Task 63

Taking Solar Neighborhood Tools to the Classroom

Solar neighborhoods are a piece in the puzzle in achieving net-zero energy districts and low-carbon cities. This is why the IEA SHC Task 63: Solar Neighborhood Planning participants are working on solar planning and economic strategies, simulation methods and tools, and case studies. One unique aspect of this project's work is holding "Fall School" for Ph.D. and Advanced Masters students.

Fall School 2021

Tackling the complexity of urban level energy simulations: Introduction to solar neighborhood simulation methods and tools

A virtual classroom brought 14 Ph.D. and Advanced Masters students from six universities in Canada, France, Italy, Norway, and Sweden together to heighten their knowledge of simulating and analyzing neighborhoods with the end goal of facilitating the design and implementation of solar strategies in urban areas. The students, taught by nine instructors from six institutions, worked together between September 30 to October 21.

Optimizing energy efficiency and solar access and understanding the impact of various technologies is key if cities are to be sustainable and resilient. The process of simulating urban areas, however, is challenging and involves several degrees of complexity. For instance, urban level simulations need to include the building level (building envelope construction, building systems such as HVAC, equipment, etc.), an accurate representation of different building types and their designs, and the outdoor areas (open spaces, materials implemented, street layouts, etc.). Due to this complexity, different simulation tools are used simultaneously to achieve the desired analysis. Therefore, expertise in understanding and manipulating these tools (or chain of tools) is required for exploring various solar opportunities and technology implementation as well as passive design aspects while planning solar neighborhoods.

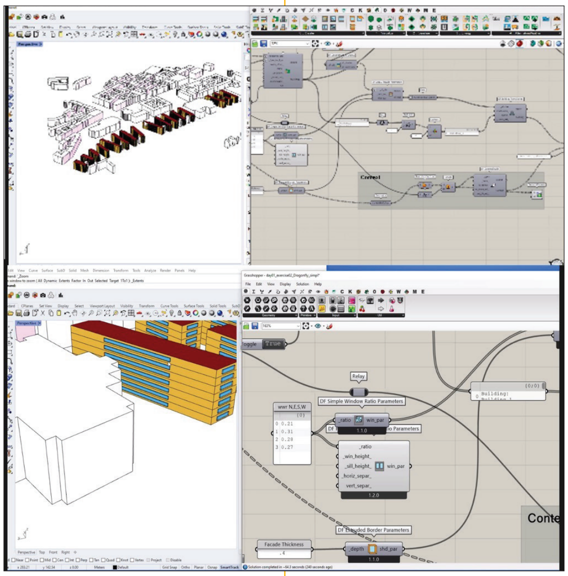

Figure 1. Examples of training materials from Day 1.

For this reason, the IEA SHC Task 63 team chose the topic of simulation tools for this year's Fall School. The course organizers focused on tools to estimate various key performance indicators such as the solar potential of buildings and sites, output of solar technologies such as integrated PV systems, daylight factors, and energy balances. The tools used by the students included GIS (Geographic Information Systems) and the visual programming environment Grasshopper.

The Coursework

The 2021 Fall School guided students through theoretical and practical topics. Below is a snapshot of the classroom days.

On Day 1, the instructors introduced the students to the fundamentals of modeling and an overview of the capabilities and limitations of existing tools and their potential application in the simulations. Next, basic geometry input/generation workflows were presented employing Rhinoceros - Grasshopper 3D environment. The instructors also demonstrated methods for obtaining basic geographic information using Grasshopper plugins (through OpenStreetMaps) and interoperability with urban scale modeling plugins. And lastly, the students were given a "survival kit" of resources for data input, learning, and problem-solving. Figure 1 shows examples of the training materials.

Day 2 focused on GIS modeling using different GIS tools (such as ArcGIS and QGIS-plugin UMEP (open source)). The students learned about the workflow to process solar radiation in an urban area and the

continued on page 16

visualization of the simulations, which is an essential step in the process of GIS modeling (Figure 2). At the end of the day, the students were asked to select one tool to practice estimating solar irradiation in different urban areas.

On Days 3 and 4, the students were given in-depth training on Grasshopper tools (ClimateStudio and Ladybug tools). These tools are used to perform climate analysis, solar analysis, and automated parametric design iterations. Over these two days, students had the opportunity to practice using the tools and applying local climate and solar potential to extract various performance criteria. Figure 3 presents some snapshots of the variety of tools presented during the training.

In addition to the hands-on training, the students were introduced to data processing methods that would allow them to handle a large amount of data. Various tools were introduced, such as MATLAB. To put what the students learned into practice, they were asked to practice simple coding to extract and plot specific data (such as cooling and heating loads).

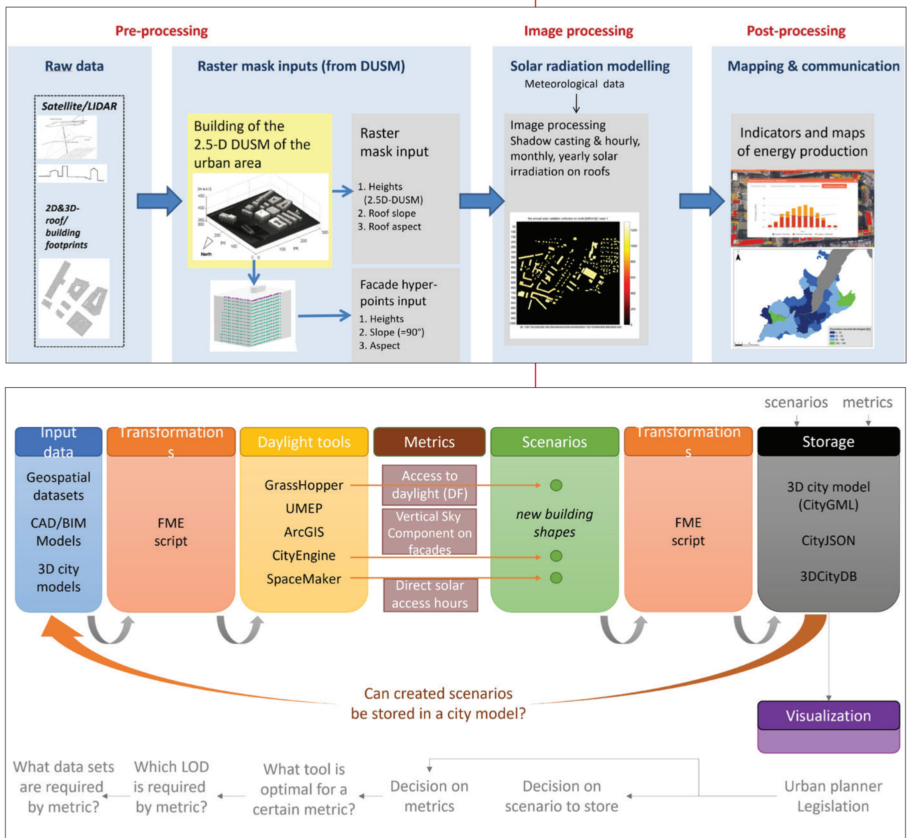

Figure 2. Methodologies employed in the application of GIS tools.

Day 5 was presentation day; the students demonstrated their new skill sets with creativity and curiosity in applying the methods and tools learned. For example, some students analyzed solar access of different neighborhood designs and their impact on design aspects, such as densification, including height of buildings and distance between them on solar radiation incident on roofs and facades (Figure 4a). While another group explored different methods for importing geographic data of existing neighborhoods into energy analysis and simulations tools. And other students focused on how to use GIS tools to study solar irradiation of the whole neighborhood (Figure 4b) and analyze the implication of specific building designs on solar access and shading on adjacent areas (Figure 4c).

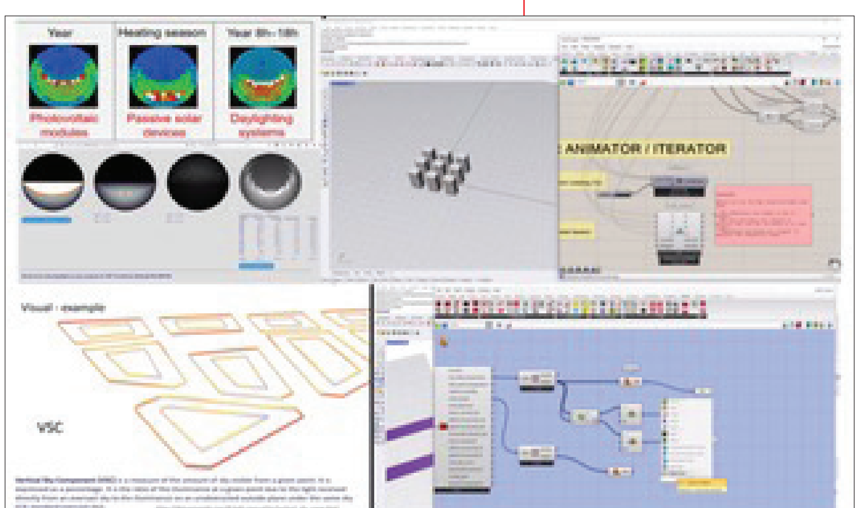

Figure 3. Examples of teaching and training material delivered on Day 3.

Looking Forward to 2022

Caroline Hachem-Vermette, the course coordinator, notes, "The 2021 Fall School was a productive event that gave students the opportunity to understand and practice the principles underlying successful simulations and analysis of solar neighborhoods. When designing and planning neighborhoods, a number of simulation tools might be needed to deal with the complexities, so a methodology to work

continued on page 17

Solar Tools to the Classroom *from page 16*

with these tools is extremely important." Fall School 2021 made this its central theme, highlighting the workflow used in different simulations and the need for flexibility. These simulation and analysis methodologies for urban areas are typically not covered in regular university or college courses. And in building simulation courses, the same tool is used by everyone to achieve a well-determined outcome.

All the participants, students and teachers, benefited from this unique international collaboration. Relationships have been built that will undoubtedly lead to future professional and academic cooperation.

As for IEA SHC Task 63: Solar Neighborhood Planning, the hope is that this program and its methodology will be used to create teaching materials or a condensed course for architects and planners.

This article was contributed by C. Hachem-Vermette, IEA SHC 63 Subtask A Leader, Ph.D., Associate Prof, University of Calgary (Canada).

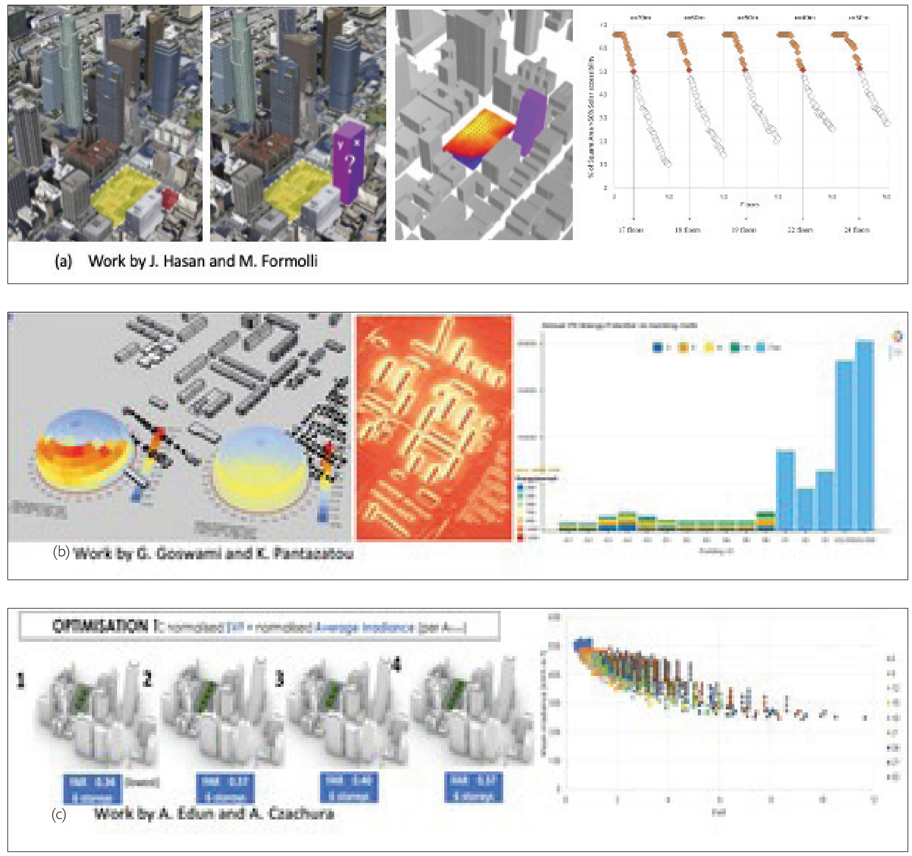

Figure 4. Examples of student work.