WEB CONFERENCE

FOREST OPERATIONS PROGRAM 2019-2020

FPInnovations®

Climate Change Tools for Design Flood Calculations

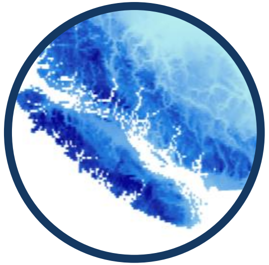
February 6th 2020

With: **MATT KUROWSKI, Researcher, Transportation Group**

Notes:

- The webinar will start at 13:00 EST / 10:00 PST
- All lines are muted during the presentation
- Go to slido.com (smartphone or computer) to participate in live polls. **code: fpi**
- Audio connection: 1-844-630-9442; code: 736 173 621

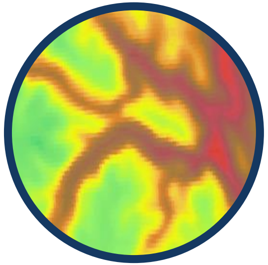
An Overview of Climate Change Tools Applied to Small Watershed Design Flood Calculations



Webinar Series: Understanding Climate Change at a Small Watershed Scale

Matt Kurowski, M.Sc., EIT| Feb 6, 2020

FPInnovations



Webinar Series

Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Understanding decision-making about climate change impacts at a small watershed scale

February 6

An Overview of Climate Change Tools Applied to Small Watershed Design Flood Calculations – Matt Kurowski, FPInnovations, Vancouver

February 13

Climate tools: What are they good for? Absolutely something… but you can't always get what you want – Kari Tyler, Pacific Climate Impacts Consortium, University of Victoria

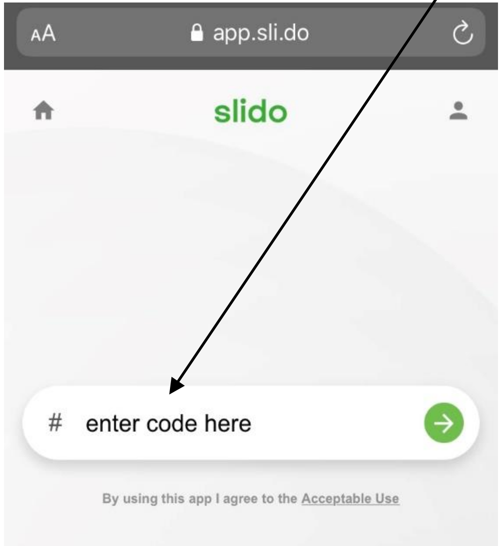
February 27

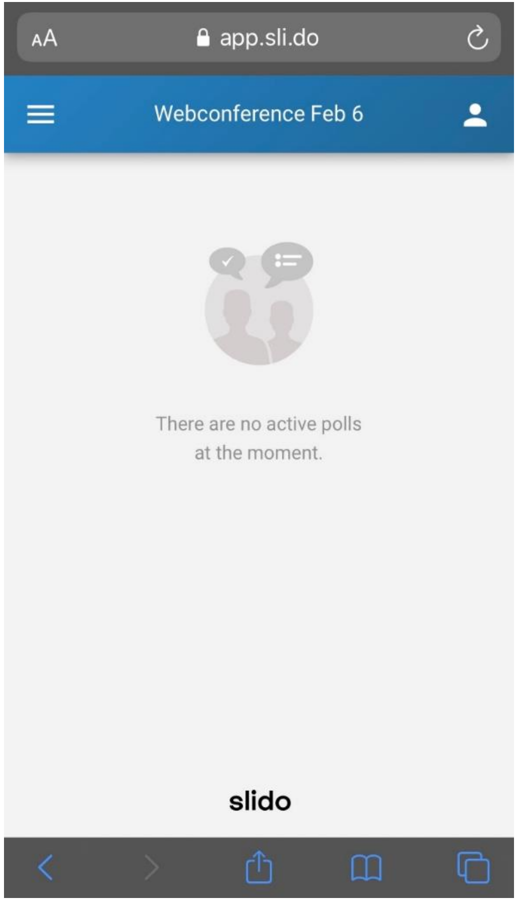
Rainfall Intensity Duration Frequency Curves for Future Climate Scenarios: A Publicly Accessible Computer Tool – Dr. Simonovic, Institute for Catastrophic Loss Reduction, Western University

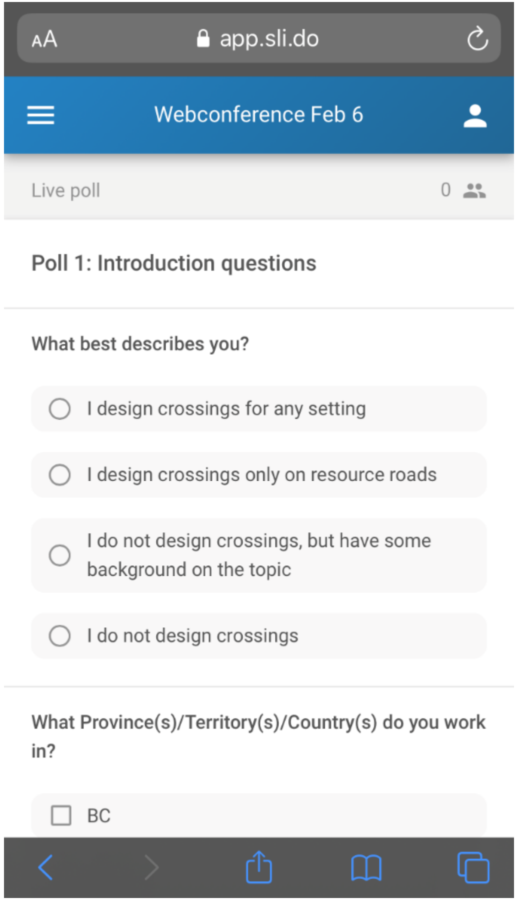
Poll # 1

Learning about who is here

go to: slido.com code: fpi







Panelists: Questions/Discussion

Brian Chow – Chief Engineer, FLNRORD, Victoria

Matt Kurowski – Researcher, FPInnovations, Vancouver

Mark Partington – Researcher, FPInnovations, Montreal

Kari Tyler – User Engagement and Training Specialist, Pacific Climate Impacts Consortium, University of Victoria

Dr. Slobodan Simonovic – Professor Emeritus, Institute for Catastrophic Loss Reduction, Western University

Harshan Radhakrishnan – Manager, Climate Change and Sustainability Initiatives, Engineers and Geoscientists BC

Why this webinar series?

BRITISH COLUMBIA

Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Content of the Presentation

Context

- Trends in practices
- Overview: how CC models for BC inform available CC tools
- Limitations: CC models/tools at small watershed scale

Using a CC tool

- 4 CC tools: focus on BC and small watershed flooding

Example location

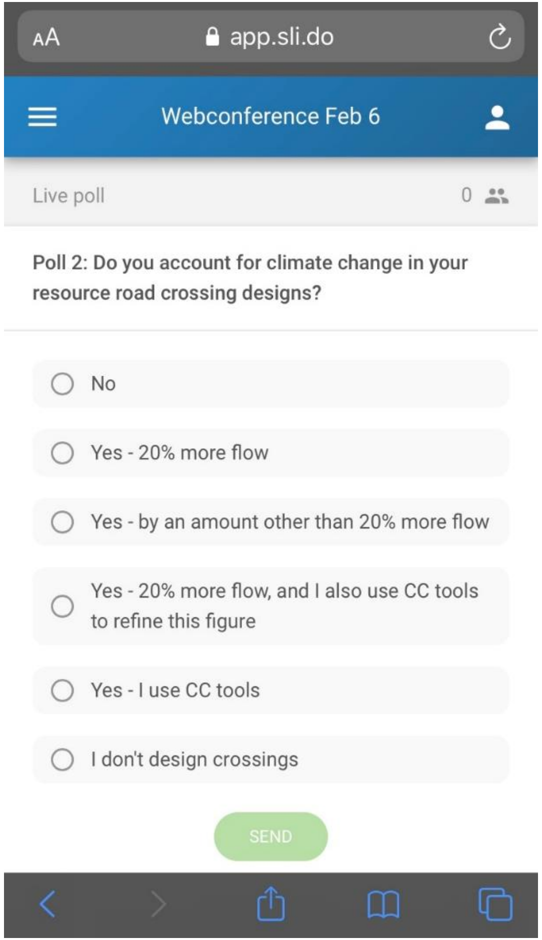
- Comparing 4 CC tool interfaces and results

Summary

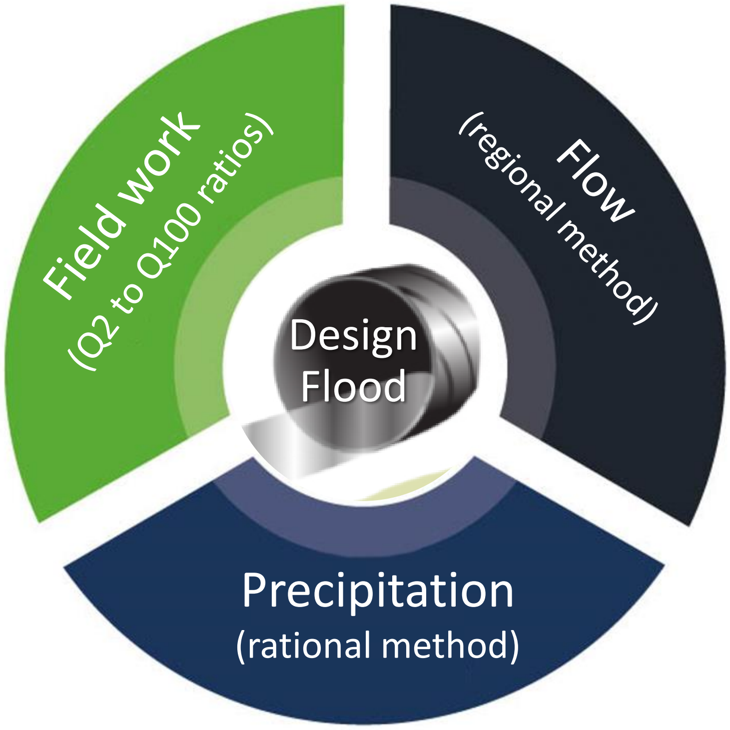
- Some trends for BC from CC tools and overall conclusions

Poll # 2

Do you account for climate change in your resource road crossing designs?



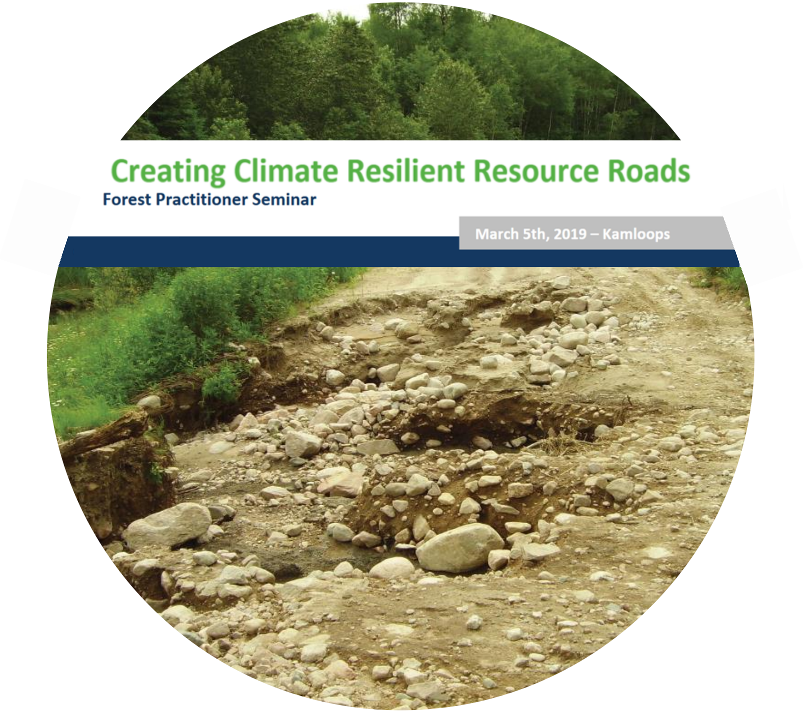
Trends in Practices – 2018 Survey



Interviews with 12 crossings designers in private and public sector:

- Field/Flow methods most trusted, rational method normally a check
- Limited modeling done/possible
- Consensus on biggest issue: not enough stream gauge stations - especially in smaller watersheds
- **Majority not using CC tools – but are using EGBC guidance: 20%**

Trends in Practices – 2019 Workshop



Mix of designers, foresters, planners in private and public sector (~50 people):

- Not all private sector had heard of all available CC tools
- Those that have used them previously (mostly private sector) exposed through bigger budget projects
- **Most in public sector had not heard of any CC tools**
- **Clearer guidance on CC needed**

Overview: GCMs and standards

General circulation models - first principles physics simulation

Use global historical data to calibrate (model able to replicate past)

Many GCMs:

inmcm4-r1
HadGEM2-ES-r1
ACCESS1-0-r1
CanESM2-r1
MRI-CGCM3-r1
CNRM-CM5-r1
CCSM4-r2
MPI-ESM-LR-r3
MIROC5-r3
HadGEM2-CC-r1
CSIRO-Mk3-6-0-r1
GFDL-ESM2G-r1
…

Standards

ipcc

Emissions scenarios:
RCP 2.6, 4.5, 6.0, 8.5

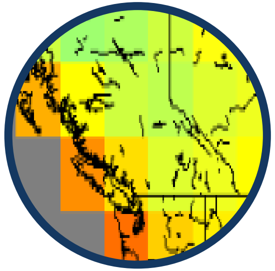
Future periods (30y):
2025, 2055, 2085

Historic periods

Example outputs for CanESM2 GCM:

CanESM2(2.6,2025)
CanESM2(2.6,2055)
CanESM2(2.6,2085)

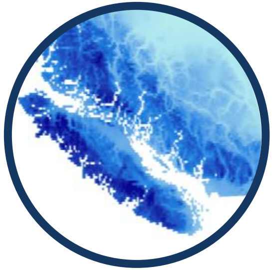
CanESM2(4.5,2025)
CanESM2(4.5,2055)
… etc



~50km2 daily & monthly simulation results

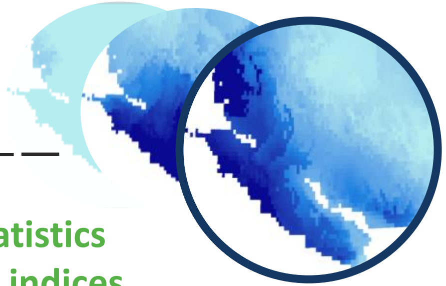
Basic CC indices: temperature, precipitation (past & future)

Overview: downscaling in BC



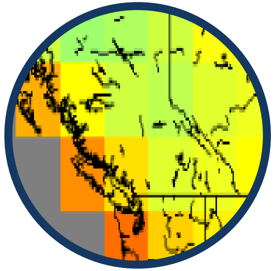
~4-10km^2
monthly/daily

summary statistics
of derived CC indices



~4-10km^2 daily
grid (~1950-2100)

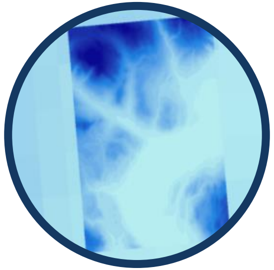
spatial and temporal
downscaling



~50km2
daily & monthly
simulation results

(Group of ~15
models – focus on
RCP 2.6, 4.5, 8.5)

spatial downscaling –
accounting for elevation, aspect



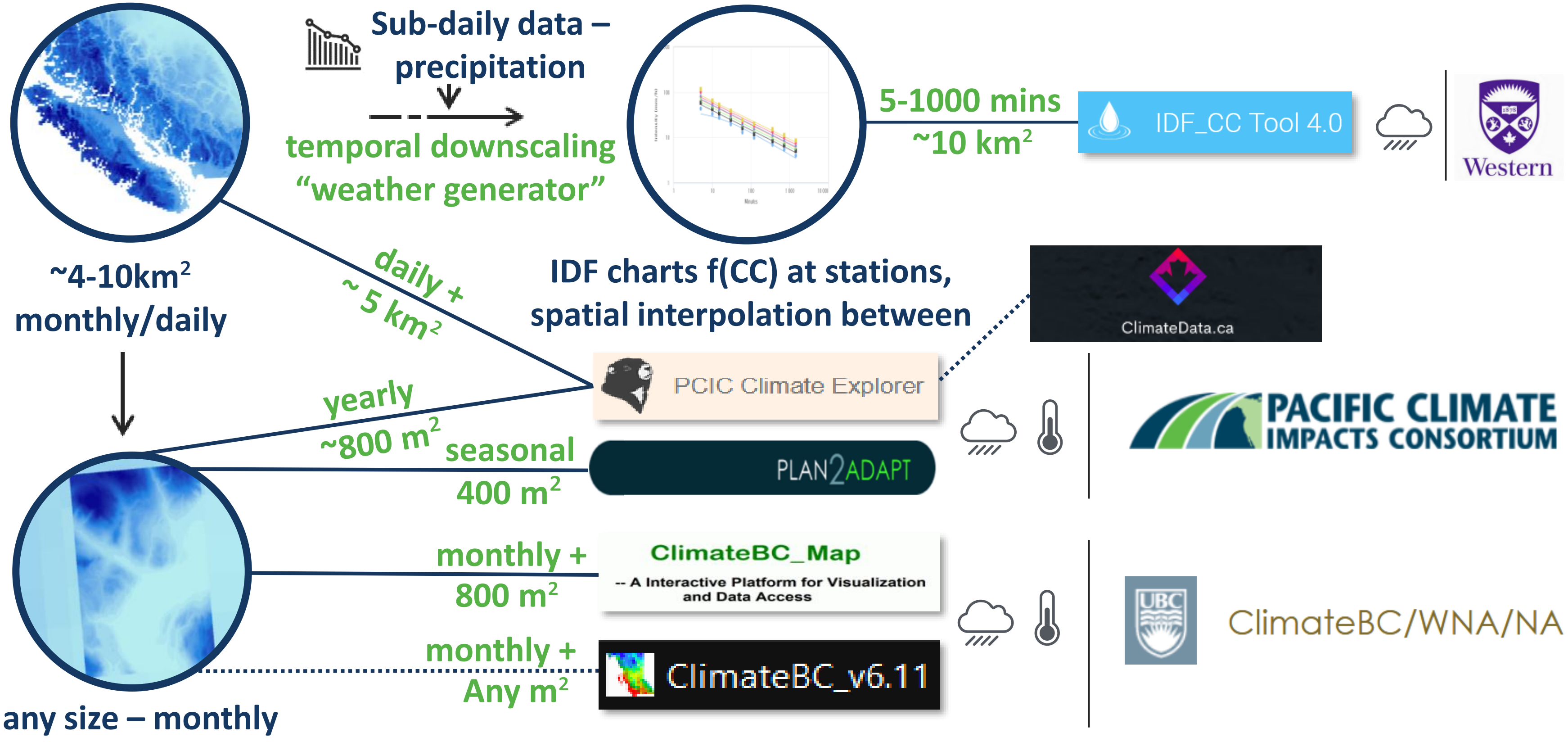
any size – monthly

downscaling
program/service

ClimateBC/WNA/NA

PACIFIC CLIMATE
IMPACTS CONSORTIUM

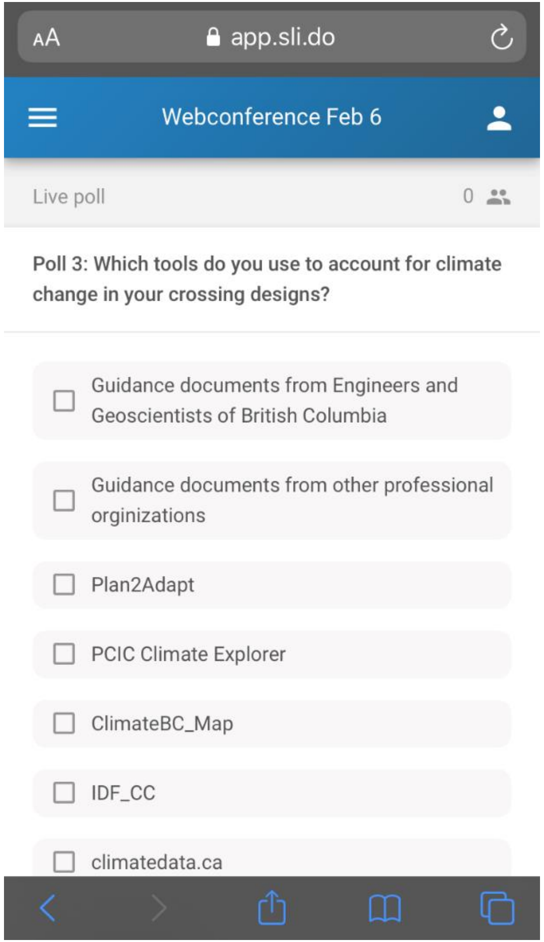
Overview: CC models and resulting CC tools



Poll # 3

Which tools do you use to account for climate change in your crossing designs?

(select all that apply)



Limitations: CC tools at small watershed scale

USING PRECIPITATION DATA: Q100 design flood change due to CC (given that rain is dominant flood)

PLAN2ADAPT

PCIC Climate Explorer

ClimateBC_Map
-- A Interactive Platform for Visualization and Data Access

IDF_CC Tool 4.0

PACIFIC CLIMATE IMPACTS CONSORTIUM

engineers: "need to rely on projections of daily extremes and professional judgement"

→ Assumption: temporally downscaled sub-daily data will have the same relationship to daily data in the future as in the past

Limitations: CC tools at small watershed scale

USING PRECIPITATION DATA: Q100 design flood change due to CC (given that rain is dominant flood)

PLAN2ADAPT

PCIC Climate Explorer

ClimateBC_Map
-- A Interactive Platform for Visualization and Data Access

→ "likely safe to assume": increases in short storm intensities proportional to magnitude and direction of averages (but consult CC specialist)

IDF_CC Tool 4.0

→ Should be "treated with caution" and as an exploratory tool

ENGINEERS & GEOSCIENTISTS
BRITISH COLUMBIA

Limitations: CC tools at small watershed scale

USING PRECIPITATION DATA: Q100 design flood change due to CC (given that rain is dominant flood)

PLAN2ADAPT

PCIC Climate Explorer

ClimateBC_Map
-- A Interactive Platform for Visualization and Data Access

→ Many "secondary" indices that may be useful for design flood hydrology (DFH) risk considerations…

Using 4 CC tools – inputs

define future

GCM(s): **CNRM-CM5-r1**
CanESM-r1
ACCESS-0-r1
inmcm4-r1
Ensemble

Scenario(s): 2.6, **4.5**, 6.0, **8.5**
Time period: 2025, **2055**, **2085**
Baseline reference: **1961-1990**
other periods

define location

Pick from list of areas
Click map point — PLAN2ADAPT

Draw/Import Area — PCIC Climate Explorer

Click map point — ClimateBC_Map -- A Interactive Platform for Visualization and Data Access

Click station point
Click ungauged point — IDF_CC Tool 4.0

Using 4 CC tools – available/applicable outputs

PLAN2ADAPT

use CC indices

Pick from list of areas

Regional Districts

- Alberni-Clayoquot
- Bulkley-Nechako
- Capital
- Cariboo
- Central Coast
- Central Kootenay
- Central Okanagan
- Columbia-Shuswap
- Comox Valley
- Cowichan Valley
- East Kootenay
- Fraser-Fort George
- Fraser Valley
- Greater Vancouver
- Kitimat-Stikine
- Kootenay Boundary
- Kootenay Boundary
- Mount Waddington
- Nanaimo
- Northern Rockies
- North Okanagan
- Okanagan-Similkameen
- Peace River
- Powell River
- Skeena-Queen Charlotte
- Squamish-Lillooet
- Stikine
- Strathcona
- Sunshine Coast
- Thompson-Nicola

Ecoprovinces

- Boreal Plains
- Central Interior
- Coast and Mountains
- Georgia Depression
- Northern Boreal Mountains
- Southern Interior
- Southern Interior Mountains
- Sub Boreal Mountains
- Taiga Plains

Forestry Regions

- Cariboo
- Kootenay / Boundary
- Northeast
- Omineca
- Skeena
- South Coast
- Thompson / Okanagan
- West Coast

Temperature

Precipitation

Snowfall

Growing DD

Heating DD

Frost-Free Days

←

→ Click map point

For small watershed flood:
precipitation (rain and snow)
seasonal, 400m²

Using 4 CC tools – available/applicable outputs

PCIC Climate Explorer

use CC indices

Draw/Import area

→ pr - Precipitation
prsn - Precipitation as Snow
tasmax - Daily Maximum Near-Surface Air Temperature
tasmin - Daily Minimum Near-Surface Air Temperature
altcddETCCDI - Maximum Number of Consecutive Days Per Year with Less Than 1mm of Precipitation
altcsdiETCCDI - Cold Spell Duration Index Spanning Years
altcwdETCCDI - Maximum Number of Consecutive Days Per Year with At Least 1mm of Precipitation
altwsdiETCCDI - Warm Spell Duration Index Spanning Years
cddETCCDI - Maximum Number of Consecutive Days with Less Than 1mm of Precipitation
csdiETCCDI - Cold Spell Duration Index
cwdETCCDI - Maximum Number of Consecutive Days with At Least 1mm of Precipitation
dtrETCCDI - Mean Diurnal Temperature Range
fdETCCDI - Frost Days
gslETCCDI - Growing Season Length
idETCCDI - Number of Icing Days
prcptotETCCDI - Annual Total Precipitation in Wet Days
r10mmETCCDI - Annual Count of Days with At Least 10mm of Precipitation
r1mmETCCDI - Annual Count of Days with At Least 1mm of Precipitation
r20mmETCCDI - Annual Count of Days with At Least 20mm of Precipitation
r95pETCCDI - Annual Total Precipitation when Daily Precipitation Exceeds the 95th Percentile of Wet Day Precipitation
r99pETCCDI - Annual Total Precipitation when Daily Precipitation Exceeds the 99th Percentile of Wet Day Precipitation
→ rx1dayETCCDI - Maximum 1-day Precipitation
rx5dayETCCDI - Maximum 5-day Precipitation

sdiiETCCDI - Simple Precipitation Intensity Index
suETCCDI - Number of Summer Days
tn10pETCCDI - Percentage of Days when Daily Minimum Temperature is Below the 10th Percentile
tn90pETCCDI - Percentage of Days when Daily Minimum Temperature is Above the 90th Percentile
tnnETCCDI - Minimum of Daily Minimum Temperature
tnxETCCDI - Maximum of Daily Minimum Temperature
trETCCDI - Number of Tropical Nights
tx10pETCCDI - Percentage of Days when Daily Maximum Temperature is Below the 10th Percentile
tx90pETCCDI - Percentage of Days when Daily Maximum Temperature is Above the 90th Percentile
txnETCCDI - Minimum of Daily Maximum Temperature
txxETCCDI - Maximum of Daily Maximum Temperature
wsdiETCCDI - Warm Spell Duration Index
tx10pETCCDI - Percentage of Days when Daily Maximum Temperature is Below the 10th Percentile
tx90pETCCDI - Percentage of Days when Daily Maximum Temperature is Above the 90th Percentile
txnETCCDI - Minimum of Daily Maximum Temperature
txxETCCDI - Maximum of Daily Maximum Temperature
wsdiETCCDI - Warm Spell Duration Index
cdd - Cooling Degree Days (Threshold: 18C)
fdd - Freezing Degree Days (Threshold: 0C)
gdd - Growing Degree Days (Threshold: 5C)
hdd - Heating Degree Days (Threshold: 18C)
rp20pr - 20-year annual maximum one day precipitation amount
rp20tasmax - 20-year annual maximum daily maximum temperature
rp20tasmin - 20-year annual minimum daily minimum temperature
rp50pr - 50-year annual maximum one day precipitation amount
rp5pr - 5-year annual maximum one day precipitation amount
rp5tasmax - 5-year annual maximum daily maximum temperature
rp5tasmin - 5-year annual minimum daily minimum temperature

For small watershed flood:

pr – Precipitation
monthly ~ $4km^2$

rx1dayETCCDI – Max 1-day Precipitation
daily ~ $4km^2$

Using 4 CC tools – available/applicable outputs

ClimateBC_Map

-- A Interactive Platform for Visualization and Data Access

Click map point

For small watershed flood: precipitation monthly, 800 m^2

use CC indices

1) Annual variables:

Directly calculated annual variables:

MAT	mean annual temperature (°C),
MWMT	mean warmest month temperature (°C),
MCMT	mean coldest month temperature (°C),
TD	temperature difference between MWMT and MCMT, or continentality (°C),
MAP	mean annual precipitation (mm),
MSP	mean annual summer (May to Sept.) precipitation (mm),
AHM	annual heat-moisture index (MAT+10)/(MAP/1000))
SHM	summer heat-moisture index ((MWMT)/(MSP/1000))

Derived annual variables:

DD<0	degree-days below 0°C, chilling degree-days
DD>5	degree-days above 5°C, growing degree-days
DD<18	degree-days below 18°C, heating degree-days
DD>18	degree-days above 18°C, cooling degree-days
NFFD	the number of frost-free days
FFP	frost-free period
bFFP	the Julian date on which FFP begins
eFFP	the Julian date on which FFP ends
PAS	precipitation as snow (mm) between August in previous year and July in current year
EMT	extreme minimum temperature over 30 years
EXT	extreme maximum temperature over 30 years
Eref	Hargreaves reference evaporation (mm)
CMD	Hargreaves climatic moisture deficit (mm)
MAR	mean annual solar radiation (MJ m^{-2} d^{-1})
RH	Relative humidity (%)

3) Monthly variables

Primary monthly variables:

Tave01 – Tave12	January - December mean temperatures (°C)
TMX01 – TMX12	January - December maximum mean temperatures (°C)
TMN01 – TMN12	January - December minimum mean temperatures (°C)
→ PPT01 – PPT12	January - December precipitation (mm)
RAD01 – RAD12	January - December solar radiation (MJ m^{-2} d^{-1})

Derived monthly variables:

DD_0_01 – DD_0_12	January - December degree-days below 0°C
DD5_01 – DD5_12	January - December degree-days above 5°C
DD_18_01 – DD_18_12	January - December degree-days below 18°C
DD18_01 – DD18_12	January - December degree-days above 18°C
NFFD01 – NFFD12	January - December number of frost-free days
PAS01 – PAS12	January – December precipitation as snow (mm)
Eref01 – Eref12	January – December Hargreaves reference evaporation (mm)
CMD01 – CMD12	January – December Hargreaves climatic moisture deficit (mm)
RH01 – RH12	January – December relative humidity (%)

Using 4 CC tools – available/applicable outputs

IDF_CC Tool 4.0

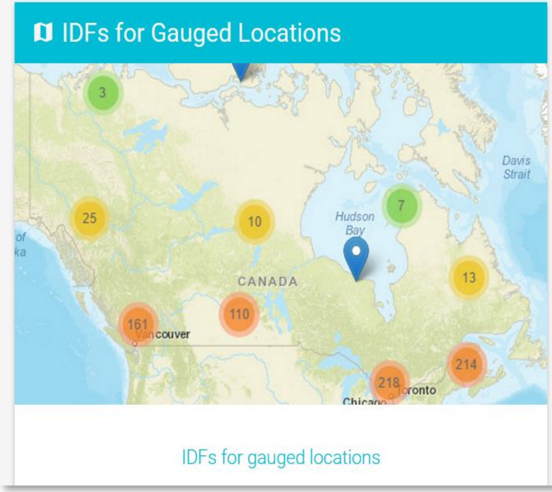
Click station point ←

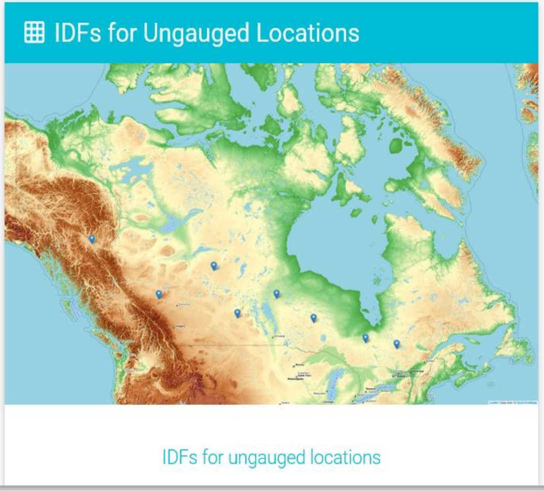
Click ungauged point

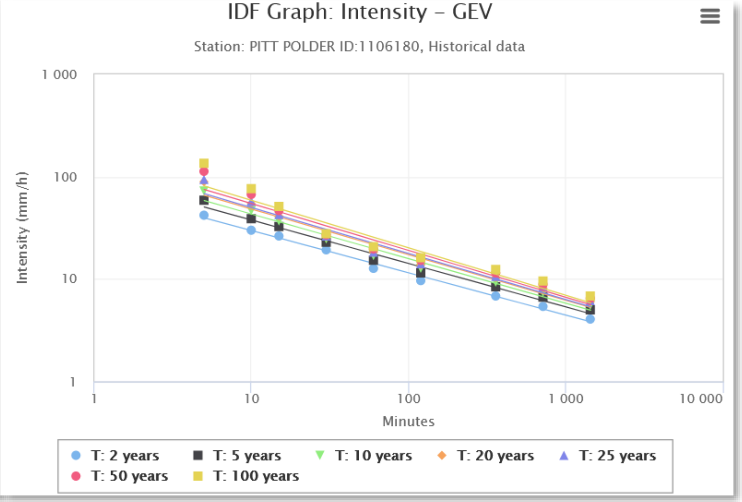
For small watershed flood:

better to use collection of stations (especially in mountains)

use CC indices



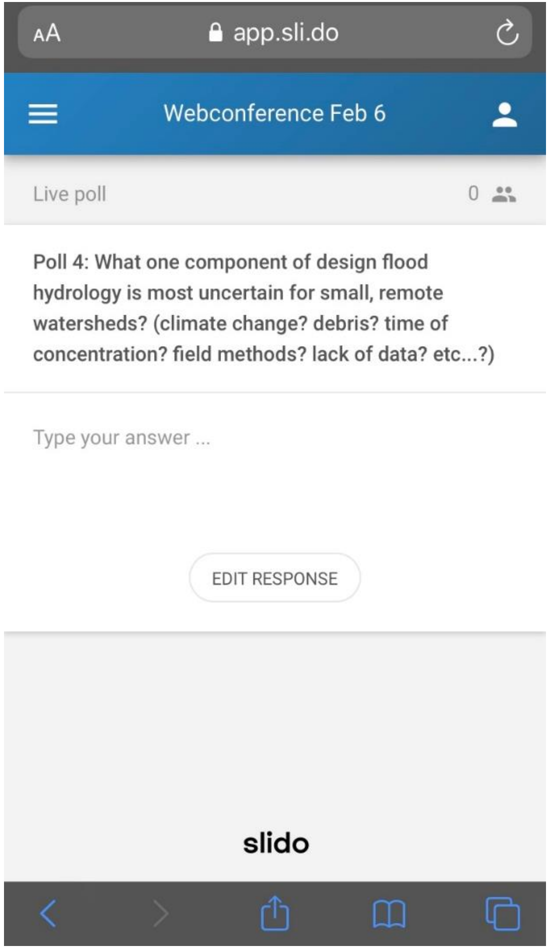




Poll # 4

What one component of design flood hydrology is most uncertain for small, remote watersheds?

(leave empty if you do not know enough on the topic)



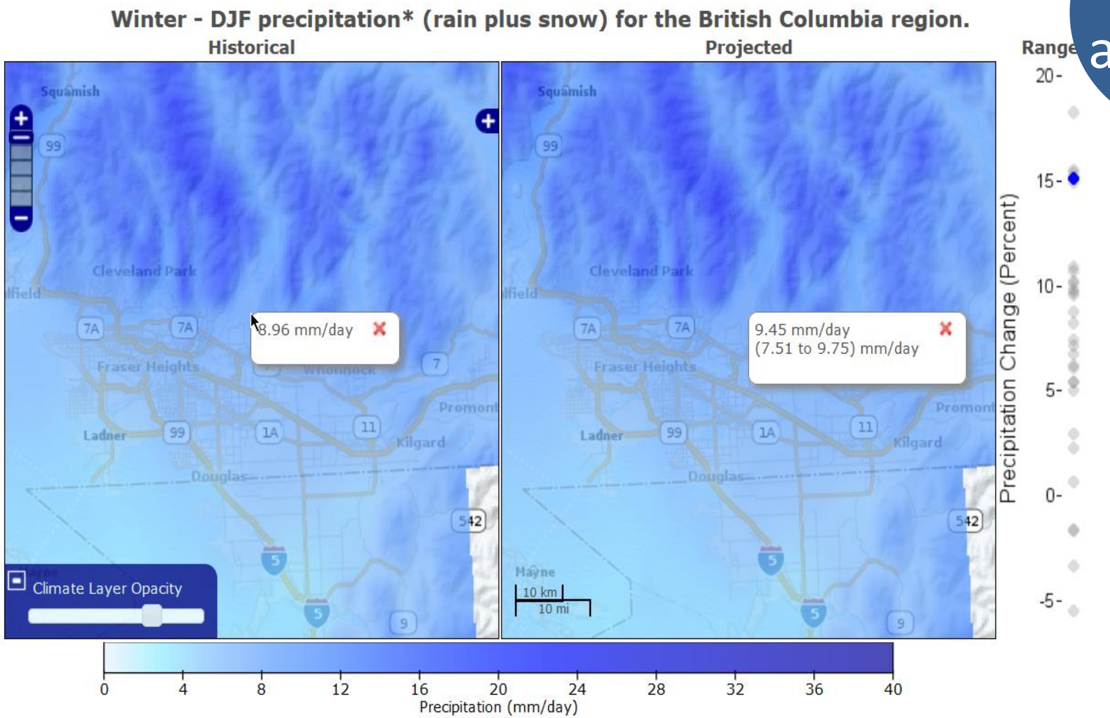
Examples: comparing tool interfaces / results

PLAN2ADAPT

get answers

+ quick to use
+ gives ranges

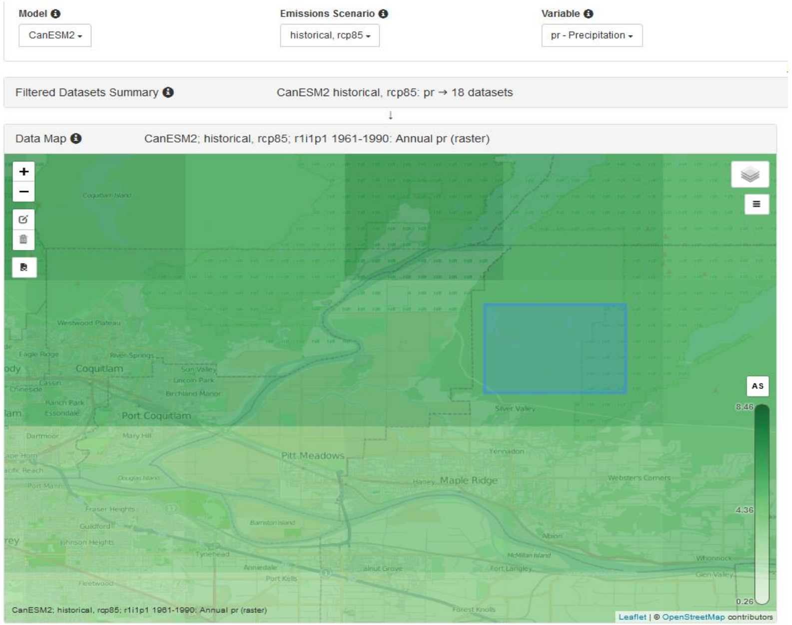
- older tool (2012) and RCP system
- comparative map could be more useful
- hard to place remote road

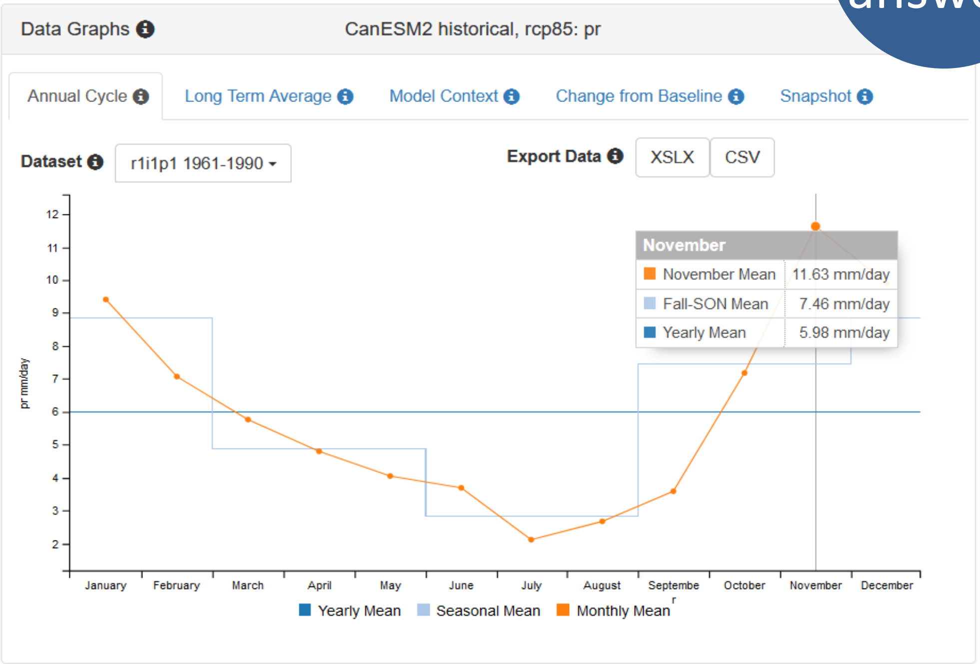


Examples: comparing tool interfaces / results

PCIC Climate Explorer

get answers





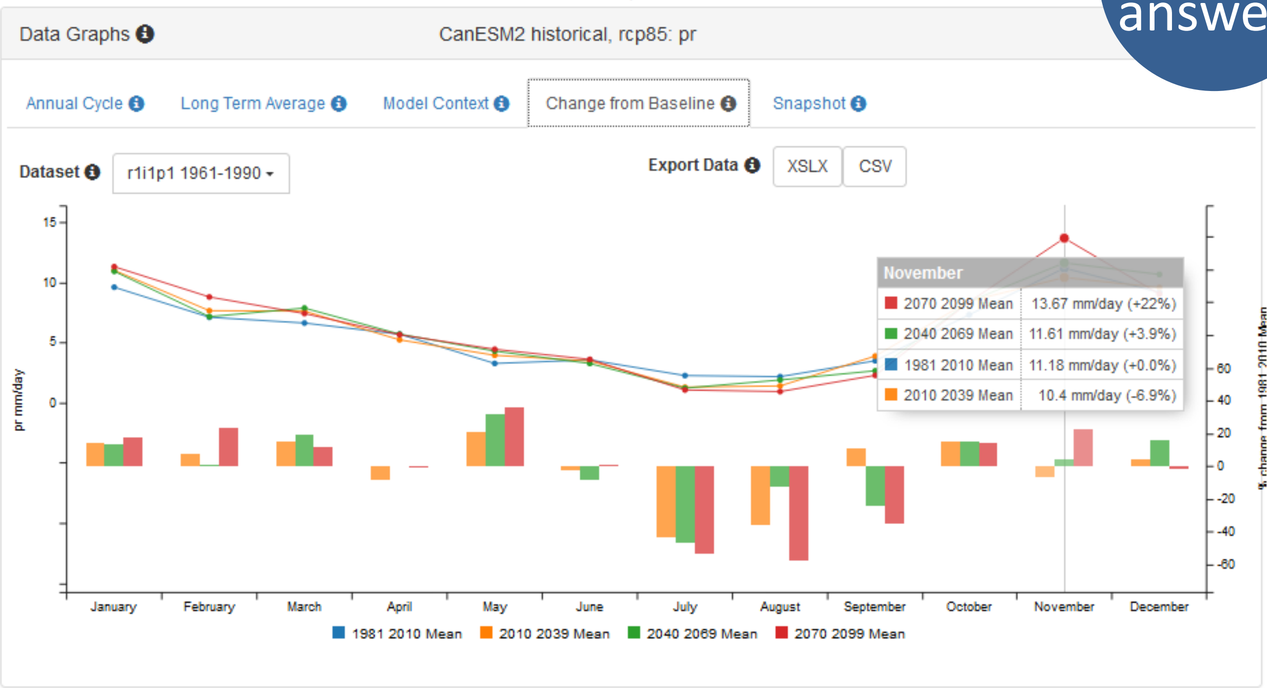
Examples: comparing tool interfaces / results

PCIC Climate Explorer

get answers

+ new indices
+ has all important GCMs
+ easy to compare

- no ensembles
- a lot of information to sift through

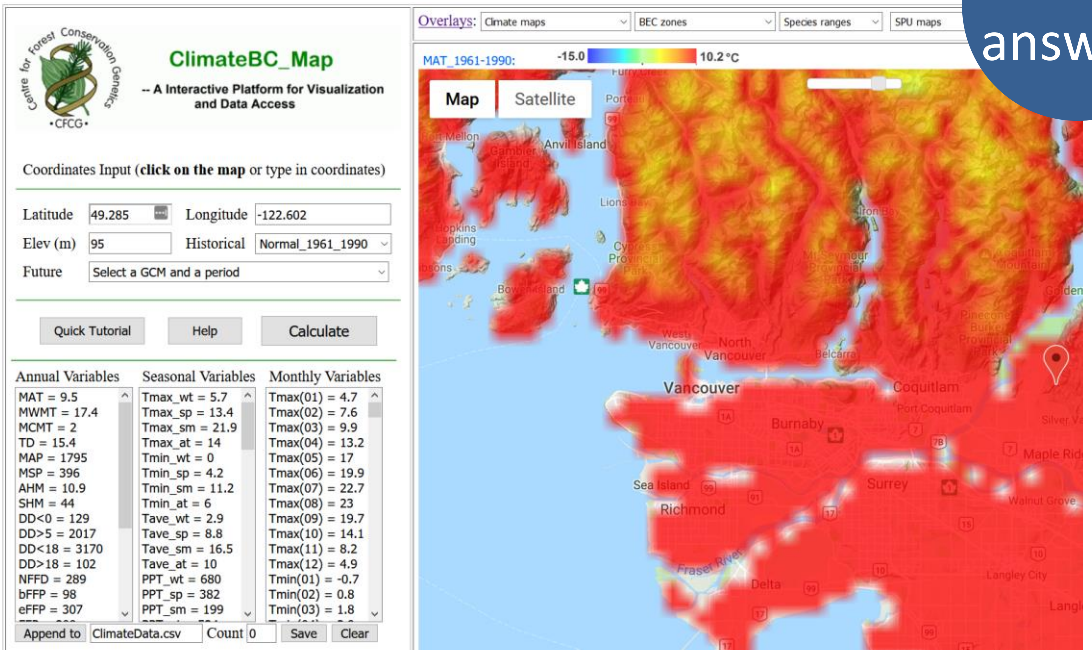


Examples: comparing tool interfaces / results

ClimateBC_Map
-- A Interactive Platform for Visualization and Data Access

get answers

+ good tool for fetching data
+ has more advanced desktop version
+ useful for historic estimation of precipitation in remote areas
- does not have the key GCMs or ensembles
- slow



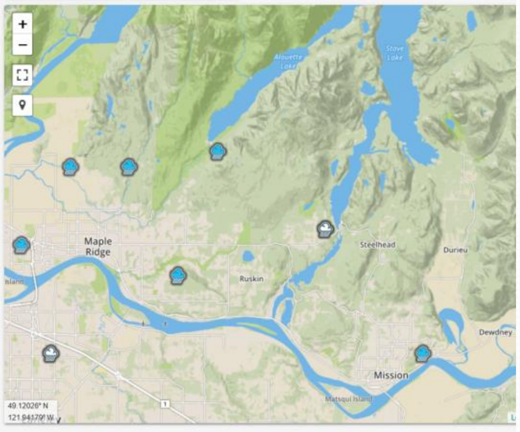
Examples: comparing tool interfaces / results

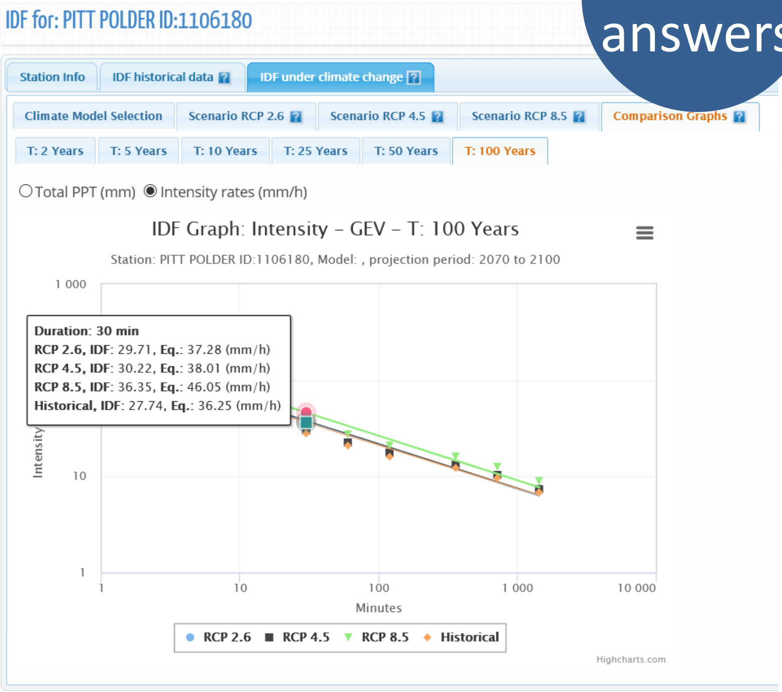
IDF_CC Tool 4.0

get answers

+ possible to import your own stations
+ easy to compare
+ has ensembles

- does not take into account elevation or aspect
- Has much more uncertainty in comparison to other tools





Examples: comparing tool interfaces / results

Comparing results for UBC forest

get answers

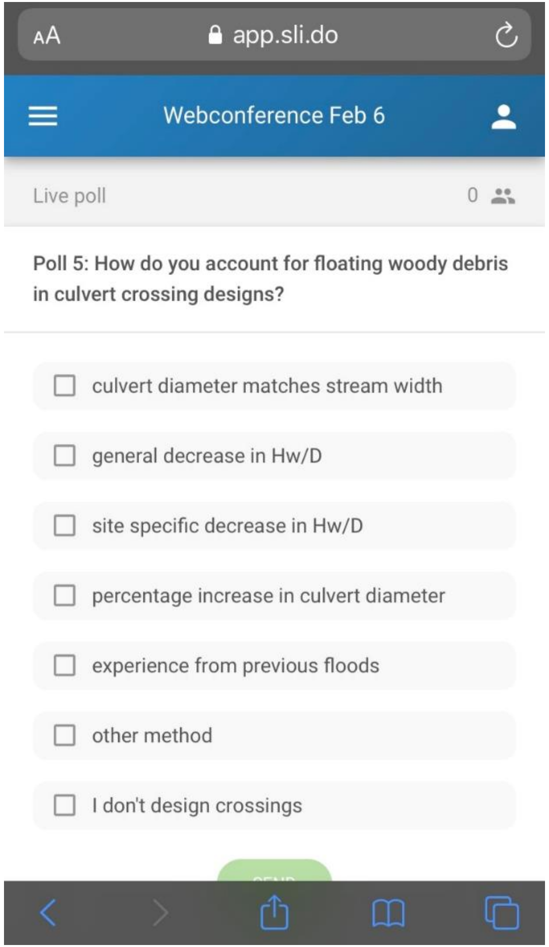
Percent increase Q100 according to 4 CC tools

		Ensemble	Avg	CanESM	ACCESS-0	inmcm4	CNRM-CM5
Plan2Adapt	2055	9					
	2085	**9**					
PCEX-precip	2055		6	0		5	13
	2085		**18**	17		9	29
PCEX rx1-day	2055		16	10	24	18	13
	2085		**35**	21	52	39	29
ClimateBC_Map	2055		2	9			-5
	2085		**14**	15			13
IDF_CC	2055	29					
	2085	**34**					

Poll # 5

How do you account for floating woody debris in culvert crossing designs?

(select all that apply)

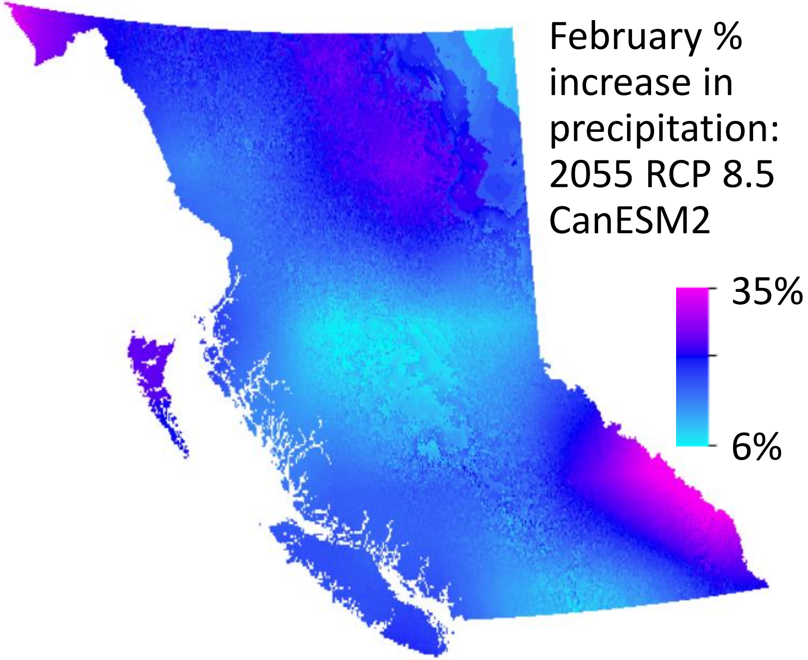


Summary: BC trends

trends

- Producing this map used new ClimateBC_Map version - results post-processed using FME software to get monthly trend maps (as shown on right)

- Desktop version has more GCMs and can process batches of locations or raster inputs



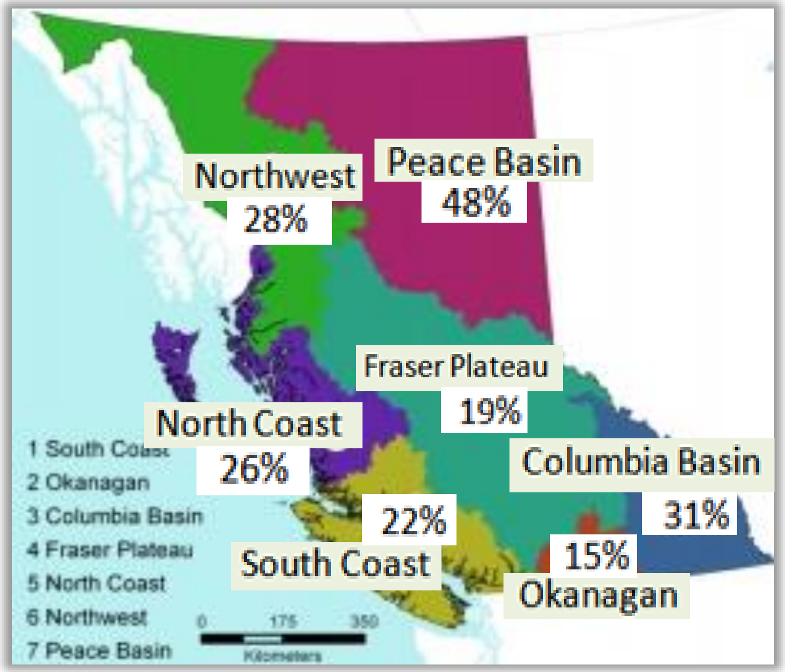
February % increase in precipitation: 2055 RCP 8.5 CanESM2

Summary: BC trends

IDF_CC Tool 4.0

trends

- Analysis for example small watershed area: 10 km^2, ToC = 15 mins, C = 0.15



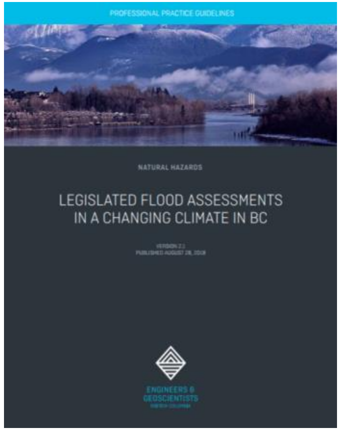
- Incorporated at least 3 IDF stations in each climatic region to calculate increase in precipitation

Averages for 2068:

- 27% peak flow/precipitation increase
- 9% culvert diameter increase

Summary

next?



Adjust expected flood magnitude and frequency according to the projected change in runoff during the life of the project, or by 20% in small drainage basins for which information of future local conditions is inadequate to provide reliable guidance. Consider potential effects of land use change in the drainage basin.

Summary

next?

- Guidelines – will not have a simple answer but clarify limitations and options for designers
- Best to compare answers from CC tools – each has strengths and weaknesses
- Crossings designers need to judge these tools to rationalize CC in crossings designs
- Incorporating debris floods is another tricky task – CC may change this too
- Keep current with CC tool developments

Resource Roads - Climate Change Team

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FPInnovations

Thank you

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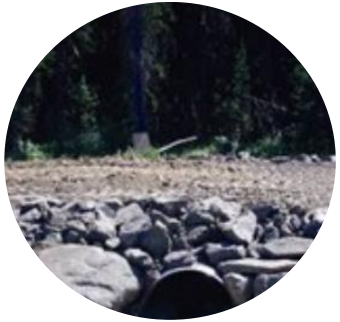
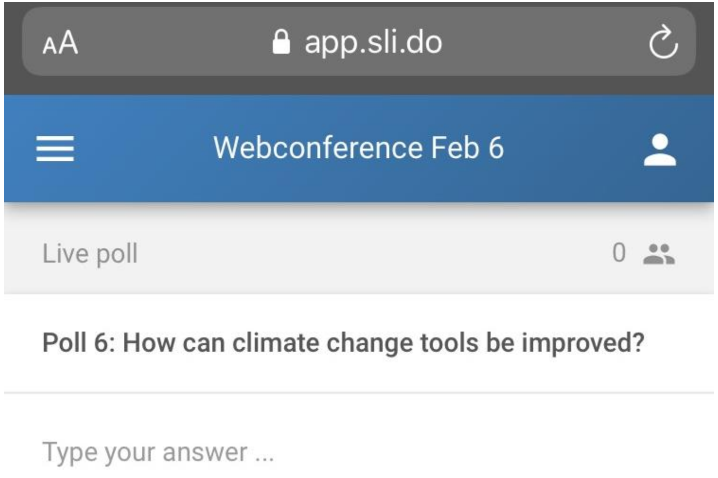


Poll # 6

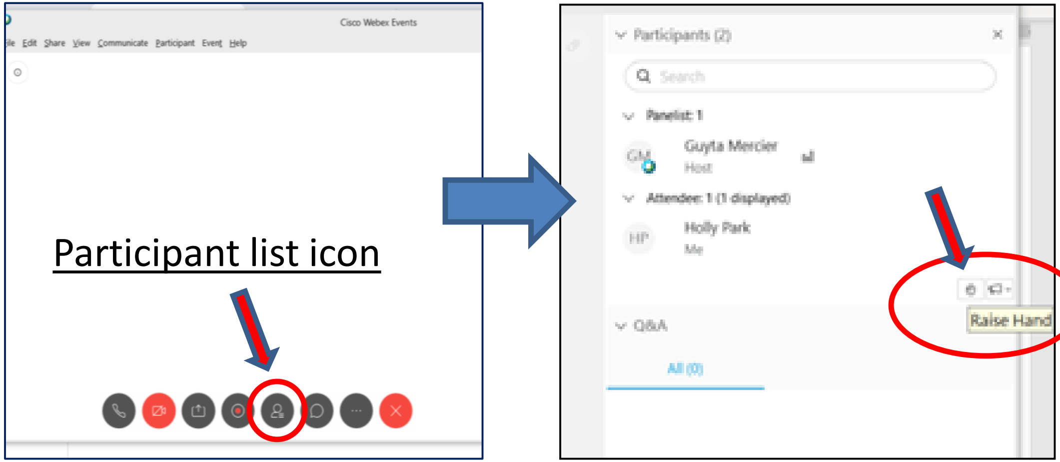
How can climate change tools be improved? (include your email if you would like)



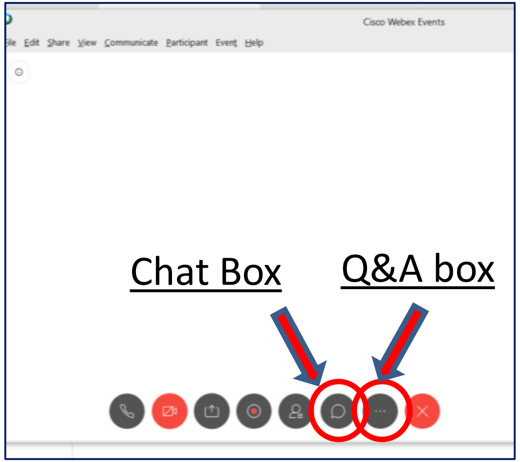
Question Period

1. Open the participant list at the bottom of the screen to open a new window.

At the bottom right of this new window, use the raise hand icon to indicate that you would like to ask a question using audio.



2. You can also type your question in the Chat Box or the Q&A Box. Both are accessible at the bottom of your screen.



Panelists: Questions/Discussion

Brian Chow – Chief Engineer, FLNRORD, Victoria

Matt Kurowski – Researcher, FPInnovations, Vancouver

Mark Partington – Researcher, FPInnovations, Montreal

Kari Tyler – User Engagement and Training Specialist, Pacific Climate Impacts Consortium, University of Victoria

Dr. Slobodan Simonovic – Professor Emeritus, Institute for Catastrophic Loss Reduction, Western University

Harshan Radhakrishnan – Manager, Climate Change and Sustainability Initiatives, Engineers and Geoscientists BC