

## KEY POINTS

- Accurate information about access to quality health care services with data that is sufficiently granular to expose disparities among marginalized or remote populations is key to achieving universal health coverage (UHC).
- Geographic information systems (GIS) are one of the suite of information and communication technology ICT-enabled solutions recommended by ADB and WHO to address health system resiliency and UHC inefficiencies.
- It is already feasible to use simple yet innovative GIS solutions that can utilize geospatial and statistical data for UHC and infrastructure investment planning.
- For vertical disease programs, GIS is an essential tool to ensure they effectively target the relevant population groups. National malaria elimination programs must be equipped to identify the location of cases and know whether there is adequate access to testing, treatment and follow-up.
- The health sector can only fully benefit from the power of GIS if its health information system (HIS) is “geoenabled,” meaning that the necessary governance, technical capacity standards, and processes are in place to support the generation of quality geospatial information and a proper use of GIS across the entire health sector.
- For Ministries of Health in Asia and the Pacific to capitalize on the power of GIS, guidance and support to geoenable their health information system is invaluable. ADB and WHO, together with private sector partners, are working to establish a GIS Laboratory for the Asia and the Pacific, under the umbrella of the Asia eHealth Information Network (AeHIN) to help countries use GIS to reveal health service delivery gaps, relationships and trends that may not be otherwise evident.

ISBN 978-92-9257-391-1 (Print),  
 ISBN 978-92-9257-392-8 (e-ISBN)  
 ISSN 2071-7202 (Print),  
 ISSN 2218-2675 (e-ISSN),  
 Publication Stock No. ABF167966-2

## THE GEOGRAPHY OF UNIVERSAL HEALTH COVERAGE

### Why geographic information systems are needed to ensure equitable access to quality health care<sup>1</sup>

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## TARGET AUDIENCES

- Ministry of Finance and other relevant line-ministry decision makers
- Health sector policy makers
- Ministry of Health department directors
- Health systems managers
- Health information systems and ICT implementers
- Health care researchers
- International development organizations

### Universal health coverage (UHC):

ensuring that all people can use the promotive, preventive, curative, rehabilitative, and palliative health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose the user to financial hardship.<sup>3</sup>

### Equity:

the absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically.<sup>4</sup>

### Effective coverage:

the proportion of the population in need of an intervention who have received an effective intervention.<sup>5</sup>

## GEOGRAPHY IS KEY TO EQUITABLE ACCESS TO HEALTH CARE SERVICES

Equitable access to quality health care is mediated by a number of factors that stand between the availability of services and actual effective service usage or coverage. Analyzing these factors following a framework such as the Tanahashi model (Figure 1) illustrates the barriers to Universal Health Coverage (UHC).<sup>6</sup>

To narrow the gap between availability of coverage and effective coverage, it is necessary to understand the social, economic, demographic, and geographic composition of the target population, and that portion of it for whom quality interventions have to be effective. This requires disaggregated and spatially distributed data, not only for the target population and the concerned points of service delivery, but also for the topography that clients have to cross in order to access services.

In many parts of Asia and the Pacific, there is adequate national-level data on health service provision, but this often belies significant subnational disparities in service access by particular groups or in specific geographical areas. Moreover, available data often only capture health services provided by the public sector.

UHC has gained renewed momentum as the era of the Sustainable Development Goals (SDGs) begins. Equity and measurement of progress towards UHC are central to the health SDG 3 where “no-one must be left behind.”<sup>7</sup> Under the SDGs, achieving UHC is the cornerstone of the health goal. At the same time, health is essential to nearly all other SDGs—including those addressing poverty, hunger, education, gender equality, energy, economic growth, climate change, sustainable cities, inequalities, and infrastructure.<sup>8</sup> Through the 2016–2030 Agenda for Sustainable Development and achieving the goals and targets of the SDGs, GIS is emerging as a common platform for intersecting multisectoral data, relationships, and trends. The common language of geography unifies all of the health aspects of the SDGs.

## GEOGRAPHIC INFORMATION SYSTEMS: AN ICT-ENABLED SOLUTION TO HEALTH SYSTEM INEFFICIENCIES

Geography is key to understanding how health service coverage develops, from simply plotting health facilities on a map to show availability, to simultaneous analysis of multiple layers of data to demonstrate UHC effectiveness. It is also an essential part of gathering sufficiently disaggregated data to expose hidden gaps in service provision and promote universal health coverage.<sup>9</sup>

<sup>3</sup> World Health Organization (WHO). Health financing for universal coverage. [http://www.who.int/health\\_financing/universal\\_coverage\\_definition/en/](http://www.who.int/health_financing/universal_coverage_definition/en/)

<sup>4</sup> WHO. Health systems. <http://www.who.int/healthsystems/topics/equity/en/>

<sup>5</sup> T. Tanahashi. 1978. Health Service Coverage and Its Evaluation. *Bulletin of the World Health Organization* 56. pp. 295–303.

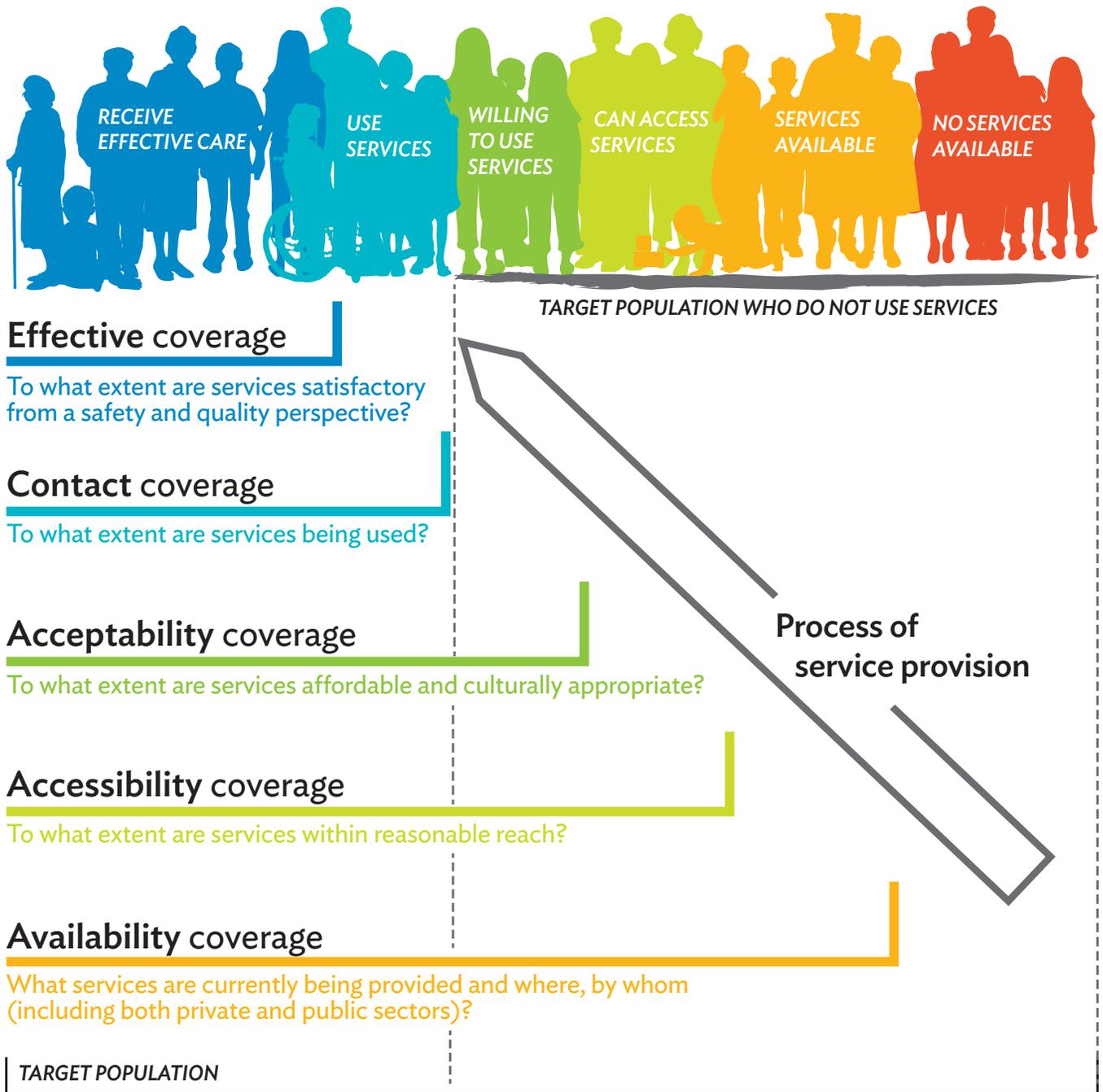
<sup>6</sup> Footnote 5.

<sup>7</sup> I. Kickbush. 2015. Benefits and Costs of the Health Targets for the Post-2015 Agenda. *Copenhagen Post-2015 Consensus Working paper*. January.

<sup>8</sup> <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

<sup>9</sup> P. Frenz and J. Vega. 2010. Universal Health Coverage with Equity: What We Know, Don't Know and Need to Know. Background paper for the Global Symposium on Health Systems Research. 16–19 November. Montreux, Switzerland. [http://healthsystemsresearch.org/hsr2010/images/stories/9coverage\\_with\\_equity.pdf](http://healthsystemsresearch.org/hsr2010/images/stories/9coverage_with_equity.pdf) (accessed 20 October 2015).

Figure 1: The Tanahashi Model of Evaluating Health Service Coverage



Source: Tanahashi, T. 1978. Health Service Coverage and Its Evaluation. *Bulletin of the World Health Organization*. 56: 295–303.

**Table 1:** Use of GIS-Enabled Analyses

GIS capacity	Example of analysis
<b>Thematic mapping</b>	Visualizing the spatial distribution of the target population
	Locating health services and visualizing their geographic relation to the target population
	Visualizing health trends and health systems performance indicators
	Mapping registries and routine health information and statistics
<b>Spatial analysis</b>	Evaluating efficiency and equity of health services delivery
	Evaluating services which are covered or partly covered by social health insurance programs are being accessed by target populations
	Tracking real-time disease outbreaks and morbidity incidence
<b>Spatial modeling</b>	Understanding how physical accessibility and distribution of services correlates with the population profile and corresponding health outcomes
	Detecting relationships using health-based geostatistics
	Analyzing links between environmental risks (e.g., exposure to vectors, pollution) and health impacts
	Identifying geographical barriers to accessing health services
	Optimizing spatially enhanced health sector reform objective functions by proposing scaling up scenarios

Source: Authors.

Geographic information systems (GIS) are one of the suites of ICT-enabled solutions recommended by ADB and WHO to address health system inefficiencies and improve health service delivery planning and management.<sup>10</sup> GIS can be used to generate, integrate, and analyze spatial data from different sources, including those collected through the use of remote sensing or Global Positioning System (GPS) technologies. In turn, this data can be used for infrastructure investment planning to ensure highest possible impact on improving access to health services. It contributes to better organized health service delivery networks and better coordination with private sector health service providers. Human resources for health can be more effectively deployed to ensure higher and more equitable accessibility coverage. GIS can be also used to gather and visualize a wide range of information at national and subnational levels (Table 1).

The multiple capacities of GIS include the support of field survey design and monitoring when used in conjunction with GPS devices, and the creation of thematic maps to convey information about the geography of a specific topic or theme. GIS can be harnessed to extract new information from spatial data, and analyze the spatial dimension of a particular health issue. It can also apply spatial models to simulate natural or anthropogenic phenomena, including the testing of scale-up scenarios aimed at improving accessibility coverage.

For vertical disease programs, GIS is an essential tool to ensure they effectively target the relevant population groups. For communicable disease programs GIS can strengthen surveillance and outbreak response. For example, to achieve malaria elimination, national malaria programs must identify the location of malaria cases and have the data to know whether there is adequate access to testing, treatment, and follow-up services.

During an emergency, GIS is used to provide a common operational picture to all the stakeholders involved in the response, ensuring a more effective and targeted intervention. In this context, the visualization on a map of the services and populations that have been affected helps decision makers make the best possible use of the assets at their disposal.

## Geographic information systems are one of the suites of ICT-enabled solutions recommended by ADB and WHO to address health system inefficiencies and improve health service delivery planning and management

There are numerous examples of how these capabilities have been put to use in Asia and the Pacific (Figure 2), including assessing potential barriers to access for maternity services in the Philippines,<sup>11</sup> mapping of the distribution of women of childbearing age, pregnancies and births in Afghanistan and Bangladesh,<sup>12</sup> and to generate scale-up scenarios in Cambodia and the Lao People's Democratic Republic (Lao PDR).<sup>13</sup> GIS has also been used in several countries, including the People's Republic of China, India, the Lao PDR, Solomon Islands, and Vanuatu, to spatially distribute malaria risk, guide the development of elimination strategies, and monitor interventions.<sup>14</sup>

AccessMod,<sup>15</sup> a WHO-developed spatial model which enables measurement of accessibility and geographic coverage, the latter combining availability and accessibility coverage into a single measure, offers a good illustration of the different capacities that GIS offers in relation to UHC.

Using this model, and the Lao PDR as an example, thematic maps (Figure 3), show travel time distribution to the nearest health facility providing Emergency Obstetric and Newborn Care (EmONC) when considering two different transportation scenarios: (i) women walking and/or being carried to reach the facility (ii) women walking and/or being carried until the nearest road and then using a motor vehicle to reach the facility.

<sup>10</sup> S. Roth, M. Landry, and J. Parry. 2015. Universal Health Coverage by Design: ICT-Enabled Solutions Are the Future of Equitable, Quality Health Care and Resilient Health Systems. *ADB Brief* No. 36. <http://www.adb.org/sites/default/files/publication/160117/universal-health-coverage-design-ict.pdf> (accessed 20 October 2015).

<sup>11</sup> M. M. Dairyt, C. M. O. Ramirez, W. Asuncion, S. Ebener, C. Bernardo, H. J. Liwanag, K. Cochon, and A. Perez. 2015. *Assessing Access to Prenatal, Delivery and Postpartum Services in the Eastern Visayas Region, Philippines*. Final technical report to WHO Philippines.

<sup>12</sup> A. J. Tatem, J. Campbell, M. Guerra-Arias, L. de Bernis, A. Moran, and Z. Matthews. 2014. Mapping for Maternal and Newborn Health: the Distributions of Women of Childbearing Age, Pregnancies and Births. *International Journal of Health Geographics* 2014. 13(2). <http://www.ij-healthgeographics.com/content/pdf/1476-072X-13-2.pdf> (accessed 20 October 2015).

<sup>13</sup> World Health Organization (WHO). 2015. *Investing the Marginal Dollar for Maternal and Newborn Health (MNH): Geographic Accessibility Analysis for Cambodia and the Lao PDR*.

<sup>14</sup> A. Daash, A. Srivastava, B. N. Nagpal, R. Saxena, and S. Kumar Gupta. 2009. Geographic Information System (GIS) in Decision Support to Control Malaria—A Case Study of Korapu District in Orissa, India. *J. Vector Borne Dis.* 467. March. pp. 72–74; G. C. Kelly, E. Hale, W. Donald, W. Batarai, H. Bugoro, J. Nausien, J. Smale, K. Plamer, A. Bobogare, G. Taleo, A. Vallely, M. Tanner, L. S. Vestergaard, and A. C. A. Clements. 2013. A High-Resolution Geospatial Surveillance-Response System for Malaria Elimination in Solomon Islands and Vanuatu. *Malaria Journal*. 12: 108; Y. Shirayama, S. Phompida, and K. Shibuya. 2009. Geographic Information System (GIS) Maps and Malaria Control Monitoring: Intervention Coverage and Health Outcome in Distal Villages of Khammouane Province, Laos. *Malaria Journal*. 8: 217.

<sup>15</sup> World Health Organization (WHO). Modeling Physical Accessibility to Health Care and Geographic Coverage (AccessMod®). <http://www.who.int/kms/initiatives/accessmod/en/index3.html>

**Figure 2: Using GIS to Support Health Service Coverage: Country Examples**

	Context	Question	GIS use
<b>Philippines</b>	 <p>Prenatal, delivery and postpartum services</p>	<p>What are potential barriers and facilitators to accessing prenatal, delivery and postpartum services?</p>	<p><b>Household survey</b> design and monitoring to ensure a geographically based sample of health facilities and households</p>
<b>Afghanistan, Bangladesh</b>	 <p>Maternal and newborn health</p>	<p>Where are women of childbearing age, pregnancies, and births?</p>	<p><b>Thematic mapping</b> and <b>spatial analysis</b> to generate high resolution population distribution maps and analyze the relationship between the population and the location of emergency obstetric care services</p>
<b>Cambodia, the Lao PDR</b>	 <p>Emergency obstetric care services</p>	<p>What is the best way to target marginal dollar spending for maternal health?</p>	<p><b>Spatial analysis</b> and <b>modeling</b> to measure physical accessibility and geographic coverage at the subnational level and provide scaling up scenarios to reach universal health coverage</p>
<b>the People's Republic of China, India, the Republic of Korea, the Lao PDR, Solomon Islands, Vanuatu</b>	 <p>Malaria control and elimination</p>	<p>Where are the population most at risk of malaria transmission?</p>	<p><b>Spatial analysis</b> and <b>modeling</b> to spatially distribute malaria risk and support decision making</p>

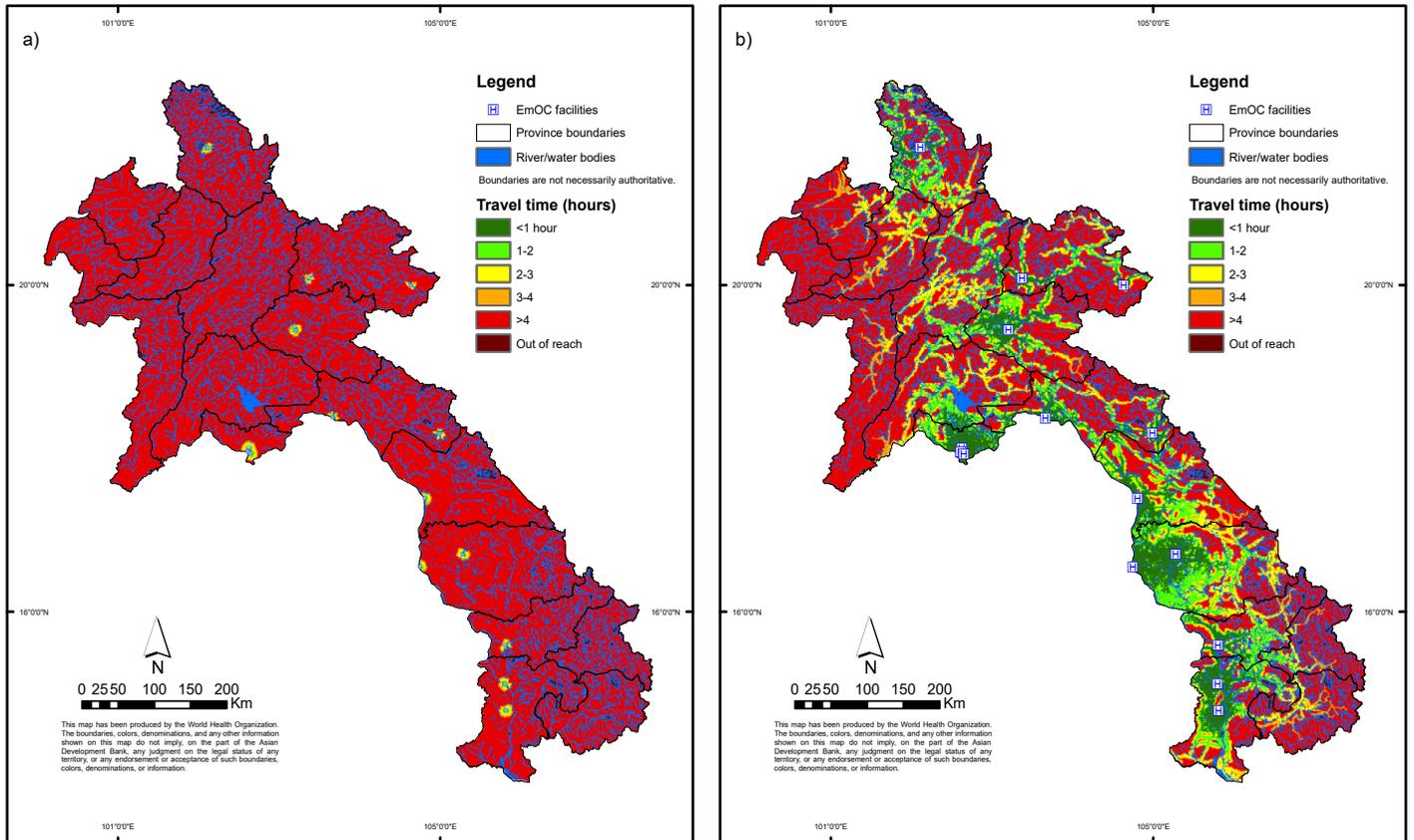
Source: Authors.

This kind of comparison does not only provide a powerful visual illustration of the gains made by financially supporting women to access motorized transportation media but does also provide planner with a direct measure of the gain in accessibility coverage—passing from 11.3% to 66.9% in the example reported in Figure 3.

If ever available, the spatial location of unattended home deliveries, as collected through surveys such as the Demographic Health Survey (DHS)<sup>16</sup> could be added to these kind of maps to estimate the percentage of unattended births within a specific given travel time to the nearest facility providing Basic Emergency Obstetric Care (BEmOC).

<sup>16</sup> The Demographic and Health Surveys (DHS) Program. <http://dhsprogram.com/>

**Figure 3:** Accessibility Coverage Analysis for BEmOC Facilities when considering that women would either (a) walk and/or being carried or (b) walk and/or be carried until the nearest road and then use a motor vehicle to the nearest facility—Lao People’s Democratic Republic



Source: WHO. Investing the Marginal Dollar for Maternal and Newborn Health (MNH): Geographic accessibility analysis for Laos – final report. Unpublished.

## TO BENEFIT FROM GIS THE HEALTH SECTOR HAS TO “GEOENABLE” ITS HEALTH INFORMATION SYSTEM

The health sector can only fully benefit from the power of GIS if the necessary data is available, of sufficiently high quality, and accessible.

For this to happen, its health information system (HIS) has to be “geoenabled,” i.e., the necessary governance, technical capacity, guidelines, standards, protocols, core data (administrative divisions, villages, and health services registries),<sup>17</sup> and technologies are in place to support the integration of the geographic and time dimensions in the HIS as well as the use of

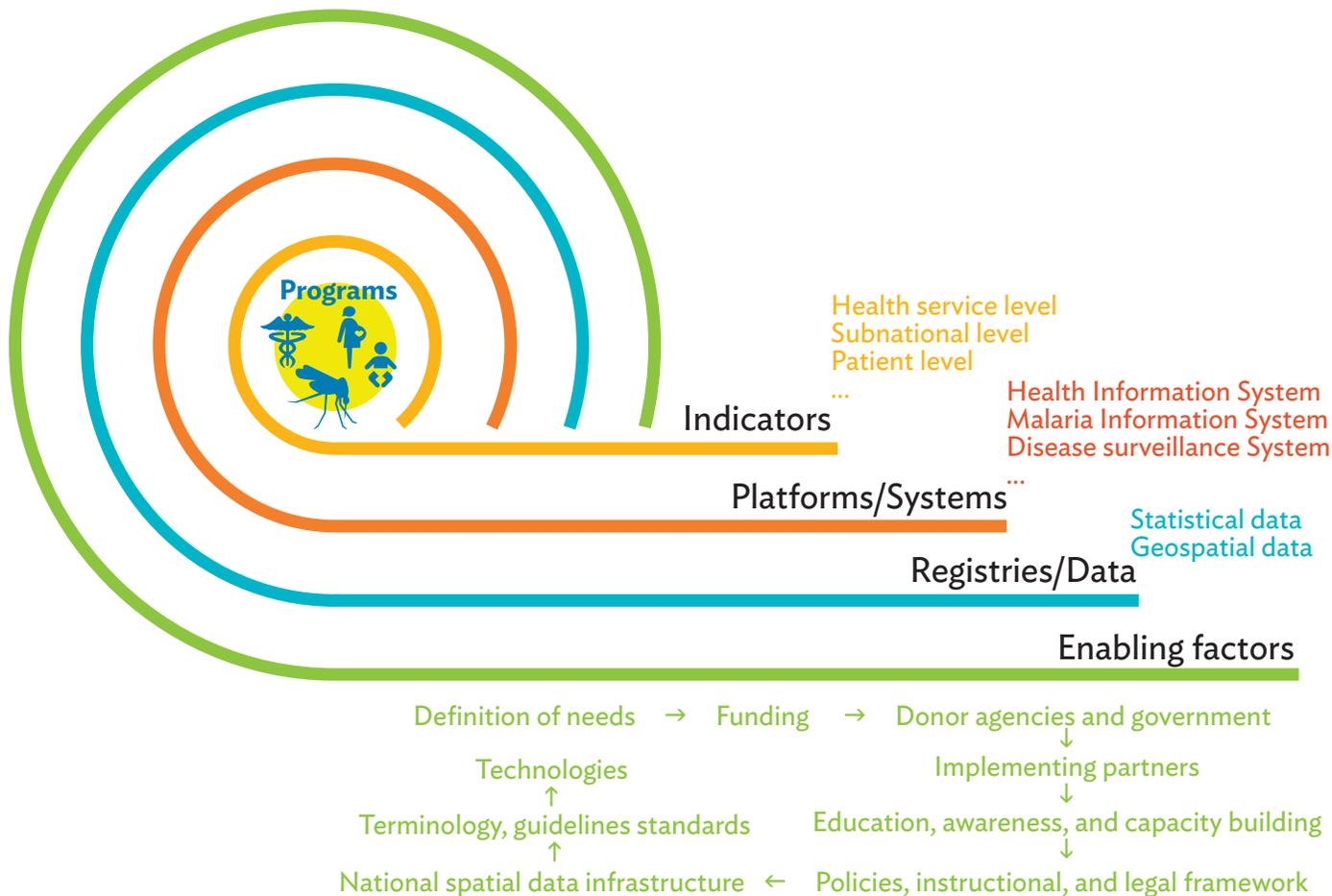
GIS across all parts of the health sector (Figure 4). This must be the case throughout the data life cycle: collection, processing, analysis, preservation, sharing, updating, and reuse of data.

For effective governance, the unit in charge of the health information system within the Ministry of Health must be mandated to oversee the integration and use of geography and GIS across divisions and diseases programs, and the necessary policies put in place to enforce this mandate.

The data management and GIS capacity of the health information system unit must then be developed or strengthened to provide the necessary technical support as well as collect and maintain geospatial data.

<sup>17</sup> Authoritative, standardized, complete, up-to-date, and uniquely coded list.

Figure 4: Elements that Ensure a Health Information System is Geoenabled



Source: Authors.

## A GIS LABORATORY FOR ASIA AND THE PACIFIC

For Ministries of Health in Asia and the Pacific to capitalize on the power of GIS, guidance and support to geoenable their health information system are invaluable. With this in mind, ADB and WHO, together with private sector partners, are working to establish a GIS Laboratory for the Asia and the Pacific, under the umbrella of the Asia eHealth Information Network (AeHIN).

Similar labs already exist, including the Mohawk College mHealth & eHealth Development and Innovation Centre (MEDIC), which works with small- to medium-sized enterprises to develop and commercialize innovative health care IT products.

MEDIC also provides a center of excellence for organizations undertaking interconnected health care projects.<sup>18</sup> There is also the more GIS-oriented Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi, contracted by 20 UN Member States to promote sustainable development through the generation, application, and dissemination of geoinformation and allied ICT technologies, products, and services.<sup>19</sup> The AeHIN GIS lab can draw on the experiences of both centers.

The foundations for the lab have been laid through a workshop during the Conference on Measurement and Accountability for Universal Health Coverage in Asia Pacific and AeHIN 4th General Meeting MA4health, which took place in

<sup>18</sup> Mohawk College. mHealth & eHealth Development and Innovation Centre (MEDIC). <http://www.mohawkcollege.ca/ideaworks/MEDIC.html>

<sup>19</sup> The Regional Centre for Mapping of Resources for Development (RCMRD). <http://www.rcmrd.org/>

October 2015, and through an ADB- and WHO-supported agreement between AeHIN and Esri, a leading GIS software company. Under the agreement, AeHIN members and Ministries of Health will be able to access Esri’s ArcGIS technology free of charge for one year, with discounted access thereafter. An online fully functional GIS with applications and free resources powered by Esri’s technology (ArcGIS online) and social networking platform (GEONet) are also being set up, not only to build a GIS community among the health sector in the region, but also to provide an entry point for decision makers to use and discover the power of GIS.<sup>20</sup>

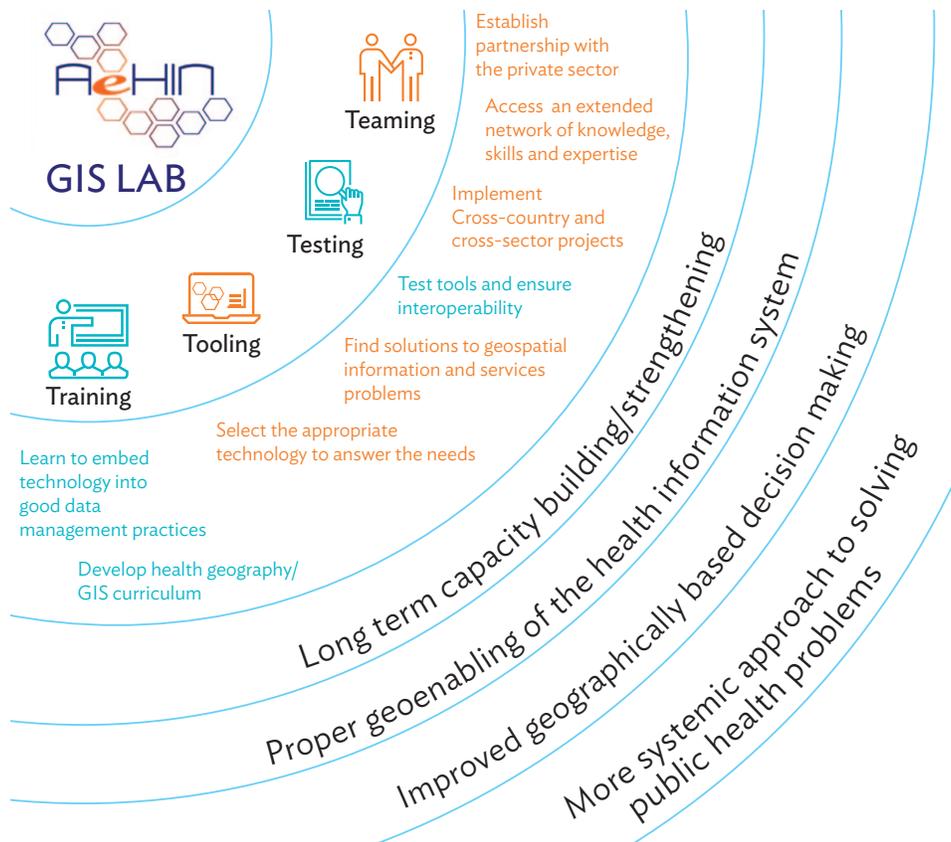
The AeHIN GIS lab’s remit is to enable countries to:

- (i) learn to embed GIS technology into good data management practices;
- (ii) receive support to geoenable their health information system;

- (iii) access an extended network of knowledge, skills, and expertise;
- (iv) find solutions to the geospatial information and services problems they are facing;
- (v) develop their health geography/GIS curriculum;
- (vi) test the tools they are developing and ensure they are interoperable with others;
- (vii) benefit from public–private partnership aiming at facilitating access to GIS technology; and
- (viii) learn from other countries’ experiences and best practice.

As countries progress in geoenabling their health information system, the benefits to the health sector and the population accrue, from long-term capacity building and health systems strengthening, to improved geographically based decision making, and ultimately a more systematic approach to grappling with otherwise intractable public health challenges (Figure 5).

**Figure 5:** The Impact of AeHIN GIS Lab Teaming, Testing, Tooling, and Training



Source: Authors.

<sup>20</sup> ADB is not promoting the use of a particular GIS technology. The collaboration and agreement with Esri is therefore an opportunity for countries to use their technology, learn from it and choose the most appropriate one to answer their needs.

### Box 1: Monitoring and Evaluation Tools for Malaria Surveillance

In a collaboration among the Asian Development Bank, Asia eHealth Information Network, Mahidol Oxford Tropical Medicine Research Unit, United Nations Children’s Fund, and World Health Organization, expert consultants have been commissioned to assess cost-effective technologies for data collection for all stages of malaria control and elimination programs in Greater Mekong Subregion countries. The team will then work with countries to link them to national e-health plans, and develop government capacity on surveillance for malaria elimination.

Assessments conducted in Cambodia, the Lao People’s Democratic Republic, Myanmar, Thailand, and Viet Nam will identify surveillance and response gaps and recommend tools for technology scale-up, as well as transferring technology between countries.

The project is also developing and testing innovative approaches using call data records and geographic information systems to map malaria transmission hotspots and ensure targeted response programs.

Source: Authors.

This AeHIN GIS lab also has a regional function in the development and implementation of regional data management and GIS-related projects that can contribute to the strengthening of the existing national technical capacity. An early example of such projects is the Malaria and Dengue Risk Mapping and Response Planning in the Greater Mekong Subregion project initiated recently by ADB (Box 1). On a larger scale, the AeHIN GIS Lab could support a more coordinated approach to the establishment and maintenance of the key registries (administrative divisions, villages, and health facilities) as the foundational pieces of the HIS, and thus effective use of GIS in countries.

### CONCLUSION

GIS is a powerful data integration platform to visualize and analyze the geography of UHC in general and any specific program in particular, such as malaria control and elimination. When the necessary data are available, GIS analytical approaches reveal relationships and trends that might not be evident through the use of other ICT-based technologies. The use of this platform can mean the difference between believing that health service provision or social health protection is improving, and knowing that interventions are in fact reaching their intended target and addressing the health needs of particular population groups. The task of geoenabling an existing health information system may seem challenging, but the AeHIN GIS lab and community of practice already exist with resources available, and are eager to work with countries, support them on the journey to better, more accurate spatial data to attain the goal of genuinely equitable UHC.

### Box 2: The Asia eHealth Information Network

The Asia eHealth Information Network (AeHIN) was created by the World Health Organization in 2012 to promote appropriate use of information communication technology (ICT) to achieve better health through peer-to-peer assistance, knowledge sharing and learning, through a regional approach for greater country-level impacts across South and Southeast Asia.

AeHIN believes that better health can be achieved by strengthening evidence-based policies and health systems through responsive health information systems (HIS), civil registration and vital statistics (CRVS). AeHIN further asserts the role of ICT for health (e-health) as an enabler to improve the flow of information, through electronic means, to support the delivery of quality and equitable health care services, and management of health systems. To achieve these, AeHIN works in four strategic areas:

- (i) enhancing leadership, sustainable governance, monitoring, and evaluation for e-health;
- (ii) encouraging peer assistance, knowledge exchange and sharing through effective networking ;
- (iii) promoting standards and interoperability within and across countries; and
- (iv) building capacity for e-health, HIS, and CRVS in the countries and in the region.

Source: Authors.

#### About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to the majority of the world's poor. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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Publication Stock No. ABF167966-2