SUBWAY FLOODING, IDA, CLIMATE CHANGE, AND 'ELEVATION COUNTS'

This interview has been edited for length from *The Conversation* in collaboration with Klaus Jacob.

Image taken from "Sandy's Wake" by Paul Hond in Columbia Magazine.

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In New York over the last few weeks (August/September 2021), we have had three subway floods – first due to a heavy downpour, then from Tropical Storm Henri, and now Hurricane Ida. Meanwhile, we have seen similar floods in cities across America and the world. The message should be pretty clear by now: Climate change isn't a matter of the future; its effects are happening right now. Warmer oceans mean more moisture in the atmosphere, and as that moisture encounters cold air, it all comes down on the cities like the proverbial cats and dogs.

It is not necessarily a problem just for coastal cities. Ida, for example, left havoc across the entire interior of the eastern United States. But, of course, many major metros – from London to Amsterdam to Marseilles to New York and New Orleans – have been built next to major rivers or on the coast. This makes them vulnerable to excess water through either rising tides, or heavy rains, or both. In the most recent case in New York, it was from above, but the flooding from Sandy came from coastal surge.

How does the age of some of these subway systems affect flood risk?

When the subway was initially built in New York, opening in 1904, no one was thinking of sea level rise or torrential rains. And therefore, the fundamental design of this underground system did not take those phenomena into account.

Now we know better. For the past 20 years, it has been clear that more severe storms are an inevitable outcome of human-made climate change.

But despite having a couple of decades to do something about it, we are still in a reactive mode rather than being proactive. Essentially, City and MTA officials are cleaning up the mess after the storm, rather than taking more fundamental, corrective measures, like relocating infrastructure or even just protecting it.

So, what can cities do to better protect aging subway systems?

Odd as it may seem, water by itself is not the problem. Rather, it is a mismatch of the amount of rainfall we are seeing and where the openings are in our subway systems – not just where people go in and out, but also the ventilation grates where air goes in and out and where the electric cables enter the system. All these openings allow for water to run off the streets and into the subway tunnels.

These are long-known engineering problems that can be fixed. In New York, the Metropolitan Transportation Authority fixed a large proportion of the problems caused by coastal storm surges, like Sandy in 2012; they did this by installing devices such as gates and barriers – some installed permanently, some that need to be inserted into place before the water shows up. These prevent water getting into the subway system. When working as designed, they can result in a 98% reduction in coastal flood potential, according to calculations I did jointly with some Columbia grad students.

But these measures work for coastal flooding. The problem we saw on Sept. 1, 2021, was the result of heavy rain runoff from the streets that gets into the system. With coastal storm surges, the water comes into the subway system only at low elevations – perhaps at entrances just a few feet above sea level. With the heavy rains, even at higher elevations in New York City, subways can flood.

How do you address this runoff street water problem?

You have to approach it in two ways: (i) Avoid street-flooding in the first place and (ii) Protect entrances to subways.

Avoiding street flooding can be achieved through increasing the capacity of street gutters, of storm drains, and of the combined sewer system to take up the runoff water from streets. This can be done by widening or adding new gutters or storm drains, but also by having larger-diameter sewer pipes in the roads; and adding more capacity at the City's wastewater processing plants.

And then you can make the ground more absorbent by planting more trees on streets and putting in permeable surfaces. For example, rather than concrete parking lots, put in gravel or other permeable surfaces that allow the ground to absorb water.

Individual property owners can, if they have flat or near-flat roofs, put gardens on their roofs rather than have just gutters. Green roofs can absorb the water coming down from the sky; and catch basins – devices that collect stormwater – and then release that water slowly over days, for each building; they can help to ensure sewer systems don't get overwhelmed. NY City is starting to mandate such retarding features for new buildings above a certain size. Trash on the streets can amplify the problem by clogging up drainage, but it isn't the systemic issue. It just makes a bad situation worse.

When it comes to protecting existing subway entrances, you can build berms – mini levees or raised banks – of several feet at every entrance. That does make it more difficult for people with disabilities, so you also have to modify elevators to take people down.

All it needs is good engineering – there is no mystery. Well, it is engineering, and political will and money.

You mentioned political will and money...

It isn't cheap. To effectively protect a city's subway system from flooding costs tens of billions of dollars. But it is cheaper to fix the problem before extreme events than having to fix the problem after the damage is done.

Unfortunately, the current trillion-dollar infrastructure bill going through Congress has a totally insufficient amount for subways – far more of it, around $110 billion goes to bridges and roads than public transportation modes, which are set to receive around $39 billion.

How long have we known that we have flooding issues with our NYC transportation infrastructure?

Oh at least 2 decades. After some earlier research, some Columbia colleagues and I wrote a 2008 climate change adaptation plan for the MTA, and then subsequently, in 2011 – three years later, but still one year before Sandy, we wrote a report as part of a state-funded project called ClimAID in which we assessed generically a hundred-year storm and what the

impact would be on the transportation system in New York City. We focused on the subway but looked at other transportation systems as well.

What are the most pressing concerns about the New York City subway system with regards to climate change?

What we figured out in the 2008 report, and was repeated in the 2011 report, and what manifested itself during Sandy, and then again with the events like the extreme rainfalls in July of this year (2021), was that very specific locations of the system were highly vulnerable to flooding. That is not surprising for coastal storm surges, because, after all, much of the subway system is subterranean, many station entrances are below or close to sea level. So those entrances at and below sea level are susceptible to having coastal storm water just pour in. In some cases, in less than 40 minutes the system is completely flooded.

After Sandy, the MTA started a billion-dollar program to fix the most obvious entrances to the subway system. They fixed not only the pedestrian steps down into the subway, which are the obvious openings, but many other openings such as the sidewalk ventilation shafts, electrical manholes and cable entryways for the subway. The MTA has many other divisions such as Bridges and Tunnels, and they installed heavy steel doors on the entrances to the Brooklyn-Battery Tunnel. And many of these protective systems seem to be effective. Fortunately, since Sandy we haven't had any major new coastal storm surges to test many of the improvements that were made.

But in 2017 we did a (unpublished) study that was testing theoretically, many of those newly installed barriers and manhole covers, and so on. And for the most part, if they perform as designed, they work well for coastal storm tides.

But there are other weather events over which the MTA does not have sufficient control yet. As we saw in this summer of 2012 during multiple heavy rainfall events, the runoff from the street caused flash floods on City streets. When the sewer system, which is under the control of the City, not the MTA, was overwhelmed because of its limited capacity, the subway system became the default sewer system. Water runs from the streets into places that have not yet been either modified by the MTA, by permanent protective devices, or in some instances, would require that the MTA, in preparation of forecast heavy rainfall, would insert certain devices that require manpower to be put in place. In short, for heavy rain events, the MTA does not seem to have yet a well-functioning operational protocol.

To solve the street runoff problem requires cooperation between the City and the MTA. When and where City streets flood, the MTA would need to act in advance. This interagency cooperation seems operationally and administratively an unsolved problem. Because of climate change we must expect more frequent extreme rainfalls; therefore, such operational action plans need to be developed, tested and implemented with urgency, until a more permanent engineered solution can be put into place. Permanent engineered solutions are needed, to avoid street flooding in the first place, and at locations where street flooding seems unavoidable, we must protect the tunnel entrances by permanent, engineered measures.

Are there other gaps you feel should be prioritized either operationally or in terms of the actual physical infrastructure?

I was recently in the subway and while it was not one of the hottest days, it was very hot down there. Some of the subway stations are a real burden for vulnerable people, especially elderly people. Also, the MTA needs to pay attention during very hot days, to ensure that all subway cars have operating air conditioning.

More than once did I find myself trapped in a car that had no air conditioning. It is bad enough that subway stations have virtually no

cooling options.

On a much larger scale, way beyond just transportation issues: we need to think much harder about land use, urban planning, zoning, and especially about managed retreat from low-lying coastal areas. The future of NYC, and many other cities, does not lie at current waterfronts that are still considered valuable real estate. The future lies at safe, high elevations. Elevation counts!

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Would you say the money dedicated to safeguarding the transportation system after Sandy enhanced our long-term resilience to climate change?

Some of MTA's post-Sandy measures were effective for the time being. But we need a long-term comprehensive plan to reduce – if not eliminate – our infrastructure's long-term vulnerability to climate change. To date there has been little support on the governance side — from the New York State governor on down. If there are insufficient funds set aside to create sustainable resilience, any plans are just a piece of paper. And that's exactly what happened before Sandy. And even then, it took another one or two years beyond Sandy to act. I think the MTA finally put its climate change adaptation task force together in 2014. There was at least a five-year delay in just forming the task force from the time we had suggested it, not to speak of coming up with financing and implementing such a plan.

True, developing a vision has been hampered by financial constraints. Engineers and planners feel: what's the point of long-term planning if there is no foreseeable financing for implementing the plan? And that's the chicken and egg problem. That's not just a problem for the MTA. That is a general problem in the United States. Infrastructure funding is very limited. Right now, we have this infrastructure bill before Congress. It has not yet passed. It has potentially billions of dollars for infrastructure adaptation to climate change. But even that would be only a first step. It is a much broader, national infrastructure problem, not just an MTA, or subway problem.

It sounds overwhelming.

We need visionary plans. And not just technical plans, but also detailed capital plans. Often budgets last only an election cycle. We do have entities in this city, like the NYC Department of Environmental Protection. They have a long tradition of making at least midterm (decadal) capital plans. For instance, when the NYC DEP built the third water tunnel, that was a multi-billion dollar project and they had to fund it. How did they do it? They issued municipal bonds, and the costs of those bonds, which we pay for by our water bills, covered at least some of the expenses.

Is that something that you think we will see more of?

Municipal or State bonds are a typical financing instrument, but there has to be a political will and financial planning. And it cannot be just top-down, many of these planning issues require a consensus from communities. It's a very slow, elaborate and demanding process, and we need to work hard towards a consensus, combined with a sense of urgency. I gather that political will and a sense of urgency are both finally emerging. We have no choice!