PRECISION EPIDEMIC FORECASTING

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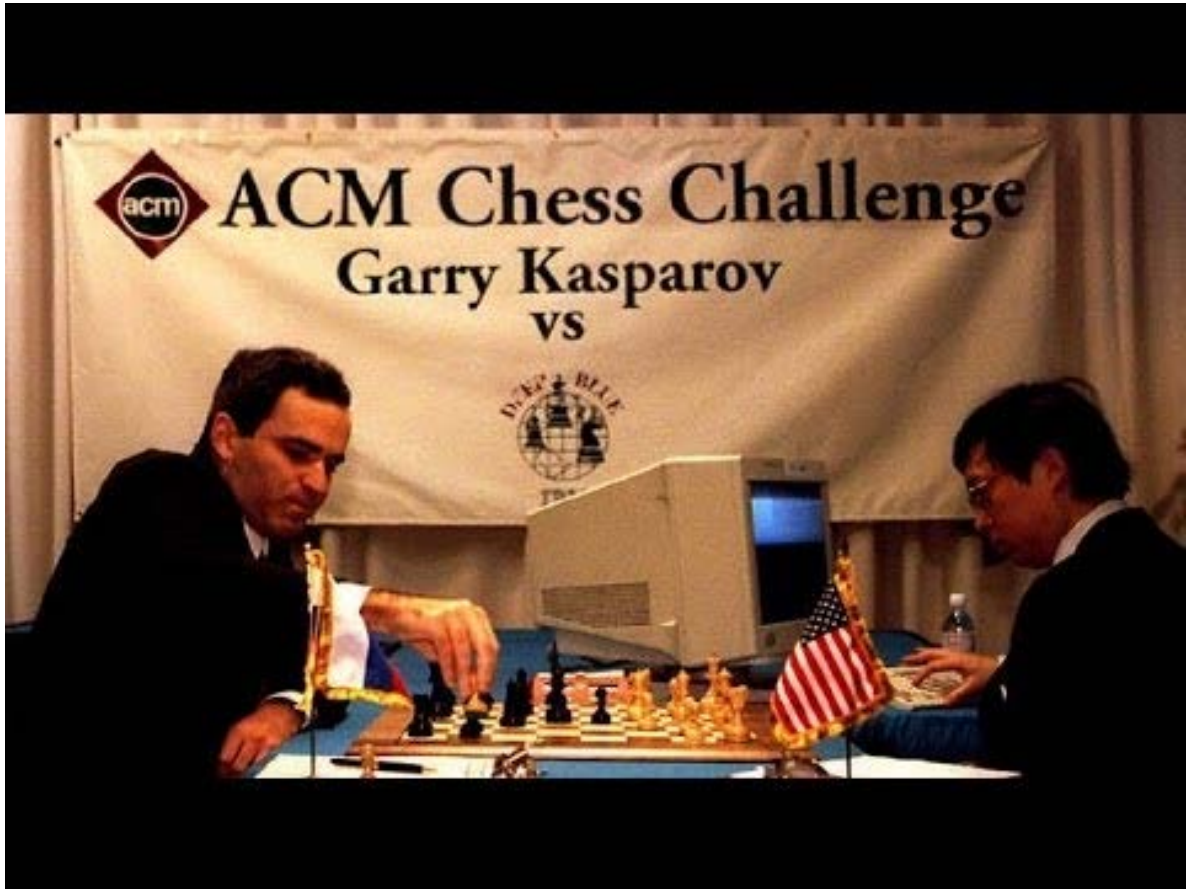
1997: The digital revolution

IBM succeeded to beat Garry Kasparov, World champion of chess



2017: Google succeeded to beat Lee Sedol

World champion of game of Go

2013: Google and AI failed to beat US-CDC

January 13, 2013 | 1:56 PM | Carey Goldberg

Is 'Google Flu Trends' Prescient Or Wrong?

FILED UNDER: Medicine/Science, Personal Health, CDC, flu, google-editors-pick, public health tracking

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Google in blue, CDC in red. Note the dramatic divergence toward 2013. (Keith Winstein, MIT)

Has Google's much-celebrated flu estimator, **Google Flu Trends**, gotten a bit, shall we say, over-enthusiastic?

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And so, how to perform better?

Are we condemned to remain powerless with regards with epidemics and pandemics?

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Could we be more *precise*?
more effective?
more efficient?

Precision public health*?*

Hum…

"Precision" Public Health — Between Novelty and Hype

Merlin Chowkwanyun, M.P.H., Ph.D., Ronald Bayer, Ph.D., and Sandro Galea, M.D., Dr.P.H.

In May 2018, the National Institutes of Health (NIH) began enrollment for a vast medical research cohort. Named "All of Us," it's meant to include 1 million U.S. volunteers, who will be studied over 10 years at a cost of $1.45 billion. The project promises to "lay the scientific foundation for a new era of personalized, highly effective health care," a counterpoint to previous "'one-size-fits-all' medicine."

All of Us derives from a decade's worth of developments in the research world. In 2011, the National Academies of Sciences, Engineering, and Medicine called for a "new taxonomy of human disease," stating that "opportunities to define diseases more precisely and to inform health-care decisions" were "being missed."[1] Five years later, President Barack Obama launched the Precision Medicine Initiative. The concept was promoted by NIH Director Francis Collins, who defined it as "prevention and treatment strategies that take individual variability into account."[2] A bandwagon effect followed, with marked shifts in resources and attention toward precision medicine.

The trend has now been extended to "precision public health" (PPH), which promises to reconfigure the mission of the public health field. Such a shift is not merely semantic. Substantial funding streams and institutional rewards are attached to all matters "precision," with significant implications for approaches to population health. The Bill and Melinda Gates Foundation hosted a 2016 conference entitled "Precision Public Health: The First 1,000 Days," which considered, among other things, infant mortality. Muin Khoury, head of the Office of Genomics and Public Health at the Centers for Disease Control and Prevention (CDC), declared 2016 the "year of precision public health." Western Australia's Office of Population Health Genomics, which first introduced the term, is cosponsoring an international conference on PPH in the coming months, as is the Rockefeller Foundation. PPH proponents argue that the public health field ignores at its peril emerging technologies that can fundamentally alter our understanding of who is vulnerable and who falls ill.

But there are key issues to consider before public health throws its lot in with the precision agenda. What are the implications of this scientific and institutional turn for the future of public health? Does it offer the opportunity for a reconceptualized, empowered public health enterprise — or might it represent an abandonment of our mission of enhancing population well-being? And how novel is PPH, anyway?

Beginning this conversation requires clarifying the divide between precision medicine and traditional public health analysis, policy, and practice. Precision medicine starts with the individual. Insofar as it considers groups that may be at increased risk for disease, vulnerability is conceptualized biologically, and particularly genomically. Improved population health follows from improved health of multiple individuals. In contrast, public health begins with populations. Increased vulnerability is framed as the consequence of structural factors, including social class, ethnic background, gender and sexual identity, and physical environment, among others. Many factors shaping the health of populations have no individual-level analogue but are properties of our shared surround-

Precision public health: why not?

Precision public health is about using the power of data to improve health and achieve social justice—equity, social inclusion, and empowerment. It should not be feared. It should be embraced.

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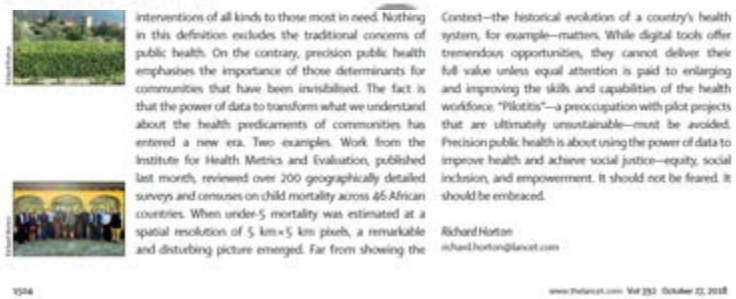

interventions of all kinds to those most in need. Nothing in this definition excludes the traditional concerns of public health. On the contrary, precision public health emphasises the importance of those determinants for communities that have been invisibilised. The fact is that the power of data to transform what we understand about the health predicaments of communities has entered a new era. Two examples. Work from the Institute for Health Metrics and Evaluation, published last month, reviewed over 200 geographically detailed surveys and censuses on child mortality across 46 African countries. When under-5 mortality was estimated at a spatial resolution of 5 km×5 km pixels, a remarkable and disturbing picture emerged. Far from showing the Context—the historical evolution of a country's health system, for example—matters. While digital tools offer tremendous opportunities, they cannot deliver their full value unless equal attention is paid to enlarging and improving the skills and capabilities of the health workforce. "Pilotitis"—a preoccupation with pilot projects that are ultimately unsustainable—must be avoided. Precision public health is about using the power of data to improve health and achieve social justice—equity, social inclusion, and empowerment. It should not be feared. It should be embraced.

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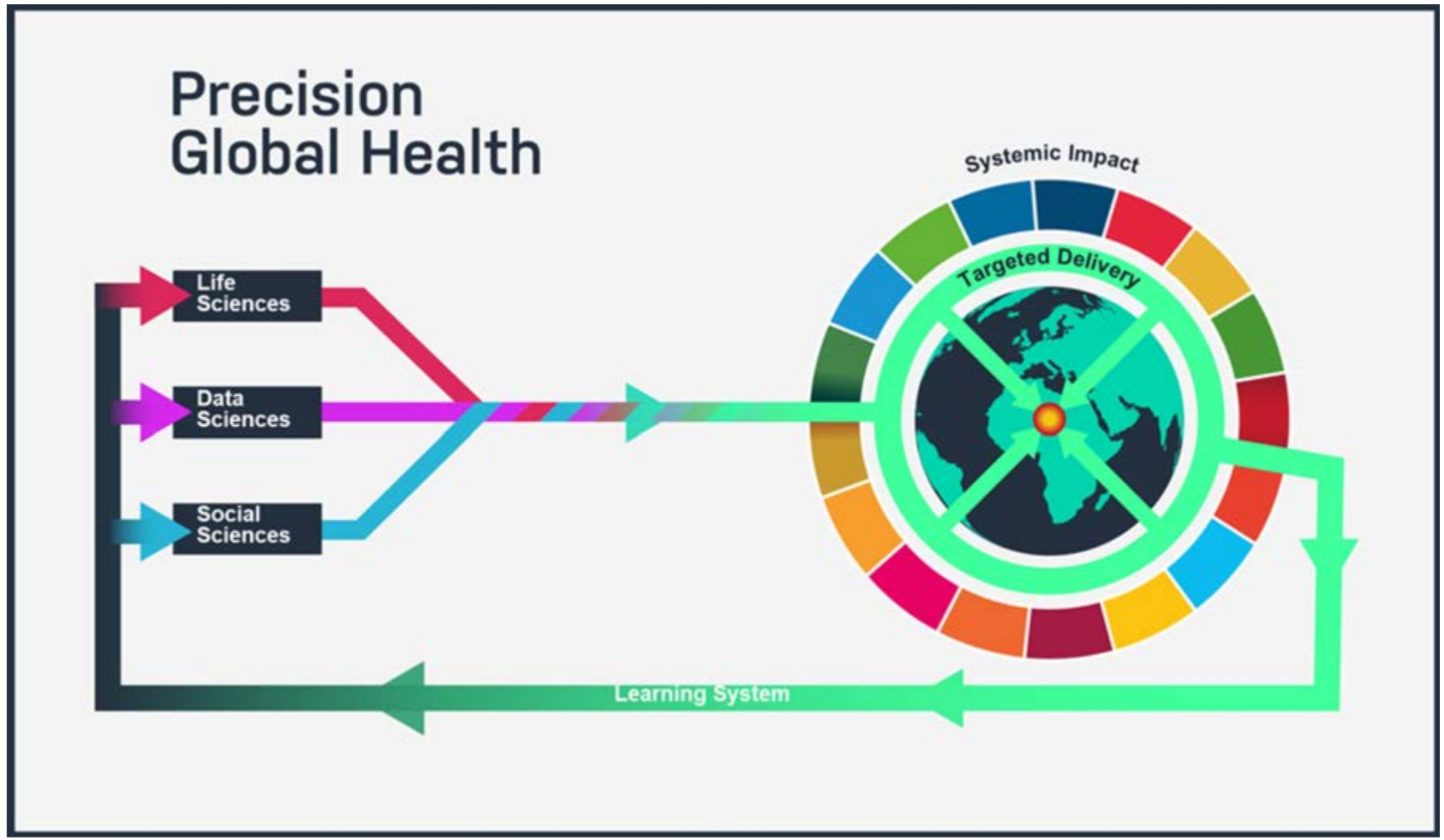
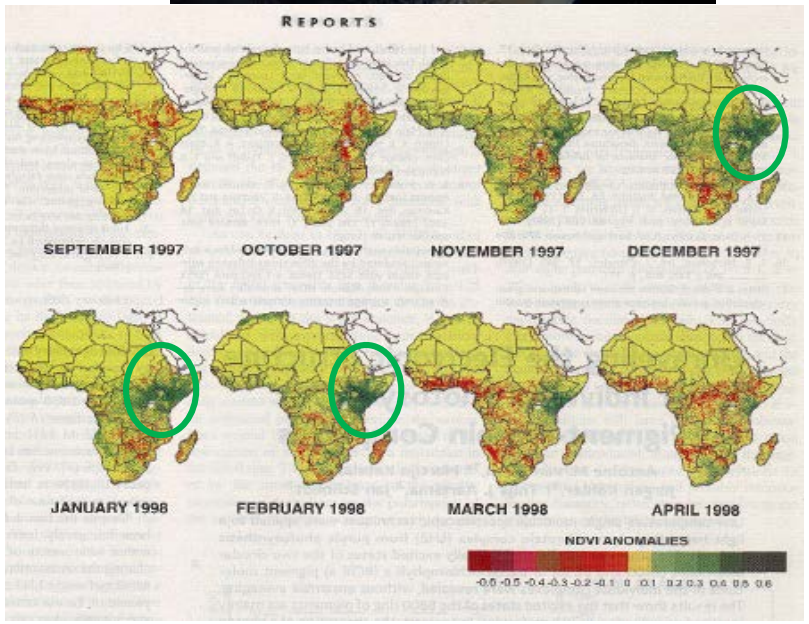
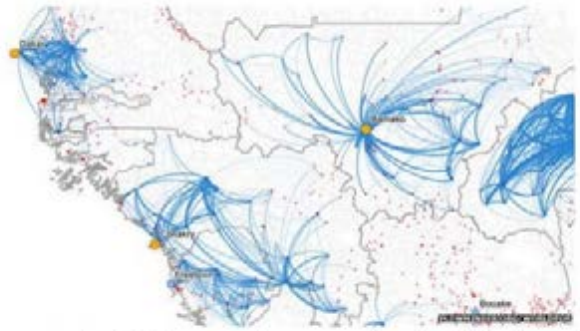


R. Ruiz de Castañeda and A. Flahault©

Tapping into the digital revolution…



mHealth and Big Data

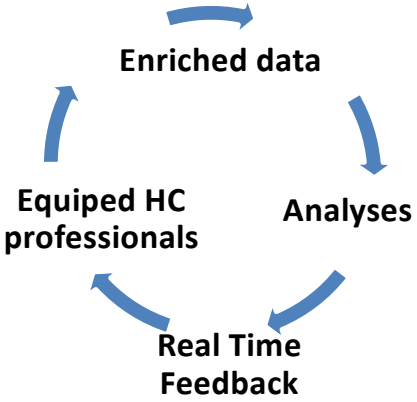


""We've never had this large-scale, anonymised mobile phone d
before as a species," says Nuria Oliver, a scientific director at m
phone company Telefonica." BBC News

Matthew Wall, "Ebola: Can big data analytics help contain its spread?", 14 October, BBC News, http://www.bbc.com/news/business-29617831

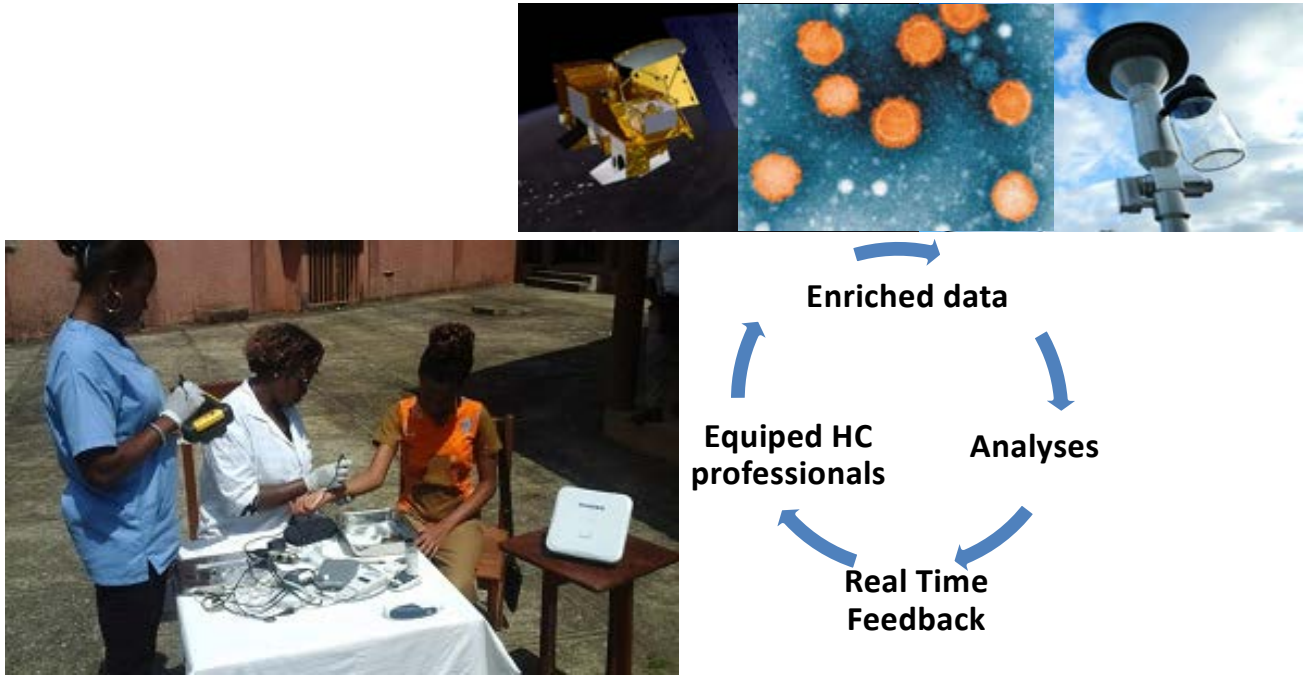
…to deliver *precision epidemic forecasting*

Augmented surveillance and detection of new outbreaks



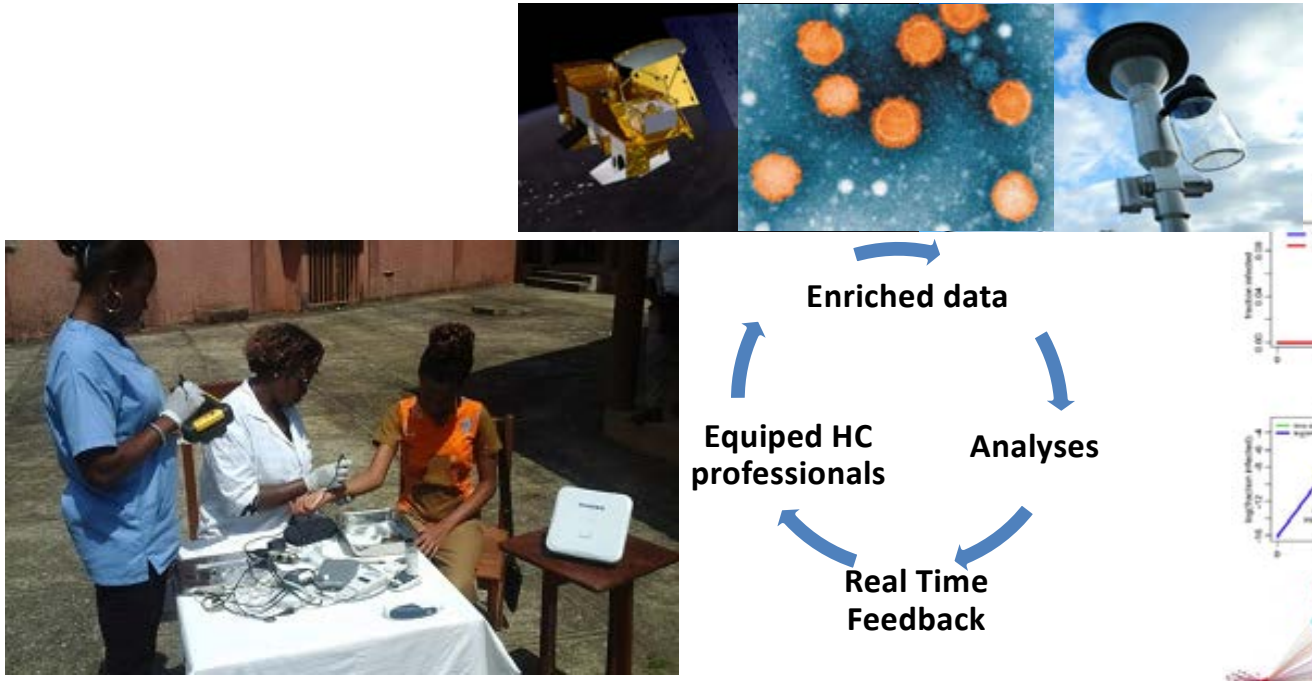
Providing medical algorithms integrated in smartphone applications offers the opportunity **to rapidly detect and report** an increase in fever cases using a syndromic and etiological approach.

Augmented surveillance and detection of new outbreaks



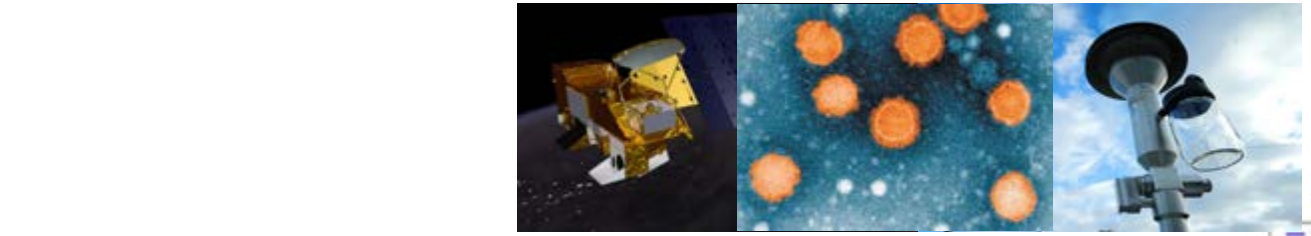
Along with these field data, **other data from diverse sources** including remote sensing data from satellites, social media and environmental can augment available information

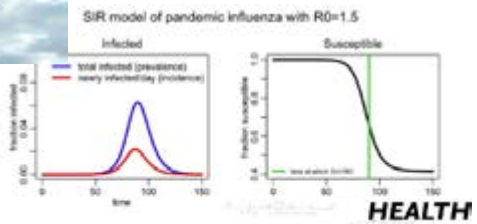
Augmented surveillance and detection of new outbreaks

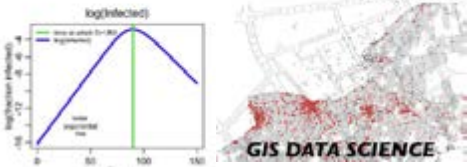


This data can be used to **inform epidemiological models**, GIS or to forecast new outbreaks and detect transmission networks through AI.

Augmented surveillance and detection of new outbreaks

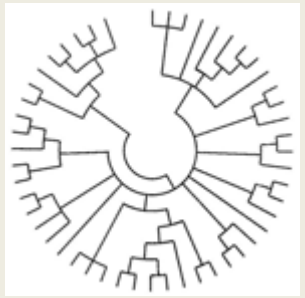






Early detection of outbreaks **guides intervention** efforts increasing capacity in relevant local clinical services and improving outcomes.

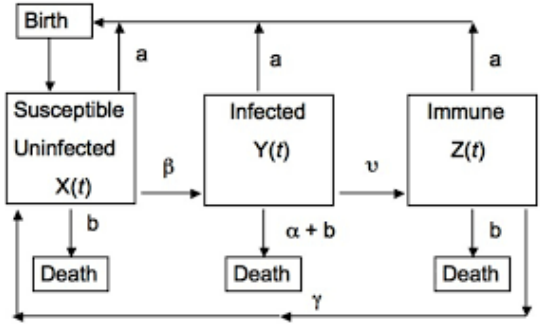
Deciphering transmission networks



Develop tools for simplified **phylogenetic analyses** in the field

(Self-) forecasting in multiple networks

The origin and phylogenies of the various circulating viruses is often poorly understood, hence there is potentially high added value in the development of a **phylogenetic software package**, which uses data and samples collected remotely, helping to predict and respond to new epidemics



Spatio-temporal and individual-based **mathematical models**

Deciphering transmission networks

Information on **pre-existing immunity profiles in the population** can help to adjust diagnostic algorithms and identify pitfalls in currently available diagnostics (such as cross-reactivity).

Deciphering transmission networks

The development of a latent and **mobile biobank** enables the collection and storage of biological samples in case of a new outbreak in any part of the territory. The samples collected during such an outbreak are then be stored awaiting further investigation and research outside of the outbreak conditions

Risks and benefits

People
at the centre

Ethics
Law
Diversity
Citizen science
Ethnography

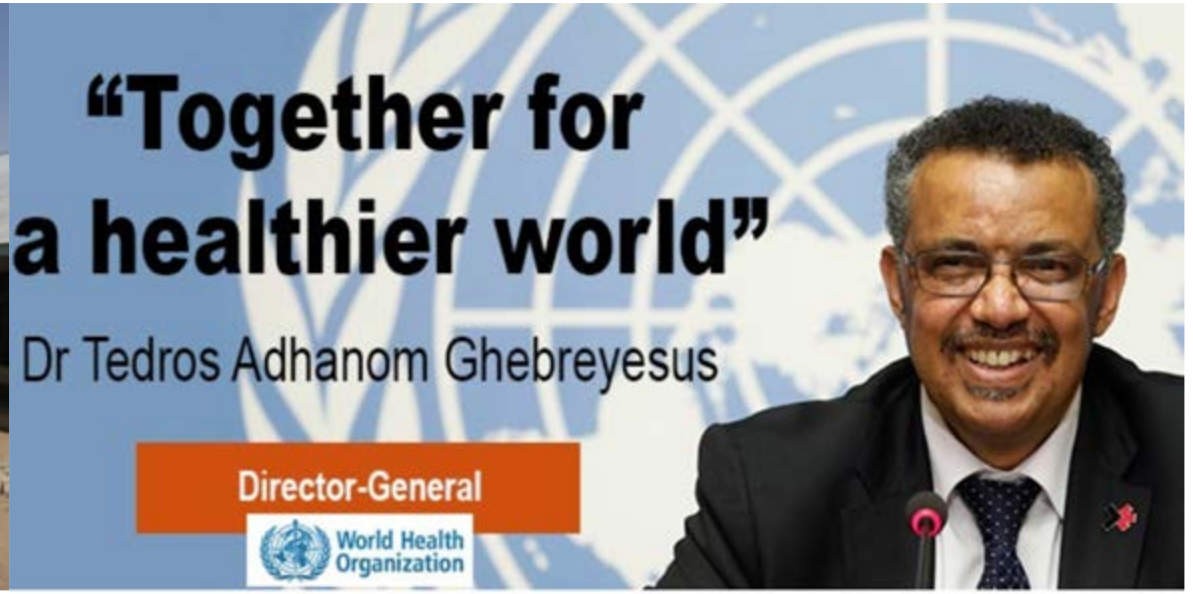
When population suffers extreme poverty and high rates of homelessness and illiteracy, it is vitally important that we **understand needs** of these groups and the challenges they face. Clearly few individuals in these vulnerable groups will be mobile phone users

Risks and benefits

It is important to understand **the role of diversity** in outbreak dynamics and ensure **equitable distribution of the benefits** of precision epidemic forecasting.

Open Science

(*R. Ruiz de Castañeda et I. Bolon, 2018*)



With ever growing internet access, and smartphone ownership by young people in the cities, the potential for **people participation** is great.

Online crowdsourcing toolkits can empower the youth to participate in scientific research, providing a personal view from inside the country, encouraging high-tech low-cost innovation.

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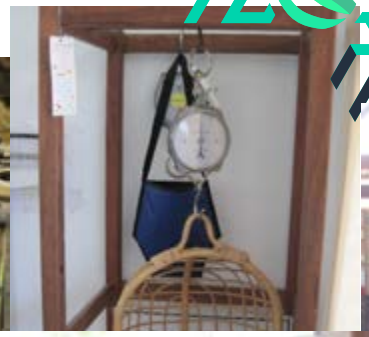

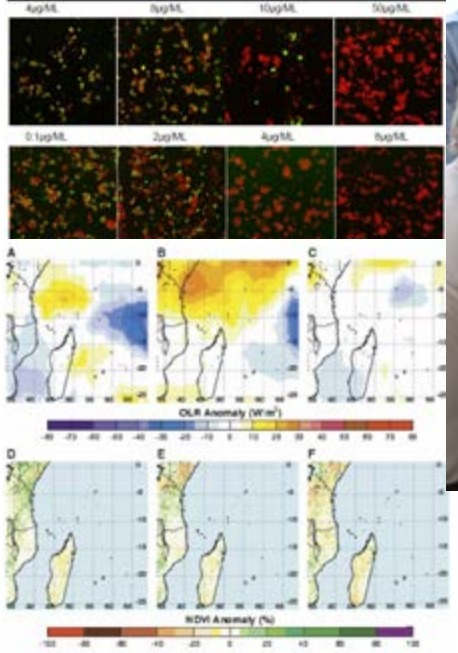

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Combining data science with life science and social science may **fundamentally change the way predictions are made**.