On the use of machine learning and GIS for estimating the solar rooftop PV potential in Swizterland

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Problem

Solar Photovoltaic (PV) deployment on existing building rooftops has proven is a very promissing resource of sustainable energy for urban areas. Large scale potential studies are needed to see the viability of the system depending on the location. Yet, estimating the PV energy potential at a large scale, remains a challenge, for several reasons:

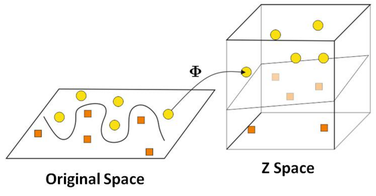
- Many solar and building variables need to be captured (weather, urban characteristics, geometrical building considerations)
- Lack of precise large-scale methodology.
- Lack of detailed large-scale roof data.

Objectives

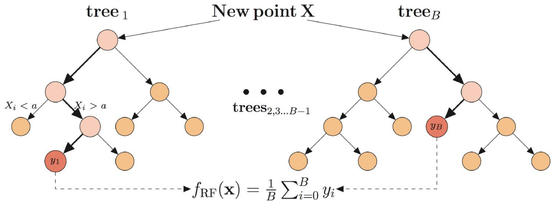
+ Develop a data-driven methodology combining GIS and machine learning algorithms, to derive rooftop PV potential at national level, at two scales, communes and 200 × 200 [m^2] pixels.
+ Derive accurate monthly solar maps of Switzerland using solar time series and weather data.
+ Estimate urban characteristics in Switzerland.

Machine learning algorithms

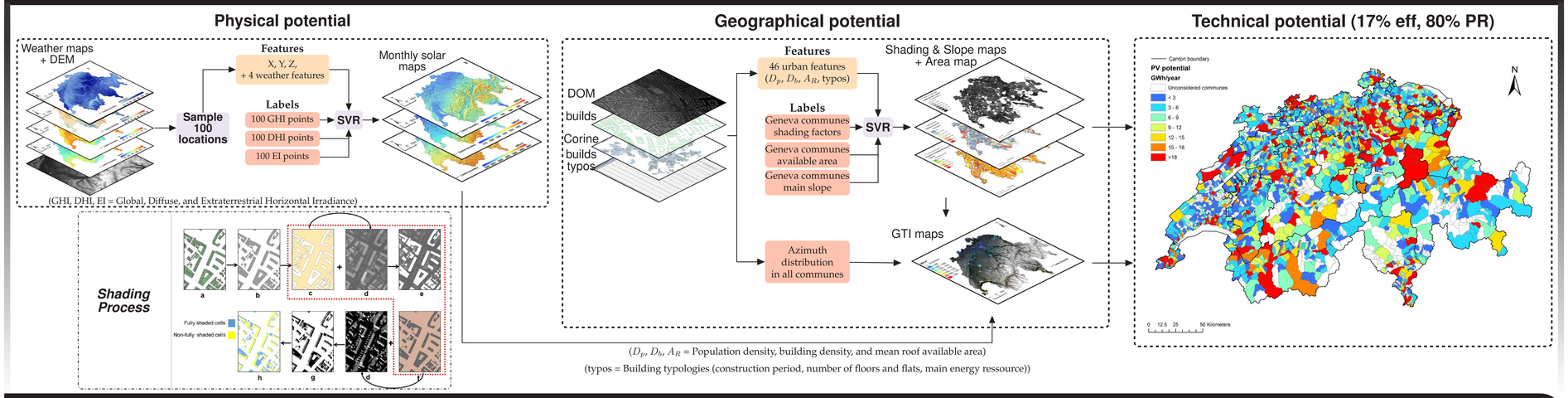
Support Vector Regression



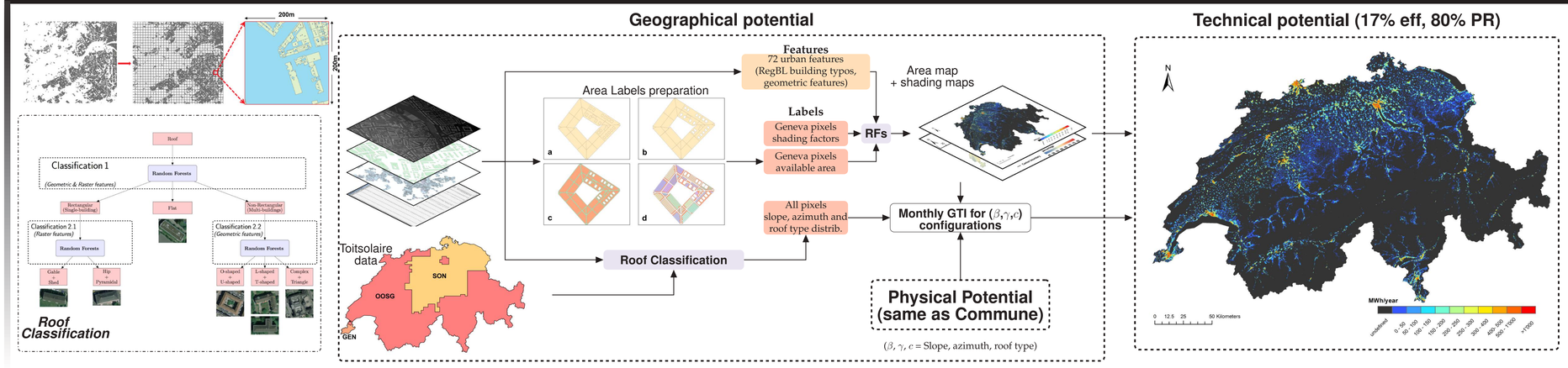
Random Forests



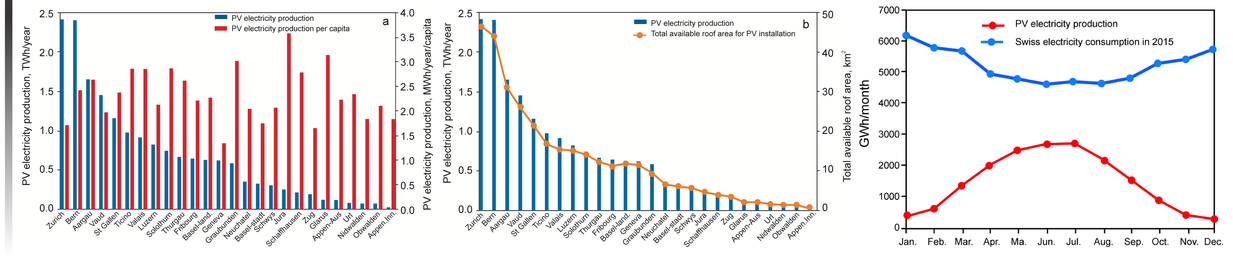
Commune potential estimation



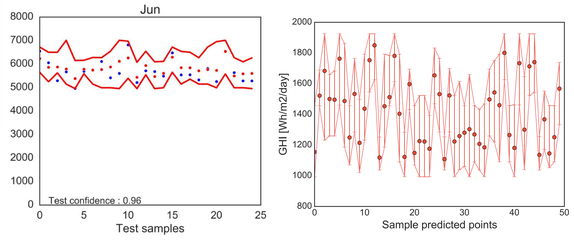
Pixel potential estimation



Resulting Plots (Communes)



Uncertainties



Solar modelling over tilted roofs

The global solar radiation on a tilted surface G_t is expressed as the sum of the direct (or beam) G_{Bt}, the diffuse G_{Dt}, and the reflected G_{Rt} tilted radiation over this surface:

$$G_t = G_{Bt} + G_{Dt} + G_{Rt} = G_B R_b + G_D R_d + G_h R_r$$

where R_b, R_d, and R_r are the direct, diffuse, and reflected radiation factor respectively for daily radiation. R_b is computed using the 1977 Klein model. R_d is computed using the 1990 Reindl model. R_r is computed using a typical irotropic model: $R_r = \rho\left(\frac{1-\cos\beta}{2}\right)$.

References

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[2] J. Friedman, T. Hastie, and R. Tibshirani. *The elements of statistical learning*, volume 1. Springer series in statistics Springer, Berlin, 2001.

Acknowledgments

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