EGU21-13488 Covid-19: What about Resilience and Scaling Dynamics?

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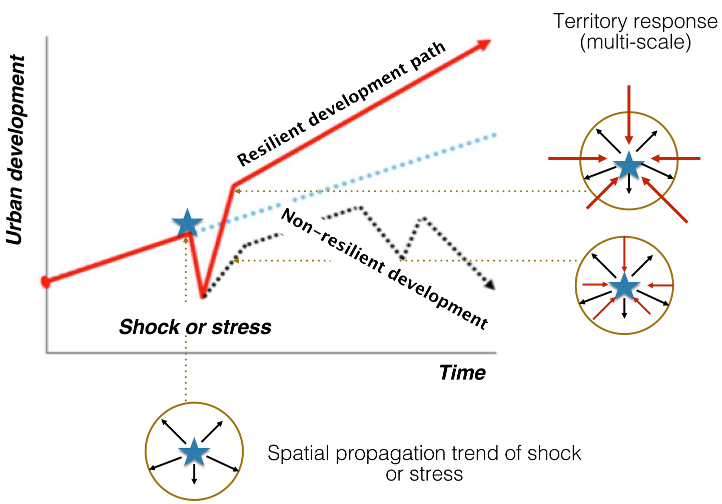
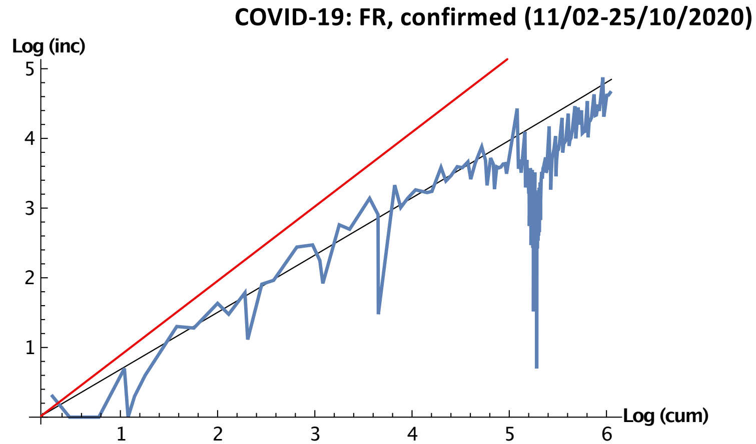
- **Context and objectives:** New challenges for our cities with a priority objective **"Resilience"**
- **Contributions:** At the forefront of disruptive methodologies





« Two months of Covid-19 lockdown will cost France €120 billion »

(FRANCE 24 with REUTERS & AFP)

- **Impacts:** Chair "Hydrology for a resilient city" / "Urban Geosciences"... and if the legislation would follow...

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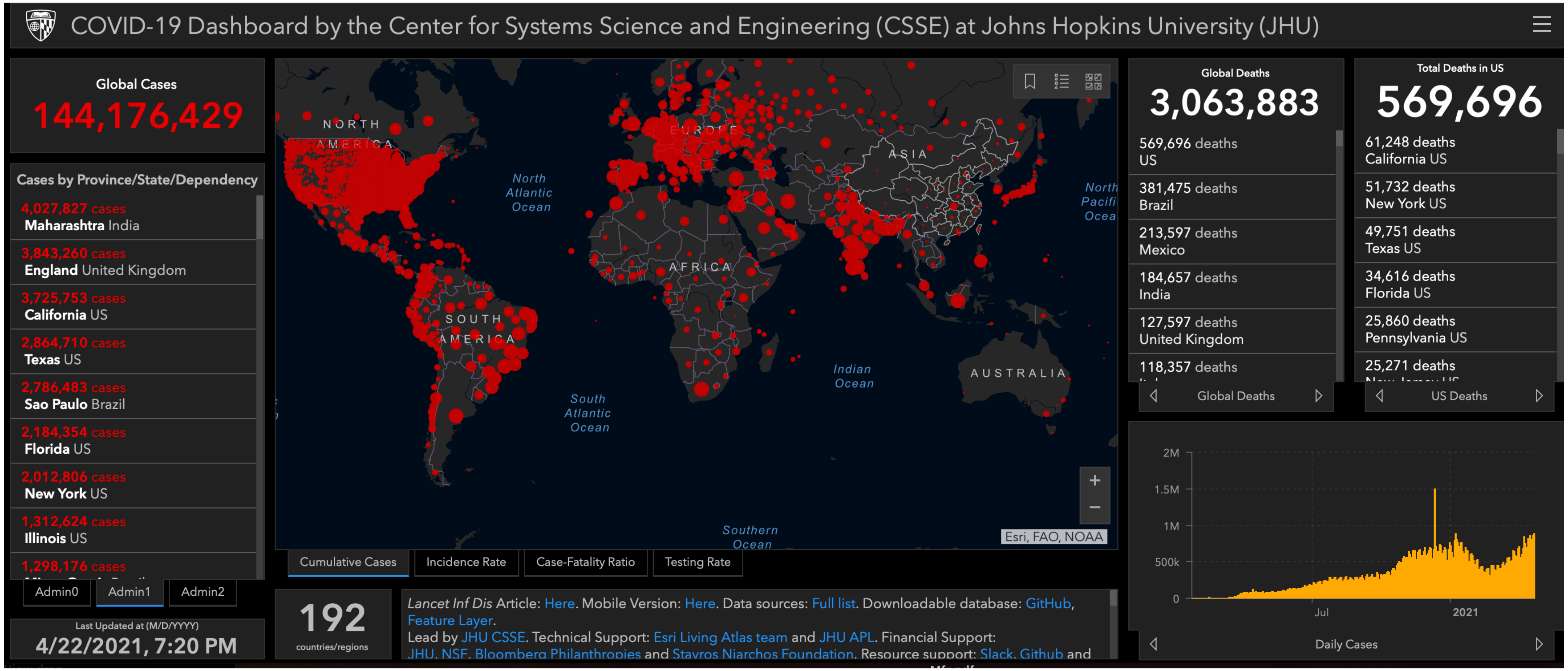

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HYDROLOGY METEOROLOGY and COMPLEXITY

EGU General Assembly 2021

- **Cascade paradigm:** The common root of most epidemics models is a cascade paradigm that can be traced back to their emergence with **Bernoulli** and **d'Alembert**, who preceded the celebrated quatrain of **Richardson** on the atmospheric dynamics cascade.
- **SIR basic assumption:** Each individual of the infected fraction I of a given population N will "on average" contaminate R_0 - the mythical **"basic reproduction number"**- individuals of the "susceptible" fraction S of this population. The complement to the fraction S is the population fraction R=$N\backslash S$ of the "removed" individuals.
- **Characteristic times T** and the corresponding **"doubling times" T_2** are related to differential equations of the type:

$$dX/dt \approx X(t)/T$$

$$T_2 = T\ln(2)$$

- **Exponential solution:**

$$X(t) \approx X(t_0)\exp((t-t_0)/T)$$

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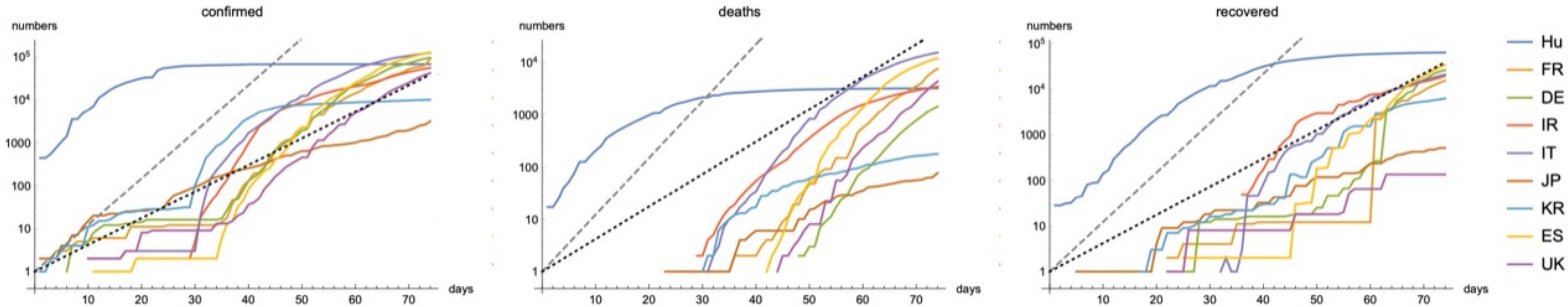

- **Sub-exponential growth phase:** log-linear plots of cumulative incidences X(t) of the following entities: Hubei, France, Germany, Iran, Italy, Japan, Korea, Spain and United Kingdom, over the period 22 January - 04 April. An exponential behaviour would correspond to straight lines like those drawn for characteristic times T=4;7 days, and therefore to doubling times T_2 approx. of about 3;5 days (respectively dashed grey and dotted black straight lines).
- **All the trajectories are sub-exponentials:** they grow slower than any of their local approximations by an exponential that corresponds to a tangent to these log-linear graphs.

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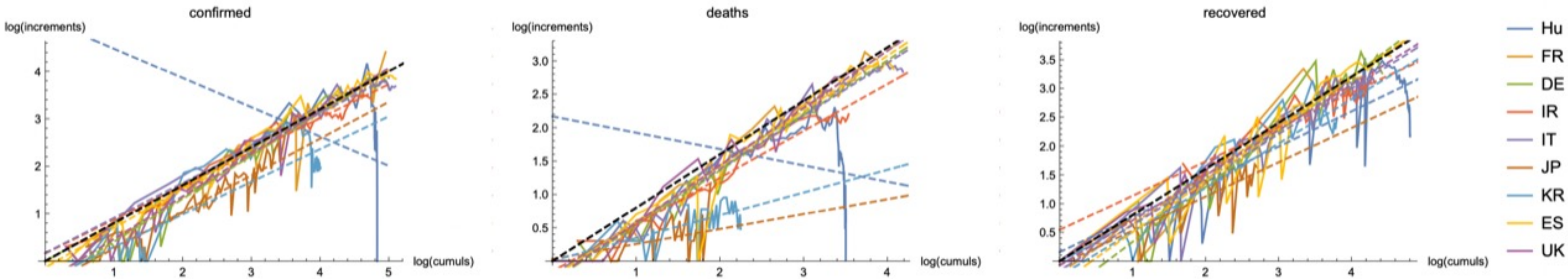

- **Cumulative-incremental analysis of the growth phase:**
  log-log plots of the couples $(X(t), \Delta X(t))$, where $\Delta X(t) = X(t) - X(t - \Delta t))$ is the increment (the time increment Δt being one day) of cumulative incidence $X(t)$ of the following entities: Hubei, France, Germany, Iran, Italy, Japan, Korea, Spain, and United Kingdom, over the period 22 January - 04 April.
- **Graphs should be read from left to right to follow the time arrow** (X(t) being non decreasing with time) and the almost vertical parts on the right-hand side corresponds to compressed views of decline phases.
- **Rather universal behaviour:** especially a common scaling/power-law behaviour.

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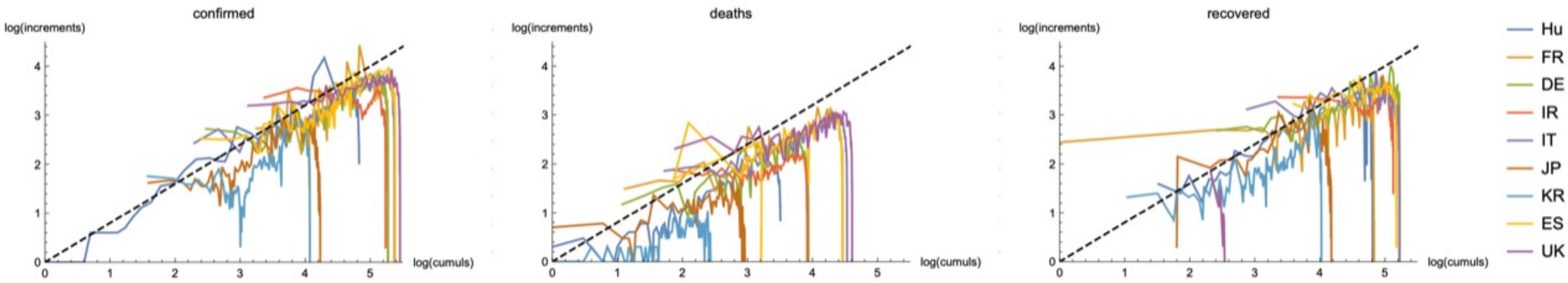

- **Cumulative-incremental analysis of the decline phase:**

  log-log plots of the couples $(X_{max} - X(t), \Delta X(t))$ to analyse the decline phase of **(a)** confirmed, **(b)** deaths, **(c)** recovered incidences cumulative $X(t)$ of the aforementioned entities (Hubei, France, Germany, Iran, Italy, Japan, Korea, Spain and United Kingdom), over the period 22 January – 07 June, with exception of shorter period for Hubei till 16 April.
- **Graphs should be read from right to left to follow the time arrow** and the almost vertical parts on the right-hand side corresponds to compressed views of growth phases.
- **Rather universal behaviour:** especially a common scaling/power-law behaviour.