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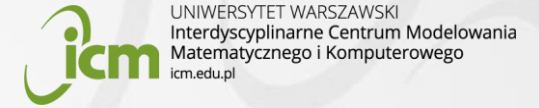
The ICM University of Warsaw Epidemiological Model

Franciszek M. Rakowski, PhD

Innovation in Disaster Risk Reduction

2023

Social structure, principles of the model.



- Agent model (microsimulation)
- The main idea of the model is based on a detailed representation of the socio-demographic structure of the country and describing the probability of infection from person to person in the appropriate context of meetings.



- Spatial location of agents (people) on a grid with a resolution of 1km² Each agent is assigned to specific contexts permanently or temporarily:



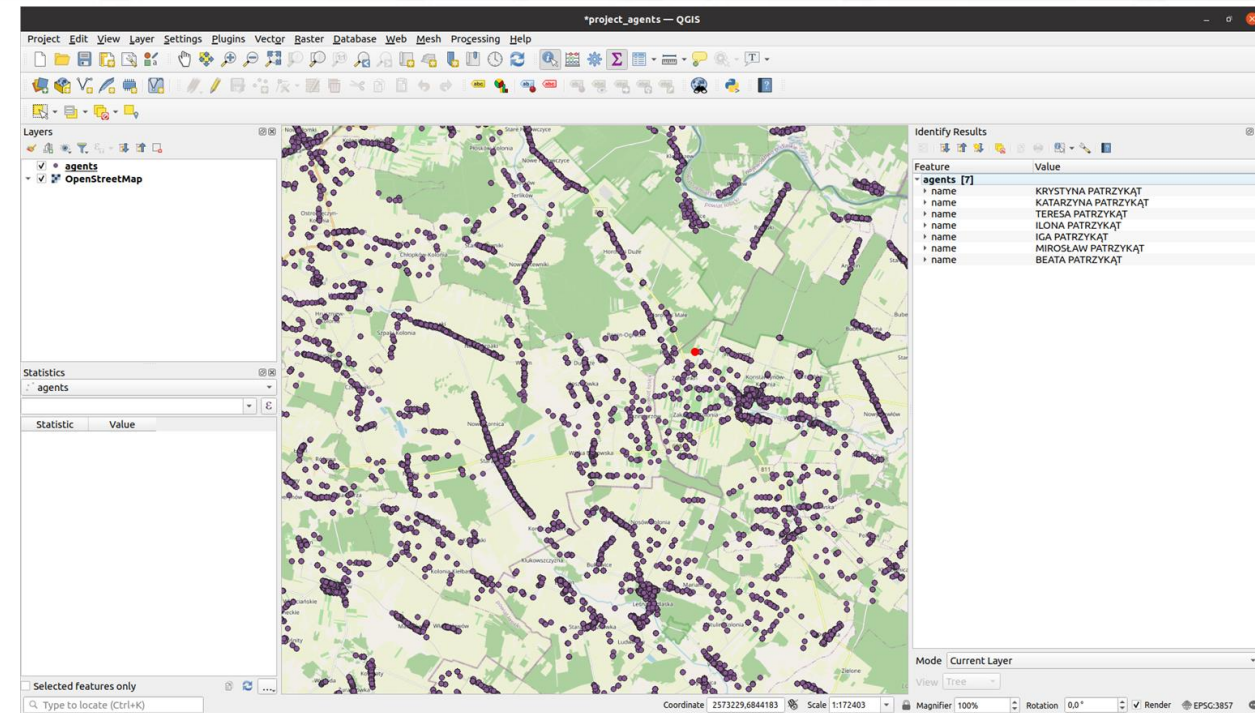
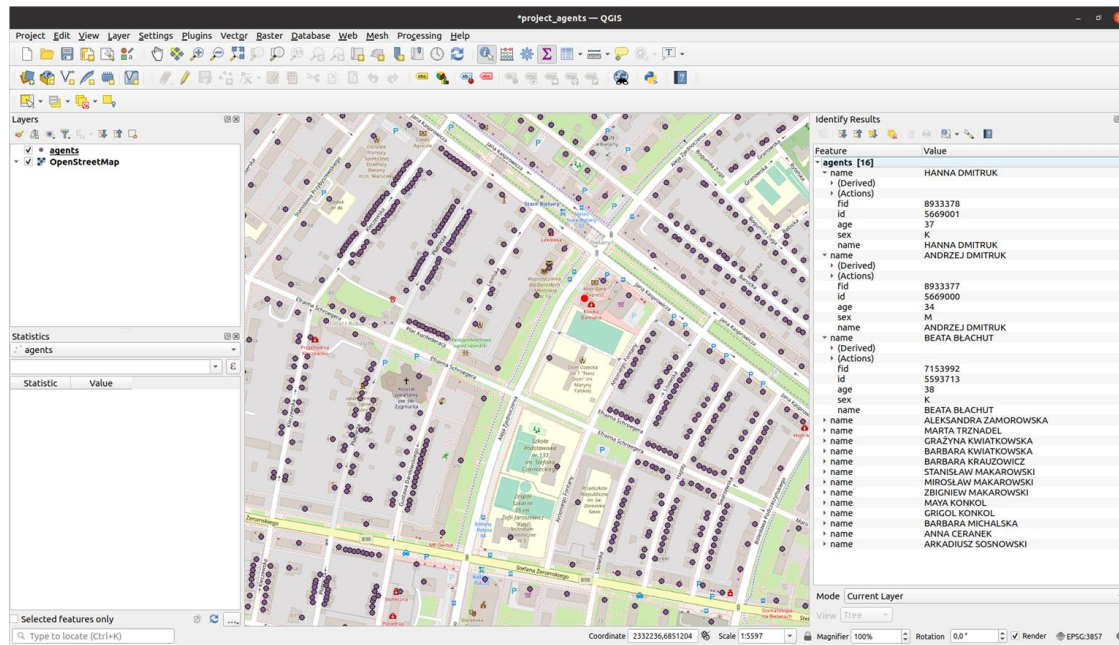
- Contexts are possible places of meeting and transmission of the virus: apartments, workplaces, schools, streets, etc.



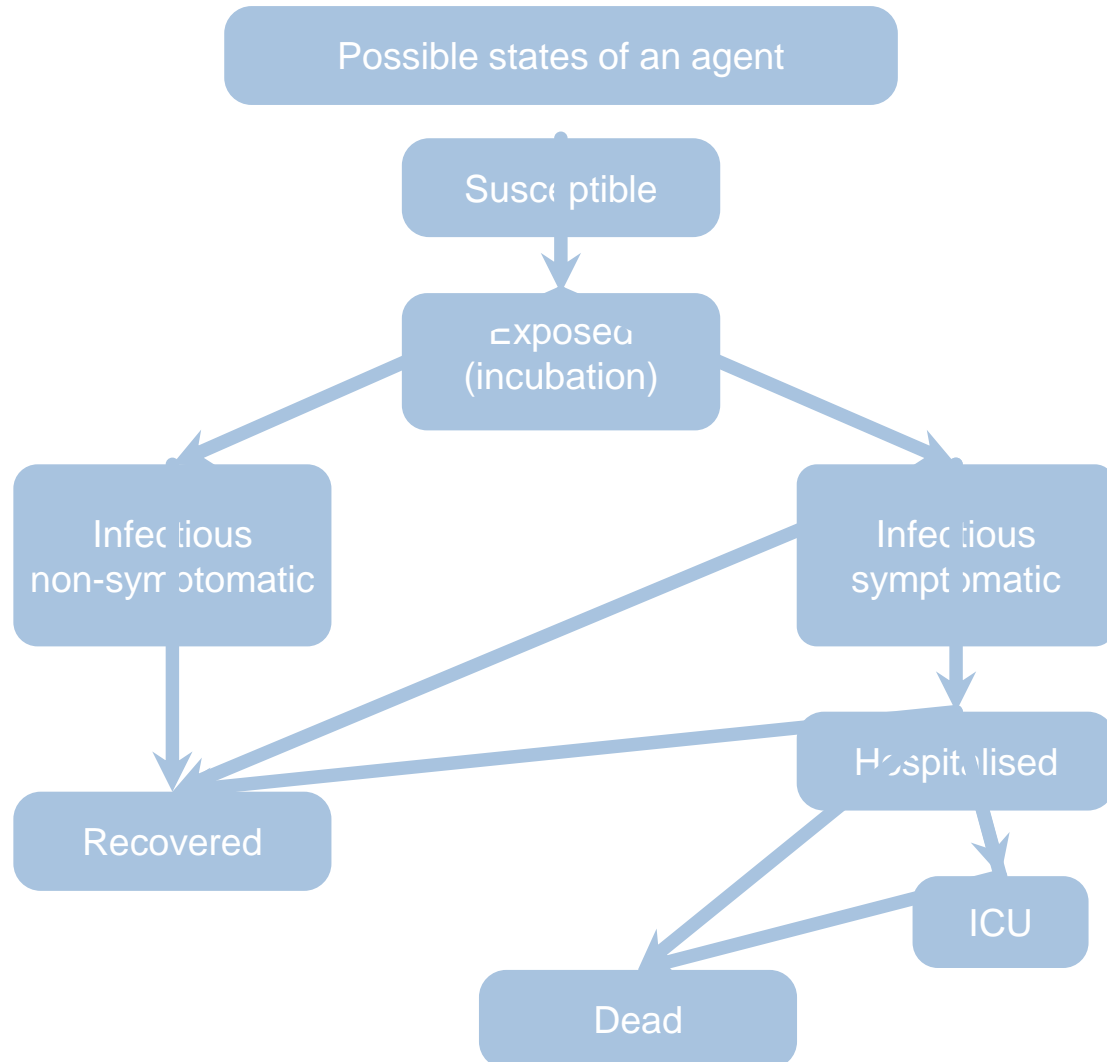
- Agent Travel Description:
 - daily commuting to school, trains, buses,

Step I - synthetic society

Reconstructing population in households: Issue: we have statistical distributions (usually marginal) or demographic samples. We want to reconstruct the location of the houses composition of households by sex and agent number and size of special MZZ housing units



Step 2: basic dynamics of the states of an agent (SEIR type)

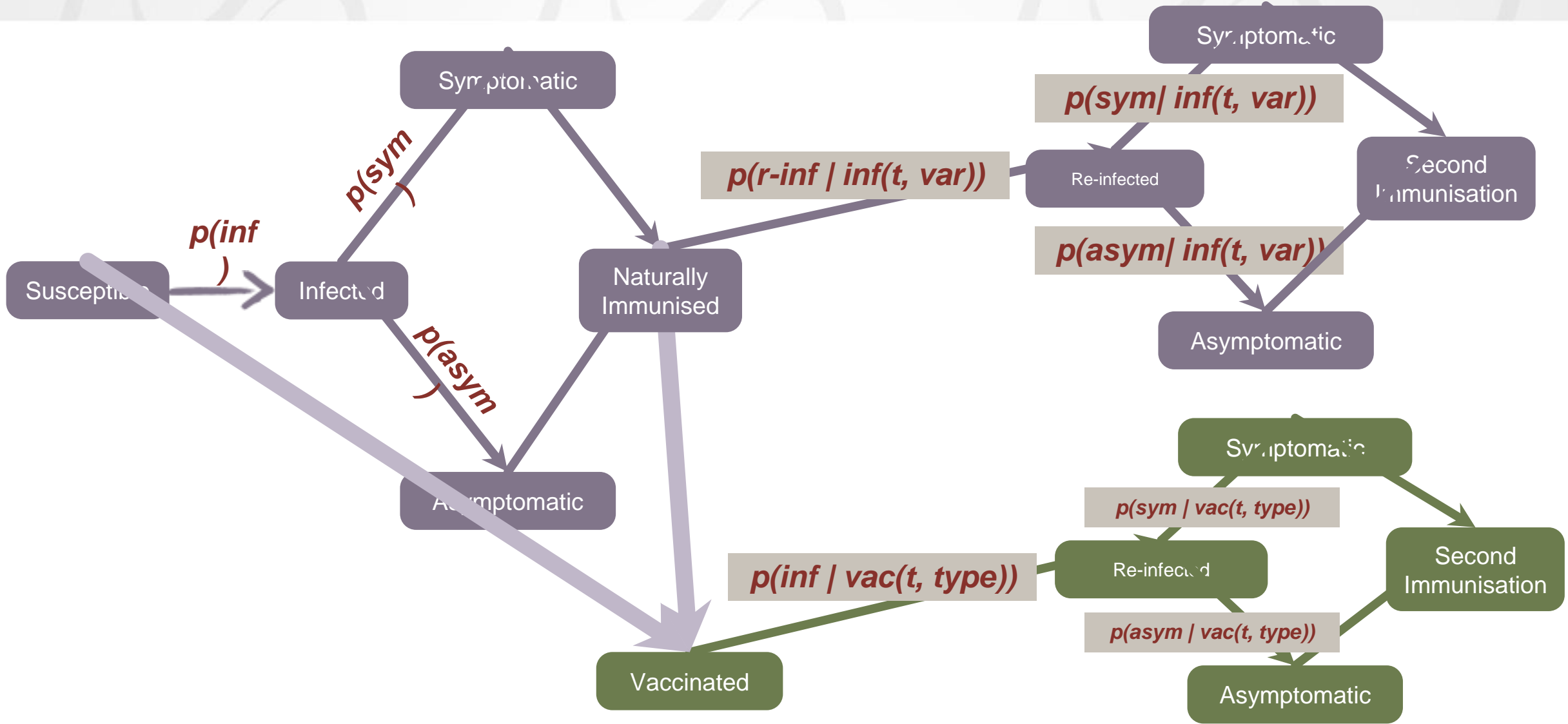


- Starting point is defined by the SEIR model, implemented for each agent.
- SEIR model is extended by the states related to the medical treatment and death. There are also two kinds of the course of illness (A-sym, symptom)
- Probabilities of the transitions between states depends on age groups.
- Infection probability depends of number of infectious people met in various contexts.

$$p^j = 1 - \exp(-\alpha \beta_{hh} I_{hh}^j - \alpha \sum_i^{\text{contexts}} \beta_i \frac{f I_i^j}{1 - (1-f) I_i^j})$$

f – fraction of people not staying at home when infected
 α – the relative infectivity of the virus
 β – context's weights
 I – current infectivity of the context (as the whole).

Extended state diagram



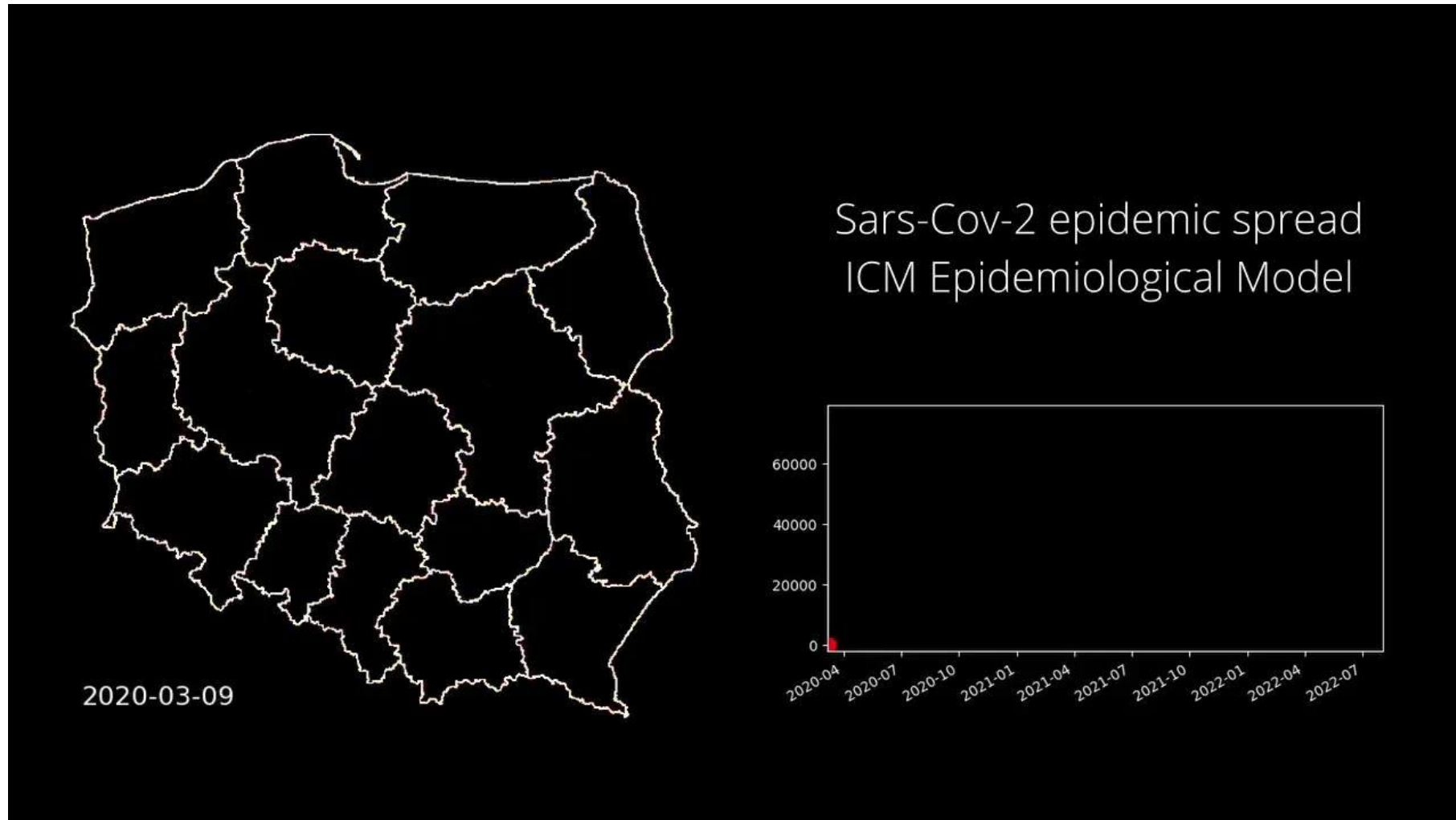
The course of the Covid-19 epidemic given by the model.



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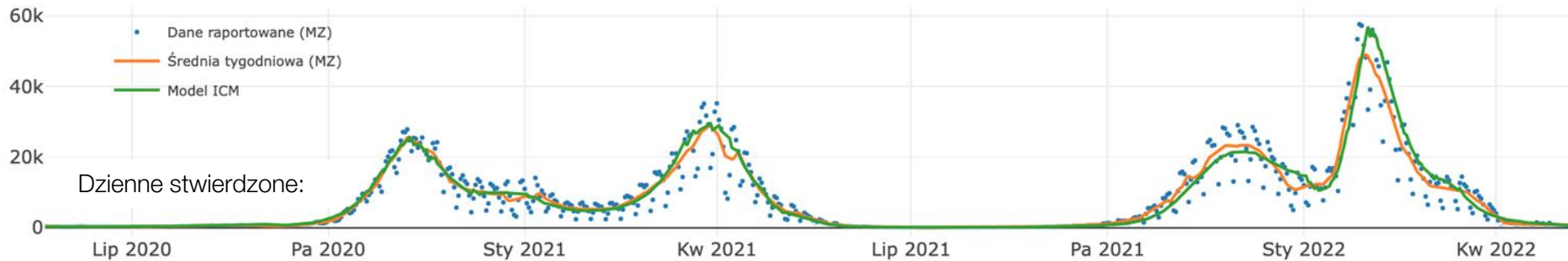
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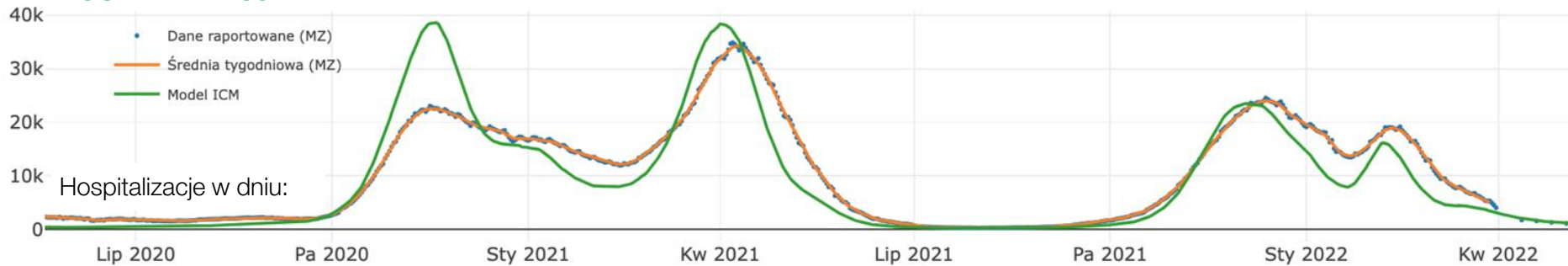
The real sizes of the waves: cases, hospitalisations

Suma przypadków w poszczególnych falach

RZECZYWISTYCH	8.1 M	7.6 M	11.4 M	21.5 M
STWIERDZONYCH	1.5 M	1.4 M	1.3 M	2.0 M

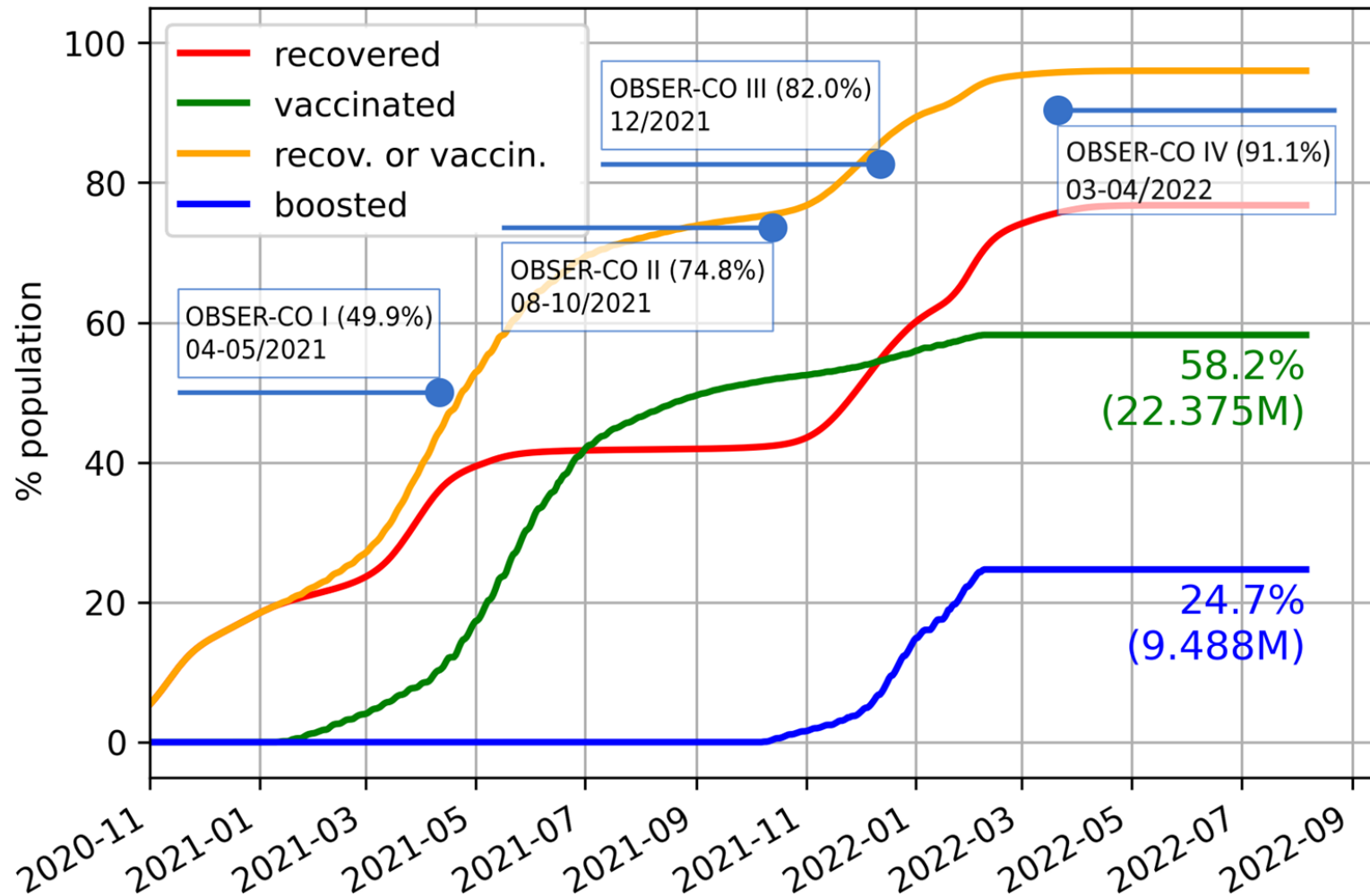


SUMA WYMAGANYCH HOSPITALIZACJI:	192 K	152 K	146 K	97 K
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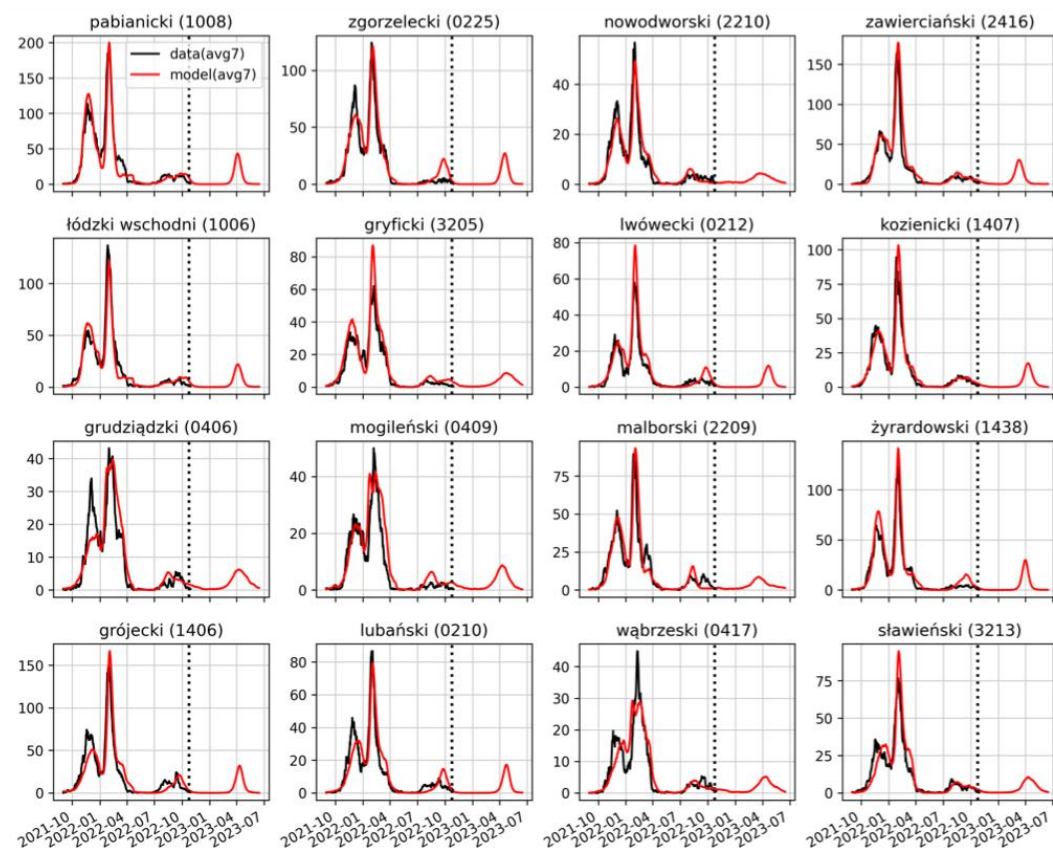
NADMIAROWE ZGONY:	70 K	50 K	46K	12K
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The immunity gain in Poland during Covid-19 epidemic

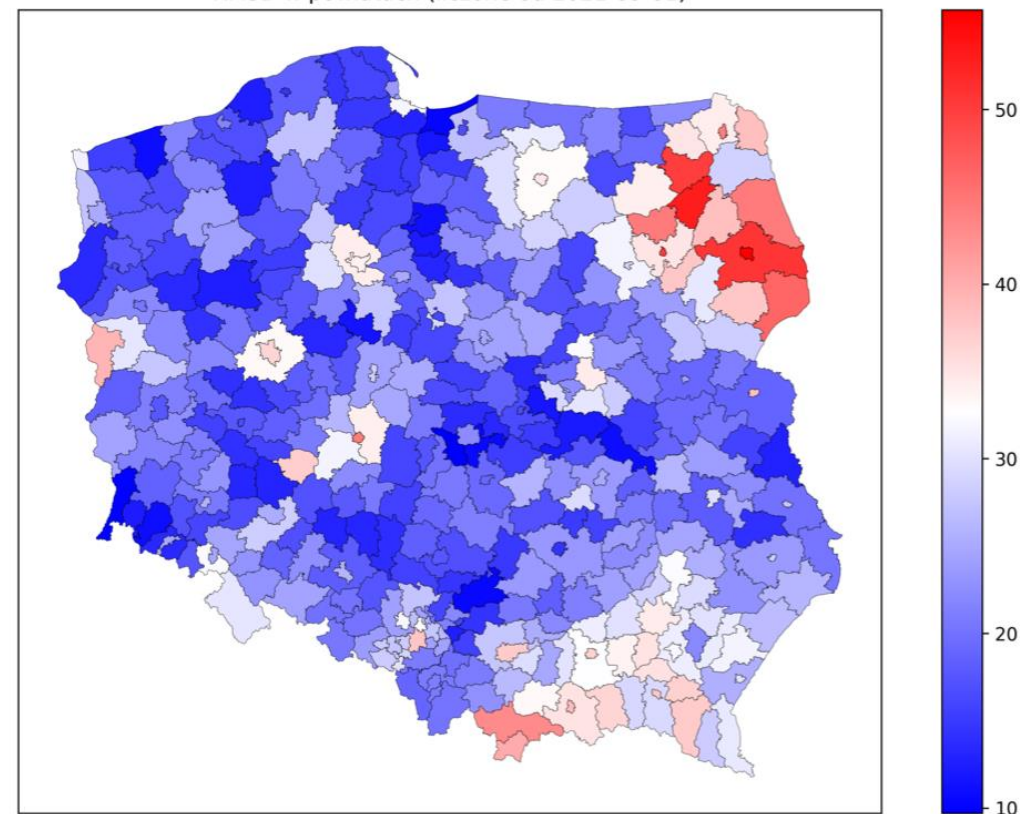


Regional Agreement of the model forecasts and official data.

New cases in counties, results of simulation and official data for top-16 counties in RMDS rank.

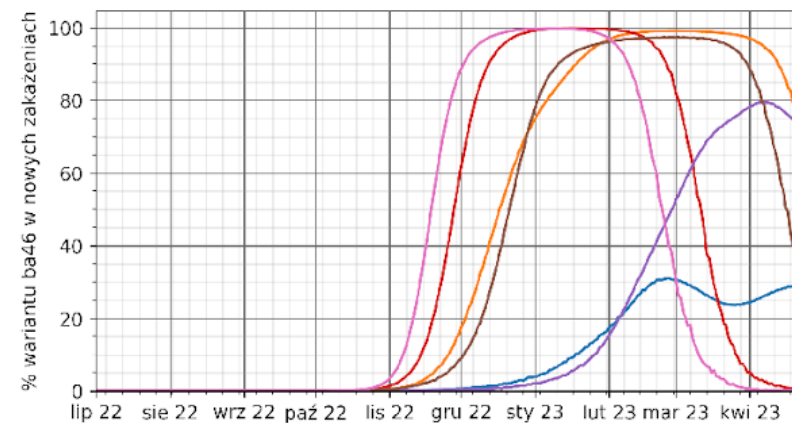
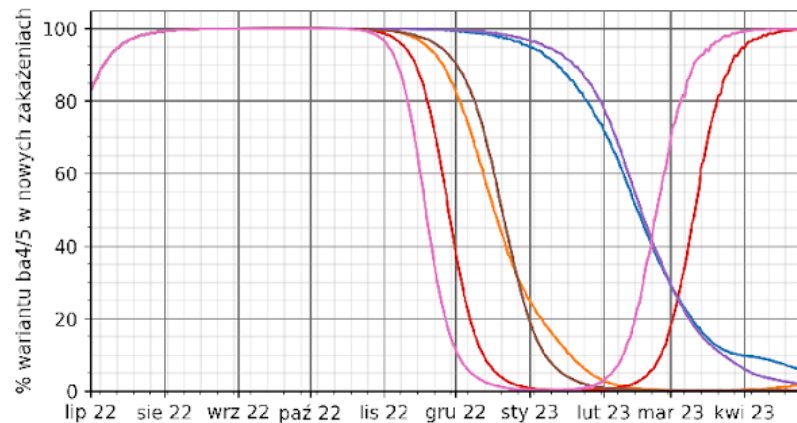
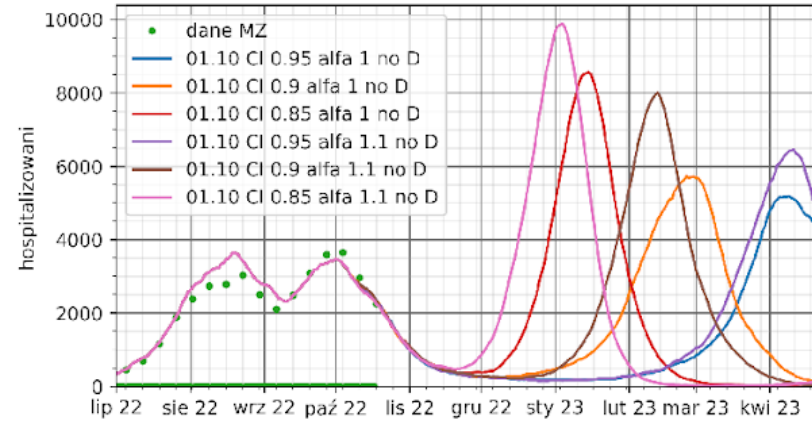
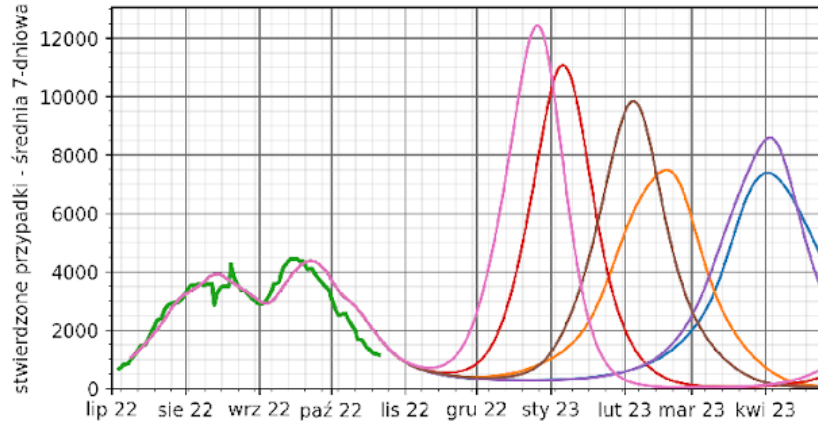


RMDS w powiatach (liczone od 2021-09-01)

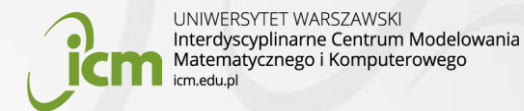


Example of the forecast:

The main factor differentiating the scenario is the degree of cross-immunity new variant to BA[1-5]. Other parameters, i.e. date of sowing or infectivity, are less important.



Advisory to the decision makers, and collaborations



The ICM UW epidemiological model team has played an important advisory and expert role for many government and medical bodies since the beginning of the pandemic. Many bodies in which we participate include professors and directors of clinics, institutes and medical academies from all over Poland, who greatly appreciate the work of the ICM UW Team and use our analyses.

We are part of:

Council for Covid 19 at the Prime Minister

Council for Monitoring and Forecasting the Covid 19 Epidemic at the Minister of Health

Our analyzes are also used by:

Strategic Analysis Center of the Chancellery of the Prime Minister

Government Security Center

National Institute of Hygiene NIZP

Medical Research Agency

Chief Sanitary Inspector

International cooperation:

ECDC European Center for Disease Control and Prevention, EU

Institute for Health Metrics and Evaluation, University of Washington

OptimAgent Germany

Publishing and scientific activity

A lot of interviews and media releases in the pandemic years.

Joint publications with foreign partners (e.g. Nature Communications, 2021, eLife 2022 and others)

Own research and publications



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Thank you.