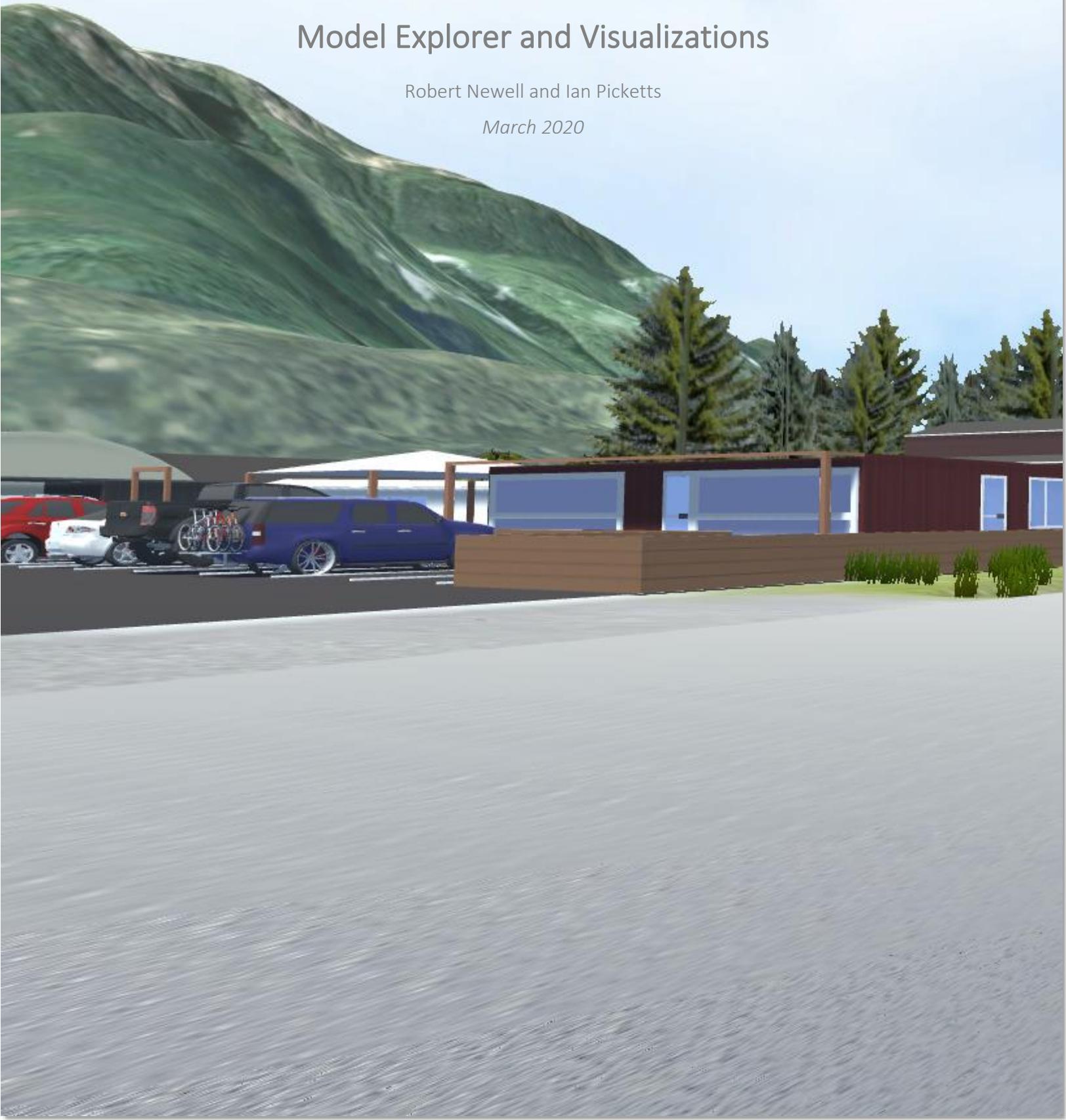


SPACES, PLACES AND POSSIBILITIES

Model Explorer and Visualizations

Robert Newell and Ian Picketts

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BACKGROUND

Places, Spaces and Possibilities was a research project that explored how models and visualizations can be used to help people better understand the implications of developing their communities in certain ways. The project had two objectives:

1. Model the outcomes of different development pathways for Squamish, or “community development scenarios”, to better understand the social, economic, and environmental implications of different land-use decisions
2. Develop tools for communicating the potential outcomes of the community development scenarios, namely an interactive model explorer and immersive visualizations

The project was led by Royal Roads University working in collaboration with Quest University, and the model was developed using input from the District of Squamish and community stakeholders. Previous reports have detailed methods and results associated with the first project objective.^{1,2,3} This final report provides a summary of the work done to achieve the objectives; however, the focus is the second objective. The report details the development of the model explorer and community scenario visualizations, as well as discusses thoughts and feedback on these tools given by community stakeholders and members.

¹ Newell, R., and Picketts, I.M. (2018). Spaces, Places and Possibilities: Summary of systems model and scenario development. Royal Roads University. https://www.crcresearch.org/sites/default/files/imce/robertgnewell/SpacesPlacesPossibilities-ScenarioDevelopment_May2018.pdf

² Newell, R., and Picketts, I.M. (2019). Spaces, Places, and Possibilities: Summary of community systems modelling and focus group feedback. Royal Roads University. https://www.crcresearch.org/sites/default/files/imce/robertgnewell/SpacesPlacesPossibilities-ScenarioModelling_February2019.pdf

³ Newell, R., and Picketts, I.M. (2019). Spaces, Places, and Possibilities: Refining the systems model and community development scenarios. Royal Roads University. <https://www.crcresearch.org/sites/default/files/imce/robertgnewell/SpacesPlacesPossibilities-ModelRefinement-May2019.pdf>

COMMUNITY SCENARIO MODELLING

The scenario modelling process involved developing both a community systems model⁴ and scenarios. The systems model (Figure 1) was developed to identify relationships between planning challenges, development strategies, and community outcomes. The community scenarios were created to identify potential "futures" for Squamish, or distinctly different (and possible) ways that the community can develop.

The systems model and scenarios were developed based on discussions with local government and community stakeholders, particularly a preliminary project scoping meeting with the District of Squamish's Community Planning and Infrastructure Department (March 2018) and a broader community stakeholder meeting that included people from non-profit, local government, business interests, development, public transportation, and academia (April 2018). The scenarios were modelled to estimate social, economic, and environmental outcomes of different development directions, and another local government and community stakeholder focus group was held (October 2018) to gain feedback on the results of the modelling exercise. Based on feedback, three community scenarios were finalized:

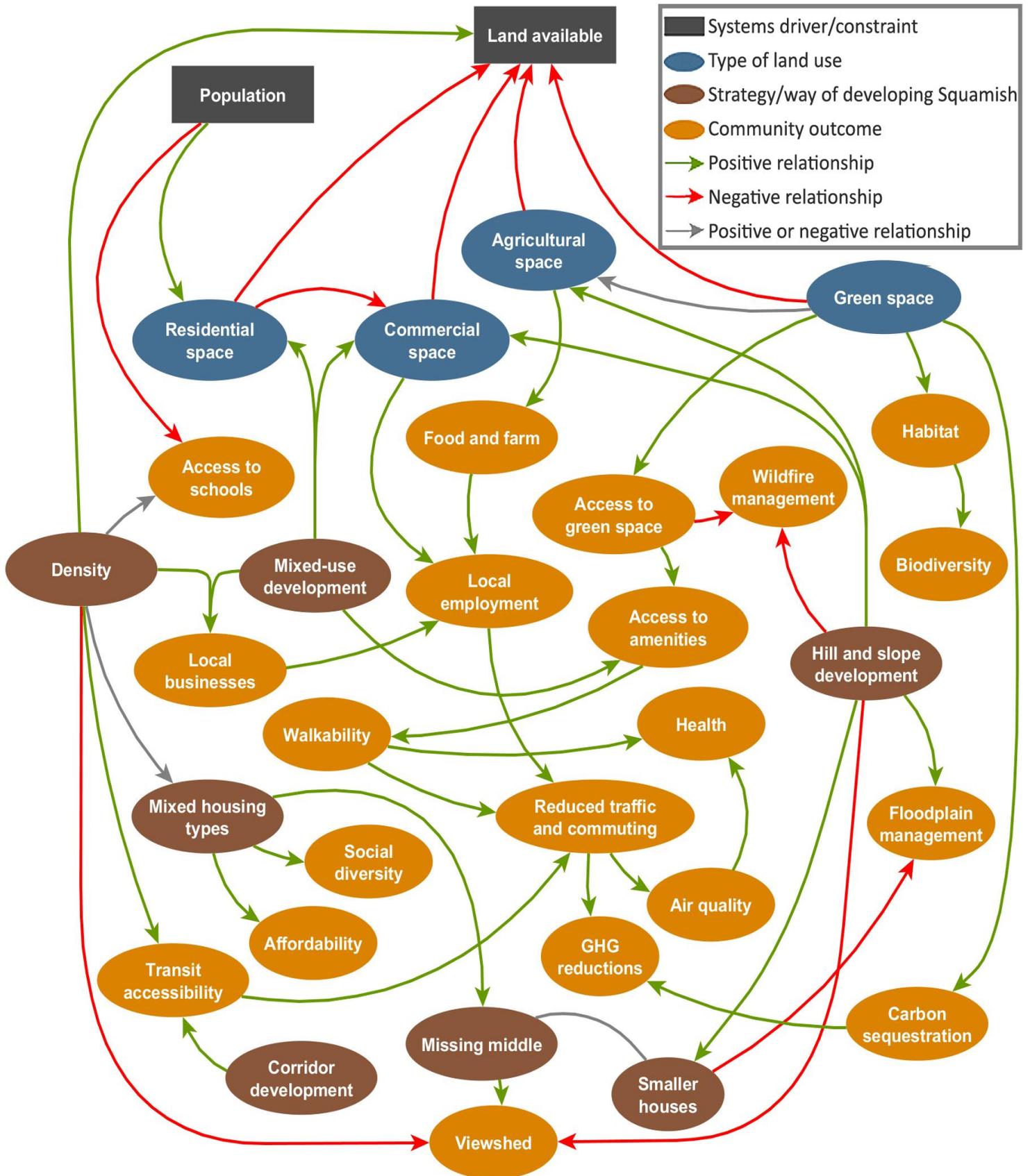
- 1. Low density residential neighbourhoods:** New residential neighbourhoods are developed with single-detached houses and do not contain mixed-use or commercial buildings. Current residential areas are not redeveloped through infill and densification, and instead, undeveloped areas outside Squamish's growth management boundaries are used for residential growth.
- 2. Medium density and enhanced agriculture:** Residential neighbourhoods are redeveloped to consist of a mix of duplexes, multiplexes, small houses, townhouses, and semi-detached houses. Densification primarily occurs in existing residential neighbourhoods, but some hillside areas are also developed to reserve valley floor space for agriculture while also accommodating population growth.
- 3. High density neighbourhood nodes:** Residential areas are redeveloped as walkable neighbourhood communities with local businesses and amenities. New development consists of mixed-use apartment buildings, townhouses, and duplexes. Densification occurs near public transit routes in order to increase transit access and viability.

Population growth is the main driver in the model, and it was consistent across all three scenarios (i.e., all scenarios had the same future population size). Squamish is growing rapidly, and an increasing local population presents considerations around where people will live, work, and play. Land availability is the major constraint in the model. Developing community land presents considerations around how to balance competing land uses, such as residential, commercial, agricultural, and green space (both parks and natural spaces), and Squamish's mountain and valley geography limits these land uses.

Development strategies were explored in the model, and these included densification, mixed-use development, corridor development, smaller houses, etc. The strategies have implications for a variety of community outcomes, such as access to schools, food and farm systems, local employment, access to green spaces, walkability, health, threats to habitat, etc.

⁴ Systems modelling refers to the use of models to understand complex processes. In this project, the systems model maps relationships between development patterns/approaches and factors related to human and environmental well-being. The model can be used to quantitatively estimate indicators associated with well-being.

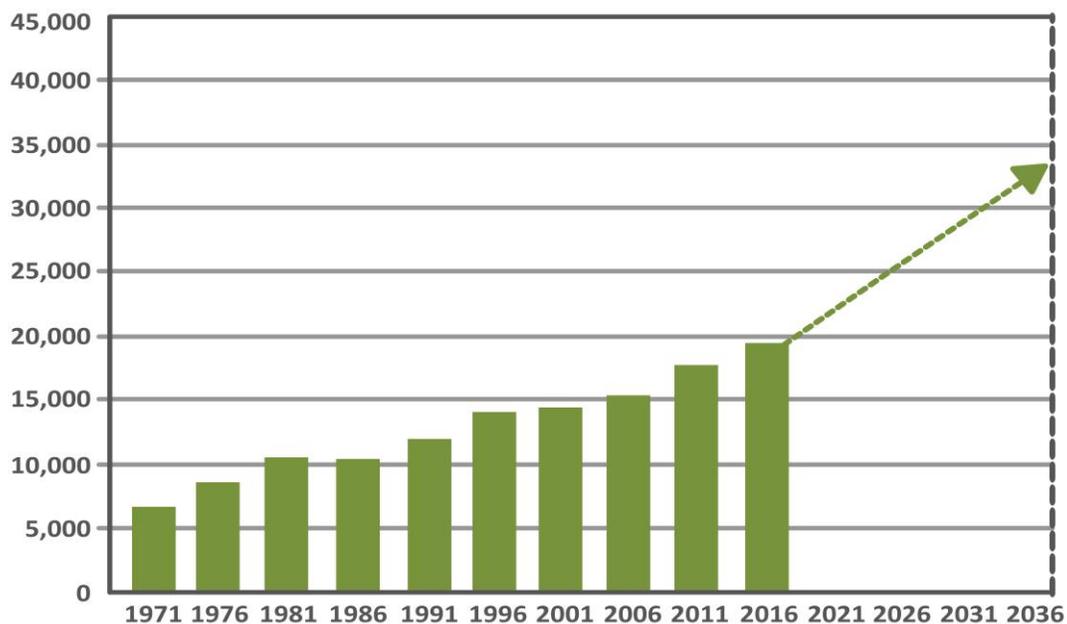
Figure 1. Community systems model for examining local development scenarios



Scenario modelling firstly involved mapping the "current conditions" of Squamish (using ArcGIS) to create a baseline scenario for the community. The mapping used data from Statistics Canada, the District of Squamish's Open Data Portal, and other sources, and it included: distribution of housing types and residents, commercial space and employee numbers, businesses, local amenities, neighbourhood boundaries, schools and public school catchment areas, parks, natural areas and sensitive habitat, lowland floodplain areas, wildfire zones, gardens, agricultural land, transit routes, and bus stops. Squamish has plans for future developments, and these were also mapped to make the community scenarios more relevant to Squamish's "future conditions". New development was added including: residences that have been approved for development, commercial land (and local employment opportunities), new transit routes to service growing areas, and new schools.

Each scenario targeted a population of 34,000 based on a 20-year growth projection (Figure 2) presented in the District of Squamish's Official Community Plan.⁵ The planned development that was mapped as part of the "future conditions" accommodates 29,920 people; thus, scenario modelling involved distributing approximately 4,100 people (i.e., 12% of the "future population") throughout the community, with a particular focus on the neighbourhoods of Garibaldi Estates, Loggers East, Dentville, downtown Squamish, and an area located east of Garibaldi Highlands.

Figure 2. Squamish population trends and projected growth



The systems model was applied to estimate different community outcomes, and this was performed through a series of calculations that were conducted primarily using ArcGIS and R statistical software. The relationships and elements in the systems model informed what and how community outcomes should be measured and calculated. A review of academic and grey literature identified a series of measurement methods,⁶ and these were applied to measure relevant outcomes and indicators for each of the scenarios.

⁵ District of Squamish (2017). District of Squamish OCP Update. Phase 3: Community engagement summary report. <https://squamish.ca/assets/OCP-Review/Phase-3-Engagement-Summary-FINAL-with-ADDENDA-Sep7.pdf>

⁶ For more information on these methods, see Newell, R., and Picketts, I. M. (preprint). Spaces, Places and Possibilities: A participatory approach for developing and using integrated models for community planning. <https://www.ccresearch.org/sites/default/files/imce/robertnewell/NewellPicketts-SpacesPlacesPossibilities-Preprint.pdf>

MODEL EXPLORER

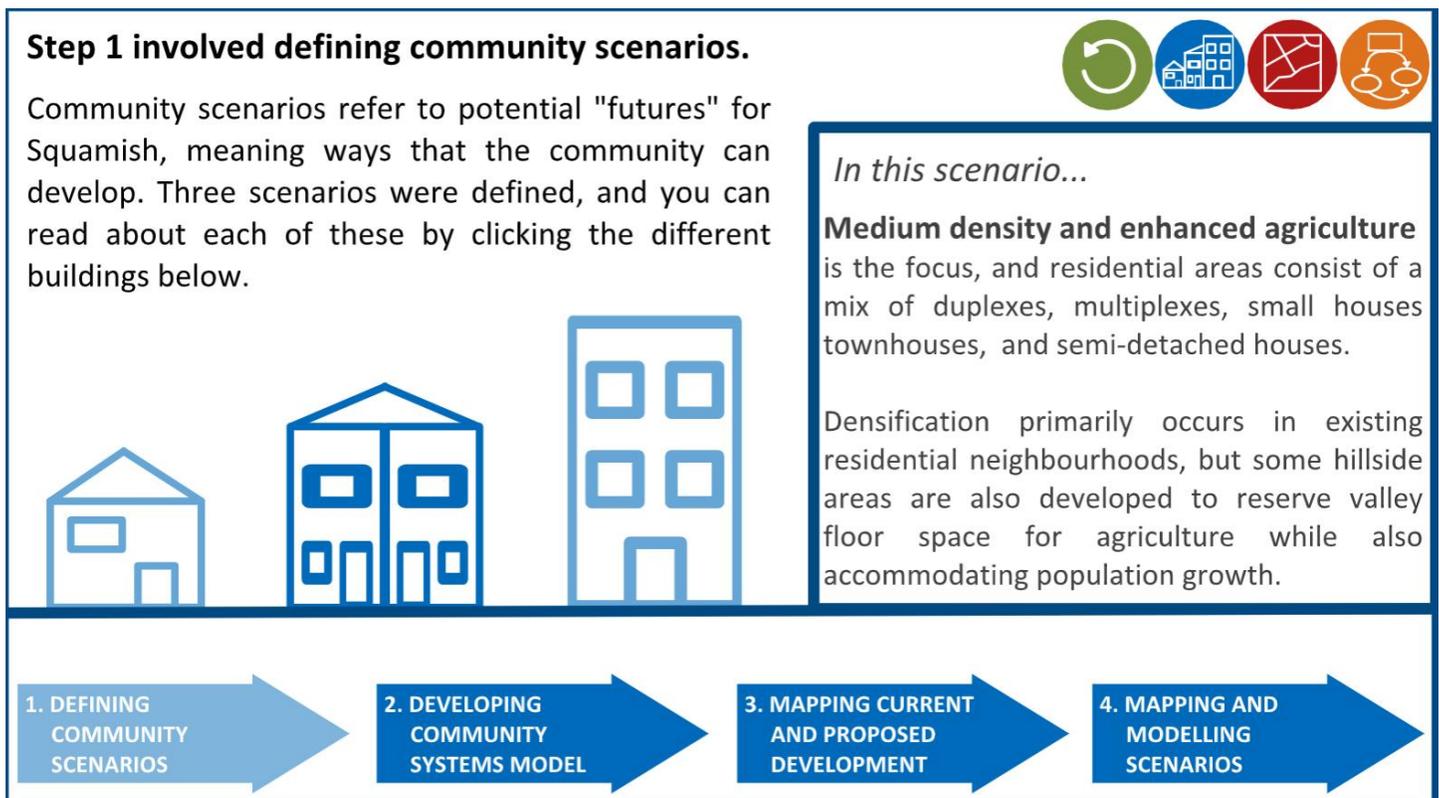
The community systems model is complex, and the scenario modelling exercise resulted in hundreds of quantitative outputs. Accordingly, tools were created to “make sense” of this complexity, and to appropriately communicate the most important and relevant model outcomes. The model explorer is one such tool. It provides an online interactive interface for engaging with the model, learning about how the model was created, browsing community scenario maps, and exploring potential outcomes of developing Squamish in different ways. The tool is navigated using a mouse, and when accessing it online, users first encounter an introduction page that summarizes purpose of the research project and the explorer tool. After clicking an “enter model explorer” button, users are given options to navigate to the three different areas of the explorer: about the model, scenario maps, and model outcomes.

ABOUT THE MODEL

This area of the model explorer provides information on how the community scenario modelling was done (e.g., Figure 3), and it describes the different steps in the modelling process (see the *Community Scenario Modelling* section above). Clicking different buttons in this area of the explorer allows users to do the following:

- Learn about the different steps involved in the modelling process
- Learn about the features and development approaches for the different community scenarios
- Learn about the mapping that was done for the “current” and “future” baseline scenarios, as well as the approach for mapping and modelling the scenarios

Figure 3. Image of the “about the model” area of the model explorer



SCENARIO MAPS

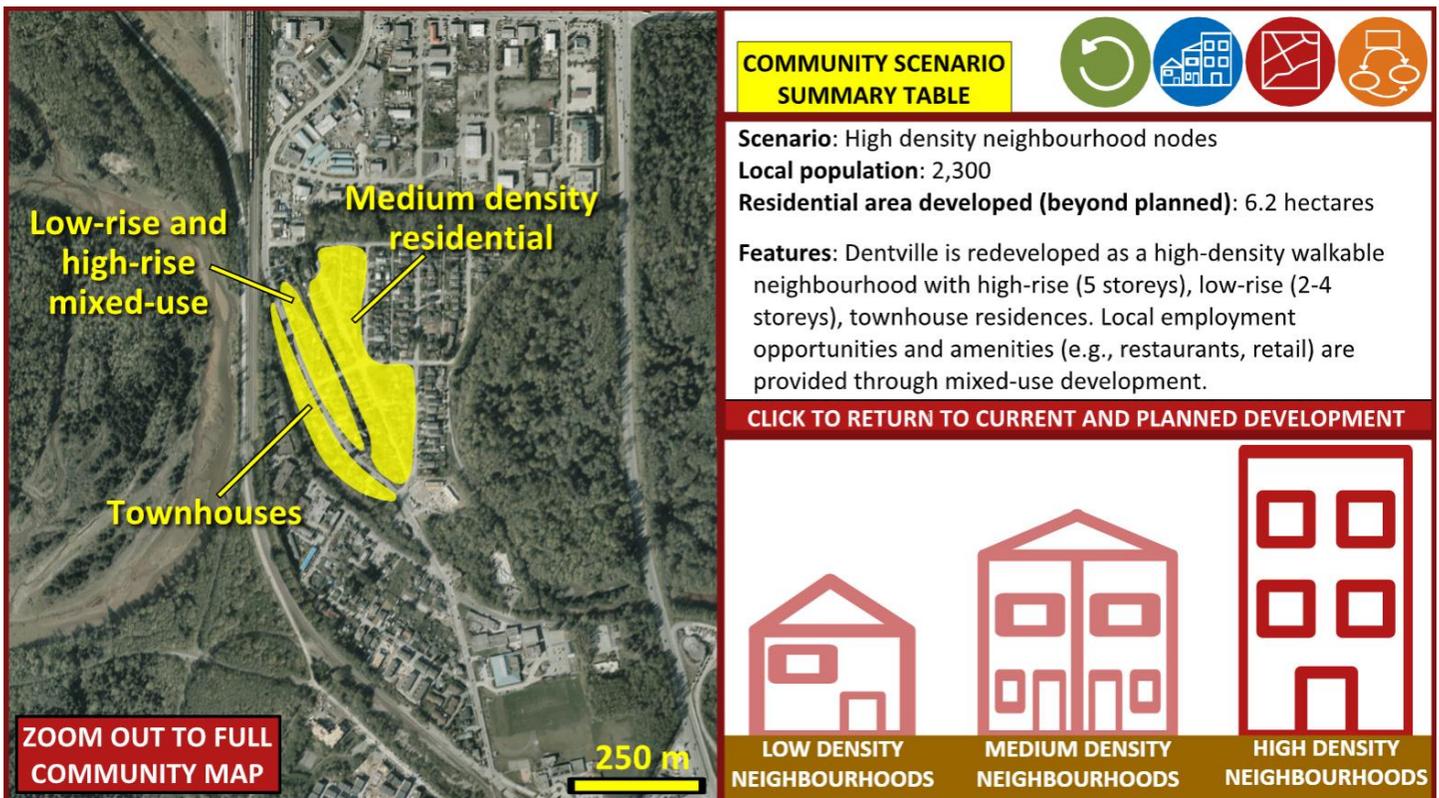
This area of the model explorer provides information and detailed views of the development characteristics and features of the different community scenarios. Users can view maps of the neighbourhoods involved in the scenario modelling process, and areas developed/redeveloped for the different scenarios are highlighted through map overlays and labelled with their respective community development features (e.g., Figure 4)

As noted above, scenario mapping focused on the neighbourhoods of Garibaldi Estates, Loggers East, Dentville, downtown Squamish, and east of Garibaldi Highlands. When users enter the scenario maps area of the model explorer, the neighbourhoods are highlighted on a map of the District of Squamish, and users can click on them to zoom in and see different scenario maps. The neighbourhood maps cover areas of approximately 1.25km², with the exception of the east of Garibaldi Highlands map, which covers a larger area (5.5km²) to accommodate an expansive new neighbourhood that is featured in the low density residential neighbourhoods scenario.

Clicking buttons in scenario maps area of the model explorer allows users to do the following:

- Learn about how the community scenario mapping was done
- Zoom into the neighbourhoods and see the maps for each of the scenarios
- Display a map that shows the extent of development throughout the entire community for the scenarios
- View a summary table that shows the local populations and residential development in the neighbourhoods for each of the scenarios

Figure 4. Image of “scenario maps” area of the model explorer



COMMUNITY SCENARIO VISUALIZATIONS

Visualizations were created to communicate implications and outcomes of the community development scenarios. The type of visualizations created through this research take the form of realistic, immersive 3D virtual environments that are experienced from the first-person perspective. Users can digitally “walk through” the visualizations and view the scenarios to gain impressions and place-based understandings around what the scenarios would look and “feel” like if implemented in Squamish.

Visualization development used methods previously developed by the Lead Researcher,^{8,9} involving a combination of ArcGIS (to maintain spatial accuracy) Trimble SketchUp (to build 3D objects), Adobe Photoshop (to develop realistic textures) and the Unity 3D gaming engine (to build a dynamic and navigable virtual environment). The process first involved creating terrain and viewshed landscapes using terrain elevation data obtained from the District of Squamish. Then, maps of current conditions and the community scenarios created during the scenario modelling exercise were imported into Unity 3D. As shown in Figure 6, these maps were used to build the virtual environments and place models, such as houses, shops, bus stops, etc.

Animated models were also added to the visualizations, including people, cars, buses, birds, etc. The process firstly involved modelling levels of car, bus, cyclist, and pedestrian traffic in the “current conditions” scenario based on field observations, and then adjusting traffic levels in the different scenarios according to modelled predictions on how these would change with densification.

Figure 6. Development process for the interactive visualization tool



Visualizations were created for two of the neighbourhoods that served as focuses for the scenario modelling exercise: Garibaldi Estates and Loggers East. Users can enter an area in these neighbourhoods, and navigate the virtual environments using keyboard arrows and mouse. Users can also toggle different community scenarios to immediately see what they would look like in these neighbourhoods and (broadly) the community of Squamish (e.g., Figure 7).

⁸ Newell, R., Canessa, R., & Sharma, T. (2017). Modelling both the space and place of coastal environments: Exploring an approach for developing realistic geovisualizations of coastal places. *Frontiers in Marine Science*, 4, 87. <https://www.frontiersin.org/articles/10.3389/fmars.2017.00087/full>

⁹ Newell, R., Canessa, R., & Sharma, T. (2017). Visualizing our options for coastal places: Exploring realistic immersive geovisualizations as tools for inclusive approaches to coastal planning and management. *Frontiers in Marine Science*, 4, 290. <https://www.frontiersin.org/articles/10.3389/fmars.2017.00290/full>

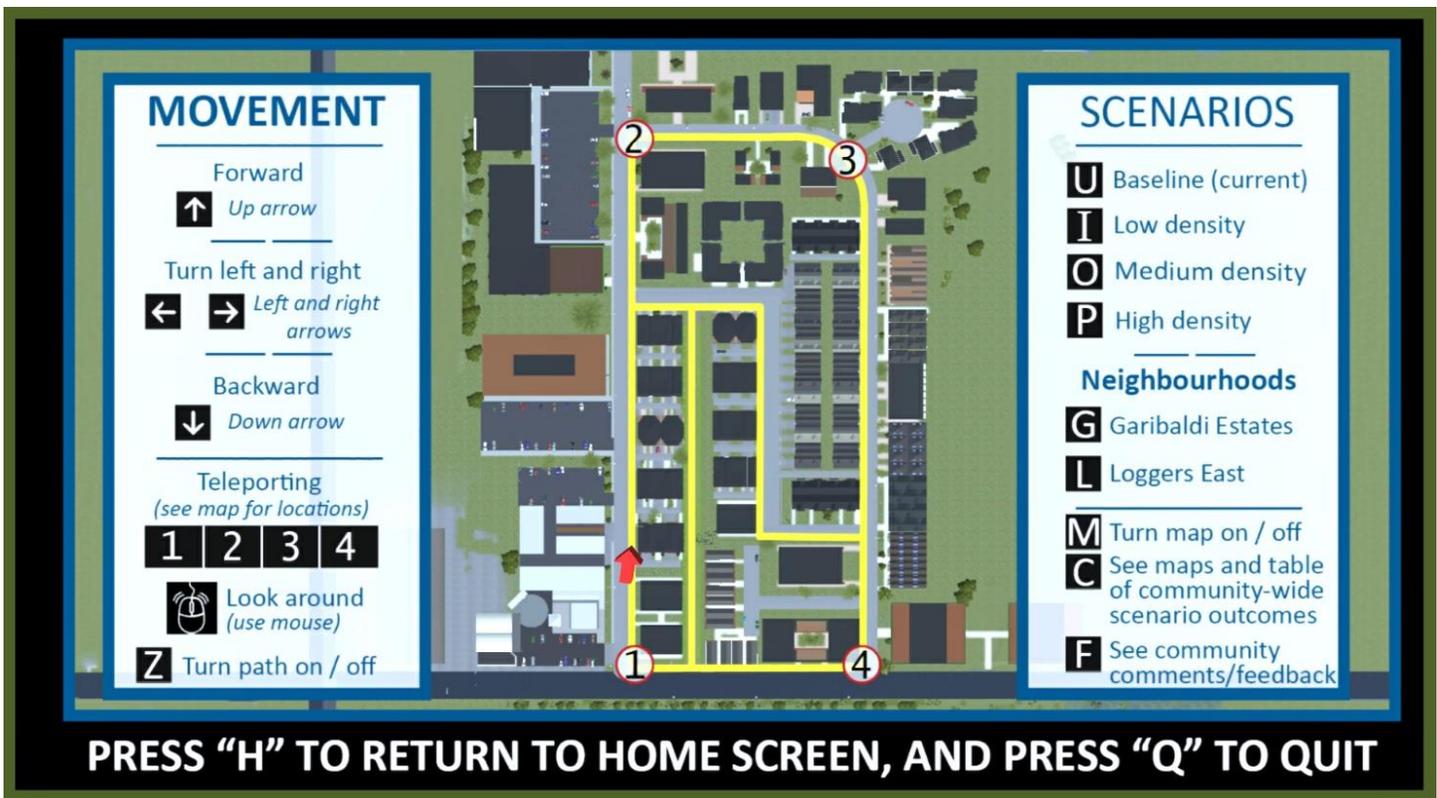
Figure 7. Community development scenarios depicted in the Garbaldi Estates visualization



The visualization tool contains features for improving navigation in the virtual environments. User movement is restricted to particular routes in order to guide navigation and exploration of scenarios, and a path highlighting these routes can be turned on or off using a key command. Users can also open a “map view” of the scenarios to help orient themselves within the visualizations (Figure 8). The map view displays locations that users can teleport to using key commands, allowing for easier access to different areas within the virtual environments.

In addition to navigation features, the visualization tool contains a function that allows users to display community-wide scenario maps and a summary table of model outcomes. This feature was added to better integrate the community scenario modelling work with the visualization tool. Users can also toggle a list of considerations around the scenarios provided through community feedback on the tools (see section below) in order to get a better understanding of the implications of the scenarios if implemented in the real-world and also where there is uncertainty or potential misrepresentations in the visualizations.

Figure 8. Map view and user instructions for the visualization



In summary, using different key commands in the visualization allows users to do the following:

- Enter the visualization in either the Garibaldi Estates or Loggers East neighbourhood
- Toggle and display different community development scenarios
- Switch to a map perspective of the visualized neighbourhood and scenarios
- Teleport to different points in the neighbourhoods
- Turn on a path that highlights the areas that you can walk within the virtual environments
- Display community-wide maps of the scenarios and a summary table of scenario model outcomes
- Display “community feedback on the visualizations and the community development scenarios

COMMUNITY FOCUS GROUP

The final focus group of the Spaces, Places and Possibilities project was held in October 2019, and the purpose of this session was to gain feedback on the model explorer and visualization tools. As with the other sessions, the focus group consisted of local government and community stakeholders. Most of the participants had been involved in at least one of the previous focus group sessions, but some were new to the project.

The focus group began with a presentation on the research project, and demonstrations of the model explorer and visualization tools. Participants were then invited to try out the tools independently, while the researchers made themselves available for questions and comments. The session concluded with a discussion guided by the following questions:

- *What do the model explorer and visualizations tell you about the ways Squamish can develop and the potential implications of these development directions?*
- *How do the model explorer and visualizations provide different insights and perspectives on the community scenarios? What information do you get from the model explorer but not the visualization, and vice versa?*
- *How effective are the model explorer and visualizations for helping you understand the implications of developing Squamish in different ways? What aspects of these tools are missing or could be improved?*
- *Do you prefer either the model explorer or visualization for gaining a better understanding of the scenarios (please explain why or why not)?*

Feedback from the focus group was examined to identify strengths and weaknesses of the model explorer and visualizations related to their potential uses as tools for community planning and public engagement. Several themes emerged from this feedback, and these are discussed below:

Consider the tools as complementary but not substitutes for one another: Although some preferences were expressed for a particular tool, the model explorer and visualizations were (for the most part) described as communicating different information, rather than one being “better” than the other. Participants noted the strength of the model explorer to be that it provides extensive information on social, economic, and environmental implications of developing Squamish in certain ways, whereas the visualizations were described as useful for illuminating personal preferences for certain development approaches and urban forms. The model explorer was described as a tool for gaining “objective” understanding of the scenarios, whereas information conveyed through visualizations was considered to be more “subjective”.

Integrate the model explorer and visualization: Focus group participants recommended a stronger connection between the model explorer and visualizations. As noted above, the model explorer and visualizations communicate different information, and thus a gaining a comprehensive understanding of the scenarios requires using both tools. However, participants noted that switching between the tools was not very convenient, and doing so disrupted continuity of thought. Accordingly, recommendations were made to integrate the tools, particularly in terms of adding features to the visualization that show how the model outcomes relate to the scenarios (e.g., pop-up boxes with data and model outcomes).

Display scenarios at different scales: The participant feedback illuminated problems related to reconciling different scales when using the model explorer and visualization tools to explore community development scenarios. This issue emerged particularly when participants examined environmental outcomes related to the low density residential neighbourhood scenario.¹⁰ The issue demonstrated a need for displaying community-wide changes associated with the scenarios in both the model explorer and visualization tools (in addition to the local changes).

Rethink the design of buildings and infrastructure: Developing visualizations with high degrees of realism requires making a number of decisions around the style and form of different models and elements within a virtual environment, such as the colour and shapes of houses, density and types of vegetation, presence and design of pathways, etc. In this project, the researchers erred on the side of being conservative and not taking too many “creative liberties” with the number of models/elements that were added; however, in some cases, this approach impacted the realism and likelihood of depictions. Participants noted that with high density development, improvements would be made to infrastructure such as bike paths, street lights, power lines, etc., and such improvements were not adequately captured in the visualizations. In addition, participants commented on the design of the residential dwellings, noting that new buildings would be designed differently in accordance with floodplain considerations (e.g., elevated ground floors).

Highlight the differences between scenarios: Focus group participants commented on how the model is quite information dense, and it would be useful to highlight the significant differences between scenarios. It was suggested that the model explorer could present curated information, which clearly conveys the benefits and trade-offs of the different scenarios. However, potential problems of taking such an approach were also discussed. Highlighting certain model outcomes and not others could unduly emphasize, place weight on, and ascribe value to particular social, economic, or environmental considerations. The tools aim to provide comprehensive understanding of the implications of different development directions, and their purpose is not to identify a “correct” development path. Regardless, the discussion indicated a need for a method of communicating a summary of scenario outcomes.

Communicate local planning concerns and challenges: The model explorer and visualizations did not capture all planning considerations and concerns associated with the neighbourhoods, and the participant feedback indicated that this could be problematic when using the tools to communicate planning options. For example, although the scenarios in Loggers East were designed to minimize impact on sensitive ecosystems, concerns were raised around how the density scenarios and increases in neighbourhood populations still could impact the area through higher levels of local traffic, recreation, and other human activity. The Loggers East area has been the focus of conservation and restoration efforts, and it was expressed that the higher density scenarios were not appropriate for this neighbourhood. These comments bring to light the need for community engagement tools that incorporate a range of place-based information and contexts, in order to provide broader understanding of the implications of actualizing a scenario in a particular locality.

¹⁰ The low density scenario involves the development of residential neighbourhoods outside growth management boundaries, and as these areas currently consist of primarily natural spaces, the scenario exhibited greater environmental impacts (e.g., encroachment on habitat) than other scenarios. However, because the visualizations and scenario maps primarily focus on the neighbourhood and not the larger community scale, some participants were confused as to why low density residential form (and fewer people in neighbourhoods) would result in more significant environmental impacts.

Expand the model: Communities are complex, and thus it is not feasible to include everything within a community systems model. Accordingly, participants in this focus group commented on considerations and elements that were missing from the model and could be valuable to include. Examples of these include increases in impermeable surfaces from residential and commercial development, greenhouse gas emission reductions from new developments that adhere to higher building standards, available rental housing, and costs of developing new public infrastructure. Such comments illustrate the importance of developing a model with a flexible design, meaning one that can be refined as more community members and stakeholders interact with it and provide suggestions for improvement.

Improve user interface and experience: Several comments were made about the user interface and experience, and suggestions were made for improving user-friendliness. Such suggestions included changing (or adding) the key commands used to make selections in the title screen, incorporating zoom in and out features in the visualization tool's map view, and including a key map in the corner of the visualization first-person view screen. Recommendations for the model explorer included changing terminology of model "outcomes" to a less vague term, such as "effects" or "results". The discussion on user interface/experience recommendations illustrated the importance of developing community engagement tools in a manner that allows for adjustments and refinements in order to continually improve user experiences for diverse community members.

MODEL EXPLORER AND VISUALIZATION REFINEMENT

Time did not permit for making significant changes to the model explorer and visualization tools in this project; however, some refinements were made based on focus group feedback. These include:

Summary tables of model outcomes were added to both tools. In the model explorer, the summary table provides a comprehensive view of the scenario outcomes. In the visualization tool, the table serves as a way of better integrating the outcomes and perspectives produced through scenario modelling work with visualization platform.

Community-wide maps that display extents of development/redevelopment in all areas of Squamish for the different scenarios were added to both tools. The maps provide a more complete understanding of the development implications associated with each of the scenarios, as opposed to the limited perspectives given through neighbourhood maps in the model explorer and the virtual environments in the scenario visualizations.

Community feedback on the scenarios and visualizations was incorporated into the visualization tool. Since time limitations prevented making changes to the visualization models and virtual environments, a pop-up window featuring feedback was added to the visualization to broaden user understanding around the implications of scenarios, as well as highlight areas of uncertainty or potential misrepresentations in the visualizations. Examples of community feedback in this visualization feature include:

- *Loggers East is an ecologically sensitive area, particularly in terms of wetland and river connectivity and habitat, and although the scenarios were designed to minimize impact on river corridors, increases in the neighbourhood populations/density still could impact the area through increased local traffic, recreation, and other human activity*

- The infrastructure in the medium and high density scenarios would likely experience more improvement than what is visualized here, including more bike lanes, better street lights, potentially burying transmission lines, etc.

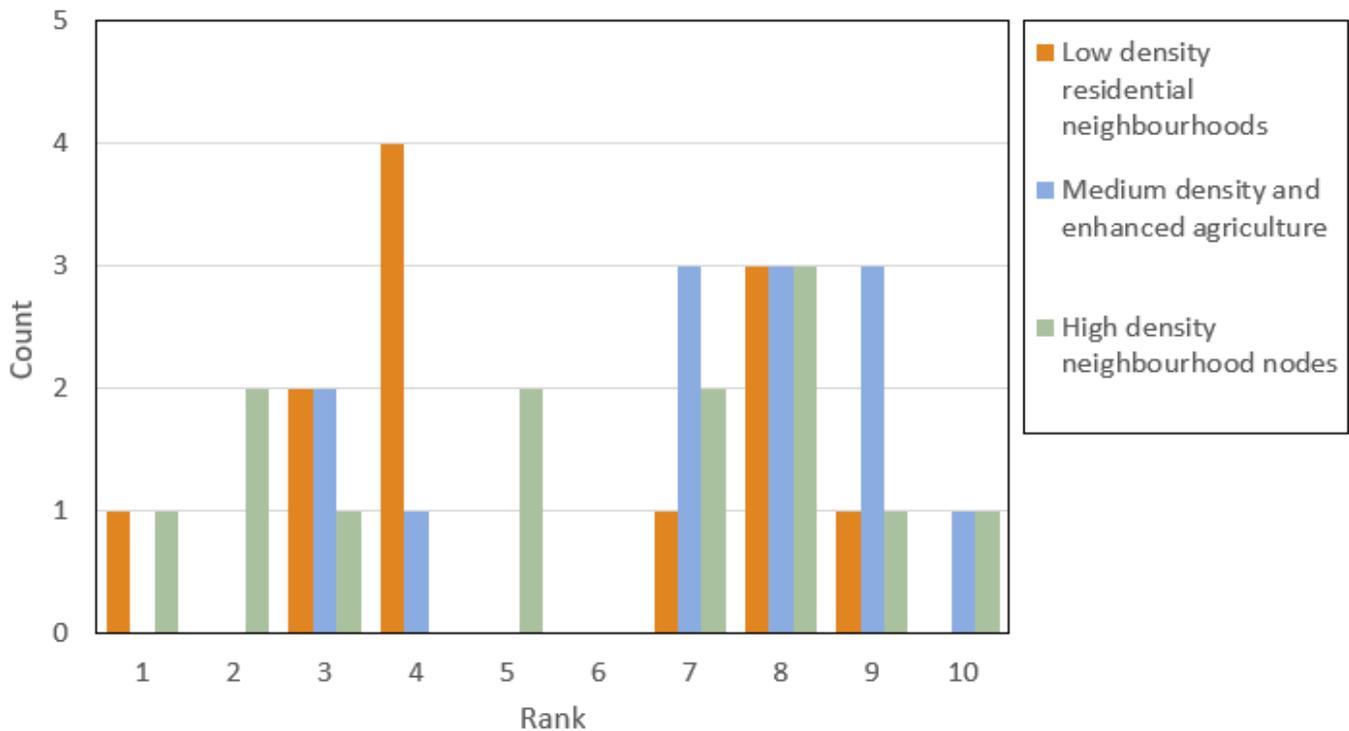
User interface and controls were improved, particularly in terms of title screen navigation. Key commands were added to make it easier to select visualization options in the title screen. Other added features include a “please wait while visualization loads...” comment that appears as users wait for the Garibaldi Estates or Loggers East virtual environments to load.

OPEN HOUSE

In November 2019, an open house event was held at Quest University, where Squamish community members were given the opportunity to use the model explorer and visualization tools. Posters detailing the research process and development of the tools were prepared as reference materials for the event, and researchers were available to answer questions of the attendees. Some attendees filled out questionnaires that solicited feedback on the scenarios and the effectiveness of the planning tools. A total of 14 questionnaires were returned. The results can not be considered representative of the community of Squamish; regardless, the responses were useful for gaining insight on the effectiveness of the model explorer and visualizations.

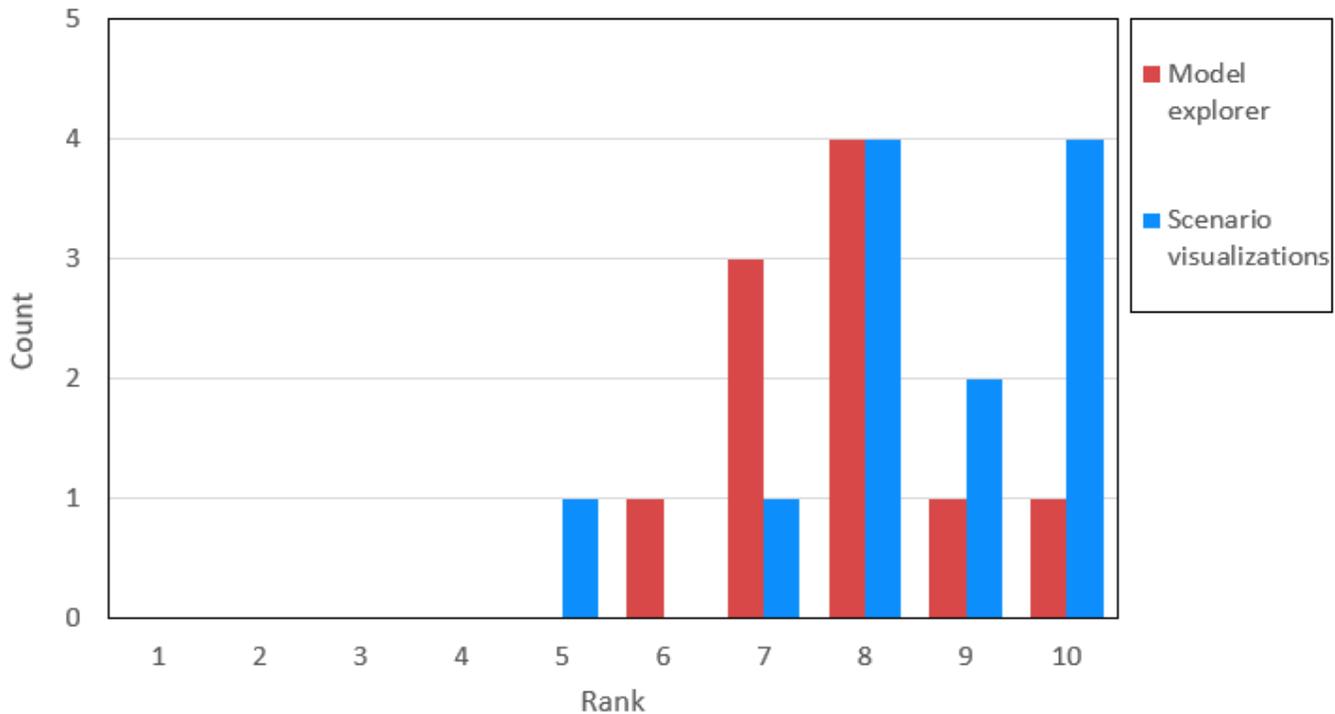
Questionnaire participants were asked to rate the three community scenarios on a scale from 1 (not a desirable future for Squamish) to 10 (very desirable). Figure 9 shows the distribution of respondent ratings for each of the community scenarios. The median ratings for the low density residential neighbourhoods scenario (M=4) was lower than the medium density and enhanced agriculture (M=8) and high density neighbourhood nodes (M=7) scenarios (the latter two being somewhat similar).

Figure 9. Preferences for community development scenarios reported by open house attendees



Participants were also asked to rate the usefulness of the tools for understanding and assessing the scenarios on a scale of 1 (not useful at all) to 10 (very useful), and their responses are shown in Figure 10. These outputs indicate that the tools indeed have value for community planning and public engagement. Median ratings for the model explorer (M=8) and visualizations (M=8.5) were similar, and they both tended toward the “very useful” end of the scale for rating usefulness.

Figure 10. Usefulness of model explorer and scenario visualizations according to open house attendees



In addition to rating the scenarios and tools, open house questionnaire participants provided comments on the development scenarios, the way the model explorer and visualizations can be used for assessing these scenarios, and suggestions for improving the tools. These comments were solicited through a series of open-ended questions, including:

- *What do the model explorer and visualizations tell you about the ways Squamish can develop and the possible outcomes of these development directions?*
- *Do the model explorer and visualizations provide different insights and perspectives on the community scenarios, and if so, explain these differences?*
- *What aspects are missing or could be improved for the model explorer and the visualizations?*

The feedback from the questionnaires was examined, and several themes were identified, relating to how the model explorer and visualizations can be used for community planning and public engagement and areas in which these tools can be improved. Major themes are as follows:

Using the model explorer and visualizations as complementary tools: Similar to the focus group feedback, comments from the open house participants indicated that the model explorer and visualization tools are complementary tools, rather than substitutes for one another. In some cases, participants stated a preference for one tool over the other, but for the most part the tools were described as communicating different information. The model explorer was noted to be useful for gaining specific information on changes that could occur in the neighbourhoods and community; whereas, the visualizations were described as providing a “sense” or “feeling” of what it would be like to be within a particular community scenario. One participant mentioned that using the model explorer prior to the visualization tool was useful for developing a better understanding of the broader implications of the scenarios experienced in the virtual environment. As with the focus group, some comments recommended a better integration of the model explorer and visualization; however, other participants noted that inclusion of the model outcomes table in the visualization tool (at least to some degree) provided this integration.

Demonstrating the liveability of different community “futures”: The visualizations appeared particularly useful for communicating how certain development patterns could affect liveability and quality of life. Opinions were divided on what constitutes a “liveable” neighbourhood; for example, some considered the high density scenario to be overly crowded, whereas others found it to be relatively liveable and not as heavily urbanized as densification might suggest. However, regardless of specific reactions toward the scenarios, the visualizations demonstrated that they can be used to help users understand how pleasant or unpleasant it would be to live within a certain scenario. Participants noted that the visualizations were particularly useful for understanding how development could impact views of the local landscape, suggesting that the tool can provide an impression of how certain developments can affect sense of place.

Using tools to incorporate community values into planning: Participants commented on how their preferences for scenarios were based on personal values for community living and features, such as walkability, climate action, local food production, affordable housing, etc., and indicated that model explorer and visualization tools were useful for highlighting how certain scenarios align or conflict with said values. Accordingly, it was suggested that the tools could be used to inform planning that incorporates community values. Participants recognized that everyone in Squamish would not necessarily have the same values, but the tools could be used to facilitate discussion around shared values and ways of developing the community in a manner consistent with the Official Community Plan

Illuminating the trade-offs around different ways Squamish could develop: In addition to illustrating how scenarios align or conflict with values, the tools were also useful for highlighting trade-offs associated with development decisions. For example, one participant recognized the benefits of densification that were identified through the model explorer (e.g., local jobs, reduced greenhouse gas emissions, etc.), but also found the high density scenario depicted in the visualization to be too crowded, thusly compromising quality of life. Other participants mentioned that medium density could be an “acceptable” level of community change, indicating that the tools can be used in concert to illuminate trade-offs and consider how to effectively weigh and balance advantages and disadvantages of different development patterns.

Understanding limitations associated with space and land use: Several open house participants provided comments related to space limitations within the community of Squamish. Participants mentioned that the model explorer and visualization tools effectively conveyed the key planning challenge of accommodating growth within a geographical restricted environment (i.e., limited valley floor space amidst mountainous terrain). Some participants recognized that although low density is the preferred residential form for many community members, continuing to develop this way may not be realistic in light of the projected population growth. Participant feedback also indicated that the model explorer and visualization tools showed how growth can be accommodated through different development patterns, and (through densification) room for growth exists in spatially limited areas. Ultimately, these comments indicate that the tools were useful for understanding spatial limitations and approaches for (and potential challenges around) addressing these limitations in community with a growing population.

Expanding the model and visualization: Open house participants identified important considerations that were not included in the model, such as availability of rental housing, broader community (rather than just neighbourhood) impacts on the estuary, and traffic concerns related to Squamish's positioning along a major transportation corridor in the province. Participants also made recommendations related to expanding the visualization capabilities, such as allowing users free movement through the scenarios (as opposed to being restricted to paths), ability to see more side streets and alleyways, and another virtual environment for the scenarios in downtown Squamish. In addition, other scenarios for the visualizations were suggested. For example, a participant expressed a desire to see a scenario that increases density beyond the modelled high density scenario (after experiencing the high density scenario and considering not too dramatic or impactful). Such feedback confirms the importance of designing planning tools with a degree of flexibility so that they can be refined and continually evolved through stakeholder feedback.

Improving the user experience: As done in the focus group, the open house questionnaire respondents gave recommendations for improving the user experience for the tools. Recommendations included the ability to adjust variables within the model, increasing walking speed in the visualization environment, and including a small map within the visualization first-person view window for orientation purposes.

CONCLUSION

The Spaces, Places and Possibilities research project is now complete. The tools have been developed based on the ideas and interests of the local government and community members, and they can be used in planning workshops, community meetings, and/or public engagement events to stimulate further thinking and discussion on how Squamish can development. The model explorer, modelling tools (i.e., ArcGIS tool package and R scripts), and visualization application are available from the website:

www.ccresearch.org/spaces-places-and-possibilities

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