An evaluation of Earth Observation as a potential tool to forecast and manage resources during the Covid-19 pandemic

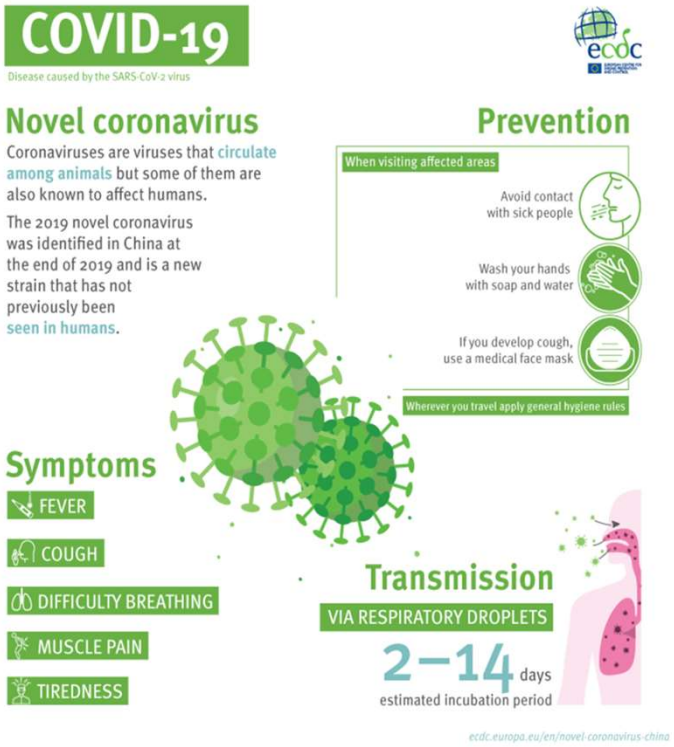
SGAC Space Medicine & Life Sciences Project Group – Team Novidien

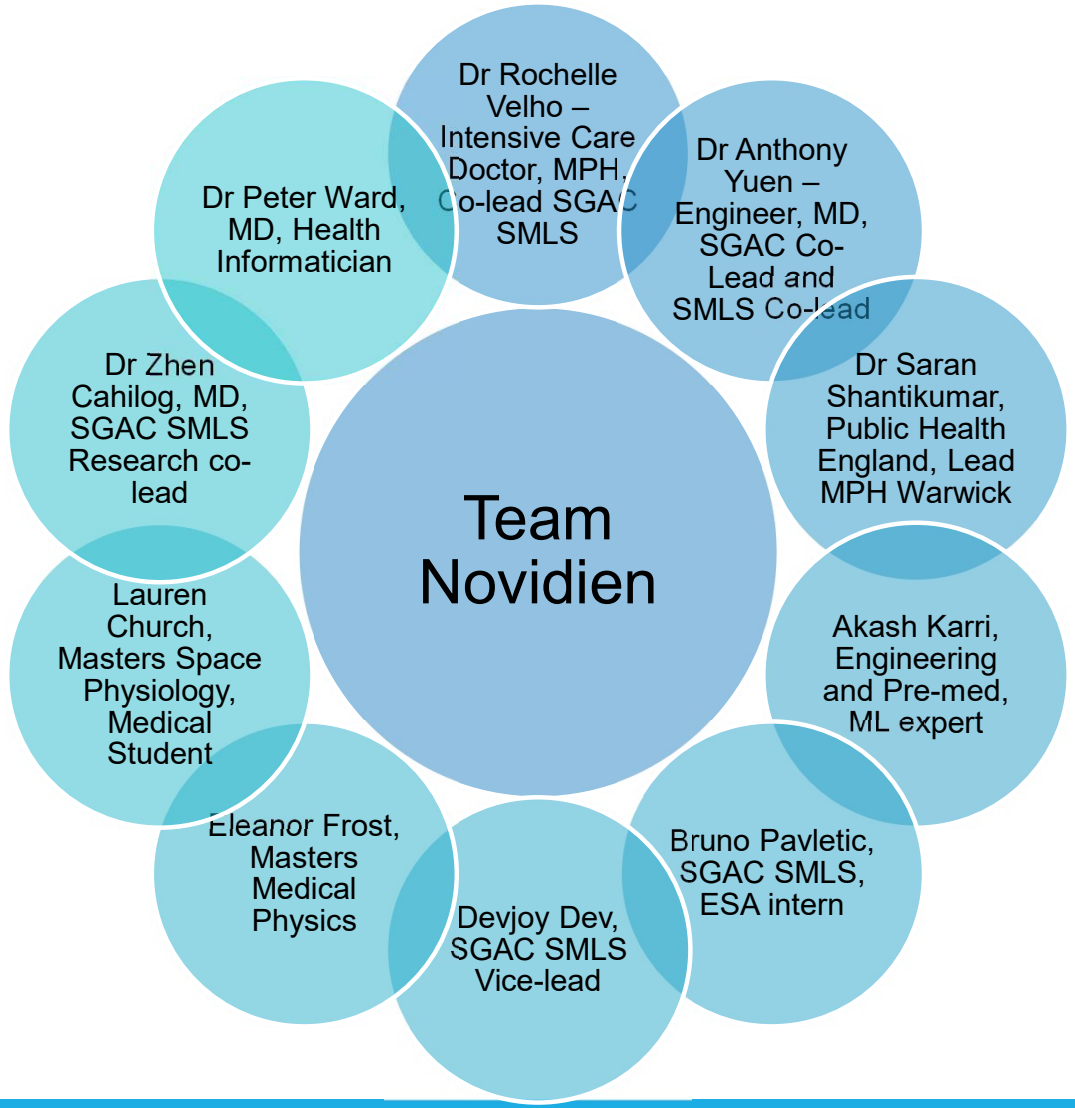
Rochelle Velho, MD, MPH, BSc (Hons)
Co-Lead, SGAC Space Medicine & Life Sciences Project Group
@SGAC_SMLS | @astro_marsrocky
smls@spacegeneration.org | rochelle.velho@spacegeneration.org

SPACE GENERATION ADVISORY COUNCIL

Space Medicine Life Sciences

C-19 pandemic





Additional affiliations:

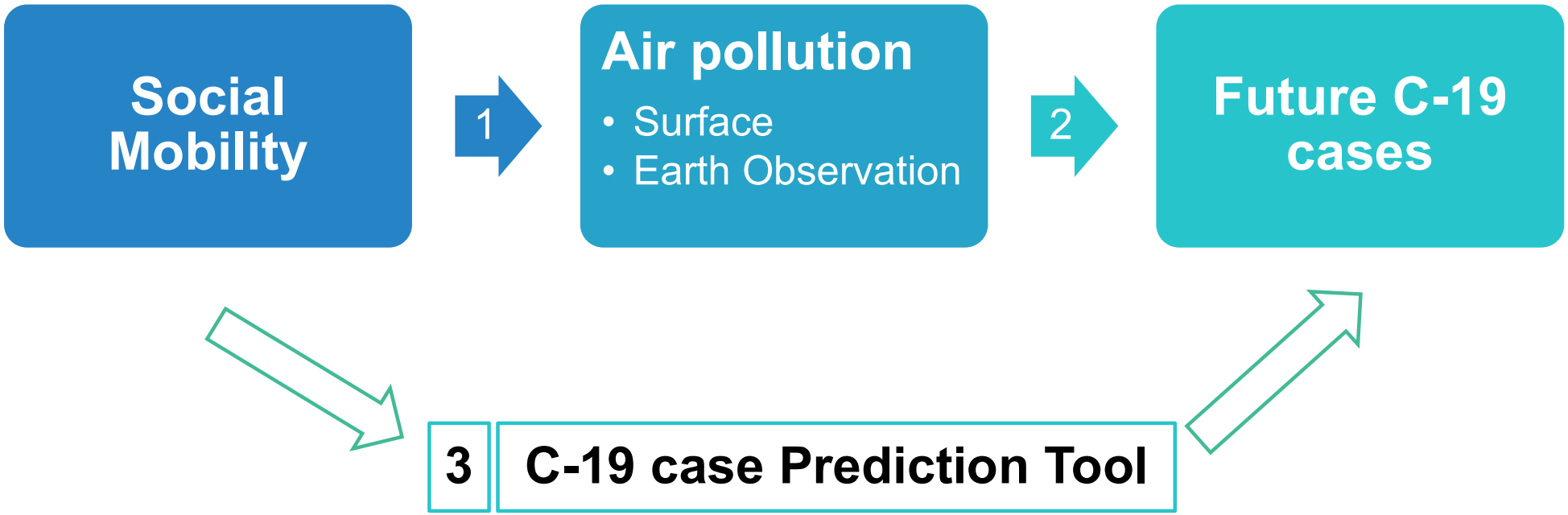
NHS

Weill Cornell Medicine

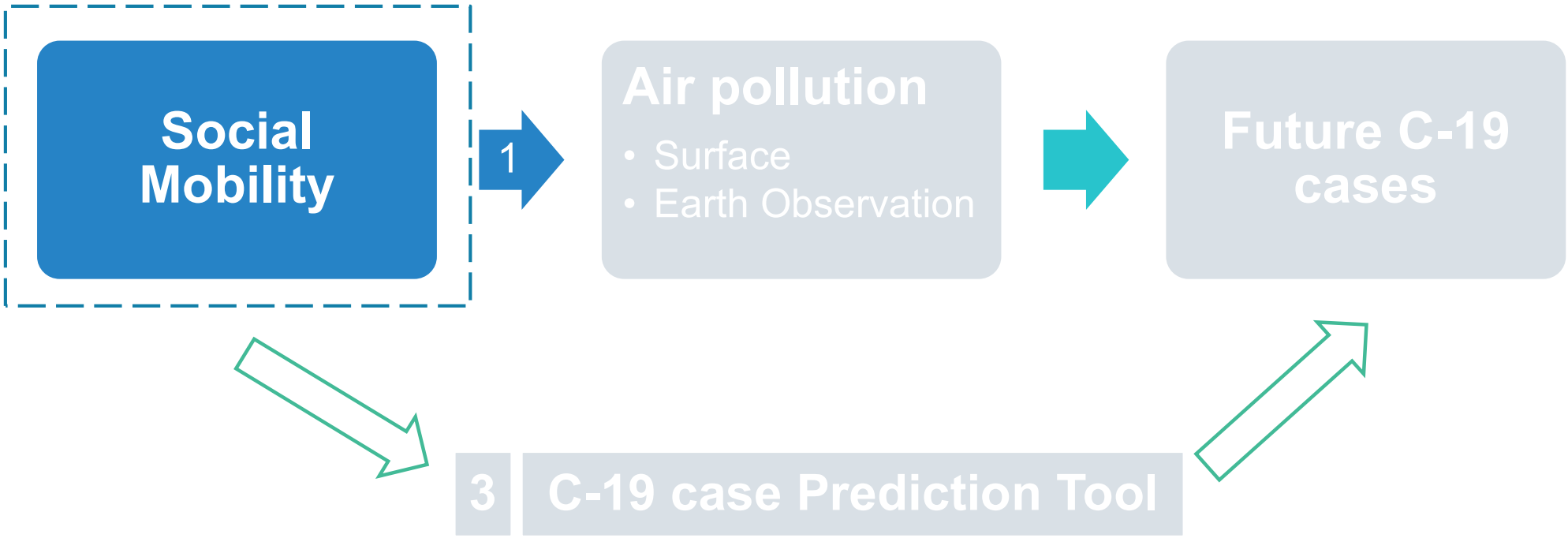
UK Space LABS

Universitas Studiorum Zagrabiensis MDCLXIX

Can Earth Observation data be used to forecast the number of C-19 cases in an area?

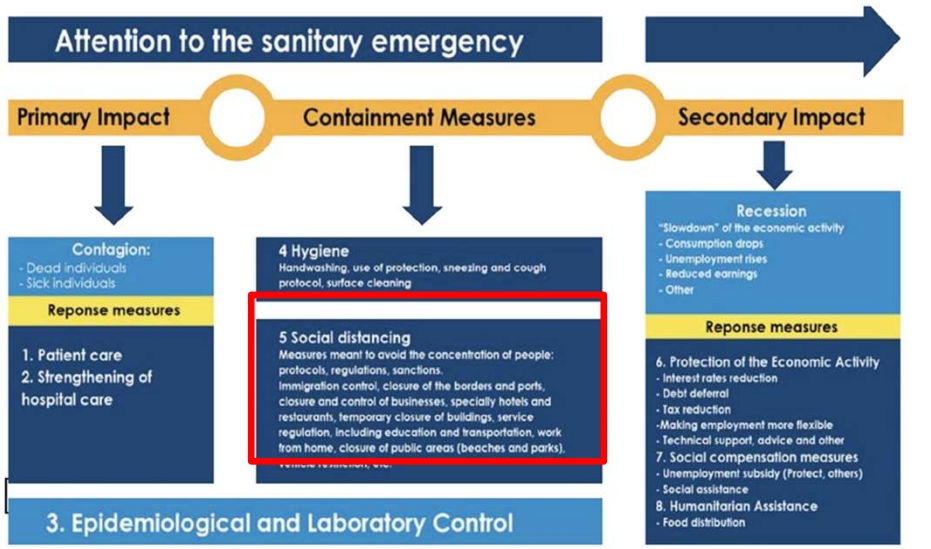


Can Earth Observation data be used to forecast the number of C-19 cases in an area?



Social distancing minimizes C-19 transmission

Figure 2
COVID-19 impact and care actions



UN/DESA Policy Brief #85: Impact of COVID-19: perspective from Voluntary National Reviews

- **Part of the public health solution for C-19**
- Lockdown and uplift timelines geographically different
- Public health guidance different across borders
- Public and workplace adherence measures variable

Mobile phone mobility data indirectly measures social mobility

Article | Open Access | Published: 18 February 2021

Mining Google and Apple mobility data: temporal anatomy for COVID-19 social distancing

Corentin Cot, Giacomo Cacciapaglia & Francesco Sannino

Scientific Reports **11**, Article number: 4150 (2021) | Cite this article

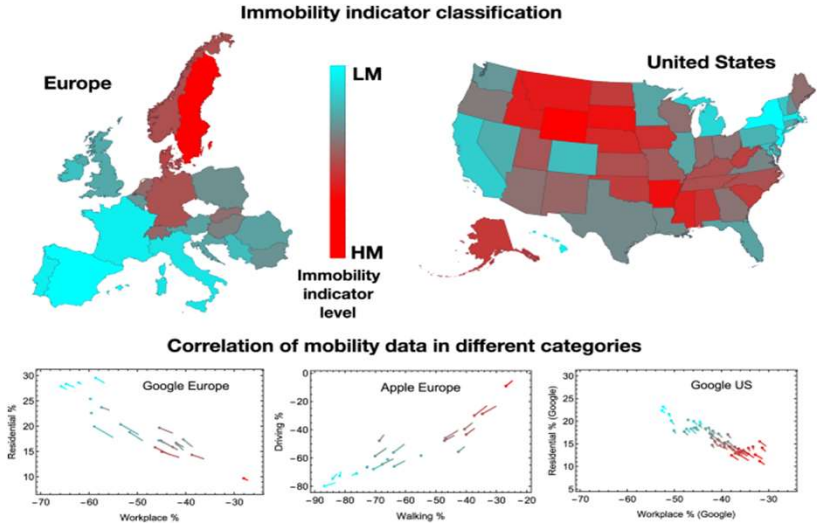
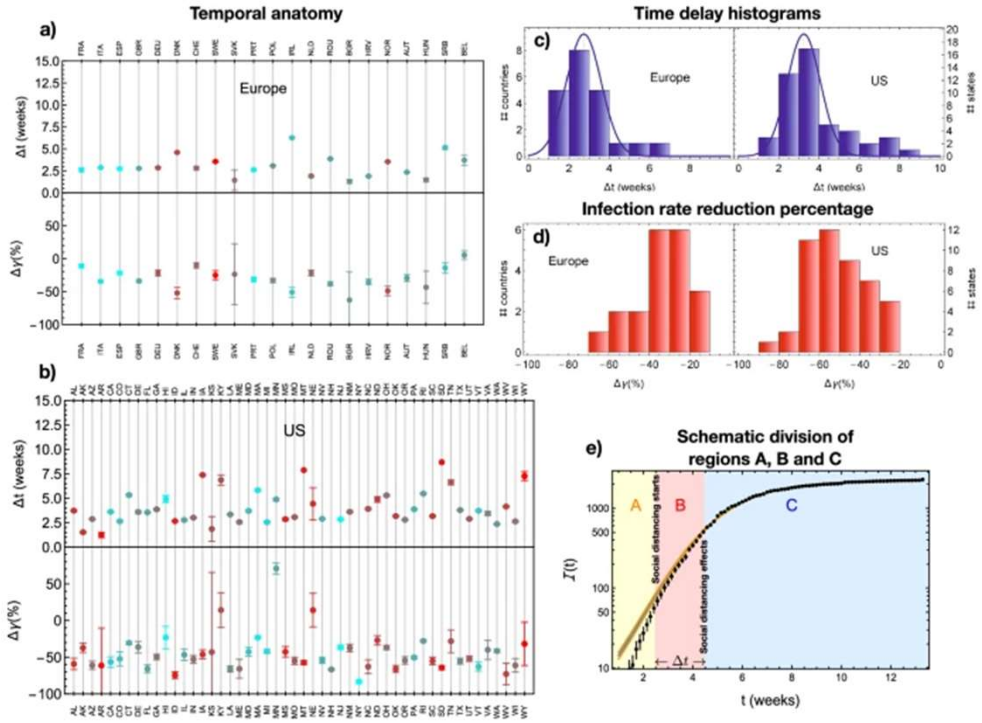
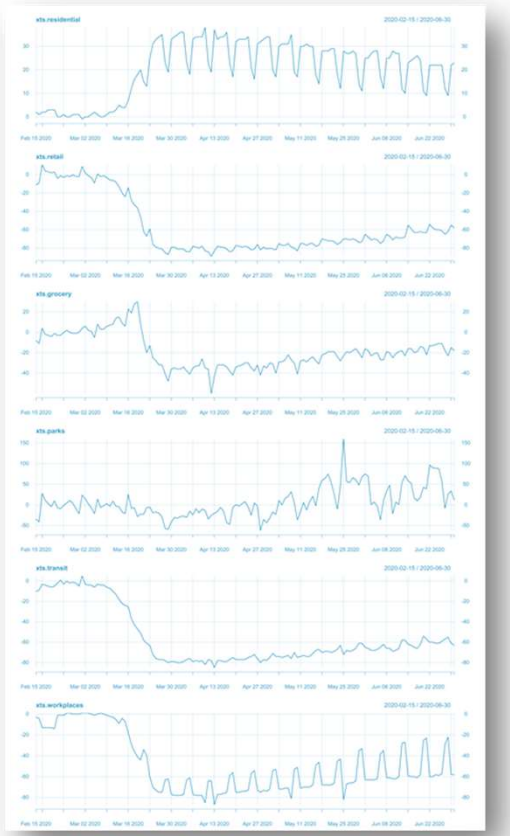


Figure 2



Our analysis → Google social mobility data good indirect measure



Home

Retail

Grocery

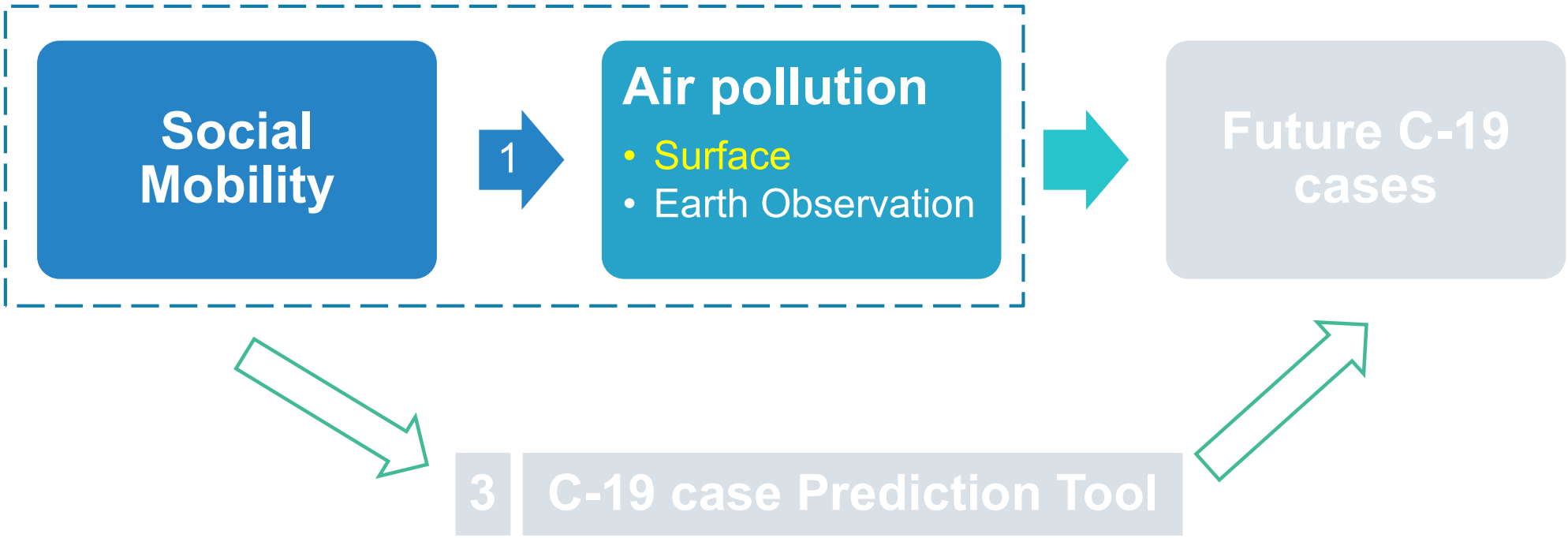
Parks

Transit

Workplace

- London – primary case study: Google Mobility data for London Feb 2020 to June 2020
- Same trend across European capitals

Can Earth Observation data be used to forecast the number of C-19 cases in an area?



Social mobility vs Air pollution (surface)

THE LANCET
Planetary Health

ARTICLES | VOLUME 4, ISSUE 10, E474-E482, OCTOBER 01, 2020

Short-term and long-term health impacts of air pollution reductions from COVID-19 lockdowns in China and Europe: a modelling study

Paolo Giani, MSc • Stefano Castruccio, PhD • Alessandro Anav, PhD • Prof Don Howard, PhD • Wenjing Hu, MSc • Paola Crippa, PhD

Open Access • Published: September 22, 2020 • DOI: https://doi.org/10.1016/S2542-5196(20)30224-2

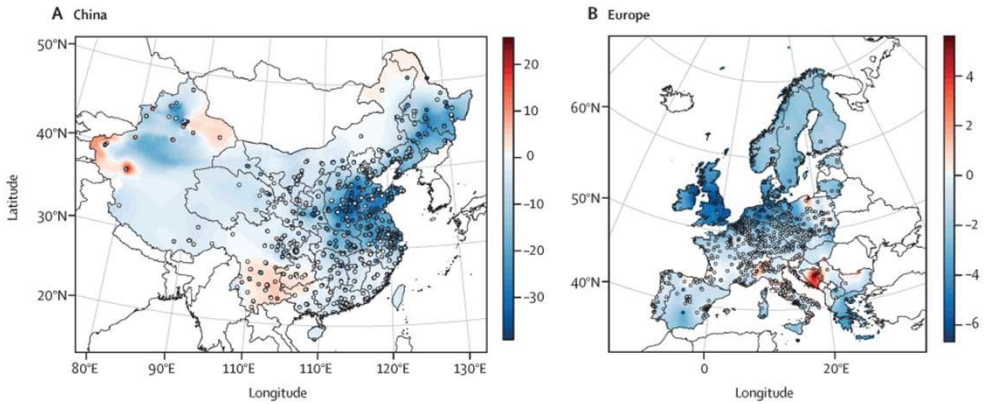


Figure 1 Effect of lockdown on surface $PM_{2.5}$ concentrations

- Observed by surface pollution stations
- Social mobility limitations (Lockdowns) = decrease in air pollution across regions

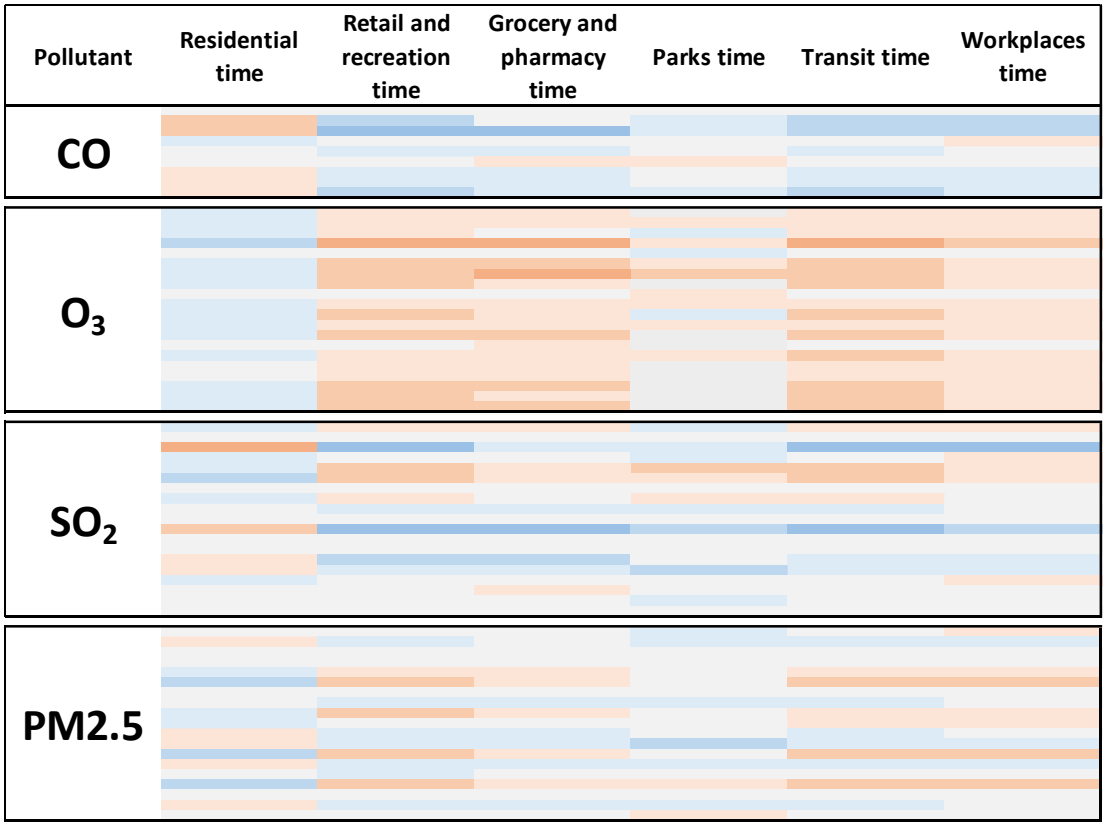
Our analysis → Surface Pollution vs Google social mobility data

NITROGEN DIOXIDE

Region	Residential time	Retail and recreation time	Grocery and pharmacy time	Parks time	Transit time	Workplaces time
Amsterdam	-0.03	0.19	0.26	0.16	0.16	-0.03
Ankara	-0.61	0.62	0.41	0.55	0.62	0.64
Athens	-0.06	0.15	0.19	0.18	0.11	0.1
Belfast	-0.37	0.59	0.58	0.33	0.51	0.38
Bratislava	0.19	0	0.08	0.04	-0.05	-0.21
Brussels	0.26	0.01	0.17	-0.01	-0.15	-0.23
Bucharest	-0.51	0.69	0.66	0.61	0.63	0.49
Budapest	-0.08	0.29	0.42	0.23	0.24	0.1
Copenhagen	-0.13	0.3	0.14	0.23	0.26	0.05
Dublin	-0.01	-0.05	0.03	0.16	-0.03	0.0
Edinburgh	-0.17	0.47	0.5	0.41	0.42	0.1
Helsinki	-0.12	0.51	0.45	-0.19	0.42	0.02
Lisbon	-0.31	0.5	0.5	0.49	0.46	0.33
London	0.05	0.15	0.21	0.12	0.06	-0.03
Madrid	-0.44	0.62	0.65	0.51	0.59	0.46
Oslo	-0.05	0.46	0.43	0.25	0.31	0.03
Paris	-0.07	0.27	0.32	0.23	0.23	0.07
Rome	-0.24	0.38	0.43	0.31	0.37	0.26
Sofia	-0.1	0.24	0.28	0.14	0.26	0.13
Tallinn	-0.12	0.32	0.27	0.26	0.27	0.04
Warsaw	0.25	0.03	0.02	-0.11	-0.09	-0.18
Zagreb	-0.21	0.54	0.61	0.09	0.46	0.3

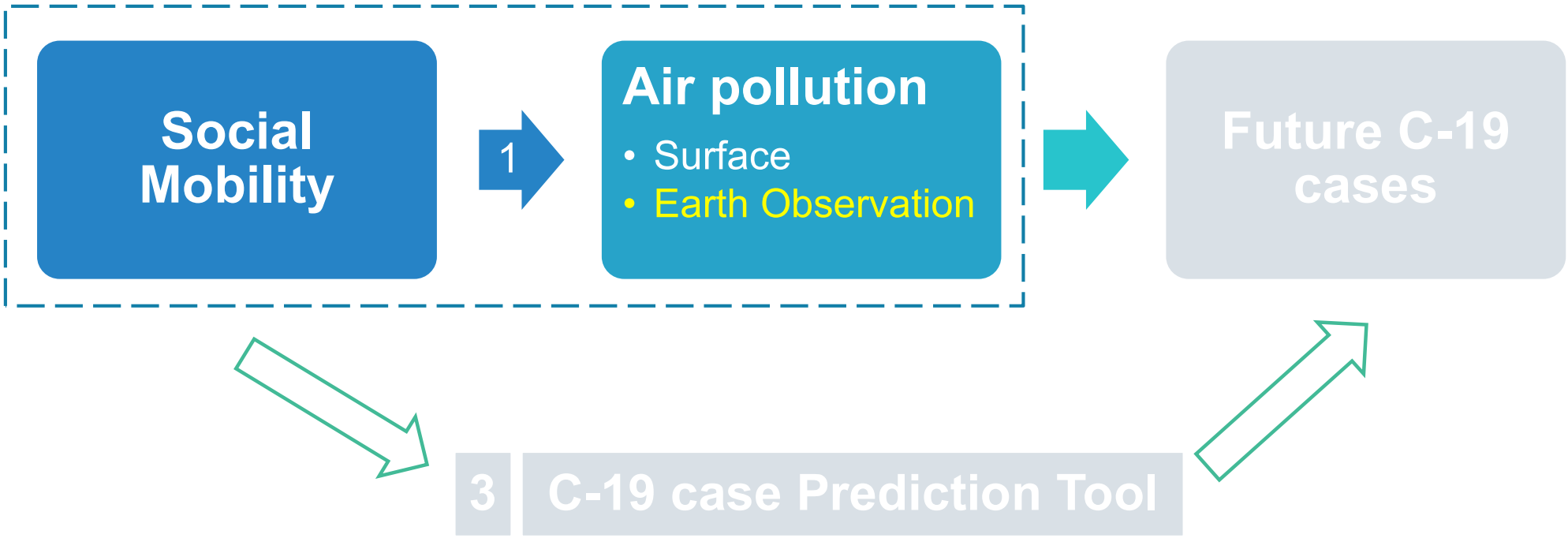
- Residential time causes significant drop in surface NO_2
- Across 22 European capital cities
- Feb 2020 to June 2020 (start of the C-19 pandemic)
- Similar trend with CO

Other surface pollutants and social mobility

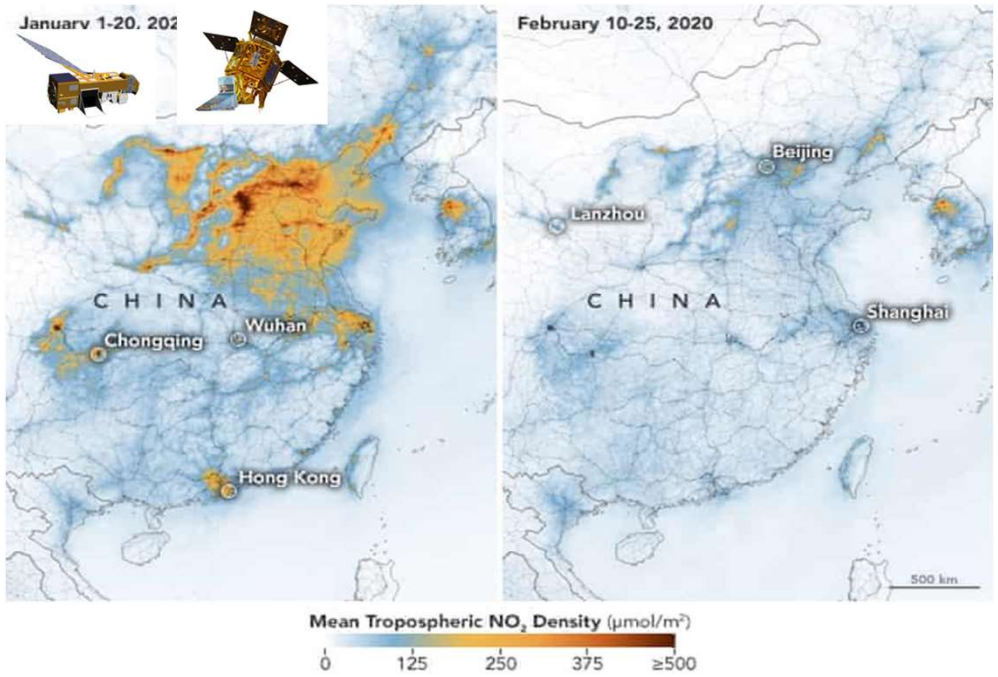


- Similar trends for surface CO = less CO more time at home
- Not all surface pollutant markers correlate with social mobility in the same way
- Opposite trends for O3, and mixed trends for SO2 and PM2.5

Can Earth Observation data be used to forecast the number of C-19 cases in an area?

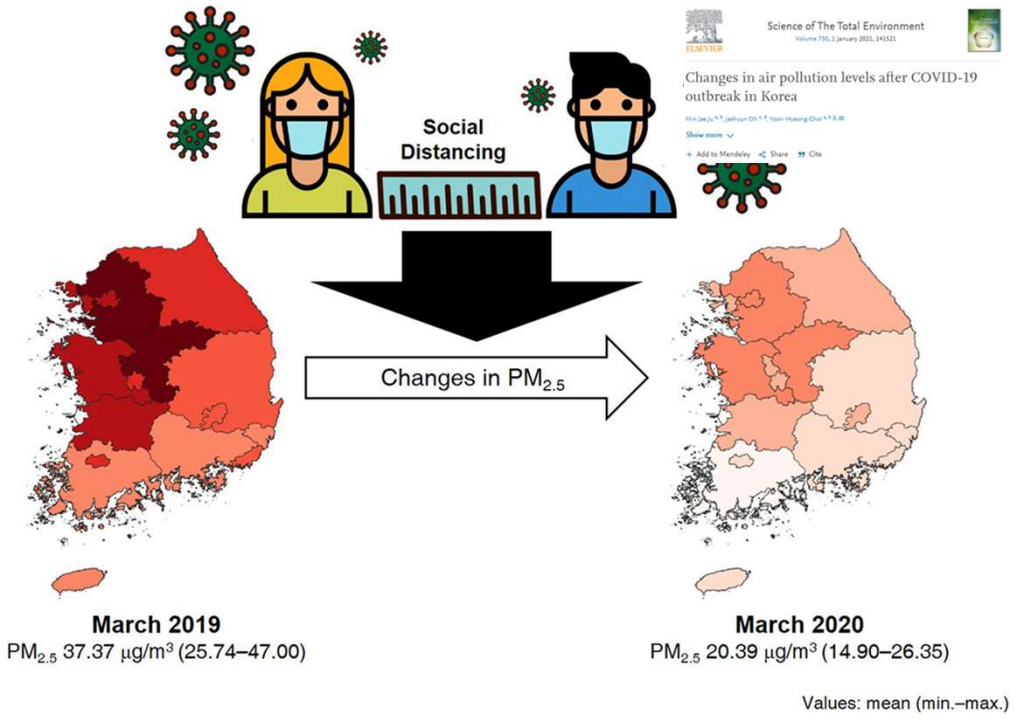


Social mobility vs Air pollution (EO)



- Social mobility limitations (Lockdowns) = decrease in air pollution across regions
- Observed on satellite Earth Observation (ESA Sentinel-5 and NASA Aura)
- Focus – Wuhan, China

Social mobility vs Air pollution (regional variation)



- Social mobility limitations (Lockdowns) = decrease in air pollution across regions
- Observed across different regions – map of Korea last year in March 2020

Our analysis → EO Pollution and Google social mobility data in Europe

EO pollutants that were lower with more time at home? NO_2 and SO_2

NITROGEN DIOXIDE

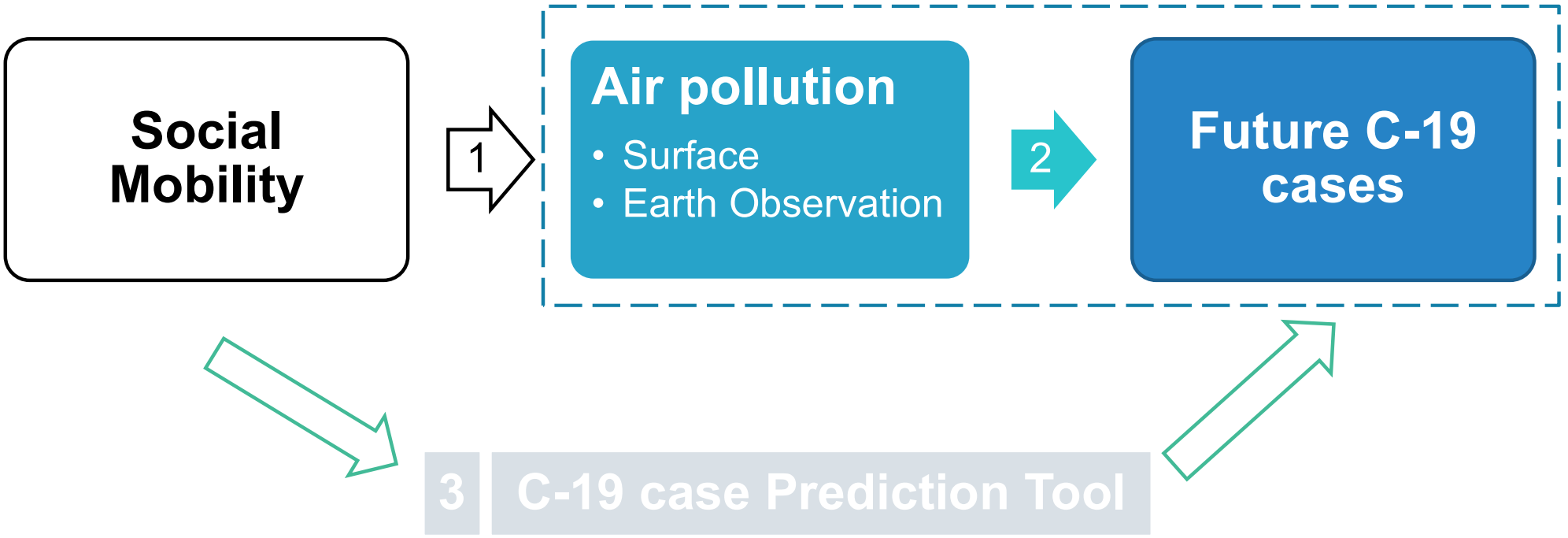
Region	Residential time	Retail and recreation time	Grocery and pharmacy time	Parks time	Transit time	Workplaces time
Amsterdam	0	0.13	0.11	-0.01	0.09	-0.01
Athens	0.11	-0.12	-0.03	0.18	-0.09	-0.1
Belgrade	0.06	-0.01	0.01	-0.05	0.01	-0.04
Berlin	-0.22	0.1	0.25	0.01	0.27	0.21
Bratislava	-0.22	0.31	0.14	0	0.29	0.19
Brussels	0.26	-0.18	0.01	-0.28	-0.24	-0.12
Bucharest	-0.03	0.08	0.09	0.02	0.05	0.06
Budapest	-0.2	0.28	0.27	0.12	0.2	0.17
Copenhagen	-0.36	0.26	0.19	0.09	0.34	0.35
Helsinki	0.03	0.04	0.05	0.28	0	-0.14
Lisbon	0.14	-0.04	-0.04	-0.02	-0.09	-0.14
Ljubljana	-0.03	0.18	0.26	0.08	0.05	0.01
Luxembourg	0.23	-0.01	0.18	-0.3	-0.12	-0.17
Madrid	-0.4	0.46	0.51	0.43	0.47	0.43
Oslo	-0.15	0.19	0.05	0.35	0.15	0.01
Paris	0.22	0.05	0.09	-0.02	-0.1	-0.18
Prague	0.21	-0.23	-0.13	-0.26	-0.24	-0.24
Rome	-0.11	0.22	0.26	0.19	0.19	0.14
Sofia	0.18	-0.15	-0.07	-0.11	-0.14	-0.18
Stockholm	-0.06	0.18	0.16	0.44	0.16	-0.12
Valletta	0.16	-0.1	-0.15	-0.02	-0.14	-0.16
Vienna	0.06	-0.01	-0.02	0.05	-0.03	-0.09
Warsaw	0.17	0.06	0.11	-0.01	-0.06	-0.15
Zagreb	-0.07	0.25	0.3	0.2	0.18	0.14
Zurich	0.38	-0.25	0.05	0.13	-0.33	-0.13

EO pollutants that increased with more time at home? PM2.5, Total PM, UV

PM 2.5

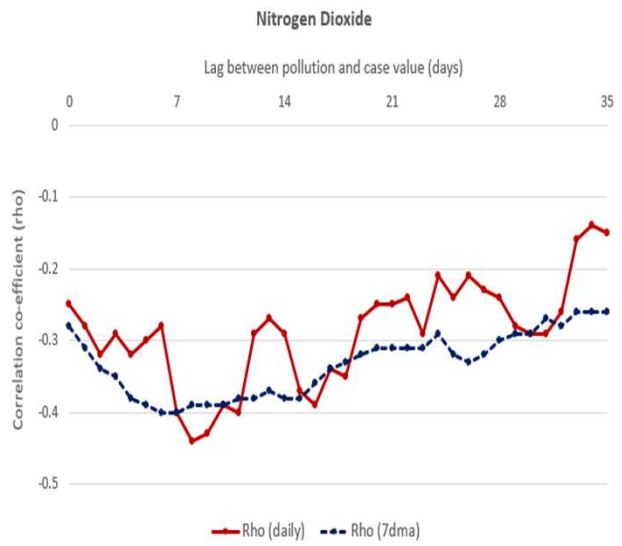
Region	Residential time	Retail and recreation time	Grocery and pharmacy time	Parks time	Transit time	Workplaces time
Amsterdam	0.53	-0.53	-0.49	0.15	-0.54	-0.49
Athens	0.32	-0.31	-0.24	-0.24	-0.33	-0.3
Belgrade	0.35	-0.34	-0.33	-0.28	-0.36	-0.33
Berlin	0.55	-0.55	-0.38	0.04	-0.59	-0.57
Bratislava	0.43	-0.35	-0.26	0.01	-0.4	-0.39
Brussels	0.52	-0.55	-0.54	-0.24	-0.57	-0.52
Bucharest	0.25	-0.24	-0.24	-0.21	-0.26	-0.26
Budapest	0.48	-0.43	-0.39	-0.43	-0.47	-0.47
Copenhagen	0.41	-0.42	-0.33	0.35	-0.51	-0.45
Helsinki	0.15	-0.36	-0.31	0.11	-0.29	-0.15
Lisbon	0.22	-0.23	-0.26	-0.27	-0.24	-0.26
Ljubljana	0.42	-0.42	-0.38	-0.33	-0.4	-0.37
Luxembourg	0.57	-0.58	-0.55	-0.42	-0.58	-0.56
Madrid	0.39	-0.48	-0.45	-0.52	-0.49	-0.43
Oslo	0.54	-0.53	-0.02	0.32	-0.55	-0.53
Paris	0.51	-0.57	-0.58	-0.55	-0.56	-0.5
Prague	0.37	-0.46	-0.39	-0.43	-0.44	-0.43
Rome	0.4	-0.42	-0.42	-0.47	-0.45	-0.41
Sofia	0.33	-0.29	-0.34	-0.3	-0.35	-0.36
Stockholm	0.41	-0.43	-0.36	0.16	-0.44	-0.42
Valletta	0.29	-0.25	-0.25	-0.31	-0.27	-0.22
Vienna	0.46	-0.43	-0.42	-0.17	-0.46	-0.47
Warsaw	0.24	-0.1	-0.11	0.05	-0.23	-0.22
Zagreb	0.51	-0.54	-0.56	-0.27	-0.58	-0.56
Zurich	0.45	-0.51	-0.21	0.13	-0.5	-0.45

Can Earth Observation data be used to forecast the number of C-19 cases in an area?

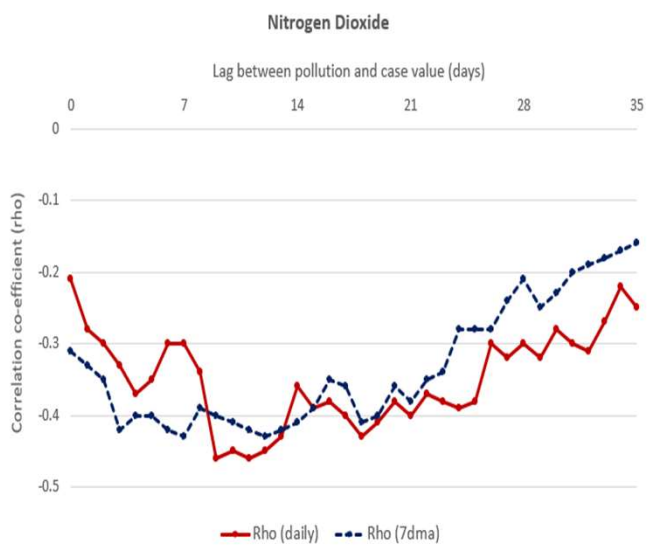


Novid analysis: Surface air pollution vs C-19 cases with differential lag times

London, UK
Nitrogen dioxide

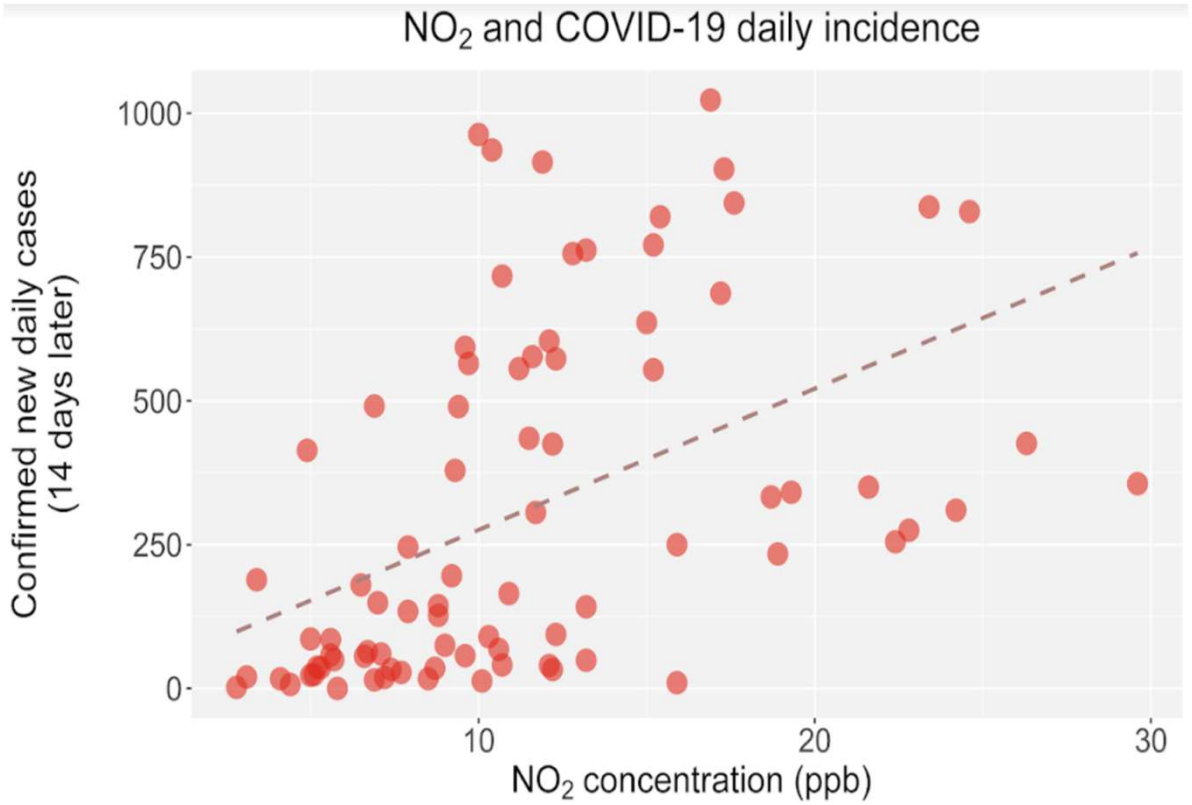


Budapest, HU
Nitrogen dioxide

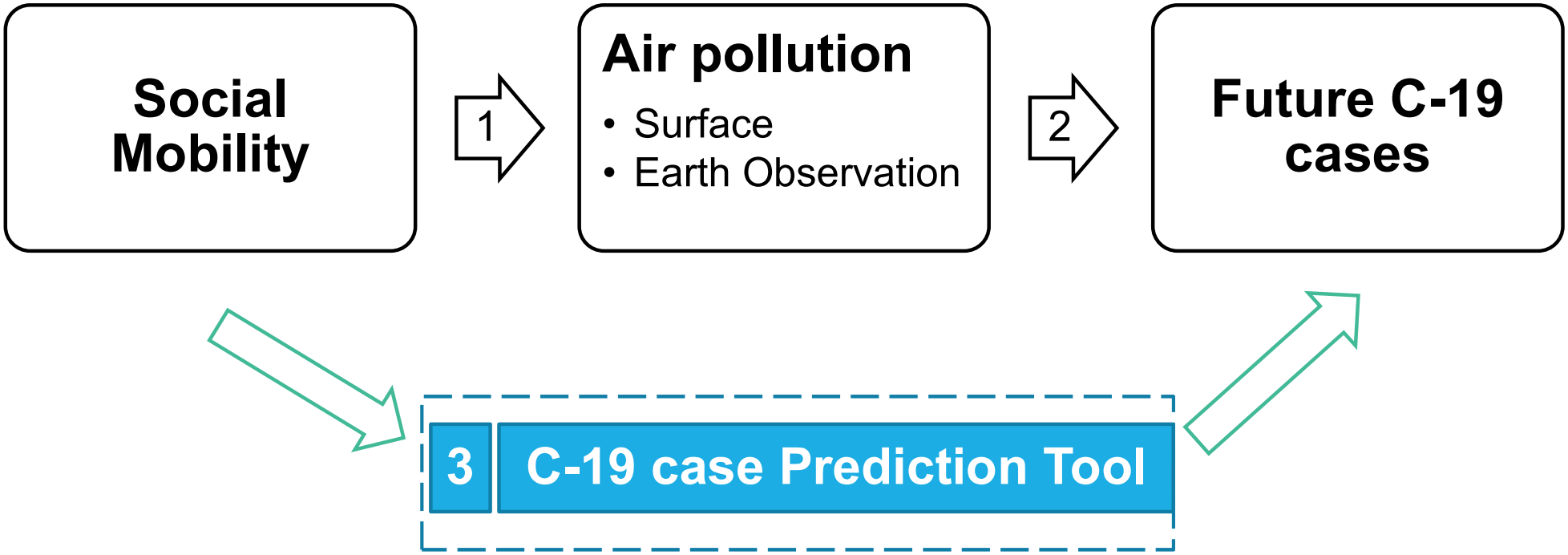


What is the best lag time (C-19 incubation time)? 14 days lag time (rho=0.59)

Novid analysis: Air pollution vs C-19 cases with differential lag times

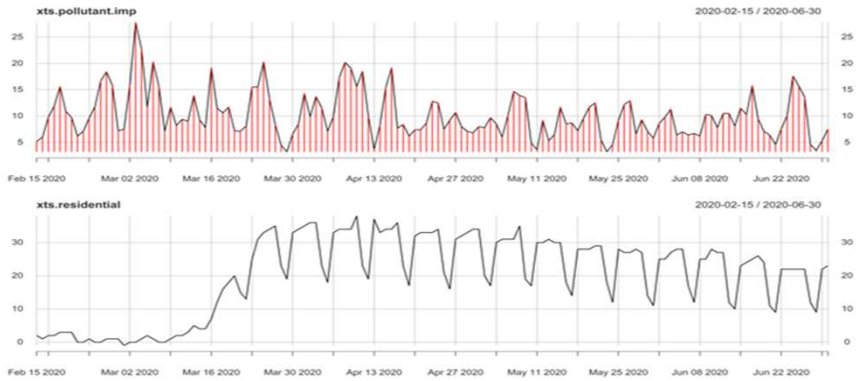


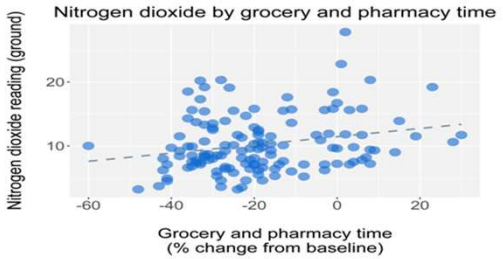
Can Earth Observation data be used to forecast the number of C-19 cases in an area?



Novid analysis: Social mobility vs Air pollution (surface)

Primary case study – Surface NO2 in London

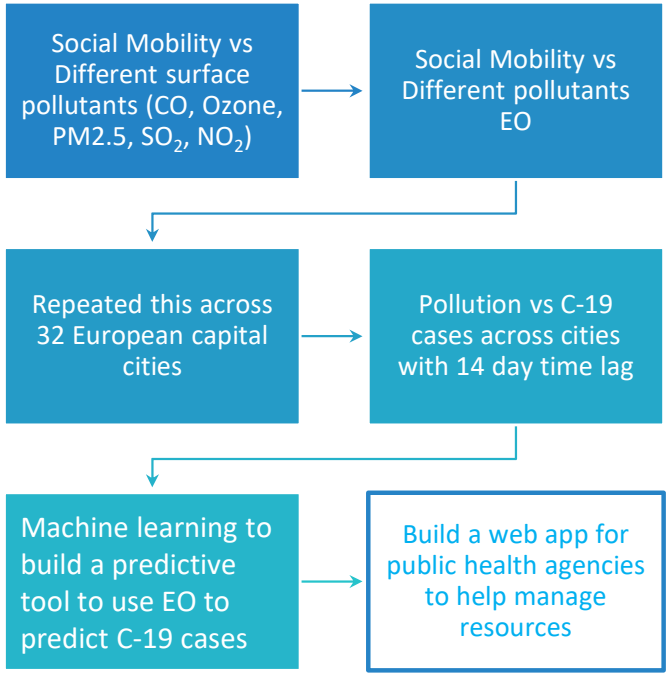




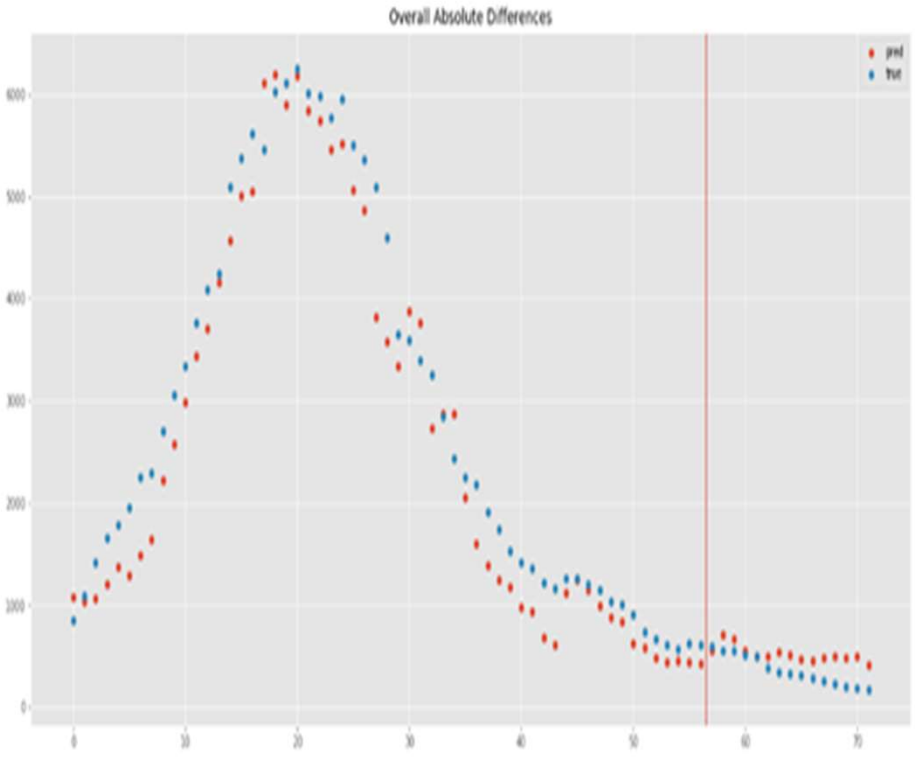
GREATER LONDON AUTHORITY

London Air

Additional analysis to build a 'forecasting tool'



EO to predict C-19 – developing a ‘C-19 forecasting tool’



→ Put all the information together in a ML Model

→ 14 day lag time

→ Trained the model with the data that we gathered

→ **Model predicts Air pollution (NO2) T+0 and C-19 cases T+14days**

→ **Limitations – vaccination drive, new variants incubation time etc.**

Can Earth Observation data be used to forecast the number of C-19 cases in an area?