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ArcIndia News

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Agendra Kumar
President, Esri India

COVID-19 has taught us – unless we have a spatial understanding of data, our ability to respond during critical situations will remain constrained. Geographic Information System (GIS) technology enables the spatial capability in our battle against COVID-19. This is the first time GIS has been used on a large scale by the healthcare sector in our country. Almost all states and major cities have established GIS-based dashboards that are helping them see the most recent information by integrating health data that comes from various health facilities and district bodies. These include national agencies such as National Disaster Management Authority (NDMA), municipal bodies in Mumbai, Pune, Bengaluru and Gurugram; and states like Punjab, Rajasthan, Tamil Nadu, Jharkhand, Orissa, and West Bengal.

A key learning from the current situation is that the healthcare segment requires a lot more attention than it has ever received. This has established a visible need for technology transformation of the public healthcare segment with a mission to drive better understanding, enable efficiency, multi-agency collaboration and rapid decision making.

GIS based mapping and analysis have been used by international agencies and health bodies such as the WHO, UNICEF, and CDC to understand the outbreak and control the spread of diseases like SARS, Ebola and Zika. In India, institutes like the National Institute of Malaria Research (NIMR) and ICMR have been using GIS for tracking vector borne disease outbreaks such as Malaria and Dengue. GIS has been instrumental in our ability to collaborate, respond, recover, and save human lives in various other natural as well as man-made disasters such as floods, tsunamis, earthquakes, and gas leaks.

Creating a reliable public health care infrastructure equipped with location intelligence and spatial analytics through GIS can improve both our 'today and tomorrow'. As the GIS ecosystem continues to evolve, GIS professionals like yourselves have a crucial role in government and businesses to use location intelligence to improve decision making. As we move towards restoring the normal life, organizations can leverage location intelligence to monitor and understand the fast-changing situation and make data-driven decisions.

We need to leap forward together to shape the vision of "New India" with GIS as its core foundation.

Stay Safe. Stay Healthy.

Agendra Kumar

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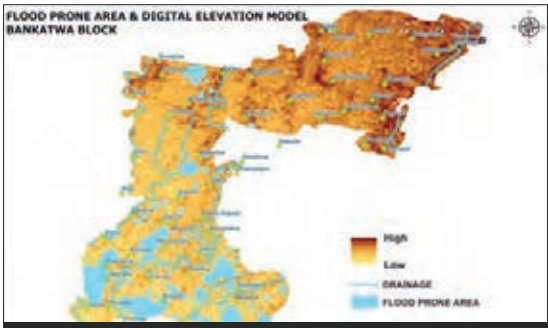

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Esri provides free mapping software for organizations fighting COVID-19

Esri, the global leader in location intelligence, has announced that it will be making its software available to public and private sector organizations fighting the COVID-19 disease pandemic.

The COVID-19 outbreak has escalated rapidly across the globe, and with municipalities struggling to respond, Esri has developed resources to help organizations understand the potential impact of the disease on public health, as well as potential community risk areas and their capacity to respond. A COVID-19 GIS Hub site provides much of this essential data, including case locations and social vulnerability, that communities and health organizations can use to inform their response.

To help public health agencies and other organizations jump-start their response, Esri is providing the ArcGIS Hub Coronavirus Response template at no cost through a complimentary six-month ArcGIS Online subscription with ArcGIS Hub. The template includes examples, materials, and configurations to rapidly deploy your ArcGIS Hub environment. ArcGIS Hub is a framework to build your own website to visualize and analyze the crisis in the context of your organization's or community's population and assets.

"Esri has always prioritized assisting communities during large-scale emergencies and natural disasters," said Jack Dangermond, Esri founder and president. "For the past 25 years, our Disaster Response Program provides data, software, configurable applications, and technical support for emergency operations. We consider it a part of our mission to provide these services free of cost during this time of national crisis."

For more information on the complimentary software and the disaster relief support, visit esri.com/disaster.

Esri supports GIS learning during lockdown

Esri India, the country's leading Geographic Information System (GIS) Software & Solutions provider, has announced that it will provide the student community free access to its ArcGIS plat-form and learning resources, through learn.arcgis.com. Via this platform, students will be able to access ArcGIS Online; over twenty apps, including ArcGIS Pro; and, a library of lessons, to complete ongoing courses, and continue their learning uninterrupted.

Students (above 18 years) can enroll themselves on the Learn ArcGIS platform, to gain knowledge on geospatial technology and acquire an indispensable skill-set in their future employment. Students can sign up between now and June 30 to have free access until August 31, 2020. For a membership on Learn ArcGIS, visit learn.arcgis.com/en/become-a-member/.

"We have taken this initiative offering free access to GIS software and courses to ensure that students continue to learn GIS, while their institutes are closed due to the COVID-19 lockdown. The demand for GIS skills continues to grow in both private and government sectors. India will need huge capacities of next-generation workforce with GIS-ready skills. At Esri India, our mission is to empower the academic community with GIS technologies necessary for future-ready students," says Mr. Agendra Kumar, President of Esri India. "India is witnessing digital transformation at an accelerated pace; it becomes all the more critical that students get hands-on training in GIS and its wide range of applications," added Mr. Kumar.

Geospatial infrastructure - the foundation for critical decision making - is driving every field today. From pinpointing new store locations; to predicting climate change; to reporting power outage; to analyzing crime patterns; and, fighting COVID-19 spread, GIS has become integral to location strategy across industries. Mission programs like Direct Benefit Transfer, Swachh Bharat, Clean Ganga mission, Smart cities, City Gas distribution, Bharatmala, Sagarmala and National Hydrology Program are realizing the benefits of GIS technology.

Esri publishes The International Geodesign Collaboration

Esri, the global leader in location intelligence, has announced the publication of The International Geodesign Collaboration: Changing Geography by Design. The world faces challenges that supersede national and regional boundaries and cannot be solved by a single individual, nation, science, or profession.

Preparing for issues like the outcomes of climate change and population growth requires a diversity of approaches and collaboration among all stakeholders. Geodesign enables these stakeholders to collaboratively design and realize optimal solutions for spatial challenges in an integrated process that utilizes all available techniques and data.

In this new book, editors Thomas Fisher, Brian Orland, and Carl Steinitz introduce readers to an approach that allows multidisciplinary teams to collaborate and design using geographic information system (GIS) software and design tools to explore alternative future scenarios that affect the world. In the book, readers will

Learn the International Geodesign Collaboration workflow for addressing complex global challenges.

Explore the potential futures of 51 university project areas around the world.

Global social and environmental issues will increasingly become multiregional and multinational. The International Geodesign Collaboration: Changing Geography by Design shows how researchers, scientists, designers, and students from around the world can use common geodesign principles to work together.

The International Geodesign Collaboration: Changing Geography by Design is available in print (ISBN: 9781589486133, 186 pages, US$39.99) and as an e-book (ISBN: 9781589485730, 186 pages, US$39.99). Both editions can be obtained from most online retailers worldwide. The print edition is available for purchase at esri.com/esripress or by calling 1-800-447-9778. If outside the United States, visit esri.com/esripressorders for complete ordering options, or visit esri.com/distributors to contact your local Esri distributor. Interested retailers can contact Esri Press book distributor Ingram Publisher Services.

Esri releases ArcGIS Analytics for IoT

Esri - global leader in location intelligence - has announced the release of ArcGIS Analytics for IoT, at the Esri Federal GIS (FedGIS) Conference in Washington DC. Part of ArcGIS Online, Analytics for IoT allows users to ingest, store, visualise, and analyse massive volumes of Internet of Things (IoT) sensor data. This new Esri capability will help organisations take advantage of insights gained through IoT, with real-time data and improved situational awareness.

"With the release of ArcGIS Analytics for IoT, we are launching powerful real-time and Big Data capabilities for Esri's Geospatial Cloud," says Brian Cross, Director of Esri Professional Ser-vices.

Analytics for IoT will help users easily leverage Big Data across a broad range of applications including personnel management, asset tracking, and weather hazard monitoring. Many users access IoT data using alternative solutions, but lack a way to readily embed geospatial capabili-ties to the process. ArcGIS Analytics for IoT will spatially enable existing systems using IoT data; and, simplify real-time data analysis for users from a wide spectrum of industries, including public safety, transportation, and natural resources.

A subscription-based ArcGIS capability, Analytics for IoT is software-as-a-service (SaaS) offering available to ArcGIS customers. As the IoT continues to grow in scope and complexity, ac-cessible and versatile analytics will be increasingly essential to enable organizations to take full advantage of the IoT's potential.

Esri and FEMA provide free access to data and mapping technology in response to COVID-19

Esri, the global leader in mapping and location intelligence, has announced that it has been working closely with the Federal Emergency Management Agency (FEMA) to provide mapping and analytics technology in supporting an integrated, multi-agency geospatial platform to combat COVID-19. This includes distribution of Esri technology to FEMA partner entities across the country.

The collaboration leverages Esri's enterprise agreement at the Department of Homeland Security (DHS), which makes its platform available to all FEMA partners during "incidents of national significance"; COVID-19 is one such incident. Esri has been working with agencies like FEMA to ensure that communities have free and easy access to cutting-edge technologies, to help them understand and respond to this outbreak.

To this end, Esri is also ensuring availability of on-call technical support services, virtual training, and a library of geospatial applications developed specifically for responding to the crisis.

FEMA's federal, state, local, tribal, and territorial partners can now obtain free Esri software and SaaS solutions to support their COVID-19 response. This includes Esri's ArcGIS platform for visualization, analytics, and geodatabase management.

"While it has always been our policy to support impacted communities during incidents of national emergencies, this crisis is special," said Jack Dangermond, Esri president. "More than ever, it requires an integrated multi-organizational response. Our partnership with FEMA will help provide its partners with an integrated multi-agency platform for data sharing, and supporting a host of mapping and geospatial applications. We appreciate this opportunity to serve, and are hopeful our collaboration will result in a more effective response."

As part of this collaboration, FEMA has created a GIS hub site for data-sharing and collaboration among partners. The Hub is a configuration of Esri's cloud-based platform, ArcGIS Online, and supports a host of capabilities well-suited for this emergency. While not public, the site can be accessed by all of FEMA's federal, state, local, tribal, private sector, and NGO partners.

Hub resources include data from FEMA and other national, state, and local organizations, as well as extensive tools and apps that support visualization and analysis. FEMA has designed the site to help users easily respond to common workflows related to the crisis. Partners are able to easily find and share data, as well as leverage apps that answer key questions and support specific decision-making. The Hub includes resources for the following applications:

- **Establishing Testing Locations:** Helping decision makers determine the best places for testing sites, and directing citizens to the nearest testing location.

- **Mitigation Measures:** Identifying measures taken at state and local levels, such as public school closure data, NEMA–state mitigation actions dashboard, and public health emer-gency status by county.

- **Alternate Care Sites:** Helping identify facilities that can support low acuity patients, including convention centers, hotels, shuttered hospitals, university dormitories, or vacant open space in commercial buildings.

- **Managing PPE:** Providing real-time standardized data collection that helps organizations track critical personal protective equipment (PPE) and other items.

- **Identifying Vulnerable Populations:** Identifying locations of vulnerable populations, including nursing homes and elder care facilities.

- **Food Distribution:** provide the public with information on where to find free or reduced-price food or meals.

Bruhat Bengaluru Mahanagara Palike
Covid-19 War Room

Empowering better decision making around COVID-19

COVID-19 has thrust city and district administrations into uncharted territories. With the novel coronavirus disease 2019 (COVID-19) attacking societies at their core, 'war-rooms' are now mushrooming across the country, using heat-mapping and predictive analytics to detect the disease's movement in real-time.

On 11th March 2020, the UN officially declared COVID-19 as a pandemic. As the UN bugled the call of Shared Responsibility and Global Solidarity, the role of data-sharing and data-integration becomes a prerequisite for coordinated and inclusive solutions to tackling COVID-19. Communities around the world are taking strides in mitigating the threat that COVID-19 (coronavirus) poses. Geography and location analysis have a crucial role in better understanding this evolving pandemic.

Mapping and containing COVID-19

By defying early detection or easy treatment, COVID-2019 has thrust cities into unfamiliar territory. India is working hard to avoid community transmission, but as long as the virus mimics surreptitious symptoms of the common cold, and lacks a viral vaccine, prevention seems to be the only real cure. This prevention is dependent on proper hygienic

practices, updated information, and minimized social contact.

As a result, measures like quarantining foreign arrivals, contact-tracing, and strengthening state- and district- surveillance teams have been adopted to break the chain of transmission. Door-to-door surveys and cluster-containment are other strategies that have been recommended. Obviously, between floating populations, the homeless, misinformation spread through social media with patient privacy concerns, governments across the country have had their hands full.

Delhi has been inundated by state-specific requests on how to implement lockdowns, and manage healthcare systems. Even for cities that have dealt with past epidemics, there is no one road-map for this one. So, the need of the hour becomes a system that can:

1. Manage constantly-updated data points

2. Support 24-hour silent surveillance, that aids prevention but avoids panic

3. Provide credible conclusions

4. Enable government departments to prioritize the first four or five hot buttons that they have to be involved in.

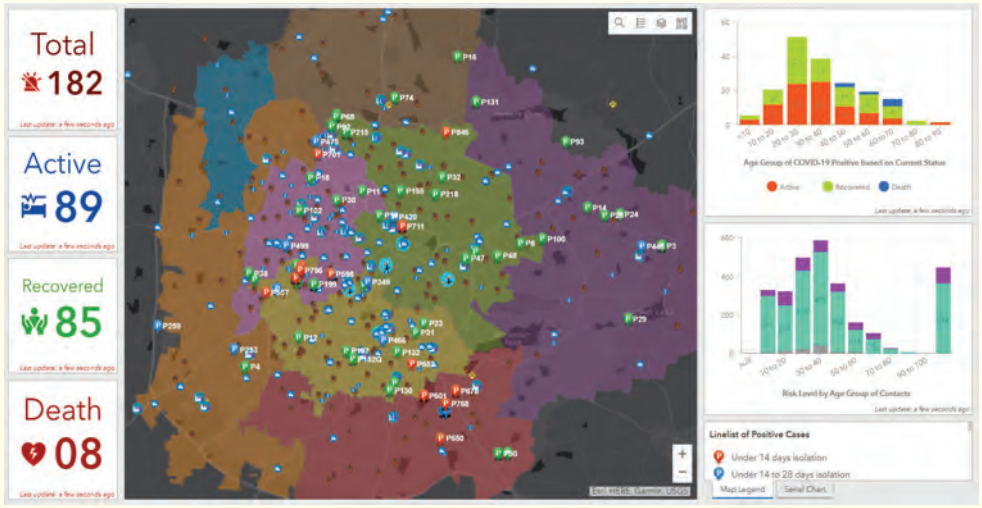
The use of various technologies has been successful in enabling the governments to manage the COVID-19 pandemic. Even the Indian health ministry emphasised the use of technology to combat the COVID-19 epidemic; it has underlined how infrastructure from smart cities is being used to fight the outbreak at the local level. The facilities at these cities are mapping each COVID-19 positive case using GIS, tracking health care workers using GPS and drawing up a containment plan using heat mapping technologies.

The need of the hour

As learning on the fly becomes the new normal in fighting the COVID-19, three main goals must underlie any system put in place to manage the epidemic proactively:

1. Fast Adaptation: A system that can identify existing health facilities, and rationalise their use to avoid healthcare fatigue, became a need of the hour. Being able to commandeer and monitor infrastructure (like hotels) as quarantine facilities, and migrant shelters is another requirement.

2. Fast Recovery: A system that can support proactive actions to monitor suspected COVID-19 cases; also needed, was a method to tie data from multiple apps (Sahyog and



The ArcGIS COVID-19 templates and dashboards are being used for date-wise, zone-wise, hospital-wise, age-wise and gender-wise details updated in real-time.

The war room monitors quarantine facilities, tracks health of suspected patients, monitors roads through drones, and pushes awareness through helplines.

Aarogya Setu being the most common) into one visual flow for hot-seat response-and-action.

3. Fast-forward Looking: A system that can use temporal data to predict the most accurate trendlines is urgent. Predictions such as these allow administrations to phase their response levels, lower red and orange alerts, and get their cities and districts back to normal.

BBMP War Room

A team of officials from the Karnataka government have been using technological interventions at the war room in Bengaluru to monitor quarantine facilities, track health of suspected patients and their contacts under home quarantine, monitor roads through drones, and push awareness through helplines.

Bruhat Bengaluru Mahanagara Palike (BBMP) launched a war room to address the coronavirus pandemic on Mar 23, 2020. Set up at the BBMP head office, it operates 24x7 with 11 collaborating agencies, 5 solution providers & overall 40+resources and a team of 10 people working in shifts to monitor cases and address the epidemic now. Key activities include real-time information gathering for situational analysis and actionable insights and also for sharing information to citizens. The officials directly get access to real-time data from health and police departments.

> “With the use of GIS technology, we are mapping the critical and less critical zones in the city for effective quarantine measures. The ArcGIS COVID-19 templates and dashboards are being used for date-wise, zone-wise, hospital-wise, age-wise and gender-wise details on a daily basis. This multi-layer comprehensive data visualisation and spatiotemporal analysis at BBMP COVID-19 War Room has been very helpful in reducing the spread of coronavirus disease and saving citizens from the pandemic.”

Hephsiba Rani Korlapati
IAS, Special Officer, BBMP COVID-19 War Room & Managing Director, Bengaluru Smart City Corporation Limited, Karnataka

The war room also keeps track of sanitation work in the city, including cleaning of roads and disposal of waste.

The core objectives of the facility include:

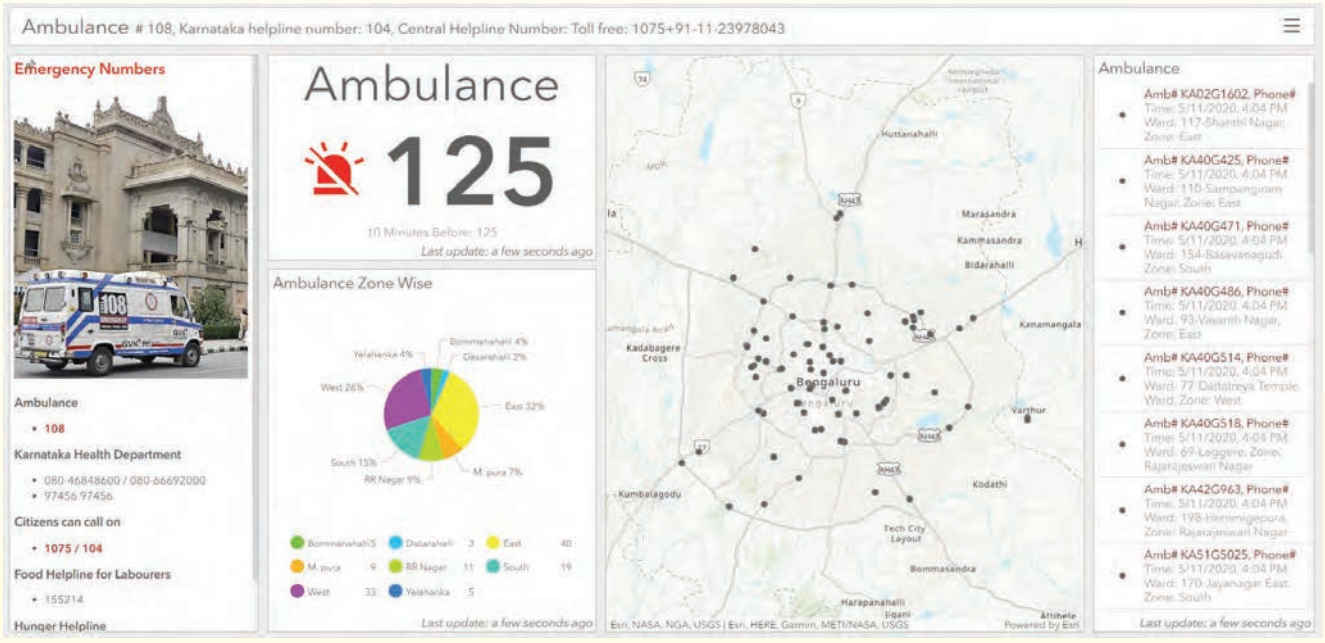
- Real-time information gathering for actionable insights
- Coordinating and collecting information from other state government departments
- Sharing information to its citizens.

Making the difference

With the Esri disaster response program, ArcGIS COVID-19 templates, and dashboards, the war room of BBMP publishes advisories in various languages, daily bulletins on trends in the spread of coronavirus disease. The date-wise, zone-wise, hospital-wise, age-wise and gender-wise details are maintained at the war room and are published daily. The BBMP war room has been successful in implementing the following:

- **Test-and-Trace methods** Bengaluru's war-room efforts support the vigorous Trace-Test-Treat (3T) method that Karnataka employs; it has been responsible for the state's low positivity rates.
- **Proactivity availed:** CCTV surveillance, and surveillance of suspected patients in an 8-km radius keeps officials prepared for a ready-response.
- **Digital governance**
  - o Multi-language advisories and daily bulletins aid transparency by displaying complaint information gathered through 2.0 application forms.
  - o Strict vigil on solid waste management ensures that public sanitation does not languish during the quarantine period. Heat maps created for virus containment keep people calm, and aware of the situation in their vicinity, avoiding misinformation.
- **Healthcare systems managed:** Tracking healthcare workers and ambulances, tele-counseling, and virtually training healthcare professionals all ensure that those at the forefront of this fight are fully equipped for any eventuality.

The war room has shown that with technology, cases can be handled better. Without IT and GIS technology, fighting COVID-19 would be difficult. The war room aims to build IT system to handle all parts of the issue and contain the spread of COVID-19.



With the Esri disaster response program, ArcGIS COVID-19 templates, and dashboards, the BBMP war room publishes multilingual advisories, and daily bulletins on disease trends

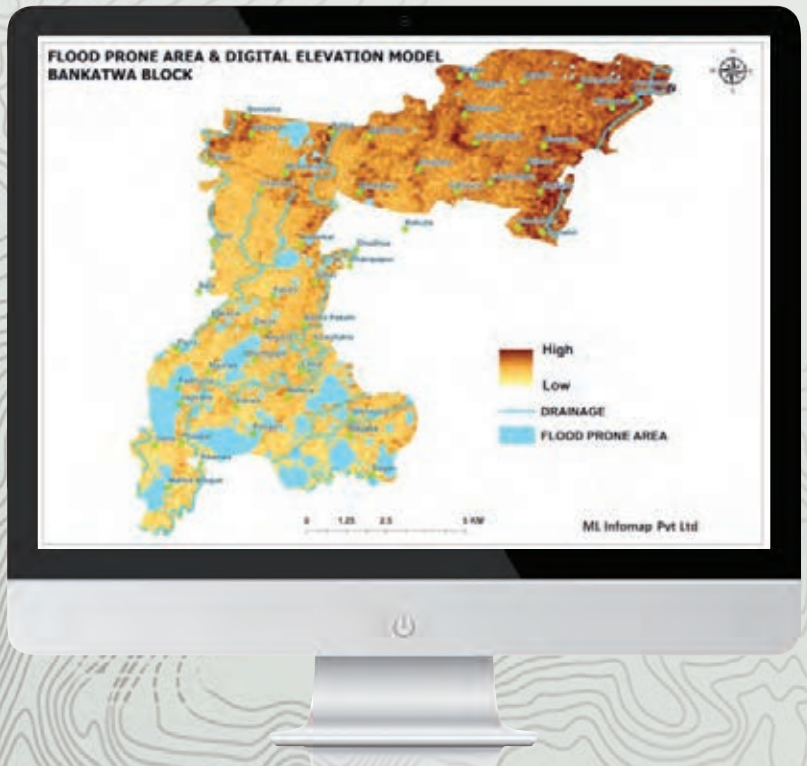
ML Infomap leverages ArcGIS to create Immunization Dynamics Application

ML Infomap – the first GIS company in India – began its geo-analytics journey in 1993 by offering off-the-shelf digital maps of India. Since then, under the able guidance of Dr. Manosi Lahiri, the company has evolved into an end-to-end full stack IT/GIS solutions provider on the Esri platform. It is an active pioneer in the fields of transportation and logistics, defense, health, retail and other verticals for the government and corporate sectors. Among other health software solutions, ML Infomap prides in its Immunization Dynamics Application, which was developed in response to a call for 'Immunization Data: Innovating for Action' funded by the Bill and Melinda Gates Foundation and monitored by BIRAC, GOI.

Immunization data: innovating for action

The Sustainable Development Goals (SDG-3 in particular) recognise that prevention of disease by effective immunisation programs can immensely reduce health care expenses. India has steadily adopted many electronic devices - with different levels of sophistication - for health monitoring and immunisation across the country. Therefore, the success of these country-wide health programs depends on access to data and apps, availability of local skill, and the communication network in the area. Immunization Dynamics works around limitations in datasets, skills, networks, and equipment, to provide much-needed technological support and uniformity at the operational level.

Immunization Dynamics innovatively validates and strengthens immunisation delivery, and micro-planning and mapping efforts using, but not restricted to, GIS. The solution accesses and integrates population coverage (HMIS) data and vaccination consumption (eVIN) data on a GIS server platform. By enabling quantitative analysis of these data sets, this app helps visualise the relevant key performance indicators through dynamic dashboards and active maps.

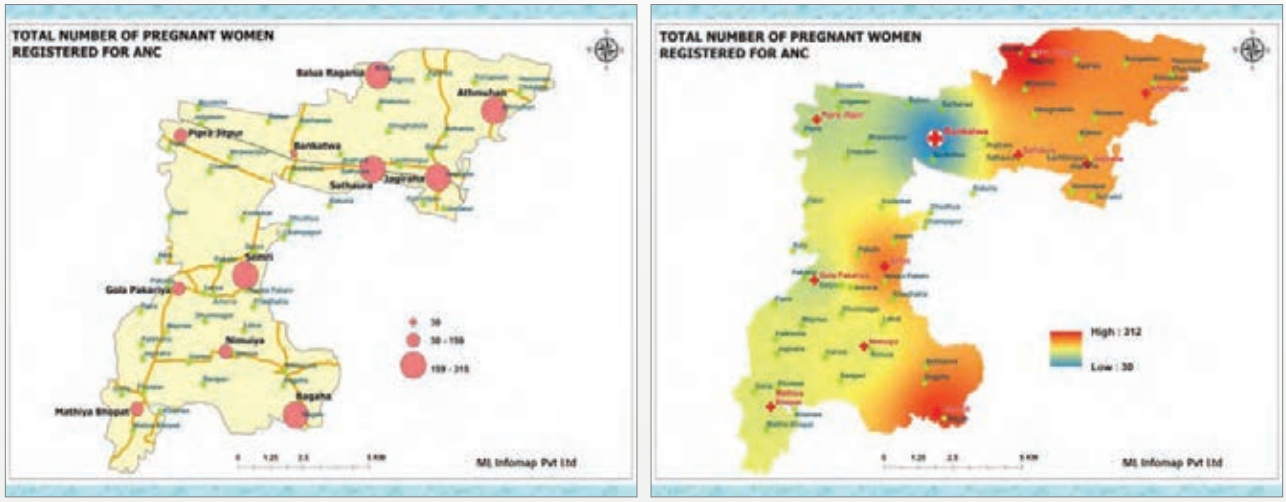


Map showing flood prone areas in Bankatwa block, Champaran, Bihar

Immunization Dynamic's prime utility in data analytics and visualisation for health was recognized through the Grand Challenges India 2018 Award. Dr. Lahiri has credited the "integrative role of the ArcGIS platform [as crucial to] understanding data organized in different layers and different units of measure".

Key features

1. Efficient tracking and triangulation: The coverage of beneficiaries (HMIS) and vaccine consumption information (eVIN) is compiled in easy-to-understand reports, and conveniently generated graphics and maps.



Map showing immunization data of pregnant women in Bankatwa block, Champaran, Bihar

> We cannot create vaccines or medicines, but clearly, as GIS professionals, we can offer technology solutions for the purpose of delivering health services. We, in the GIS community, can provide data, tools and methods to support policymakers for continuous data monitoring and to local health officials for data collection and aggregation for the purpose of planning and operationalizing field events.

Dr. Manosi Lahiri, Founder, ML Infomap

2. Rich data analytics and visualisation: Routine reports are created digitally, and illustrated with relevant tables, graphs, maps that can be emailed to the district and state officials.

3. Custom dashboard view: Data analytics tools build complex background algorithms that are then accessed through simple dashboards. The users can visually understand physical and geographical relationships, while custom dashboards have been created for health administrators.

4. Versatility: Digital mobile data-entry tools can be used by field workers, with minimal training.

Benefits

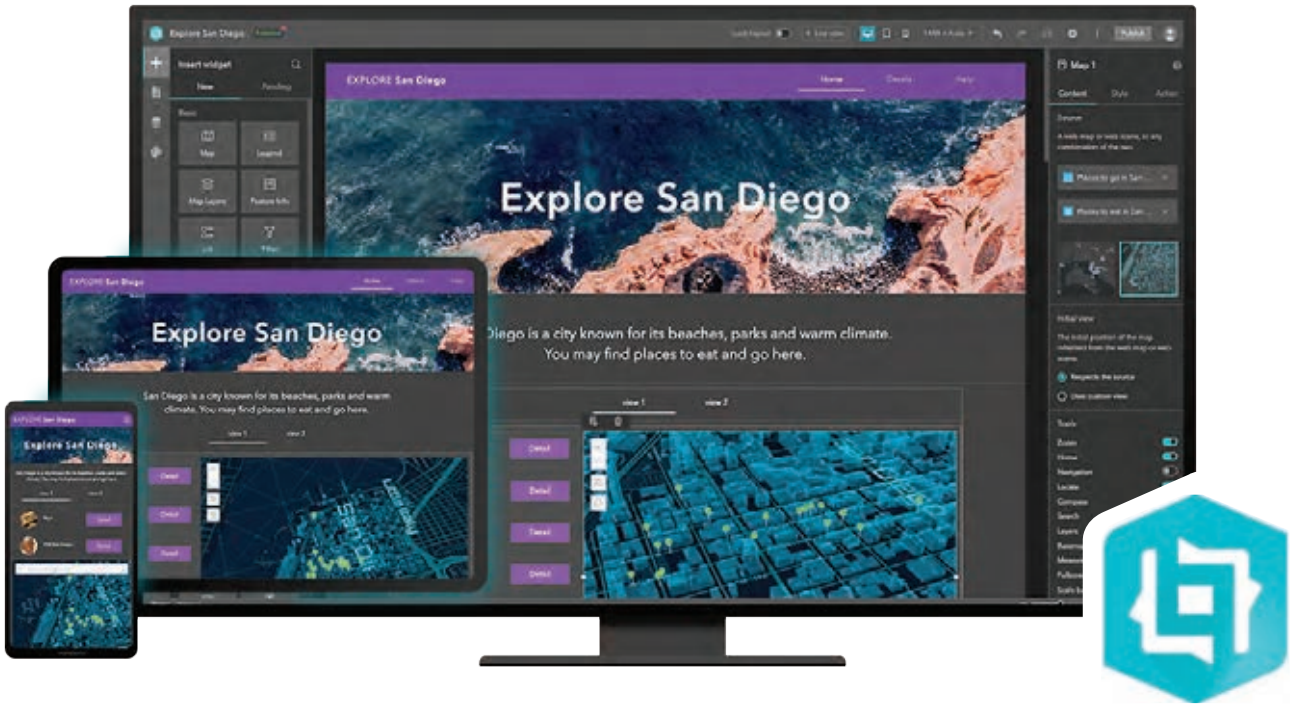
1. It integrates data from multiple silos and provides a platform for advanced analytics within reach of health officials and other stakeholders. This can help identify under-served areas and ensure evidence-based action

2. It supports policymakers through continuous data monitoring and local health officials by aggregating data for planning and operationalising field events

3. It significantly increases the situational awareness of managers who routinely monitor vaccine supply chains and plan immunisation sessions

4. With the triangulation of population coverage and vaccine consumption data now possible in Immunization Dynamics app, vaccine delivery can be targeted to designated places more accurately

5. Automated processes reduce the workload of the district and block health officials tasked with executing immunization programs while helping to manage the operational aspects of running them.



ArcGIS Experience Builder

ArcGIS Experience Builder allows you to create unique web experiences using flexible layouts, content, and widgets that interact with 2D and 3D data. Start with templates to create mobile-adaptive apps; modify template layouts to customize design for different screen sizes; or, build apps from scratch with more creative freedom.

You can do the following with Experience Builder:

- Build single and multi-page apps (map-centric or not) for display on a fixed or scrolling screen
- Interact with 2D and 3D content in one app
- Add interconnected tools with drag-and-drop widgets
- Brand apps with themes
- Deploy responsive apps to any device
- Design custom app templates
- Create, deploy, and manage apps in a single place

ArcGIS Experience Builder is built into ArcGIS Online, to make available all pre-existing content. Developers can use the Experience Builder Developer Edition to extend Experience Builder with their own widgets, templates, and themes.

A quick look through the features of ArcGIS Experience Builder:

1. Experience Gallery

The Experience gallery displays all Experiences

ArcGIS Experience Builder

that are created, or shared. Use the gallery to view, edit, or change your Experience, view templates, or create a new Experience.

2. Template Gallery

Within the Experience Gallery, click on "Create New" and open the Template Gallery. The Template Gallery contains default templates, along with shared and public templates.

Template gallery in Experience Builder

3. Widgets

When you begin building your Experience, widgets are the main building blocks. In Experience Builder there are majorly two types of widgets, Basic and Layout.

- Basic widgets are functional widgets which behave as app tools. For example, Button Widget, Legend Widget and Filter Widget.

- Layout widgets are containers that help organize widgets on the page. For example, Column Widget and Fixed Panel Widget.

The Configuration Panel displays attributes of the selected widget. In the example below, the Map Layers widget has been selected, showing its properties in the Configuration Panel.

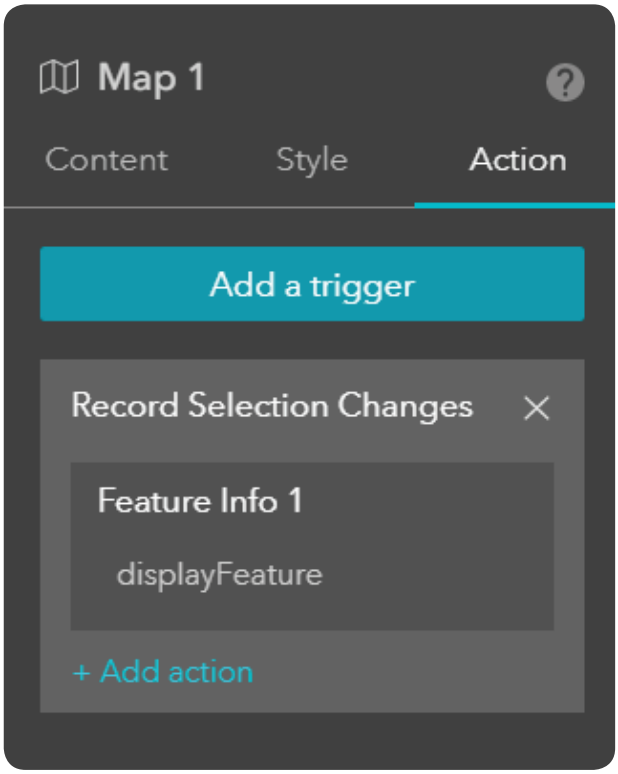
Adding a widget

4. Triggers and Actions

Triggers and actions are those two capabilities that allow you to create the dynamic and interactive apps, simply by configuring the interactions between widgets.

Not all widgets support Triggers and Actions. Clicking the Action tab will let you know if the selected widget does have a Add a trigger button available.

A trigger is something that happens within the widget. For example, you can synchronize two maps, such that when the extent of one map changes, the second map will also change to match.



Adding a trigger for Map Widget

Using the above features, and many others, in ArcGIS Experience Builder, you can deliver responsive web experiences without writing a single line of code. Experiences can focus on one type of content, or can combine and link many types of content to create a complete experience and destination for your audience. Get started with an experience using existing template or create one from scratch.

Transforming public health with GIS

Good health and well-being are essential to sustainable development of our nation and is one of key priorities of 2030 Agenda. Over the last decade, India has undertaken major strides in the area of public health and its accessibility. The average life-expectancy has risen from 64 to 68; neonatal mortality rates have dropped on average from 57 to 37, per 100 live births; there has been a renewed focus on non-communicable diseases. Various government programs such as National Health Mission, Ayushman Bharat and Pradhan Mantri Jan Arogya Abhiyan (PM-JAY) are aimed towards making healthcare facilities available and accessible to the economically weaker segment of the population. Swachh Bharat Mission is another such initiative which aims at making India free from open defecation and achieving 100% scientific management of municipal solid waste while also generating awareness about sanitation and its linkage with citizen's health.

India and 2030 agenda

At the Sustainable Development Summit on 25 September 2015, UN Member States adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030. These SDGs will guide policy and funding for the next 15 years and address the root causes of poverty and the universal need for development that works for all people. Having an integrated approach to supporting progress across the multiple goals is crucial to achieving the SDGs.

Emergence of geographic thinking in health

The use of location intelligence for health is neither new, nor unheard of. The relationship between geography and health can be traced back to the time of Hippocrates (400 BC) where physicians observed that certain diseases tend to occur in some places and not others.

By the mid-19th century, with large-scale industrialisation, this relationship became increasingly apparent; also, the need for a public health system was made obvious. Maps based on environmental conditions began to be used by practitioners and clinicians alike – Charles Piquet made colour-coded maps of cholera distribution in Paris; Robert Cowan linked yellow fever to over-crowding in London's Glasgow; and, perhaps most famously, John Snow used maps to trace the source of London's cholera epidemic. In fact, by identifying that cholera was being spread through certain public taps, Dr. Snow's dot-map became the evidence that compelled officials to remove pump handles off of these taps. This one action was the game-changer that slowed down the Broad Street Cholera Outbreak.

Since then, use of location intelligence in healthcare has seen enumerable applications. We have seen the examples of Polio eradication and controlling the spread of Ebola as live examples of the role that GIS has played in the Health sector. Use of GIS based analytics over a period can help in controlling out-break of recurring epidemics like Dengue. Bill Gates-funded Malaria Atlas Project (MAP) helps predict global malaria burdens, while ensuring that countries receive early-warnings for targeted interventions. Using the Landsat Program; the Global Urban Footprint initiative; and GIS, the project crunches data on environmental conditions that influence malarial transmission.

GIS applications in public health

Today, thousands of health organizations use GIS every day. GIS is being used to prevent the spread of infectious disease (disease surveillance); tracking child immunization; promoting and encouraging healthy behaviors (to prevent chronic and infectious diseases); protecting communities against environmental hazards; conducting health policy research; preventing injuries; responding to disasters and assisting communities in recovery; and assuring the quality and accessibility of health services as well as many other programs and services.

GIS is the core foundation of all the key public health functions - assessment, policy development, assurance and operational awareness.

Data generated through key public health functions - assessment, policy development, assurance and operational awareness - must undergo a systems thinking approach for insightful research.

Assessment

To devise effective health care strategies for communities, agencies need to be able to respond to questions such as:

- What are the key health challenges our communities are facing?
- Which are the immediate interventions needed?
- Where these interventions are needed?

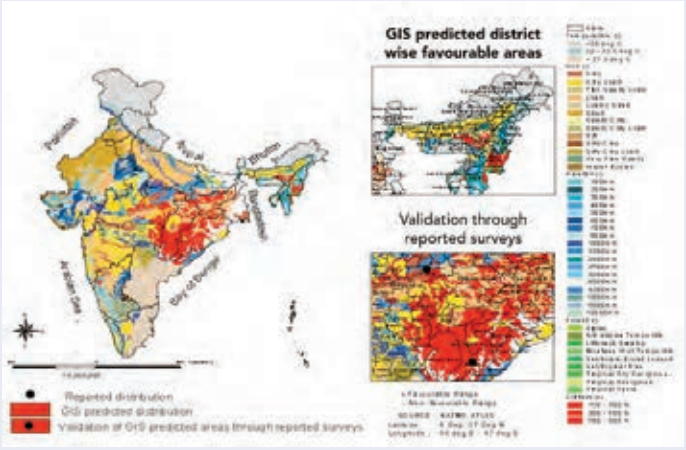
The use of GIS technology can enable leaders / public heath agencies to take larger steps in addressing national healthcare needs. GIS helps agencies get these answers from the variety of invaluable data residing in their existing system such as health MIS and CRM systems. Taking the data that has a geographic component and putting it in the GIS equips them with new perspectives and provides them with the ability to enrich it to make more effective decisions for e.g. which districts / wards are in greater need of specific health services such as senior care facilities. By connecting their own data and adding layers of data that are available through variety of other sources e.g. demographic data, weather data, point of interest data, spatial analysis can be performed to visualize hot spots that can inform and even change a decision to be more effective. This help health agencies to plan targeted interventions in the pockets where health needs are critical by allocating resources where they make a greater impact. For e.g. where to open a new hospital or the specialization to built in a specific service area / district for chronic diseases such as cancer, diabetes or cardiovascular disease.

GIS for health assessment

- Monitor health status to identify community health problems
- Diagnose and investigate health problems and health hazards in the community

GIS for vector-borne disease surveillance and control

When vector-borne disease outbreaks occur, fast, effective response protects people from infection and its consequences. Integrated pest management programs respond through the vital functions of prevention, surveillance, and control activities. Temporal and spatial information are critical to those efforts to curb the spread of disease. GIS can help organizations achieve faster, more efficient response by providing a platform that can capture multiple, complementary areas of expertise among epidemiologists, entomologists, health officials and staff, geographers, and others.



This map shows the GIS-based distribution of An. sergentii in India. (Source: National Institute of Malaria Research)

Policy development

Almost all policy decisions involve location, and frequently that same location component has an impact on finding the solution to community problems. Governments at all scales use GIS to plan, measure and improve operations, and guide policy be it for issues related to demography, strata, or larger issues related to climate change, cleanliness or healthcare accessibility. GIS help to better assess the needs of our communities and the impacts of policy options and decisions. GIS not only helps identify the communities who would be beneficiaries of these policies but also helps analyze, create maps and reports showing the future your policy hopes to deliver. GIS-based maps form the key foundation for communication as agencies such as state departments and NGOs use various thematic maps to communicate, engage and take feedback from the communities about policy matters that affect them most.

GIS for policy development

- Inform, educate, and empower people about health issues
- Mobilize community partnerships to identify and solve health problems
- Develop policies and plans that support individual and community health efforts

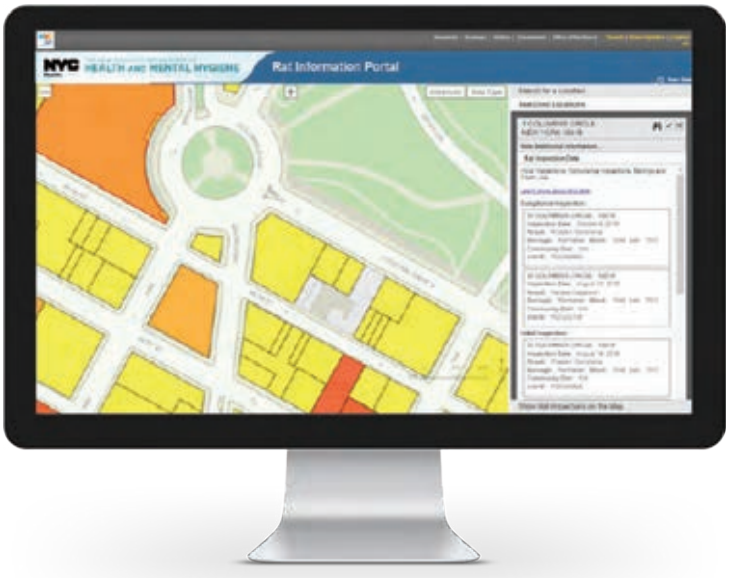
Vision Zero is a global initiative whose goal is to reduce severe injuries and deaths in roadway collisions. Through the LA GeoHub you can explore, visualize, and download Vision Zero's location-based Open Data, as well as use and develop web and mobile applications that support this initiative. http://visionzero.geohub.lacity.org/

Assurance

GIS enables health agencies to increase efficiency. GIS facilitates targeting vector control efforts. GIS tools and methodologies can be used to measure compliance with specific legislation (e.g., specific types of industry/ businesses being prohibited from operating within certain distances of rivers or other environmentally sensitive areas or restrictions regarding advertising tobacco within certain distances of schools). GIS helps determine the prudent use of staff in implementing health inspections (calculating location-based workload assessment, finding efficient routes, and determining which vehicle should serve each location in the best stop sequence). Some of other programmatic areas include Improving the accuracy of air pollution health impact assessments with GIS; Assessing the size and dimensions of green spaces and their respective distances from the population of potential users or Detecting regions of higher incidence of say water-borne diseases.

GIS for service assurance

- Enforce laws and regulations that protect health and ensure safety
- Link people to needed personal health services and assure the provision of health care when otherwise unavailable
- Assure a competent public health and personal health care workforce
- Evaluate effectiveness, accessibility, and quality of personal and population-based health services
- Research for new insights and innovative solutions to health problems



New York City's Rat Information Portal displays map-based details about inspection results across all five boroughs.

Situational awareness

Safeguarding public health and providing protection against health-related threats are responsibilities that fall directly in the purview of public health preparedness professionals. These individuals, the agencies they work for, and their partners generate volumes of data in a variety of systems. Integrating these disparate data types into one comprehensive view so that it is accessible to all stakeholders is a challenge. Location is often the only data feature that's common among these different systems. Public health staff use GIS toolsets to visualise all types of information. Some tools connect different data types. Other tools expose data relationships and patterns that are impossible or difficult to see by using traditional tabular data methods. GIS produces intelligent maps that show where a disease outbreak is occurring and predict where it might occur next. By turning data into intelligence, GIS gives preparedness professionals the situational awareness they need to respond to an emergency efficiently and effectively.

GIS for situational awareness

- Emergency preparedness
- Response monitoring and management

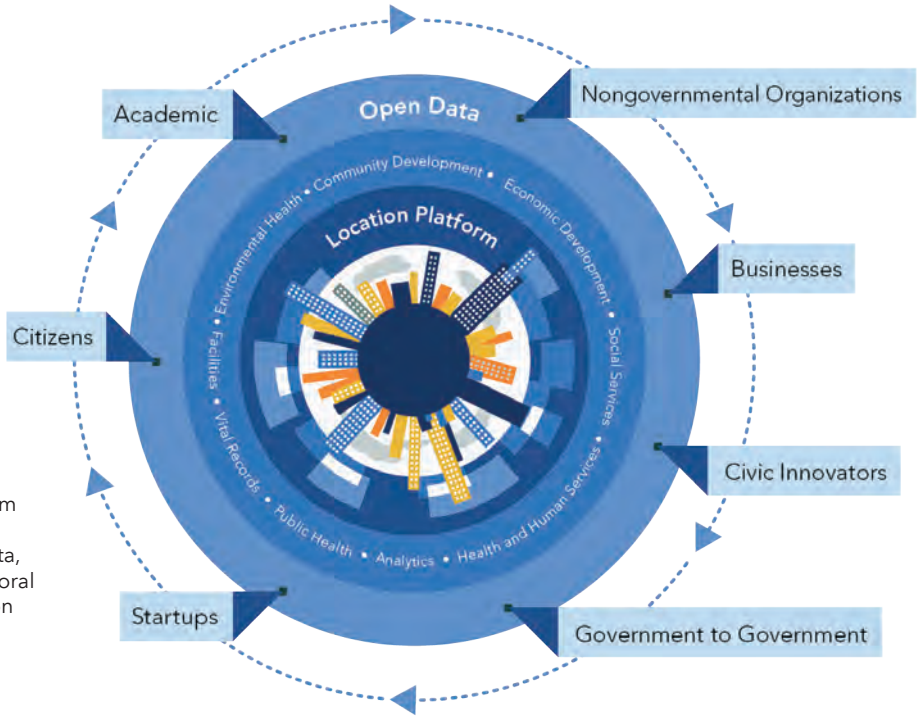
GIS supporting battle against COVID-19

Today, various agencies in India involved in COVID-19 response, at national, state and even at district level, have turned to GIS to develop coherent, synergistic response strategies and surveillance measures. GIS is being used to map existing cases at individual level, identifying hotpots and combining these with local demographic data to identify vulnerable populations. The spatial context of hotspots is enabling informed decision making for health capacities - existing and to develop, quarantine centre capacities and identify new sites to ensure disease containment. Artificial intelligence (AI) and spatial predication models are being used to model various scenarios - pessimistic, optimistic or as-is of disease spread to evaluate preparedness and stay ahead of the curve. GIS based maps and analysis are driving the coordinated and rapid response across multiple agencies - such as health, public safety, NGOs, field staff and policy makers by providing a common operating picture.

The COVID-19 dashboard by MoHFW, Govt of Tamil Nadu shows the update on the COVID-19 response strategies in the State of Tamil Nadu.

Enterprise GIS strategy for public health agencies

Geospatial technology leads the way giving public health agencies / stakeholders / policy makers the location-based intelligence and spatial analysis they need to build and maintain a healthy community. Government agencies realize significant return on investment and fulfill their mission every time they use GIS to solve problems.



A responsive health ecosystem demands that multiple stakeholders access open data, and can reinterpret it for sectoral improvement upon a common location platform.

4 steps to create a successful strategy that supports a healthy community

1 Start with a world-class GIS platform
The ArcGIS platform gives governments the power to approach problems in a way that serves decision makers, residents, fieldworkers, GIS professionals, and non-GIS users. ArcGIS supports major government workflows including data collection, analysis, what if scenarios, operational awareness, field operations, and civic engagement.

2 Build a location-based strategy
A location-based strategy enables governments to prioritize the GIS applications they need. An organization can analyze issues department by department or tackle a single concern (such as children and family services) to meet goals within a more limited scope.

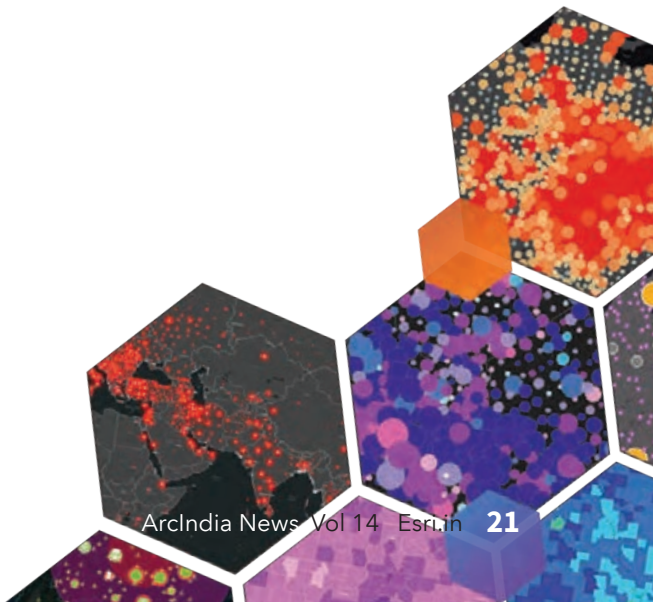
3 Deliver real solutions that serve government priorities
Governments know their biggest health and human services challenges include eliminating health disparities, improving access to care, maximizing resources, and designing effective interventions to improve community health. Esri's ArcGIS applications are free for users to download and share with their organization and community.

4 Develop strong relationships with the Esri Partner Network
The Esri Partner Network is a community of organizations that helps you get the most out of your GIS investment. Esri partners deliver sophisticated solutions that can fulfill your organization's requirements such as licensing and inspection and community health needs assessments. These solutions are built on top of the ArcGIS platform and can extend customized solutions that scale with a state, municipal, or regional government over time.

Evolving technology landscape and the future of healthcare with GIS

Everyday technology ecosystem is evolving rapidly. Health agencies are collecting more and more data for analysis to build further efficiencies and effectiveness into their decision making, operations and processes. In all this data, location continues to play an integral part for strategies, planning and decision making for both population and individual health. Integration of AI, ML, big data analysis and data science methods and tools with spatial analysis will enable more accurate, efficient, and productive insights with potential applications across several disciplines within public health, precision medicine, and Internet of Things-powered smart healthy cities. These can help in predictive modelling to identify populations at high risk for disease, in healthcare delivery of tele-medicine / mobile health to masses or even integrating social media feeds for syndromic surveillance.

GIS will continue to be the core foundation to support the heath tech revolution we are witnessing.



What's new in ArcGIS Enterprise 10.8?

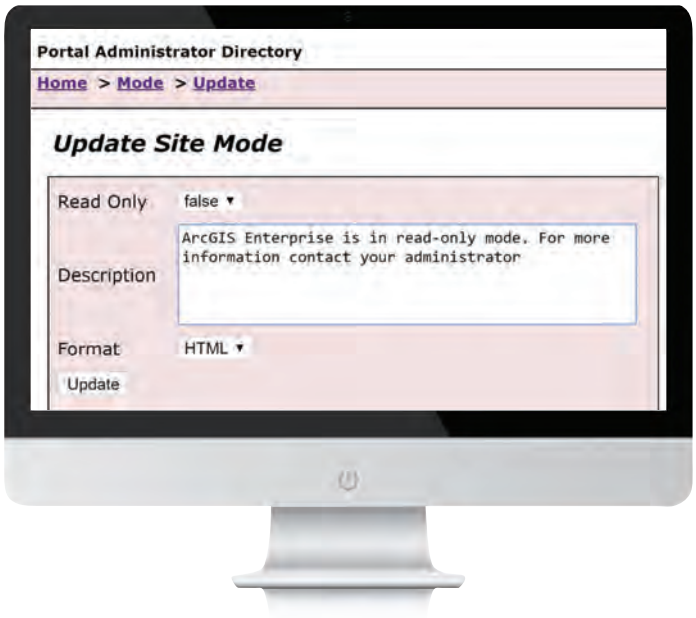
Esri started this year by releasing ArcGIS Enterprise 10.8, loaded with updates and enhancements throughout the product, from administration, to data, maps, and apps. Let's have a look at what's new in ArcGIS Enterprise 10.8!

Administrative

• Read-only mode

With 10.8, you can put all of ArcGIS Enterprise into read-only mode. In read-only, users can log into, and view content, in ArcGIS Enterprise; but they will not be able to make changes to data, create or save items like web maps, or update administrative settings.

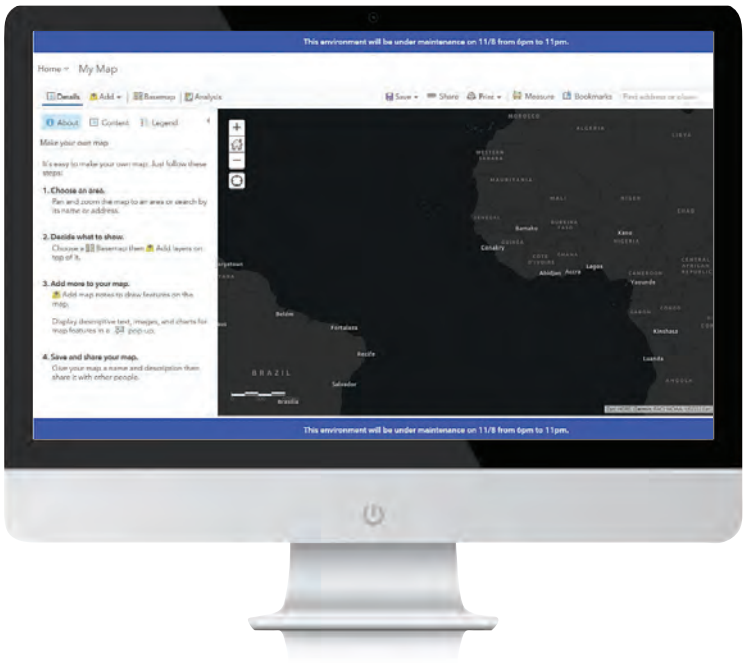
As an administrator, you can set ArcGIS Enterprise as read-only, within the portal Administrator Directory (shown below). Here, you can customize the message displayed to users, if an action is prevented because of read-only mode.



The option to set ArcGIS Enterprise as read only in the Portal Administrator Directory

• Information banner

With the new information banner, you can customize a static message that appears for every user at the top and bottom of each page in the Enterprise portal. Your banner can notify users of upcoming system maintenance; direct users to new



The new information banner is displayed at the top and bottom of each tab of your enterprise portal

resources or information; or even help distinguish your ArcGIS Enterprise environment from your ArcGIS Online organisation.

• Access notice

The new access notice appears as a dialog whenever someone visits ArcGIS Enterprise and/or any URL leading to it. Before granting further access, the user must accept the notice. If the notice is declined, the user is denied from accessing the environment.

• New webhook events

In 10.8, new webhooks triggers are available for creating, updating, or deleting user roles. This is helpful when you have multiple administrators creating new custom roles, for users who need different privileges in ArcGIS Enterprise, and want to be sure that other administrators know of these new roles. Another webhooks enhancement in 10.8 is the ability to subscribe to specific events across all items, groups, or users.

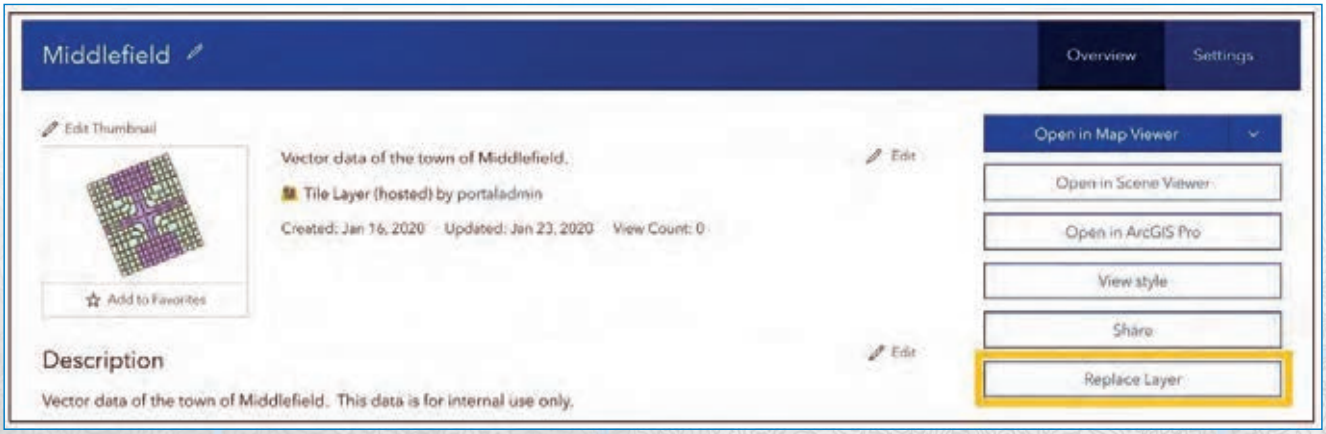
• Server Manager updates

Updates include the ability to search your services by Instance Type (shared, or dedicated), and by Authoring Client.

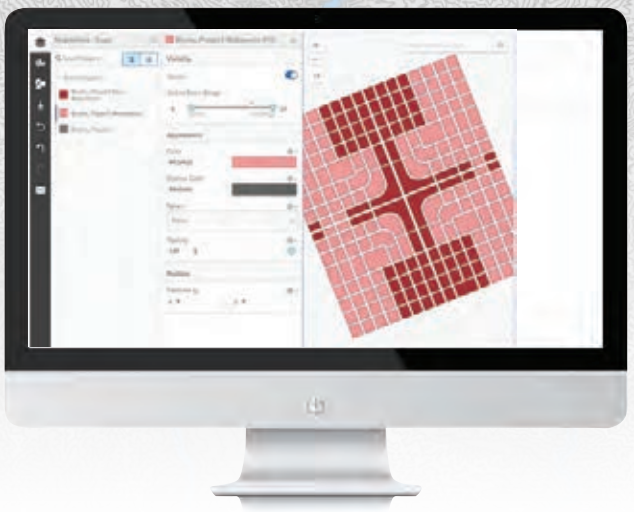
Data, publishing, and services

• Maps and apps

Vector tile enhancements: ArcGIS Enterprise 10.8 brings in two new updates for vector tile layers. First is an update to the workflow for replacing vector tile layers. The Replace Layer operation allows you to replace the content of a current hosted vector tile layer, with the content from a replacement layer, while retaining the same item URL. Updates to vector tile layers don't stop here! Starting with this release, you can customise vector tile layers in the Map Viewer using the new ArcGIS Vector Tile Style Editor app. This will enable you to style vector layers and basemaps to best suit your map's cartography needs.



Replace layer can be accessed from the overview page on your vector tile layer



The new Vector Tile Style Editor allows you to deeply customise your layers

3D enhancements: In Scene Viewer, there are new Smart Mapping styles to help you style your lines and polygons in new ways. You can now display pop-ups on Point Cloud Scene layers, and even select individual points to inspect their properties to see attributes, such as elevation. In your scenes, you can animate water and take advantage of the new 3D models, such as bicycles and fire hydrants, to bring your scenes to life.

New configurable app templates: Three new configurable application templates are available in 10.8 - Attachment Viewer; Nearby; and, Zone Lookup. App templates make it easy to build your own app focusing on a key workflow or theme.

• New Web AppBuilder widgets

Enhancements to ArcGIS Web AppBuilder in 10.8 include new widgets, as well as Widget and Theme enhancements. Highlights include the new Business Analyst widget, Query and Filter widget, and Public Notification.

• ArcGIS Enterprise Sites

The first update you may notice in ArcGIS Enterprise Sites on 10.8 is the updated user interface. There is now a streamlined display for creating and managing all of your sites. Also in 10.8, you can quickly see how many sites have been created, including their URL, and how many pages make up each site. The ability to clone a site within your environment is an added feature in the recent update. Also, for sites, you can now assign site administrators on a per-site basis.

Group enhancements

New options are available for groups within your Enterprise portal. As a group owner and/or manager, you can choose to hide the list of the group members, on the Members tab of the group page, when creating a new group.

Server roles

- ArcGIS GeoAnalytics Server now includes the new tool Find Dwell Locations, which identifies areas of idling with no movement.

- With ArcGIS GeoEvent Server (real-time tracking), there is a new Quick Start Guide available. When using GeoEvent, you will see enhancements to GeoEvent Manager's service designer. Inputs and outputs are now stopped by default, once created.

- ArcGIS Image Server includes new multidimensional raster analysis tools and tasks, as well as enhancements to OrthoMaker.

- In ArcGIS Notebook Server, there is a new Notebook Manager interface to manage your notebooks. You can also collapse sections within your notebook, and schedule notebooks.

Documentation updates

There have been many fantastic updates to ArcGIS Enterprise documentation and resources. One example is the new applications landing page, which highlights the different types of apps that can be used with ArcGIS Enterprise. Other welcome additions include introductory topics like Services in ArcGIS Enterprise and Services, and portal items. These (and more) topics are all included on the new essentials tab.

Escorting health through GIS

In conversation with **Dr. R. C. Dhiman,** Scientist 'G' (Former) and currently Sr. Consultant & Principal Investigator of DST-ICMR Centre of Excellence on Climate Change & Vector Borne Diseases, at NIMR Delhi.

What comes under the purview of ICMR-NIMR?

The National Institute of Malaria Research (NIMR) is a premier institution under the Indian Council of Medical Research (ICMR), one of the oldest medical research bodies in the world. It aims to promote, coordinate, and formulate biomedical research in India.

Established in 1977 as a malarial research centre, NIMR uses basis, applied and operational field research to formulate short- and long-term solutions. Fauna surveys and epidemiological investigations help to understand the transmission dynamics of malaria under different eco-epidemiological regions while testing and transferring new tools helps control vectors and parasites at field-level. NIMR has 10 field units in various paradigms of malaria apart from malaria parasite banks, insectary, malaria and dengue clinic. Our outcomes have found widespread application through the National Vector Borne Disease Control Programme (NVBDCP).

Why and how GIS is crucial in managing the vector-borne disease? How have you leveraged Esri technology in the past?

Our relationship with GIS began in 1991 with satellite data and remote sensing. Today we feel that GIS is the vital link between all NIMR studies. Without maps that

detail the distribution of vectors in a region, it is impossible to pinpoint the reason behind the prevalence of the disease in different foci.

There is a considerable variation in the type of data collected, varying from faunal surveys, to molecular marker studies, and insecticide resistance monitoring. Given this variation, without mapping, it becomes difficult to analyse why a vector is prevalent in a particular area. Mapping is essential; it is the basis for all epidemiological studies conducted at the institute.

For example, India has launched the National Strategic Plan for Malaria Elimination (2017 – 2020), which aims to eliminate indigenous cases by 2030. By mapping at state, district, primary health centre, and village levels, India is being stratified into four categories based on the malarial burden. This gradual mapping will help us find whether the map of malaria is shrinking or expanding.

Our main advantage in using GIS for such broad tasks is that it takes very little time compared to other technologies. The most recent outcome, like the 'Esri COVID-19 Resource and GIS Hub' can be crucial in countering diseases that are vector-borne, communicable, or non-communicable. It helps containment by enabling the understanding of epidemiology.

Currently, what are the areas in which this platform is helping?

NIMR is identified as a centre of excellence for the impact of climate change on vector-borne diseases and is a WHO-recognized centre for phase-I pesticides and malaria RDT lot-testing laboratory. GIS can be utilized for both these functions.

NIMR primarily uses mapping for epidemiological and climate change studies. The varied applications include mapping of breeding habitats, the distribution of vectors, faunal surveys, and genetic studies. Certain areas of the country – Gujarat, Rajasthan, and the Brahmaputra Valley – are prone to repeated outbreaks of malaria. We have identified early-warning tools for such outbreaks. To make these tools available at

the field-level, we are attempting to develop a web-based early warning system for malaria and dengue.

As for climate change, documentation of a climate baseline, and assessment of the expected trend-line, will not be possible without mapping. A thrust area of GIS lies in identifying the thresholds for disease transmission – for example, studying the particular temperature above which malarial transmission cannot take place. Climate-induced disasters, like floods and earthquakes, and ecological changes (including deforestation), can sometimes cause outbreaks of vector-borne disease; NIMR deals with counter-strategies against such outbreaks. Even global weather systems, like El Nino, are mapped using GIS tools.

Several applications are being developed to collect and disseminate information to the ground-level, on the very same day, through mobile phones. This makes GIS very helpful for speedy surveillance and reliable data.

Do you think other functions are also able to leverage GIS technology? If yes, which functions/departments, and how?

In addition to the Epidemiological and Clinical Research, GIS, Taxonomy, HIA, and other vector-borne diseases groups also use mapping technology. These groups are associated with extremely detailed surveys, beginning at the household level, and the continuous monitoring of disease. Beyond this, several of our field stations also use GIS. Especially for NIMR, employee exposure to GIS holds a lot of potential in expanding its use in departments like molecular taxonomy.

GIS has made it easier to track and trace vectors and strengthen surveillance with minimum manpower. You can rely on the workers who are transmitting the data. One significant advantage through GIS is that information arrives on the same day as it is mapped on the field.

We are also attempting to adopt a mobile app to NIMR's vector tracking and for surveillance framework. Not only will this ensure information at our fingertips, but it will also be possible to make it available to the community. This helps the public contact at the earliest, ensuring early detection and treatment.

Are you using GIS in the current COVID-19 mapping? How is it helping in managing the situation?

No, not at NIMR. But at the global level as well in India, the COVID-19 mapping provides an overview of the number of cases across the whole world and at the district level which is being updated live and allows one to see recovered cases, new cases, testing facilities, temperature graphs of red zones, and so on. The dashboard view of COVID-19 greatly speeds up decision-making, which is a crucial requirement of epidemiology. So I will say that epidemiology has advanced a lot by the use of GIS.

Through the COVID-19 mapping exercise, we can analyse the underlying causes at a particular point, and what factors will hinder our counter-strategies. We can also consider additional factors like ecological conditions and climatic resonance that could prolong the outbreak. When we compare such data in situations across the country, it becomes possible to predict where COVID-19 could flourish.

From pinpointing the disease to studying its progression, the COVID-19 portal has been immensely useful. The portal has been so successful in its tracking that, i wish, a similar platform be developed for vector-borne diseases, and other health aspects. By plotting the recurrence of infectious cases, we will be able to assess what disease scenarios can face us in the future.

Going forward, how do you think will the enterprise health GIS system evolve?

At the outset, I will say that the way GIS has been used for COVID-19 is a model example for studying other health aspects; studies that would take a year to complete could be done within a month or so. It can improve surveillance, tracing, tracking of patients, decision making, and, most importantly, help to contain outbreaks of recurring diseases.

Significantly, it will help to coordinate intelligence at the state and district levels. Today, many departments in the country manually collate data and draw conclusions; a GIS dashboard, with all health problems on display, would be a massive improvement over this method. It will make departments' functioning tremendously effective.

RESEARCH PAPER

Holistic planning for urban and rural health care infrastructure

A case study for a district in India

Sanjay Sinha

CPO, Department of Tribal Affairs, Govt. of Andhra Pradesh

Priyanka Sharma

Lead Analyst (Geo Analytics), Boston Consulting Group

The health and welfare of citizens of an Indian district are managed by a three-tier system comprising of (1) the Community Health Centre (CHC) – a 30-bed hospital/referral unit; (2) the Primary Heathcare Center (PHC) – a referral unit for 6 sub-centers; and, (3) the Sub Centre – the peripheral point of contact between the primary health care system and the community. Further these facilities are, linked to District hospitals that are usually located in large urban centers.

Facilities are traditionally located on the basis of population size, i.e., as a village's or town's population increases, facilities get upgraded. However, we argue, not considering the spatial relationship between population centers can lead to a sub-optimal allocation of resources. While conducting the following case study in Hisar

district (Haryana), it was found that nearly 40% of the rural population was unable to access hospitals within 30 minutes of travel time. This time taken by people to travel to health centers can become a critical life or death issue.

The spatial approach accounts for the location of all population centers. This study considered the most accurate source of population statistics available - the Census of India. Travel Time polygons were generated around existing facilities, using the Service Area Polygon tool in ArcGIS's Network Analyst extension. Esri's Street Map Premium, which contains a detailed street network dataset for entire India, was also used.

The analysis played a vital role in finding villages falling within service areas. Further, we extrapolated two optimal locations apt for future setting up of new hospitals, ambulance services, etc. To this end, we used the Location Allocation tool in ArcGIS's Network Analyst extension.

The objective of the exercise was to find locations that served a higher proportion of the population within 'X' minutes. Using existing facilities as the origin, a catchment analysis was carried out. The option 'Non-Overlapping' was selected to prevent double-counting of villages that fall in multiple catchment areas. After determining the current coverage, we developed recommendations for siting new facilities.

Interestingly, the study found that improving infrastructure in existing city hospitals, and adding new hospitals, can potentially allow for nearly 95% coverage of the population. Thus, a spatial approach to select health facility locations provides for higher levels of coverage. This method is superior to the current method of selecting villages or towns, based on population size. Spatial analysis promotes efficient utilisation of funds and manpower from the supply-side. The general population also sees a reduction in the time taken to reach a medical facility. These numbers indicate ArcGIS's ability to attend to emergency situations.

Once a Geo-approach is in place, continuous decision-making support can be provided to managers of health facilities. Using spatial analysis, additional health sector programs – such as selection of Anganwadi locations, prenatal care centers, or HIV/AIDS clinics – can be planned. Esri software and tools can be similarly leveraged to provide inputs in finding ambulance locations, optimal paths for inspectors and other related functions.

Introduction

Access to primary health care plays an essential role in maintaining the health standards of a developing country like India. To counteract the enormous inequity in health care, across the wide sprawl of urban and rural areas, there is a strong requirement to increase performance, by improving accessibility to basic health care centers. Understanding the performance of the overall health system, from a location perspective, could aid stronger planning- and evidence-based healthcare policy development.

This study talks about an optimal utilisation of available health care resources in rural areas. It analyses spatial accessibility of the nearest health care facilities in Hisar district of Haryana, and finds the optimal number of facilities required to cover a maximum population possible, within a given interval of travel-time. Despite the fact that spatial accessibility to health care facilities is an important focus area, there have been few studies conducted at the rural level. There could be several reasons for this, including a lack of high resolution data, awareness about geographic perspectives, improper planning, and so on.

It is possible to provide medical care, even in the most untouched rural areas, by utilising simple procedures at a nominal cost. The research emphasises on freely available data from Census of India, so that District Centers can easily avail information required to incorporate this study within their existing framework. Using the above-mentioned dataset layers together (census, streets, and locations), we can build a geospatial framework which can help us understand population coverage, visualise inefficiencies, and come up with alternatives.

Study area and datasets

Study Area

The study uses health facility locations, Esri Street data, and population data from Census of India for Hisar district. As per Census of India, Hisar is one of 22 districts in Haryana, with a population of 1,743,931(931,562 are male and 812,369 are female). Hisar is largely rural, and depends on farming for livelihood.

The health and welfare of citizens of Hisar is managed through a three-tier system:

(i) Community Health Center (CHC)

(ii) Primary Health Center (PHC)

(iii) Sub Center

CHCs include 30-bed hospital/referral units; PHCs serve as the referral unit/dispensary for six sub-centers; and, Sub Centers act as the peripheral point of contact between the primary health care system and the community. Further, these facilities are linked to District Hospitals, generally located within large urban centers. These facilities are traditionally located on the basis of population size, i.e., as a village's or town's population increases, facilities get upgraded. We argue that, not taking into account the spatial relationship between population centers, can lead to a sub-optimal allocation of resources.

Datasets

This study explored available data options from census of India; data is freely available at a very high resolution.

(i) Healthcare Facility Locations: Datasets of Primary Health Care facilities were downloaded from the Census of India (http://censusindia.gov.in/) database. In total, four city hospitals were considered in this study: Hisar, Hansi, Adampur and Narnaund.

(ii) Population Data & Village Locations: Coordinates (latitude & longitude) of villages under Hisar administration, along with their population data, was also downloaded from the Village Town Directory of Census of India. In total, we used 280 village locations (with their population data) for this analysis. Population size varied from 50 to a maximum of 3,01,383 people.

(iii) Street Level Data: High resolution Street Map data was used from Esri Street Map Premium

(iv) administrative Boundaries: The administrative boundaries at district-level were obtained from GADM (http://www.gadm.org/)

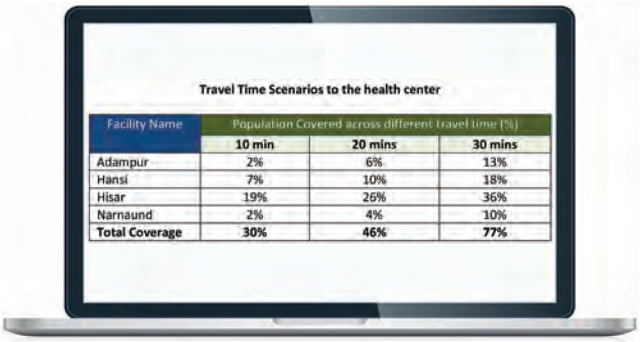
MS excel and Esri's ArcGIS were used to perform data acquisition and pre-processing. Village locations were manually geocoded with population data using Google Maps (https://www.google.co.in/maps/).

City hospitals and primary health facilities in Hisar, Haryana

Travel Time Analysis: Spatial accessibility to health care facilities

In order to analyse spatial accessibility and geographic coverage of the existing facilities, we generated Travel Time polygons around each facility. Travel time reflects the amount of time taken by a patient to reach health care facilities, using the existing network of rural roads. Using high-resolution street-level data from Esri, Travel Time polygons were generated for different scenarios at a) 10 minutes b) 20 minutes c) 30 minutes d) 45 minutes of travel time.

Additionally, we tried to investigate spatial accessibility and population coverage for up to 60 minutes of travel time. For all health care facilities, 60 minutes was considered to be the maximum travel time for all scenarios. However, in this study, travel time to the nearest health facility does account for components like the type of facility available, access to advanced health equipment, etc.



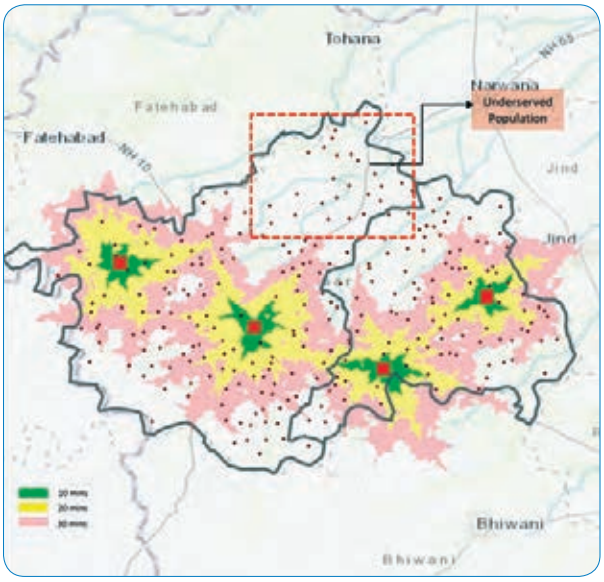
Travel Time Scenarios to the health center

Facility Name	Population Covered across different travel time (%)		
	10 min	20 mins	30 mins
Adampur	2%	6%	13%
Hansi	7%	10%	18%
Hisar	19%	26%	36%
Narnaund	2%	4%	10%
Total Coverage	30%	46%	77%

Variation in population coverage across different travel times to health facilities

For each Travel Time scenario, there is a significant variation in the percentage of population covered by healthcare. The existing health facility network is able to cover only 30% of the total population. Figure 2 depicts that most of the population in Hisar district remains under-served.

Considering travel time to each health care facility can provide a numeric measure to understand healthcare performance. We can study these measures further to understand the causes of poor performance within the health care system. This study provides a comprehensive, detailed and realistic method to understand the overall performance and spatial extent of health care systems in India.



Existing scenario: spatial accessibility to hospital facilities based on various travel times

Analysis & results

Spatial accessibility to health facilities

The overall population coverage for each of the health care facilities has been visualised above. For the 10-minute travel time scenario, health care facilities in Adampur and Narnaund showed minimum population coverage. The highest amount of population coverage was observed around health care facilities located in Hisar city. Since these facilities are located at a city center, it can be easily approached by most villagers within the considered time period. Patients prefer to walk or use bicycles, and then shift to public transportation to reach Hisar city. The highest level of geographical accessibility was observed in the scenario with Hisar district, where 36% population can reach a hospital facility in 30 minutes.

For all travel time scenarios, Narnaund represents the lowest degree of spatial accessibility. There could be several reasons behind this, including poor accessibility, weak transportation services, and poor infrastructure. This finding can lead us to further recommendations like investing for better infrastructure in Narnaund district.

Current scenario: spatial distribution and population coverage for existing healthcare network

Per district, a Catchment Area Analysis was employed using village-level population data, to

summarise each travel time polygon level. In other words, village locations were used as demand locations, and population covered played an important role in studying the overall spatial distribution.

Current distribution indicates that facilities in Narnaund and Adampur districts have the lowest degree of spatial accessibility. The existing network covers only 46% of the total population in 20 minutes of travel time.

Finding potential locations to set up new facilities: maximising population coverage

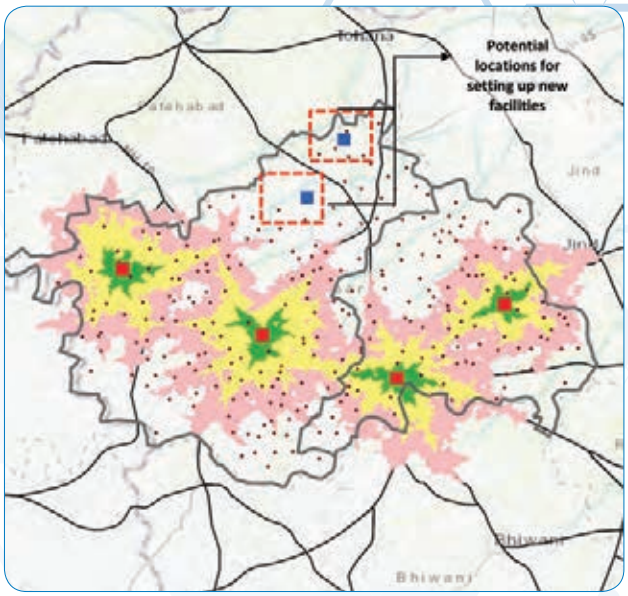
Using the Location Allocation tool in Esri's ArcGIS, we extrapolated two potential locations (as shown above) to set up new facilities. Setting up facilities at these two locations can bring nearly 95% of Hisar's population in reach of a hospital facility, within 30 minutes of travel time. We can also setup new emergency or ambulance services to provide first-aid to patients in critical situations.

Conclusion

The study demonstrates that leveraging census data and village-level data in a geospatial framework can play a vital role in supporting evidence-based planning and allocating facilities efficiently. It also explores important aspects of locating health care facilities in rural districts like Hisar, and provides a powerful solution toward deciding potential sites for setting up new hospitals.

Running different travel time scenarios indicates significant variations in spatial accessibility. The study clearly demonstrates that, regardless of the number of facilities and dispensaries, a majority of the population is still under-served, and cannot reach hospitals within thirty minutes. Nearly half the facilities lack dedicated emergency services for urgent treatment.

The Ministry of Health is putting substantial effort towards improving healthcare infrastructure in Haryana. The study raises the need to attend to issues such as access to health care centers, shortage of health staff, and poor infrastructure. Healthcare tragedies remind us to pay attention to our public health framework as efficiently, as possible. This case study demonstrates how spatial access to health care



Potential locations to maximize population coverage

facilities, and overall variation in population coverage, are measures that can be clearly used to help health research and decision-based planning at a district level. Strong investment to strengthen health care infrastructure is highly needed to expand the overall coverage.

Another of the result of this study was that we were able to find two additional optimal locations to set up primary health care centers which could potentially lead to 95% of population coverage in 30 minutes. This result could provide valuable support to government authorities in the overall development of health infrastructure at a low cost.

At the same time, when faced with limited resources and running costs to set up new infrastructure, the study can help identify focus areas where economically-feasible solutions can be implemented to reduce inequities. This could be along the lines of spending more on existing facilities; setting up new dispensaries with emergency facilities at optimal locations; or, setting up emergency ambulance services with basic facilities at optimal sites.

This could be a more generic and comprehensive approach to address health infrastructure issues at a district or sub-district level. To conclude, we can easily design good quality and cost-effective geospatial frameworks for health care infrastructure in a developing country like India. Simple geospatial methods can be easily incorporated to play a vital role in evidence-based planning, and also help in finding potential sites which can reduce inequities and maximise population coverage. Lastly, the study also represents the importance of leveraging Census information at such a granular level.

Taking comfort from the past

We should not be quick to call this the new normal. Normal has always been something of an illusion.

The COVID-19 pandemic has altered the world swiftly and profoundly – and will continue to, in the months ahead – but it is valuable to consider the long-term view.

The urgent challenge is to solve the medical crisis, and the now-unfolding impacts to the economy. As we start to look forward, we should remember that, throughout history the world has found its way through eras of upheaval, and even tragedy. Across time, societies have endured terrible hardships that feel novel – and, sometimes, unbearable. But each time our resilience was tested, we have struggled for betterment.

Disruptive and terrible moments like these push leaders to think in new ways, mine new sources of information, fundamentally changing the way they operate.

As we consider how the COVID-19 outbreak might shape people, organizations and companies in the years ahead, a look back may offer insights and hope.

The impact of major events

Following the Great Depression of the 1930s, people shifted towards frugality. Some adjusted in small ways – reusing aluminum foil, or rationing their water usage. Larger changes happened as well. By 1940, the savings rate, which had been negative, surpassed 15 percent, as people protected themselves against the risk of another contraction. Automakers, like GM, moved aggressively to accommodate the decrease in household spending, ramping up production and marketing of its low-cost Chevrolet brand. That shift ultimately led to a time when nearly every family could afford a car. However, that change didn't happen en masse – buying habits varied across demographic groups and locations.

During World War II, the military appetite for metals drove manufacturers to embrace alternatives for consumer goods. This boosted

Article snapshot: Few decades pass without an event that changes the world. No matter how widespread each event is, its effects are best examined one location at a time.

a plastics innovation and production which continued for decades, shaping regional manufacturing economies, inspiring new consumer habits, and altering the environment.

Then, in rapid succession, major changes continued to punctuate what might otherwise have been 'normal' times: the space race, civil rights struggle, Vietnam War, economic globalisation, and internet-based communications.

More recently, the 2007 Great Recession severely impacted labor dynamics – in manufacturing, administrative, and similar jobs – forcing middle-skilled workers out of earnings. Subsequently, studies of location data revealed that US counties with higher levels of income inequality were less able to withstand the economic downturn. The fallout from that disparity continues to influence economic conditions and voting patterns today.

COVID-19's effects have been widespread, but not equivalent; different countries have experienced different rates of infection and impact. In the US, New Jersey had more than 64,000 COVID cases by April 14, while Maine had fewer than 700. Italy had lost 20,000 citizens to the virus, while Greece saw fewer than 100 deaths.

In ordinary, and extraordinary, times, location shapes what people experience and how they view the world. This reality should be embraced as leaders and executives create plans for business recovery in the weeks ahead.

What changes will come?

In retrospect, events that define history tend to shape our views and societies more profoundly than the "normal" times that pass quietly between them.

At the moment, many business leaders are practicing a kind of COVID-19 protectionism – ensuring the well-being of employees; idling non-essential production and services; and, planning recovery, when conditions allow. It is heartening to see leaders rally around their employees, customers, and front-line workers. Companies taking action is welcome evidence of the business community's commitment to Corporate Social Responsibility, and a reminder of the resilience that shines during shared hardship.

"In retrospect, events that define history tend to shape our views and societies more profoundly than the "normal" times that pass quietly between them."

As we begin to map out recovery plans, it is important to recall major shifts of decades past - considering how this pandemic will influence habits and views - to assess where and how businesses will change, as a result. Here are a few examples where this dynamic is already playing out:

Commercial real estate and corporate offices

Millions of professionals are now working from home; when COVID-19 shelter-in-place orders recede, a percentage of them will likely become permanent or semi-permanent remote workers. For those who return to office, things may change too. Cushman & Wakefield, a top corporate real estate firm, has formed a task force to advise clients on setting up (what it calls) "the 6-foot office" – a space that encourages social distancing, and better protects employee health.

This push towards careful space planning is likely to change CRE and corporate offices for years to come. HR planners and corporate leaders are already using indoor location technology to map facilities and understand their asset usage. That same tech will play a central role as offices reconfigure in a post-COVID reality.

Many companies have assigned employees to work-from-home solutions while

accommodating Coronavirus shutdowns. When executives have more time to assess long-term options for remote work, they will begin to rely on new sources of information - including data on which areas have reliable access to broadband service (see the sidebar for more). With that location intelligence in hand, executives might seek ways to creatively partner with broadband providers, and improve access for people on the wrong side of the digital divide.

Remote readiness by location

As the COVID-19 outbreak unfolded, the team at SmartAsset examined occupation data from the Bureau of Labor Statistics to determine which US locations were the most receptive to remote working. The analysis was based on the prevalence of certain occupations in a location, not directly accounting for digital access. The results are interesting – from the finding that Arlington, VA, has the best profile for remote work, to the discovery that Sunrise Manor, NV, is least equipped to make the shift. For data on broadband access across the US, visit this smart map.

Retail industry in flux

Effects of the COVID-19 outbreak in the retail sector have been stunning. Shutdown orders have driven some companies toward the brink, while others have benefited from spikes in online shopping, or have found creative forms of contactless delivery to keep customers safe.

Business leaders who embrace new customer expectations during the pandemic are likely to retain many of those customers in the long run. As Gartner's Amie Song told AdWeek recently, Chinese online retailers JD.com and Tmall grew precipitously in the early 2000s after the SARS outbreak scared many shoppers away from stores, and onto computers and phones.

Today, though ecommerce is ingrained in our shopping patterns, it accounted for just 10 percent of US retail sales at the close of 2019. COVID-19 is changing this dynamic, as evidenced by March's 74 percent year-over-year increase in online sales. Like social distancing in offices, online shopping habits formed during the pandemic may persist well beyond it. These preferences will differ across global locations, and businesses that use location data to understand them will find ways to cater to evolving tastes.

In a retail climate, where fashions change rapidly, it is misguided to assume a 'new normal'. Companies that stay nimble, and explore emerging sales techniques, may make a positive impression on shoppers long after COVID-19 fades.

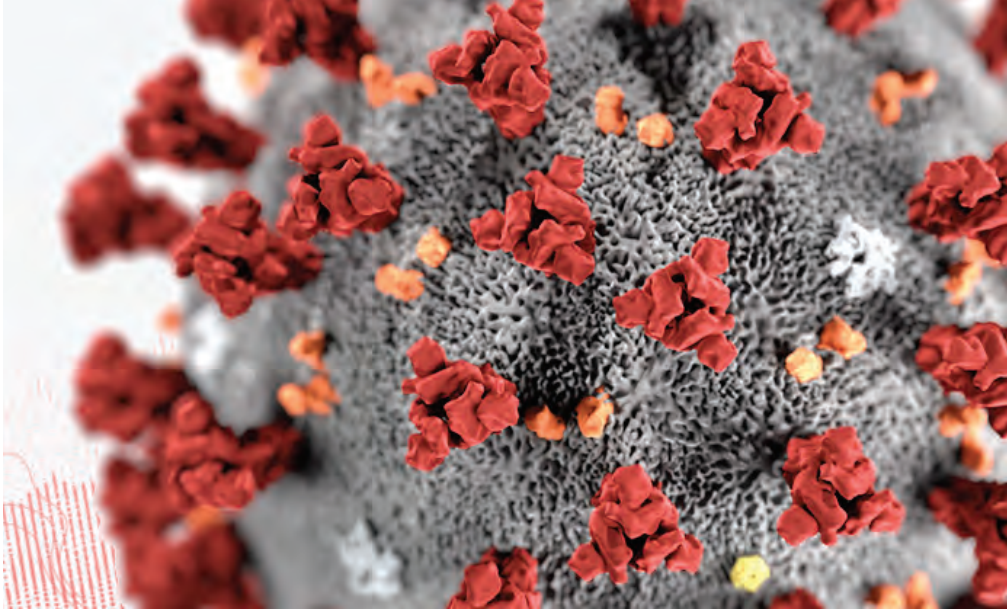
Manufacturers locate weak spots

COVID-19 has changed the fortunes of many manufacturers nearly overnight. Late March saw the sales of hair clippers rise 166 percent from a year earlier, as at-home hair care caught steam. Similarly, makers of products - as diverse as video game consoles to toilet paper - were unable to keep their offerings in stock at retail outlets. On the flipside, milk producers dumped excess product as restaurants idled and grocery shoppers opted for less-perishable foods. Automakers reported sharp sales declines, while some paper mills went on hiatus, as shuttered schools and offices undercut demand for paper products.

The pandemic has exposed many truths about manufacturing, the most prominent being the benefit of knowing your supply chain.

When similar slowdowns or surges hit, manufacturers that use GIS technology know the exposure risk at their Tier 2 factories; the status of finished goods in transit; and, where the demand for products has gone outside normal levels. Some have built this supply chain awareness, over years, to cope with natural disasters; more will in the near future. For them, considering which forms of customer demand will reach beyond the crisis and which may emerge, will be advantageous.

Following the SARS epidemic of 2003, many Beijing residents bought cars to avoid (what they saw as) the health hazards of public transportation. The COVID-19 pandemic could reset transportation attitudes in similar ways. Executives can use GIS to track consumer sentiments, in locations worldwide, and prepare for consumer changes.



The pandemic has exposed many truths about manufacturing, but most prominent is the benefit of knowing your supply chain.

Banks and financial service institutions

Before COVID-19, bank leaders were already on the way to becoming savvy with location information. In the wake of the virus, wise executives will pay greater attention to how location affects their customers.

COVID-19 has exposed glaring inequities across the country and the world. In addition to indications that the disease disproportionately imperils minority populations, we are also reminded that many communities lack access to key services, including healthcare, the internet, and banking.

As of early April, the pandemic produced a 50 percent jump in online banking, as home-bound citizens turned to mobile devices to manage finances. Certain communities have contributed heavily to that surge, while others have been left out due to poor digital access, lack of bank accounts, or both.

This may prompt bank executives to continue rethinking the format of branches. The innovative Capital One Cafés that debuted in 2017, for example, are designed to resemble coffee shops more than traditional bank branches. Aimed at millennials who might otherwise shun traditional banking options, the locations feature resources such as community rooms for local nonprofits; free money coaching; and, WiFi-equipped meeting spaces.

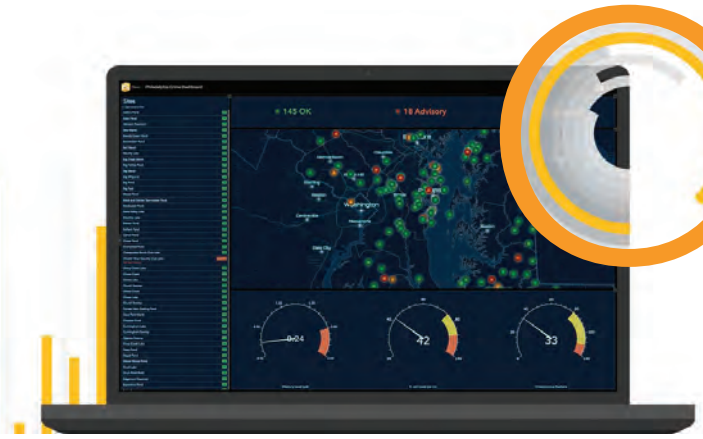
The COVID-19 experience will likely change banking habits even further. People with prior access to mobile services may emerge from the pandemic confident that they can handle finances exclusively online. Others may see, ever more clearly, the need for in-person options.

Some banks are already experimenting with a middle ground, including the delivery of banking services via customized trucks that visit neighborhoods on a rotating schedule. Decisions on whether, and where, to expand such services will be highly influenced by the needs of individual neighborhoods - something that leading banks have been analysing with GIS technology for years. As pandemic restrictions fade, demands on banks will continue, but the countenance of their presence in many locations may well change.

Data analysts drive decisions across commercial industries

Throughout the COVID-19 crisis, one employee group has been busy helping executives and colleagues navigate decision-making. Analysts and data scientists have been the newsgatherers of this pandemic, using GIS technology to map conditions for many types of businesses. They have used data, from inside and outside their companies, to deliver intel on the well-being of employees and customers, while making sense of health and business conditions around the world.

At one retailer, with a presence in almost every US state, the pandemic immediately raised executive interest in smart maps and dashboards. Analysts used GIS technology to map store-level data, so far confined to spreadsheets, and create near-real-time maps of store openings; employee availability; and, COVID-19 cases in each location county.



Operations Dashboard

Make decisions at a glance

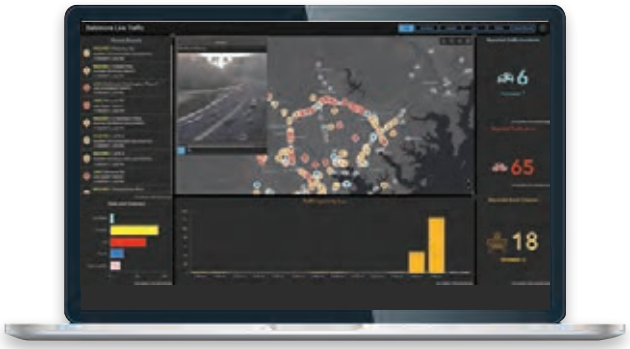
As a GIS professional, do you contribute in making GIS platforms valuable and successful? Are you a champion of geography-based decision making within your organisation? Do you define and drive the adoption, and application, of spatial technologies? If this is you, GIS is your platform to visualize, question, analyse, and interpret data to form relationships, patterns, and trends. As millions eye the reach and rising toll of the Novel Corona Virus Disease 2019 (COVID-19), map-based dashboards have become a compelling and near real-time way to monitor the outbreak. They have also substantiated the message that everyone must take precautions, and alter daily interactions.

What is Operations Dashboard?

Operations Dashboard for ArcGIS is a configurable web app. It brings together location-aware data, from multiple sources, to help visualize an organization's operations, in real-time.

How do Operations Dashboards help?

- Facilitate understanding, by providing information at a glance
- Provide a flexible layout, where data can be displayed on single- or multi-screens
- Offer a cohesive suite of visualizations that can be configured to author interaction between visual elements
- Display any type of data you choose to show, including people, assets, events, services, or dynamic data providing real-time views



Operations Dashboard

Operations Dashboards are intended to support many different use cases. Within a single organisation, you can have an Operations Dashboard, a Real-time Dashboard, tactical dashboards and strategic dashboards. Below are some innovative examples, beyond the standard patterns of use, which can hopefully inspire you.

Dynamic filtering

By utilising multiple elements to visualise data, dashboards can comprehensively inform the end- user, through a single glance. Under default configuration, a dashboard's display changes only

when the underlying data is refreshed. To provide a more interactive and immersive experience, you can configure Actions on dashboards.

Tip: Map Actions and Action layers can drastically change the dashboard display, when displaying data related to your filter variable.

COVID-19 Global Cases.

Styling

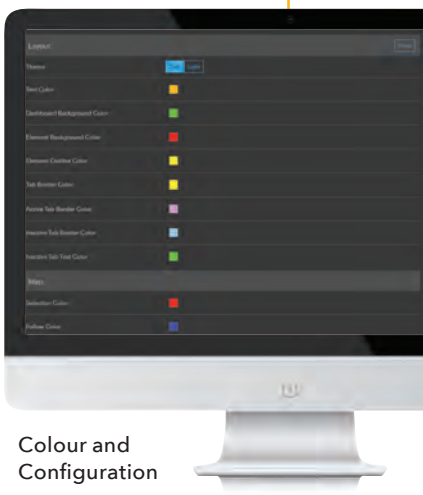
Esri Vector Basemaps are multi-scale vector tile layers that can be styled and customised for mapping applications. For example, the National Football League has used simple styling to create a dashboard, with a base map configured to match the style of their infographics.

Tip: Base maps are easily styled using Esri's new Vector Tile Style Editor.

Nfl super bowl history dashboard using vector tiled base maps

Colour and configuration

Operations Dashboard creates new opportunities for branding your company/ organisation, as shown by the City Cancer Challenge and COVID-19 Global Cases Dashboard examples above.



Colour and Configuration

Tip: Go beyond the standard Light and Dark Themes to really gain control over your users' experience. Use the new Colour and Theme options under Dashboard settings to leverage this to the maximum. Another technique we're beginning to see is the use of the expanded Theme elements to blend elements together, instead of highlighting them in separate boxes. This technique lends a seamless look to your dashboard.

Mobile compatibility

This is huge for the configurable web app. Enhancing the Operations Dashboard has made huge leaps for the configurable web app; dashboards can now be viewed on mobile devices, as well. For further configuration, the web app must be used in tandem with the Operations Dashboard on a web browser.

A streamlined mobile operations dashboard displaying greenspace

Tip: When creating a dashboard for mobile applications, audience is key. Mobile users prefer simple, targeted apps. Mobile dashboards and desktop versions should be designed to complement one another. Similarly, within a dashboard, users know what information is up on display; help keep it minimal and crisp, by avoiding lots of explanatory text.

GIS Transforming Careers

Location intelligence through GIS is becoming indispensable in nearly every sector – whether run by government or private hands. To stay ahead of the curve, knowledge of GIS is a pivotal feather in the cap of every T-School cohort who thinks global but acts local.

Modern-day technical workforces face new demands from increasingly tech-conversant employers who follow the look-and-learn culture, while social media keeps them updated in their fields; they recognise the potential for game-changing solutions in ideas generated globally, and understand that these solutions are in the hands of a competent workforce. Today, companies hire for top-notch efficiency, unlike in the past when firms invested months toward training fresh graduates. Better productivity invites better pay, as employers cash-in on the chance to become global leaders in their sector. To develop a versatile workforce, and counter the claim that only 20% employability exists among Indian engineers, a higher focus is needed on applying technology and imparting practical knowledge to graduating students.

The omnipresence of GIS gives India the opportunity to train a workforce that will increasingly be in demand across sectors, from construction and real estate to service utilities, banking, retail, and natural resources. As GIS takes centre-stage, T-schools that run specialised courses, or mandatory skilling, in GIS become the need of the hour.

The tech landscape is changing rapidly with healthcare, governance, infrastructure, emergency management, and commerce being just some of the beneficiaries of this revolution.

Healthcare: GIS systems are expected to support government healthcare programs like Ayushman Bharat (PM-JAY) and Swachh Bharat. It is also notching victories in India's quest for Universal Health Care, offering a geographic understanding for accurate prevention, detection, and response and helping establish new health-and-wellness centres, tracking the effectiveness of immunisation initiatives, and managing pre-emptive steps to contain vector-borne diseases (malaria and typhoid).

Governance: The government's programmes for urban transformation, water and agriculture are benefiting from GIS-based dashboards. GIS has been instrumental in India's NITI Aayog success at helping States learn best practices from each other, through evidence-based solutions.

Emergency management: GIS provides powerful mapping and analytics that allow emergency management agencies to see the 'what' and 'where' of things, real-time. From Californian wildfires and Ebola outbreaks to refugee crises, cyclones, and nuclear disasters, GIS has managed it all. In 2020, GIS helped cities in their COVID-19 War Rooms for deploy responses to the pandemic.

Infrastructure: GIS holds the answer to several infrastructure applications in a Digital India. GIS is already a by-word in major programs like Bharatmala, Sagarmala, and Smart Industrial Ports Cities, as well as utility programs like R-APDRP and City Gas Distribution. Integration with BIM and IoT devices, as well as steady data collection through RFID tags and microchips for project monitoring, will only increase GIS use across this sector.

Private sector: Banks, insurers, automobiles, real-estate, construction, retail and logistics have been employing GIS to streamline their operations at both ends. From geotechnical exploration and space to irrigation and warehousing, GIS has imprinted itself in every field.

AI, ML, Big Data, and (IoT) are finding new-world applications with everyone using mapping in daily life. Students need to imbibe to GIS to prepare them for work-life. Esri India is here to support the academic community with learning and entrepreneurship in location analytics. The power of location is an indisputable power tool for the employees of tomorrow.

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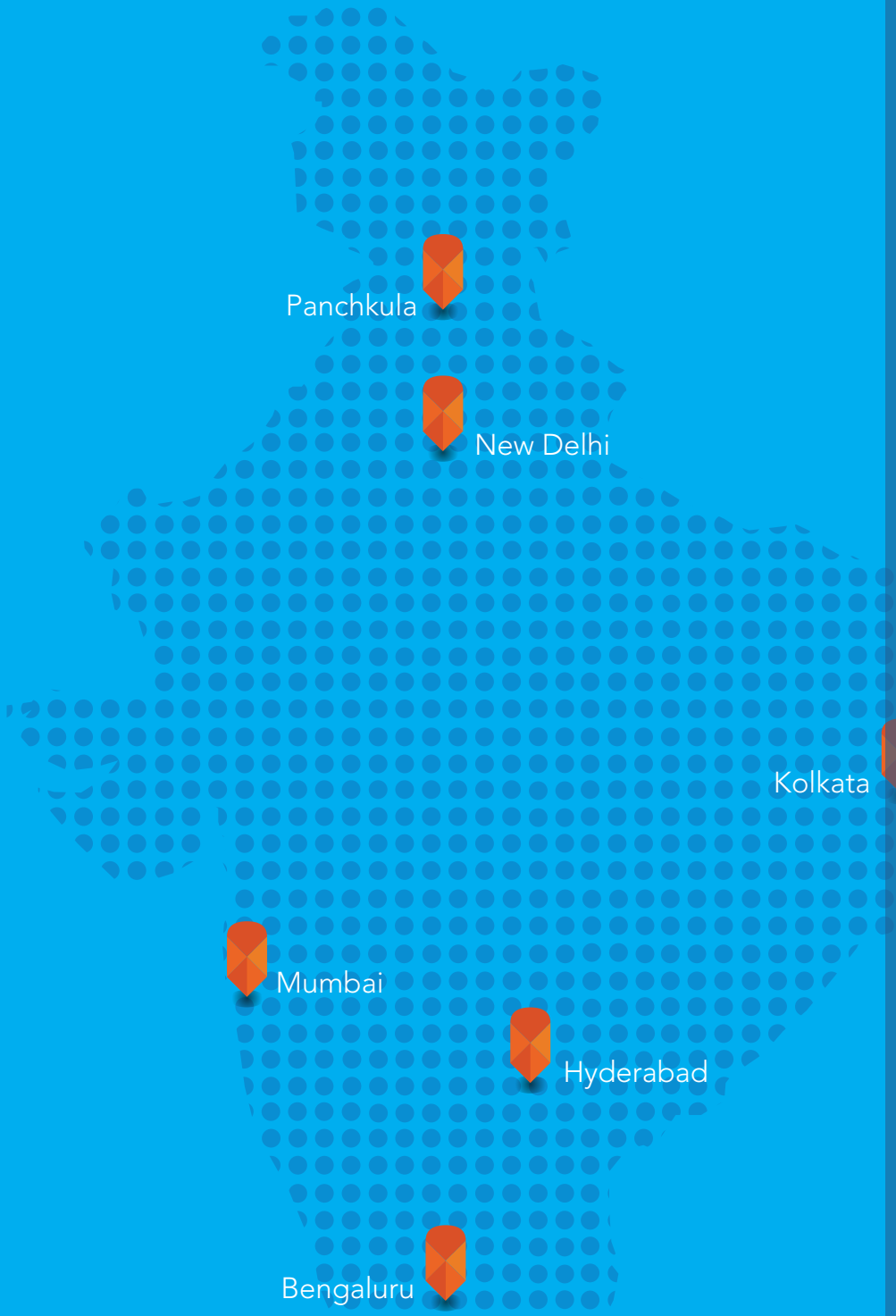

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Above ICICI Bank,
45th Cross, 8th Block, Jayanagar
Bengaluru - 560082, Karnataka

Hyderabad
Apeejay Business Center, Tresorie,
1st Floor, The PARK, 22, Raj bhavan Road,
Hyderabad - 500 082, Telangana

Kolkata
Block DN - 62, Sector - V, 12th Floor, Tower II,
Millennium City Information Technology Park,
Bidhan Nagar, Salt Lake
Kolkata - 700 091, West Bengal

Mumbai
EFC Business Center,
D wing, 14th floor, Empire Tower Reliable Cloudcity
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