus and taxi routes), and other social infrastructure provided the opportunity to conduct further analyses, visualize trends and patterns associated with clusters of missing children, and hot spots, that would otherwise be difficult to discern through non-spatial data.

From the 2012 sample data, an examination of carnal abuse information superimposed with the Ananda alerts datasets reveals a spatial correlation, with an overlay resulting in an increase in intensity for the identified hotspot areas (See ***Figure 5***). The hotspot areas for carnal abuse were heavily concentrated in the same areas identified as hotspot areas for missing children in the south west region of St. Andrew and the south of Kingston, occurring within a 1km radius. The only anomaly noticed is the intensity of the carnal abuse in the Western Kingston region, which does not correlate with the spatial distribution of the Ananda alert data.

The hotspot maps make it easier to perceive data density. It is important to study the environment surrounding the clusters of missing children to look for location attractors and generators or what may be described as push factors for children going missing. This type of visualization further allows for targeted interventions in the related hotspot areas and the better deployment of resources and proactive responses.

Network Graphs

Representative views of network graph procedures are shown in ***Figure 6***. From the visualization, it was demonstrated that over the period, on average 70 % per cent of the children who go missing are within the pm period. This connectivity is easily represented with other features, so that inferences can be made about complex relationships between each feature. For example, one child being reported missing on more than one occasion, or the geographic location where a missing child was last seen in relation to the time of day they went missing; or, the geographic location where they were last seen in relation to where they reside.

From the data sampled, more children go missing in the pm period when their last seen location was in an area where people congregate such as parks, football fields, town squares, transportation centres (bus and taxi stands) outside of the homes.

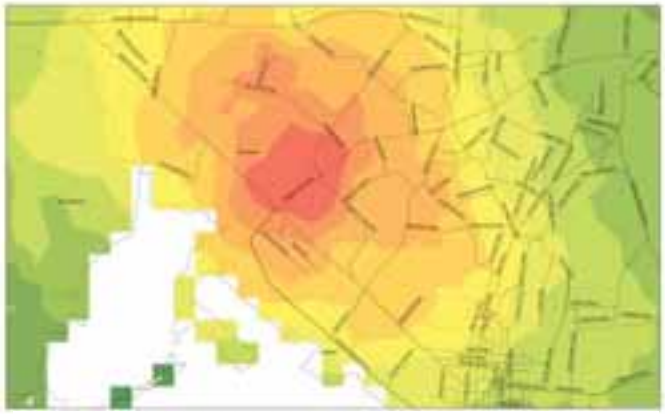
The network graph analysis therefore helps to identify trends and may suggest push factors that result in a child going missing thereby providing grounds for further detailed focus on these issues.

Web Maps

From the spatial analyses undertaken, geospatial web maps were developed and shared with relevant stakeholders (See ***Figure 7***). The web map allows for information collection, visualization, and rich interactive mapping. Stakeholders can utilize this web map to access information including attribute data on the missing children and can view, edit, and analyze vector and raster data, visualize trends, query the location information regarding a missing child's case, the nearest police station, corresponding social infrastructure and government services.

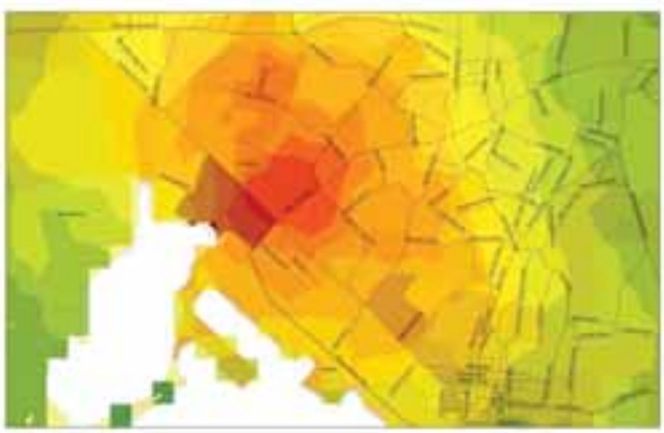
Through this medium, decision-makers have a global picture of the status of missing children and can develop appropriate responses. In this regard, stakeholders are empowered to make more efficient the mitigation and recovery exercises. The web map is therefore a useful tool in planning targeted interventions as it relates to public education and awareness, and guiding police operations. The distinct advantages to utilizing the web map are its easy-to-use interface that requires no understanding of GIS nor database management and its secure availability through any browser interface.

***Figure 4*: Overlay of Ananda Alerts Hotspot Maps with Poverty Map for Kingston Metropolitan Area**



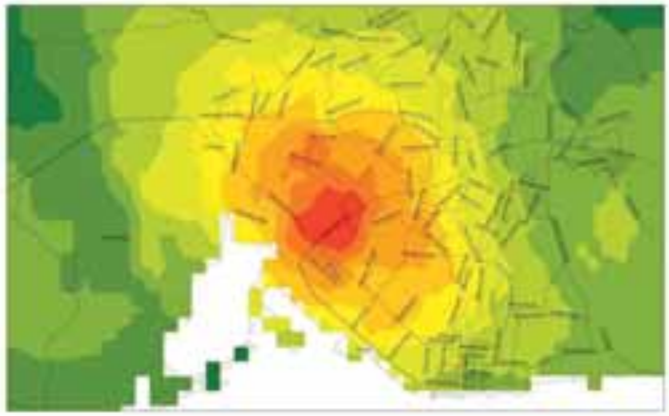
Ananda Alerts 2012

Poverty Map of KMA



Poverty Map and Ananda Alerts 2012 Overlay

***Figure 5*: Hotspot Pattern Analysis Ananda Alerts with Carnal Abuse, 2012 Kingston Metropolitan Area**



Ananda Alerts Hotspot, 2012

Carnal Abuse Hotspot, 2012

Figure 6: Network Graph - Time of Day/Missing Children

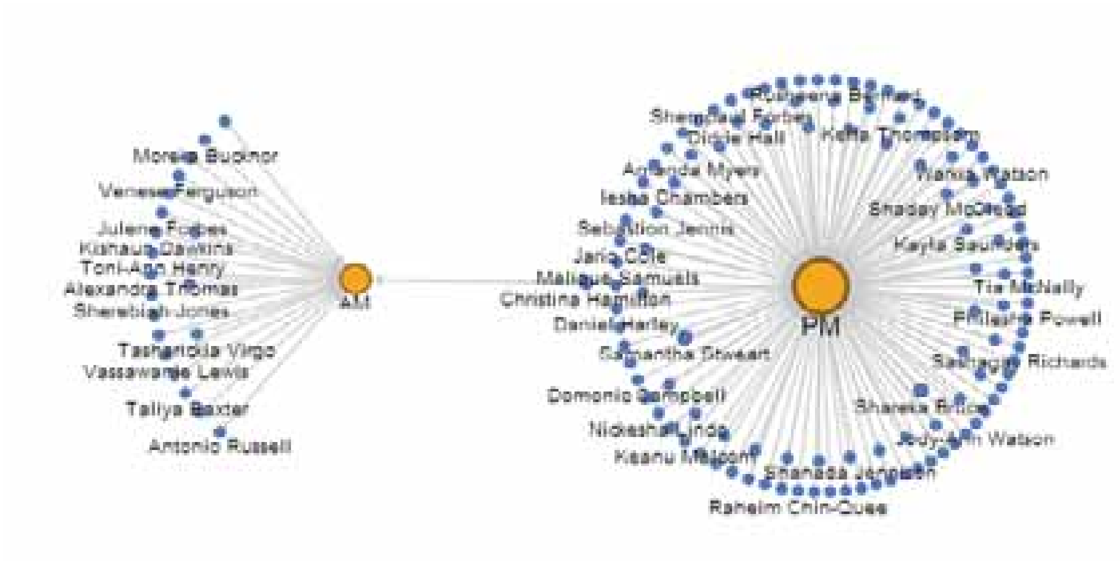


Figure 2: Web Map with Various Layers

Way Forward

The ability to integrate missing children information with other spatial datasets in the ways aforementioned described, helps in the better deployment of resources and proactive responses. However, the real power of spatial analysis can be leveraged only by seeing patterns at various geographic scales—from neighbourhood level to national levels. For example, the number of children that go missing within a given distance of a school can be mapped, and charts showing when these incidents occurred, could help with recovery in a short period of time.

The limitations identified with the analyses undertaken include the paucity of a comprehensive set of data including information on recovered children, when they were recovered and the status in which they were found. The more data layers, that can be superimposed onto the missing children dataset, especially those of a socio-economic nature, the richer the analyses that can be undertaken and the inferences that can be made. The lack of a proper addressing system also makes geocoding of the Ananda alerts more challenging and time consuming. By being able to visualize the locations of addresses it could eventually lead to real time recovery of children in less time.

Conclusion

It has been demonstrated that the ability to integrate missing children information with other spatial datasets can help in better visualization and trend analysis which can in turn assist with the deployment of resources and proactive responses, as well as the strategic planning for focussed intervention and public education programmes. The inclusion of additional data layers would enrich the process and enhance the Ananda Alert Programme.

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