



# Epidemics

## Definition

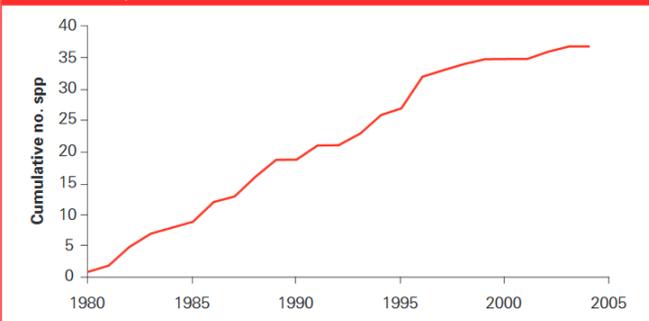
Epidemics are rapid increases in the incidence of disease. When an epidemic affects a large number of people across multiple countries or continents it is then known as a pandemic.<sup>1</sup> In the 19<sup>th</sup> and early 20<sup>th</sup> century, there was great progress in the fight against infectious diseases. However, since the second half of the 20<sup>th</sup> century an emergence of new infectious diseases has been observed, such as HIV/AIDS, severe acute respiratory syndrome (SARS), H1N1 influenza, Ebola, and Zika. In 2012, infectious diseases still accounted for almost one third of global deaths (32%)<sup>2</sup>. Every year, more than 14 million people die because of infectious diseases disrupting the economic, political, and societal environment in areas affected.

## Key Insight

**By 2030, extant diseases will be compounded by new infections and diseases**

Humans, animals, and plants will continue to suffer from extant diseases<sup>3</sup>, while at the same time they will also be threatened by new infections. This is a significant threat as new infectious diseases could be difficult to diagnose and treat and could be highly virulent and highly transmissible.

**Fig 3.3** Accumulation of newly recognised emerging human pathogen species since 1980. This does not include newly recognised aetiological agents of endemic diseases, nor pathogenic sub-species variants.



Source: United Kingdom Office of Science and Innovation, Infectious Diseases: preparing for the future Future Threats; Print.

<sup>1</sup> Centers for Disease Control and Prevention (CDC), (2012), "An Introduction to Applied Epidemiology and Biostatistics", Principles of Epidemiology in Public Health Practice, Third Edition

<sup>2</sup> World Health Organization (2016) [The top 10 causes of death](#)

<sup>3</sup> Brownlie et al (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London



## Changes by 2030

### ➤ **Re-appearance and emergence of new diseases**

Since the 1960s, a significant decrease of mortality for infectious diseases (i.e. polio, tetanus, measles, diphtheria) was achieved. Though there has been a decrease in global mortality due to infectious diseases, the elimination of diseases such as polio, particularly in developing countries, continues to be a priority. Funding the fight against extant diseases (i.e. tuberculosis, malaria) while preparing for the outbreak of new ones is a critical challenge. The latter is certain to occur given the characteristics of new infectious diseases: the evolution of the capacities of microbes', the greater potential geographic spread of infectious diseases, and the weakening of health systems in fragile countries. In addition, environmental, technological and demographic changes such as population growth, agricultural practices (deforestation, intensive livestock farming...), globalization and intensification of trade and transport, human migrations, climate change and the spread of vectors, and urbanization may all exacerbate the emergence of new infectious diseases<sup>4</sup>. In 2016, more than half of the world's population lived in an urban area<sup>5</sup>.

Cities often grow faster than infrastructure is developed resulting in a dearth of critical services such as running water<sup>6</sup> or a functional waste management system. In addition, elevated levels of air pollution, poor housing, and high population density create an environment that is conducive to the spread of infectious disease, particularly to the increase of diarrheic disease and pneumonia<sup>7</sup>. The number and diversity of outbreaks increased notably over the previous decades. 330 new or re-appearing infectious diseases were identified over

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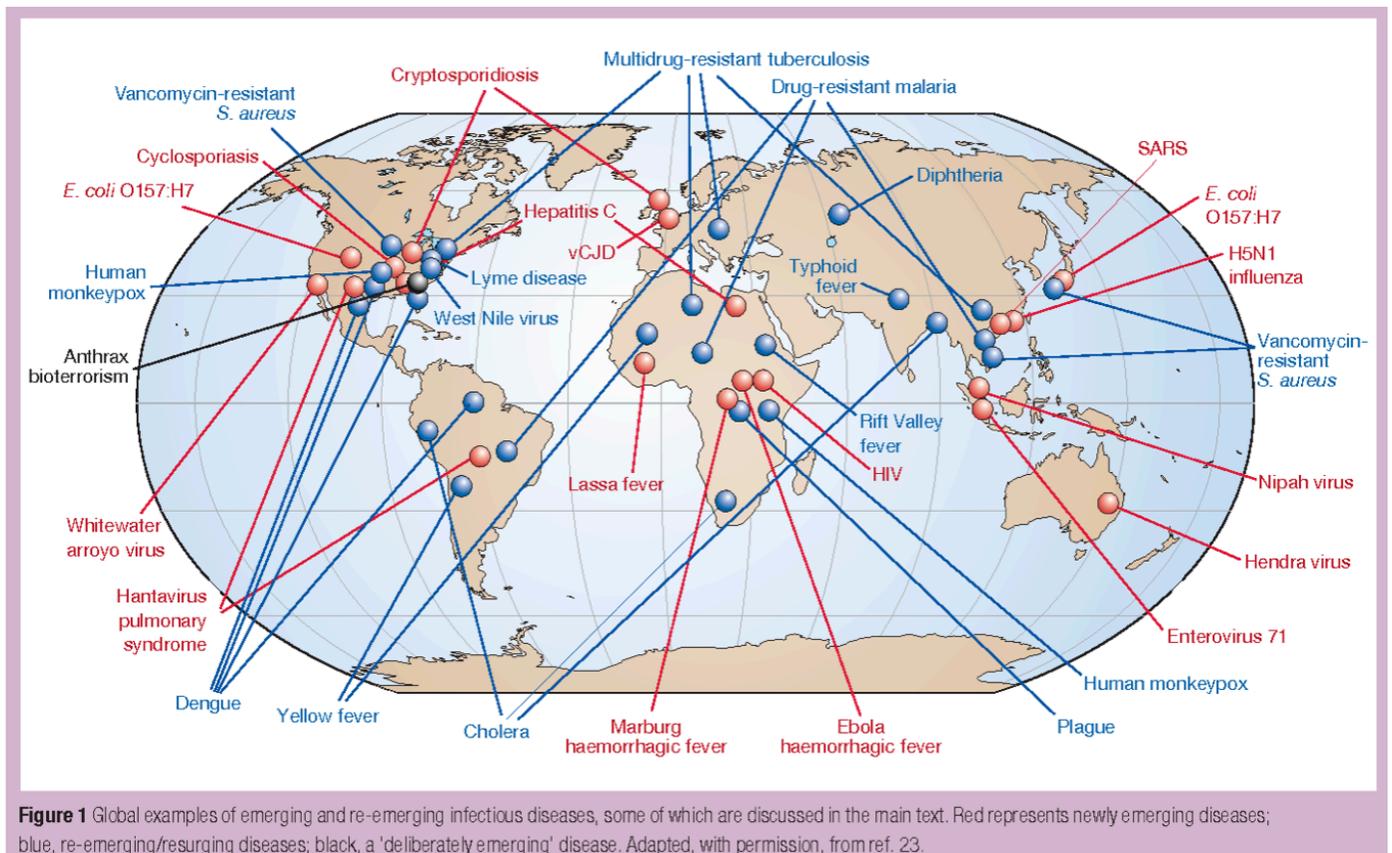
<sup>4</sup> Brownlie et al (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London.

<sup>5</sup> United Nations (2014) [World's population increasingly urban with more than half living in urban areas](#).

<sup>6</sup> United Nations Water (2017) [World Water Development Report 2017](#), United Nations Educational, Scientific and Cultural Organization

<sup>7</sup> Neiderud, CJ (2015) [How urbanization affects the epidemiology of emerging infectious diseases'](#), Infect Ecol Epidemiol.

the last 60 years with the most intense acceleration since 1980.<sup>8</sup> This proliferation can also be explained by the use of new tools and the discovery of new organisms<sup>9</sup>.



Global examples of emerging and re-emerging infectious diseases, Source: Morens David M., Folkers Gregory K. & Fauci Anthony S., Nature review (2004) The challenge of emerging and re-emerging infectious diseases

<sup>8</sup> Smith, KF, Goldberg, M, Rosenthal, S et al. (2014) 'Global rise in human infectious disease outbreaks', Journal Of The Royal Society. And Keller Fabienne (2012) [Les nouvelles menaces des maladies infectieuses émergentes \[New threats from emerging infectious diseases\]](#), information report n° 638 (2011-2012), made for French Senate foresight delegation, published July 5, 2012

<sup>9</sup> University of Massachusetts at Amherst (2013) '[Researchers develop tools for discovering new species](#)', Science Daily



## ➤ **Animal and plant disease outbreaks**

Trends in human and animal health are of increasing concern<sup>10</sup>. There is an emergence of new animal and plant diseases. Outbreaks underline, particularly in plants, capacities for “rapid evolution through the hybridization and mixing of genes conferring pathogenicity”<sup>11</sup>. Some of these diseases can be directly transmitted to humans, such as through respiratory transmission of influenza, from pigs to people, or by eating beef infected with bovine spongiform encephalopathy (BSE) also known as mad cow disease.

Epidemics and pandemics have the potential to greatly impact crops and livestock. Half of the world food supply is based on four staple food crops: rice, maize, potatoes and wheat.<sup>12</sup> An epidemic in one of these crops would represent a significant global threat for food security. In the 1950s, *Fusarium oxysporum* f. sp. *cubense*, better known as Panama Disease, destroyed nearly all of the world’s commercial banana crop. As they were nearly all genetically identical clones of a cultivar called Gros Michel, they lack the genetic diversity to resist sudden pandemics.<sup>13</sup> Other crops face similar circumstances. The latest development of a virulent fungus observed in Uganda in 1999 threatens 90% of all current African wheat varieties.<sup>14</sup> The FAO estimates that there are roughly a quarter million plant varieties viable for agriculture, but less than 3 percent of these are in use today<sup>15</sup>. This lack of diversity increases the risk of disease to the global food supply.

## ➤ **Discrepancies in the impact of infectious diseases**

Infectious diseases are responsible for 14 million deaths globally each year<sup>16</sup>, though there is great disparity in the impact. More than 90% of the total deaths linked to infectious

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<sup>10</sup> National Intelligence Council (2017) [Global Trends: Paradox of Progress](#)

<sup>11</sup> Brownlie et al (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London.

<sup>12</sup> Brownlie et al (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London.

<sup>13</sup> [Panama Disease website](#)

<sup>14</sup> Chamy, C. (2014) '[Wheat rust: The fungal disease that threatens to destroy the world crop](#)', The Independent, 19 April 2014

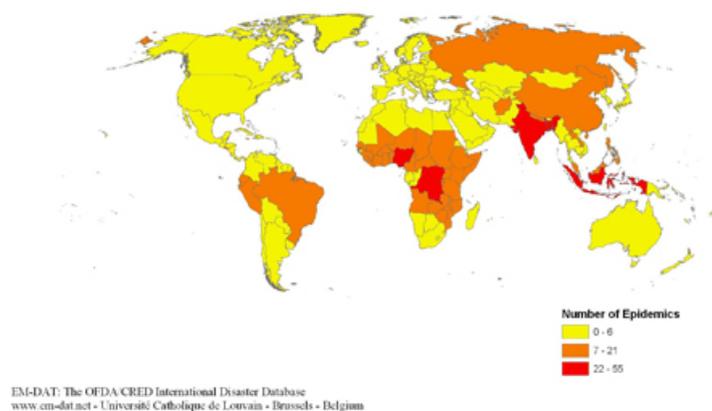
<sup>15</sup> IDRC, [Facts & Figures on Food and Biodiversity](#).

<sup>16</sup> Keller Fabienne (2012) [Les nouvelles menaces des maladies infectieuses émergentes \[New threats from emerging infectious diseases\]](#), information report n° 638 (2011-2012), made for French Senate foresight delegation, published July 5, 2012



diseases occur in less developed countries<sup>17</sup>. Infectious diseases represent 43% of overall mortality in these areas compared to only 1% in developed countries<sup>18</sup>. Less economically developed and fragile states struggle with poor access to healthcare, low quality of service delivery, low levels of vaccination, poor access to clean water and improved sanitation and a lack surveillance systems and response capabilities. Several diseases such as the plague, considered anomalous in developed areas, are still endemic in many others (Asia, Africa, particularly Madagascar). Moreover, Africa has the largest proportion of immunosuppressed individuals with AIDS who are more vulnerable to other infectious diseases. Many less developed countries (particularly those situated in the tropics) are located in areas with the largest reservoirs of disease organisms<sup>19</sup>. **Among the 335 new infectious diseases discovered between 1940 and 2004, 60% can be transmitted from animals to humans, also known as zoonoses<sup>20</sup>.**

Worldwide epidemics occurrences: 1974-2003



Source: EM-DAT, CRED International disaster database

Developing countries are also impacted by diseases affecting livestock and crops that severely damage their economies. Africa is particularly vulnerable with an increasing demand of bush meat, the backyard rearing and marketing of livestock. At the same time, veterinary infrastructure and services are in decline, restricting further early detection capacities.

<sup>17</sup> Ndeboc Fonkwo, P (2008) '[Pricing infectious disease: The economic and health implications of infectious diseases](#)', EMBO Reports.

<sup>18</sup> Keller Fabienne, (2012) [Les nouvelles menaces des maladies infectieuses émergentes \[New threats from emerging infectious diseases\]](#), information report n° 638 (2011-2012), made for French Senate foresight delegation, published July 5, 2012

<sup>19</sup> Brownlie et al. (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London.

<sup>20</sup> Jones, Kate E. et al. (2008) Global trends in emerging infectious diseases, Nature, 451, pgs 990-993



Consequently, **the likelihood of zoonotic disease will increase in the next 15 to 30 years, while HIV/AIDS, tuberculosis and malaria will remain a critical challenge, particularly for Africa.** Developed countries will have less mortality but rising social costs and an increasing incidence of emerging infectious diseases.

➤ **Development of antimicrobial resistance**

Antimicrobial resistance is a growing threat to human security. Concurrently, the development of resistance against herbicide and insecticide treatments is also increasing. This resistance is partly due to the misuse or overuse of antibiotics (in part a result of a lack of information, qualified staff and the false belief that antibiotics are a better treatment than other alternatives) for both livestock and humans. Compounding this issue, **no new class of antibiotics had been discovered since the 1980s**<sup>21</sup>. This situation forces the return to medicines once avoided due to their strong side-effects<sup>22</sup>.

Moreover, the lack of knowledge about the levels of resistance present in humans, animals, and plants and the increasing market of adulterated or fake medicines particularly in developing countries<sup>23</sup> is a serious concern. Drug-resistance infections are already responsible for 700,000 deaths each year. **This could rise to 10 million deaths annually by 2050 making it the primary cause of death globally**<sup>24</sup>. “Even diseases that are currently under control could become untreatable and could re-emerge, posing a serious public health threat”<sup>25</sup>. Antimicrobial resistance poses the greatest threat in areas which suffer from a lack of well-trained medical staff, inferior diagnostic capacity, poorly regulated drugs and strong black markets of sub-standard medicines. As a result, though antimicrobial resistance is an issue of global concern, the death toll linked to antimicrobial resistance is expected to be concentrated in those areas.

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<sup>21</sup> Keller Fabienne (2012) [Les nouvelles menaces des maladies infectieuses émergentes \[New threats from emerging infectious diseases\]](#), information report n° 638 (2011-2012), made for French Senate foresight delegation, published July 5, 2012.

<sup>22</sup> O’Neil Jim (2016), [Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations](#), The Review of Antimicrobial Resistance, May 2016.

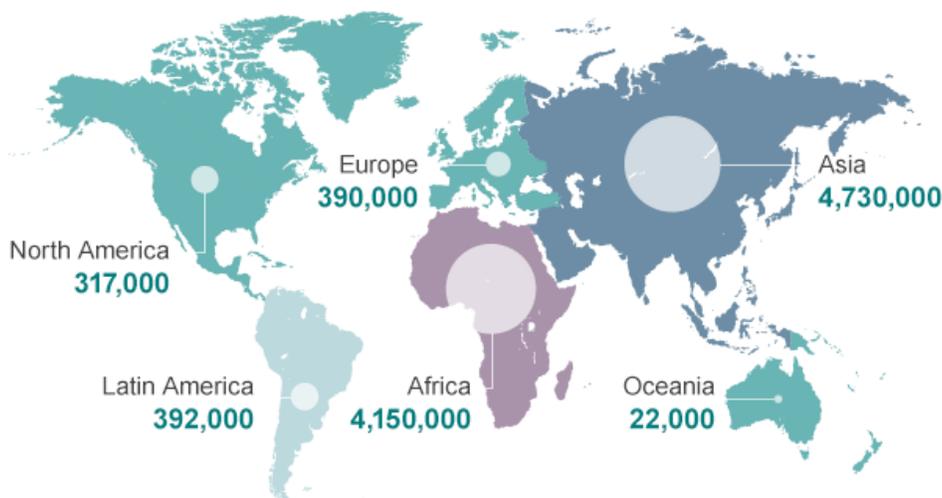
<sup>23</sup> Brownlie et al. (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London.

<sup>24</sup> O’Neil Jim (2016), [‘Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations’](#), *The review of antimicrobial resistance*, May 2016

<sup>25</sup> Brownlie et al. 2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London



### Deaths attributable to antimicrobial resistance every year by 2050



Source: Review on Antimicrobial Resistance 2014

#### ➤ **Breaks: Climate change's role in epidemic extension**

Climate change brings temperature variability, disturbs rainfall pattern and disrupts ecosystems, the distribution of species, and their interactions. Consequently, the link between climate change and the geographic and temporal distribution of infectious diseases, in particularly cholera, malaria, and dengue<sup>26</sup> is of significant concern. Climate change will permit the migration of insect vectors to new geographical regions. This trend is reinforcing the increasing transboundary movements of peoples and trade, which also help diseases spread to new areas<sup>27</sup>. Climate change can also facilitate the development of plant diseases threatening economic and food security of some areas. In addition, an increasing number of people will be forced to flee extreme weather conditions often resulting in concentrating vulnerable populations and very poor sanitary conditions which encourage the emergence and spread of some infectious diseases. Given the trajectory of climate change, it is likely that in the next 10 to 25 years, new infectious diseases will emerge while others will be reinforced.

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<sup>26</sup> Chastel C. (2006) '[Changements climatiques et maladies infectieuses](#)' [Climate change and infectious diseases], [La lettre de l'Infectiologue](#), Tome XXI, n°6, november-december 2006

<sup>27</sup> Brownlie et al. (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London



➤ **Weak signals: weakening in the availability of antibiotic treatment and research**

Antimicrobial resistance and re-emerging diseases highlight the vulnerabilities of the global health care system, even in developed countries. Health crises of SARS, avian influenza or more recently Ebola highlight the pressing need for a greater allocation of resources to identify and respond to emerging diseases to face these threats<sup>28</sup>. There is a lack of scientific research in the antimicrobial domain as it is poorly incentivized. Between 2003 and 2013, less than 5% of venture capital in pharmaceutical research and development was dedicated to antibiotics and antimicrobial resistance<sup>29</sup>. Moreover, doctors working in infectious diseases earn less than their colleagues of other specialties<sup>30</sup>. Consequently, healthcare systems could be ill prepared to face re-emerging or new diseases outbreaks potentially resulting in a situation comparable to the pre-antibiotics period.

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<sup>28</sup> Keller Fabienne (2012) [Les nouvelles menaces des maladies infectieuses émergentes \[New threats from emerging infectious diseases\]](#), information report n° 638 (2011-2012), made for French Senate foresight delegation, published July 5, 2012

<sup>29</sup> Brownlie et al. (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London and Keller Fabienne (2012) [Les nouvelles menaces des maladies infectieuses émergentes \[New threats from emerging infectious diseases\]](#), information report n° 638 (2011-2012), made for French Senate foresight delegation, published July 5, 2012

<sup>30</sup> Brownlie et al. (2006) [Foresight. Infectious Diseases: preparing for the future Future Threats](#). United Kingdom Office of Science and Innovation, London