

NEHA Here They Come: New Diseases Caused by Familiar Bugs

Hello and welcome to the presentation Here They Come: New Diseases Caused by Familiar Bugs. To ask questions about this presentation, join the presenter for a chat hour in the Networking Lounge.

I would now like to introduce our presenter, Dr. Leon Vinci, CEO of Health Promotion Consultants and the NEHA Climate Change Technical Advisor.

Hello. It's great to be here today, and I'm pretty excited that we're doing this virtual conference, Vectors and Public Health Pests, sponsored by the National Environmental Health Association. And as you may have heard, my name is Leon Vinci, and the title of my presentation today is Here They Come: New Diseases Caused by Familiar Bugs.

And you'll see that we've got a little overview in this first slide where throughout the discussion we'll start with an introduction, talk a little bit about what vector diseases are, go into more detail with diseases vectors. Then I'm going to use the new Zika virus, very out there on all the news and dead center on the radar screen, as a case example. And then we'll close with a future forecast and some general conclusions.

The first section is the introduction, so I'll start there. And I'm going to cover a couple of things. But it's important to realize for all of us, as we probably all know, because of travel and things like the spread of Ebola and other health concerns, our world is shrinking. And it is really made possible by our increased travel and improved forms of transportation, etc.

But another concern for all of us as humans is that many of our urban centers, particularly in developing countries and third-world areas, the urban centers are growing and really getting densely and heavily populated. Dense concentrations of humans in one place.

Another concern or factor that we need to be looking at is that vectors, insects, etc., that like where they live, it's because they've adapted and grown there over the centuries and eons, for that matter. However, with some climate change issues, and we've really seen habitat changes and the opportunity for these insects and agents to live longer as well. So we'll talk about that a little bit.

And very important for all of this is where we all fit in here in the environmental health community. NEHA, as well as all of us, realize the important and critical need to strengthen the environmental health infrastructure so that we as humans can deal with the points I mentioned above and control disease as best we can.

I just want to say one thing as we get started, and that is the data from many of my slides comes from almost everywhere. WHO, the World Health Organization, CDC, private organizations and foundations, colleges and research scientists, and the list goes on. So I just wanted to let you know that as part of the presentation.

For vector-borne diseases, these are illnesses caused by pathogens and parasites into human populations. The disease is introduced in by a vector, pathogen or parasite, and then the humans become ill with that biological entity. Every year there are more than a billion cases and over one million deaths from vector-borne diseases, and they include a long list which you're all familiar with. I don't think I'll go into detail with every one I have on my slide, but of course they include things like malaria, yellow fever, dengue, schistosomiasis, etc.

Vector-borne diseases. They certainly can cause economic woe as well as human catastrophe. Sixty billion dollars are the annual expected losses due to estimates for potential pandemic. If the world gets hit with a virulent bug in some way, and it goes around the globe, \$60 billion is a huge number, but it certainly has a financial cost.

Same with working to get ready for such an event, to build that infrastructure I mentioned earlier. If we look at low and middle-income countries, to improve their public health systems, which are often very

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fragile and/or nonexistent, you would need just – not just – you would need \$3.4 billion just for that target group. And as you can see, that came out of the Commission on Global Health Risk Framework for the Future – that should be 2015 in the date – we're not jumping ahead to the future that fast – and the name of the document is called the Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Crises.

Moving on to the next section called Vector Disease Overview, I thought we'd define vectors again as living organisms that can transmit infectious diseases between humans or from animals to humans.

Many of these vectors by nature are blood-sucking insects, that's the mode of transmission that they bite and transmit through a blood meal. Those insects ingest disease-producing microorganisms during a blood meal from an infected host. And they can be biting a human and then transporting it to a human, or an animal to animal, or across species as well. And then later inject it into the new host during a subsequent blood meal.

Mosquitoes are the best known disease vector. They've had, as I said earlier, many years to perfect who and what they are and their mode of survival for themselves, but sadly, humans become victims along the way.

Other such insects and disease vectors include ticks, flies, sandflies, fleas, other bugs, etc.

Well here's just a photo that just kind of brings that out. You can see this particular mosquito is on a human layer of skin, so, you know, what happens next?

Once again, just to focus on the importance of our whole discussion today, vector-borne diseases can account for more than 17% of all infectious diseases. And when you look at how many annual deaths that is, it's a million. In over 100 countries, dengue alone, that number is 2.5 billion people. Malaria, and we'll talk about that at the very end of the discussion today, but certainly malaria, a long-standing and huge public health impact disease, causes more than 600,000 deaths every year across the globe. And sadly it's the children under five years of age that are most susceptible.

Other diseases can affect hundreds of millions of people worldwide. And, again, those diseases tend to be on non-developed countries or countries that are emerging and growing, etc.

As my last bullet shows, through good environmental health practices, we can control and prevent diseases. And that's known going back to the days of building the Panama Canal and fighting yellow fever and all that great history that we've been able to accomplish.

Well I thought we'd move on to a little bit more discussion about diseases and vectors next. And I've laundry listed on these next two or three slides just some of the most common diseases that correlate with the perspective vector attributed as follows: I mean, tsetse flies and sleeping sickness, many of you are aware of that. Fleas, plague and rickettsiosis diseases. More common are on the next couple of slides. We have sandfly vectors with a couple of diseases that are very close to, you know, to what they carry. And some of the – and I apologize for – due to a technical glitch on the slide, but some of the first couple letters have been dropped off, but you can certainly figure out what those diseases are. We'll go right down and see sand fly fever. You can see Lyme disease, relapsing fever, rickettsial, tick-borne encephalitis and so on.

For mosquitoes, and I had it by species, most popular diseases associated with those particular types of mosquitoes, but the Aedes mosquito, Dengue fever, Rift Valley fever, yellow fever, Zika. Anopheles is malaria, (inaudible) got the bottom knocked off of that slide, but moving on.

This slide shows what we spoke about a little earlier. Insects can go from – in vectors can go from animal to animal, animal to human, human to animal, etc. And it pretty much shows this on the schematic. On the top half is the human side and the bottom half is more the animal kingdom, if you will. And just to walk

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through them very briefly, for direct transmission for humans, clearly a human transmitting to another human. One quick example, I mean the most obvious, is influenza. It's not really vector-borne in the sense that it's a creature carrying the influenza from one human to the other, but along with measles and other types of infectious diseases, a human can transmit to a human through droplets and other forms of airborne contamination. So I just wanted to use that as a quick example.

Indirect transmission focuses a little bit more on the use of a vector and/or a vehicle that would be a human-to-human, maybe with hepatitis A, it might be transmitted through a contaminated glass or toothbrush, that kind of thing. The infection can transmit that way through having some kind of carrier, for lack of a better word.

Zoonoses tracks almost the same way on that lower graphic in the – well, lower left-hand corner. Animals to animals, and then maybe even on to humans, or in the indirect transmission, animals having a vector that transmits to each other and then carrying it back to humans as sometimes a direct consequence because that vector will target humans as a blood meal or whatever it might be in terms of the bite. Or it might be accidental. They really don't know what they're landing on, they just want to go to the nearest warm body, and it happens to be human rather than – they like horses in the case of encephalitis or whatever.

Well, I've got the top ten vector-borne diseases. This came out of the WHO a year or two ago and really hasn't changed much. Sadly malaria is leading the pack. Over 100 countries worldwide, 1.2 million deaths annually. And that's, you know, mosquito-driven as a vector.

Some other diseases, dengue, plague, again I'm not going to read those for you because they're pretty common. But this slide is important because you can see, and the vectors have been identified, including rodents which I didn't mention yet, as well as fleas and certainly mosquitoes are always in the picture.

The bottom five include chikungunya, Lyme disease, yellow fever, and the last two, again with mostly mosquitoes but certainly other bugs endemic to those areas where those particular diseases might be thriving.

Well I've added this slide simply because it focuses right in the middle, third bullet down in the green rectangle, how as climate conditions change, wherever they may be, vector-borne diseases are an impact, and such things as malaria, Dengue, encephalitis, hantavirus, Rift Valley fever, can change, in our case for humans, for the worse because they are the kind of changes allowing them to expand their horizons to areas where, you know, they were deemed quote/unquote "safe" or non-disease zones. And we'll, again, talk about that in a few minutes, but this slide summarizes that. But it also shows there are other impacts as well. And I'd like to point out through this slide that there's an overlap, I mean, just vector-borne diseases, and it's five or six diseases as identified, are not stand alone. There's a lot of overlap into water-borne diseases, and/or air pollution, and/or up above the first item, urban heat island effect, the heat aspects. And if you look at the bottom of the slide, of course, environmental refugees, and it talks about infectious diseases transmitted through those particular populations especially because they are high risk. And their environmental situation is high risk, too, if they're refugees.

Well back to the mosquito. Another illustration of how if the habitat changes, a bug like the mosquito can live or thrive where they didn't normally live or thrive. And another issue that we're not going to talk about too much today, but some mosquitoes can over take the habitat of another mosquito, and if that new mosquito moving in that conquers or survives at a better rate than the older mosquito, if that new one happens to be a real disease carrier and of a serious disease for humans, well, you can put two and two together. It's not a good thing.

This slide confirms that about temperature and a little bit – and one added dimension I wanted to share. As you'll see from these two curved slopes, the graphs talks about the relationship between temperature and malaria parasite development time inside the mosquito. Or you can call it an incubation period. But, of course, as I said before, not only is the mosquito living longer, but in their gut, if it's ideal conditions, the parasite can grow sooner, and faster, which means that mosquito becomes more infectious over a longer

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period of time. But it becomes infectious earlier. And, of course, the graph is simply days across the bottom for length of days and then how the temperatures – and take a look, the left hand of the slide is very acute with where those graphs peak with a shorter day period correlated with higher temperature.

What I'd like to do now is just to keep looking at more diseases that are vector borne, and we'll start with the U.S. and kind of jump across the globe a little bit. I didn't achieve what I wanted to with this slide, but it's still pretty good in that the lower right-hand corner shows the Four Corner state in the U.S. – Colorado, Utah, New Mexico and Arizona. And within that area you see a little – actually two rectangles put together, kind of upside down. Well it looks almost like a small "7". That's the high incidence area for hantavirus. And, again, I apologize that the lettering with the other images is so small, but if you look closely you can just make out the dates. And what this slide shows is that the fluctuation of temperatures happens all the time, and as we are becoming a – that part of the country is becoming warmer, it also is allowing the hantavirus to spread a little bit – well, at a higher rate simply because the rodent population that helps the hantavirus hibernate, or incubate, I should say, and move on, it has a longer period to do that. So not a good thing.

This speaks to that issue a little bit, coupled with El Niño. Now there's something called the THC – the Tropic Cascade Hypothesis. And basically it's just kind of a series of dominoes, when the first domino goes down, then the next one gets hit, and it continues. When El Niño weather patterns come in to – they impact everywhere they go, but particularly the U.S. southwest. This allows an increase in winter and spring precipitation, and then, of course, you're going to get more vegetation and increased insect population growth. Shelter and food for rodent populations also increases also as a result of better weather conditions for them to survive. These increases allow for more rodent populations, which means an increase in density of rodent populations, and that allows the SNV, which is the short nickname for hantavirus, to survive in populations – that's the species name for the deer mouse, or the mouse.

Back at the bottom, return to normal weather patterns leads to increased contact with humans because when you get back to more normal weather patterns after all this has happened, humans will go back out, start hiking, camping, whatever, it increases their exposure levels to rodent populations and therefore hantavirus.

This slide shows the Trade Winds and El Niño effect. Take a look at this. This is the normal pattern of an El Niño. You'll see that it starts way out on the western edge of the Pacific Ocean, that's Australia and New Zealand and the southeast Asia peninsula there with the islands. That's the heavy concentration of winds, and they go from west to east, and they hit mostly Central America, a little bit South America, and not so much the United States, but that's the main pattern of it.

Now that's normal conditions. But under El Niño conditions, you can see that there is a stronger and more consistent profile going from west to east, and if you look at where it ends up, it's now hitting a large part of the northern northwestern edge of South America as well as the Central America areas, you know, all of them instead of just a few of them. And the warm waters of the central Pacific allow that to happen. So that's definitely an impact.

That kind of supports this next graph, which demonstrates some research done in Lima, Peru after the 97-98 El Niño event. When you look at that normal sine wave cycle for both graphs, above and below, one is hospitalizations due to diarrhea, a direct reflection of illness, as well as daily temperature, first thing you notice is that the waves are pretty much consistent. If we push the bottom graph upwards, you'd see that it would almost just kind of fit on top pretty easily of the upper graph. So there's a direct correlation, then, of hotter temperatures and then diarrhea hospitalizations. As you see El Niño, you'll see that there's not only that same correlation, but actually hospitalizations has intensified more in terms of being spread across that particular graph area. So definitely, I would say, a higher level of illness over a wider period of time as opposed to a very sharp graph, or more consistent as it's been in both the top graph and how very sharp the temperature graph is, which the temperature graph did remain pretty constant. But also you'll see it remains hotter due to El Niño.

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And these circles just kind of show the shift in the concentration areas, and a discussion in the lower graph of the five degrees centigrade difference. And the hospitalizations, that increases significantly, 33%.

And conclusions that Checkley, et al. made in the Lancet magazine correlated to a one degree centigrade rise. As temperature rises one degree centigrade, that's when you see these effects.

Well, going, again, across the globe, plague is pretty common in almost – well certainly almost every continent, except not so much Australia, and definitely not Antarctica, but the yellowish color – light brown color – is who has plague. And the red is where plague has a great opportunity to expand. If you remember back – the notes on the bottom, back in the 1850s up to 1870s, a huge pandemic of plague occurred, and that's one of the reasons plague remains to be endemic today because, you know, it has its roots throughout the different country areas.

There are, in Central Asia in particular – well, let me back up. The epicenter for that pandemic was Central Asia. There are some changing public health and political systems going on in Central Asia, and that may or may not be helpful to controlling plague in the future, and we have some concerns because plague still occurs there on a regular basis. And this slide just, again, shows this is centrally an issue of global importance.

Looking at temperatures again, temperatures can assist plague transmission. The researchers in the lower corner there speak to the two bullets on the right-hand side, warmer springs can increase flea population, and that's because, if you look above that, a one degree centigrade increase there, in the spring temperature, allows almost 60% greater spring prevalence in gerbils, which is the control animal in experiments. So out there, you know, rodents are carrying fleas, and if they are plagued with plague – did I say that? Yes I did – that's a problem for disease transmission.

Let's move a little further east to China. Now China is a very mountainous country. Many folks don't really know that. But in this particular part of China the mountains are pretty high, and what's most – the important message that's a take home here is that the snail vector was, of course, or is limited by freezing conditions. In other words, as you go higher up on the mountain, you're not going to have these snails that are infectious that can cause certain diseases.

Well, in looking at the temperature changes from 1960 to 1990, the habitat for these snails to live literally higher up on the mountains puts an additional 20.7 million people at risk for catching the disease. And some people live there naturally, that's where their homes are, so you could be up the mountain and never have – or not never have to worry, but your concern for a snail vector contamination issue would have been nonexistent, and yet now, with a change in climate and the snail habitat increasing, suddenly you have to be pretty – very concerned about this.

Looking at Zimbabwe, you'll see that the same thing holds for malaria. There's a correlation in this study, Taylor and Mutambu in 1986, looking at temperatures as you go up, and that correlates with altitude, so you could just say altitude and not worry about temperature knowing one is pretty much equatable to the other. But as you go up in altitude, obviously, it's getting cooler. Less chance for mosquitoes carrying malaria. However, with temperature changes, which have sadly warmed up, that's not the case. The case is that the region has shifted to higher elevations still being potentially infectious.

And a good example of that are these next two slides. This shows 2000 showing the amount of intense heat, if you will, in the Zimbabwe country. And it's actually a projection, but based on current temperature trends, 2050 is a lot more red, as you can say, and I think that, you know, pretty much is self-explanatory. As we're heating up, the insects have a greater opportunity to live longer and move their habitats, which means humans get a higher level of exposure.

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And just sort of to recap what I just said, there's clear evidence that climate change is a factor in a string of disease outbreaks affecting both animals and humans. And that goes one step further. There's actually been studies that have had very strong correlations.

Areas that kind of support this are just one of the things we talked about. Spread of malaria into highlands of eastern Africa. Of course here in North America, Lyme disease and how that's expanding. Another disease called Blue Tongue is expanding into Europe. And previously that was too cold for that to happen. Blue Tongue is a serious livestock affliction. And this map shows how the spread is occurring. At one time the solid lines were not where there was any Blue Tongue. But Rogers and his study group in 2007, when they started looking at this, saw that suddenly Blue Tongue went from the African continent, and not even - even the Middle East really didn't have it - now it's as far north as Italy, Spain, and some of those other countries right there. Definitely a concern.

Again another global map just showing, this is from NOAA, showing where there tends to be warm episodes in the December through February months. As you know, there's the Northern Hemisphere and the Southern Hemisphere, and when it's spring and summer in the Northern Hemisphere, it's fall-winter in the Southern Hemisphere. But nonetheless, December through February you can see these zones of warm episodes, and in some cases wet or not wet as well. So it gives you that perspective of what's going on climatically across the earth.

Well, we talked a little bit about east Africa and how mosquitoes are growing, if you will. This slide is entitled An Abundance of Mosquitoes 1970 to 2000. You should take the - kind of split the screen in half just vertically, so on the left-hand side, that lower graph talks about temperature over time. And the upper graph again shows incidence of mosquitoes. And sure enough, as the temperature rises, and that's been in the last - on this slide - the last 30, 40 years, now almost 50, clearly mosquito populations have also just tracked the same and that curve shows an increase.

Going to the other side of the page, on the right-hand side, with those two graphs, it shows the same message just using a different technique, and the top right-hand corner is the one I think illustrates most dramatically how certain disease and mosquito abundance activities were below the threshold and then all of a sudden they're way above as that part of the world and the rest of our climate has warmed up.

Rift Valley Fever is another transmittal disease. It's an acute viral disease. It can cause severe disease in domestic animals, but it also affects humans. And domestic animals include cattle, goats, camels, buffalo, sheep, etc. These species get symptoms that are characterized by fever, severe illness, abortions and high morbidity and mortality rate. The virus which causes Rift Valley Fever, or RVF, belongs to the genus Phlebovirus, and they cause, in humans, and its related partners, cause fever and encephalitis. Of import there is even though Rift Valley Fever is in other countries and not North America, not the U.S., it's related to hantavirus. And it's, of course, of serious enough concern that the World Organization for Animal Health has a code requirement that it be reported when it occurs so they can help track it.

Here is Rift Valley Fever again, in deep red on the far right graph showing Africa. And it shows in one distinct area. If you look at the left side, the title of that page is Anomaly for January 1998. And how that turns out is that in 98, actually the graph on the right shows a heavy concentration of red in the endemic areas whereas on the picture on the left of Africa shows it not quite as intense. And just confirming, once again, the impact of heat particularly in disease transmission.

Why should we be concerned about the spread of infectious diseases? Well, certainly we live in a buggy world. And new and emerging diseases are a real problem. Viruses are out there, and they jump from species to species, and they find new ecological niches as well. That's what happened with Ebola.

HIV is another good example. That particular virus jumped from primates to humans. It adapted to humans. And then there was a pandemic that we experienced. And we humans, including the U.S., we're in the middle of all these pandemics. We have to realize that and we have to be concerned about that.

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Viruses, although they've always existed with us, and we've been able to figure out with some of them how to cope with them and control them and to actually conquer them or even get vaccines, but now they're getting to us in new ways, and causing new problems. As I mentioned before, Zika virus is center stage in the media of late. And it does serve as a good example of the spread of a vector-borne disease with a footnote, and we'll talk about that in a minute. And I'm going to talk about that case example next.

Well, first, permit me please to say that West Nile Virus really serves as one of the best examples which illustrate disease transmission using the vector which is a mosquito, expansion, in our case, across the U.S. If you look at the course of a three-year period, you can easily track its dramatic spread from the East Coast across the USA to the west, West Coast.

West Nile Virus, in terms of that transmission, that whole distribution process was directly attributable to humans being bitten by infected mosquitoes. And, again, not to get into too much depth on the West Nile Virus story, but in southeast USA and as far north as New York, the virus was introduced into the mosquito population, and the mosquito population just became super infected. And, again, if we looked at maps, and I think everyone watching today's presentation probably has seen those maps, where it's just as if a child was doing a coloring contest. You'd color the East Coast first. And then the following year you'd cover a lot further west, right to the Mississippi. And at that time there was even discussion that it might not cross the Mississippi, but of course with transportation and other modes of getting the mosquito across, animals, etc., sure enough, it was in Colorado and the mountain range states and so on. So certainly a good story in the sense of education and illustrating how vectors can transmit disease to humans, but a sad episode in our nation's life because of the huge toll it took with deaths and a lot of negative excitement at the time.

Zika virus can do the same thing, but thus far it's done the complete opposite. At present, every case in the U.S. is connected to an overseas exposure or bite, not on the continent. What we have is everyone who is ill here in the USA has been traveling, and they've come back to the USA and they're being bit elsewhere and they've developed the disease here. With a short footnote there, and that footnote is we're now learning a lot more about the Zika virus, because it's right in front of our faces and in the middle of our radar screen, and we're seeing that – and the documented cases of transmission from human to human through sexual contact.

Back in 1947 in the Uganda forest was when Zika was first discovered. And today it's changing by the hour. It's up to 23 countries across the globe have Zika virus.

Our cases in the U.S. are from mosquito bites that were non-U.S. And, again, if you have been infected through sexual transmission, your partner who might have transmitted it to you was infected from out of country. So that's the difference there.

The symptoms can be severe – as severe as miscarriages and microcephaly. Usually in most of the cases, and it was 80 to 90% of the cases, are mild illness, general soft cold symptoms is what you would get, if that, and you might not even know you had the disease. We're now seeing sexual transmission and impacts through pregnancy to the fetus as well. And Guillan-Barre syndrome is another consequence.

The virus has been isolated in saliva, blood, urine and bodily fluids. And in this past year, which is the first year of widespread contact in North and South America, and that's really the reason it's right on the center of the radar screen, in 2013 and 2015, 1.7 million people were infected, and that particular number came from WHO, I believe. They were looking at both chikungunya and Zika and had combined the total.

Well, just to give you an update for the U.S., up through and including this month, 82 infections, with this month being March even though the presentation is going to actually occur in April. Eighty-two infections. All with a history of travel. There are 14 cases which are identified as probable sexual transmission, and they're still kind of verifying that although there's a high level of confidence. And then 12 cases are currently under study as they are trying to determine whether it was the real source.

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Our travelers have been all over the place, mostly southeast islands or South America related to North America, meaning south of us here in Mexico or down further in Brazil, Haiti, Puerto Rico, Guatemala, and so on. Honduras.

Well, this is just a graphic that again shows those countries. Places with active Zika virus are highlighted with that pinkish-lavender color. The U.S. is clear. Just a matter of time. My prediction is that we will see a similar travel sequence as to West Nile Virus with Zika. We'll talk about that in a minute.

Another important thing to consider that's going on around us and in our world. Our world is a big place. There's always things going on. Scientists are looking at mountaintop regions in tropical areas. They do have mountains. They do have snow even in tropical areas. And over the centuries, those mountaintop areas have been homes and a niche area for rare and ancient plant species, you know, very unique plants and rare plants grow there as well as some animals and insects, but certainly plants. The prediction is that, at least from a plant perspective, due to the warming climate trends, we could see, sadly, an extinction of anywhere from eight to 12 species of these very unique parts of our world that were there yesterday and may not be there tomorrow.

This brings us kind of to the end of the presentation. I just want to talk a little bit about forecasting and conclusions.

In the forecast area, and it's kind of what we have been doing in almost advocacy. There is an action activity which has happened legislatively. There's biology we can look at from insect life cycles. I'll talk about that in a second. Ideology in terms of infectious pathways of the disease. And exposures for human habitats and lifestyles.

I don't think I'll concentrate on these individually, but as you can see from the slide, and you can footnote it accordingly, there have been many primarily mosquito control and pesticide use control bits of legislation passed over just the last year. This is since I think the beginning of 2015. California, Arizona, Florida, the list goes on. Hawaii, Maine, Mississippi, New Jersey, looking at how to address mosquitoes and pests. And the last one on the bottom is Texas as well. Again, looking at how can humans better control through good environmental health measures our insects.

Another concern I'd like to share, and this just happened most recently. I've got the thousand-year flood events in the USA since 2010 itemized. Now growing up as a young guy, we never heard about a thousand-year flood. We only heard about a 500-year flood, and that was very seldom. It was usually a hundred-year flood. When a hundred-year flood, like a rain or something that was heavy, came, we knew about it. And maybe an occasional hurricane if you were on the East Coast, maybe an occasional hurricane would have enough to demonstrate that, and then you'd talk about the last one of a hundred years ago or whatever.

We'll look at this. 2010 to 2015. South Carolina, up to Tennessee. Colorado Springs. Baltimore. Nebraska. We've had six thousand-year flood events. And there's a chance that with the heavy rains that just happened in Louisiana in the middle of – early March or middle of March this year – with 14 inches just in one area, that might even qualify. I'm not sure yet. But certainly issues about weather and how that whole warming effect, El Niño, all those things, add up.

So again, as we kind of exit this conversation, I wanted to just again show this particular slide because it brings home the very important point that humans can infect humans, animals can infect animals. But you know what? Other things get in the way, and in the case of animals it's humans. And that gets serious with disease vectors.

Remember now, over 17% of all infectious diseases are vector borne. And as I shared with you with a variety of slides earlier, there's a complex dynamic of environmental and social factors which come together in the distribution of these diseases.

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As I said before, globalization of travel and trade, including unplanned urbanization and environmental challenges such as climate change are combining to have a significant impact on disease transmission, especially over the past few years as we've seen. Look at these diseases. Dengue, chikungunya, and West Nile Virus. They're emerging in countries where they were previously unknown. That's actually here in the U.S. is one of those countries.

Changes in agricultural practices due to variations in temperature and rainfall can affect the transmission of vector-borne diseases as well.

We're looking closely at climate information to try to monitor and predict distribution and longer-term trends in malaria and other climate-sensitive diseases.

Again, another future concern is that bacteria and viruses always adapt, as we all know. In this case there is a bacteria that you cannot fight with antibiotics anymore because it developed a gene, or the gene got smart enough, to create an enzyme within the organism called KPC, and that disables the effect of antibiotic. So here we create this great miracle drug, an antibiotic, to control a particular problem, and the bacteria, you know, they've survived, they want to survive, and they outsmart us.

Another new technique that's going on that's very important to try to control exposure, human exposure, to dengue and chikungunya is genome sequencing, so they're looking at that science and that technology.

As you probably know, right now in China with H5N6, and in France, H5N9, that's avian influenza, they're having some outbreaks there in the bird populations. But as we've all known, the viruses can jump from the birds to us, and that's one of the concerns of a potential pandemic. And you often hear the phrase, not that it won't happen, it's a matter of when it's going to happen.

I mentioned vaccines. Yes, we can still develop new vaccines, and they are working hard to develop a vaccine, both through that gene sequencing project as well as looking at other ways to control Zika, dengue and West Nile Virus. And with Zika here in the U.S., there's a huge effort. In fact Congress just passed a new appropriation bill to help put some funding there. Sadly, in the same breath, the House just released, here in the middle of March, a proposed budget which, of course, pretty much strips and cuts funding for health infrastructure, environmental health, and that's not a good thing.

As I said, viruses, but also insects can also have biological changes. And the biological changes can drive them to be more conducive to carrying chikungunya, dengue, and yellow fever. And one of the things humans are doing is they're trying to introduce populations of, for instance, the *Aedes aegypti* mosquito that don't carry these diseases, or can't carry them, into the populations to see if they'll take over and do some biological controls that way, which is pretty challenging.

I'm from Virginia, and in the Commonwealth we've seen in another insect population, as an illustration, that we historically have a ten percent failure rate in beehives. That's just kind of the way it is. That's the history from tracking since 2001. Well, they've noticed that since from the late eighties, lost hives have started to rise, and that's because two new parasites have been introduced to the region, the greater part of Virginia, and, again, demonstrating that there's many avenues of threat from vectors and parasites, etc. that can impact you.

Turning the corner and looking at a little bit more positive note, we've made great strides over the last 15 years in malaria prevention world wide. There was a 37% decrease in incidence of malaria in the last 15 years, and that translates to 60% mortality reduction. So pretty much good news there across the globe regarding malaria.

Well, again, as I said in the earlier slide, our world is shrinking due to travel. We have more urban centers and growing concentrations of humans in one place. Habitats and lifespan increases for vectors are changing and can be impacted by climate change, and that is having a significant result. One way to

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really control this for the benefit of humans and public health is to strengthen our environmental health infrastructure.

Again, as I said earlier, a lot of different sources were used for the graphs and statistics and other information provided today.

And I want to thank you for your attention for today's presentation. And as always, would be happy to respond to anyone who wants to contact me in the future concerning any of these items and what I've said today.

Again, it's been a pleasure working with the National Environmental Health Association. As you heard in the introduction, I am the Climate Change Technical Advisor for the organization this year. And I've been a past officer in terms of Executive Committee Regional Vice President and had several other activities with NEHA.

Glad to be here today, and thank you again very much.

Thank you, Dr. Vinci, and thank you everyone for attending today's presentation, Here They Come: New Diseases Caused by Familiar Bugs. On behalf of the National Environmental Health Association and our presenter, thank you for joining us today.