

Grand Challenges

How We Consider the Biggest Problems Facing Humanity

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Talk track

The fundamentals

Pandemics and disease

Food security

Human displacement

Final thoughts

Some facts

Globally, nearly **1 in 9** people are undernourished

After 20 years of decline, infant mortality and malnutrition are on the rise

10% of the world's population earns less than **\$1.90 a day** – lacking access to clean water and basic healthcare

About **16,000** children under the age of five die every day, mainly from preventable causes

By **2050**, the population will grow to nearly **10B**

71 million people around the world have been forced from their homes; nearly **26 million** refugees, up 65% from a decade ago

An estimated **10 million** people are stateless with no nationality or access to basic rights such as education, healthcare, employment and freedom of movement

A pathogen can travel from a remote village to major cities on all continents in **36 hours**

Humanitarian crises are national security crises

The velocity by which infectious disease and pandemics spread is supercharged as a result of climate change and globalization. **How do we manage this threat and simultaneously eradicate diseases such as malaria, TB and HIV?**

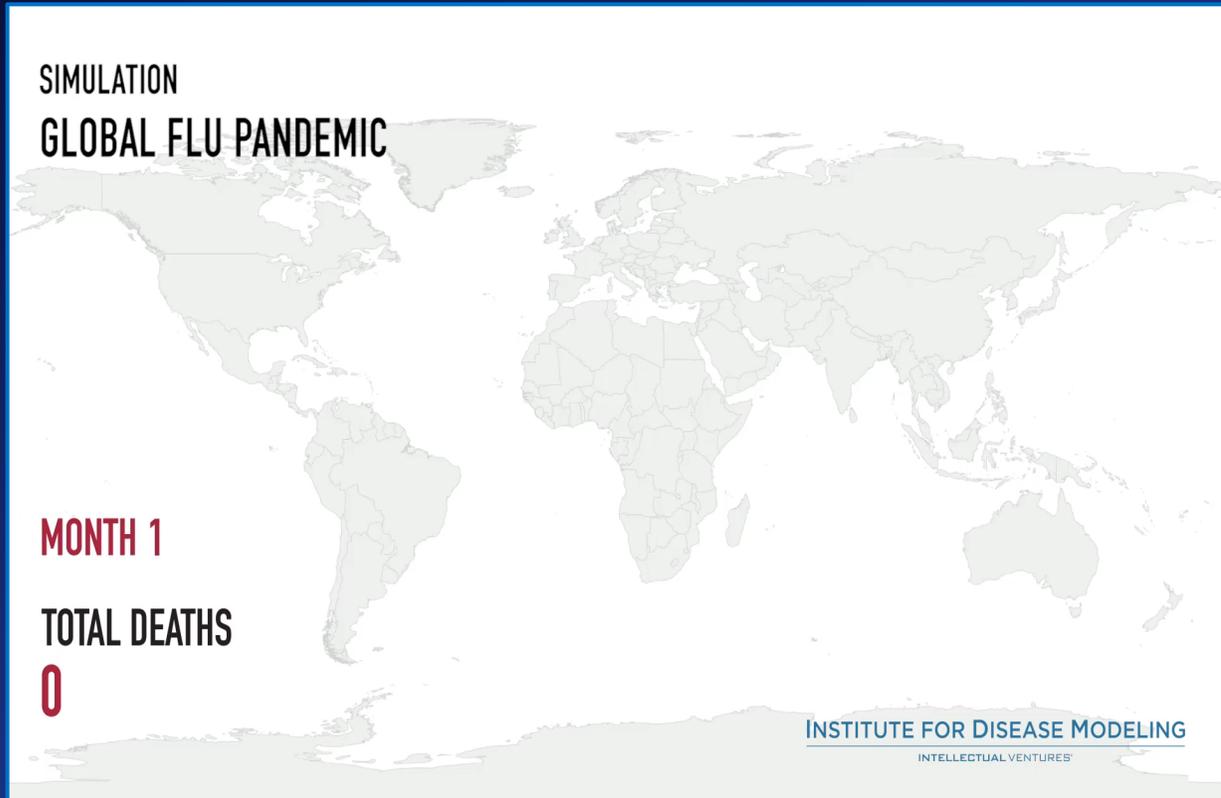
Food riots have toppled governments...with population growth currently exceeding our ability to produce and equitably distribute... **what is our path to food security?**

Global policy regarding human displacement is fundamentally inadequate - with the number of dislocated people growing 65% over the past decade ...**what does our world look like when every 2 seconds 1 person is forcibly displaced as a result of conflict or persecution?**

101 Years Since the Spanish Flu

...the next one is expected to be much worse

“A new influenza virus, such as the one that caused the 1918 pandemic, could kill 30 million people within six months”



50 million deaths in 1918

Zoonotic diseases high risk; of 1,415 pathogens known to infect humans, 61% were zoonotic

Combinatorial flus, drug resistant super bugs and viruses such as Ebola and Zika are on the rise

Infectious diseases do not respect borders

Individuals in the model could travel both locally and by airplane, thereby moving the virus within and across countries. With an initial seeding of about 800 infections, the simulation demonstrated how an unchecked epidemic can very quickly evolve into a pandemic within a wholly susceptible population

Risk mitigation demands holistic strategy

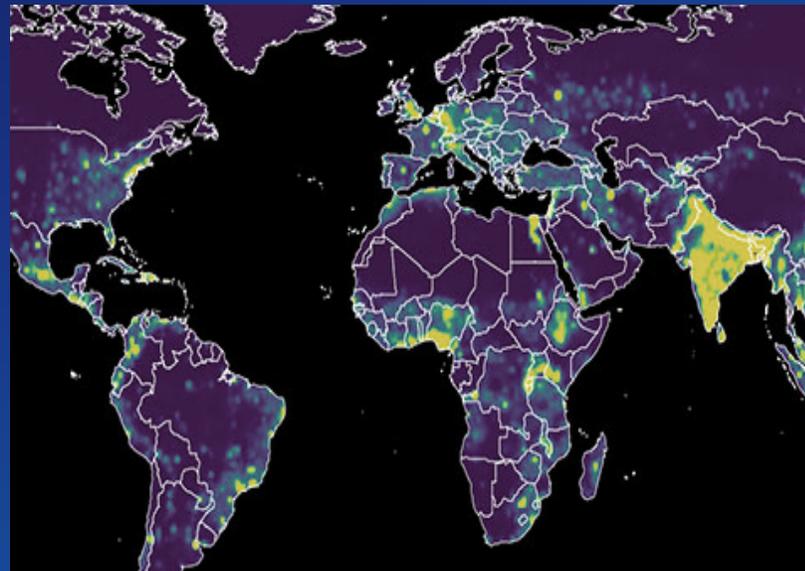
...AI and HPC fundamental elements throughout

**Surveillance,
Epidemiology, and
Laboratory Activities**

**Community
Mitigation
Measures**

**Medical Countermeasures
Diagnostic Devices, Vaccines,
Therapeutics, and Respiratory
Devices**

**Domestic and International Response Policy,
Incident Management, and Global
Partnerships and Capacity Building**



**Communications and
Public Outreach**

**Healthcare System
Preparedness and
Response Activities**

**Scientific Infrastructure
and Preparedness**

IDM – Malaria

How do we rethink disease transmission and eradication?

An idea

New methods and frameworks

Create an organization

Change the world



EMOD



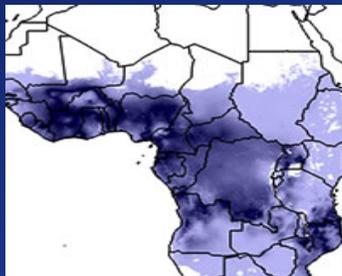
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Risk Map



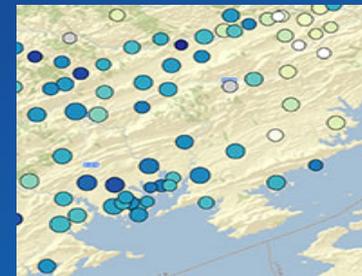
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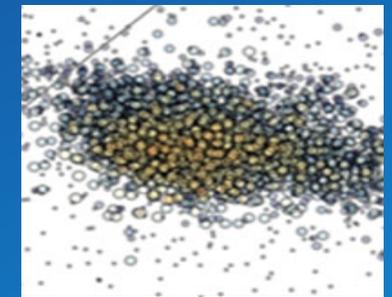
Vaccine Impact



Anti-Malaria Drug Campaigns



Spatial Surveillance



Parasite Genetics

Food Riots in 2008, 2011...

...a prelude to increased global insecurity



Egypt on the eve of the Arab Spring in 2011 when people were out in the streets protesting the price of bread

Food riots in 2008

- Egypt Thousands of demonstrators in Mahalla el-Kobra loot shops and throw bricks at police during protests at rising food prices and low salaries, as part of nationwide strike
- Haiti At least four people killed in the southern city of Les Cayes after food prices rise 50 per cent in the past year
- Côte d'Ivoire Police injure more than ten protesters as several hundred demonstrators demand government action to curb food prices
- Cameroon Riots last four days and result in at least 40 deaths. Unrest is due to high fuel and food prices. Worst riots in country for 15 years
- Mozambique At least four people killed and 100 injured following fuel price rises
- Senegal Violent demonstrations in Dakar as prices of rice, milk and oil soar. Senegal imports almost all its food
- Yemen Five days of rioting and a hundred arrests after the price of wheat doubled over two months. Protesters set up roadblocks in Sana'a and Aden
- ...and in Mauritania, Bolivia, Indonesia, Mexico, India, Burkina Faso, and Uzbekistan
- *New Statesman, April 17, 2008*

By 2050, global population will rise to 10B

"In the next 40 years, humans will need to produce more food than they did in the previous 10,000 put together" Economist., 2014



The global food crisis

"The world's 200 wealthiest people have as much money as about 40% of the global population, and yet 850 million people have to go to bed hungry every night."

Climate change

War and famine

Political - sanctions

Inequity

Pollution and environmental

Waste

Science

Technology

IoT, HPC and AI catalyzing a revolution in farming

...robots, drones, digital agriculture, genomics, 3D printing...



Scientists identify genome regions leading to better yield, disease and climate resistance in wheat

“...we've got to increase the nutritional value of the same amount of biomass than we have now if we're gonna feed the world”

Extreme urbanization will drive circular models improving yield and reducing waste

The growth, yield and quality of crops in vertical farms are consistently much higher than in open-field cultivation; the reliability of harvest throughout the year independent of the season and external climate conditions is virtually guaranteed



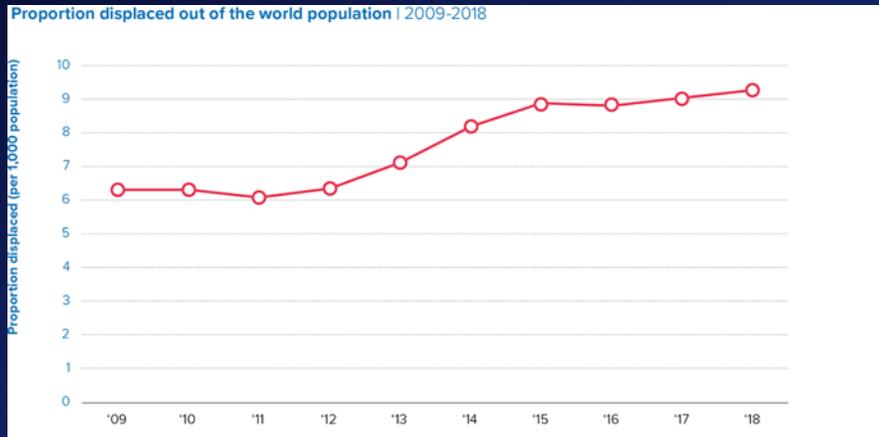
Refugee protection and state stability are linked together ...undermining one factor weakens the other



...the dangers related to the global refugee crisis interact with many other threats that emanate from civil wars and weak states, such as fragile governments, rebel and terrorist group activity, and religious or ethnic fragmentation

COLOMBIA. Venezuelans risk life and limb to seek help in Colombia. A father carries his young daughter through treacherous, muddy scrublands by the banks of the Táchira River, which forms the border between Venezuela and Colombia. In a context of rampant hyperinflation, food shortages, political turmoil, violence and persecution, more than 3 million Venezuelans have fled the country, making such perilous journeys in search of safety. @UNHCR/Vincent Tremeau

Countervailing dynamics demand new thinking



70.8 million people were displaced by the end of 2018

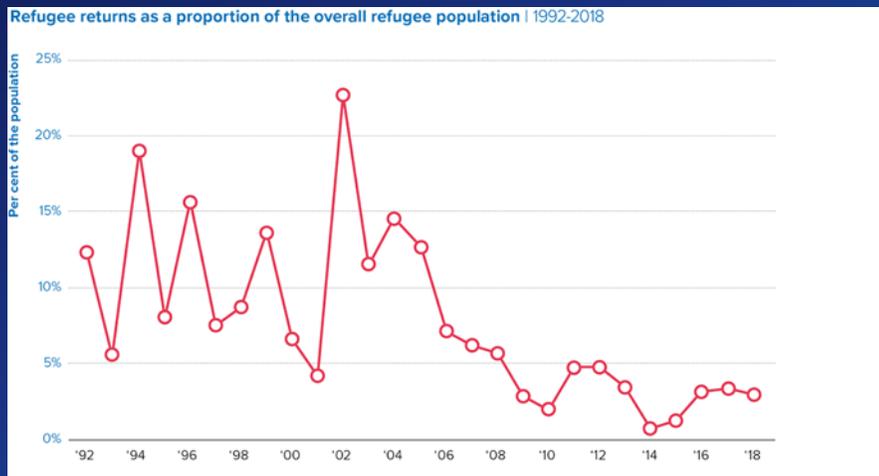
Climate change, food and water scarcity are expected to displace an additional *2 billion people* in the next 80 years—some predict sooner

Nearly 80% sought refuge in a neighboring country

Repatriation to their homeland is declining

Almost half of the world's refugees are children – a lost generation; most are uneducated

More than two-thirds originate from just five countries: Syria, Afghanistan, South Sudan, Myanmar and Somalia



Mobility, IoT, AI and HPC are making a difference ...however, the last mile matters

PHONE CALLS FOR GOOD?

Scientists have analysed call-detail records from tens of millions of mobile-phone owners in 'data for good' projects in dozens of countries, according to published papers, press releases and information shared with *Nature*.



HAITI

Karolinska Institute researchers tracked 1.9 million SIM cards to estimate population movements before and after the 2010 earthquake.

TURKEY

International teams used call records from 1 million subscribers to track Syrian refugees in a humanitarian challenge.

NEPAL

Flowminder and the United Nations studied mobility among 12 million phone subscribers after the 2015 earthquake.

KENYA

A US team analysed call records from 14.9 million people to link travel patterns with movements of malaria parasites.

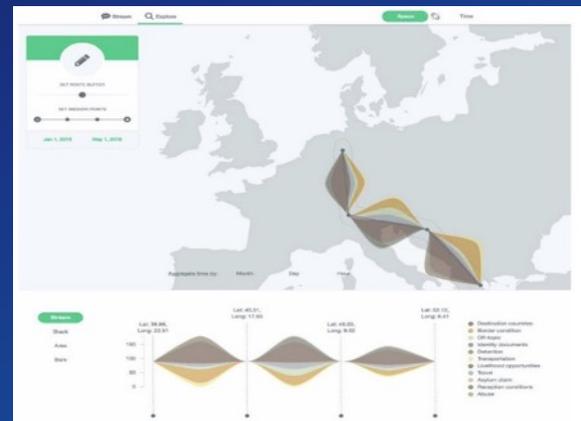
SIERRA LEONE

Harvard and Flowminder scientists used call records from >1.6 million subscribers to examine travel restrictions during the 2014–16 Ebola outbreak.



Nature publications remain neutral with regard to contested jurisdictional claims in published maps.

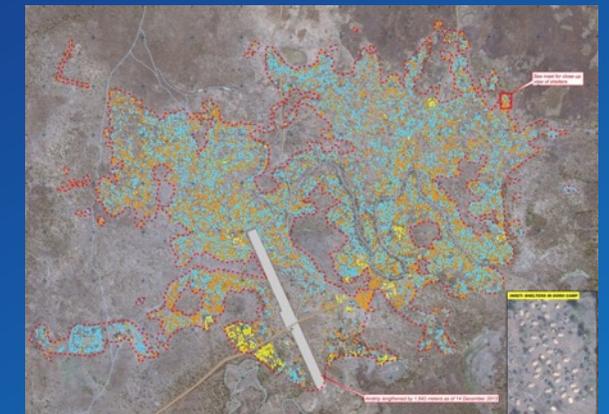
The App-ification of the refugee crisis



Migrants & refugees encounter increasing protection risks ⚡ as they travel across borders in search of safety. Sentiment analysis of social media data can help humanitarian practitioners provide better assistance:

<http://bit.ly/2we7sLX> #MigrantsDay
#WithDignity

Refugee Camp Sub-Saharan Africa



Automated algorithms that more efficiently and effectively count and analyze structures within refugee and migrant settlements

Final thoughts...almost

World is at a new set point – the divide between rich and poor expanding; humanitarian crisis increasingly complex and escalating

Amplifying risk and increased global instability

Consequences and risk are enormous, funding and commitment lag

Think differently - reimagine how we implement and scale

Its all about the last mile – environment and usability matter... a lot

Reimagine the possible...

Kill pathogens that make people sick and transform human waste into valuable resources at a low cost to users—all without connections to water supply or sewer systems

The Reinvent the Toilet Challenge aimed to create a toilet that:

- Removes germs from human waste and recovers valuable resources such as energy, clean water, and nutrients.
- Operates “off the grid” without connections to water, sewer, or electrical lines.
- Costs less than US\$.05 cents per user per day.
- Promotes sustainable and financially profitable sanitation services and businesses that operate in poor, urban settings.
- Is a truly aspirational next-generation product that everyone will want to use—in developed as well as developing nations.

4.5 billion people lack safe sanitation today

Diarrhea kills 2,195 **children** every day—more than AIDS, malaria, and measles combined ¹. **Diarrheal** diseases account for 1 in 9 **child** deaths worldwide, making **diarrhea** the second leading cause of death among **children** under the age of 5