THE COUPLING OF SYSTEM DYNAMICS MODEL WITH GIS TO VISUALIZE THE POTENTIAL OF RENEWABLE ENERGY

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INTRODUCTION

Due to the economic growth and the global climate crisis, energy supply is a pressing concern.

Various biding legislative documents oblige prioritizing renewable energy sources **(RES)** and focus on **green, local energy**.

Society cannot do such a transition without estimating the available resources and **understanding the links** among various factors influencing the energy market.

The presented **coupling is not dynamic** but provides an insight into the potential implementation of the spatial data into models.

INTRODUCTION

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Environmental issues are complex and interdimensional	• Modelling is the way to transform those complicated systems into something we can understand and influence
The system dynamic **(SD)** is an effective modelling tool	• But it lacks the spatial component that is crucial for nature-related issues. • Geographic Information Systems **(GIS)** provides this missing part.
Energy supply is a pressing concern	• Local energy sources are an essential part of sustainable development, but they are also providing workplaces and energy independence.
Comparing the planning regions	• Incusion of the spatial data in the modelling

Objectives

Data acquisition for the SD model.

Alignment of the parameters between the SD model and GIS functionalities.

Creating the tool that visualizes SD model results

Evaluation of the results and adaptation to the needs of the wider project scope.

The study aims to visualize SD model parameters in GIS to analyze the potential of renewable energy in Latvia.

It is necessary to promote the use of local and renewable resources to move towards sustainable development, achieve climate goals, and promote energy independence.

Software

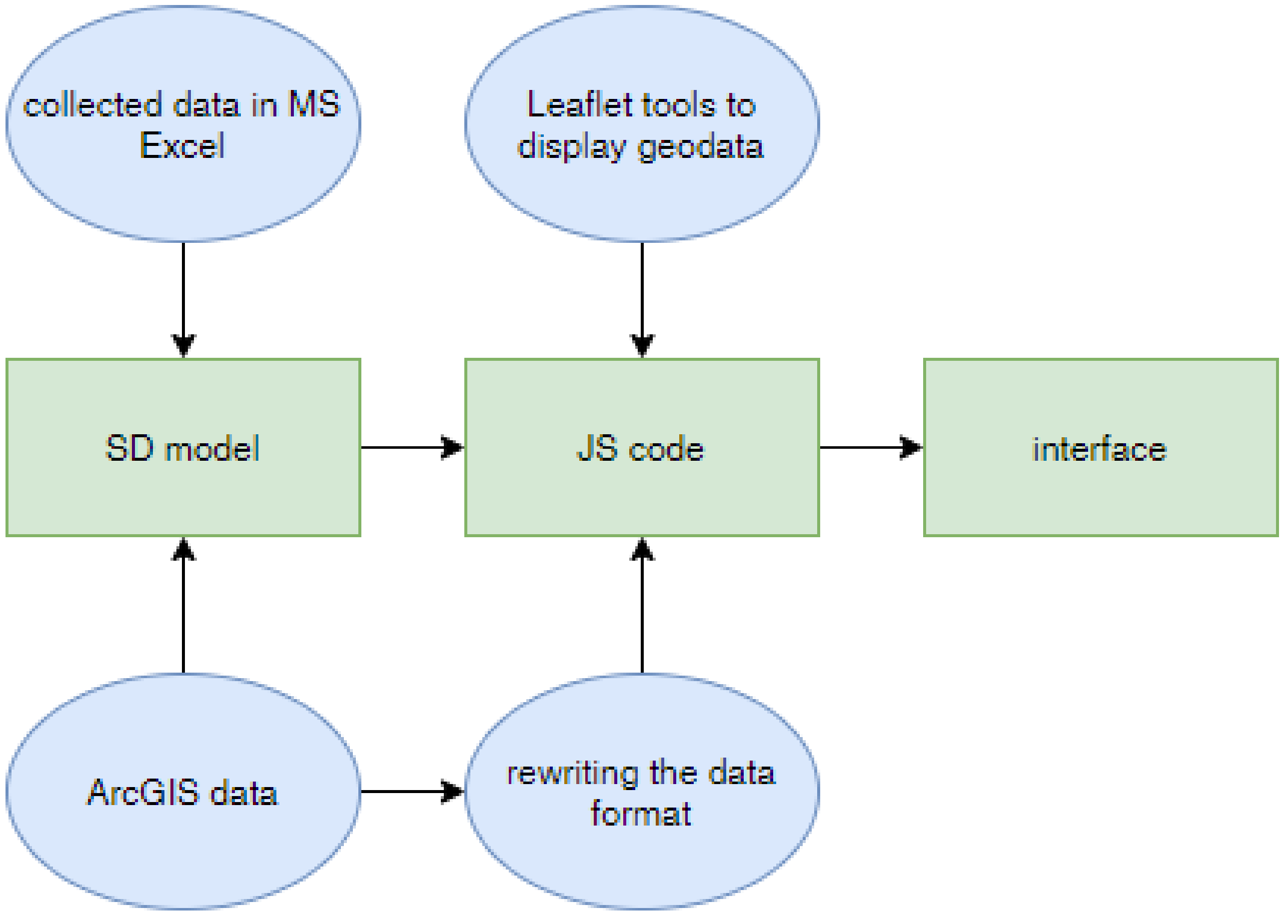
MS Excel	data collection and analysis
Stella Architect	creation of the system dynamic model
ArcGIS PRO	obtaining the spatial data for the model
Python	translating csv files into geoJSON
JavaScript	main script for the model output visualization
Leaflet	cartographic visualization part of the output
HTML	graphic user interface

Workflow

SD model uses data that is systemised in **Excel**; part of the data is obtained using **ArcGIS**.

ArcGIS provides layers of the regions further used by **Leaflet**; but it needs to be rewritten in a different format (done by **Python**)

JavaScript code combines the output of the model and cartographic layers using Leaflet and displays it in **HTML's** graphic user interface.



RESULTS

Available area for the wind energy generation

- Buffer zones around towns, villages, buildings.
- Protection zones of water bodies and roads

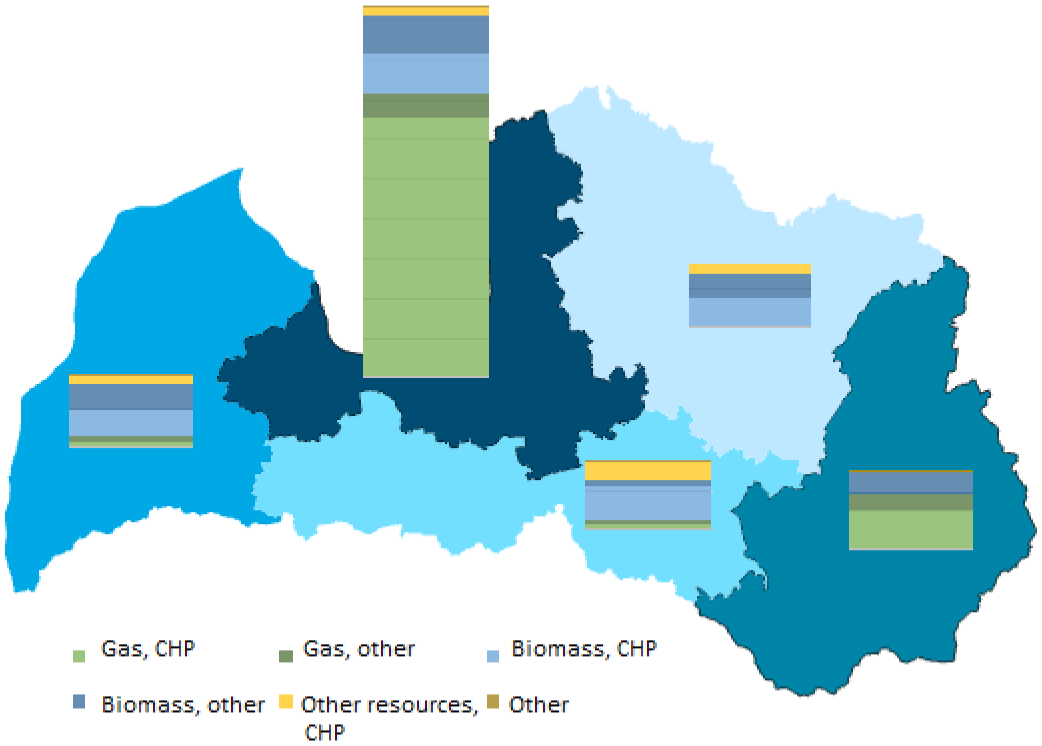
The new created layers are grouped into one layer to estimate the territory that cannot be used for the wind energy

Region	Area, km²	Buffer zone area, km²	Available area, km²	Available area, %
Kurzeme	13604,0	2836,3	10767,7	79
Latgale	14562,6	3553,6	11009,0	76
Riga	10447,9	2769,9	7678,0	73
Vidzeme	15257,2	3059,5	12197,6	80
Zemgale	10741,2	2430,8	8310,5	77
Total	64612,8	14650,0	49962,8	77

RESULTS

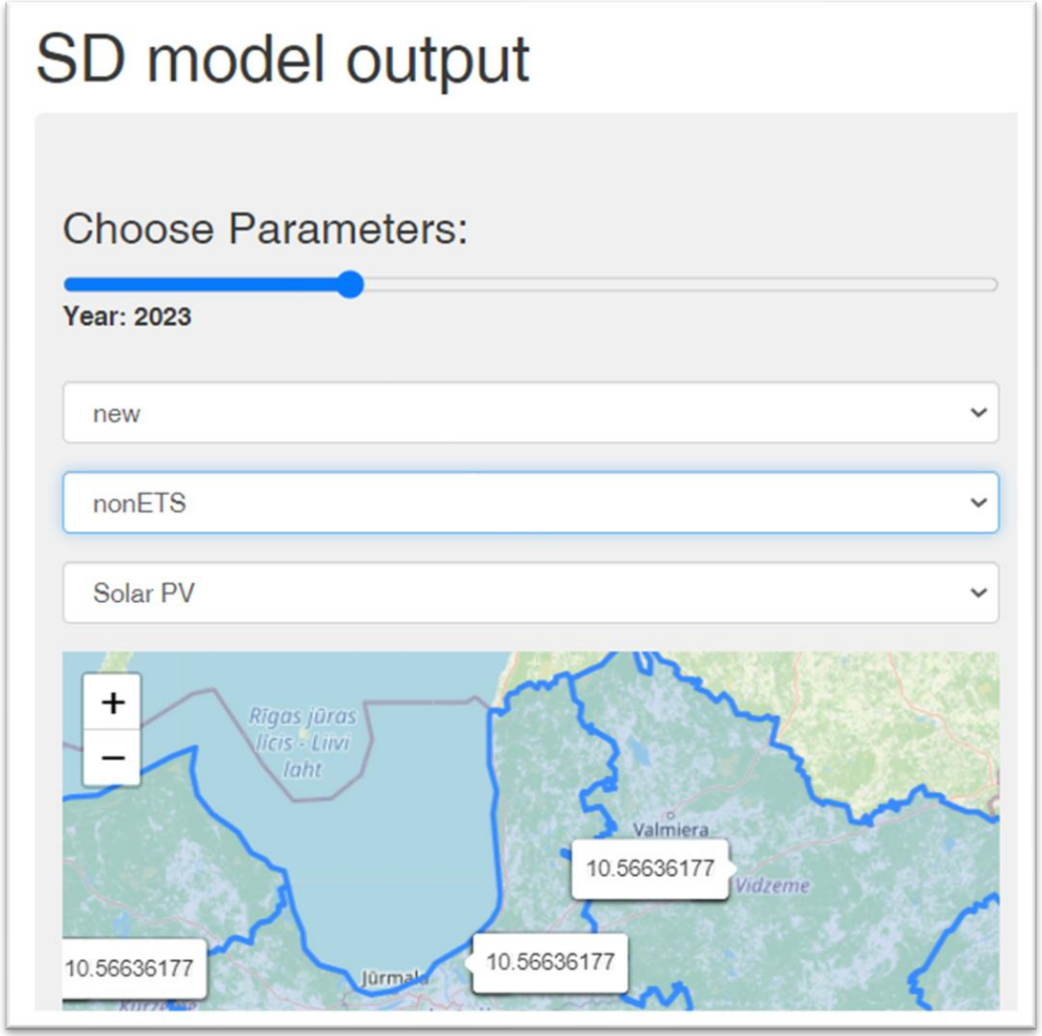
The data is linked to the corresponding region, so it is possible to get the general picture of the resource distribution or other parameters.

Graphic user interface allows to display the data that is currently needed



Produced energy, MWh/year

Interactive visualization tool



The graphic interface allows to choose parameters and displays the corresponding value on the map.

Current settings allow to choose:

- Year
- Weather the technology is new or not
- Whether ETS quotas are applied
- Power plant type

CONCLUSION

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RES and economy

- A tighter interdisciplinary connection between the Ministry of Economics and the Ministry of Environmental Protection and Regional Development is needed to integrate environmental aspects into energetics better.

Public

- A negative social image in the general public regarding the overall green energy topics: more explanatory and educational work to prevent emotional barriers while pushing for more RES in the energy sector are needed.
- RES is the main direction that can assure the fulfilment of the energetic independence objectives

Interactive coupling

- The coupling here is not dynamic; it is illustrative yet lacks spatial interactivity.
- Further progress in this direction would be most possibly achieved, using Python libraries.
- To achieve better linkage, spatial parameters are to be taken into account during the SD model

Detailed approach

- Cartographic tools work better with spatially more divided data or data tightly depending on the spatial components
- It will be beneficial in future works where counties or municipalities are observed

Thank you!

For questions:

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