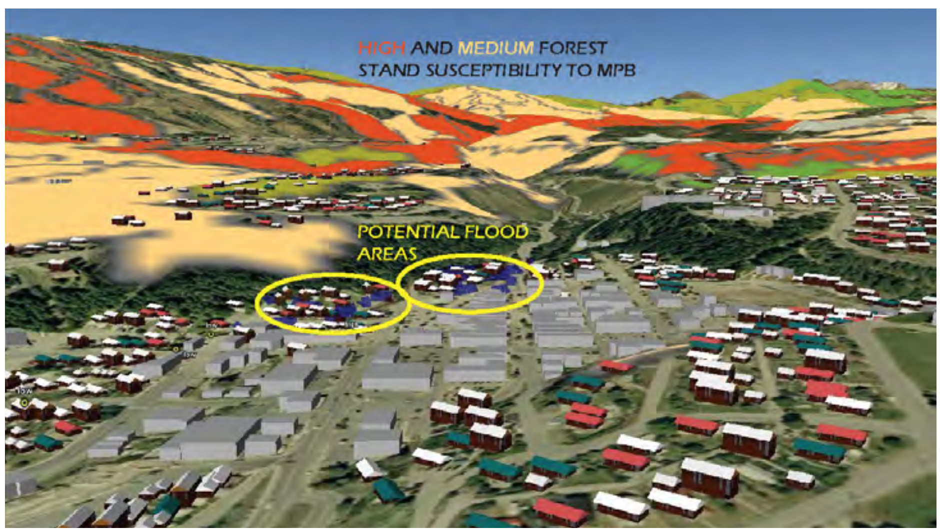
LOCAL CLIMATE CHANGE VISIONING AND LANDSCAPE VISUALIZATIONS

GUIDANCE MANUAL



Collaborative for Advanced Landscape Planning
University of British Columbia

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C A L P

PROJECT TEAM AND FUNDERS

The Collaborative for Advanced Landscape Planning (CALP) at the University of British Columbia specializes in sustainable landscape planning and design, and landscape visualization, with a focus on visualizing local climate change impacts and solutions. CALP has been leading the development of tools and processes for visioning future climate impacts, adaptation, and mitigation strategies at the local level using 2D Geographic Information Systems (GIS), 3D visualization techniques, and "4D visioning" of alternative futures.

CALP's tools and processes have been previously tested in several locations across BC: for forestry planning in the Slocan Valley/Arrow Lakes, for First Nations land planning in the Fraser Valley and Shuswap, for sustainable development planning on Bowen Island, and for climate change planning in MetroVancouver (Delta, North Vancouver). The Guidance Manual's main case study is the 2008-2009 climate change adaptation project in the City of Kimberley, BC.

CALP's ongoing research on Local Climate Change Visioning has been funded by the GEOIDE National Centre of Excellence.

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CALP's Kimberley work would not have been possible without the collaboration of:

For the Kimberley case study, CALP wishes to thank: the City of Kimberley including Mayor Jim Ogilvie, all the Councilors, and the staff, particularly Operations staff, Troy Pollock in Planning, and Al Collinson the Fire Chief; the Kimberley Climate Adaptation Project team, particularly Project Coordinator Ingrid Liepa, the Steering Committee, and all the members of the Working Groups; all the residents of Kimberley who participated in workshops and public open houses; the CALP team including Dr. Duncan Cavens, Nicole Miller, Adelle Airey and Courtney Miller; the Swiss National Science Foundation; the Selkirk College Geospatial Research Centre, particularly Paul Sneed; the Pacific Climate Impacts Consortium, particularly Trevor Murdock; the Columbia Basin Trust and their Climate Advisory Committee, particularly Dr. Stewart Cohen; Art Stock, Entomologist, BC Forest Service; Bob Gray, Fire Consultant with the City of Kimberley; The British Columbia Ministry of Community and Rural Development, particularly Cathy LeBlanc; and, the Real Estate Foundation.

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HOW TO USE THIS GUIDE

The guide is **intended to be used by local communities: decision-makers/practitioners, sustainability citizen groups, consultants, and others**, to help develop resilient local communities in an uncertain climate change future.

The guide is based on a pilot Visioning and Climate Adaptation Project in the City of Kimberley in 2008-2009, as well as previous Collaborative for Advanced Landscape Planning (CALP) work on other visioning and visualization projects (Delta and the North Shore, Prince George). The Kimberley pilot project tested the feasibility of visioning and visualizations for planning processes related to climate change in small, more rural communities.

The guide is **intended for use BC-wide**. Supportive bodies similar to the Columbia Basin Trust, which funded the community component of the Kimberley project, and local or regional GIS support similar to the services provided within the Columbia Basin by the Selkirk College Geospatial Research Centre in Castlegar, could aid visioning feasibility in smaller communities.

The guide should be seen as a living document, to which are added locally relevant resource materials and climate scenarios. The process can also be re-worked to fit each community's particular needs, including identifying and prioritizing key local issues. Local citizens and local experts will be a strong asset to local Visioning processes, while external experts such as climate scientists can provide helpful data. The collaboration between "locals and outsiders" can prove very fruitful.

Section 1 explains WHAT visioning is and WHY it is a valuable tool, as well as WHAT and WHY for scenarios and visualizations in climate change planning. Note that Visioning refers to a participatory process to develop local climate change responses and planning, while 3D visualizations are products that come out of the Visioning process.

Section 2 provides an overview of the actual process, a basic "how to" do visioning, develop scenarios, and produce 3D visualizations.

Section 3 works through the 10 Steps in Three Phases that comprise the core of the Visioning Process. Each phase goes through an iteration of participation, data/modeling, and materials production. The third phase produces a final Visioning Package: the set of tangible products including scenario storylines, visual outputs/visualizations, presentations, and technical background materials that can be used to improve public outreach and decision-making.

The process is flexible and iterative - phases may be repeated and steps added or omitted depending on local needs.

Section 4 has references organized by theme, such as Adaptation, Scenarios, or Participatory Processes. Each reference is numbered with corresponding reference numbers in the text.

Section 5, the Appendices, includes an introduction to CALP's Kimberley project, an overview of Visualization Ethics, European Union research findings on types of visualizations and audiences, and a brief discussion of spatial greenhouse gas (GHG) emissions.

The PINK BOXES give examples from case studies.

What is local climate change visioning?

Local communities face multiple challenges related to climate change, including the need to adapt to uncertain futures and meet deep greenhouse gas reduction (mitigation) targets. Local climate change visioning integrates climate science with local planning, using participatory processes and "virtual reality" techniques based on digital mapping and scientific data to accelerate community awareness, help to build a constituency for change, and support decision-making on climate change options.

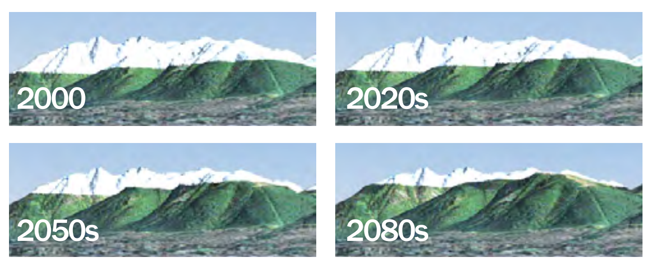
Local climate change visioning is a flexible process that can be adapted to a range of contexts and output needs, from engaging in a full stand-alone visioning process to using smaller components and tools embedded in other ongoing planning or engagement processes. Its critical and distinguishing components include:

PARTICIPATION Participatory processes provide local knowledge, prioritize and evaluate local climate change responses and planning options, and ensure that visualizations are locally credible.

DATA INTEGRATION of local knowledge and the best available scientific data, mapping, and modeling brings climate science, local knowledge, and cross-disciplinary expertise together.

SCENARIO BUILDING provides a framework to address holistic, future climate change possibilities and current and future response options. The objective is to describe complex and uncertain alternative future pathways as simply as possible in "plausible storylines" or scenario narratives.

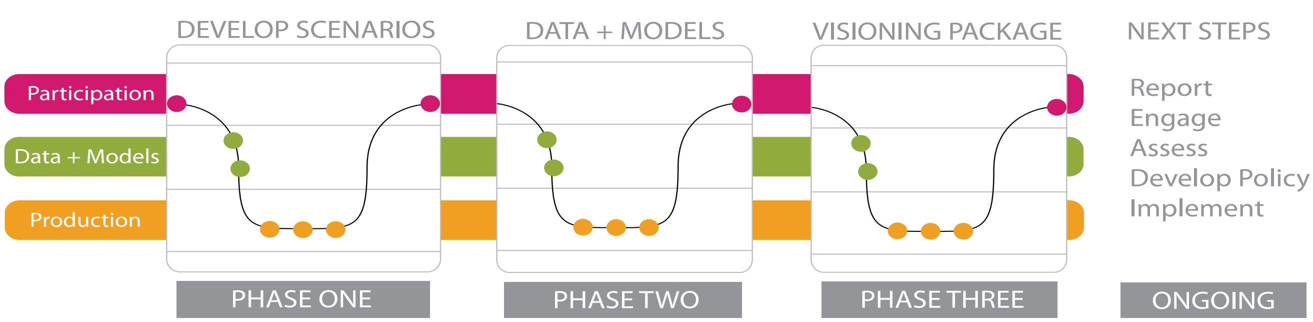
2D, 3D & 4D (across time) VISUALIZATIONS ("viz") are graphic images that represent scientific and other data. They communicate complex and long-term issues and scenarios to community members and decision-makers in an easy to understand and compelling way.



MetroVancouver April 1st snowline projection

How is climate visioning done?

Climate change visioning is an iterative process, as shown below, that moves through three main phases. Each phase includes the key components of participation, data integration and production.



The full stand-alone climate change visioning process involves 10+ steps

PHASE ONE, PARTICIPATORY SCENARIO BUILDING: initiate project, review local climate science, identify local priorities, develop scenarios

1. Convene Working Group or Team
2. Collect spatial and non-spatial baseline data for scenario development
3. Produce scenario development materials: maps + scenario frameworks
4. Scenario Development Workshop to select and define scenarios

PHASE TWO, DATA + MODELING: data generation and integration, viz development, review

5. Map, model and integrate land use, spatial impacts, and response option data
6. Produce 2D mapping and 3D viz materials to flesh out the scenarios, for review
7. Data and Visualization Review Workshop

PHASE THREE, FULL VISIONING PACKAGE: data + viz refinement, materials production, community/stakeholder presentation

8. Refine and improve spatial and numerical data and modeling
9. Produce final mapping, viz, virtual globes, animations, and technical documents
10. Community Open House, other public engagement to review scenarios/options

NEXT STEPS: Dissemination and Implementation

10+ **Further steps may include:** Further engagement, reports, assessment, policy development and implementation, evaluation, monitoring

Visioning is an iterative process, moving through three phases to produce a visioning package.

The process starts by downscaling global climate change **scenarios** to the regional and local level. The scenarios enable consideration of potential future conditions in a coherent and easy-to-grasp manner. They are developed in a participatory process that considers GHG emissions and local trends; provides a structured way to ask "what if" questions exploring risks, options, and possible outcomes; and incorporates both adaptation and mitigation.

Local climate change visioning uses the visual landscape, usually within a geographic information system (GIS), as a platform to synthesize **diverse data sets and modeling**, including current risks and locally prioritized issues, development plans, carbon emissions sources, climate change impacts, and adaptation and mitigation strategies.

Landscape visualizations – or 2D, 3D and 4D (across time) graphics and images - function as a tool to both verify data and modeling, and enhance communication of complex information. The most straightforward visualizations are 2D spatial data draped over 3D terrain, while more complex visualizations involve multiple integrated datasets and photo-realistic 3D renderings of vegetation and buildings. Non-map-based visualizations using photo-editing software can also be useful. Virtual globes (eg. GoogleEarth) that allow for interactive fly-throughs and 3D mapping display of GIS spatial data can make straightforward visualizations realizable with local or regional spatial planning resources.

Visualizations are supported by an underlying set of participatory processes, scenario building, and data and modeling. Final visualizations should be presented in a "**visioning package**" that includes scenario narratives, the background data sources, and the context for the visualizations. They should also adhere to visualization ethics, meeting criteria around drama, defensibility, and disclosure.

Why do local climate change visioning?

Shared Learning, Decision-Support

Using collaborative participation, the **local climate change visioning process emphasizes shared learning** around climate change, its impacts and local response options in order to communicate complex information more clearly to citizens and stakeholders. Local climate change visioning localizes, spatializes and visualizes complex data to support improved local decision-making on climate change.

The process can:
• Increase community and practitioner awareness & understanding of local climate change impacts and response options
• Increase public engagement
• Provide a platform for discussing and evaluating adaptation and mitigation options
• Support decision-making on tough climate change choices
• Help to build support for local climate change adaptation and mitigation policies.

The visioning process may be used as a stand-alone **engagement process**, such as developing a community climate change plan or sustainability strategic vision. Alternately, select components may be used for smaller stand-alone efforts such as wildfire management planning, or visioning steps may be embedded in larger ongoing planning and engagement processes, such as an Official Community Plan (OCP) review, or a community-led process such as Transition Towns[38].

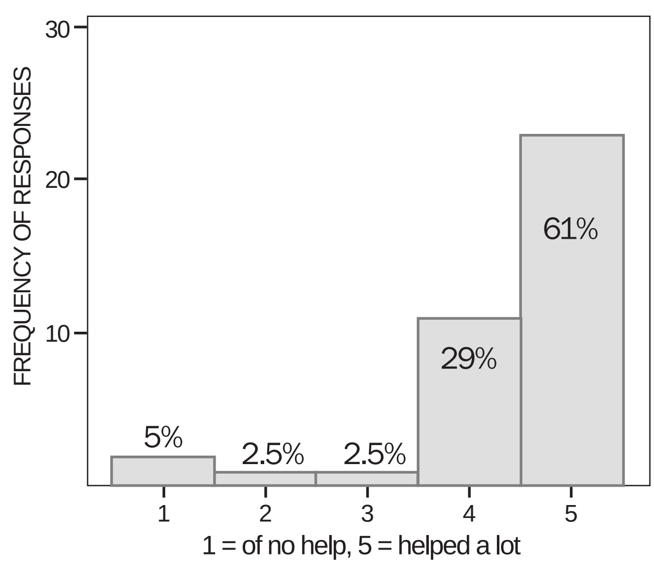
Local climate change visioning provides an opportunity to **find solutions that fit the community** and incorporate local knowledge into policy development. Visioning considers outcomes at all scales – from the landscape scale (watershed and beyond) to individual parcels, including exploration across jurisdictions and legal boundaries. The **desired outcome is moving communities forward** towards low carbon, resilient communities in the face of climate change.

Research findings on visualizations

Visualizations help people to understand complex spatial data more quickly. Thus, visualizations can enhance the communication of and engagement with complex and future-oriented information within a local setting: people may for the first time "see" future climate change in their own backyards, and better understand their choices. Visualizations clarify and illustrate climate change for local participants, in the context of known landscapes, increasing participant comprehension. Visualizations also verify scientific modeling, enhance citizen engagement, and provide decision-support.

Research in Kimberley at a Community Open House asked the following: "If you were asked for your opinion on mitigation and adaptation strategies for climate change in Kimberley, **would the visualizations you have seen help you?**"

The majority participant response (90%) was that they either "(4) helped a little" or "(5) helped a lot".



Participant rating of the visualization benefits in Kimberley
(38 respondents, Mean 4.370, Standard Deviation 1.051)

Planning and climate change related acronyms

A + M - adaptation and mitigation (see box to right)

CED - community economic development

CEP - community energy planning

DEM - digital elevation model

GHGs - greenhouse gas emissions

GIS - geographic information systems (digital spatial data and mapping)

ICSP - Integrated Community Sustainability Plan

IPCC - Intergovernmental Panel on Climate Change

OCP - Official Community Plan; prepared by municipalities

PCIC - Pacific Climate Impacts Consortium

RD - Regional District

RGS - Regional Growth Strategy; prepared by Regional Districts

SWOT - Strengths, weaknesses, opportunities, threats analysis

Virtual globe - digital 3D globe used to display mapping and 3D data

"Viz" - visualizations, usually of 3D landscapes

4D visualizations - 3D visualizations that show change over time

Mitigation refers to reducing greenhouse gas emissions. Global emissions must decrease by over 80% by 2050 in order to stabilize climate and avoid catastrophic climate change.

Adaptation refers to acting to minimize vulnerability to climate change impacts now and into the future due to past greenhouse gas emissions. Without mitigation, adaptation will need to be continuous: mitigation is thus critical to long-term adaptation.

Many **Adaptation** and **Mitigation** strategies require buy-in and public support at the local level. **Local climate change visioning** can accelerate community awareness and understanding of climate change causes and possible impacts, increasing confidence and support for local climate change planning decisions and actions.

SECTION 1
THE VISIONING FRAMEWORK

1.1.1 What is local climate change visioning?

Local climate change visioning is a flexible process used to accelerate understanding and planning around climate change[58, 69]. The process can be adapted to a range of contexts and output needs, from engaging in a full stand-alone visioning process to using smaller components embedded in other ongoing planning or engagement processes. Its critical and distinguishing components include:

PARTICIPATION Participatory processes provide local knowledge, prioritize and evaluate local climate change responses and planning options, and ensure that visualizations are locally credible.

DATA INTEGRATION of local knowledge and the best available scientific data, mapping, and modeling brings climate science, local knowledge, and cross-disciplinary expertise together.

SCENARIO BUILDING provides a framework to address holistic, future climate change possibilities and current and future response options.

3D and 4D (across time) VISUALIZATIONS test scientific models and provide credible and compelling ways of communicating and assessing complex issues to local community members and decision-makers.

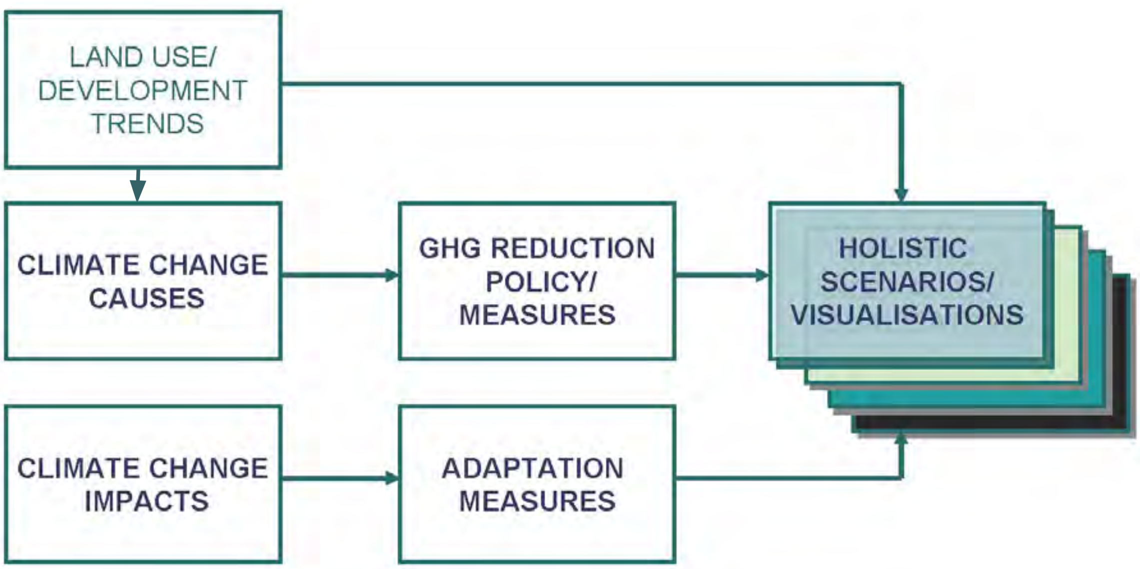


Figure 1. The multiple inputs used in climate change visioning cross knowledge "silos" and include land use trends, local climate change causes and impacts, emissions reductions strategies, and adaptation options. Scenarios and visualizations integrate and communicate this material, including pros and cons of alternative response options.

Climate change visioning builds in part upon spatial planning, i.e. planning that considers the impact and form of planning decisions in the landscape at various scales, from small town to regional resource/working landscapes.

1.1.2 Why use climate change visioning?

Local communities face multiple challenges related to climate change, including the need to adapt to uncertain futures and meet legislated GHG mitigation targets. Visioning holistically integrates climate science with local planning, accelerating community awareness, helping build a constituency for change, and supporting decision-making on climate change options.

One of our most urgent priorities is responding to climate change and its impacts on society, as well as slowing and stopping the greenhouse gas emissions that are causing it in the first place, including meeting legislated targets (as in the BC "Green Communities" legislation)[17]. However, there is often a gap between available information from climate change science and understanding of the local responses that will be required to mitigate and adapt to climate change, hence the need for new, more effective tools and processes to help agencies meet climate change targets.

The local climate change visioning process developed by CALP is aimed at enhancing community engagement, citizen and practitioner learning, and policy-change processes in response to long-term climate change at the local level. Previous research by CALP and others[64, 66, 72] suggests that the visioning tools can rapidly enhance awareness of climate change and response options, and help a community explore tangible and specific potential pathways for climate change action into the future.

Two of the evaluation comments at the Kimberley climate adaptation project's final open house[61]: the presentations showed "the positive vision to shoot for in Kimberley", and "It was positive and not full of gloom and doom".

VISIONING CAN:

- Increase local climate change awareness and understanding of local vulnerabilities/risks, projected impacts, and adaptation and mitigation options
- Enable community involvement in developing local climate change solutions
- Build a local constituency that supports climate change planning and policy change
- Integrate adaptation and mitigation options to find synergies and avoid conflicts, helping to identify win-win opportunities
- Develop and illustrate low-carbon and adaptation options whose implications may be difficult for local residents to imagine
- Identify and help overcome social barriers to climate change mitigation and adaptation
- Communicate the urgency of mitigation
- Enhance understanding of longer term impacts of various land use and development trajectories
- Aid in understanding GHG emissions and their links to lifestyle and land use decisions
- Stimulate meaningful discussion on alternative response options
- Empower local citizens to make different choices in their individual and collective lifestyles
- Assist with setting and meeting policies and targets
- Accelerate the transition to low-carbon, resilient communities

Some adaptation options, such as using air conditioners, increase GHG emissions and conflict with mitigation, while other adaptation options, such as using street trees for cooling, also sequester GHG emissions (synergies). Visioning, where Adaptation and Mitigation can be assessed together, allow these conflicts and synergies to be identified, and win-win solutions developed.

1.2.1 What are scenarios?

Visioning uses scenarios to describe complex and often unpredictable alternative future pathways as simply as possible in "plausible storylines"[52] or scenario narratives. The scenarios distinguish between and provide pictures of different future pathways.

Scenarios are ways to tell stories about communities - where they have come from, what their assets and vulnerabilities are, and where they might be going depending on the choices that they make in planning for the future. Scenario methods were developed in the 1970s as a way to explore and plan for possible futures, particularly when facing uncertain or unexpected events.

Scenarios provide a structured way to ask "what if" questions that explore risks, planning options, and possible outcomes while accounting for uncertainty, surprise, human choices, cultural values and complexity[51, 53]. In order to provide a range of possible futures, scenarios are based on modeled quantitative data (such as population projections) or quantitative assumptions, as well as qualitative data including cultural values and norms. They are thus multi-dimensional, and strive for coherence across diverse elements including socio-economics and the environment[52]. By framing uncertainties, scenarios provide coherent stories of possible futures. They use medium and long-term timelines to explore possible human and environmental responses under contrasting future conditions[53].

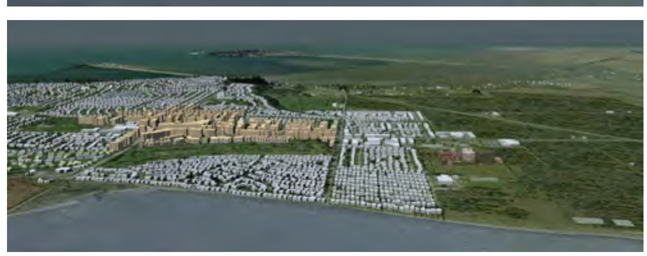
There are several types of scenario methods. **Exploratory "what-if"** scenarios examine the implications of different assumptions. Possible developments are explored from diverse perspectives in order to understand how different assumptions may play out and to identify potential surprises. For example, what might happen to BC communities if climate impacts elsewhere lead to large-scale population in-migration?

Forecasting scenarios delineate a range of futures based on current trends. They work well for shorter term scenarios, and for examining what actions could be taken now, given current social, political, environmental and ecological realities.

Backcasting scenarios start with a goal for the future and explore how the desired future state can be achieved, thus assessing the feasibility of desired futures. Backcasting scenarios are useful for setting future greenhouse gas (GHG) mitigation targets and then working backwards to figure out how to achieve them.

Scenarios are **schematic**, aiming not for precision and detail but for essential elements and plotlines that articulate large-scale patterns[51]. Therefore, scenarios should not be judged for their probability, but rather used to book-end a range of possible futures. They often include extreme cases, eg. from the "do-nothing" climate change scenario with catastrophic impacts, to the "do everything" scenario with both adaptation and extensive mitigation associated with stabilizing the future climate. The extremes can be useful to understand the full range of risks, choices, and consequences facing society.

The images below show extremes for development by 2100 in Delta: sprawling / compact (Flanders/CALP).



The Intergovernmental Panel on Climate Change (IPCC) has used scenarios to develop a range of different global GHG emissions and impacts projections. The Special Report on Emissions Scenarios (SRES)[50] projected how changes in population, energy, and economics could alter future GHG emissions projections (left, below), leading to different projections for climate change impacts, particularly global average temperature increases (right, below).

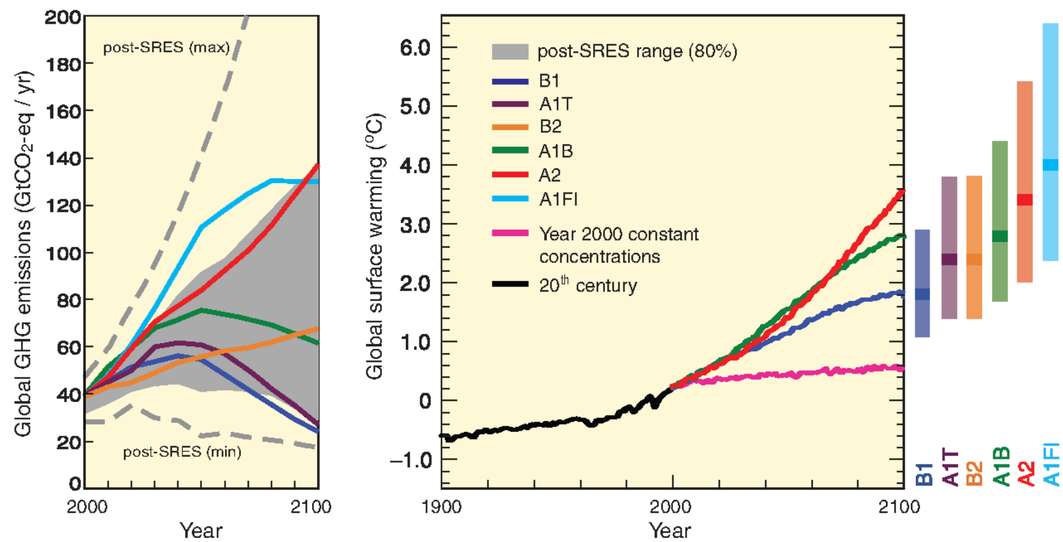


Figure 2. Scenarios for GHG emissions from 2000 to 2100 (in the absence of explicit climate change policies) and projections of surface temperatures[48 pg7] (**'**post-SRES' is a new set of scenarios with projections expected in future IPCC assessments[49]).

1.2.2 Why use scenarios?

Scenarios provide a mechanism to consider comprehensive future states in a coherent and easy-to-grasp manner, which is particularly useful when dealing with the numerous implications and complexities of climate change.

By providing a framework within which communities can explore "what if" questions, scenarios can help communities to plan for a range of futures with uncertainties in climate projections and impacts, economics, and culture. Embedding climate change into local scenario narratives or "local stories" can make climate change and its impacts more relevant to local communities.

Without scenarios, public consultation and planning may miss important options and potential outcomes, and move too rapidly on a single preferred or assumed plan, without thinking through key inter-relationships, or considering some longer-term future risks. As well, piecemeal uptake of mitigation and adaptation options, rather than pursuing a holistic future pathway against which planning and operations decisions can be assessed, may not lead communities to their desired future, nor meet stringent GHG mitigation targets. Scenario-based planning aids in developing long-term, integrated plans.

Specifically, scenario-based stakeholder engagement is a promising approach to climate decision-making due to:

• **The uncertainty of climate change impacts**. Justifying climate-change related planning decisions can be difficult given that the precise location and extent of local impacts cannot be predicted with certainty. Building and assesing plausible scenarios allow for decision-making even with uncertainties.

• **The complexities of climate change**. The combination of stakeholder analysis, climate change management scenarios and participatory techniques is a useful tool to address the complexities and challenges of climate change.

• Significant mitigation and adaptation measures, at the local level, **require major public support**. Participatory scenario building may be more effective than top-down planning decisions in climate change plannning due to stakeholder engagement: participatory construction of alternative scenarios can build local understanding and buy-in when dealing with vulnerability and planning for resilience, adaptation, and mitigation.

• Scenario-building can be employed to frame a community process that **integrates both adaptation and mitigation planning**, which allows participants to examine a wider range of available decision paths and their consequences. The process can empower participants, contribute to the desire for behavioural change, and lead to more sustainable long-term choices.

Additional Advantages of scenarios:

• Scenario building can capture community values, and show how a range of values can lead to a range of positive and/or negative outcomes
• Scenarios provide local storylines and narratives within which to embed climate change data and options, making the science more locally relevant
• Scenarios help the community to "see itself" and understand how choices now could impact results later - they connect the present to the future
• Scenarios help plan for extreme contingencies

Limitations of scenarios:

• It may be difficult to integrate narrative or qualitative storylines with quantitative projections
• There may be a lack of current quantitative data and quantitative projections for many variables
• Lack of low-emissions climate science scenarios, particularly at the local level
• They may be perceived to be subjective, not formal, or not very "scientific" and therefore hard to defend
• They could be subject to political influence - for example, providing 3 scenarios to choose from, in which only 1 is a viable option, could potentially manipulate the scenario process

How to overcome limitations (see also 2.2)**:**

• Provide transparency in assumptions/drivers and clarity about the limitations of quantitative projections
• Communicate assumptions clearly to audiences
• Use four scenarios to allow for more choices, given that using three scenarios may suggest the middle option is the preferred pathway
• Treat scenarios as an exploratory framework to tell different possible "stories" about the community
• Develop further variants of initial scenarios to examine new issues or pursue preferred directions further.

1.3.1 What are landscape visualizations?

Landscape visualizations are 2D, 3D and 4D graphic images that represent scientific, policy and planning choices, and other data, and communicate complex and long-term issues and scenarios[67].

Visualizations are images of conditions, processes, or places that use the local landscape as a medium for data integration and visual communication. Landscape visualizations depict real places seen by people in the area, and help the viewer understand subject matter by visually illustrating significant characteristics and possible future conditions.

Visualizations (sometimes referred to as "viz") may represent a single data source, such as a single thematic map, or they may show a set of inter-related data integrated onto one landscape. Complex visualizations aim to portray holistic images of scenarios that draw on multiple knowledge "silos", such as climate change impacts, community energy options, transportation alternatives, local adaptation strategies, development plans, and forestry or agricultural practices.

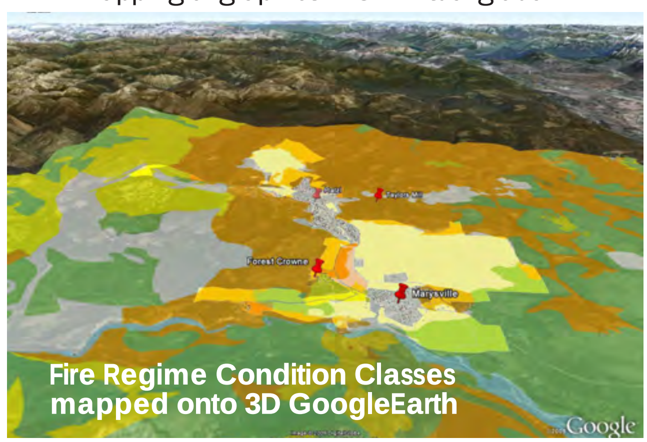
Visualizations:
• Can be still images, an interactive platform (such as the virtual globe GoogleEarth), or animations
• Should be based on the best available scientific data, models, and local knowledge
• Can show change over time, capturing the long-term impacts of climate change: people can see possible future impacts now
• Can show the relationships between different data sets, for example, Mountain Pine Beetle susceptibility, community watersheds, and fire risk
• Can show "best practices and beyond" response options to climate change, and help people to imagine the unfamiliar
• May be stand-alone or integrated into visioning or other planning processes

Many visualization types, ranging from open source, self-taught, user-friendly programs to sophisticated 3D modeling/rendering programs, are available, including:
• 2D GIS maps
• 2D photo edited collages of future scenes
• 3D maps (maps draped over 3D terrain)
• Realistic 3D landscape visualizations
• Virtual globes and other interactive media
• Animations produced from 3D visualizations

Visioning Packages use various visual media to combine landscape visualizations with indicator charts and graphics, presentations using visualization materials, and/or, technical posters or other explanatory materials in order to present integrated, visually compelling scientific and local knowledge.

Visualizations have several levels of image complexity and photorealism, from simple mapping and 2D applications to complex 3D and city modeling:

• 2D mapping or graphics in 3D virtual globe:

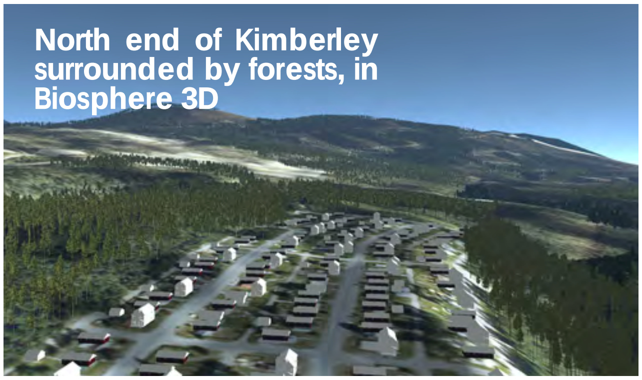


Fire Regime Condition Classes mapped onto 3D GoogleEarth

• Semi-realistic 3D city models, in virtual globes or other software, with minimal or no 3D vegetation:

3D model of the City of Kimberley, in the virtual globe GoogleEarth.

• Photorealistic 3D landscape scenes with 3D buildings and 3D vegetation; may include atmospheric (weather, lighting) effects as well:


North end of Kimberley surrounded by forests, in Biosphere 3D

• 4D visualizations employ any of the previous types, and show change over time:

Some visualizations use photo-editing (eg. Photoshop) or non-georeferenced 3D software to generate "before and after" scenes, ranging from abstracted or cartoon-like with lower levels of complexity to highly photo-realistic renditions (example below). Such visualizations often integrate non-spatial, less quantitative data, and may be conceptual.


North Shore low-carbon

Complex visualizations may involve multiple datasets and software steps: GIS mapping or LiDAR aerial imagery, 3D building and vegetation production in 3D software, photo-editing to enhance rendering, and possible exporting to virtual globes. They integrate scientific/quantitative data and spatial data.


Delta, flood adaptation, 2100

The mixed-media low-carbon image below integrates hand drawings, 3D Sketchup buildings, and a photo-edited orthophoto.


Low-carbon Kimberley

Virtual Globes such as GoogleEarth and Bing are promising web-based interactive visualization tools that can present 2D mapped information (geospatial data) in a geo-referenced 3D model, and allow users to zoom between global and local scales. In many virtual globes, users can navigate in three dimensions, turn information layers on and off, build or see 3D buildings, and experience change over time using time sliders. Other virtual globes such as the open-source Biosphere 3D allow for complex 3D visualizations of landscape elements including trees and plants.

1.3.2 Why use landscape visualizations?

Visualizations can enhance the communication of and engagement with complex and future-oriented information within a local setting, thereby enabling people to "see" future climate change in their own backyards[58, 64].

When **people see images of their community** integrated with scientific data drawn from maps, graphs, or charts, the information suddenly becomes real: the data's meaning becomes clear in the context of actual places that people recognize. Thus, landscape visualizations can unlock rich sources of information and link them to community members' own experiences[69].

By visually displaying important characteristics and possible future conditions, 3D landscape visualizations help the viewer to **understand and interpret** complex subject matter related to climate change. Climate change is usually difficult to grasp beyond the individually experienced time-frame because it is still perceived as geographically remote and a long-term problem. Local impacts of climate change are often even more difficult to grasp, with local trade-offs between alternative adaptation options, and implications of mitigation strategies adding to the challenge. Landscape visualizations of future scenarios can help to explain, and highlight, the local relevance of climate change, building the public understanding and support needed for decision-makers to move forward with climate change policy and implementation.

VISUALIZATIONS CAN: [41, 56, 62, 64, 67, 68]

- Provide engaging presentation material that attracts more participants, is easily and quickly understood, and enables more meaningful participation of non-experts in planning
- Show impacts and solutions "in people's backyards", making climate change relevant and bringing it home via iconic and familiar places,
- Increase awareness and understanding of climate change response options, and their potential impacts on neighbourhood character
- Collapse time so that people can see future possible impacts now ("time travel")
- Verify scientific/numerical modeling by revealing unanticipated implications, and errors or omissions in the modeling itself; therefore, they enable local experts and local knowledge holders to "check" the science and proposals for local accuracy and feasibility
- Communicate expert data and critical messages to lay people in a more compelling way than graphs, maps, text, or verbal presentations
- Meet multiple learning styles, particularly for those people who learn visually
- Reveal underlying environmental conditions not generally visible (such as declining forest health, relative risk of erosion, or Mountain Pine Beetle susceptibility) by adding mapped data to realistic visualizations, eg. colour-coded polygons draped on the landscape

VISUALIZATION LIMITATIONS: [67, 73, 74]

- They cannot by themselves show all climate impacts (eg, some health impacts) or all mitigation/adaptation options (eg, cost incentives, or fiscal policies), or meet the needs of all learners[61, 65.] Therefore, using other media as well, such as technical posters and presentations (a comprehensive Visioning Package) will enhance the benefits of visualizations.
- If done poorly (ie, they have poor clarity, or low credibility with the audience due to obvious errors, or obvious bias), they can be rejected by viewers
- They risk misleading viewers if they imply greater certainty than the modeling or projections provide
- Lack of data and its quality may limit the scope and complexity of visualizations

Landscape visualizations are still relatively novel in planning contexts for laypersons. They can sometimes aid in engaging emotional issues, identifying impotant community trigger points such as impacts on well-loved community places, or perceived threats to neighbourhoods and regional landscapes due to proposed changes. It is vital to explore such issues before planning decisions are made.

INTERACTIVE VISUALIZATIONS[41, 64, 65]

Stakeholders need to assess options for climate change adaptation and mitigation at different locations and points in time, requiring participants both to think across alternatives and to understand multiple space and time relationships. Interactive visualizations using virtual globes can support these complex cognitive tasks, allowing users to choose their preferred viewing perspective, and control the flow of information through:

- Fly-throughs
- Zooming from global to local levels
- Navigation through time
- Layers to compare data and alternate storylines

Hands-on navigation of interactive virtual globes such as GoogleEarth can also provide a platform for small group discussion, particularly when a navigator is available to be directed by the group. Non-experts in particular seem to respond well to "flying through", and seeing and discussing options.

The benefits of using virtual globes include[61, 65, 74]: ease of access and use, and a growing confidence in the public in using such tools; enhanced interest and awareness in the subject matter; users can self-select views and perspectives; and virtual globes may allow for empathy or identification with geographically distant groups [74].

Risks in using virtual globes include[61, 65, 74]: users may misinterpret data; potential for cognitive overload (i.e. too much visual information); and, some viewers dislike virtual globes as a medium (as found in Kimberley[61, 65]). Virtual globes do not automatically display data sources and caveats, nor provide legends with screen capture, making it difficult to judge the validity of the data and sometimes its meaning. Use of alternative media, such as technical posters, can complement virtual globes and reduce their limitations.

RESEARCH FINDINGS ON VISUALIZATIONS

CALP and others have tested whether visualizations can increase awareness and understanding of local climate change issues and options. For example, in Kimberley, research with Community Open House participants asked the following[65]:

"If you were asked for your opinion on mitigation and adaptation strategies for climate change in Kimberley, would the visualizations you have seen help you?"

The majority response, 90%, was that visualizations were helpful: "(4) helped a little" and "(5) helped a lot".

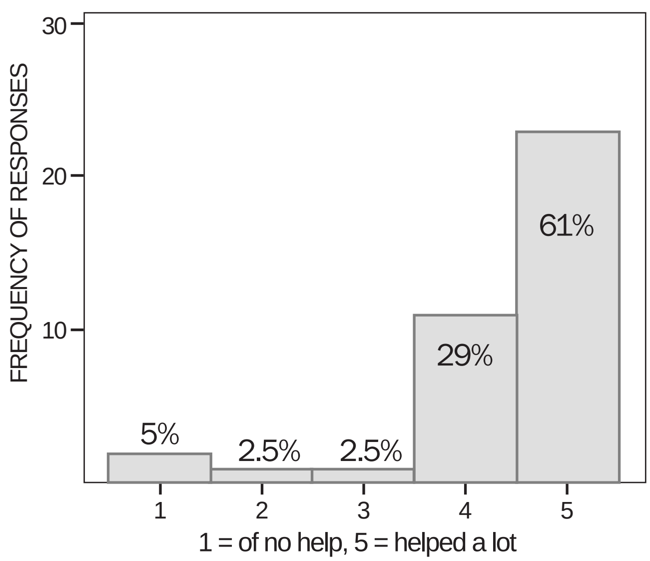


Figure 3. Participant rating of the visualization benefits in Kimberley (38 respondents, Mean 4.370, Standard Deviation 1.051)[65]

Previous CALP research on visioning and visualizations in MetroVancouver tested participant awareness before and after local climate change visualization presentations, as well as against a control group that had a matching presentation without the visualizations. The findings suggest that use of visualizations can enhance participant understanding and learning, even when compared to the control group[71].

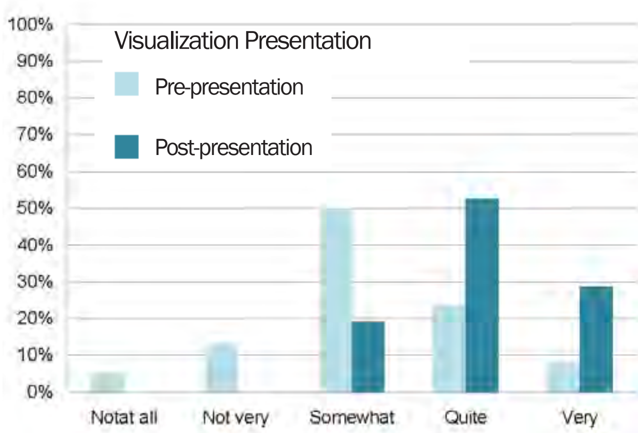


Figure 4. How knowledgeable are you about the effects of climate change on the local area? (42 respondents)[71]

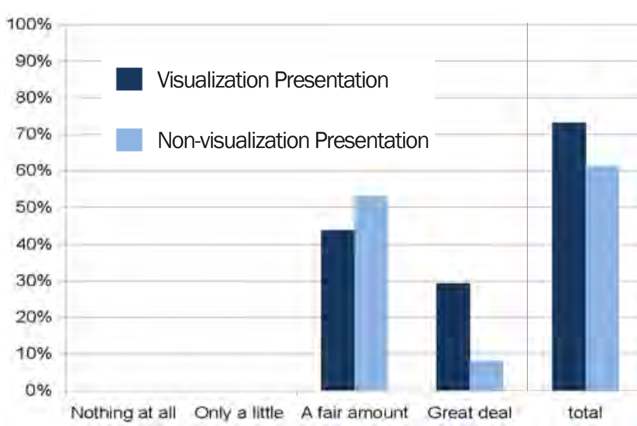


Figure 5. How much did you learn about climate change? (42 viz respondents; 49 non-viz respondents)[71]

VISUALIZATIONS COMMUNICATE

Basing visualizations in scientific modeling means that the visualizations both gain credibility, and are better able to communicate scientific data. In Kimberley, the fire season extension under climate change and the fire spread model had been presented prior to the final Open House visualizations. Earlier presentations did not lead to visible emotional reactions or apparent breakthroughs in understanding. However, the fire visualizations evoked significant expressions of concern when shown in the public Open House, raising awareness within the community of the wildfire issue and projected fire season extension under climate change. The wildfire visualizations have already been incorporated into local and regional fire planning processes, and local fire smart education.

1.3.3 The relationship between Visioning and Visualizations

Visualizations are the most visible component of the visioning process, the end product of an underlying framework of participatory processes, scenario-building, and data/modeling.

The final use of visualizations, as well as the goals of a project, will determine the type of visualizations needed, and the depth of the visioning process required to achieve project goals. As well, new tools are emerging that support simpler (i.e. faster and less expensive) production of 3D visualizations, such as GoogleEarth.

VISUALIZATION TYPES AND USES

1) Stand alone data and specific issues

Visualizations may be used as a stand-alone product, particularly where communication of single data layers is considered important. Many regional districts, regional colleges and First Nations Bands already use and maintain GIS resources. Where existing data showing current vulnerabilities exists – as with the wildfire model for Kimberley – the visualizations can increase community understanding of a specific issue.

The potential to enhance non-expert understanding and engage participants in discussion using 3D visualization and virtual globes, coupled with the relative ease of translation from GIS to GoogleEarth, suggest that such tools can be very useful for public engagement and spatial planning in many communities.

2) Integrated data and scenarios

While straightforward 3D visualization of existing GIS data is possible and in many cases desirable, the strength of a broader visioning process is that data from multiple sources is integrated, local knowledge is incorporated, and scenario development allows participants to ask "what if" questions critical to planning for the unexpected, including climate change. The combination of a scenario and visualization team working alongside a local, participatory planning process with citizens and local experts ensures that scenarios and data are locally relevant, visualizations meet the community's needs for enhanced outreach and public education, and the planning process is robust.

EASE OF USE / REPLICABILITY

The diagram below delineates visualizations by type (from simpler 2D maps and virtual globes to more complex 3D photorealistic modeling), and by the complexity of the visioning process (from a single data layer to integrated scenarios). The most locally replicable visualizations still require good spatial data, while visualizations needing data integration and scenario development, and expertise in photorealistic 3D software, require the most expert input.

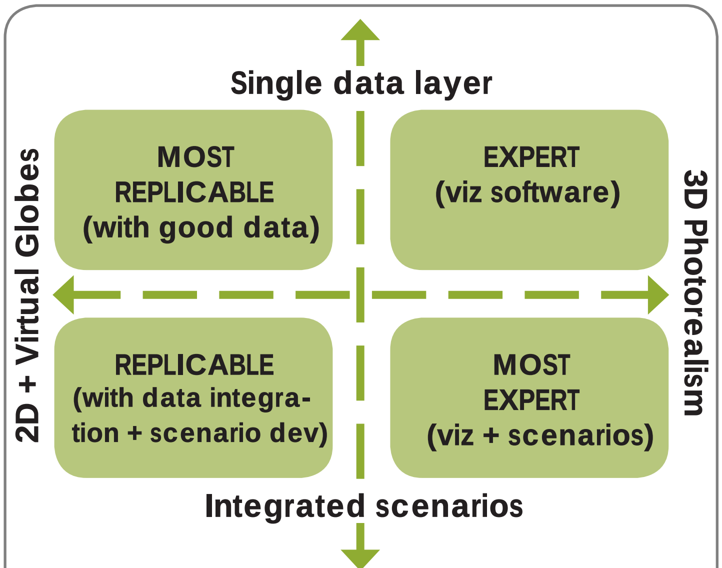
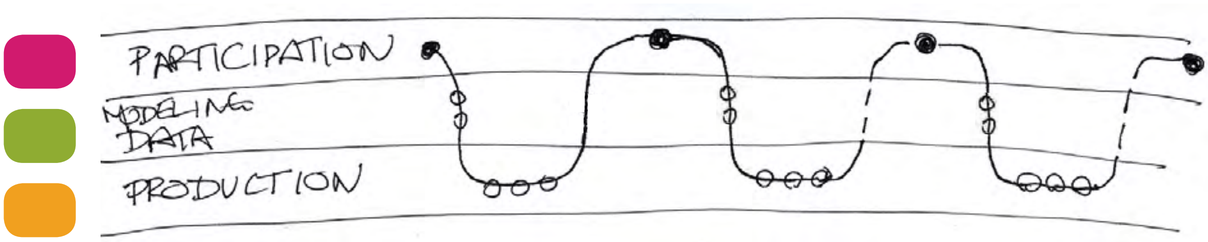


Figure 6. Visualization types by degree of realism and level of data integration, both of which impact replicability.

Note that visualizations may not capture the whole narrative. Strong visualizations depend upon the quality of the data, yet for many climate change impacts, local spatial data is not yet available. In such cases, visualizations run the risk of privileging some issues, particularly those that are visible, over others. Accordingly, a full visioning package, more background context, and other presentation modes may be required to provide a balanced storyline.

SECTION 2
THE VISIONING PROCESS OVERVIEW

2.1.1 How do we do climate change visioning?



As illustrated above, visioning processes are iterative – they are undertaken collaboratively with a working group, and use the best available data and local expertise to produce materials for planning and climate change work which are continually revised and improved upon.

The process alternates between the critical participatory components of input, ideas, and review (solid circles), and the technical production components (blank circles). These two kinds of activities (participatory, production) are linked by data gathering, generation, analysis, and modeling which provides the credible scientific base for the visualizations and other outputs. The process may repeat itself, particularly with 2D and 3D visualization review, until a full Visioning Package is produced, in a process that takes 10 steps in three phases.

Each step in the Visioning Process focusses on a different colour-coded component:

PARTICIPATION is critical

- Meetings / interviews with Council/Board, staff, stakeholders, experts
- Charettes, workshops, viz materials review
- Open houses, other community engagement

DATA + MODELING form the basis of the visualizations

Data/models may be gathered, analysed, and/or generated by the visioning working group or others, and include:

- 2D spatial data: municipal / regional, Provincial, other; spatial modeling and analysis
- Non-spatial data: socio-economics, demographics, other
- Numerical modeling: snowpack elevation changes, energy use / GHG emissions projections, other
- 3D modeling: digital elevation models, building models, tree / vegetation models

PRODUCTION enables the process + communicates the outputs

- Presentations
- 2D viz, including GIS maps, graphics
- Scenario storylines
- 3D visualizations; virtual globe models; animations
- 4D visualizations, showing change over time
- Other (sketches, posters, etc)
- Final visioning package: precedent imagery, sketches, charts and tables, visualizations (including mapping, 2D, 3D, and animations), and technical background materials

2.1.2 Climate change visioning is a process

10 STEPS in THREE PHASES

PHASE ONE, PARTICIPATORY SCENARIO BUILDING: initiate project, review local climate science, identify local priorities, develop scenarios

1. Convene Working Group or Team
2. Collect spatial and non-spatial baseline data for scenario development
3. Produce scenario development materials: maps + scenario frameworks
4. Scenario Development Workshop to select and define scenarios

PHASE TWO, DATA + MODELING: data collection/integration, viz development, review

5. Map, model and integrate land use, spatial impacts and response option data
6. Produce 2D mapping and 3D viz materials to flesh out the scenarios, for review
7. Data and Visualization Review Workshop

PHASE THREE, FULL VISIONING PACKAGE: data + viz refinement, materials production, community/stakeholder presentation

8. Refine and improve spatial and numerical data and modeling
9. Produce final mapping, viz, virtual globes, animations, and technical documents
10. Community Open House, other public engagement to review scenarios/options

NEXT STEPS: Dissemination + Implementation

10+ Further engagement, reports, assessment, policy development and implementation (eg. into strategic, financial, and asset management plans), evaluation, monitoring

In Phase One, the critical outcome is to build scenario frameworks based on local knowledge and localized climate science data that is linked to global climate science and emissions scenarios. Data gathering is preliminary, and includes local priorities and GIS baseline data such as orthophotos, land use (if possible), and socio-economic data. Visualization considerations include what software platforms could be used, which iconic landscapes or views could be represented, and how/where the final visualizations will be used.

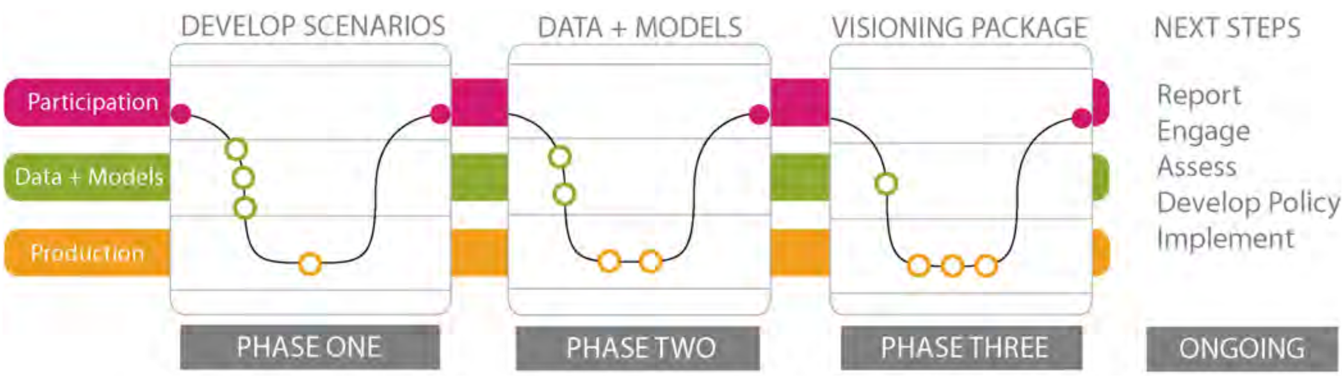
In Phase Two, the critical outcome is stakeholder/local review of the scenarios, data and preliminary visualizations. Spatial data gathering and modeling should be extensive, including local impacts and vulnerabilities, adaptation strategies, delineation of mitigation opportunities/options, and future land-use plans based on the scenarios, including a build-out plan for development. If possible, the data should be compiled in a GIS database. Preliminary visualizations are developed and tested, and the data and viz are reviewed at least once by local stakeholders, the working group, and/or community and council/board members.

In Phase Three, the critical outcome is production of a visioning package that is presented to stakeholders and the community. Spatial and numerical data are refined based on the visualization review, and visualization production is extensive. The full visioning package should include technical background material, with the option for assessment of scenarios.

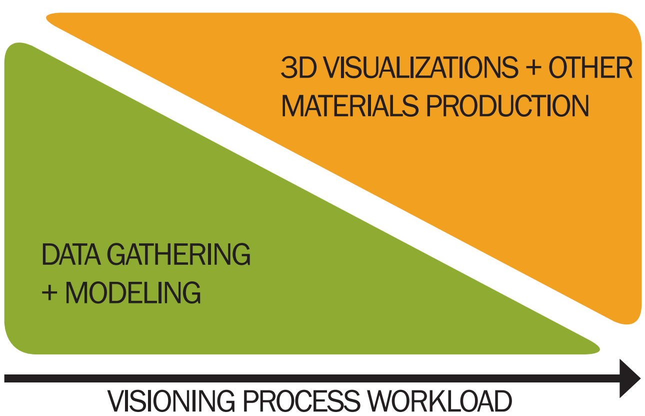
During **NEXT STEPS,** recommendations and reports are prepared for council/board, further presentations or community outreach and education can occur, and policy development begins for implementation. Next Steps depend upon local processes and policy needs, and may involve use or revision of key visioning material.

COMPONENTS, STEPS AND PHASES OCCUR IN AN ITERATIVE PROCESS

Phase Two in particular may be repeated several times



WORKLOAD:
The front end of the process is heavily loaded with data gathering. Early visualizations can begin while also doing data analysis and modeling. As the process moves forward, the workload shifts to predomimantly visualization production, so that by the end, producing visualizations and supporting materials continues, while the data gathering + modeling has been completed.



WORKING WITH OTHER PROCESSES

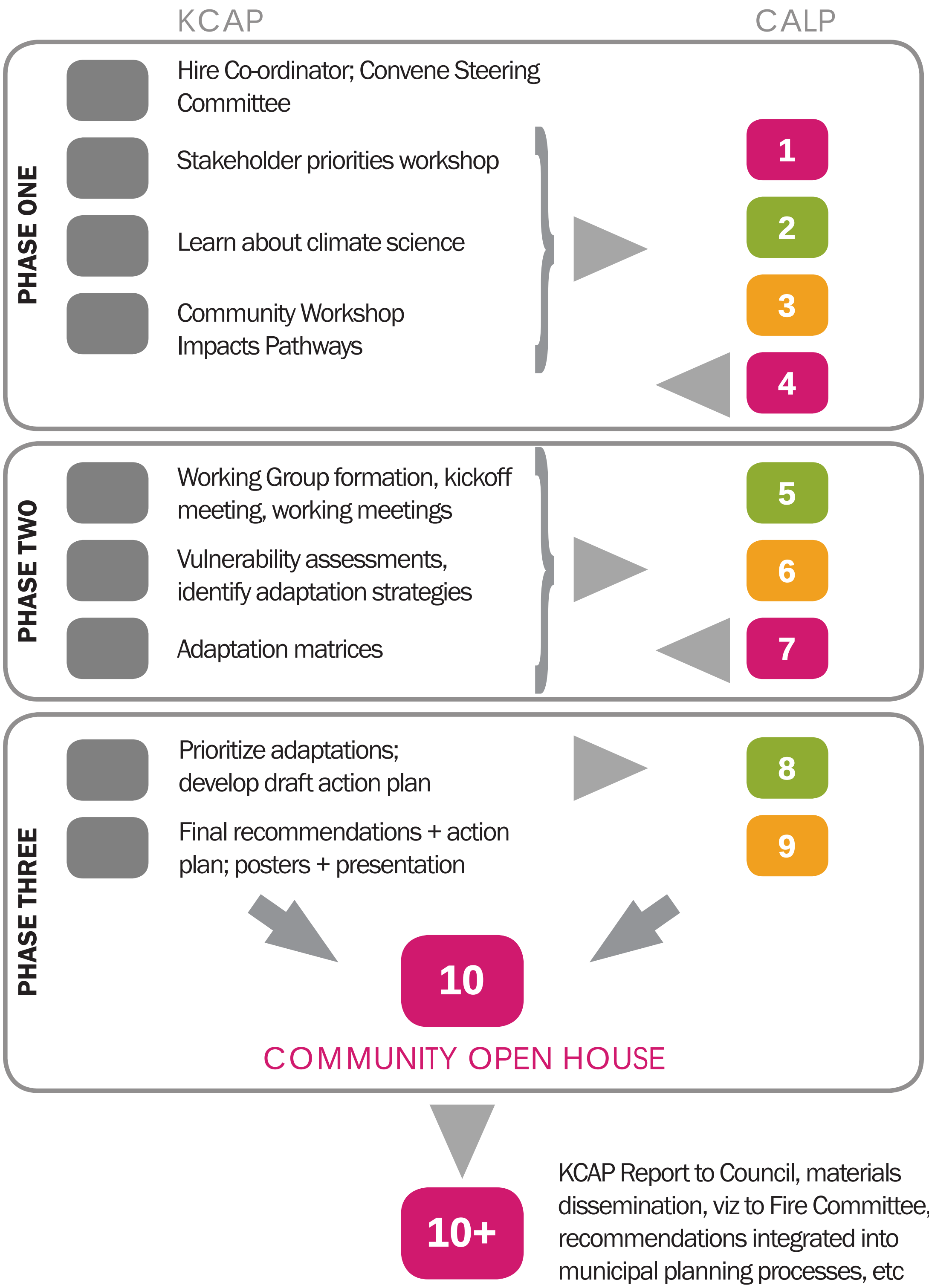
The Climate Change Visioning Process may be run in parallel to or integrated with other planning projects. For example, in Kimberley, visioning "piggy-backed" onto the CBT-funded community Climate Adaptation Project. The Columbia Basin Trust's "Six Steps to Successful Climate Change Adaptation Planning" (www.cbt.org/Initiatives/Climate_Change/) are:

1. Get started
2. Learn about climate change
3. Identify priorities
4. Assess vulnerabilities and risk
5. Develop adaptation strategies
6. Implement and monitor

In Kimberley, CBT Steps 2-5 provided community priorities and data to the visioning process and visualizations; the community project also had local working groups, and organized stakeholder and community events that structured the supporting visioning activities.

Example of visioning integrated with another process

The visioning process worked alongside the Kimberley Climate Adaptation Project (KCAP). Issues and priorities identified by KCAP fed into scenario development and data integration, while scenarios and visualizations supported KCAP working group processes. Joint workshops/open houses were held at Steps 4, 7 and 10.



The Kimberley Climate Adaptation Project Participatory Process Timeline

KCAP AND CALP EVENTS

The KCAP process was based on "Learn, Share, Plan": collaborative participatory events run by KCAP or CALP were critical to the project's outcomes and success.

Phase	Event	Date + Place	Participants	Topics
PHASE ONE: BUILD SCENARIOS	Stakeholder Workshop	June 2008 Kimberley	KCAP Coordinator, Steering Committee and Invited Local Stakeholders	Climate Change Introduction, Identifying and Prioritizing Impacts
	Community Workshop	October 2008 Kimberley	KCAP Steering Committee, CALP, PCIC, CBT Representatives, CBT Advisor, Community Members	Climate Change Introduction, Science, and Impacts Pathways Mapping
	Scenario Development Workshop	December 2008 UBC	CALP Team, KCAP Coordinator, City Planner, Community Representative, Selkirk Geospatial Representative	Scenario Building and Visualization Discussion
PHASE TWO: DATA + VIZ DEVELOPMENT	Working Groups Kickoff Meeting	February 2009 Kimberley	21 Local Stakeholders and Experts and CALP Team (via Skype)	Scenarios, Visualizations, and Themes Discussion
	Expert Visualization Review Workshop with three thematic groups	March 2009 Kimberley	CALP Team and approx. 30 experts from City staff, local and regional government agencies, private consultancies, CBT, KCAP Steering Committee members, Council members and the Mayor	Review and discussion of the scenarios, underlying data, and preliminary visualizations
PHASE THREE: VISUALIZATIONS	Community Open House	June 2009 Kimberley	KCAP Steering Committee, CALP Team, CBT, and over 40 members of the public and City of Kimberley staff and Council members	Presentation and Public Discussion of Project Findings and Outcomes

2.2.1 How do we develop scenarios?

Scenario development is undertaken as a group process, usually in one or more workshops that explore and develop a number of plausible alternatives or scenario storylines to "book-end" a range of futures. The scenarios are extrapolated from uncertain yet influential trends and driving forces (drivers).

The visioning process "downscales" broader climate change and other scenarios to the local community level. The scenarios are linked to local trends including land use and resource planning options. **Scenario frameworks** are developed in Phase One, and the scenarios are fleshed out, revised and updated through Phases Two and Three as the project database and knowledge increases.

Scenario development can be a complex process involving **drivers** such as local socio-economics, energy, population and other modeling by experts, integrated with the latest climate change projections. However, for smaller communities, a shorter participatory process with simpler prioritized themes may be enough to frame the visioning when detailed climate science and other futures modeling is not available.

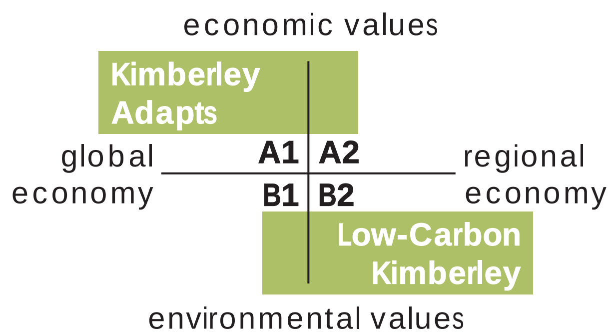
TWO SHORT-HAND APPROACHES to developing scenarios:

1. Use an **"off-the-shelf" framework** with a given set of emissions drivers, eg. IPCC, CALP (right) or Global Scenarios Group (pg 28). Then convene a scenarios development workshop to explore plausible projections for the community around a set of key drivers and trends, using available data (see 3.1, Steps 3 and 4). CALP's terminology "Worlds 1, 2, 3, and 4", and the visual icons (right), were developed for public presentations, and provide a useful shorthand way of communicating alternatives.

2. Use a **2-staged participatory format**:
A) A first session to define key drivers and trends;
B) A second session to develop plausible scenarios grounded in the drivers, trends and available data.

After scenario development, a next stage in the participatory format could include scenario discussion and evaluation, and the development of recommendations for implementation (see Steps 10 and 10+).

The **IPCC global emissions scenarios A1 to B2** and their key drivers: global vs regional trading blocs, and an emphasis on economy or environment. Kimberley Adapts assumed continuing high emissions (A1/A2), while Low-Carbon Kimberley assumed better than B1/B2 emissions.



CALP's "4 Worlds"[66] provide a framework based on the IPCC emissions scenarios, as well as the Global Scenarios Group (GSG) set.

World 1 (Do Nothing) has ongoing high emissions with high impacts;
World 2 (Adapt to Risk) is adaptation only;
World 3 (Efficient Development) is slow mitigation - not enough to stabilize climate - with adaptation;
World 4 (Deep Sustainability) has extensive and rapid mitigation that stabilizes climate, as well as minor adaptation.

CALP's work in MetroVancouver found that people accepted scenario frameworks, responding positively to the concept of different possible futures and the "4 world" icons.

The **Global Scenarios Group**, Stockholm Environmental Institute and others, use a narrative framework: three branches each with two possible pathways lead to six different possible future worlds[46].

CONVENTIONAL WORLDS
- Market Forces
- Policy Reform

BARBARIZATION
- Breakdown
- Fortress World

GREAT TRANSITIONS
- Eco-communalism
- Great Transition

HOW MANY SCENARIOS?

A minimum of two scenarios is required to show different pathways and options, with a recommended maximum of four for initial or resource-limited studies. How many and which scenarios are chosen will depend on the local planning process and community needs.

Having two scenarios - focusing on adaptation and mitigation respectively - allows for identification of conflicts and synergies; the combined scenarios can also help to develop holistic resilient plans for a community's future. Three scenarios allows for a "do-nothing" high impacts baseline scenario, an adaptation scenario, and a mitigation scenario; or, an adaptation, a mitigation, and a combined (or "resilient") scenario. Two scenarios may not offer enough choice, while three scenarios can suggest that the middle option (neither extreme) is the default best choice.

Four scenarios provides a range of pathways and more choices. Care must be taken to ensure that the scenarios are each well-rounded so that real comparison can be made. However, with fewer resources, fewer but better-built scenarios may be a preferred option. A final option could be a framework with two scenarios which show sub-variants - for example, an adaptation scenario may include two or three different adaptation strategies.

TIMEFRAME

Scenarios should look as far into the future as possible: further than current typical planning horizons. Climate projections usually go to the 2080s or the end of this century and provide a good end-date. Other data may not project that far and longer-term assumptions may have to be made. Using a set of timing points that correspond to planning horizons and long-term scenario planning can integrate the two. For example, 2020 and 2050 are common climate change planning horizons for GHG reductions targets, while going to 2080 allows the assessment of longer-term climate impacts, as well as for consideration of infrastructure lifetimes. Additionally, using an even shorter (2012, 2015) first timing point captures immediate climate change actions.

SPATIAL SCALE

It is important to work at a scale large enough to cover climate change impacts that happen in the surrounding landscape and affect the community, such as wildfire, or mountain pine beetle. A larger scale enables exploration of regional issues as well, including transportation planning. The neighbourhood level allows for visualization of specific options, such as firesmarting houses, flood adaptations, or adding district heat plants.

The chosen scale(s) depend upon local needs for visioning and planning; however, the projections and scenario concepts should usually cross scales - from the neighbourhood (if not the individual lot) to the community and the surrounding working landscape, including community watersheds, in order to capture crucial system-wide effects.

TIP

Where possible, link adaptation and mitigation scenarios to multiple planning objectives (eg. affordable housing, community economic development, community energy planning) to improve their robustness.

2.2.2 Scenario indicators and wildcards

ASSESSING scenarios is important in order to make choices about which pathway a community wishes to follow, and developing and operationalizing recommendations. Assessment may occur in Step 10, or in Next Steps, 10+; however, assessment methods should be discussed during scenario development (Step 4), and preliminary indicators chosen. Assessment may use methods such as multi-criteria assessment (MCA)[32] or Strengths/Weaknesses/Opportunities/Threats (SWOT analysis).

INDICATORS are one important way to measure differences and potential performance across scenarios. For climate change planning, whether adaptation or mitigation or both, **GHG emissions are a key and critical indicator**. Other indicators may be developed locally. See, for example, Girling et al 2006[31] on the use of indicators in participatory processes/charettes; or Sheppard et al 2009[33] for a discussion of possible resilience and low-carbon indicators.

Land use planning can provide key indicators of lower or higher carbon communities[23]: compact communities with smaller building sizes and shorter travel distances (with the potential for fewer vehicle and more biking/walking trips) have lower emissions than sprawling developments. Distinguishing between different land use plans should be part of scenario development.

TIP
It is important to remain flexible when developing local scenarios - a lack of data may hamper efforts to paint a complete local picture; however, asking "what-if" questions, and showing multiple pathways and options, are valuable tools in planning for resiliency in an uncertain and changing climate future. Be ready to make and record logical assumptions when data is missing.

WILDCARDS are another tool to test scenarios[30]. Wildcards are potential drivers or emerging trends that have **high uncertainty / low probability but potentially large impacts** if they were to occur. Wildcards often lack projected evidence or quantitative models, and are therefore difficult to incorporate into planning and forecast/backcast scenarios. Examples of wildcards are peak oil, loss of food security, or a combination of "worst case" events ocuring at the same time.

Wildcards can be used in developing exploratory scenarios, and one of their best uses is to "test" and modify existing scenarios. For example, while a sprawling new development may have design guidelines to ensure adaptation to wildfire risk, how would the development respond to peak oil? Scenarios may similarly be assessed by asking what-if wildcard questions.

Wildcards enable citizens, stakeholders, and decision-makers to grapple with issues such as peak oil or environmental migrants, and consider the consequences. Wildcards enable an engagement process to capture issues not usually on the radar in terms of planning time frames, and ensure that planning for contingencies now does not impede handling of less well predicted contingencies in the future.

Wildcards are useful as a way to identify limits to our current knowledge, and provide placeholders to consider very real concerns held by citizens about possible future vulnerabilities. Their consideration could lead to improved adaptive capacity as they allow for examination of future conditions normally seen as outside the realm of the possible, yet ones that could potentially have devastating impacts were they to occur.

2.3.1 How do we do visualizations?

Visualizations can be developed as stand-alone products from existing GIS data, or can be embedded in visioning planning processes using iterative development and review. The visioning process sources and integrates data, local knowledge, and priorities, and develops scenarios to frame the visualizations. Visualizations verify scientific modeling data, allow for review, and communicate issues, strategies and options. The participatory nature of visioning ensures local input to the vizualizations, and high credibility of both science and visual images with community members and stakeholders.

HOW TO CHOOSE WHICH VISUALIZATION TYPE?
Visualization choice will depend upon effectively balancing available data, time, expertise, budget, and the type of audience and desired messages. Key considerations include:

Message/data?

- What are you trying to communicate? Maps? Complex changes in local landscapes? One particular issue, or an inter-related set of issues?
- What **existing data** do you have? How much data are you integrating?

Single spatial data sets, for example historical fire maps, work well as 3D drapes in a virtual globe. Although complex information can be layered in virtual globes, full 3D landscape modeling is better for user comprehension of complex landscape interactions.

Audience?

Experts usually are comfortable working with GIS maps, while non-experts tend to prefer 3D visualizations if they are clear and easy to use (see Appendix 4.3).

Other important considerations:

- Are you producing one-time fixed-use products, or an ongoing 3D digital resource for multiple applications?
- What **SCALE** are you working at?
- How much **TIME** do you have?
- What **RESOURCES** (money, staff, knowledge base) do you have?

IMPLEMENTATION + HUMAN RESOURCES will impact the choice of visualization tools. Generally, as visualizations progress from simple to more complex, both in data sourcing/integration and 3D visual production ((i.e. from 2D maps to photorealistic 3D, see also Figure 6), the time and costs will increase. Such costs also depend upon the skills of those producing the visualizations.

2D maps, 3D GIS models (eg. 3D Analyst + ArcScene) and exports to **3D virtual globes** used to enhance comprehension of mapped data are relatively straightforward and could be done by local GIS experts.

2D photo-editing techniques, to portray before and after scenes, could be done by laypeople; however, more realistic imagery done quickly requires skilled practitioners.

Semi-realistic 3D city massing models as a baseline for the current community, to show alternative development options, risk and responses including emissions reductions, could be done by GIS staff with some additional training in CommunityViz/Sketchup/GoogleEarth Pro.

Photorealistic 3D renditions of iconic landscapes, including detailed 3D city or neighbourhood models with colours and textures, vegetation, and scenarios require expert staff using complex 3D modeling and rendering softwares, such as the open source landscape renderer Biosphere 3D[54, 55], or Visual Nature Studio.

ETHICAL ISSUES: graphic communication skills, ethical visualizations, transparency in data sources and caveats are all critical to avoid misleading the public and decision-makers. Appendix 4.2 provides a recommended code of ethics to guide production of transparent, defensible visualizations.

2.3.2 Visualization workflow

The **BASIC WORKFLOW** for georeferenced visualizations (ones that are based on maps), is as follows: ArcGIS serves as the platform for collecting geodata, modeling, and local data/knowledge inputs. Visualization production is done in GoogleEarth, Biosphere 3D, Visual Nature Studio, or other software platforms, possibly with Sketchup and Community Viz providing content along the way (Figure 7).

As software is constantly evolving, the actual programs used may vary, but the workflow of data and models through a shared platform to a visual output remains similar.

The novelty of the shared platform approach is that visualizations of scenario drivers and scenario narratives can be aggregated in an interactive, multi-dimensional and comprehensive 3D landscape model as the principal medium for communication.

Non-georeferenced (non-mapped data) visualizations may be produced using stand-alone software. Photos often provide reference material, and mapped data can be interpreted for manual photo-editing. Photoshop uses photos of existing conditons as a base, while Sketchup allows 3D modeling of building or neighbourhood scale views.

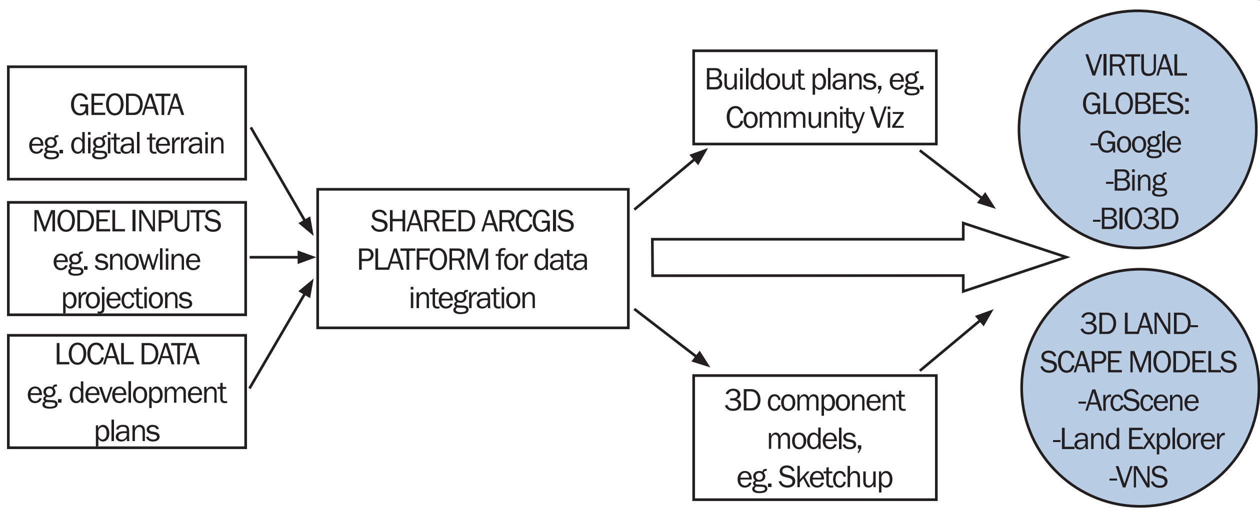


Figure 7. GEO-REFERENCED WORKFLOW. Data inputs are integrated in a GIS database, and then visualizations are produced using the georeferenced data in a virtual globe such as Google Earth, or the more sophisticated open source Biosphere 3D, or other 3D landscape modeling software such as Visual Nature Studio. Community Viz and Sketchup can produce 3D buildings and other landscape components (adapted from Schroth et al 2009[65]).

TIP
Georeferencing your Sketchup model prior to beginning 3D work, by importing a geo-referenced GIS base layer, will allow you to export finished material into GoogleEarth, GIS, or other geo-platforms, more smoothly.

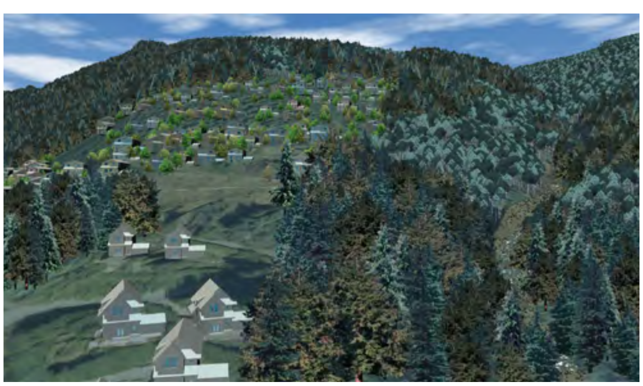
High-end 3D visualizations with scientifically-based photorealism are capable of illustrating complex landscape interactions, including integration across impacts and adaptation and mitigation strategies. They also provide the most flexibility in showing "on-the-ground" views accurately, require complex inputs and skilled practitioners, and can make use of increasingly available engineering datasets such as LiDAR.

2.3.3 Examples of different types of visualizations

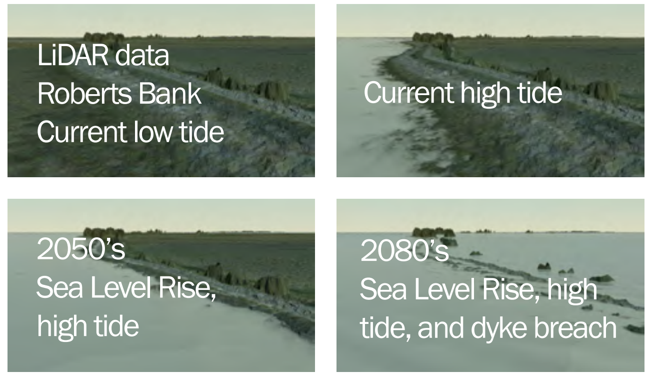
1. GEO-REFERENCED, SINGLE DATA LAYER OUTPUTS (GIS data in GoogleEarth)

2. GEO-REFERENCED, SINGLE MODEL DATA, SHOWN OVER TIME: each colour comes on as a new layer using a time slider (GIS data in GoogleEarth)

3. GEO-REFERENCED, MULTIPLE VARIABLES North Shore with blow-down, pests, and diseases (GIS, Sketchup, VNS)



4. GEO-REFERENCED, MULTIPLE VARIABLES AND CHANGE OVER TIME (LiDAR, VNS)



5. NON GEO-REFERENCED, 2D PRE AND POST IMAGES - "cartoon" of mitigation options

6. NON GEO-REFERENCED, 3D PRE AND POST IMAGES, firesmart actions (Sketchup)

7. NON-SPATIAL, GRAPHIC COMMUNICATION OF CHANGE OVER TIME (FIRE SEASONS)

Image credits: 1, 2 Schroth/CALP using GoogleEarth; 3, 4, 5 Flanders/CALP; 6 Miller/CALP ; 7 Pond/CALP.

SECTION 3
THE VISIONING PROCESS
10 Steps in Three Phases

3.1 PHASE ONE: Participatory scenario building

- **STEP 1** Convene working group or team
- **STEP 2** Gather baseline data
- **STEP 3** Produce scenario workshop materials
- **STEP 4** Scenario development workshop

3.2 PHASE TWO: Data and modeling

- **STEP 5** Data analysis, generation, and modeling
- **STEP 6** 2D mapping and 3D visualizations
- **STEP 7** Review workshop

3.3 PHASE THREE: Final visioning package

- **STEP 8** Refined data and modeling
- **STEP 9** Visioning package production
- **STEP 10** Community engagement

3.4 NEXT STEPS

- **STEP 10+** Dissemination, assessment, implementation

3.5 MEETING CHALLENGES

PHASE ONE
PARTICIPATORY SCENARIO BUILDING

STEP 1 CONVENE WORKING GROUP OR TEAM

STEP 2 GATHER BASELINE DATA

STEP 3 PRODUCE SCENARIO WORKSHOP MATERIALS

STEP 4 SCENARIO DEVELOPMENT WORKSHOP

In Phase One, the critical outcome is to build scenario frameworks based on local knowledge and localized climate science data that is linked to global climate science and emissions scenarios. Data gathering is preliminary, and includes local priorities and GIS baseline data such as orthophotos, land use (if possible), and socio-economic data. Visualization considerations include what software platforms could be used, which iconic landscapes or views could be represented, and how/where the final visualizations will be used.


LAND USE MAP


PARTICIPATORY SCENARIO BUILDING

1 Convene working group or team

Relationship building is critical to project success.

Climate change visioning crosses disciplinary boundaries (silos) by bringing a wide range of people to the table in order to integrate multiple forms of knowledge into holistic alternatives, engage the community, and support decision-making. Therefore, **a broad set of participants** (experts, consultants, Working Group members, etc) will ensure credible data, successful and engaging visualizations, and visioning uptake into local planning and decision-making.

MEMBERS:

Visioning working groups should have approx. 6 to 12 members drawn from:

- Scientific team, including climate change and energy experts, and other local experts
- Viz team (may overlap with scientific team)
- Local officials: elected representatives, planners, engineers, operations, other staff such as economic development officers (these are key people to have engaged, particularly for implementation)
- Local community members and reps of community organizations; local educators
- Other stakeholders, including youth and business

If the visioning is running concurrently with a related process such as OCP review, adaptation or sustainability planning, etc., the visioning working group should include members from these processes.

A local project co-ordinator is essential, either to run the visioning process, or to provide local support for external visioning experts (consultant, college/ university, other).

Participatory events during Step 1 may include: Start-up meetings; meetings with Council/Board, and/or stakeholder workshops and community open houses or workshops to identify local priorities; meetings with or presentations by climate scientists to explain local projections and possible impacts.

TIP

At the first working group meeting, identify local climate change causes, issues and impacts, and roughly outline any adaptation and mitigation responses already under consideration. Identify sources of data & share resources. Decide on how to communicate with each other; consider using online tools such as social media to stay connected and share information.

Understanding Local Issues, Setting priorities

- Use meetings with Council/Board, community members and others to ask about local viewscapes, concerns, vulnerabilities, assets, current plans and policies, and priorities for the community.

- Be flexible. Understanding local climate change impacts and response options is a learning process for everyone. For example, in Kimberley, the viz team initially thought that the ski hill and changing snowlines would be THE iconic visual. However, a combination of difficulties with snowpack data and learning about vulnerabilities that were less “on the radar” at the beginning of the project, meant that the focus shifted during the project to forests and wildfire.

- Consider spatial scales: at what scale can you tell which story? Watershed, regional, municipality, neighbourhood, street?

TIP

Providing good local food at Open Houses, meetings and other community events shows appreciation to people for engaging and encourages further participation.

1

Draw on local, regional and other experts, and establish links with outside climate change experts and other data and process providers.

Because climate change visioning requires a range of knowledge bases and expertise (Figure 8), having a Working Group with a broad base of expertise can help to fill some of these needs. You may also consider establishing a formal agency / specialist working group or Advisory Committee at the project onset with local, regional, and provincial representation. Such expertise can offer specialised data and knowledge to the process and contribute to scenario development and evaluation. University researchers may also offer expertise, including evaluating the process.

Local/Regional Resources to draw on include:

- Regional district boards and municipal councils, staff; consultants; engaged community members; Chamber of Commerce and Tourism Boards; CBT Advisory Committees (through adaptation projects); regional GIS resources at colleges/universities; the Fraser Basin Council's sustainability facilitators

Provincial/Federal Resources to draw on:

- Pacific Climate Impacts Consortium (PCIC) and their publically available materials (http://pacificclimate.org/)
- Climate Action Secretariat, Ministry of Environment (MOE); Integrated Land Management Bureau (ILMB); Ministry of Forests (MOF)
- Adaptation experts at Environment Canada
- Natural Resources Canada

The Kimberley Climate Adaptation project identified these organizations to have representation on the Steering Committee:

Chamber of Commerce; Resorts of the Canadian Rockies; City Planner; SPARK Youth Society; City Councillors; Tourism Kimberley; College of the Rockies; Wildsight (Environmental Organization); Nature Park Society; Nordic Club; CBT Advisory Committee

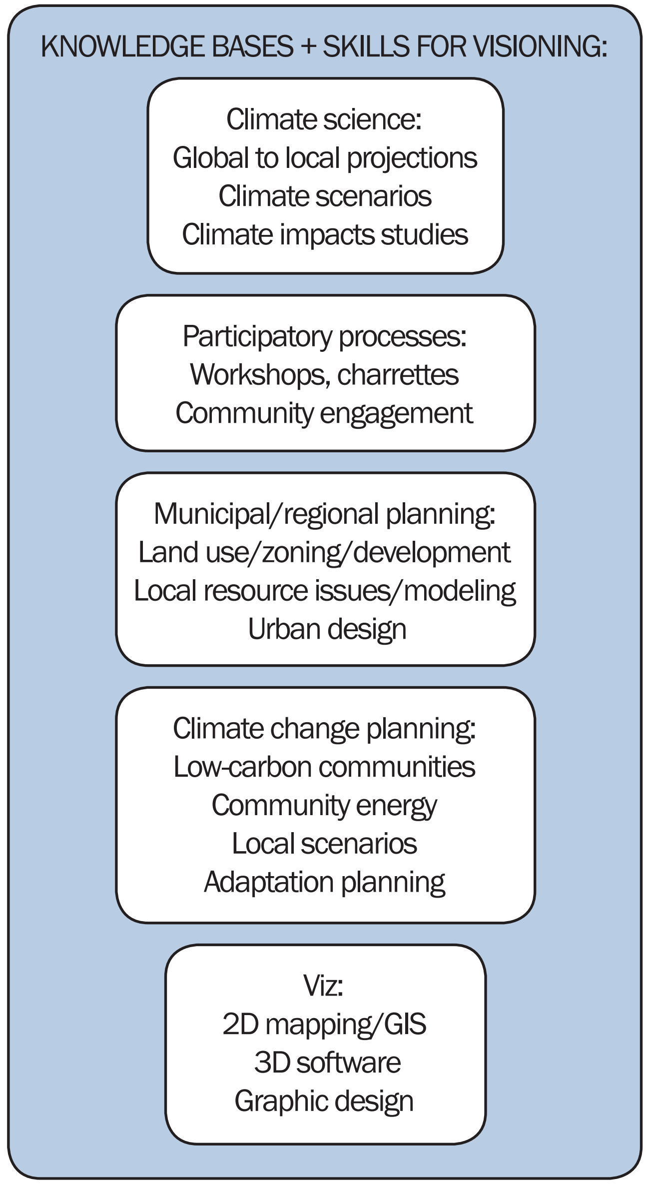


Figure 8. Climate change visioning integrates many knowledge bases and skill sets.

1

Work with community processes.

Visioning can be a stand-alone process for "test-driving" policy options before a formal binding process, with outcomes integrated into future community plans and engagement such as an Official Community Plan (OCP) review.

As well, visioning may be integrated into or run in parallel with other community planning processes, including:

Local government-driven planning

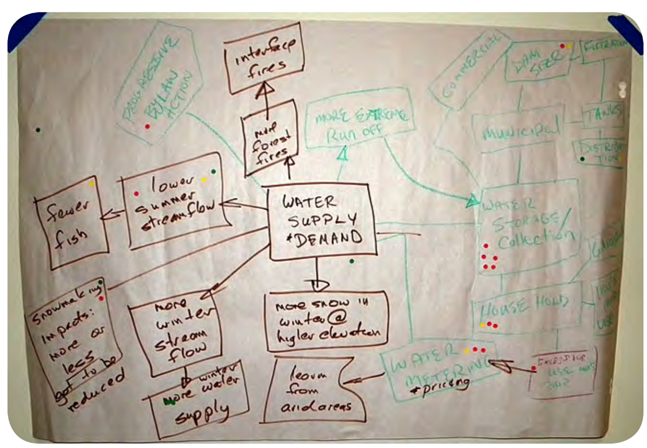
- Official Community Plan (OCP) reviews
- Neighbourhood and area plan reviews
- Regional Growth Strategies (RGS)
- Mitigation planning, eg. as required by the "Green Communities" Act (Bill 27, 2008)[17] that obliges local governments to include targets, policies and actions for GHG reductions in OCPs and RGSs
- Climate Action or Climate Protection Plans
- Adaptation planning, including vulnerability and risk assessments
- Community energy planning (CEP)
- Downtown revitalization plans; tourism/cultural plans
- Community economic development (CED) plans
- Sustainability Strategy, Strategic Vision or Plan, or Integrated Community Sustainability Plan (ICSP)
- Development Permit Area (DPA) guidelines review, to address energy performance, community character, etc.
- Strategic, financial and asset management planning

Bringing a wide range of community members together builds local adaptive capacity through cross-disciplinary social networks.

Community-driven initiatives

Community initiatives may be spear-headed by community members and local organizations. They may not be official, although they can transition to plans adopted by Councils and Regional District Boards. Examples include:

- The volunteer West Vancouver Climate Action Working Group has developed the municipality's Climate Action Plan, with adoption by Council
- Transition Towns[38] deal with peak oil and climate change through re-localization and grassroots energy descent planning and action. They started in the UK and have spread around the world: www.transitiontowns.org/



Kimberley Climate Adaptation Project, Community Impacts Pathways Mapping Workshop

2 Gather baseline data

To build a holistic picture of your current community

The purpose of Step 2 is to understand the current community, as well as relevant climate change projections, impacts, and GHG emissions sources. Step 2 may begin after Step 1, or as soon as the working group is set up and the project begins. Community issues and priorities should be identified during the participatory events of Step 1.

Data gathering and integration into a GIS (Geographic Information System) platform is critical to scenario building, participatory mapping, and visualization production. For Phase One, focus on gathering readily available baseline data, understanding projected climate change impacts, and exploring initial adaptation and mitigation options.

BASELINE DATA includes:

2D (spatial)

- Community (municipality or regional district) GIS/ cadastral (property lines) data - some data may be available as CAD (Computer Aided Drafting software) and will require conversion to GIS
- Orthophotos (georeferenced aerial photos, in GIS)
- Policy and planning maps including current land use in GIS, and zoning if available
- TRIM (Terrain Resource Information Management) GIS data - eg. contours, roads, railways, waterways
- VRI (Vegetation Resource Index), eg. forest polygons
- ALR (Agricultural Land Reserve) if applicable
- Community Watersheds
- Additional data relevant to your community, eg. soils mapping, historical features, geotechnical data

If you do not have GIS data, you can use Google Earth - however, printing large maps is difficult. Without GIS, you will be limited throughout the project to what is available in GoogleEarth, Photoshop and non-georeferenced visualizations - full city models and the larger landscape visualizations will not be possible.

Non-Spatial / numerical data

- Census data: demographics, including population growth/loss
- Land use trends or projections; land values trends
- Other economic data (resource base, jobs, etc)
- Transportation data if available (# of trips per day, trip diaries/destinations, etc)
- Energy use
- GHG emissions (the CEEI emissions inventory provides baselines: www.env.gov.bc.ca/epd/climate/ceei/index.htm)
- Background Reports: flood risk, watershed, wildfire, mountain pine beetle, economic development. Use data that is as local as possible, regional and provincial data may also be helpful. These may also be compiled in Step 5.

Data sources include: Municipalities, Regional Districts, college/university geospatial research centres, ILMB (BC government), Environment Canada, Natural Resources Canada, other local data (eg. Teck Cominco supplied high quality orthophotos to the Kimberley project); Census Canada; and, prior community engagement processes.

GIS data sources: A good starting point: http://gis.ubc.ca/; Provincial: http://geobc.gov.bc.ca/ (click on download) or https://apps.gov.bc.ca/pub/dwds/home.so; Federal: http://geobase.ca/.

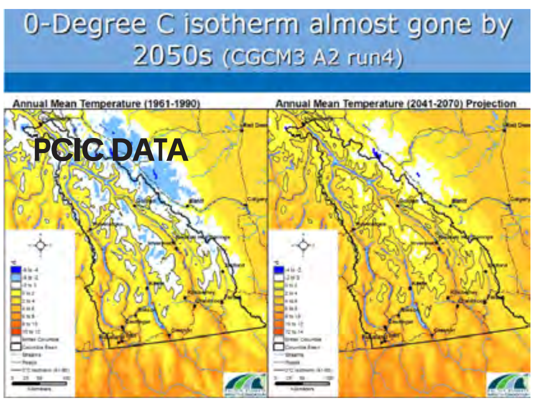
Energy information sources

- Comprehensive energy demand tables: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0
- Solar radiation data, available for each municipality through NRCAN (https://glfc.cfsnet.nfis.org/mapserver/pv/index_e.php)
- Solar photovoltaics (electrical) calculations: www.pvwatts.org/
- Wind resources www.windatlas.ca/en/index.php

2

Climate science and Impacts Studies

The Working Group and Viz teams need to familiarize themselves with the available localized climate science and climate change projections. PCIC (http://pacificclimate.org/) is a good source for data, if they are not already engaged in your process. The Regional Analysis Tool lets you build climate projection maps to explore regional results from Global Climate Models (http://pacificclimate.org/tools/select), while their PLAN2ADAPT website provides "planning ready" material (http://plan2adapt.ca/). Historical climate data is also available through PCIC, Environment Canada, and provincial government sources (eg. snow station data).



3D Modeling

• You may want to experiment with exporting some of your simple data - such as land parcels - into Google Earth, Land Explorer, Biosphere 3D or other, and begin working with the Viz team on the 2D to 3D workflow and possible outputs.

TIP

Think "spatially" as early as possible. Visualizations require spatial or "picture" data, so introduce maps and orthophotos as early as possible into community processes in order to build the capacity for spatial thinking and planning.

Photo Narrative (optional)

Photo libraries are useful to help outside experts learn about the community. They also provide image resources to the viz team.

Use a field tour to photograph iconic views and important places, important buildings and those representing local character, commercial / tourism areas, other community assets, and locations of potential local impacts.

If possible, georeference the photos using GPS and available software - the photos can be added as a layer into GIS or GoogleEarth.

Data sharing agreements with Regional Districts, municipalities, or other data providers, may be required and provide for privacy protection.

Metadata

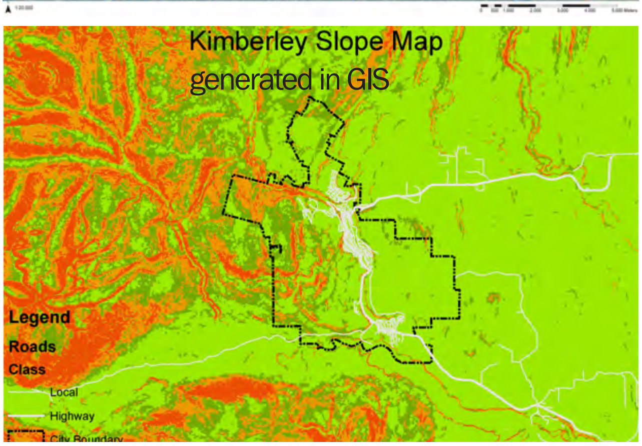
As the data is collected, develop a "Data Pedigree" (outlining the accuracy, data source, time, organisation, coordinate system, projection) for each piece of data; include a metadata template (text document) that outlines all steps that led to the current data so that it is reproducible. Archive a copy of original GIS data to preserve the set - make working copies for analysis, editing, and mapping.

3 Produce materials for scenarios workshop

Step 3 prepares materials for a Scenarios Workshop. Based on the data gathered in Step 2, you should be able to produce:

- Basemaps, both aerial and of land use, in GIS
- Community overview, including:
  - Municipal/regional GHG emissions
  - Census and population data
  - Climate change science, as localized as possible, with temperature and other projections
  - Community priorities, if identified in Step 1, and mapped if possible

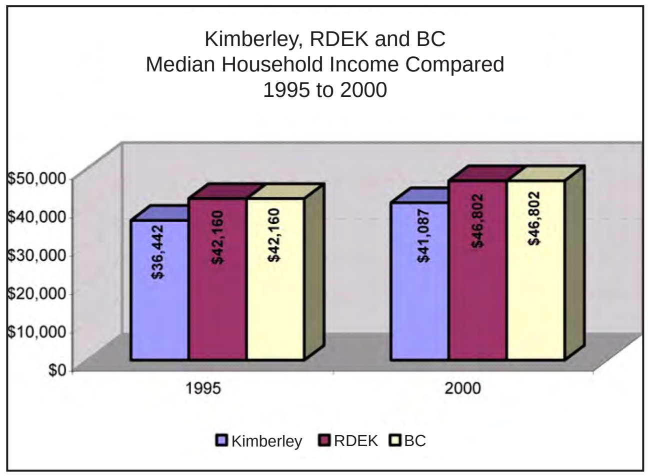
EXAMPLES of base maps, demographic data, and land use stats:



Demographic data, source: Census Canada

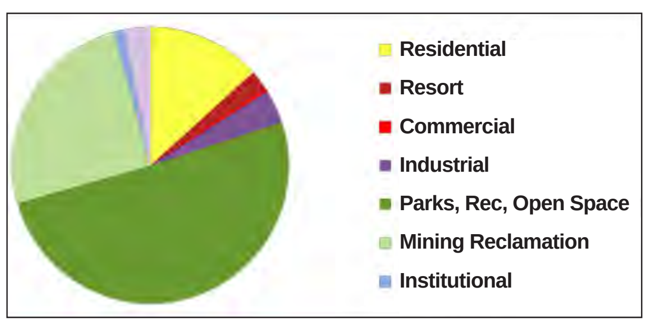
AGE COHORTS	KIMBERLEY	BC
0-19	20	23
20-29	9	12
30-44	20	21
45-64	21	28
65+	31	15
75+	10	7

Income data, source: Real Estate Foundation, 2006[14].



Land use stats, source: City of Kimberley

	Ha	% Total
Residential	761	13.26%
Resort	137	2.39%
Commercial	17	0.30%
Industrial	229	3.99%
Parks, Rec & Open Space	2907	50.65%
Mining Reclamation	1442	25.13%
Institutional	67	1.17%
Other	179	3.12%



3

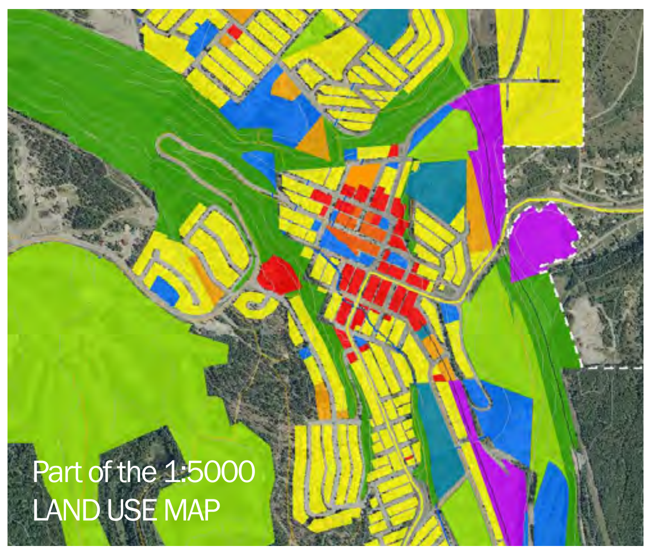
The materials that you may need to produce for the scenarios workshop include:

PRESENTATIONS or a **DESIGN BRIEF** to bring everyone up to speed on the material and data to date:
• Local climate science: historical and projections
• Vulnerability and risk assessments, if available
• Local GHG emissions data
• Socio-economic background material (census, local economic drivers, other as necessary)
• Land use material: maps and statistics
• Presentation of photos if not all participants (eg. Viz team) are familiar with the community
• An overview of the scenarios' drivers (if you are using an established framework) and what you are trying to achieve during the workshop
• Background material about possible drivers, if you are using a collaborative workshop to determine them

BASE MAPS including:
• Orthophoto maps of the community at 1:5000 or 1:10,000, depending on the size of the area and the desired size of the map. The 1:5000 is useful for more conceptual viewing and designing,, while the 1:10,000 (or other depending on community size) should show the full community. For neighbourhood design, use 1:2000 or 1:1000.
• Land use maps at the same scale as the orthophoto maps.
• A context orthophoto map at 1:20,000 or other appropriate scale to show the surrounding landscape. Include at least the community watersheds, if possible.

Base maps should be of a size that a group can work with them on a table: 3'x 4' is a reasonable size. Have copies for each small group (1 set/scenario table).

SCENARIO WORKSHEETS
• See pages 45-48 for examples
• Optional: icons, or visual graphics, to aid in scenario development (see right for examples)



Kimberley's land use map used converted city CAD data in GIS, and simplified the land use categories for ease of comprehension and use by a wide variety of people. Conventional land use classification colours were used.

Example icons for scenario workshops

Icon credit: Dagmar Wandinger

4 Scenarios development workshop

GOALS

• Development of two to four localized scenarios or alternative pathways, within a global emissions scenarios framework and localized storylines (it is important to give participants permission to be expansive in their thinking)
• Mapped or diagrammed adaptation and mitigation options
• Determination of data needs to move forward with visualizations of scenarios, impacts, and response options

PARTICIPANTS

• Local representatives from the Working Group, Steering Committee or other organizational body: include local planners, community members, and the local project co-ordinator
• The project's Working Group members
• Outside experts in: climate science, and/or community mitigation strategies, and/or adaptation planning
• The workshop team (may be drawn from Working Group members)

WORKSHOP FORMAT

The format will depend on whether you have a single step or two-step process (see Section 2.2.1). **How many scenarios** should be determined prior to the workshop, determined by the project's goals and resources.

The workshop format may include:

• Presentations: overview of community; key issues and identified priorities; localized climate science projections; other adaptation + mitigation options
• Small group sessions to develop scenarios using flipcharts and mapping/diagrams
• Reporting back to the whole group
• Determination of next steps: data needs, possible visualizations, further scenario refinement
• Optional (recommended): identification of wildcards
• Optional (recommended): choose indicators to measure the different scenarios for future assessment

How long should it take?

• Ideally, 1-2 days (for a two-step process, 2 days is necessary); or it could be done in one morning or afternoon session

MATERIALS

• Table-sized maps (as in Step 3); worksheets
• Local climate projections; localized impacts as known; local adaptation and mitigation strategies as known - in overview presentations or other formats
• Pens, tracing paper, flipcharts (1 set per group)

ROLES

• 1 facilitator for each scenario group; 1 note-taker per group; 1 or 2 presenters for introduction and overview.

TIP

The mitigation scenario should at the minimum address:

• reducing emissions through better land use including compact new development and infill development; reducing building emissions through efficiencies and better building practices
• renewable energy supply (whether local, regional or other)
• transportation options including alternative transportation modes and fuel switching

4

OUTPUTS
Images (conceptual drawings / mapping) and write-ups, including:

- The "bones" of the scenarios (number, range, and timeframe), with key distinguishing differences across them; the scenarios should tie to local land use and resource use where applicable
- Quantitative and qualitative local drivers described (in words, numbers, or pictures); acknowledged omissions and limitations
- List of desired indicators
- Drawings of actions/strategies/changes to the community including preliminary adaptation and mitigation options, and other actions depending on scenario definition
- Summary of key local drivers, potential climate change impacts, possible adaptation options, possible mitigation strategies
- Identification of data needs and initial visualization ideas

SCENARIO REFINEMENT
Scenarios are "living" documents that will be fleshed out throughout the project as more data is gathered and generated, and local knowledge integrated. The core drivers should hold, but the details will likely change, especially the impacts and adaptation options. Initial scenario development should be reviewed and refined by climate scientists and those with expertise in adaptation and mitigation; a local scenarios group, if deemed necessary to add more local oversight than provided at the workshop; and, the Working Group and visualization team as the project progresses.

See 10+, NEXT STEPS, for additional discussion about using further community engagement to choose the preferred adaptation and mitigation actions that together would lead to a "Robust and Resilient" (integrated adaptation and mitigation) community scenario. The "Green Ribbon Vision" for Kimberley, shown in the Case Study, suggests a conceptual vision to begin the "Robust and Resilient" conversation.

GHG Emissions are an important indicator that should be used to assess the different scenarios. Other indicators that could be used to compare across scenarios include adaptive capacity (by vulnerability, social capacity, or other); how well the scenario would respond to "what if" wildcards; and indicators important to the community (eg., water use per person). Indicators provide an opportunity to measure multiple benefits within an adaptation and mitigation framework.

TIP
Local community plans and studies, such as economic development plans or market studies, can provide valuable socio-economic background information for scenario building.

4 Examples of scenario workshop outputs

CASE STUDY EXAMPLE

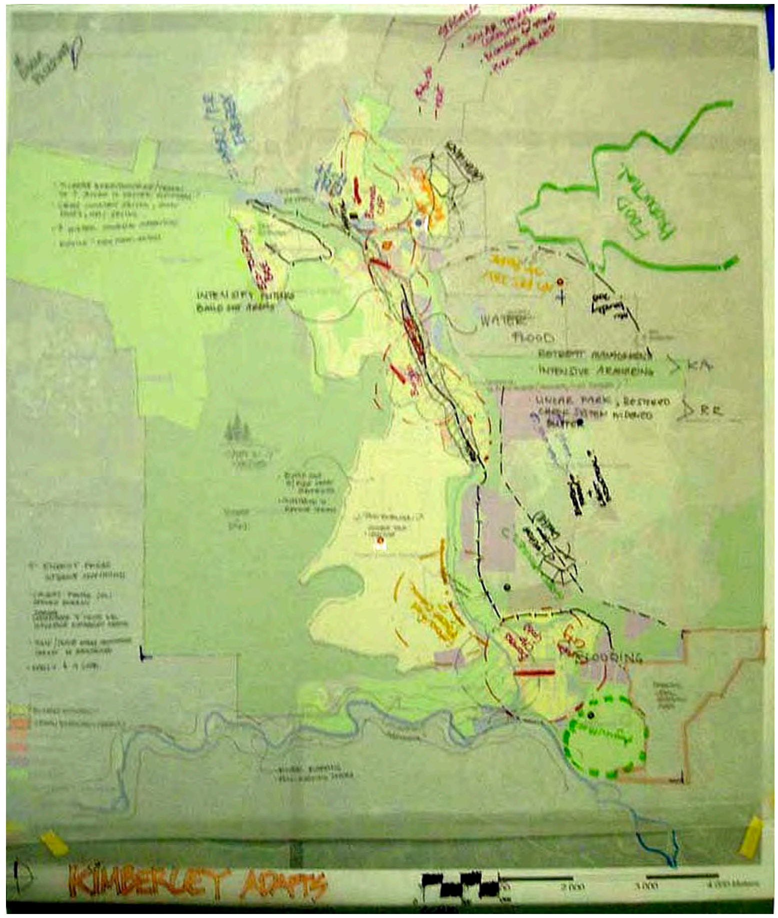
Outputs from the Kimberley scenarios workshop included drawings as well as completed worksheets:

KIMBERLEY ADAPTS

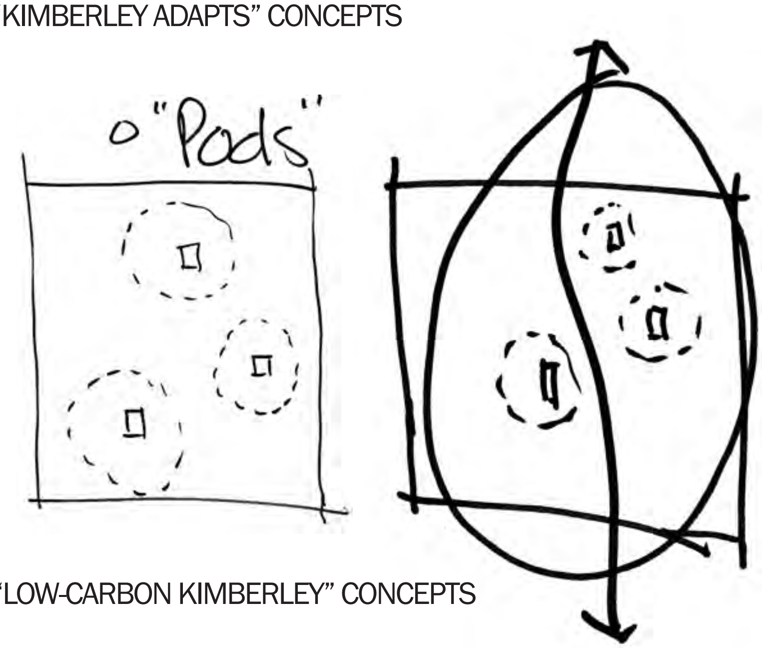
• Large trace drawings drawn over existing landuse maps identified potential adaptation options including flood adaptation zones, concepts for ski/tourism adaptations, and localized food production. Such early concepts were later refined as more data became available. For example, the flood adaptation areas shifted as the most vulnerable areas were identified. However, the concept that flood adaptation could be necessary was already "in the picture".

LOW-CARBON KIMBERLEY

• Concept sketches for Low-Carbon Kimberley conceived of multiple scales for renewable energy, starting with individual house retrofits for high efficiency wood stoves and solar thermal systems, using hot water as a heat carrier. Such houses could later be tied into compact district heating systems fuelled by local wood. The compact neighbourhoods could be connected by express buses or light rail that link to other communities.



"KIMBERLEY ADAPTS" CONCEPTS



"LOW-CARBON KIMBERLEY" CONCEPTS

Sample Scenarios Workshop Agenda

City of Kimberley's Climate Change Visioning Pilot and Regional Template:

Exploring Scenarios Workshop
Thursday, December 11, 2008 – Agenda

9.00 - 9.30	**Coffee, muffin, Check In and Qualitative Questions Session.**
9.30 - 10.00	**Welcome & Project Overview.** Presentation about the purpose, scope and background information about Kimberley, and today's agenda.
10.00 – 10.30	**Framing the Scenarios.** Presentation on the framework for proposed Scenario 1: *Kimberley Adapts* and Scenario 2: *A Robust & Resilient Kimberley*.
10.30 - 10.35	**Break and Regroup.** Group divides into 2 scenario teams: Kimberley Adapts and Robust & Resilient.
10.35 – 12.15	**Team One: Kimberley Adapts.** KA team "talks and doodles" about climate change impacts and adaptations Kimberley faces given current trends of growth and development to 2100. **Desired Outputs:** 1. Summary of key drivers, impacts, and proposed adaptations (2-3 for each impact) 2. Diagram(s)/map(s) of impacts and adaptations 3. Expanded scenario storyline (based on scenario template) 4. Additional data needs **Team Two: A Robust & Resilient Kimberley.** RR team "talks and doodles" about climate change adaptation and mitigation strategies for Kimberley to become a "robust and resilient" community by 2100. **Desired Outputs:** 1. Summary of key drivers, mitigation and adaptation strategies 2. Diagram(s)/map(s) of mitigation and adaptation strategies 3. Expanded scenario storyline (based on scenario template) 4. Additional data needs
12.15 – 12:30	**Report Back.** Each team takes 5 to 10 minutes to summarize their discussion and present key strategies.
12:30 - 1:00	**Lunch.** Presentation on Entleburch, Switzerland

1.00 – 2.30 **Diagrams and Mapping (participation optional).** Project team breaks into two groups (KA and RR) to refine, collate and map, by +hand and with GIS, the morning discussions. Groups also provide a brief narrative to describe each scenario.

Desired Outputs:

1. Refined set of drivers, mitigation and adaptation strategies
2. Refined adaptation and mitigation diagram(s)/map(s)
3. Refined scenario storylines
4. List of additional data needs

2.30 – 3.15 **Visualization Prioritization (participation optional).** Project team discusses and decides on key issues and iconic locations to visualize in relation to the scenarios that have been developed.

Desired Outputs:

1. Proposed visualizations and identification of iconic locations

3:15 – 3:45 **Next Steps**. CALP and KSCCA discuss next steps, missing data to be obtained, other.

3:45 – 4:00 **Exit Interview / Qualitative Questions Session.**

Sample Scenario Worksheet - Business as Usual Development + Adaptation

City of Kimberley's Climate Change Visioning Pilot and Regional Template:
Exploring Scenarios Workshop

Kimberley Adapts: World One + Two Worksheet, Page 1

Current Trends Projected to 2100	Principle/Narrative
Population	
Population increases by ## % by 2100	
Other:	
Emissions	
Emissions by 2030 = 300 to 320% 1990 levels	
550 ppm by 2050; 850 ppm by 2100	
Regional Average temp increase: range of 2.2 to 4.0 by 2100	
Other:	
Energy	
Peak oil = oil and gas prices soar	
Primary energy = oil, natural gas, hydro, coal	
Coal-fired plants built to meet energy demand	
Other:	
Economy	
No Carbon tax	
Economy doubles by 2050	
Massive economic disparity	
Massive inflation	
Other:	

Page 2

Land Use	
Low density, low diversity sprawl	
All residential designated land used by 2025	
____% decadal growth in developed land area	
____% overall increase in land area used	
1.02 x population density of 2006	
Other:	
Transportation	
Food Security	
Rural and resource land used for suburban expansion	
Reduced food security	
Other:	
Governance/Policy	
Ecosystems	

Sample Scenario Worksheet - Low-Carbon

City of Kimberley's Climate Change Visioning Pilot and Regional Template:
Exploring Scenarios Workshop

A Robust & Resilient Kimberley: World Four, Page 1

Current Trends Projected to 2100	Principle/Narrative
Population	
Population increases by ## % by 2100	
Other:	
Emissions	
Emissions by 2050 = -80% of 1990* *Global consensus and close to BC law	
445 ppm by 2050, 450 ppm by 2100	
Regional Average temp increase:	
Other:	
Energy	
Technological changes minimize carbon-based fuels	
Increased energy and water conservation; increased self –sufficiency and resilience	
By 2040, new energy sources matched to end-uses, including geothermal, biofuels, PV, and wind, etc.	
Existing neighbourhoods are retrofitted; rooftops = energy producers using micro wind, PV and solar tiles	
Economy	
Development of emerging new technologies drives economy	
Other:	

Page 2

Land Use	
Compact growth	
0 % growth on undeveloped land by 2040	
_____% increase in developed land area	
_____ x population density of 2006	
Almost all population density is accommodated through infill development	
Other:	
Transportation	
Rapid transit to alternative housing stock and transportation infrastructure	
Heavy-duty vehicles and transit buses 100% hybrid by 2020	
Food Security	
Local farming enhanced	
Local agriculture provides jobs, food security, regional resilience	
Other:	
Governance/Policy	
Carbon Tax - yes	
Ecosystems	

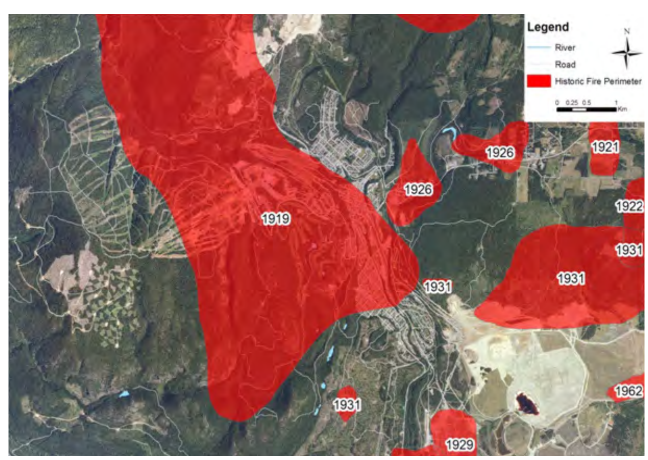
PHASE TW0
DATA + MODELING

STEP 5 DATA ANALYSIS, GENERATION + MODELING

STEP 6 2D MAPPING AND 3D VISUALIZATIONS

STEP 7 REVIEW WORKSHOP

In Phase Two, the critical outcome is stakeholder/ local review of the scenarios, data and preliminary visualizations. Spatial data gathering and modeling should be extensive, including local impacts and vulnerabilities, adaptation strategies, delineation of mitigation opportunities/options, and future land-use plans based on the scenarios, including a build-out plan for development. If possible, the data should be compiled in a GIS database. Preliminary visualizations are developed and tested, and the data and viz are reviewed at least once by local stakeholders, the working group, and/or community and council/board members.



5 Data analysis, generation + modeling

TYPES OF DATA/MODELS for Step 5:

GATHERED DATA:

• **All baseline data** converted and integrated (parcels, land use, TRIM, VRI, community watersheds, and other pertinent data as listed in Step 2)

• **Biophysical impacts data**:
Depending on the community, this may include: mountain pine beetle susceptibility, forest fire risk, flood mapping, and other vulnerabilities or possible impacts - local experts and consultants are a good source for this data.

• Other data depending on your scenarios - for example, you may want to map the energy resources such as transmission lines, biofuel supply, etc.

Where **data gaps** exist, which is very common, data may be generated by digitizing or by converting other data formats, or by pursuing original data collection (e.g. recording GPS coordinates of roads and popular transportation routes using mobile GPS devices, then uploading into a GIS platform).

GENERATED GIS DATA:

• **Figure-ground**: a map of all the building footprints, used to see and assess the structure of the community (eg. sprawl, compactness), calculate building footprints and GHG emissions, and produce simple 3D city models (extrusions)

• **Analysis** of common sustainability indicators such as 400m walking circles to services; population densities; energy use; other

• **Digitization and analysis** of possible mitigation opportunities, including potential energy resources (such as good solar exposure areas)[22], possible district heat plan locations, infill development, alternate transportation planning (eg. express bus routes and stops, potential light rail locations, trails, etc).

• **Buildout:** maps of planned, proposed, or conceptual developments using masterplans and other available development material. May involve hand-digitizing roads and development parcels in GIS. Use Community Viz to populate the plans with houses according to setback and other regulations.

• **Digital elevation model (DEM)**: terrain in GIS, to assess slopes, for snowpack modeling, other.

Why do a buildout plan?

• Climate impacts and potential adaptations will occur over time, and changes in the community structure need to be considered in long-range adaptation planning and risk assessment.

• Communities must meet GHG reduction targets, and a buildout plan that includes future buildout and potential associated GHG emissions can help the community to decide how to develop in a low-carbon manner.

Spatial GHG emissions: Carbon emissions are a critical indicator in climate change planning. Preliminary carbon emissions for the current City of Kimberley and the full build-out pathway (Kimberley Adapts) were initially calculated using a spatial methodology to assess the potential GHG implications of current development plans, barring any GHG mitigation actions. Final emissions numbers used a combination of CEEI and spatial modeling (see Appendix 5.4).

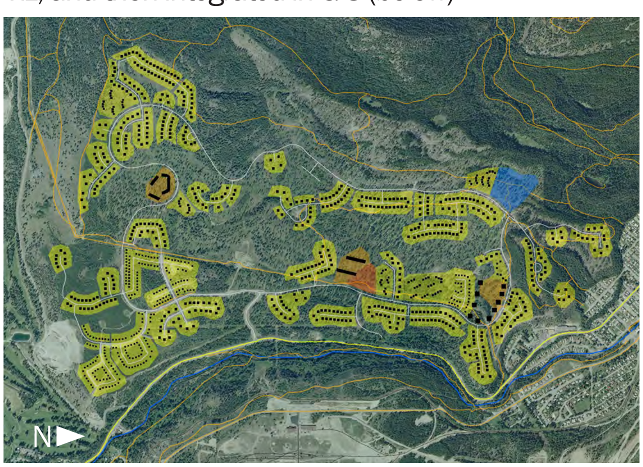
TIP

Practical, common-sense review of the data can spot errors, particularly once data has been mapped. For example, the first snowpack mapping for Kimberley showed snow retreating from the mountain tops and moving downslope on a southern exposure - clearly an error in the modeling that needed correction.

5

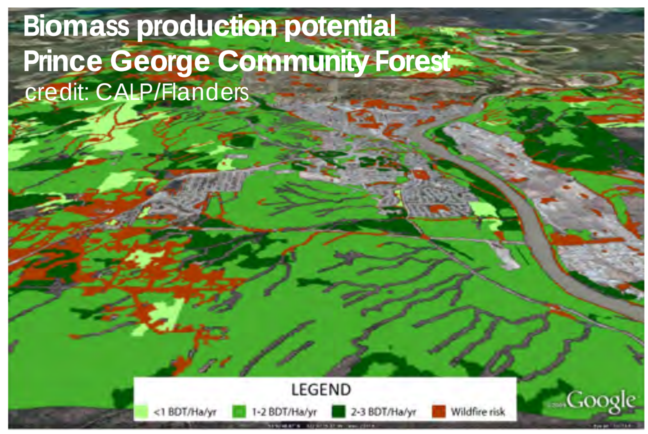
For the Kimberley project, spatial data generated within CALP included a figure-ground - prepared in GIS by drawing the building footprints for all existing building within the community - and used to show current development and land use patterns. Proposed development plans for roads and lots were hand-digitized in GIS, and then CommunityViz was used to generate future build-out maps. These show how current land use and development plans will alter the community's form, and potentially increase GHG emissions.

An example of the development masterplans (above) that were hand-digitized (roads and parcels/phases) in GIS in order to generate a buildout using Community Viz, and then integrated in GIS (below).



MODELING includes:

- **Numerical modeling,** eg. snowpack modeling; climate projections; hydrological modeling; GHG emissions inventories
- **Spatial modeling**, eg. spatializing numerical outputs of a snowpack model to show spatial changes in snowline; spatializing GHG emissions based on land use
- **3D modeling**, eg. terrain, texture, and 3D models of buildings, other structures, trees, other vegetation
- **Hybrid modeling** combines multiple modeling types together



An example of modeling that was used to assess renewable energy capacity in Prince George. In this case, the modeling and visualizations were used as supportive data to an external (Smart Growth) project.

Modeling results in Kimberley came either from external scientific models specific to the project, such as the PCIC hydrological model used to project future snowpack conditions (converted by CALP into spatial data), or from pre-existing models, such as numerical/spatial data of Mountain Pine Beetle Susceptibility (updated by ILMB 2006) and the Farsite fire model run by the City's fire consultant.

6 2D Mapping and 3D Viz materials production

Storyboarding

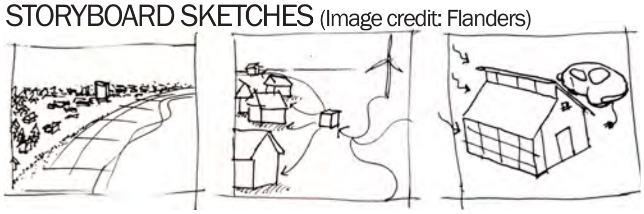
Storyboard the visualizations

Sketch out what visuals the working group would ideally like to produce based on the scenario storylines, the issues that need to be communicated, what the data is showing, and what you are able to achieve with available data (see also Appendix 4.3).

Consider:

- What are the iconic views, landscape features, or places that you could visualize? Key places which contribute to a region or city's identity make for compelling visuals.
- How to represent the scenarios and a variety of alternatives?
- What time period(s) do you want to show?
- What scales do you want to work at: working landscape / regional, community / municipal, neighbourhood, parcel?
- What level of realism is desired? What details?
- Can you make comparisons across scenarios?
- Do you have the data required? Can you get the data? This will drive your ability to create defensible visualizations.

STORYBOARD SKETCHES (Image credit: Flanders)



ETHICS (see also Appendix 4.2)

Have the viz team review the preliminary visuals to ensure that the "Three D's" of visualization ethics are being followed:

- Drama - is the level of drama acceptable (i.e. not overly melodramatic)?
- Disclosure - are the assumptions and data sources transparent or readily available?
- Defensibility - are the visualizations based on credible and defensible scientific data, local knowledge and transparent assumptions?

Visualizations and Data Availability: It can be helpful to chart the expected availability of data, as shown in the working document below. Desired visualizations by theme (Forestry, Snowline, Development), scale (landscape, neighbourhood and parcel) and scenario (Adaptation, Low-Carbon) were assessed for data.

KIMBERLEY VISUALIZATIONS… what is possible

Requires considerably more data, or data difficult to get	Requires more data, or some design work	We can do this now

White text represents mappable material from WG recommendations

Think of the material as 3D GE tour, with pop-up photomontage, text, and precedent images for the different scenarios, at neighbourhood, parcel, or specific locations scales.

Scenarios: MODEL/SCALE:	IMPACTS	ADAPTATION	LOW-CARBON
3D MODEL ONE:	**LANDSCAPE**		
FORESTS	**MPB** Also add: species changes, community watershed boundaries, forest licenses (esp. in community watersheds?)	**Logging + re-planting**, some areas left to grey attack – we have the data for logging plans in the Mark Creek watershed	Any difference? Happening too fast
	Wildfire risk…? **Season extension, yes** **Show burnt areas?** More smoke in the air? At very least, give increase in residential fire protection areas with new dev.	Fire smart (parcel) **Management plans?** Spill response locations + pumping stations More smoke in the air?	Fire smart (parcel) **Shorter season extension?** **Less dev in forest interface areas?** Changes in house construction? (to strawbale, etc) **Not as many burnt areas?**
	PARCEL		
2D photomontage; pop-up info	Impact: drought/dead landscaping? Heat? Smoke in air?	Fire smart Rain barrels Xeriscaping; improved soils	Fire smart Rain barrels Xeriscaping Solar thermal
3D MODEL TWO:	**LANDSCAPE**		
SNOWLINE	**Snowline retreat** (viewed aerially? Also do a 2D viz of skihill from sec. school?)	Add snowmakers (note increased water use + increased GHGs) Move ski operations uphill (re-open Rosa chair?)	Snowline for low-c emissions scenario – WE ARE NOT GETTING THIS DATA
3D MODEL THREE:	**LANDSCAPE**		
DEVELOPMENT	**Buildout** **Add roofs and correct**	Same? Or do more compact to reduce fire protection area?	**Compact Kimberley** (Needs more development… eco-buildings, multi-family, solar thermal on buildings, etc.)
2D POP-INFO ON INDICATORS	With 2D text on unit numbers, carbon emissions, area, etc. for each new buildout area	**ASK QUESTIONS USING INDICATORS ABOUT LAND USE PLANNING DECISIONS AND FIRE/water use/other** Add indicators: CO_2e, area under fire protection; interface perimeter	
3D Community energy options precedent images			Solar farm Biomass district energy locations?
2D POP-UP INFO			Transportation options: express bus and LRT stops (make sure these are linked to highway/Cranbrook)
			EV charging stations?
			Horse stables?
	NEIGHBOURHOOD		
2D photomontage	Show snowline regression on	Snowline, plus Adaptations to	**Marysville Main Street** Mixed-use

6

All the data, modeling outputs, mapping, and 3D visualizations to date should be prepared for review at a Review Workshop (one or several), or similar forum.

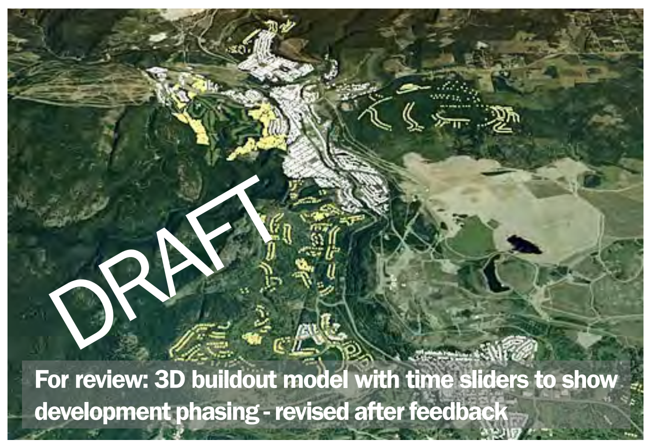
In Step 6, you produce maps and visual materials of the data gathered, generated, and integrated to date, for review in Step 7. You may do a digital (powerpoint) overview presentation, and provide printed maps and 3D visualization images as well as use interactive 3D models (2D maps imported into GoogleEarth) or other 3D visualizations.

Materials should include:
- Impacts maps (MPB, fire, flooding, other)
- Buildout maps
- Low-carbon maps of mitigation options
- A GoogleEarth or other 3D model to test for workability/comprehension, etc
- Other 3D visualizations, such as those produced in Biosphere 3D or Visual Nature Studio
- Vulnerability and risk assessment results, if available
- Presentation of the material

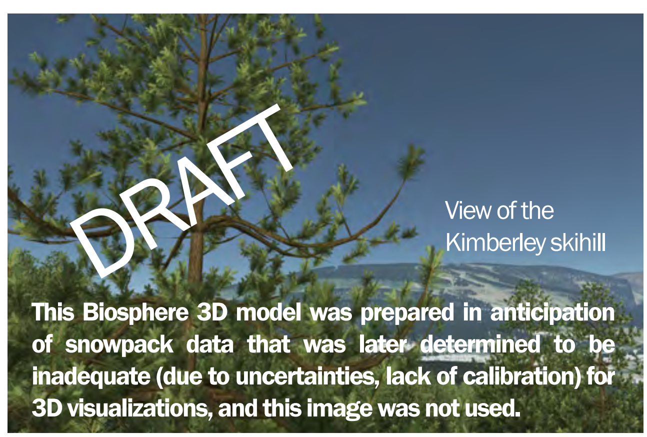
Who should review?
- Minimum: the Working Group
- Better: stakeholders, resident representatives, Mayor and/or Councilors or Board members, experts, and City staff

TIP
When using digital presentation forms, particularly GoogleEarth or other interactive models that could fail to perform during live presentations, have backup printed materials for the review teams to work from.

For review: GIS digitized potential flood water flows with high and low risk debris jam locations, based on 1999 flood risk study; 20m buffers were used to estimate potential overland flow routes for discussion (note: the buffers were challenged in review as inadequate, and flood mapping was revised).



For review: 3D buildout model with time sliders to show development phasing - revised after feedback



This Biosphere 3D model was prepared in anticipation of snowpack data that was later determined to be inadequate (due to uncertainties, lack of calibration) for 3D visualizations, and this image was not used.

7 Review workshop

GOALS

The Review workshop, or set of review workshops/ meetings, is absolutely critical to the overall process. In it, a group of stakeholders and community representatives will review the data for accuracy, ensure that the issues are represented fairly, identify what issues or data may be missing, and provide feedback on whether the visualizations are legible and appropriate.

The feedback will be invaluable in preparing the final visualization materials, and allows the viz team to refine their datasets and visualization models.

GOALS for the Kimberley Review Workshop

Show where we are at and ask:

1. How can our work help the Kimberley adaptation project process?

2. Confirm accurate data + 2D mapping, identify gaps: are the maps reasonable? Gaps? Further areas?

3. Research on the 3D viz: what do we want to see for the final Community Open House?

PARTICIPANTS

- Working group members
- Community representatives
- Council/Board members/Mayor
- Other stakeholders and local experts

FORMAT

- Overview presentation of material (mapping, data, viz) to date
- Small group review, by theme and/or by scenario

TIME NEEDED

- One day should be ample time; a half day would be adequate
- Can be done in an evening session, but this is a tight timeline

TIP
Use flipcharts for each group, so that participants can correct what is written down and know that their input has been listened to and captured.

TIP
Use other meetings for feedback from specific experts, such as adaptation or climate science experts.

7

MATERIALS

- Presentation: goals of workshop, overview of material, etc; laptop, projector(s) and screen(s) (walls may be adequate for projections for small groups)
- One set of printed maps/images of material per small group; trace paper and pens; flipcharts
- Data sources, if applicable (may be part of the printed map package)

If you are using interactive 3D models:

- One laptop computer and projector per small group
- One screen per group (or you may project onto walls)
- Internet access - optional - if you have previously cached your GoogleEarth model, internet access is preferable but not necessary

TIP
Have large tables available where people can collaboratively work on the maps. Also provide pens, trace paper, flipcharts, stickers/post-it notes, and other facilitating materials.

ROLES

- One overview presenter
- Minimum one working group member and one viz team member per small group
- One facilitator and one note-taker per small group
- If you are using interactive visualizations / virtual globes, each small group should have, if possible, a navigator/tech support person

TIP
Ensure that the facilitators are familiar with the available materials before the workshop starts.

WORKSHOP OUTPUTS

- List of missing issues/priorities
- List of data revisions and new or improved data sources, including contacts for additional data
- New or revised ideas for adaptation/mitigation opportunities, mapped if possible
- Improved map communications, eg., changing the colours or titles
- List of visualization changes, such as: from building volume extrusions (simple block forms) to rendered buildings with pitched roofs; viewscapes; etc
- Local knowledge capture to embed in the viz

These results go back to the data and viz team to review and incorporate in the next Phase.

TIP
Ideally, the small group facilitators will be different from the person doing the overview presentation, and you will have backup technical support if you are using interactive virtual globes.

YOU MAY NEED TO REPEAT THE STEPS IN PHASE 2 MORE THAN ONCE - perhaps as a series of meetings with stakeholders, a series or workshops, or simply asking for stakeholder feedback via email or phone conferencing.

PHASE THREE
FINAL VISIONING PACKAGE

STEP 8 REFINED DATA + MODELING

STEP 9 VISIONING PACKAGE PRODUCTION

STEP 10 COMMUNITY ENGAGEMENT

In Phase Three, the critical outcome is production of a visioning package that is presented to stakeholders and the community. Spatial and numerical data are refined based on the visualization review, and visualization production is extensive. The full visioning package should include technical background material, with the option for assessment of scenarios.

8 Final data + viz refinement + compilation

Following the Review Workshop(s), you should have data to revise and new data sources to follow up on, as well as proposed revisions to the 3D visualizations.

2D data improvements may include:
- Aquisition of new/improved data (and continue to ask for updated data)
- Revised mapping
- Expanded scenario details
- Revised priorities based on new or improved vulnerability assessments
- Updated numerical modeling
- Revisions to build-out plans

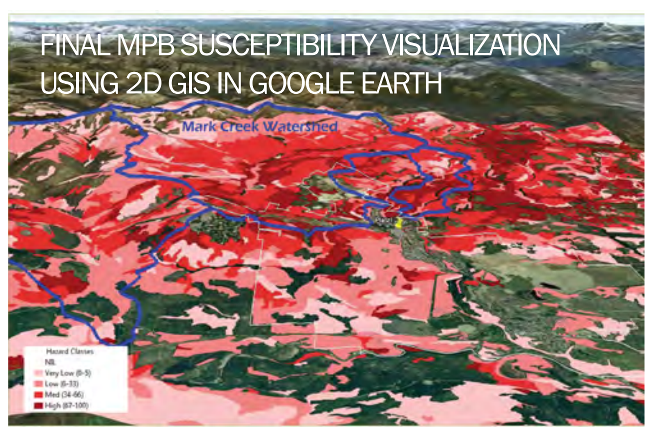
3D visualization improvements may include:
- Improved city / building models (see below)
- Moving from mapped or conceptual adaptation and mitigation scenarios for land use and other strategies into 3D models such as Sketchup, GoogleEarth, or Biosphere 3D

Example: Based on feedback, early building models using simple extrusions (above) were later revised to include pitched roofs and building textures.

> **TIP**
> **Use multiple sources where possible, eg. the majority of the Kimberley wildfire data came from the City's Fire Consultant; however, the Fire Solutions poster also included material from FireSmart Alberta and BC, the local Nature Park fire plan, and the City's Fire Chief.**

Example of preliminary and final visualizations, Mountain Pine Beetle Susceptibility:

The draft 2D GIS map (below) was produced based on the age of pine in the forest stands; the 3D map below was produced using data located via a local forestry expert at the review workshop - it has current susceptibility mapping based on a more complex algorithm, the community watersheds have been added, and the colour range has been improved.



9 Visioning Package Production

The **final visioning package** includes 2D mapping; 3D visualizations; technical documentation of sources, assumptions and caveats; and the final presentation formats. If possible, frame the final outputs with the local scenario storylines. Visioning package materials may include:

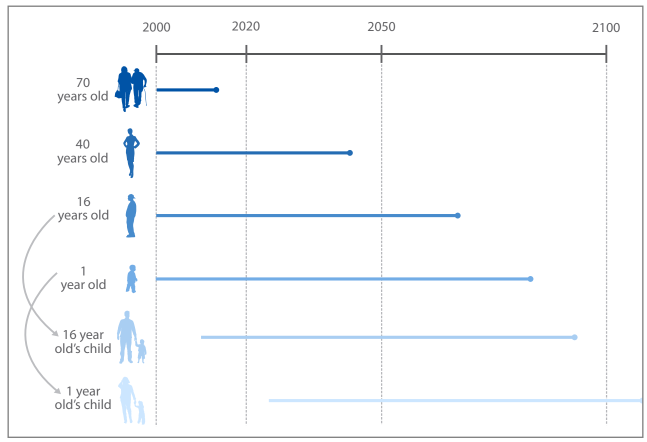
• GIS data to GoogleEarth / virtual globe; Google Earth model with layers (interactive station, live presentation, animations, screenshots)
• Posters and technical data
• Powerpoint and/or virtual tour; other presentation format
• 2D maps if necessary (for posters or presentation)
• Graphic images to communicate numerical data, such as carbon emissions; numerical data in charts or graphs
• Time sliders in GoogleEarth or other virtual globe
• Sketchup or photo-edited imagery

Pre-test the visualizations / presentation for clarity and storyline, prior to the community engagement or other public events.

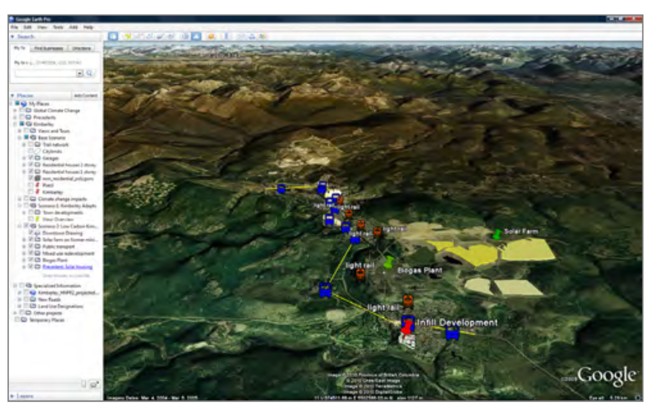
Technical posters present the visualizations with their background context, data sources, and possible connections to policy development. Technical posters:
• Provide context for the visualizations
• Gather all the material together, including sources
• Use a medium which complements virtual globes
• Help to meet Disclosure and Defensibility ethical requirements
• Can be used in further community engagement

TIP
Allow enough time for visualization production: draw the line on data gathering and move into visioning package production well ahead of the final presentation.

TIP
Some impacts, such as extended fire season extensions, economics, or demographics, are temporal but not spatial, and can be shown using graphics.



Example of graphics: Illustration of generational lifespans in a climate impacts and GHG target timeline.
(Image credit: Salter/CALP)



Screenshot of GoogleEarth model with multiple scenario layers - the Low-Carbon layers are turned on.
(Image credit: Schroth/CALP)

9 Sample presentation slides

From the CALP Open House Presentation, Kimberley, June 2009

2
Climate change + community

Opportunity to ask questions about where you want your community to be in 10, 25 and even 50 years

Kimberley Climate Adaptation Project | Visualization Presentation 2009

13
Forest Fire

History:
Forest fires are part of Kimberley's landscape

Fire-dependent ecosystems:
Historically, wildfires occured around Kimberley every 0-35 years

Fire suppression has led to heavily fuel-loaded forests

Kimberley Climate Adaptation Project | Visualization Presentation 2009

6
Kimberley Virtual Tour

- City overview, and planned expansion
- Climate change impacts
- Adaptation options
- Low-carbon options
- Resilient, low-carbon vision

Kimberley Climate Adaptation Project | Visualization Presentation 2009

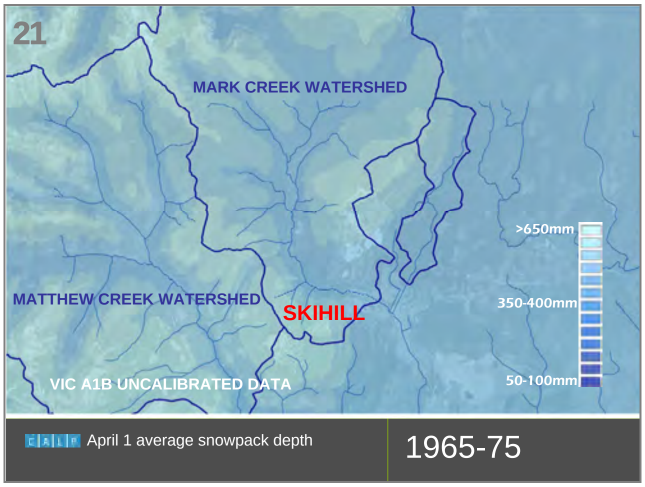
16
Projected fire season extension

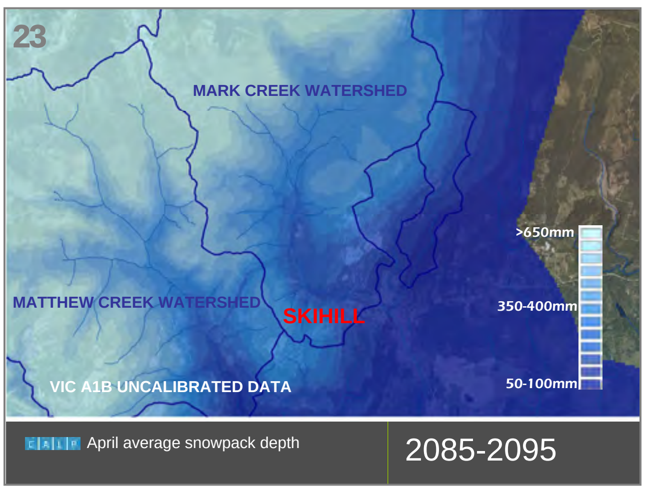
8
Google Earth fly-over

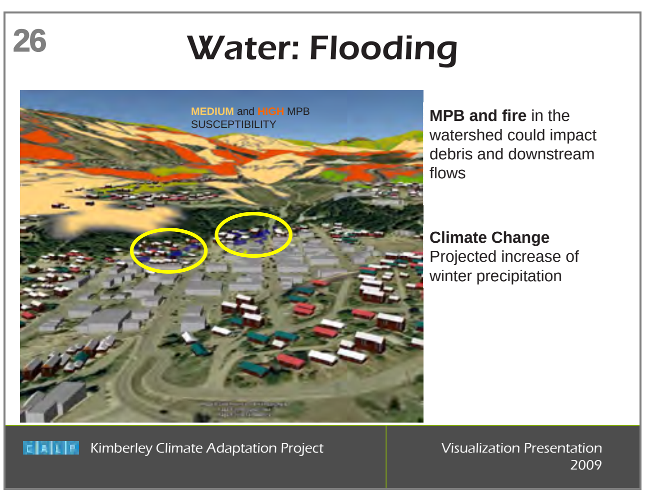
19
Adaptation options for fire and MPB

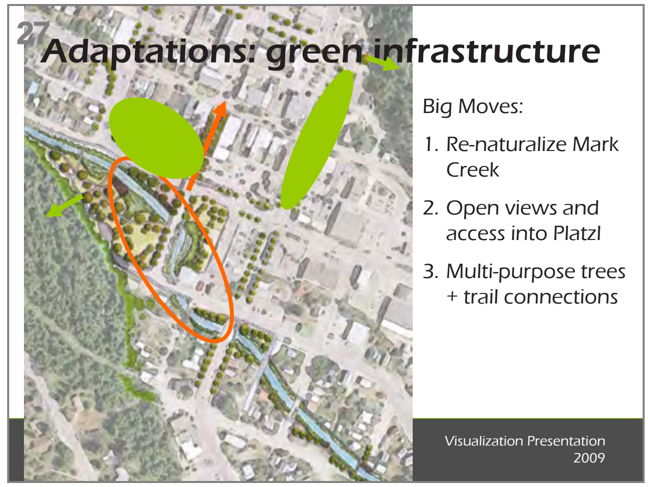
Kimberley Climate Adaptation Project | Visualization Presentation 2009

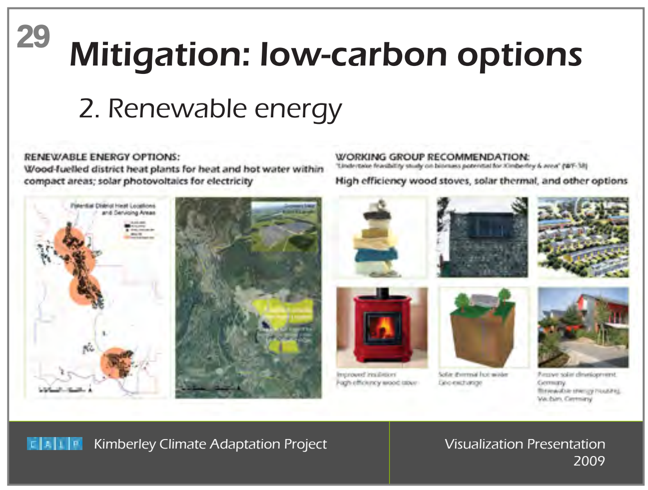
9

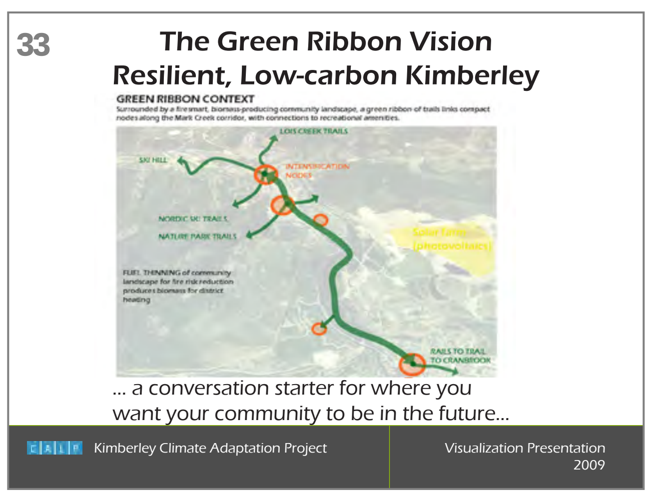

21
MARK CREEK WATERSHED
MATTHEW CREEK WATERSHED
SKIHILL
>650mm
350-400mm
50-100mm
VIC A1B UNCALIBRATED DATA
April 1 average snowpack depth
1965-75


23
MARK CREEK WATERSHED
MATTHEW CREEK WATERSHED
SKIHILL
>650mm
350-400mm
50-100mm
VIC A1B UNCALIBRATED DATA
April average snowpack depth
2085-2095


26
Water: Flooding
MEDIUM and HIGH MPB SUSCEPTIBILITY
MPB and fire in the watershed could impact debris and downstream flows
Climate Change
Projected increase of winter precipitation
Kimberley Climate Adaptation Project
Visualization Presentation 2009


27
Adaptations: green infrastructure
Big Moves:
1. Re-naturalize Mark Creek
2. Open views and access into Platzl
3. Multi-purpose trees + trail connections
Visualization Presentation 2009


29
Mitigation: low-carbon options
2. Renewable energy
RENEWABLE ENERGY OPTIONS:
Wood-fuelled district heat plants for heat and hot water within compact areas; solar photovoltaics for electricity
WORKING GROUP RECOMMENDATION:
High efficiency wood stoves, solar thermal, and other options
Kimberley Climate Adaptation Project
Visualization Presentation 2009


33
The Green Ribbon Vision
Resilient, Low-carbon Kimberley
GREEN RIBBON CONTEXT
... a conversation starter for where you want your community to be in the future...
Kimberley Climate Adaptation Project
Visualization Presentation 2009

10 Community engagement

GOALS

Present the Visioning Package or visualizations within a scenario framework or "storylines" in a workshop setting or community open house, using pre-existing planning processes where possible.

- Share the learning of the working group/community process
- Build climate change awareness and increase understanding of climate change causes, solutions, impacts and responses
- Show that there are alternatives and choices to be made now that will determine future pathways for the community
- Optional: collaboratively assess and choose a prefered scenario or "bundle" of actions using multi-criteria analysis[32] or other methods[29, 31, 33]
- Optional: evaluate the process and Open House

PARTICIPANTS

- Attempt to include a wide range of participants, reaching out to the broader community through the working group's networks, local media, and other means (churches, schools, colleges, etc)
- Depending upon your project's objectives, you may narrow the scope of participants (e.g. if you are testing the impacts of the visuals on decision-makers, or working with staff, Council or Board to build policy).

FORMAT

At a minimum include:

- Presentation of material
- Feedback / assessment
- Q & A

Optional:

- GoogleEarth or other interactive stations; small group evaluations; posters; food

Visualization Presentation tips

- Present the graphics in a visually compelling manner.
- Consider using 2 – 3 large screens if possible to create an immersive visual environment.
- Size and visual quality matter: the screens should be as large as possible to assure clarity and participants should sit as closely as possible
- Projector colour should be calibrated & room lights dimmed (if required) to make the images as vivid and engaging as possible.
- NOTE: the above are ideal, but may not be attainable in all community settings!

MATERIALS

- Projector(s); laptops; power cords
- Internet access if using live GoogleEarth or other web-based platform
- Questionnaires; dots for dot-mocracy; sticky notes for feedback on posters; other materials depending on assessment methods
- Enough wall space for technical posters, if applicable
- Pens, nametags, post-it notes, etc.

ROLES

- One or two presenters
- One technical facilitator if you are presenting live 3D interaction such as GoogleEarth; technical facilitator(s) at the interactive Station(s)
- Co-ordinator; door person/greeter; set-up and take-down volunteers; food folks; etc.

TIP

"Dot-mocracy" is one simple way to quickly prioritize a set of outcomes, ideas or scenarios. Participants are given a specific number of sticky dots each, which they use to rank or prioritize a list of alternatives posted on the wall. Participants may choose to "spend" all of their votes on the alternative they feel most strongly about, or to allocate their votes to various alternatives. At the end of the exercise, votes are tallied to indicate the priority issues.

10

KIMBERLEY OPEN HOUSE: one possible Open House format:

- Presentation:
  - Powerpoint + live GoogleEarth presentation
  - Posters on the walls
  - Interactive GoogleEarth station
- Feedback:
  - Evaluation forms
  - Sticky notes for comments on the KCAP posters
- Formal Q & A following presentation
  - Informal Q & A afterwards, and at GoogleEarth station
- Food before presentation, door prizes and ice cream during informal Q & A

Other formats, depending on engagement goals:

- Community Feast - works well in communities that traditionally gather around food
- Presentations in high schools
- Storefront poster display (care needs to be taken to provide enough background material as Q&A is not possible)
- Displays at community events
- Online GIS or GoogleEarth for interactive viewing (ethics and other concerns should be discussed with CALP, Selkirk Geospatial, or other GIS providers prior to using this tool)
- Small focus groups with facilitator and note-taker
- Viz "worksheets" showing alternatives, and/or before/after scenes, with specific and/or open-ended questions about the scenarios and options presented that can be submitted via fax or email, useful if gathering community is difficult.

For engagement with policy-makers and decision-makers, you may want to run engagement, awareness, and/or alternatives assessment workshops based around the climate change scenarios, strategies and options (Next Steps, 10+).

ASSESSMENT

Draw on your local planning tools to determine whether you need questionnaires, "dot-mocracy", sticky notes for comments, or other forms of feedback.

Resources for community engagement:

- Sustainability Facilitators with the Fraser Basin Council's Smart Planning for Communities[36]
- Participatory process references in Section 4

10+ Dissemination, assessment, implementation

Following your Visioning Process, and depending on your community's planning, awareness, engagement, and policy-making needs, the Visioning Package may be used to move climate change planning forward in multiple ways. These can be pursued either concurrently with each other, or as needed.

FURTHER REFINEMENT

- GAPS or ERRORS may have been identified through the feedback processes in Step 10 that require corrrection
- Further visualizations tailored to specific end purposes may be produced
- Stand-alone viz products - such as animations from GoogleEarth - may be produced to enable wider dissemination and others to use the materials

CONTINUING COMMUNITY ENGAGEMENT

- The Viz materials could be used in other community engagement events, such as EarthDay, sustainability fairs, Environmental or Green Trade Shows, etc.
- The Visioning Package materials may be used during an OCP review process, other municipal/regional planning processes; wildfire planning; sustainability planning; ongoing climate change awareness building, and grass-roots initiatives
- The Visioning Package may be presented to various local organizations including churches, the Chamber of Commerce, and local schools - these organizations could also provide a broad range of participants for scenario assessment workshops (below).

SCENARIO ASSESSMENT

- If Step 10 did not include choosing a preferred pathway, a workshop or Open House could be convened to follow on the awareness/engagement building in order to refine and choose a preferred scenario, Community Vision, or set of climate change actions for the community - this may also be done in collaboration with municipal/Regional District staff, and Mayors and Councils/Boards.
- Assessment involves using indicators to compare the scenarios; discussing scenario strengths and weaknesses; and choosing the preferred scenario or a bundle of preferred options (eg. creating a final scenario that combines the best and win-win actions - robust, resilient, and low-carbon).
- Assessment could be based on SWOT, multi-criteria assessment (MCA)[32], or other[31, 33]
- Wildcards can also be used to test scenarios by asking how each scenario might respond to wildcard events (eg. large numbers of environmental refugees arriving), and will help to assess the strengths and weaknesses of the scenarios
- The preferred scenario then needs to be integrated into community planning processes; and/or may be used by grassroots organizations to spearhead low-carbon, resilient community initiatives.

REPORTING

- Project report and recommendations for Council
- Summary Report available for community members, and other communities

Further refinement

Following the Community Open House in Kimberley, a SOLUTIONS fire poster was produced for further community engagement, and the fire visualizations were made available to the Fire Chief for use in presentations and meetings on wildfire management planning in Kimberley and the region.

10+

POLICY DEVELOPMENT + IMPLEMENTATION

It is important that participatory process outcomes be considered in actual policymaking so that participants know their input is valued and they will continue to engage in future public processes.

Through community collaboration, the preferred scenario or bundle of actions could be incorporated into:

- OCP (Official Community Plans), including targets, policies and actions to meet the Local Government (Green Communities) Statutes Amendment Act (Bill 27, 2008), particularly for community emissions reductions
- ICSP (Integrated Community Sustainability Plans, often branded with a different name within specific municipalities)
- Strategic and financial plans; asset management plans
- Zoning bylaws
- Municipal and regional operations, as determined by working with City and Regional Operations staff, and Council/Board

EVALUATION + MONITORING

Ideally, both the visioning process and its outcome will be evaluated afterwards. For evaluation of the process, short feedback questionnaires for participants may be used at the Open House. The questionnaires may collect:

- Basic demographic information to get a sense of who the participants were
- Whether they felt more informed through the process
- Did they feel that their views were respected and understood (see, for example, the CaliforniaSpeaks participatory process evaluation[35])

It is much more difficult to evaluate long term policy outcomes and such an evaluation is likely out of scope for most communities. However, if possible, later follow-up interviews with participating stakeholders and decision-makers and a policy document analysis can monitor the impact of the visioning on policymaking.

3.5 Meeting Challenges

What if the data doesn't exist?

You may be missing spatial baseline data (eg. detailed elevations within a community to map potential flood risk areas), and/or localized climate data (eg. snowpack elevation changes) that can be visualized. The technical bottleneck in visualizations for small communities seems to be with the underlying data and (lack of) modeling, rather than the visualizations themselves.

Where you have data gaps:
- Put together what you can, generate data through modeling, ask others for more input data, or find another way to communicate impacts
- Be clear about what you know now, and what you don't know - there are limits to downscaled climate science (although these are changing too)
- Use historical records/experience and ask what-if questions about the impacts of possible changes in the future
- Remember that planning always occurs with data gaps - decisions are made based on the best available data and knowledge

Source as much of your data as you can and BE CLEAR ABOUT THE LIMITATIONS. With climate change, we cannot wait for more research and the real-world experiment to catch up to - and prove - the climate change models to be absolutely accurate. What we need to do is communicate what is known, acknowledge the limits of current data, modeling and climate change projections, and continue to plan for resilient communities.

Be careful to find a balance between respecting the scientists' need to express "uncertainty" (which means variability/range in the models), and the need to communicate the findings and their implications clearly, to the best of our current knowledge. The Columbia University's Climate Change Communications Guide has more on how to translate between scientists and lay people[12].

What if community members want certainty or specifics from the climate projections that cannot be provided?

Ensure that you are working with the most up-to-date climate science projections, and be clear about the limitations. Educate yourselves and your community on the climate models - what they can and cannot do (yet) - *Climate change in the 21st Century*[1] is a good resource for a clear explanation of the global and regional climate models, and the links to impacts and adaptation.

> **TIP**
> **The data gathering and generation is likely to take longer than you think - allow adequate time in the process.**

What if we don't have a GIS platform to work from, can we still do visualizations?

Getting your data into GIS provides you with a versatile platform from which to work: you can export to GoogleEarth and other virtual globes, Community Viz, or do georeferenced buildings in Sketchup.

Without GIS, you can do photoshop visualizations which, while difficult to make realistic, can communicate holistic scenarios through one or two images, particularly before and after. Good photoshop visualizations require expertise. As well, you will need to choose your location and the material to be communicated carefully. You may opt for a "cartoony" looking visualization, which can show options without using extreme photo-realism.

Other non-GIS options include: hand-sketching, as done in traditional architecture, landscape architecture, and urban design; or, using Sketchup or other 3D tools for smaller areas of visualization. However, these do not allow you to develop visualizations from georeferenced spatial data and modeling.

Lastly, some impacts may be better communicated using good graphics, rather than a map or 3D model; in these cases you could develop graphic communications alongside the 3D visualizations.

Using graphics to communicate Kimberley wildfire projections

Credible projected locations of high, medium and low wildfire risk were not possible, given the multiple variables that would impact such a future map (including water availability, snowpack levels, pests and diseases in the forests, species shifts, logging practices, and wildfire management measures). Instead, the current risk and conditions were shown, and then existing fire season projections were communicated in a graphic way that tied to the 3D local narrative.

What if the data is sensitive or unwelcome or potentially alarming?

Examples include: showing existing housing in flood risk or wildfire areas, and potential property damage due to impacts or adaptation/mitigation strategies

- Do not hide the data, but do contextualize it and provide caveats to clarify (un)certainties

- Test the visualizations out on the working group first, and ensure thorough review before going to the public or larger stakeholder group; modify if necessary to ensure clarity and that the impacts are not exaggerated

- Show precedents and potential solutions, with multiple options if possible

- Use techniques to demonstrate the content without using specific, recognizable houses, such as flipping or altering images so that the precise location cannot be discerned, or changing the layout and details on modeled buildings to not mimic the existing, real world structures

- Ensure that the visualizations follow the code of ethics around Drama, Defensibility, and Disclosure

The risk and liability of not disclosing sensitive issues or risks (when they are known or projected) can be greater in the long-term, even when they can be potentially difficult for communities to deal with in the short-term.

SECTION 4 REFERENCES

ADAPTATION

1. Cohen, Stewart and Melissa Waddell. *Climate Change in the 21st Century.* McGill-Queen's University Press, 2009.

2. The Columbia Basin Trust: www.cbt.org/Initiatives/Climate_Change/.

3. Climate Impacts Group, King County and ICLEI. "Preparing for Climate Change: A Guide". University of Washington, 2007. http://cses.washington.edu/cig/fpt/planning/guidebook/gateway.php.

4. European Environment Agency. Regional climate change and adaptation, EEA Report. Copenhagen, 2009. www.eea.europa.eu/publications/alps-climate-change-and-adaptation-2009.

5. K. Larsen and U. Gunnarsson-Östling, "Climate change scenarios and citizen-participation: Mitigation and adaptation perspectives in constructing sustainable futures," *Habitat International.* 33, No. 3 (2009): 260-266.

6. Pacific Climate Impacts Consortium. Plan2Adapt website. http://plan2adapt.ca/.

7. Roberts, Debra. "Thinking globally, acting locally — institutionalizing climate change at the local government level in Durban, South Africa." *Environment & Urbanization*. 20.2 (2008): 521-537.

CLIMATE SCIENCE

8. Bernstein, Lenny, et al. "Climate Change 2007: Synthesis Report: Summary for Policymakers". Intergovernmental Panel on Climate Change, 22 pg. www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

9. Pachauri, R.K. and Reisinger, A. (Eds.) "Climate Change 2007: Synthesis Report". Intergovernmental Panel on Climate Change. www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm.

10. Pacific Climate Impacts Consortium: pacificclimate.org/.

11. Richardson, K., et al., "The IARU International Scientific Congress on Climate Change: Global Risks, Challenges and Decisions (10–12 March, Copenhagen, Denmark)." IOP Conference Series: Earth and Environmental Science, No. 00 (2009): 001002.

COMMUNICATING ABOUT CLIMATE CHANGE

12. Shome, Debika and Sabine Marx. "The Psychology of Climate Change Communication." Centre for Research on Environmental Decisions, Columbia University, 2009. cred.columbia.edu/guide/.

COMMUNITY GHG EMISSIONS

13. Community Energy and Emissions Inventory reports: http://www.env.gov.bc.ca/cas/mitigation/ceei/index.html.

KOOTENAY AMENITY MIGRATION

14. Pringle, Tim and Sara Muir Owen. "How Growth in the Recreation and Resort Property Market is Driving Change in the East Kootenay Region." Communities in Transition, Real Estate Foundation of British Columbia, May 2006. www.communitytransition.org/resources/Resort Recreation & Change in EK.pdf.

15. Sandford, Robert William. *The Weekender Effect: Hyperdevelopment in Mountain Towns*. Calgary: Rocky Mountain Books, 2008.

MITIGATION + LAND USE, COMMUNITY ENERGY PLANNING

16. BC Climate Action Toolkit, Bill 27 Resources. http://toolkit.bc.ca/resource/local-government-green-communities-legislative-amendments-bill-27-2008-information-resources.

17. Bill 27 — 2008 Local Government (Green Communities) Statutes Amendment Act, 2008. http://www.leg.bc.ca/38th4th/1st_read/gov27-1.htm.

18. CanmetENERGY. "Urban Archetypes Project." http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/buildings_communities/communities/urban_archetypes_project.html.

19. Community Energy Association. www.communityenergy.bc.ca/.

20. Community Energy Association and the RuralBC Secretariat. "Clean Energy for a Green Economy: An Introduction for Rural BC Communities." May 2010. www.ruralbc.gov.bc.ca/library/resource_corner/Clean%20Energy%20for%20a%20Green%20Economy.pdf.

21. District of North Vancouver. "Climate Change Action Plan - Foundations Report." Prepared by HBLanarc Consultants. Vancouver, July 2009. http://identity.dnv.org/upload/pcdocsdocuments/4wh01!.pdf

22. Flanders, D., J. Salter, K. Tatebe, E. Pond and S.R.J. Sheppard. "A Preliminary Assessment of Renewable Energy Capacity in Prince George, BC." Report for Natural Resources Canada, UBC: CALP, 2009. www.sgog.bc.ca/uplo/PG_4_Bioenergy_Low-carbon.pdf.

23. Miller, Nicole and Duncan Cavens. "City of North Vancouver 100 year sustainability vision: GHG measurement and mapping." BC Ministry of the Environment CEEI Working Group, 2008. www.env.gov.bc.ca/epd/climate/pdfs/ceei-nvan.pdf.

24. Ministry of Community and Rural Development. "Targets Workbook: Implementing GHG and energy reduction measures in your community (content materials from workshop held in May/June 2009)." With BC Hydro and the Sheltair Group, 2009. http://toolkit.bc.ca/sites/default/files/Targets%20Workbook2.pdf.

25. Pond, Ellen, D. Cavens, N. Miller and S. Sheppard. "The Retrofit Challenge: Re-thinking Existing Residential Neighbourhoods for Deep Greenhouse Gas Reductions." CALP, UBC, June 2010.

26. Sheppard, Stephen, E. Pond and C. Campbell. "Low-carbon, Attractive, Resilient Communities: New Imperatives for Sustainable Retrofitting of Existing Neighbourhoods". Climate Change and Urban Design: Third Annual Congress of the Council for European Urbanism (2008): 42-59. www.cityclimate.no/ceu-oslo-conference-reader-10-sep.pdf.

27. Sustainability Solutions Group. "GHGProof: a straightforward tool to manage emissions through informed land use decision making." http://www.sustainabilitysolutions.ca/downloads/SSG%20GHG%20Iand%20use%20model.pdf.

28. Webster, J. "Smart Growth on the Ground, Prince George - Research Bulletin #6: Residential Energy Characterization and Mapping". CanMet ENERGY, Natural Resources Canada, 2009. www.sgog.bc.ca/uplo/PG_6_%20Residential_Energy_Characterization.pdf.

MULTI-CRITERIA ASSESSMENT, OTHER INDICATOR METHODS

29. Adger, W. Neil et al. "Governance for sustainability: towards a 'thick' analysis of environmental decisionmaking." *Environment and Planning A*. 35 (2003): 1095-1110.

30. BIPE Conseil et al. "Wild Cards: A multinational perspective." 1992.

31. Girling, Cynthia, R. Kellett and S. Johnstone. "Informing Design Charettes: Tools for Participation in Neighbourhood-scale Planning". *The Integrated Assessment Journal*. 6:4 (2006): 109-130.

32. Sheppard, S. R. J. and Meitner, M. J. 'Using multi-criteria analysis and visualisation for sustainable forest management planning with stakeholder groups', *Forest Ecology and Management*. Vol. 207/1-2 (2005): 171-187

33. Sheppard, S., E. Pond, C. Campbell. #26 above.

PARTICIPATORY PROCESSES

34. Beckley, T.M., J.R. Parkins, and S.R.J. Sheppard. *Public Participation in Sustainable Forest Management: A Reference Guid*e. Edmonton, Alberta: Sustainable Forest Management Network, 2006.

35. CaliforniaSpeaks. "Public Impacts: Evaluating the outcomes of the CaliforniaSpeaks statewide conversation on health care reform." Online pdf. www.californiaspeaks.org.

36. Fraser Basin Council. Smart Planning for Communities. www.smartplanningbc.ca.

37. Girling, C. et al. #31 above.

38. Hopkins, Rob. *The Transition Handbook: From oil dependency to local resilience*. Green Books, UK, 2008.

39. Kaner, Sam et al. *Facilitator's Guide to Participatory Decision-Making.* Gabriola Island: New Society Publishers, 1996.

40. Lennertz, Bill and Aarin Lutzenhiser. *The Charrette Handbook: The Essential Guide for Accelerated, Collaborative Community Planning.* The National Charrette Institute. Chicago: American Planning Association, 2006.

41. Schroth, O., U. Wissen, and W.A. Schmid. "Developing New Images of Rurality - Interactive 3D Visualizations for Participative Landscape Planning Workshops in the Entlebuch UNESCO Biosphere Reserve." DISP 166, No. 3 (2006): 26-34. www.nsl.ethz.ch/index.php/de/content/download/1298/7856/file

42. Valencia, C., D. Flanders and R. Kozak. "Participatory Landscape Planning and Sustainable Community Development: Methodological Observations from a Case Study in Rural Mexico." Accepted in the *Journal of Landscape and Urban Planning* 94:1 (2009): 63-70.

SCENARIOS

43. Alcamo, J. "Scenarios as tools for international environmental assessments". Environmental Issue Report No. 24. Luxembourg: Office for Official Publications of the European Communities, European Environmental Agency, 2001.

44. Cohen, Stewart. #1. above.

45. Economics of Climate Adaptation Working Group. "Shaping Climate-Resilient Development: A framework for decision-making." 2009.

46. Global Scenarios Group: www.gsg.org/scenario_descriptions.html.

47. Hopkins, Rob. #38 above.

48. Intergovernmental Panel on Climate Change Working Group III. "Summary for Policy-makers - Emissions Scenarios." 2000. www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf .

49. Moss.

50. Nakicenovic, Nebojsa et al. "Intergovernmental Panel on Climate Change: Special Report on Emissions Scenarios." 2000. www.grida.no/publications/other/ipcc_sr/?src=/climate/ipcc/emission/.

51. Parson, Edward, et al. "Global-change Scenarios: Their Development and Use." US Climate Change Science Program: Synthesis and Assessment Product 2.1b, Draft for CCSP Review, November 2006.

52. Swart, R.J., J. Robinson and P. Raskin. "The Problem of the Future: sustainability science and scenario analysis." *Global Environmental Change* 14 (2004): 137-146.

53. van't Klooster, S.A., and M. van Asselt. "Practicing the scenario-axes technique." *Futures* 38 (2006): 15-30.

VISIONING + VISUALIZATIONS

54. Biosphere 3D: www.biosphere3d.org/.

55. Biosphere 3D BC forestry tutorial (Schroth, 2009) http://sourceforge.net/apps/mediawiki/biosphere3d/index.php?title=Forest_Tutorial .

56. Bishop, I.D., and E. Lange. *Visualization in Landscape and Environmental Planning - Technology and Application*. London / New York: Taylor & Francis, 2005.

57. Dockerty, T., et al. "Developing scenarios and visualisations to illustrate potential policy and climatic influences on future agricultural landscapes," *Agriculture, Ecosystems & Environment* 114, No. 1 (2006): 103-120.

58. Flanders, D.N., S.R.J. Sheppard, A. Shaw, and S. Burch. "Hot in my Backyard: Visualizations of our future landscapes can help landscape architects plan for climate change". *Landscape Architecture*. ASLA

(May 2008): 82-87.

59. Flanders, D.N., S.R.J. Sheppard, S. Burch, E. Pond, A. Shaw and S. Cohen. "Blueprints for Green Communities: Climate change visioning and participatory landscape planning for resilient low-carbon communities." Proceedings in Fábos International Conference in Landscape and Greenway Planning, July 8-10th, 2010, Budapest, Hungary.

60. Nicholson-Cole, S.A. "Representing climate change futures: a critique on the use of images for visual communication," *Computers, Environment and Urban Systems* 29, No. 3 (2005): 255-273.

61. Pond, Ellen, Olaf Schroth and Stephen Sheppard. "CALP Visioning and Visualizations, Kimberley Climate Adaptation Project: Final Report to the Real Estate Foundation Communities in Transition Program". Collaborative for Advanced Landscape Planning, UBC, 2009. www.calp.forestry.ubc.ca/.

62. Salter, J.D., et al., "The digital workshop: Exploring the use of interactive and immersive visualisation tools in participatory planning," *Journal of Environmental Management* 90, No. 6 (2009): 2090-101.

63. Schroth, O, et al. #41 above.

64. Schroth, O. "From Information to Participation - Interactive Landscape Visualization as a Tool for Collaborative Planning." 2007. http://e-collection.ethbib.ethz.ch/view/eth:30427

65. Schroth, Olaf, Ellen Pond, Sara Muir-Owen, Cam Campbell, and S.R.J. Sheppard. "Tools for the understanding of spatio-temporal climate scenarios in local planning: Kimberley, BC, case study". Bern: Swiss National Science Foundation SNSF, 2009. www.lviz.org/?p=231

66. Shaw, A., Sheppard, S.R.J., Burch, S., Flanders, D.N., Wiek, A., Carmichael, J., Robinson, J., Cohen, S. "Making futures tangible – synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building". *Global Environmental Change* 19(4) (2009): 447–463.

67. Sheppard, S.R.J. & J. Salter. "The role of visualisation in forest planning." *Encyclopedia of Forest Sciences*. Academic Press/Elsevier, Oxford, UK. (2004): 486-498.

68. Sheppard, S.R.J. "Landscape visualisation and climate change: the potential for influencing perceptions and behaviour," *Environmental Science & Policy* 8, No. 6 (2005): 637-654.

69. Sheppard, Stephen. "Local Climate Change Visioning: A New Process for Community Planning and Outreach using Visualization Tools." *Plan Canada*, 48:1 (Spring 2008): 36-40.

70. Sheppard, Stephen, J.L. Lewis, C. Akai. *Landscape Visualization: An Extension Guide for First Nations and Rural Communities*. Sustainable Forest Management Network: Edmonton, Alberta, 2004.

71. Tatebe, K., A. Shaw, and S.R.J. Sheppard. "Technical Report on Local Climate Change Visioning for Delta: Findings and Recommendations." University of British Columbia, CALP, 2010. In press.

VISUALIZATION ETHICS

72. Sheppard, S.R.J. "Guidance for crystal ball gazers: Developing a code of ethics for landscape visualization". *Landscape & Urban Planning* (special issue), Volume 54 (May 2001): 183-199.

73. Sheppard, S.R.J. "Validity, reliability, and ethics in visualization". In: Bishop, I. & Lange, E. (Eds.) *Visualization in Landscape and Environmental Planning: Technology and Applications.* Taylor and Francis, London. Chapter 5 (2005): 79-97.

74. Sheppard, S.R.J., P. Cizek. "The Ethics of Google-Earth: Crossing thresholds from spatial data to landscape visualization." *Journal of Environmental Management* 90(6) (2009): 2102-2117.

SECTION 5
APPENDICES

5.1 KIMBERLEY CASE STUDY Available at: www.calp.forestry.ubc.ca/

SEE ALSO: Dr. Schroth's report to the Swiss National Sciences Foundation[65]; the final KCAP Report to Council, of which CALP's work was a part, is available at www.city.kimberley.bc.ca.

CALP Visioning and Visualizations Kimberley Climate Adaptation Project

Final Project Report to the Real Estate Foundation Communities in Transition Program

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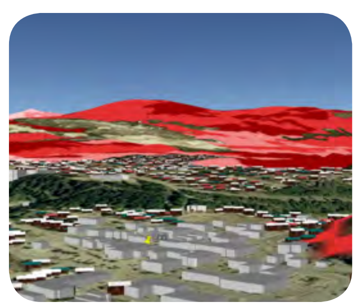

KIMBERLEY CASE STUDY FINAL PROJECT REPORT

EXECUTIVE SUMMARY

Small towns and rural communities in areas such as BC's Columbia Basin face multiple climate change challenges, requiring new strategies for policy change and action on both adaptation and mitigation. However, the complexities and uncertainties of climate change at the local level are difficult for both decision-makers and citizens to understand. Clearer communication of complex and diverse information is required to explore risks and possible responses, and to build public support for the difficult choices involved in local climate change planning.

Kimberley is a Kootenay municipality located in southeastern BC on the eastern edge of the Purcells and with a view of the Rockies.

In 2008, the City of Kimberley was one of two chosen by the Columbia Basin Trust to pilot a year-long climate adaptation project. Kimberley has a population of approximately 6000, and originated as a mining town over 100 years ago. Since the Sullivan Mine closure in 2001, Kimberley has relied on tourism & outdoor recreation for its economic base, along with second home ownership and amenity migration. The City's assets include an alpine ski resort, a Nordic ski centre, over 100 kilometres of trails, and an 800 hectare nature park. It is potentially vulnerable to a range of impacts on snowpack, water supply, flooding, forest pests, and fire, among others. The Kimberley Climate Adaptation Project (KCAP) sought to identify a range of potential climate change impacts, assess local vulnerabilities, and develop adaptation strategies.

To help Kimberley address these issues, UBC's Collaborative for Advanced Landscape Planning (CALP) joined the KCAP team to pilot a climate change visioning process for use in small communities in BC's interior. The process uses tools such as GIS mapping and 3D visualizations to localize, spatialize, and visualize climate change impacts and solutions. The collaborative process contributed to Kimberley's project by helping to engage the community, integrate disparate databases, develop future scenarios with adaptation/mitigation options, and generate new mapping and analysis. Most notably, it created visualizations and GoogleEarth fly-bys to communicate complex information more clearly to citizens and stakeholders. Previous Lower Mainland visioning case studies have shown that similar techniques can lead to increased community and practitioner awareness, including a sense of urgency, and increased support for adaptation and mitigation policies.

CALP's research goals were to enhance Kimberley's adaption planning, test the effectiveness of the climate change visioning process, and adapt it so that it can be used by other communities in the future.

The Visioning Process has four critical components: stakeholder participation, data integration and modelling, scenario development, and production of visualizations informed by the best available science. Data relevant to climate change from multiple sources, disciplines, and jurisdictions can be integrated and checked locally in 3D, while scenarios allow participants to ask "what if" questions critical to planning for the unexpected. Two future climate change scenarios developed by CALP and KCAP - "Kimberley Adapts" and "Low-Carbon Kimberley" - provided a framework in which current land use plans, local vulnerabilities, projected climate change impacts and various response options could be explored. CALP produced mapping and 3D

KIMBERLEY CASE STUDY FINAL PROJECT REPORT

EXECUTIVE SUMMARY

Visualizations can improve the communication of expert data to lay-people and decision-makers, and bundle cross-disciplinary knowledge into coherent, future "what-if" scenarios.

visualizations of proposed housing expansion, susceptibility to Mountain Pine Beetle around the City, including in the community watersheds, wildfire vulnerabilities, and potential impacts such as flooding in town. Multiple adaptation/mitigation options were also depicted, including re-naturalizing creek channels, management to reduce wildfire risk, solar energy facilities, and low-carbon transportation options.

The visioning process contributed to development of the 75 KCAP recommendations presented to Council. The collaborative project culminated in a Community Open House to present the KCAP recommendations and CALP visualizations; CALP also evaluated the visualizations through survey forms and interviews. The visualizations shown to residents included a live Kimberley "Virtual Tour" using the virtual globe GoogleEarth, an interactive GoogleEarth station, and technical posters explaining the results. Participant feedback shows that visualizations and virtual globes were found by many to be engaging and compelling, and increased understanding of various local impacts and adaptation/mitigation options. The research findings suggest, however, that caution should be used when employing GoogleEarth or other "virtual globes" to communicate spatial data as a minority of participants disliked virtual globes.

Capacity-building with the Geospatial Research Centre at Selkirk College in Castlegar was built into the project, so that future visioning and visualization work can be initiated within the Basin.

In terms of replicability, CALP explored different types of visualizations – some more easily produced than others. The simplest method is to export existing GIS data to a 3D virtual globe such as GoogleEarth. More sophisticated visualizations are needed to depict 3D vegetation, such as forest health effects. A major project outcome was that CALP shared its work, experience, and findings with the Geospatial Research Centre at Selkirk College, building climate change visioning capacity within the Basin.

The Pacific Climate Impacts Consortium (PCIC) tested different models to provide projected snowpack changes under climate change for Kimberley – and developed an early prototype model for downscaling snowpack – the first such modeling use in Canada.

Lessons learned include that locally downscaled climate projections are still experimental, particularly for complex modeling such as snowpack. As well, where integrated datasets for climate change planning do not already exist, considerable time must be spent gathering and integrating data from disparate sources. However, the visualization process can add significant value to existing data on current conditions, such as fire-hazard mapping, by effectively conveying risks and climate change trends. A skilled navigator, structured presentations, and/or technical posters are needed with interactive visualizations to ensure that all participants can engage with and understand the material.

Recommendations for the future include continuing to research and apply locally-relevant downscaled climate projections in order to communicate vulnerabilities that may be exacerbated by changing climate conditions; exploring regional level visualisations of iconic locations and climate change impacts, applicable to multiple communities within the Columbia Basin; and integrating adaptation and mitigation planning to identify potential synergies in meeting climate change objectives.

5.2 VISUALIZATION ETHICS

The following material is taken from[72]:

Sheppard, S.R.J. "Guidance for crystal ball gazers: Developing a code of ethics for landscape visualization". *Landscape & Urban Planning* (special issue). Volume 54 (May 2001): 183-199.

Abstract

Computer visualization of landscapes in three or four dimensions constitutes a ''crystal ball'' capable of showing us views into the future. This paper discusses the risks of the growing but unstructured use of these landscape visualizations as a popular decision-making and public communications tool in planning. The author argues that we need to establish a framework for guidance and supporting resources for the use of landscape visualization, including accepted procedures, training, appropriate databases, and a communication network for users. In particular, it is argued that the preparers of visualizations — whom we can think of as the ''crystal ball gazers'' who conjure up and interpret the imagery — need to be governed by a code of ethics for defensible landscape visualization.

Drawing on research on visualization effectiveness and validity, as well as anecdotal evidence from professional practice, the paper identifies potential problems associated with emerging visualization technologies, and reviews the needs for, progress toward, and potential benefits of a support infrastructure for visualization preparers and presenters. A framework for guidance and support of visualization practitioners is proposed, in the hope of improving the chances of ethical practice and scientific validity in the use of these systems. Pending more comprehensive findings from the considerable body of research which is needed on this subject, an interim code of ethics is presented, for consideration, testing, and amendment by other researchers and users. It is suggested that such a code include broad principles and guidance on ethical conduct in producing visualizations, presenting them to viewers, and analysing responses to them from users as feedback.

Implications for future research and practice are provided, with an emphasis on the urgent need for researchers to monitor and evaluate the use and influence of landscape visualizations in practice.

Keywords: Visualization; Visual simulation; Ethics; Computer graphics; Simulation validity; 3D modelling; Decision support; Virtual reality

From Sheppard 2001: page 196[72]

Table 2
Proposed interim code of ethics for landscape visualization

Purpose of landscape visualization

Professional preparers and presenters of landscape visualizations are responsible for promoting full understanding of proposed landscape changes; providing an honest and neutral visual representation of the expected landscape, by seeking to avoid bias in responses (as compared with responses to the actual project); and demonstrating the legitimacy of the visualization process

General principles

Preparers and presenters of landscape visualizations will adhere to the following general principles

- *Accuracy*: realistic visualizations should simulate the actual or expected appearance of the landscape as closely as possible (at least for those aspects of the landscape being considered)
- *Representativeness*: visualizations should represent the typical or important range of views, conditions, and time-frames in the landscape which would be experienced with the actual project, and provide viewers with choice of viewing conditions
- *Visual clarity*: the details, components, and overall content of the visualization should be clearly communicated
- *Interest*: the visualization should engage and hold the interest of the audience, without seeking to entertain or "dazzle" the audience
- *Legitimacy*: the visualization should be defensible through making the simulation process and assumptions transparent to the viewer, and by clearly describing the expected level of accuracy and uncertainty
- *Access*: to visual information: visualizations which are consistent with the above principles should be made readily accessible to the public via a variety of formats and communication channels

Code of ethical conduct

The use of landscape visualizations should be appropriate to the stage of development of project under consideration, to the landscape being shown, to the types of decisions being made, to the audience observing the visualizations, to the setting in which the presentation is being made, and to the experience level of the preparer. Within this context, preparers and presenters of landscape visualization will:

- Demonstrate an appropriate level of qualifications and experience
- Use the appropriate visualization system(s) and media for the purpose
- Choose the appropriate level of realism
- Identify, collect, and document supporting visual data available for or used in the visualization process; conduct an on-site visual analysis to determine important issues and views
- Seek community input on viewpoints and landscape issues to address in the visualizations
- Estimate and disclose the expected degree of error and uncertainty
- Use more than one appropriate presentation mode and means of access for the affected public
- Provide the viewer with a reasonable choice of viewpoints, view directions, view angles, viewing conditions, and timeframes appropriate to the area being visualized
- Present important non-visual information at the same time as the visual presentation
- Avoid the use or the appearance of "sales" techniques or special effects
- Avoid seeking a particular response from the audience
- Provide information describing how the visualization process was conducted and key assumptions/decisions taken
- Record responses to visualizations as feedback for future efforts
- Conduct post-construction evaluations to document accuracy of visualizations or changes in project design/construction/use

5.3 VISUALIZATION TYPES and AUDIENCES

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FACT SHEET 2: VISUALISATION TOOLS

BACKGROUND

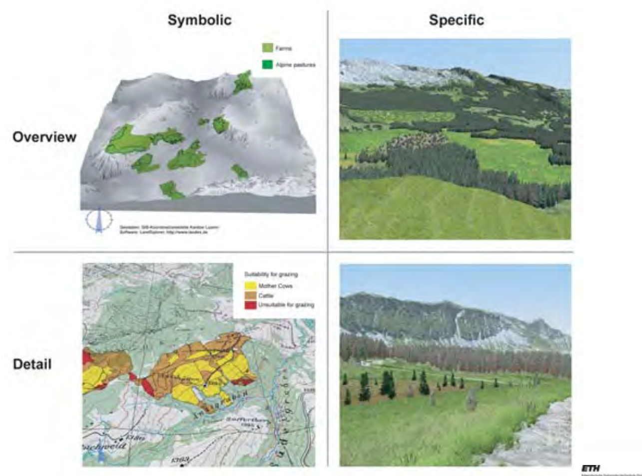
3D landscape models are based on a digital terrain model (DTM) which represents the topography. Orthophotos and satellite images are projected onto the DTM as geotextures. Then, built objects and vegetation are inserted. Like this different types of 3D landscape visualisations and different modes of interactivity can be produced.

LEVEL OF ABSTRACTION

A visualisation is the more realistic the more specific textures and the more specific geometry is used in the modelling of the objects e.g. of a specific single family house at a specific geographic location. In contrast, a symbolic representation would be a simple volume representing a house or a single colour texture map.

Four different types have been defined: Symbolic resp. specific overview and detail visualisations.

VISUALISATION TYPES

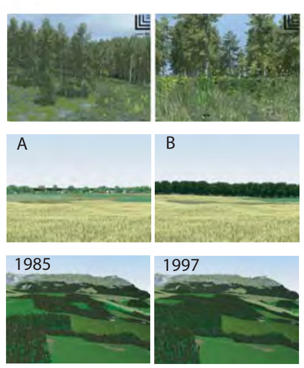


INTERACTION TYPES

geographic navigation

scenario navigation

temporal navigation



LEVEL OF INTERACTIVITY

Virtual landscapes require a certain degree of interactivity to allow their spatial and thematic exploration. A selection of the most important interactive functions for planning applications includes various modes of realtime navigation, e.g. temporal navigation and the selection of scenarios, as well as functions to change the representation of the model.

CONCLUSIONS

Visualisations designed to facilitate participation need to be closely integrated into the planning process. Through iterative testing, the visualisation tools were gradually adjusted with regard to the display of the information and the type of interaction offered to fulfil the needs of end-users.

For further information please contact: xxx@email.address

Research undertaken as part of the European Commission Shared Cost Action Project in Quality of Life, QLK5-CT-2002-01017, "Visualisation Tools for Public Participation in the Management of Landscape Change".

Project partners

THE MACAULAY INSTITUTE · ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zürich · Forest Research An agency of the Forestry Commission · Escola Superior Agrária de Coimbra · UMB · INRA · SLU

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FACT SHEET 3: DECISION GUIDE

BACKGROUND

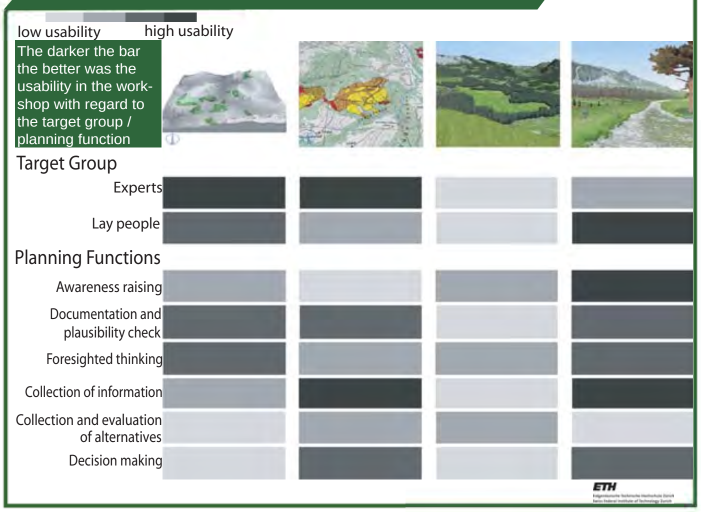
Different types of 3D landscape visualisations and different modes of interactivity are available. The decision, which visualisation type should be chosen, depends on several factors as the role of the visualisations in the planning process, the background of the stakeholders or the setting in the single workshop, to name only a few.

EVALUATION

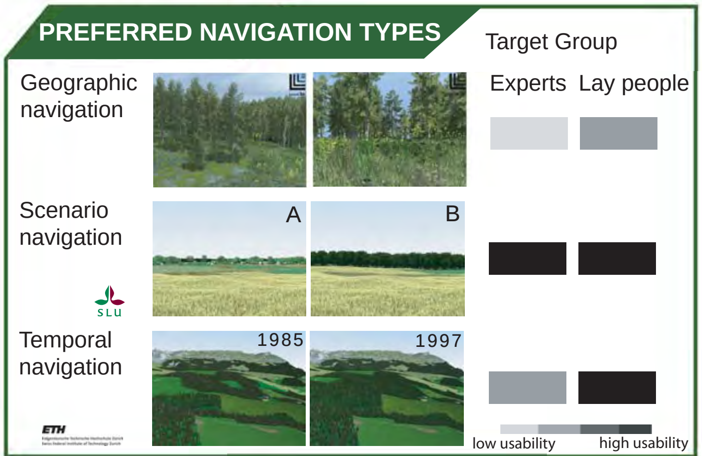
Overall, the 3D visualisations have shown to be most suitable for raising peoples' awareness and supporting the collection of information.

They are also rather efficient to document and present the status of planning for checking the plausibility and consequences of planned measures. In some cases, they were useful to support foresighted thinking in giving an impulse for a certain direction.

CHOOSING A VISUALISATION TYPE



PREFERRED NAVIGATION TYPES



INTERACTIVE PRESENTATION

In collaborative processes, various interactive functions are required to respond to the participants. Realtime models provide this flexibility: Geographic navigation allows to zoom in the issue, time travel enhances the perception of landscape change over time, and scenario navigation facilitates the comparison of planning alter-natives.

CONCLUSIONS

Interactive visualisation tools can support the anticipation of planning alternatives, and thus they accelerate the discussion. Therefore, they can be a catalyst to participative planning processes. Hence, interactive visualisations are mighty tools, although they have to be used with careful consideration.

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5.4 SPATIAL GREENHOUSE GAS EMISSIONS

As discussed in Section 2.2.2, GHG emissions are a critical indicator for assessment and comparison across scenarios. **For a simple GHG indicator,** start with the CEEI inventory[13]. For a rough "business-as-usual" future projection, increase the community emissions inventory numbers by same percentage as the projected increase in housing units (include both housing emissions and transportation).

While CEEI emissions inventories are a good starting point for local communities, the **CEEI inventories do not capture** all emissions associated with our current lifestyle, such as food and air travel. They may have difficulty handling issues such as emissions associated with amenity migration, and who is responsible. As well, they are not spatial, as CEEI building emissions are determined by dividing the communities' total residential emissions by the total number of housing units. Thus, the CEEI inventories are not able to show the relationship between different development types/land uses and different GHG emissions, making it more difficult to assess alternate development options for their GHG implications.

Because **emissions by housing type can be significantly different**[23, 28] - single family typically is high while multi-family typically can be much lower - the non-spatial method does not capture the emissions reductions possible with changes in housing type. A spatial methodology, in contrast, accounts for the size of the buildings (by measuring emissions per m2), the type (by differentiating between single-family and higher density per m2), as well as simple locational modeling (higher transportation emissions due to residences located further from services can be accounted for).

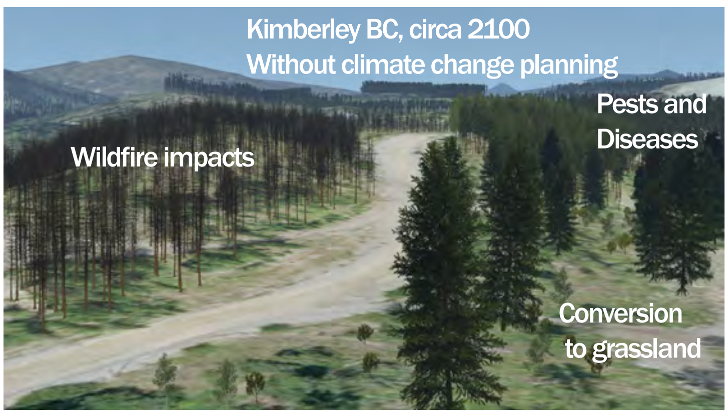
Therefore, **spatializing local GHG emissions can be helpful in understanding the trade-offs between development types, land uses, and meeting GHG targets.**

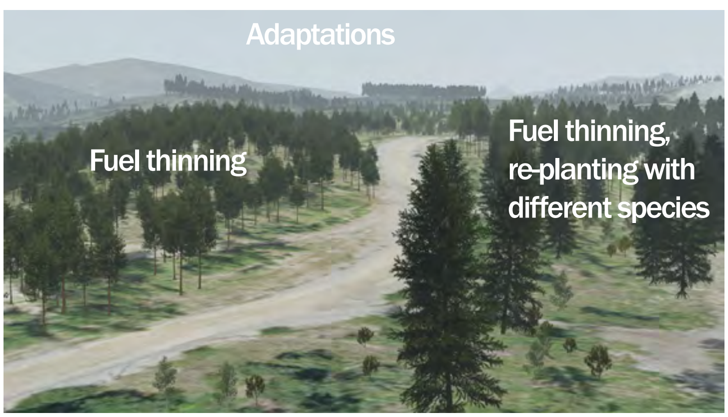
The following is a **very preliminary discussion of methods** for calculating spatial emissions. It may be appropriate for smaller communities; other open-source resources include the GHGProof land-use and GHG emissions tool[27]. A more complex methodology for larger communities with significantly more residential units can be found in GHG modeling work for the City of North Vancouver[23], as well as for the District of North Vancouver[21].

Spatial emissions for residential buildings can be calculated using the building area (which, if not known, can be calculated using building footprints multiplied by the number of stories), and an energy or CO2e (GHG) density (i.e. per square meter), with different numbers by housing type (single-family, rowhouse/lowrise), and preferably adjusted for age of building. This captures the difference between smaller and larger houses, housing type, and housing age/energy performance.

Transportation emissions are far more complicated to model as they are behaviourally based. However, the link between location (i.e. sprawling vs compact land use), and transportation emissions (i.e. higher vs lower) has been well documented[21]. Again, rough and preliminary calculations, based on the average number of trips per day and standard distances from housing to different service centres, can yield comparative numbers, showing the difference in transportation emissions between those residents able to walk to services, and those who need to get into a car to meet their basic daily needs, as well as the emissions associated with traveling to further locations such as the next community. Destinations to consider include: work, schools, recreational activities, grocery shopping, other shopping, etc.

Lastly, neither projecting CEEI numbers nor the spatial method will capture future opportunities to reduce emissions through adding renewable energy sources for space heating, hot water, additional electricity, and vehicle fuels, whether at the provincial, RD/municipal, or building-scale. Modeling for such additions, particularly at the community/neighbourhood scale, is still preliminary[22], and assumptions will need to be made about the potential reductions achievable.





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