DEATH AND DESTRUCTION BY ALGORITHM: A MASK FOR HUMAN RIGHTS ABUSES

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Abstract

As an example of policy-by-algorithm, we examine 'operations research' models adopted by the FDNY in the 1970's. The algorithms were used to justify immense service reductions mainly in densely populated, high fire incidence neighborhoods of color, neighborhoods where, in earlier years, fire companies had been opened precisely because of extreme fire hazard. The algorithms served as a smoke screen for policies of ethnic cleansing directed against minority voting blocs. The service reductions accelerated a combined fire/abandonment epidemic that destroyed many neighborhoods, forced mass migrations, and triggered a public health and safety crisis spanning the 1970's into the early 1990's. We explore the implications of this catastrophe for current uses of 'Big Data' and 'Artificial Intelligence' algorithms to implement discriminatory policies.

Key Words: algorithm, artificial intelligence, discrimination, ethnic cleansing, fire epidemic, operations research, public policy

1 Introduction

At the West 85th Street entrance to Manhattan's Central Park there is mounted a memorial plaque for the community of Seneca Village, erased from existence by the creation of the Park itself. Founded in 1825, the Village was one of the first free black neighborhoods in New York City. Slavery was abolished in 1827 in New York State, and Seneca Village attracted freemen who wanted to own land so that they could vote. Already, in the first half century of the United States, well before the Civil War, voting rights for African Americans motivated a pattern of settlement in New York City. With the wave of immigration due to the Irish Potato Famine, Irish families also settled in Seneca Village. By 1853, one third of the population was Irish but the land was up for grabs to create Central Park. Politicians began calling Seneca Village a shanty town and smearing it, although the integrated inhabitants were educated and hard-working. Eminent domain legislation passed in Albany doomed Seneca Village and its residents were uprooted: the episode of Seneca Village set cultural and political precedence and a historical trajectory for evicting both African American communities and immigrants. For information on Seneca Village, go to Wikipedia and references therein.

More recently, public policies and private practices have destabilized communities of color in most major American cities, with New York acting as a laboratory. Indeed, Donna Shalala, later HHS Secretary in the Clinton Administration, boasted that New York would be the laboratory for increasing efficiency of providing municipal services when she was director of the Municipal Assistance Corporation during the 1970's fiscal crisis.

Long before the opportunities for planned shrinkage that arose just before and during that fiscal crisis, communities of color suffered from red-lining (denial of mortgages and property insurance), urban renewal, and racial steering. The federal mortgage and insurance agencies such as FHA had an explicit algorithm whereby neighborhoods with more than a particular percent of their population black would be redlined and an actual red line was drawn around the neighborhood on the mortgage and insurance map. After this practice was abolished, the private finance and insurance firms retained it. Thus, the FAIR Plan came into being in 1968, as a quasi-governmental property insurance plan for poor communities. The Plan, however, was flawed in that it charged relatively high 'risk rates' for premiums while paying out much reduced 'market value' rates on actual damage. As a consequence, landlords were often unable to repair.

For the effects of urban renewal, see Joel Schwartz's 1993 book, *The New York Approach.* Schwartz provides the details of how the 'master builder' Robert Moses wooed liberal white New Yorkers into supporting urban renewal, the numbers of people who were evicted, who benefited from the land grab, and the social outfall of tearing these communities apart. Indeed, a fairly large literature documents the horrors of urban renewal. For example: *Root Shock*, a 2005 book by Mindy Fullilove. By the late 1960's, urban renewal had become politically toxic in New York City when the major religions, headed by the Episcopal bishop, condemned it.

After 1960, many shifts occurred that made chivying the neighborhoods of color even more necessary, in the eyes of the political establishment. The civil rights movement began looking toward the North. The Model Cities Program actually worked at least partially, and communities of color were becoming more educated, organized, and empowered. By the late 1960's, black and Latino candidates were appearing for citywide offices in New York itself, and by 1970, Black mayors were elected in Newark, Detroit, and other cities.

New York City Mayor John Lindsay, to great fanfare, embraced the policy of weaning defense corporations away from war work by giving them civilian work.

So at the same time that the Rand Corporation was mathematically modeling the Indochina War and falsifying body counts so crudely for the Nixon Administration that Viet-Nam would have been essentially depopulated if that many died, Lindsay invited Rand to form the New York City/Rand Institute, a quasi-governmental chimera with no accountability. However, this policy masked other agendas. Lindsay seconded Spiro Agnew's nomination for vice-president at the 1968 Republican convention; Agnew conceived the Republican Party's infamous 'Southern Strategy' to woo Southern Democrats by gutting Civil Rights and funneling Federal money South. Harvard professor Daniel P. Moynihan became President Nixon's urban policy advisor and wrote the infamous 1969 'Benign Neglect' memo to Nixon. The memo included considerable misinformation about fire in New York City supplied by NYC/Rand Institute, especially the role of 'arson' in the burgeoning fire epidemic. The Benign Neglect memo blamed the residents of poor neighborhoods of color for the fire problem, the same smearing technique that destroyed Seneca Village.

2 The New York City/Rand Institute and its Fire Project

The fire service unions in New York City had addressed a sudden rise in fire workload with the creation of the FLAME Committee in the late 1960's. The FLAME Committee amassed data about fire incidence, fire damage, civilian deaths and injuries, firefighter deaths and injuries, and unit workload. With these data, the unions convinced the Public Employee Relations Board (PERB) of New York State that fire companies had to be opened in the areas suffering the worst of the fire rise. In negotiations with FDNY before the PERB, the unions won opening of second sections of grossly overworked companies in the high-density neighborhoods of old housing. With the opening of 16 companies, the number and size of fires began leveling off. Average damage dropped. Deaths and injuries declined. The FLAME Committee used global measures of fire service such as damage, injuries, and deaths.

In March, 1970, Deputy Chief Charles F. Kirby wrote a memo to Fire Commissioner John T. O'Hagan in which he laid out in some detail the impending firestorm that was to consume the Bronx, explicitly citing the newly-opened 'second section' fire units as essential to containing that catastrophe. Excerpts from what became known as 'The Kirby Report' are included in the Appendix to this paper. It is worth noting that there was a similar 'Jonat Report', patterned on Kirby's effort, that predicted a similar firestorm in the Bushwick section of Brooklyn.

In 1969, Roger Starr, who later became Housing Commissioner in NYC's Beame administration and a member of the New York Times editorial board, provided the intellectual political framework to undo the victory of the FLAME Committee, namely 'planned shrinkage' whereby neighborhoods are triaged and those deemed dying get their services cut. Planned Shrinkage is the local adaptation of Moynihan's Benign Neglect. To implement Planned Shrinkage, the NYC/Rand Institute's Fire Project opted to use internal measures such as model-calculated response time of the first-arriving engine to evaluate fire service. Before we get into how these internal measures were warped and allowed stripping of fire control resources, we briefly review something of building fire dynamics.

Fires in NYC have many causes: leaving a pot on the stove untended, overloading an electrical outlet, careless disposal of matches and cigarette butts, improper storing of organic material leading to spontaneous combustion, piling up of building trash, children playing with matches or stoves, boiler malfunctions, elderly wiring, and deliberate fire setting. Even during the height of the fire epidemic of the Brooklyn neighborhood of Bushwick, we found that fewer than half the fires were deemed suspicious, let alone judged arson. All other fires had normal causes.

Fires grow exponentially in time, with a slow initial phase that ramps up into very rapid spread from the origin. Additionally, heat from relatively small fires can thermally decompose organic materials and generate high concentrations of combustible gases which explode when they come into contact with the flames (flashover) and lead to general involvement in the room of origin. Details of speed of spread, flashover, combustibility of the smoke and fumes, and other characteristics of spread depend on quality and quantity of the fuel load, design of the room and building, behavior of the people, and building materials (wood vs concrete for example). Rapid teamwork by engine and ladder companies is absolutely necessary to keep fires small.

Before 1975, a fire service alarm assignment was three engines, two ladders, and a battalion chief. For multiple dwellings, the first arriving engine and ladder would tackle the fire floor and the second arrivals the floor above to block spread. The third engine would stand fast in case of need of firefighters, equipment, or relief unless the fire was an 'all-hands' from the start. Furthermore, each engine had five firefighters and each ladder six. The engine staff put water on the fire; the ladder, opened doors, vented, and rescued. Furthermore, the chief could call extra alarm assignments as needed, five units arriving rapidly. The tactics for fighting tenement fires in crowded neighborhoods had evolved under a draconian 'selection pressure' over many decades, to become almost a kind of highly skilled 'ballet' performance on the fire ground.

We developed an index of fire damage that was based on a principal component analysis (PCA) of number of structural fires, number of 10-75 'all hands' fires, and of 'extra alarm assignments' (EAA), alarm assignments above the initial response. The largest principal component, representing an environmental index of 'fire volume', was then adjusted so that zero fires gave a zero index. See Figure 1.

After the opening of the units under the negotiation with the FLAME Committee, that damage index stabilized and even declined after 1968, until Rand and the FDNY began closing companies in poor neighborhoods and permanently relocating them out of poor neighborhoods in November, 1972. Figure 2 lists the neighborhoods that lost fire companies, and the number of lost compa-

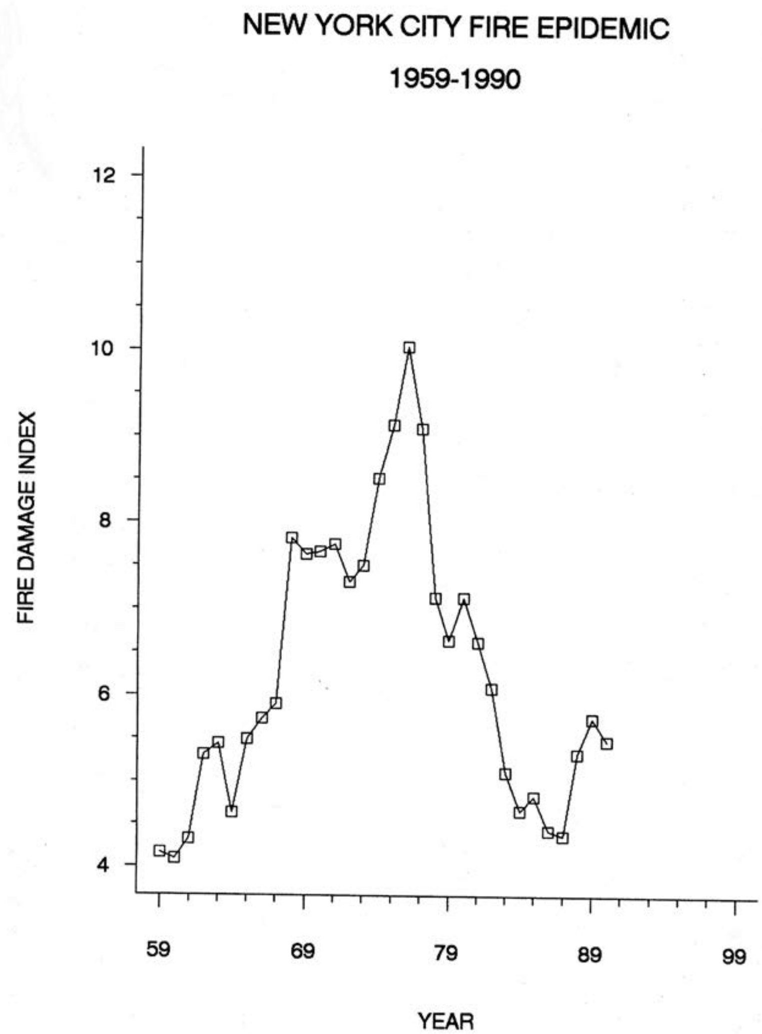

Figure 1: Composite index of structural fire damage, 1959-1990, in New York City. The sudden rise from 1967 to 1968 impelled the fire service unions to successfully demand the opening of 'second section' companies in the worst affected communities. Fire damage began declining until the Rand models were used to justify closing companies. The subsequent peak represents a contagious fire/abandonment epidemic that reduced housing stock to a level that could be accommodated by the reduced level of housing-related municipal services.

nies. Other neighborhoods were then drained of fire service by the 'relocations' needed to, at least partially, fill the resulting geographically concentrated service deficits.

FIRE COMPANY CLOSINGS, 1972–1991

BOROUGH	NEIGHBORHOOD	NO. OF REMOVED COMPANIES
Manhattan	Lower East Side	4
	Lower West Side	3 (2 restored)
	Times Square	1
	Upper West Side	2
	Harlem	3
Brooklyn	Brownsville	6
	Bedford-Stuyvesant	2
	Crown Heights	1
	Greenpoint	2 (1 restored)
	Park Slope	2 (1 restored)
	Red Hook	1
	Brooklyn Heights	1
Bronx	South Bronx	7 (1 restored)
	City Island	1 (restored)
Queens	Flushing	1
	Richmond Hills*	1
	Rockaway	2
	Stapleton	1
	Tottenville	1 (restored)

Total: 42 areas affected, 34 permanently.
(Only one of the restored companies was in a poor area.)

*This company was closed and reopened twice.

Figure 2: Neighborhoods that lost fire companies and the number of companies they lost. Other neighborhoods, often city-wide, suffered serious indirect fire service reductions as their units were 'relocated' in attempts to cover the resulting direct service holes caused by the Rand models.

The most sophisticated mathematical operation that Rand used to model response time was taking a square root. Children in eighth or ninth grade learn about square roots. Yet, just last year when then-City Councilman James Vacca asked the FDNY for its algorithms, he was told that he wouldn't understand them and thus would not receive them. So we know that these models used to close and move fire companies provided (excuse the pun) an essential smoke screen intended to keep communities and their elected representatives silent in

$$r_i = k_i \sqrt{\frac{A_i}{C_i - U_i}}$$

where r_i = average response time within area A_i

k_i = a constant depending on average velocity

C_i = the number of companies in area A_i

U_i = the number of companies in area A_i unavailable for dispatch.

Figure 3: The Resource Allocation Model

the face of high tech. In one swift operation, FDNY and Rand disempowered both communities and labor unions. The genius of the FLAME Committee was its identification of community and firefighter dangers.

The first three rounds of company cuts and permanent relocations, 1972-1974, depended solely on the Resource Allocation Model of Figure 3.

Very large areas of the city were divided up into hazard regions and labeled as to an assigned hazard level within a scheme of seven levels. The division itself was biased. For example: East Flatbush and Astoria were classed in the same hazard level as Riverdale, although Astoria had major industrial sites with large fuel tanks and East Flatbush had higher population density and higher concentrations of tenements than Riverdale. Harlem was lumped into the same huge region as the Upper West Side although its population density, housing overcrowding, and housing conditions differed greatly from those of the Upper West Side.

The geography of the hazard regions was partly motivated on the way that the Resource Allocation Model worked. Regions within the hazard designation that enjoyed lower than average model-calculated 'response times' for that designation would lose a company to even up the 'response' times. So, of course, the regions of high company density due to high fire incidence and size would lose companies because they hosted several second units opened by the FLAME Committee negotiations. The formula and its application ensured that high population density areas of extreme housing overcrowding and housing in poor condition would lose companies. Average velocity was assigned as 20 mph.The number of unavailable companies is an estimate based on alarm rate and estimated operation time. Mirabile dictu, these areas turned out to be largely African-American, Latin-American, and low income.

The 1975 and later rounds of company closings and permanent relocations depended on the Fire House Siting Model as well as the Resource Allocation Model. The Resource Allocation Model would identify regions of lower than average travel time. The Fire House Siting Model would choose the company

$$T(D) = 2\sqrt{D/a} \qquad \text{if } D \leq 2D_c$$

$$= V_c/a + D/V_c \qquad \text{if } D > 2D_c$$

where a = acceleration $\qquad V_c$ = cruise velocity

D = distance $\qquad T$ = travel time

D_c = distance to cruise velocity.

Figure 4: The Firehouse Siting Model

within the regions to close or relocate permanently.

The cruise velocity and distance to cruise velocity were data acquired from 15 fire companies: thirteen ladders and two chiefs' cars. Eleven of the fifteen were in Manhattan below 14th Street. So the actual data were non-representative on many fronts. The data also lacked quality; they were acquired by company officers using stop watches and taking notes. We will discuss the deep problems with these data below: the dynamics of congestion on real road networks is not well understood, and has been the subject of study since the 1930's by many of the world's most sophisticated scientists and engineers, with great controversy down to this time.

It is important to note that the Rand/FDNY travel time calculations were not for the distance between the firehouse and the fire building, but between the firehouse and the street alarm box.

Think about that. A whole segment of travel is ignored in both Rand models.

Models of this extreme simplicity would never be used for policy decisions on management of wild animal populations; yet they were used to determine service levels on which lives, homes, and property depended. Figures 5-7 display lists of simplifying assumptions, relevant policies that were ignored, and relevant changes in service and neighborhood conditions.

For example: in 1975, one firefighter was taken off each company and an alarm assignment was reduced to two-and-two plus chief. Later, when heart attacks began to pile up in engine companies, the lost ff was restored temporarily to engines in areas of multiple dwellings. The Bloomberg Administration reversed this restoration. In 2016, five engines got back the fifth ff; in 2017, another five engines got the fifth ff. So the Rand models were and are being applied uniformly over times of non-uniform fire responses.

It is interesting to note that NY FAIR Plan insurance data showed a step function increase in dollar loss per fire in Brooklyn after July, 1975, the 'fiscal year' month in which the fourth round of company closings occurred.

Model Assumptions vs. Reality

Assumption 1: Unchanging ratios of types of alarms
Reality: Rapid changes both citywide and within areas. Physical and social instability leads to rapid changes
Model: Resource Allocation Model

Assumption 2: Predictable alarm rates
Reality: Rates highly variable from year to year
Model: Resource Allocation Model

Assumption 3: Service times independent of each other and of the state of the system
Reality: Many factors increase service times: servicing of alien areas, firefighter exhaustion, dispatching delays during peak periods
Model: Resource Allocation Model

Assumption 4: Availability of units is stable
Reality: Massive changes in availability with cuts and with unstable alarm rates
Models: Resource Allocation Model and Firehouse Siting Model

Assumption 5: Very low probability of all units busy in an area
Reality: Even borough-wide unavailability (all busy) sporadically since April 1975
Models: Resource Allocation Model and Firehouse Siting Model

Assumption 6: All alarms are answered from the firehouse
Reality: Alarms are regularly answered from the field, especially during peaks in high-alarm areas
Models: Resource Allocation Model and Firehouse Siting Model

Figure 5: Problems with the Rand fire models 1.

Local variables omitted from the NYC-Rand models

1. Potential for fires to spread between buildings
2. Hydrant pressure and maintenance
3. Design of streets
4. Parking customs (double-parking, parking at hydrants)
5. Presence of special hazards (natural gas tanks, pipelines, etc.)
6. Variable traffic patterns
7. Arson rate
8. Age structure of the population: the old and children are especially susceptible to fire-injury and death
9. Special seasonal fire characteristics such as brush fires and the use of heaters and stoves in areas of many heating violations
10. Access to means of turning in alarms reliably
11. Population density and changes therein
12. Spatial and temporal patterns of fire occurrence on the neighbourhood level, *e.g.* Harlem and the affluent Upper West Side were lumped into a single 'hazard region'

Workload policies confounding the models

1. In busy areas, the nearest fire company was not always the one dispatched to the alarm. A less busy one may have been sent
2. Companies are given a two-hour rest after a big fire or after many small ones
3. 'Interchange' exchanged busy with less busy companies to even out the workload. The lack of familiarity with the busy area degraded service
4. In the mid-1970s, relocation occurred mainly between ghettos. Relocation sends a company into another company's service area if that service area has all units out working

Figure 6: Problems with the Rand fire models 2.

Let us focus on the heart of these models: travel time and travel velocity. A fundamental basis of the Rand models was and is an assumption about 'travel time vs. distance'. Figure 8, from Rand (1979), shows a typical 'empirical model fitting' exercise for such a relationship, here, across the full Trenton, NJ road network in 1975. Rand collapses an obviously diffuse pattern into a simple 'square root-linear' model. Wallace and Wallace (1977, pp.33-34) show two NYC examples.

For contrast, figure 9, from Wallace (2018a), shows traffic flow vs. linear vehicle density for road segments in Rome, Japan, and Flanders. A similar figure for the Minneapolis-St. Paul road network can be found in Wallace (2018a, Fig. 3.2). The essential point is that, above a critical traffic density of vehicles/unit length, traffic flow undergoes a 'phase transition' into irregular, clumped, and jammed conditions that are not predictable. At high traffic densities, these changes can be analogous to the sudden freezing of a 'supercooled' fluid when triggered by some minor shock. Indeed, as said, many of the world's finest minds have been, and remain, stymied by such 'phase transition' behavior, which occurs in many so-called 'complex systems' and is not restricted to traffic flow.

In the early 1970's, however, the brilliant people of the NYC/Rand Institute had 'solved' the traffic flow problem by simply collapsing a nearly-random data point cloud onto a 'square root-linear' model.

Inadequacies of the Rand models did not go unremarked at the time. Some

Policy changes that increased size of fires or alarm rates, 1972 – 1976

1. Closing or moving fire companies from high fire-incidence areas
2. No voice contact on emergency response system (ERS) boxes gets at most one engine response
3. 1972 – 1974: less than standard responses to ghetto alarms
4. staffing reduction: five to four on engines, six to five on ladders
5. Reliance on firefighters tired from mandatory overtime
6. Understaffing in dispatch centres delays the response
7. 1974: reduction by one engine in the standard response
8. Dispatchers and battalion chiefs can no longer call automatic higher alarms but are pressured to 'special call' units one by one
9. Cuts in trash collection lead to more trash fires
10. Cuts in building inspections lead to more fire violations left unremedied
11. Understaffing of fire marshals hampers arson investigations
12. No more inspection for repair of fire damage contributes to building abandonment
13. Cuts in hydrant inspection and repair increase the percentage of defective hydrants

Figure 7: Problems with the Rand fire models 3.

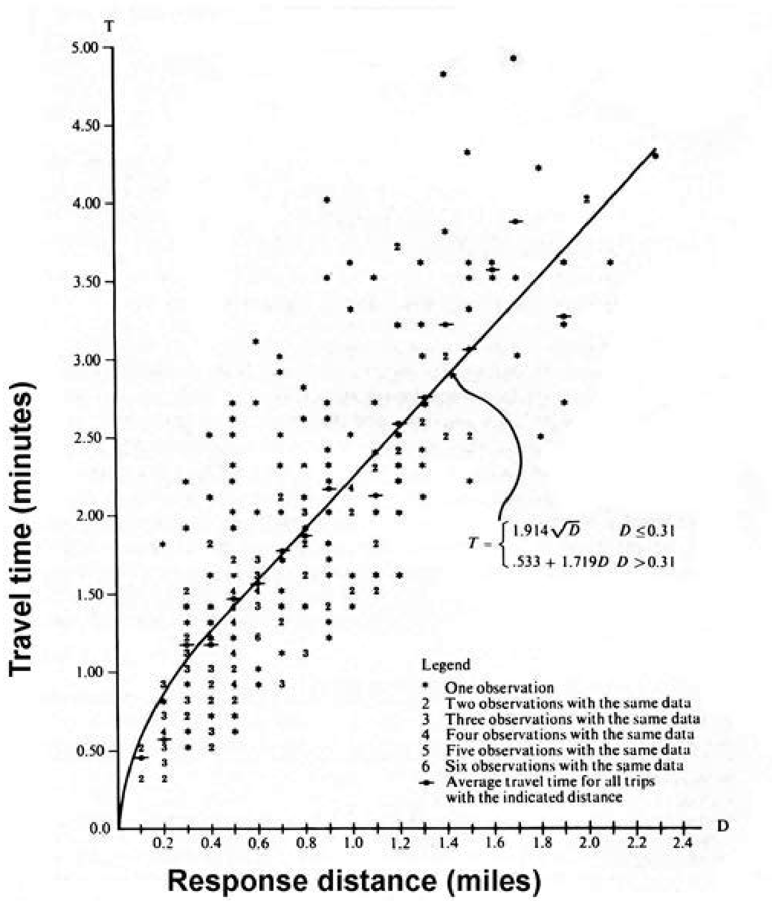

Figure 8: Adapted from Fig. 6.4 of Rand (1979). Relation between fire company travel time and response distance for the full Trenton, NJ road network, 1975. The Rand Fire Project collapsed evident large-scale traffic turbulence into a simple 'square root-linear' model used to design fire service deployment. Real traffic flow is highly dependent on nonlinear 'phase transition' effects driven by traffic density and road conditions. See Fig.9.

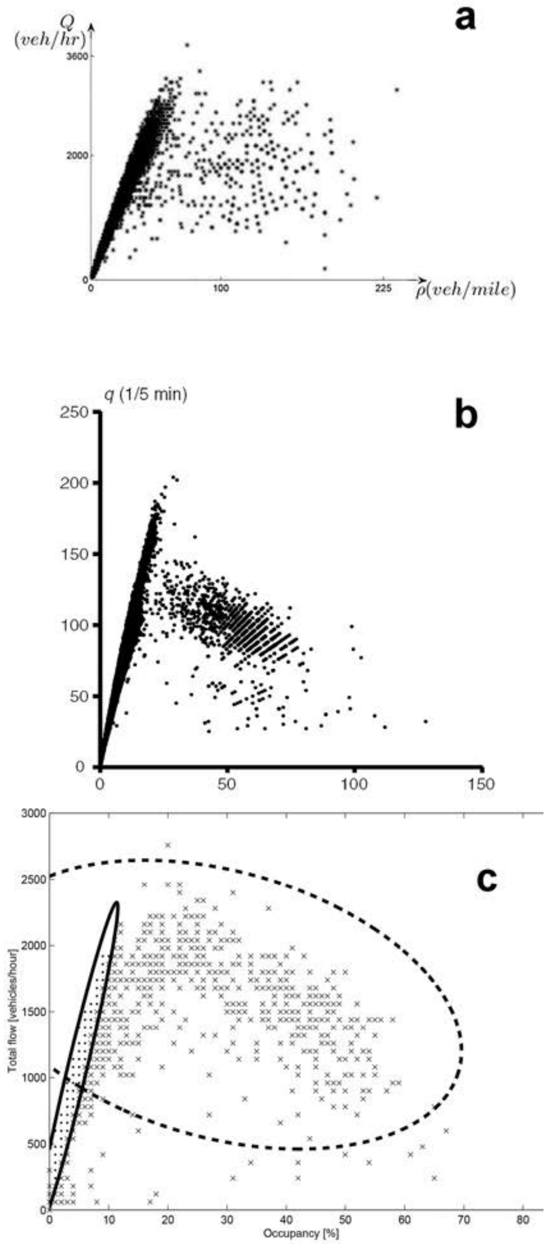

Figure 9: (a) Vehicles per hour as a function of vehicle density per mile for a street in Rome (Blandin et al. 2011). (b) One month of data at a single point on a Japanese freeway, flow per five minutes versus vehicles per km. (Sugiyama et al. 2008).(c) 49 Mondays on a Flanders freeway (Maerivoet and Moor 2006). All show a highly irregular 'phase transition' to traffic jam conditions at a critical value of traffic density.

had been the subject of formal inquiry by the New York State Assembly Republican Task Force on Urban Fire Protection, under the aegis of Minority Leader Perry Duryea. The Task Force concluded as early as 1978 that

> [T]he level of fire protection provided by the New York Fire Department ... contributed to the deterioration of neighborhoods and has increased the hazard to human life, and there is a strong indication ... [that] undue loss of life has occurred. While the fiscal crisis [of 1975] has been a major influence, fire department policies dating back to 1969 laid the ground work for this deterioration.
>
> Commencing in 1969 New York City hired the Rand Corporation to develop computer models, such as used in defense planning, to improve the efficiency of fire services. The models they developed were simplistic and inadequate, failing to consider many needed variables, and employed methodology inappropriate to the intended purposes ...
>
> There is strong indication that as neighborhoods deteriorated, the fire department redlined [them] ... further hastening deterioration and causing the fire blight to spread to previously viable neighborhoods (Mega 1978, page 2).

In a preamble to that report Duryea stated

> [There] are indications that the City Planning Commission and other agencies condoned [fire service] reductions in the context of a 'planned shrinkage' policy ... [which has] resulted in the unwarranted loss of life and destruction of city neighborhoods (Duryea 1978, page 3).

Indeed, as early as 1972, Edward Ignall, a principal architect of the Rand fire models, distributed an internal memo titled 'What is a minute of response time worth?', in which he made many of the criticisms that were later published in Wallace and Wallace (1977). Ignall writes

> First: we do not have response times. The best we can do are Euclidean distances from an alarm box near the incident to the house of the first arriving engine... Actual first arriving engine and ladder response times may not be in one to one correspondence with these distances for several reasons...
>
> Second: We do not have good measures of the extent of fire when fire companies arrive and of the damage once it has been extinguished
>
> Third: Delays in discovering fires are sometimes long, sometimes short... they are probably more variable than response times...
>
> Fourth: Some fires grow quickly, others grow slowly...
>
> Effects like these can cripple a naive approach to estimating the value of response time.

More specifically, while ambulance response time is critical in bringing an individual to a hospital, fire service must build a 'hospital' around a 'patient' who is growing sicker at an exponential rate. The 'response time' of the first arriving unit is a minor factor compared with the adequacy of the full initial response and its staffing level. These latter questions are best answered by empirical examination of damage and injury patterns.

3 Impact of the fire service reductions

Correspondence with FDNY's Planning and Operations Research Dept. (PANDOR) indicated that the Department used a relatively simple empirical measure of unit response time, having the form

Response Time = (Time Unavailable − Worktime)/Number of Responses = (1/3)(Operational Time − Worktime)/Number of Responses

Figure 10, reproduced from p.31 of Wallace and Wallace (1977), examines these numbers for ladder and engine companies 1972-1975, using data released to us under a Freedom of Information lawsuit. Unremarkably, if disturbingly, as service was cut, ladder response time increased irregularly according to this crude measure. Ladders were not closed until 1975. Somewhat more remarkably, calculated engine company response time decreased exactly linearly without scatter during that period, in a perfect straight line down.

The table on p.47 of Wallace and Wallace (1977) shows how this miracle occurred: some fire companies were reported in official year-end statistics as responding on average to fires as many as three minutes before they were reported.

Really.

When one of us communicated these discrepancies to law enforcement (the 'Bronx arson task force' of the time), the reply was 'maybe it isn't against the law for the Fire Department to manipulate policy planning statistics'. This was the response of law enforcement in a time of mass social catastrophe.

Figure 1 represents a contagious fire/abandonment epidemic curve focused in the city's most overcrowded sections which were, of course, also the centers of ethnic minority voting blocs. Fire service had acted as a kind of immune system against contagious fire/abandonment dynamics. A fire that suddenly gets out of control, extending beyond a single room, and either out the windows or to other units, marks a building or an entire block.

Typically, the landlord is unwilling or unable to repair significant fire damage. Landlords on the block now marked by fire stop maintenance and begin milking the buildings in preparation for abandonment, resulting in more fires that further mark the block. People begin to move out. Disturbed individuals begin setting fires in abandoned buildings. Whole blocks become engulfed, and the process moves on to adjacent blocks until enough residents have moved out to bring the number of overcrowded housing units below epidemiologic threshold,

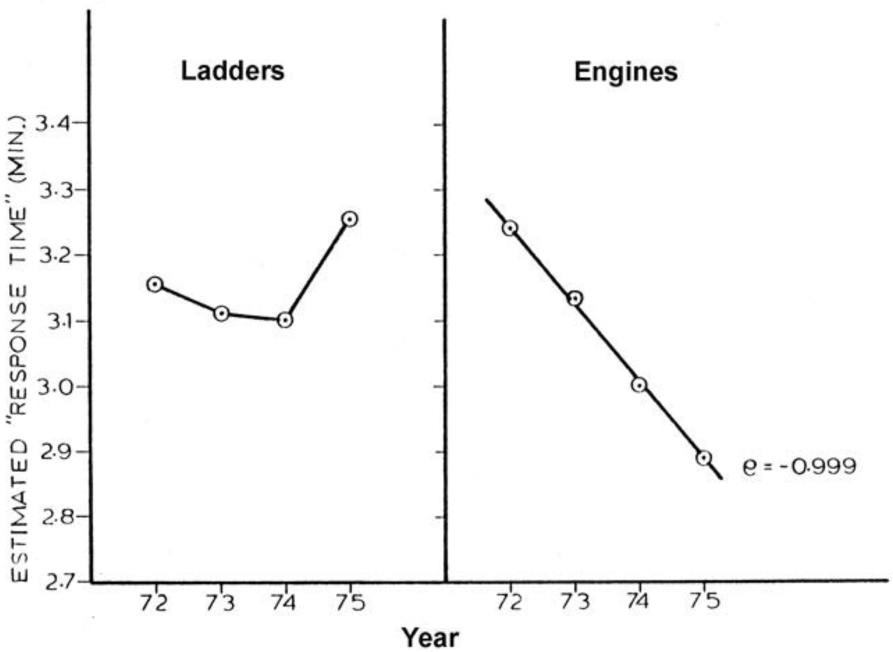

Figure 10: Using the PANDOR formula, estimated 'response time' for Ladders and Engines, 1972-1975. While the 'response time' for Ladders shows degradation beginning with closings in 1975, the values for Engines display a straight line decline as companies were closed. Getting this result required working the statistics so that some Engines were reported as responding to fires, on average, more than three minutes before they were reported.

and the process shuts down. In essence, the number of housing units declines by fire and abandonment to a level that can be supported by a reduced fire service.

It is possible to estimate a geographic region's susceptibility to fire/abandonment catastrophies, although their timing depends deeply on public policy. Figure 11 shows, for 'Health Areas' in the Bronx by which mortality and morbidity statistics are reported, the change in percent population 1970-80, as a function of the product of city HA SES rank and percent badly overcrowded housing in 1970, i.e., housing with more than 1.51 persons per room.

Figure 12 maps, for Bronx Health Areas, the loss of housing and population, 1970-1980. The Bronx, with 1.4 million persons, was one of the largest metropolitan regions in the developed world. Between 1970 and 1980, it suffered a level of loss similar to that experienced by European, Russian, and Japanese cities during WWII.

Figure 13 shows the pattern of forced migration citywide, using school transfer data. Needless to say, children suffering displacement as de-facto refugees will suffer many of the problems that are well known in refugee camps: failure to learn, failure to thrive, loss of social support resulting in higher levels of interpersonal and intercommunity violence such as gang warfare, substance abuse, sexual risk-taking, etc. The refugee literature is immense.

As an example of the impact of this massive disruption, Figure 14 shows the impact of massive forced displacement on New York City's homicide rate.

In essence, following the massive disruption of community networks needed to both socialize adolescents and limit 'acting out', homicide rose from about 500 to around 2,000 deaths per year, and remained at or near that level for nearly a generation, some 20 years, resulting in perhaps 30,000 excess mortalities. It can be expected that perhaps another 30,000 persons were seriously injured in that time and shunted onto life course trajectories resulting in premature mortality. McCord and Freeman (1990), in their study of Central Harlem after the loss of about half its housing to the fire/abandonment epidemic triggered by the fire service cuts, found that, as a consequence of substance abuse, homicide, and AIDS, men in that community had their life expectancies reduced to below the level of men in Bangladesh.

We are led to estimate that the fire/abandonment epidemic triggered by 'planned shrinkage' fire service reductions focused on ethnic minority voting blocs resulted in as many as 100,000 premature mortalities over a 30 year period. Even by 20th Century standards, this is not a trivial number.

Indeed, as an anonymous public official put it, 'planned shrinkage shotgunned AIDS over the Bronx'. Other studies (Wallace et al. 1999) explore how New York City, as the peak of the US urban heerarchy, fueled the spread of AIDS nationally.

Fire deaths form only a small fraction of policy-driven deaths, but do provide a measure of fire service adequacy.

We have shown the faking of the internal measure of service, engine response time. The public was also bamboozled with faked fire death data. See Figure 15.

Before the FLAME committee second sections opened, fire deaths closely

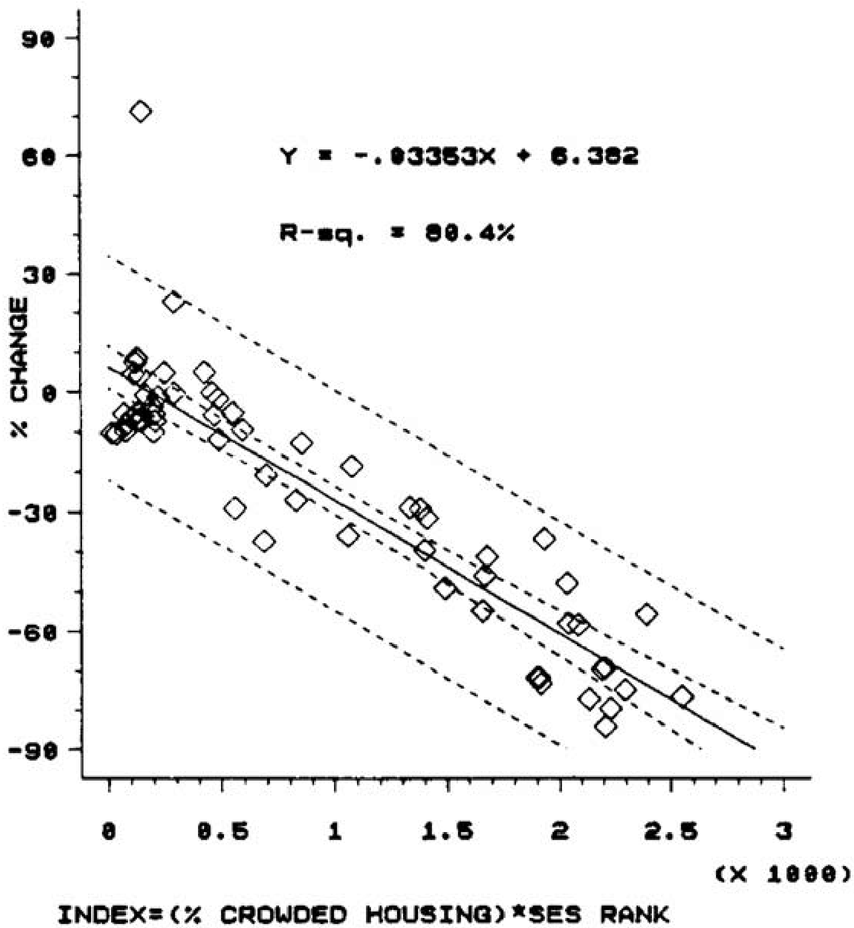

Figure 11: From Wallace 1990. Percent change in contiguous Bronx Health Area population 1970-80 vs. the product of the 1970 values of citywide SES rank and percent badly overcrowded housing. The outlier contains the 'Coop City' development and has been omitted.

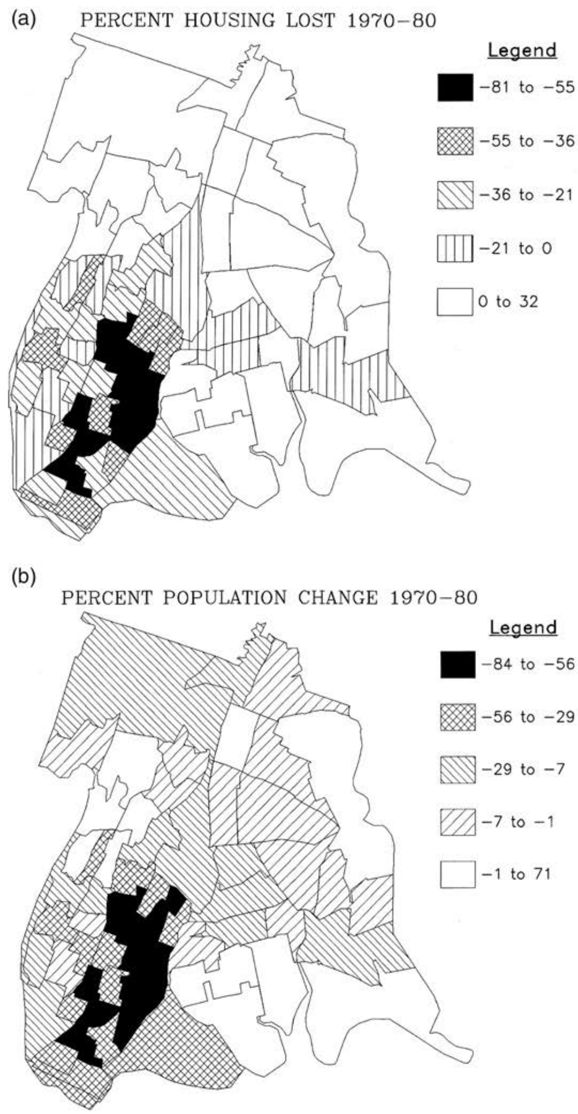

Figure 12: (a) Percent housing units lost by Bronx Health Area, 1970-1980. (b) Percent population change by Bronx Health Area, 1970-1980. This is a level of damage not seen in modern times outside of protracted armed conflict.

Figure 13: From Wallace 1990. NYC Planning Commission map showing the magnitude and direction of pupil transfers between Community School Districts for the school year 1974-75, time of maximum occupied structural fire worktime for the Bronx.

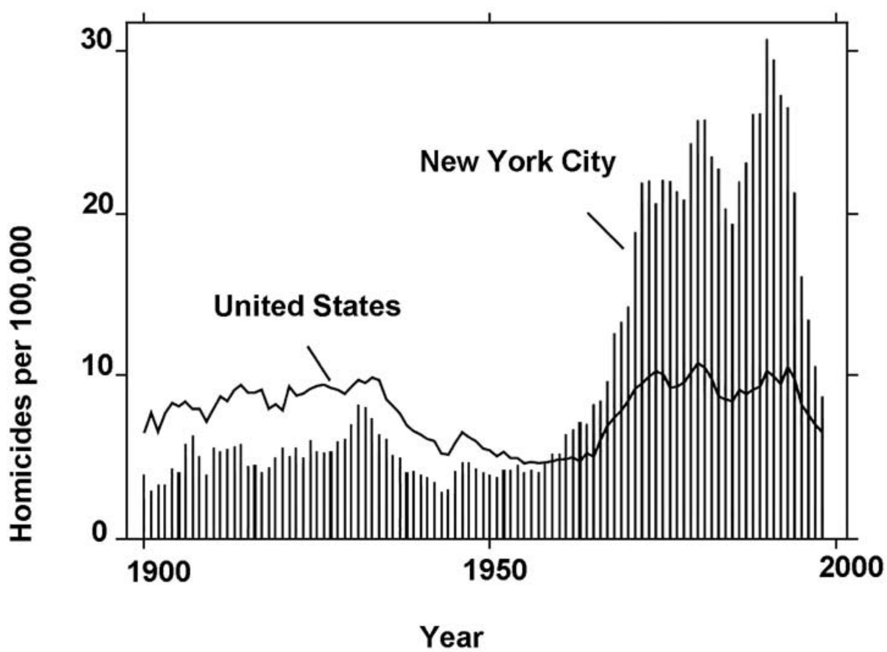

Figure 14: Adapted from Monkonnen (2001). New York City homicide rate per 100,000, 1900-1995, compared to total USA rate. The second NYC peak appears to represent a second wave of social disintegration subsequent to the initial burnout of minority communities, i.e., the 'crack wars' that followed the dispersion of social networks needed for the socialization of the young and their entrainment into adult patterns of work and family.

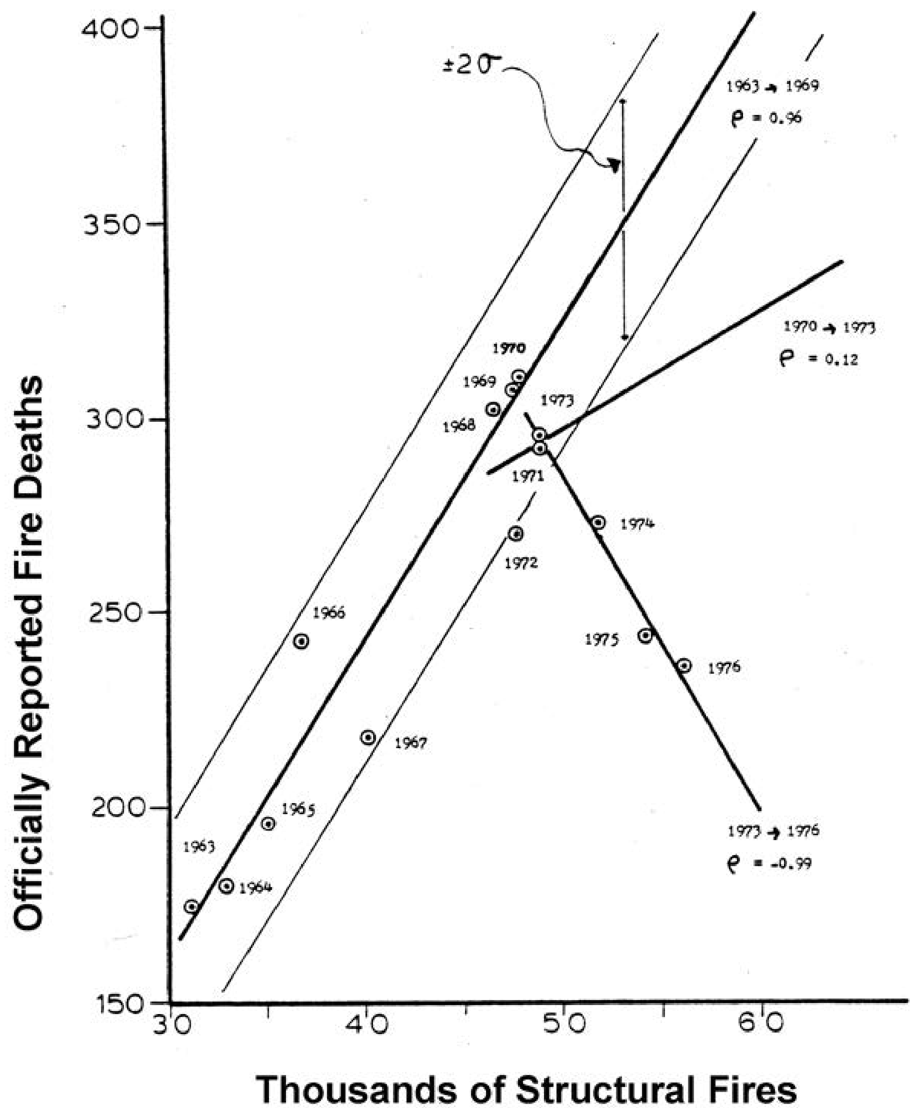

Figure 15: Reported NYC fire deaths vs. number of structural fires. The 1973-1976 results are impossible: while fires increased, reported deaths declined in a perfect straight line.

tracked structural fire numbers. Opening the second sections led to smaller fires and fewer deaths per thousand fires. It also stabilized the number of fires. Closing the companies led to immediate rise in fire deaths and fire size. Number of fires per year resumed its increase. But another miracle happened, according to Rand and its collaborators within FDNY: reported fire deaths dropped!

Here we have the other side of the coin of the faked body counts in Viet-Nam, reporting of ever lower numbers of fire deaths. The fire service unions got together with us and presented our combined data to then Assemblyman Charles Schumer who exposed this fakery in 1978. The unions produced individual instances of deaths that were not recorded and we showed this unbelievable relationship between fires and deaths: the more fires, the fewer deaths in a perfect linear relationship. So the firefighters of the fire epidemic era were superheroes with magical powers: they could arrive at fire scenes before the fire was reported to the dispatcher and they could raise the dead. Both internal and global measures of fire service were falsified during the fire epidemic to silence concerned residents and their elected representatives. We have concluded that the fire epidemic brought into extreme intensity by the cuts in fire control resources killed people both directly and indirectly. It also severely affected public health via housing destruction.

One example of public health backsliding from the cascade of effects from the housing destruction was the tuberculosis epidemic of the late 1970's-early 1990's, shown in Figure 16.

The patterns of extreme housing overcrowding, largely determined by the housing destruction and resulting migrations, fueled the rise in TB cases. Housing units with more than 1.51 persons per room are extremely overcrowded.

Figure 17 shows TB was allowed to spread from its primary foci in Central Harlem and the Lower East Side to secondary foci in the South Bronx and Brooklyn. It spread geographically from these foci until all health districts but the wealthy Upper East Side entered into the epidemic. All health districts but the Upper Eastside had a higher 1990 TB new case incidence than incidence of 1978. Figure 18 shows a three-year running average of TB cases vs. year, 1979-89.

This is a classic epidemic curve.

In 1991, the NY Academy of Medicine had to call on the Dinkins Administration to declare a public health emergency. Dinkins had booted Kevin Cahill, the tropical disease expert, off the Health Commission in 1990 for forcefully proposing a public health emergency. Yet the epidemic had begun surely in 1979. The TB epidemic began ebbing in 1993, the same year the homicide, AIDS, and low-weight birth epidemics began ebbing and before the directly observed therapy program was fully operational. Fifteen years had passed since the 1978 ending of the fire-and-abandonment intertwined epidemics, and communities had rebuilt themselves somewhat socially. The authorities bamboozled the public again by claiming that the ebbing was caused by imposing directly observed therapy.

The NY Academy of Medicine called a conference in 1989 on Housing, Community, and Health where many of the public health consequences of the fire-

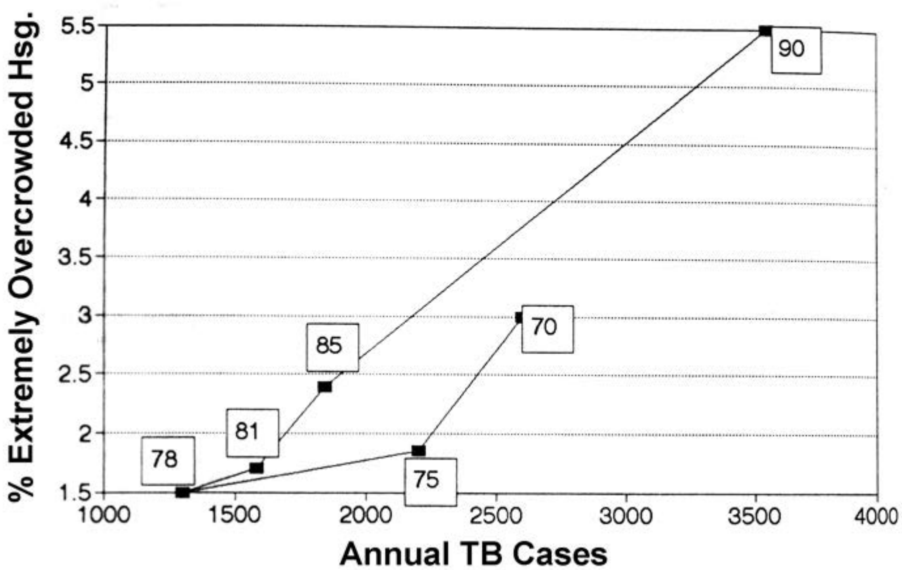

Figure 16: Relation between annual tuberculosis cases and percent of extremely overcrowded housing in NYC.

and-abandonment epidemics were analyzed. Papers from this conference appeared in the NYAM Bulletin, Vol. 66, 1990. Struening et al. gave a paper on housing unit loss and quality of singleton births, using birth weight as a measure of quality. The massive loss of housing resulted in elevated incidence of low-weight births in the affected populations. The difference in incidence of low-weight births between affluent white and poor black neighborhoods widened.

The Center for Children's' Environmental Health at Columbia School of Public Health employed us as their social ecologists in 1997. Hundreds of pregnant women in Upper Manhattan and the South Bronx were recruited as participants in a long-term study on children and environment. D. Wallace (2011) looked at the weights of infants born 1997-2000 to women of different age cohorts.

Figure 19 shows that babies born to women themselves born during or immediately after the fire epidemic (1975-1979) had lower birth weights than those born to women born 1970-1974 or 1965-1969. Also, the percent of these babies in the low birthweight category (lower than 5.5 lbs or 2500 gm) was much greater in this cohort of women. The effects of this disaster are intergenerational to at least the third generation. About half the women were African-American; the other half, Dominican. This cohort effect runs against the well-established pattern of age-related decline in birthweight among African-American women, the famous 'weathering' effect first detected by Arline Geronimus (1996).

The intergenerational effect goes beyond the cohort expression of low-weight

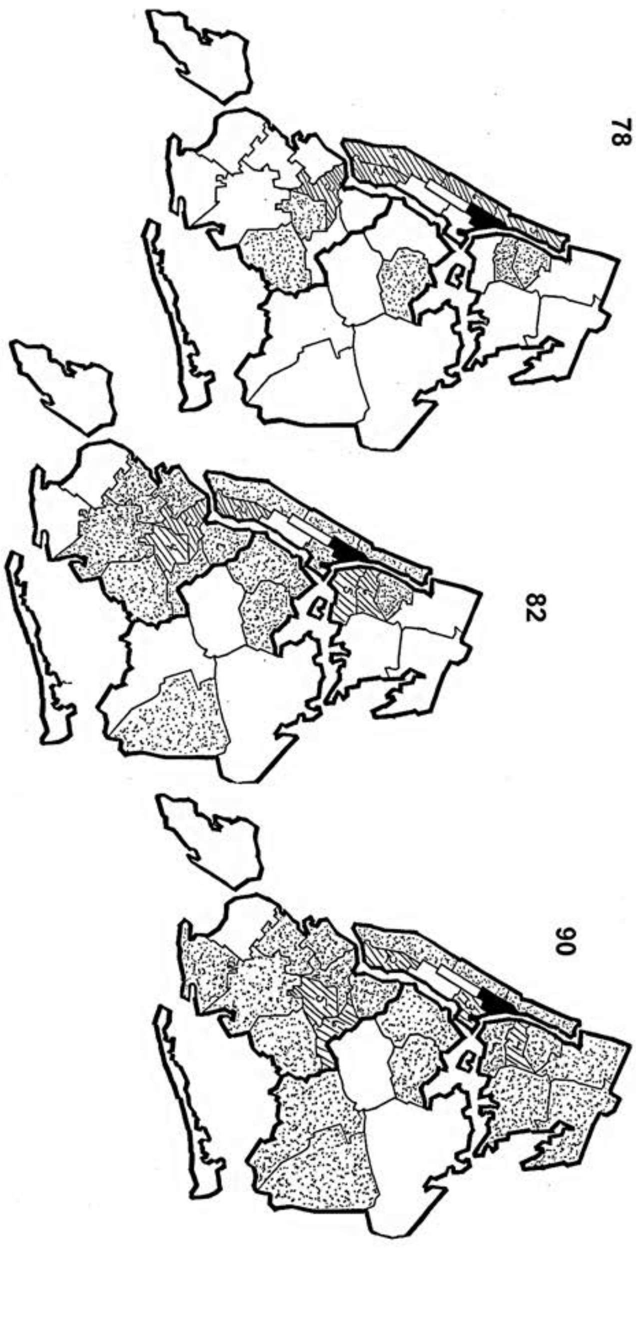

Figure 17: Spread of TB incidence, 1978-1990. Black=highest incident Health District, Striped=five HD just below the top. Stippled=HD with incidence above the 1978 citywide incidence.

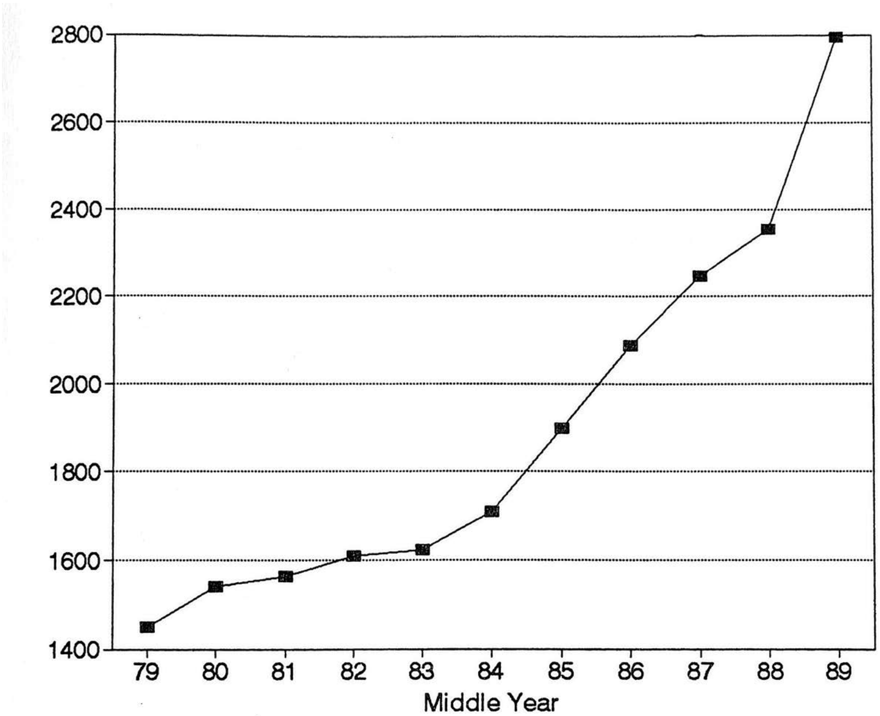

Figure 18: 3-year running average of TB cases vs. year.

Mother's birth year	before 1965	'65-'69	'70-'74	'75-'79	'80 and later
Number	15	38	63	116	61
Babies' mean birth weight (g)	3375	3405	3466	3320	3391
SD	503	470	535	504	448
%below 2500g	6.7	2.6	1.6	6	3.3

Figure 19: 1999-2001 Birth-weight patterns for different age-cohort women. The Center for Children's' Environmental Health Columbia University. Note the low mean birthweight and high percent of low-weight births for women born 1975-1979, the height of the fire/abandonment epidemic.

births. Neighborhoods affected by the fire-and-abandonment epidemics show extreme vulnerability to further impacts. The Recession and Subprime Mortgage Crisis hit these neighborhoods early and hard. This formed yet another wave of neighborhood destabilization after the 1970's fire-and-abandonment epidemics. Brownsville, East New York, Bushwick, and Crown Heights North, all in Brooklyn, included high densities of low-income homeowners of color hit by the mortgage crisis.

These neighborhoods showed raised incidence of low-weight births. See figure 20. Before the 2004-2006 build-up to the Recession and Mortgage Crisis, these neighborhoods had shown improved birth weights with smaller and smaller percents of the neonates having low weights. Suddenly, they experienced a reversal with low-weight neonates constituting over 12% of the live births beginning around 2005 and spreading by 2008. The CDC goal is 5%.

Stress is one of the primary roots of low-weight births (examples: Texeira et al., 1990; O'Campo et al., 1997; Love et al., 2010; Schempf et al, 2009). The changes in geography of low-weight birth incidence over the neighborhoods of New York shown here arise from interaction of vulnerability to stress (essentially an allergy induced by previous community experiences) and imposition of stress. The patterns of low-weight births during the Crisis reflect community-level anxiety.

These data were published in Journal of Urban Health as part of the follow-up to the NY Academy of Medicine's 2008 Conference on Serial Forced Displacement, itself a follow-up to the Academy's 1989 Conference on Housing, Community and Health. The Academy's long-term interest in low-income communities and their well-being signals the role that these communities play in the public health of the metropolitan region. We found that the public health deterioration from the fire-and-abandonment epidemics spread out to the counties of the whole metropolitan region as defined by the US Census Bureau.

Finally, figure 21, from Wallace (1981), work performed under contract with the Uniformed Firefighters' Association, shows the impact of the fire/abandonment epidemic on firefighter health. It displays the annual percent of the firefighting workforce retiring under disability between 1960 and 1978 as a function of the workload index from figure 1 per 10,000 firefighters. The years 1974-1978 take the relation into a nonlinear realm as a classic 'dose-response' curve showing the population effect of massive toxic exposure. Retirement under disability is an adversarial procedure requiring medical certification.

4 Metroregional linkages via commuting and poverty rate

The metro region – the 24 counties linked to Manhattan by the daily commuting pattern – is one society. The counties link together economically and socially through the daily, weekly, and seasonal travel patterns. We used a 'mixmaster' index of job commuting per square mile of county to index the linkage and

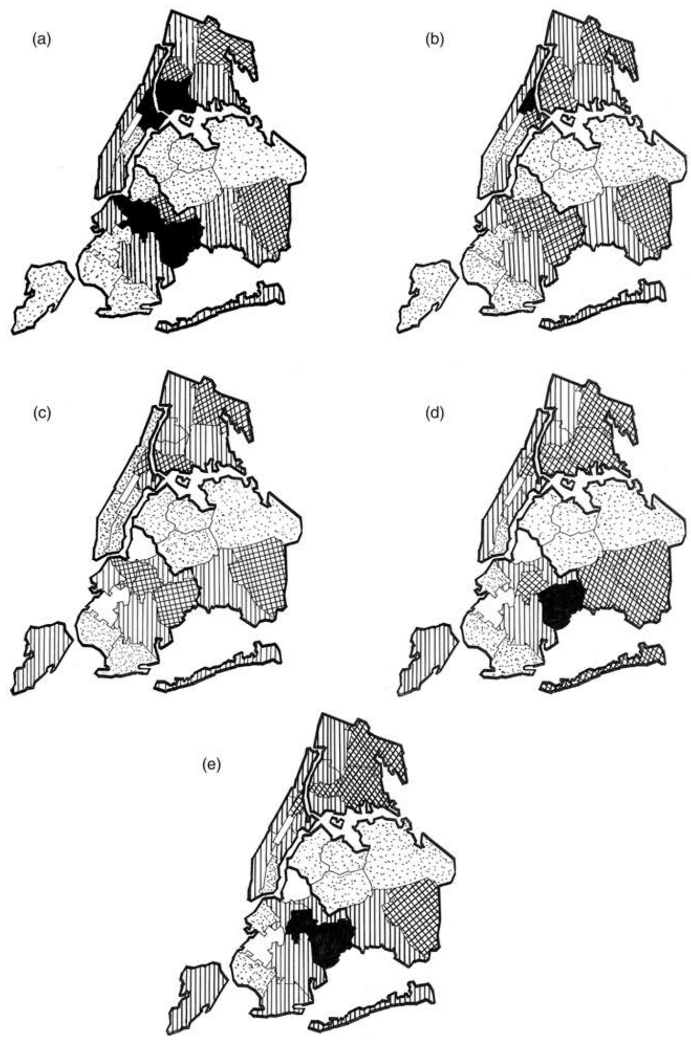

Figure 20: Geography of low-weight birth incidence. (a) Annual average incidence 1989-91. (b) 1994-96. (c) 1999-2001. (d) 2004-06. (e) 2008. Black - incidence of 12% or more. Cross-hatched 10.0-11.9%. Stripes 8.0-9.9%. Stippled, 6-7.9%. White, below 6%.

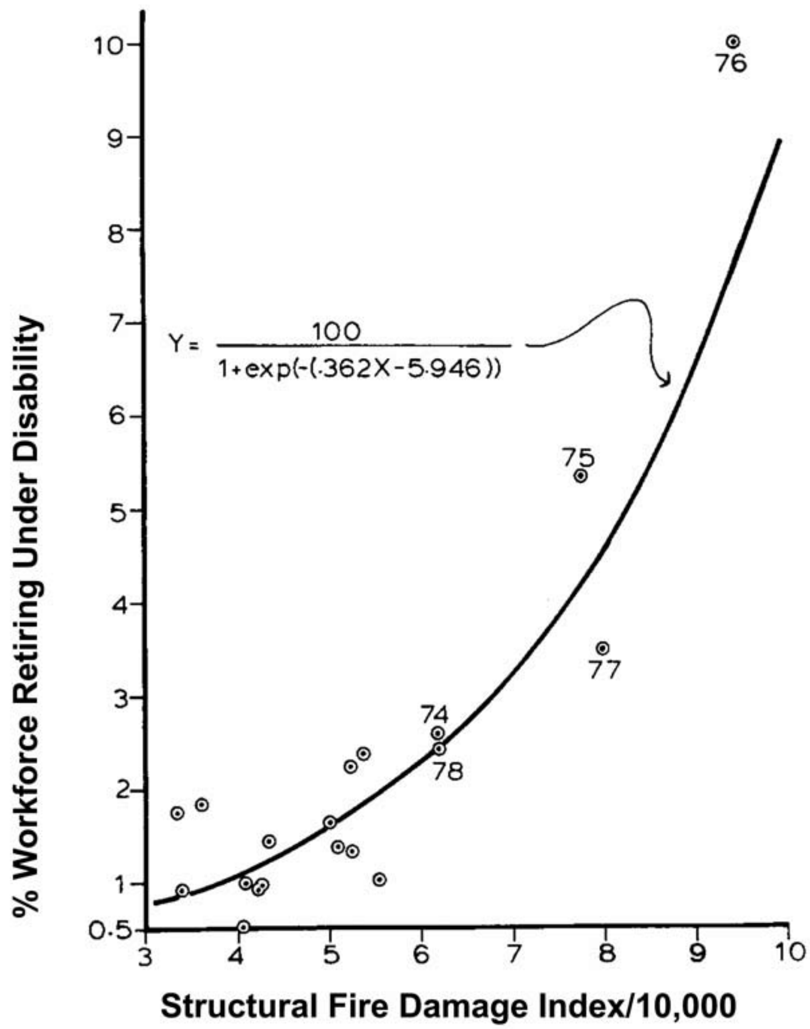

Figure 21: From Wallace (1982). Annual percent of NYC firefighters retiring under disability, 1960-1978, as a function of annual structural fire damage index/10,000. Disability retirement, at 3/4 salary, is an adversarial procedure requiring medical evidence. From 1974 through 1978, the financial deficit in the FDNY pension fund grew from $200 million to $1.2 billion.

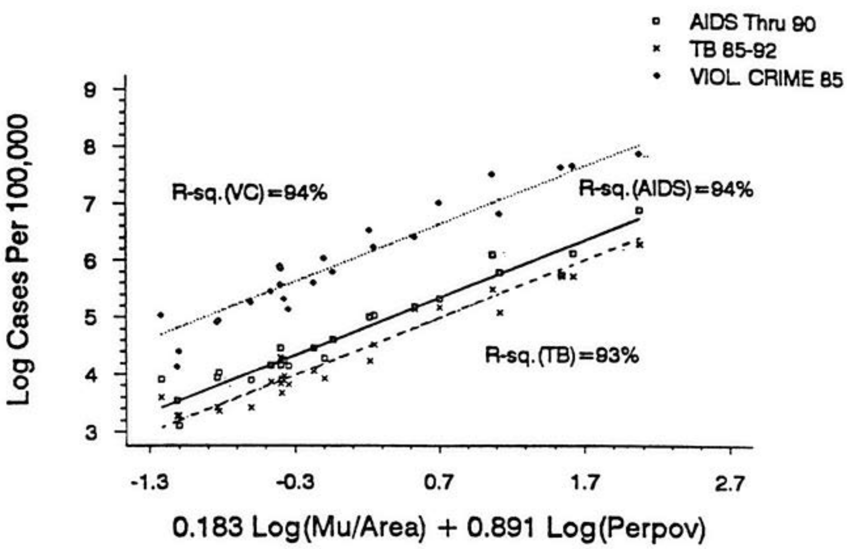

Figure 22: Multivariate analysis of covariance of AIDS cases, violent crimes, and tuberculosis cases for the 24-county New York Metropolitan Region as a function of a 'global' index of commuting with the central city and the local degree of poverty. The NYMA is a single entity in which the overall patterns of pathology are driven by what happens in the upper right section of the graph: the counties of New York City. Note that low birthweight rates were also regionalized, but not parallel to these graphs.

poverty rate to index vulnerability. For a description of the full methodology, see Wallace et al., (1997). In essence, a 24 by 24 matrix of number of persons commuting within and between counties in the metro region is 'normalized' to unit row sum, creating a 'transition matrix' for a Markov process. The equilibrium distribution of that process, normalized by the county area, is used to construct the 'Mu/Area' number. The other number for the model is the percent of persons within the county living in poverty, according to the census.

Figure 22 shows the relation between AIDS, violent crimes, and tuberculosis rates as a function of a particular linear combination of the two indices. The three lines are parallel according to multivariate analysis of covariance. What happens in the New York Metropolitan Area is determined by what happens in the upper right section of the graph: the counties of New York City. A similar regionalization was found for low birthweight, but not parallel to the other relations.

Elsewhere (Wallace et al. 1999), we explore how New York City's position at the apex of the national urban hierarchy determined the rate of national spread of HIV/AIDS. The inference is that, while, as one public official put it, 'Planned shrinkage shotgunned AIDS over the Bronx', the policy also profoundly affected the national diffusion of infection.

5 Discussion

What are the implications of this case history for 'Big Data' and governance by algorithm?

At present, the 'tech' industries, and their academic fanboys, tout the coming of an 'artificial intelligence revolution' based on 'reinforcement learning' and 'deep learning' algorithmic systems that will alter our lives. Here, we have provided a detailed case history of the implementation of an earlier generation of Operations Research algorithms on a real-time critical system. While OR is useful for simple 'toll plaza', 'warehouse' and 'milk route' problems, the application to New York City's fire service was literally catastrophic. Similarly, AI may be good for looking at X-rays and playing Go, but more sophisticated applications will not lead to good outcomes.

More specifically, as is now increasingly discussed, reinforcement learning and deep learning algorithms will, at best, only be as good as the 'big data' sets on which they are based, and 'big data' is as biased as those who collect it. One singular example is arrest records. Under the 'stop-and-frisk' regime of NYC's Bloomberg Administration, most young men living in primarily African-American neighborhoods were repeatedly stopped on the streets of their home communities, and often abused. Many were repeatedly arrested under 'broken windows' policing of minor offenses. The resulting arrest records are bloated with such 'LWB' offenses - Living While Black. Arrest record patterns are fed to algorithms to 'train' them in estimating probability of future arrest for parole or sentencing decisions.

First, this is known as the 'ecological fallacy' in statistics: attributing to individuals what is a population-level measure.

Second, the population level measure itself has been bloated by racism and discrimination.

Another 'training' problem is that the algorithmic machine literally wires and rewires itself on the training data, either fed in initially, or, under 'reinforcement learning', fed in over a period of time, as the machine converges on a final internal format.

Different training data sets, and even taking different initial points in a single fixed training data set, produce different final machine wirings. In addition, each machine wiring has a unique failure mode spectrum, i.e., a unique pattern of mistakes under the best of conditions. The same basic neural network can, and usually will, configure differently under repeated training. Each configuration will have a different failure spectrum. The final configurations are usually not monitored - they are almost always unknown. These are the 'known unknowns'. The different failure spectra, however, are not at all understood. These are the 'unknown unknowns'. Each flaw, in itself, is sufficient to invalidate the use of artificial intelligence for critical decisions in a public context. Their synergism moves us well beyond even 'unknown unknowns'.

More importantly, from the perspective of what we have presented here, the algorithms built or self-built for real-time critical systems like fire service, will be subject to the same challenges of 'friction' and the fog-of-war that have stymied practitioners of armed conflict for centuries.

One way of approaching this is to understand that the language of business - the language of 'big tech' – is the language of dreams, but the language of armed conflict is the language of nightmare made real. Yet business dreams of driverless cars on intelligent roads, and of other real-time critical systems under the control of algorithmic entities, have much of armed conflict about them. All such systems, including military institutions at the tactical, operational and strategic scales, act on rapidly-shifting roadway topologies whose 'traffic rules' can rapidly change.

Armed conflict is never without both casualty and collateral damage, and real time critical systems of any nature will inevitably partake of fog-of-war and frictional challenges almost exactly similar to those that have made armed conflict intractable for modern states.

Into the world of armed conflict, the world of Carl von Clausewitz, John Boyd, Mao Tse-Tung, Vo Nguyen Giap and Genghis Khan, and following in the steps of the Rand Corporation in Vietnam and the South Bronx, now come the brash, bright-eyed techies of Alphabet, Microsoft, Amazon, and Uber who forthrightly step in where a phalanx of angels had not feared to tread, but had treaded badly indeed. Elsewhere (Wallace 2018a, b) we use cutting-edge tools from information and control theories to examine canonical and idiosyncratic failure modes of real-time cognitive systems facing fog-of-war and frictional constraints. In sum, nobody ever navigates, or can navigate, the landscapes of Carl von Clausewitz unscathed. The big Tech's 'deep learning' and 'reinforcement learning' algorithmic future is going to look much like the Rand Corporation's algorithmic past we have outlined here.

We go from the simple algorithm of 'Redlining' which required only Census data on percent African-Americans to the simple Rand algorithms which required even less real data, to the era of Big-Data based algorithms that determine who goes to jail, who gets paroled, and even who gets stopped and questioned. None of these algorithms has firm, objective scientific bases for their particular uses. All come from deeply discriminatory assumptions and cultural skewing. All use pretenses to high tech and science to baffle the public.

The essential point, then, is that 'Big Data', 'Algorithms', and AI are the second generation of the operations research models used as tools for ethnic cleansing in New York City. They will, as did their earlier incarnations, serve primarily as a smokescreen to protect existing patterns of power relaitions and will maintain historical trajectories of racism and discrimination, and we all know what those trajectories are.

The Zapatistas called this class of technocrats 'Cientificos' and knew how to deal with them.

6 Appendix: Excerpts from the Kirby Report

March 17, 1970

To: John T. O'Hagan

From: Charles F. Kirby

Subject: Projections of Fire Occurrences – Borough of the Bronx

A study of fire occurrences in the Borough of the Bronx from 1959 through 1968 and including partially available figure for 1969 reveal [some disturbing] factors...

At present the Bronx, which covers 13% of the City area and holds about 18% of its population, participates in about 23% of the City structural fires, 28% of its non-structural fires and about 25% of all responses... Fire companies assigned to the Bronx consitute 17% of all City forces.

More relevant than the actual percentages is the rate of rise of the Borough of the Bronx between 1964 and 1968. While structural fires in the City rose 42% the Bronx increased 70%. In the same period, non-structural fires in the City rose 75% while the Bronx increased 95%. In both instances the Bronx led all boroughs in percentage increase.

A disturbing factor is that in no instance during this period can we find a clear indication of leveling in any area of the Borough. The South Bronx retains its general rate of rise while the increases show indication of spread to other areas... [I]t would be unrealistic to assume that the trend will not generally follow the rise of the last five years. There are no physical or sociological changes to warrant a contrary assumption at the present time. Following these figures, we must assume that 1973 Bronx structural fires will probably show a 69% increase when compared with 1969 and a non-structural rise approximately 70%...

The assumptions made in this projection are based largely on the fact that the area of the West Bronx between Third – Webster Avenues and the Harlem River from 161 St. to Fordham Road is a fertile ground for fire increase... On many streets near the Grand Concourse, the potential for density of population based on maximum use of apartment space is unusually high... If allowed to reach slum proportions, these streets will present fire and social problems exceeding any previously encountered in the City.

It is fortunate that many of the new additional fire units established over the past year will cover portions of this area. Engine 41-2, E 50-2, Ladders 17-2 and 27-2 as well as Batallions 26 and 56 will find increasing usefulness in this district... If critical situations are developing there is room for an additional engine unit with Engine Co. 92 and a ladder unit with Engine 43...

[Kirby then goes on to examine the Bronx neighborhood-by-neighborhood. We quote him on the South Bronx]

South and Central Bronx

In reviewing the South and Central Bronx, we consider the area bounded by Third, Webster Aves., Fordham Road, The Bronx River and the South End of the Borough. The pattern of fire increase in this area over the past 20 years is definable. The increase originated in the area around Engine 82 and Ladder 31, spread southerly to the South End of the Borough and between 1950 and 1960 included the area bounded by 169 St. – Southern Boulevard, 133 St. and Third – Webster Aves. During 1960-1970 the increase intensified severely in this area and spread northwardly to 180 St. and bulged into the Hunts Point area. The potential of the spread for the 1970's consists of a further intensification of fires in all but the most Southern portion and a spread in the Central area to Fordham Road. In this area all of the additional Bronx units created in the last few years will continue to find utilization...

Within the next few years the geographical advancement of fire in the South – Central Bronx area will be completed. Involvement of the area between 180 St. and Fordham Road, between Webster Ave. and the Bronx River brings us to the physical barriers of the Bronx Zoo, the Botanical Garden and Fordham University which serve as the guide lines for the geographical description. In this northern end of the South – Central area, Engine 88-2, Ladder 27-2 and TCU 512 are already operational and will find added workload...

Summary and Conclusion

The major increases in fire companies recently added to the Bronx will assist in absorbing a large part of the expected fire rise. These units will also afford a greater flexibility of Bronx operations. As stated before I feel that the T.C.U. program has great potential. These are capable administrative decisions and help us face our problems but not our causes.

As has been said 'trend is not destiny'. If we learn from examples of the past, a great part of the expected fire rise can be averted. To do so rehabilitation must move forward at a greater rate than decomposition. Sanitation facilities in the Bronx must be brought up to a level that exists in Manhattan, for example. The non-structural to structural fire figures in the 11th Battalion [Manhattan] are close to 1:2, while slum areas of the Bronx are over 2:1.

The city should develop a realistic program for sprinkler installation... [for] multiple dwellings...

There are many more physical and social changes which must be planned to reverse the fire trend. If these are beyond the fiscal capabilities of the City or inequitable with our economic structure it does not relieve us completely of our obligation to point up problems as we see and forecast them. For this reason I would recommend that a very high ranking member of the Department be a full-fledged member of all New York City agencies dealing with Housing, Redevelopment and similar functional gro8ups.

It has been said that the major part of funds in the City should be allocated to improvement of social conditions for the poor. The actual fires and the constant threat of fire must surely be a devastating horror to the people required to live in houses in a deteriorating neighborhood. We also know that fire is a large component of the decay cycle and we can suspect that it adds to the uneasiness and insecurity of the poor. After years of fire experience, fire prevention, and fire investigation, I feel that rather than being accidental, fire is largely a social problem and the Bronx has and will have its share of such problems.

7 Acknowledgments

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References

Blandin, S., et al., 2011, A general phase transition model for vehicular traffic, SIAM Journal of Applied Mathematics, 71:107-127.

Duryea, P., 1978, press release dated Friday, 27 January, Office of the New York State Assembly Repubican Leader.

Fullilove, M., 2005, Root Shock: How Tearing Up City Neighborhoods Hurts America and What We Can Do About It, Ballantine Books, New York.

Geronimus, A., 1996, Black/white differences in the relationship of maternal age to birthweight: a population-based test of the weathering hypothesis, Social Science and Medicine, 42:589-597.

Love C., David R., Rankin K., Collins J., 2010, Exploring weathering: effects of lifelong economic environment and maternal age on low birth-weight, small for gestational age, and preterm birth in African-American and white women, American Journal of Epidemiology, 172:127-134.

Maerivoet, S., B. De Moor, 2006, Data quality travel time estimation and reliability, Katholieke University Leuven 06-030.

McCord C., Freeman, H., 1990, Excess mortality in Harlem, New England Journal of Medicine, 322:173-177.

Mega, C., 1978, Report of the New York State Assembly Republican Task Force on Urban Fire Protection, Office of the New York State Assembly Republican Leader.

Monkonnen, E., 2001, Murder in New York City, University of California Press, Berkeley.

O'Campo P., X. Xue, M. Wang, M. O'Brien Caughy, 1997, Neighborhood risk factors for low birthweight in Baltimore: a multilevel analysis, American Journal of Public Health, 87:1113-1118.

The Rand Fire Project, 1979, Fire Deployment Analysis: a public policy analysis case study, North Holland, New York.

Schwartz, J., 1993, The New York Approach: Robert Moses, Urban Liberals, and Redevelopment of the Inner City, University of Ohio Press, Columbia.

Struening E., R. Wallace, R. Moore, 1990, Housing conditions and the quality of children at birth, Bulletin of the New York Academy of Medicine, 66:463-478.

Sugiyama, Y., et al., 2008, Traffic jams without bottlenecks – experimental evidence for physical mechanisms to the formation of a jam, New Journal of Physics, 10:033001.

Texeira J., N. Fisk, V. Glover, 1999, Association between maternal anxiety in pregnancy and increased uterine artery resistance index: cohort based study, British Medical Journal, 318:153-157.

Wallace D., 2011, Discriminatory mass dehusing and low-weight births: dehousing, scales of geography, time, and level, Journal of Urban Health, 88:454-468.

Wallace D., R. Wallace, 1998, A Plague on Your Houses: How New York City Was Burned Down and National Public Health Crumbled, Verso, New York and London.

Wallace, R., 1982, The New York City fire epidemic as a toxic phenomenon, Occupational and Environmental Health, 50:33-51.

Wallace, R., 1990, Urban desertification, public health, and public order: 'Planned Shrinkage', violent death, substance abuse and AIDS in the Bronx, Social Science and Medicine, 31:801-813.

Wallace, R., 2018a, Canonical Instabilities of Autonomous Vehicle Systems: The unsettling reality behind the dreams of greed, Springer, New York.

Wallace, R., 2018b, Carl von Clausewitz, the Fog-of-War, and the AI Revolution: The real world is not a game of Go, Springer, New York.

Wallace, R., D. Wallace, 1977, Studies on the Collapse of Fire Service in New York City 1972-1976: The Impact of Pseudoscience on Public Policy, University Press of America, Washington DC.

Wallace, R., D. Wallace, H. Andrews, 1997, AIDS, tuberculosis, violent crime and low birthweidht in eight US metropolitan regions, Environment and Planning A, 29:525-555.

Wallace, R., J. Ullmann, D. Wallace, H. Andrews, 1999, Deindustrialization, inner city decay, and the hierarchical diffusion of AIDS in the US: how neoliberal and cold war policies magnified the ecological niche for emerging infections and created a national security crisis, Environment and Planning A, 31:113-139.