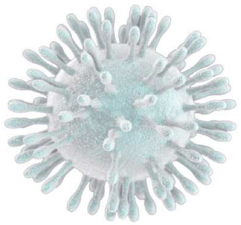


Lockdown Light: smarter and better

"By including the weather and humidity conditions in Coronavirus modelling, a much more focused policy can be pursued."

Drs. Maurice de Hond, social geographer

Purpose of this article

It is quite right that governments now pursue a policy to (strongly) reduce the chance of carriers transferring the Corona virus to other persons. In addition to quarantining potential carriers of the virus, measures are aimed at reducing contact between people.

Globally, we see different variations of this strategy. From banning meetings with larger numbers of people, through closing schools and restaurants, to a complete lockdown of countries. Despite the obvious enormous social and economic consequences, these measures are widely implemented and accepted by the communities.

In determining the severity of the measures, it is crucial to understand the influence of weather conditions in the transferal of the virus. Including weather conditions in the modelling and mitigation strategies will sustain support and increase effectiveness.

Distribution conditions

There is very thorough evidence that the weather - and especially the humidity - plays a major role in the rate at which the virus spreads. Weather conditions as an important factor of spreading of the disease seem to be underexposed and increased awareness with policymakers would possibly strengthen their strategies.

The overall effect on casualties could be the same as a lockdown, but with significantly fewer disadvantages on the social and economic circumstances. An abrupt deterioration in social and economic conditions will also have a negative impact on public health in the longer term.

First, I will show how the weather / humidity works on the spread of the coronavirus. Then I will describe the consequences this can have for decision-making.

The spread of the virus across the Earth

Interesting patterns can be seen if you look at the spread of the Corona virus across the Earth. In some countries / areas there are many infected people in other countries / areas much less.

The problem, of course, is that testing is not done in the same degree. There will certainly be (much) more infected people per country than the figures show. A better indicator of the degree of infection in a country / region seems to be the number of people admitted to a hospital or the number of deaths as a result of the virus.

Still, the maps available provide some important pointers.

Global distribution (click on the map for the current image)

Regionally specified distribution (click on the map for the current picture)

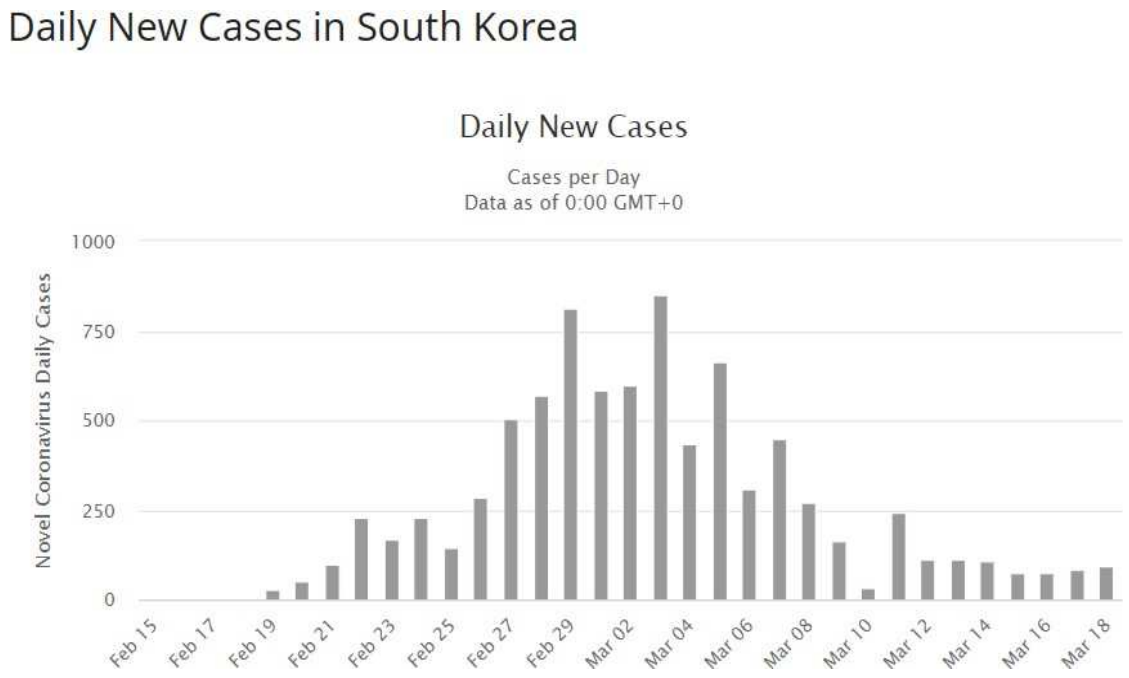
Striking differences in distribution

If you look at the maps you will see that in the Northern Hemisphere, between 30 and 60 degrees Northern latitude, most of the major outbreaks occurred: Wuhan, Seoul, Tehran, Northern Italy and Madrid, with the fastest increase in effected populations.

About 1000 kilometers from Wuhan to the South and Southeast are Hong Kong and Taiwan. On March 20, there were resp. 250 and 100 infected cases and a few deaths.

Why is that? What is the secret of the difference between those countries? And indeed, also with Singapore - still 2500 kilometers south - with very few deaths. Did those countries / areas immediately take great measures to ensure that the virus did not spread or is something else (also) going on?

And why is there a strong downward trend in China and South Korea, as shown below?



Now it is certain that Hong Kong, Taiwan and Singapore have quickly taken measures to improve the opportunity to limit contamination of the local population. But is that the only reason?

This interesting article shows how South Korea is focusing strongly on reducing the number of new cases, without draconian measures such as a lockdown.

The big influence of the weather / humidity

There are two main articles that point to an important additional statement:

This article by US scientists was written on March 5. Their conclusion is below.

> Methods: We examined climate data from cities with significant community spread of COVID-19 using ERA-5 reanalysis, and compared to areas that are either not affected, or do not have significant community spread.
>
> Findings: To date, Coronavirus Disease 2019 (COVID-19), caused by SARS-CoV-2, has established significant community spread in cities and regions along a narrow east west distribution roughly along the 30-50o N' corridor at consistently similar weather patterns consisting of average temperatures of 5-11oC, combined with low specific (3-6 g/kg) and absolute humidity (4-7 g/m3). There has been a lack of significant community establishment in expected locations that are based only on population proximity and extensive population interaction through travel.

The map in that article shows the following pattern:

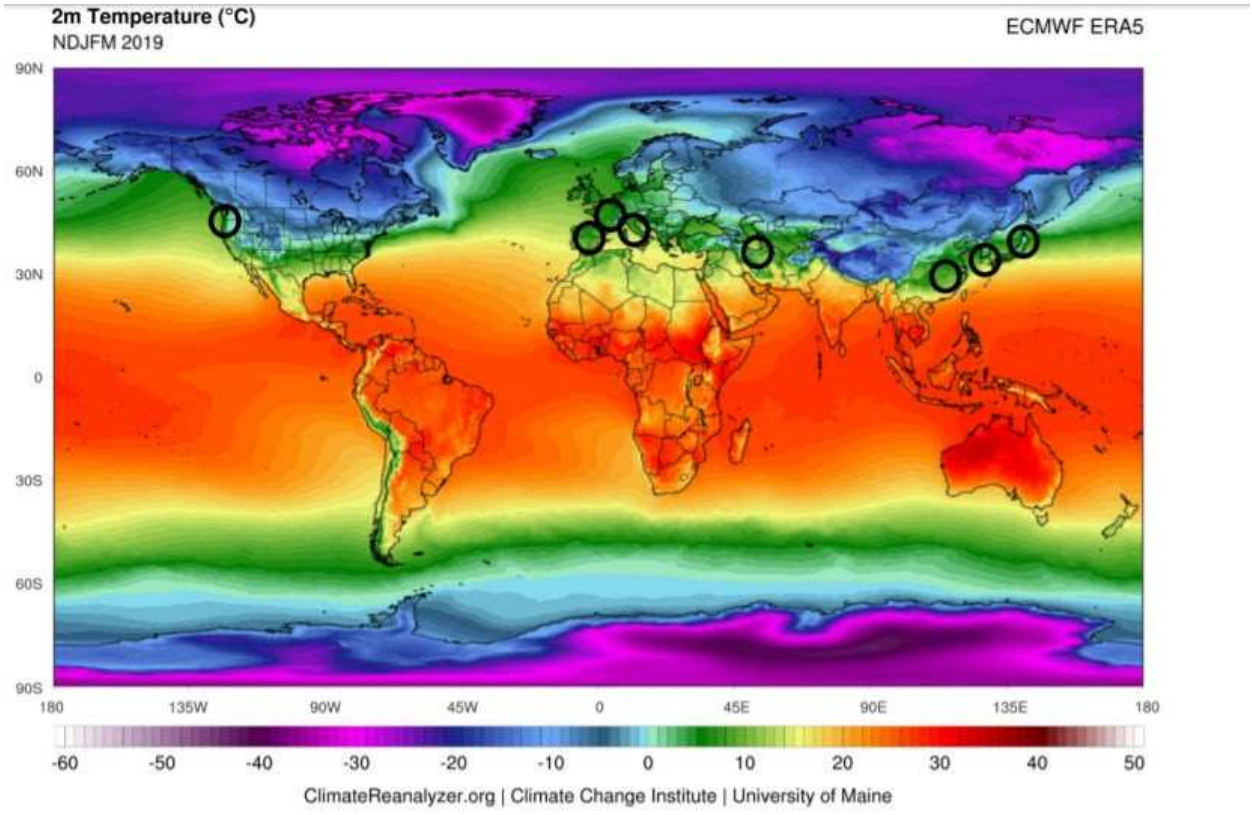
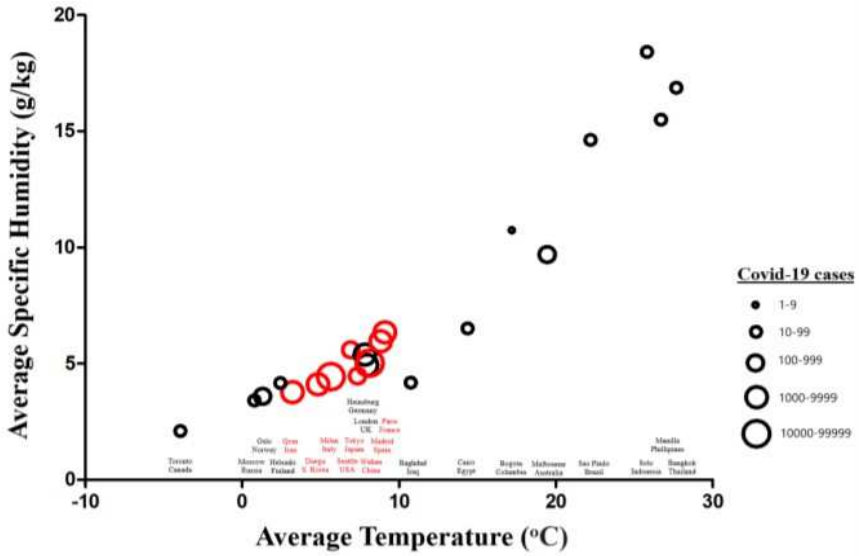


Figure 1. World temperature map November 2018-March 2019. Color gradient indicates 2-meter temperatures in degrees Celsius. Black circles represent countries with significant community transmission (≥ 10 deaths as of March 10, 2020). Image from Climate Reanalyzer (https://ClimateReanalyzer.org), Climate Change Institute, University of Maine, USA.

And the graph below shows that relationship again. Horizontally, the mean temperature is plotted from 20 to 30 days before the first death from a regional outbreak, vertically the mean specific humidity. The size of the circles represents the total number of infected people in that area. The red circles are cities with more than 10 deaths.

Temperature versus humidity plot for cities with COVID-19 outbreaks



They note that regarding the rapid spread of the virus in the respective populations, there is a clear correlation with weather and humidity. The temperature between 4 and 11 degrees, combined with specific humidity, is apparently the optimal condition for the rapid spread of the virus.

Weather conditions that applied in January-February for Wuhan, Tehran, Northern Italy, Seoul and Madrid.

Temperature Wuhan, first half of January 2020

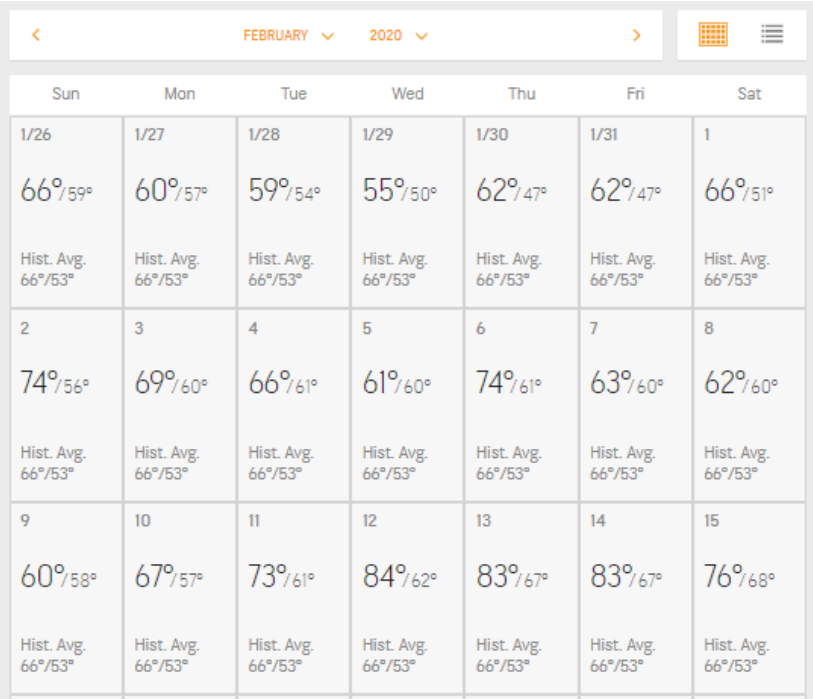
The temperature in Wuhan is illustrated here in January.

Seoul, Bergamo, Tehran and Madrid also show somewhat similar weather in February, sometimes with slightly higher temperatures.

JANUARY 2020

Sun	Mon	Tue	Wed	Thu	Fri	Sat
12/29 53°/39° Hist. Avg. 49°/33°	12/30 53°/37° Hist. Avg. 49°/33°	12/31 43°/34° Hist. Avg. 49°/33°	1 44°/34° Hist. Avg. 49°/34°	2 42°/40° Hist. Avg. 48°/34°	3 44°/40° Hist. Avg. 48°/34°	4 47°/42° Hist. Avg. 48°/33°
5 49°/42° Hist. Avg. 47°/33°	6 47°/39° Hist. Avg. 47°/33°	7 46°/31° Hist. Avg. 47°/33°	8 42°/29° Hist. Avg. 47°/33°	9 36°/31° Hist. Avg. 46°/33°	10 38°/33° Hist. Avg. 46°/33°	11 43°/28° Hist. Avg. 46°/33°
12 49°/26° Hist. Avg. 46°/33°	13 50°/27° Hist. Avg. 46°/33°	14 50°/30° Hist. Avg. 45°/33°	15 41°/33° Hist. Avg. 45°/33°	16 38°/32° Hist. Avg. 45°/33°	17 40°/28° Hist. Avg. 45°/33°	18 46°/26° Hist. Avg. 45°/33°

Temperature Taipei first half of February 2020



FEBRUARY 2020

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1/26 66°/59° Hist. Avg. 66°/53°	1/27 60°/57° Hist. Avg. 66°/53°	1/28 59°/54° Hist. Avg. 66°/53°	1/29 55°/50° Hist. Avg. 66°/53°	1/30 62°/47° Hist. Avg. 66°/53°	1/31 62°/47° Hist. Avg. 66°/53°	1 66°/51° Hist. Avg. 66°/53°
2 74°/56° Hist. Avg. 66°/53°	3 69°/60° Hist. Avg. 66°/53°	4 66°/61° Hist. Avg. 66°/53°	5 61°/60° Hist. Avg. 66°/53°	6 74°/61° Hist. Avg. 66°/53°	7 63°/60° Hist. Avg. 66°/53°	8 62°/60° Hist. Avg. 66°/53°
9 60°/58° Hist. Avg. 66°/53°	10 67°/57° Hist. Avg. 66°/53°	11 73°/61° Hist. Avg. 66°/53°	12 84°/62° Hist. Avg. 66°/53°	13 83°/67° Hist. Avg. 66°/53°	14 83°/67° Hist. Avg. 66°/53°	15 76°/68° Hist. Avg. 66°/53°

Now let's look at the weather in Taiwan in February.

It was considerably warmer there and already regularly (far) above 20 degrees. In January we also see temperatures there, which we would be very happy with in The Netherlands in June.

The weather in Hong Kong was like in Taiwan. In Singapore it was even warmer (and more humid) this winter.

The explanation for this difference in distribution

The number of Corona infections is also significantly lower in other warm countries than in Europe. Like everywhere else, the virus has also been introduced there by travelers from areas where the virus was already prevalent but spreads considerably slower than is (is) the case of the hot spot.

In a recent interview, an important statement was made about how humidity affects the spread of the flu virus.

The American microbiologist Dr. Alan Evangelista, who researched the relationship between the spread of the flu virus and humidity, concludes:

> Those findings show that "transmission is highly efficient under drier and colder conditions," but far less so in a humid environment.

His statement is strictly physical and of great importance for the current and future fight against the virus:

> "As humidity increases, the viral droplet size is larger and settles out of the air rapidly," Evangelista found, according to a statement he provided to ABC News on his research.
>
> "In contrast, in low humidity, there is rapid evaporation of respiratory droplets," he continued. "They remain airborne for prolonged periods, increasing the time and distance over which transmission can occur."
>
> Evangelista argues that while "there are obviously no guarantees that COVID-19 will behave exactly like the known coronaviruses ... the laws of physics should apply."

In layman's language, he states that at lower humidity, the viral drop floats in the air longer. And that with higher humidity, the viral drop quickly disappears from the air.

An interesting experiment in 2013 by the American institute NIOSH confirms that physical laws always hold. In this experiment on the behavior of the influenza virus, its spread was found to decrease sharply with higher humidity.

Humidity

So, these are strong proofs that humidity has a major influence on the rate of spread of the virus. There are several ways to express the degree of humidity. The most used is relative humidity (in percent). But in the article, the specific humidity is seen as an important measure, expressed in grams per kilogram.

In laboratory conditions, the Coronavirus appears to survive at 4 Celsius and a relative humidity of 20 to 80% according to the American researchers of the former article. However, the specific humidity seems to be the most important measure of the extent to which the virus can spread. The higher the temperature or the relative humidity the higher, the higher the specific humidity.

The same appears everywhere

This is therefore an important explanation for the fact that the rapid spread of the virus has not occurred in areas below the 30th parallel. There it was / is (much) warmer and more humid than it was in places where this spread has quickly spread among the population.

Relative and specific humidity 22nd of february 2020

Measurement at 2 PM	Temperature in Fahrenheit	Relative	Specific
Seoul	48	57	4.2
Bergamo	55	45	4.3
Teheran	61	39	4.5
Madrid	72	29	4.8
Seattle	48	76	5.6
Wuhan (22nd of january)	45	90	5.9
Wuhan (22nd of february)	63	58	6.6
Los Angeles	64	59	7.6
Miami	72	50	8.3
Taipeh	74	80	14.1
Hong Kong	25	54	15.1
Singapore	88	66	19.2

You can also see it in the US. Where in the Seattle area (with 2 million people) with unfavorable weather conditions 60 people have died and in the much warmer Florida (with more than 20 million people) only 10 have died.

Now there are those who say that it is only a matter of time that the same developments will take place in the warmer areas as in the areas where the virus spread so quickly.

But if you look at Brazil and Australia, for example, you will now see a number of hundreds of cases, but on the one hand they can mainly be traced to travelers from contaminated areas and on the other hand those infections do not lead to a rapid spread of population.

And that's not because those two countries have taken such great measures against those spread, but because the weather conditions are a strong containment on the spreading.

What does this mean for the policy to be pursued?

That certainly does not mean that one should sit back quietly under those circumstances. In any case, maximum measures must be taken to prevent travelers from introducing the virus.

In South Korea and some other countries in East Asia, this is done by requiring travelers to quarantine for 14 days. That is checked by a wristband with a connection to a smartphone with geofencing. This is in fact a modern version of the ankle strap.

The dilemma

In the Northern Hemisphere, and therefore also in Europe, the temperature (and the specific humidity) will rise rapidly in the coming weeks. The governments in those countries are struggling with the dilemma of choosing between measures that greatly reduce the spread of the virus and limit social and economic damage.

A lockdown is a rigorous choice that minimizes the likelihood of the virus spreading but will lead to significant social and economic disorder. Also, the timing of the conclusion of the lockdown period and the impact on the virus´ further development is hard to predict.

The measures being taken are aimed at significantly slowing down the spread of the virus. But as the above teaches, the weather can be your friend or your enemy.

The solution

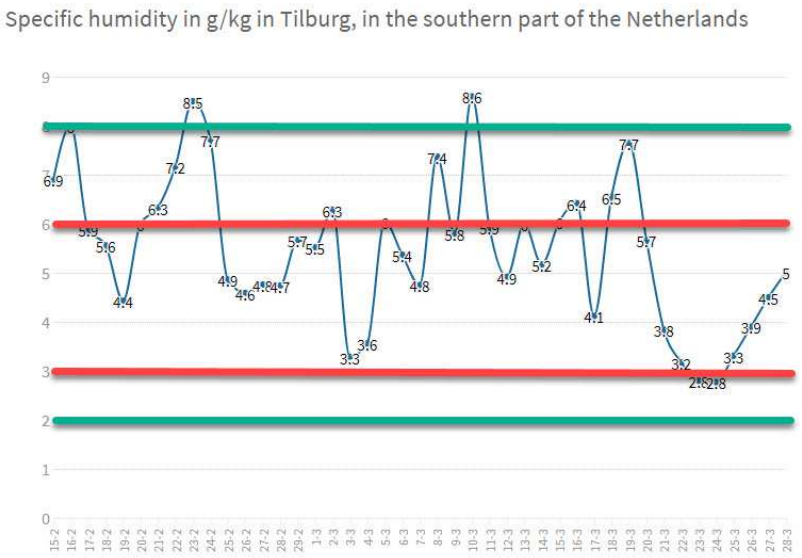
This means that, when determining the optimal measures, one must consider how the weather conditions (in particular the specific humidity, therefore) fluctuate. Because if those conditions are unfavorable (the virus remains floating in the air for longer), then those measures must be stricter than if those conditions are favorable.

Another factor is that both the temperature and the specific humidity are not similar across regions or countries, they differ locally.

I therefore strongly advocate that the (regional) weather forecast should be considered in the policy of delaying the spread of the virus. In this way, the optimal measures can be taken and there is less risk of the drug being worse than the disease.

The weather in the coming week: unfavorable situation in a big part of Europe.

Now, for example, the weather forecast for the Netherlands is unfavorable about the spread of the virus. This are the figures for Tilburg since February 15, measured at 2 pm Tilburg is in the south of the Netherlands and in the pinnacle of the Dutch outbreak.



It is easy to see how it fluctuates, but most values of the specific humidity are between 3 and 6 g / kg.

It can also be seen that this situation will persist in the coming week. Only when the maximum temperature comes close to 15 degrees with an air humidity around 60% does the specific air humidity rise above 6 g / kg. A higher temperature and a higher relative humidity therefore have a favorable effect.

But that only happens around March 30. This support, on one hand, to pursue a policy to limit social contacts as much as possible for the coming 9 days, but on the other hand that these measures can be lowered again if the temperature and air humidity rise at the end of March.

Calculate the specific humidity in your area yourself

I made a special calculator to calculate the specific humidity. The temperature at 2PM of any day must be entered and the corresponding relative humidity. Here you will find this calculator.

It is also noteworthy that the weather forecast in much of Western Europe (from Copenhagen to Madrid / Rome) will be quite similar over the next week and thus offers good conditions for the spread of the virus. Only in the south we see that the temperature rises are more likely to occur.

The good news is that normally, in April and May, temperatures will continue to rise and so conditions regarding the spread of the virus in those areas will become much smaller.

A Corona weather forecast?

A very targeted policy to reduce / prevent the spread of the virus and not to cause the damage to be unnecessarily high (which will otherwise also have an impact on public health) must therefore be taken into consideration again. (Just like the hay fever weather forecast, we could also get the Corona virus weather forecast per region, so that residents can also adjust their behavior based on this.)

The successful approaches to the Corona virus between China and South Korea differed considerably. The South Korean approach, as this article describes, was very focused and without a lockdown. Based on the culture and possibilities of that country.

Other countries can also come up with an intelligent and focused policy, based on the possibilities and culture of their country, by taking the weather forecast into account. This will serve the short- and long-term risks to public health as well as the economy (both directly and indirectly).