It has been a year since recognition of the coronavirus that sparked a global pandemic. Response to that pandemic has highlighted several characteristic challenges of averting and managing disasters. Primary amongst them are: 1) that successful disaster management gives people a sense that the disaster risk is overblown or artificially constructed, and 2) that disasters are driven by human behaviour.

Successful disaster management results in few disaster symptoms. Without the symptoms, few recognize the necessity to do anything, or support anything, to reduce their risk. This is also true of situations where the disasters have return periods longer than three generations (or so), or a disaster hasn’t affected you yet. Examples are successful vaccination programs that have kept diseases at bay and the reaction to the success of reducing the spread of COVID-19 by the summer of 2020.

What we do causes and drives disasters. Flood damage does not happen when we construct our buildings and infrastructure in places that do not flood. Viruses cannot spread unless we share them. Changing our behaviour so that we eliminate the potential for a disaster is difficult. We did prove that we can “bend the curve downward”, which may be all that is possible. We won’t really know what is possible unless we strive for more.

Rather than disaster behaviour, this edition of Risky Ground carries summaries of research about the Cascadia subduction zone, groundwater, and the prehistoric climate record, developments at the Centre for Natural Hazard Research and links to news of the Elliot Creek landslide-displacement wave-debris flow event of November 28, 2020. Several new theses and an internship financial support program in climate change adaptation are announced.

All the best for the new year, whichever one you celebrate.

Bert Struik, Centre for Natural Hazard Research, Simon Fraser University (SFU), lstruik@sfu.ca

Back issues of Risky Ground
http://www.sfu.ca/cnhr/news_events/newsletters.html

Playlist

Wikipedia
https://www.wikipedia.org

Wikipedia supports and hosts disaster information as disasters develop, and as a record of past events. Disaster watchers contribute quickly to Wikipedia as disasters unfold. Information about a disaster is scooped from local and regional official news sources as well as citizen news sources. The Wikipedia articles are quickly updated as new information arises.

If you are a disaster watcher, it is a venue for sharing your knowledge, and helping other disaster watchers provide a factual and comprehensive record supported by references that document the information sources.
**Current Activity**

**Magnetotelluric studies of the Cascadia subduction zone and Garibaldi volcanic belt in southwest British Columbia**

Subduction zones are the location of a number of important geological processes. Fluids transported from the surface into the crust and upper mantle have a profound impact on both (a) arc magmatism and (b) the seismic behaviour of these convergent plate boundaries. Subduction zones are also associated with significant seismic and volcanic hazards. They are also important in terms of resources, since arc volcanism leads to the formation of mineral deposits and the development of geothermal reservoirs.

Understanding these scientific questions, hazards and resources requires geophysical studies of the crust and upper mantle. Electromagnetic methods are especially useful since they measure subsurface electrical resistivity and define the location of fluids, such as water and partial melt. The magnetotelluric (MT) method is the most useful for crustal and upper mantle studies, because the use of natural electromagnetic signals allows investigations from the near surface to depths in excess of 100 km. The MT method has developed in recent years and it is now routine to obtain 3-D models of subsurface resistivity.

Regional scale MT studies have defined the fluid content on the plate boundary beneath Vancouver Island and imaged the pathways of melt migration from the mantle wedge to the volcanic arc. More detailed MT studies have investigated the magmatic and hydrothermal system beneath Mount Meager and other volcanic centres. Additional MT studies planned for the near future have the potential to define the distribution of partial melt and hydrothermal fluids beneath the entire Garibaldi Belt. Seafloor MT surveys are also planned to investigate the structure of the locked region of the Cascadia subduction zone located offshore.

*Dr. Martyn Unsworth, University of Alberta*

Abstract of online presentation through SFU Earth Sciences, October 8, 2020

**Comparing approaches for reconstructing groundwater levels in the mountainous regions of interior British Columbia, Canada, using tree ring widths**

Observed groundwater level records are relatively short (<100 years), limiting long-term studies of groundwater variability that could provide valuable insight into climate change effects. This study uses tree ring data from the International Tree Ring Database (ITRDB) and groundwater level data from 22 provincial observation wells to evaluate different approaches for reconstructing groundwater levels from tree ring widths in the mountainous southern interior of British Columbia, Canada. The twenty-eight reconstruction models consider the selection of observation wells (e.g. regional average groundwater level vs. wells classified by recharge mechanism) and the search area for potential tree ring records (climate footprint vs. North American Ecoregions). Results show that if the climate footprint is used, reconstructions are statistically valid if the wells are grouped according to recharge mechanism, with streamflow-driven and high-elevation recharge-driven wells (both snowmelt-dominated) producing valid models. Of all the ecoregions considered, only the Coast Mountain Ecoregion models are statistically valid for both the regional average groundwater level and high-elevation recharge-driven systems. No model is statistically valid for low-elevation recharge-driven systems (rainfall-dominated). The longest models extend the groundwater level record to the year 1500, with the highest confidence in the later portions of the reconstructions going back to the year 1800.

*Stephanie C. Hunter, Diana M. Allen, and Karen E. Kohfeld*

Reconstructing deep-ocean circulation during Cenozoic climate transitions from the marine sediment record

Ocean circulation plays a critical role in the Earth’s climate system through the storage and transfer of heat and carbon dioxide. The North Atlantic and Southern Ocean are of particular interest because these are regions where deep-water components of global circulation develop. Overall patterns and functioning of modern oceanic circulation is relatively well understood, but significant uncertainty remains about circulation in the geologic past and during different climate regimes. The deep-sea sedimentary record is used to reconstruct past ocean circulation and its relationship to past climatic and tectonic conditions. Information integrated from a broad range of spatial and temporal scales, and from seismic-reflection data reveals regional sedimentation patterns to high-resolution records based on quantitative grain-size analysis from cores. Research from the North Atlantic Ocean (IODP Expedition 342, Newfoundland Drifts) shows how vast deep-sea “drift” deposits relate to the onset of and changes in ocean circulation in the Eocene through Miocene. In addition to work on the North Atlantic, preliminary findings from new drilling (January-February 2018) in the Ross Sea (IODP Expedition 374, West Antarctic Ice Sheet History), are used to study interactions of Southern Ocean circulation and Antarctic ice sheet dynamics during significant climate events of the Miocene and Pliocene.

Brian Romans, Virginia Tech.
Abstract for SFU Earth Sciences Presentation October 29, 2020

Mt. Meager 10 years after!

The 2010 Mount Meager landslide was a large (~52 Mm³) debris avalanche in the southern Coast Mountains north of Pemberton, BC. Shortly after the landslide, in August 2010, a team of Italian and Canadian researchers began to collect field data to document the event. They continued their field program in subsequent years to record landscape changes within the area impacted by the landslide. During the most recent (2019) campaign, a UAV quadcopter survey was performed along the landslide path. Three drones were used to cover the entire landslide area, some 4745 km². More than 4000 photos were taken and used to create a photogrammetric DSM and an orthophoto. Twenty-five ground control points were collected with two geodetic GNSS receivers. The spatial resolutions of the orthophoto and DEM are, respectively, 10 cm and about 20 cm for the DSM.

During 2020, the Italian researchers analyzed the datasets and compared them to data acquired over the previous 10 years. They compared the 2019 digital terrain models to previous DTMs and successfully quantified the amount and spatial pattern of erosion done by Meager Creek and Lillooet River. A REM (Relative Elevation Model) showing stream channels on the landslide deposit was created from the 2019 drone DTM (see example below). A multi-temporal comparison of the REMs provides detailed documentation of channel evolution and, accordingly, erosional dynamics.

Example of REM of the debris avalanche accumulation.
L.Perotti

Serendipity, Scanning and the Elliot Creek slide

An ongoing project of the CNHR, involving Citizen Scientists, is to create an open-access database for future research into environmental change. One way a
citizen scientist can contribute to the database is to share their photographs that show scenes from years past. Such scenes can be used to determine environmental changes since when they were taken. The importance of gathering decades of old photographs was demonstrated with the recent Elliot Creek slide.

With the recent acquisition of a portable slide scanner, I started scanning the slides of John Clarke, who, from 1967 to his death in 2003, wandered the glaciers from the Fraser to the Nass River headwaters six months of the year. In late November, his widow, Annette, had loaned approximately 5000 of the 20,000 slides in John’s collection as a start. I was 300 slides into the scanning when the landslide at Elliot Creek occurred.

When I got home that night, I looked on Google Earth to see exactly where in the Southgate valley the landslide had occurred as I had been on a couple of past climbing expeditions in the area. As I looked at an oblique view of the area, something looked familiar. I quickly looked at the slides I had been working on and found an eerie resemblance to the oblique view in slide 206.

I sent a digital copy to one of John’s regular climbing partners who confirmed my suspicions; John’s slide 206 showed a view up Elliot Creek in the late 1980s. Shortly after announcing the existence, others came forth with photos from more recent times. To say I was as ‘pleased as punch’ was an understatement. Here 206 slides into the project was evidence as to why the scanning of the old photographs is worthwhile.

However, it also demonstrated the challenge that CNHR faces due to the potentially enormous scale and limited resources. Just think, the Clarke collection alone consists of over 20,000 slides (he also has 20,000 slides of long-lost Vancouver buildings). At 40 slides an hour that is 500 hours, or 12 weeks of work for just John’s collection – and that is just the scanning without entering all the crucial metadata into a database to make them truly useful.

All the work is performed by volunteers and while there are plenty of enthusiastic volunteers, they cannot yet be used to their full potential because the CNHR currently only has two portable scanners.

While donating your photographs or time would be greatly appreciated, we would also really benefit from the donation of more scanners to allow the project to proceed more efficiently.

If you are interested assisting us, please contact me at pjadam@sfu.ca

Paul Adam, pjadam@sfu.ca  Manager of Citizen Science Initiatives, Centre for Natural Hazard Research, SFU.
Events

**Elliot Creek debris flow, British Columbia**

A large debris flow caused extensive damage along the Elliot Creek valley in British Columbia’s central coastal region. The November 28, 2020 flow originated from a glacial lake in the Coast Mountains and spilled debris into Bute Inlet. Elliot Creek is located about 120 km north of Powell River and 220 km northwest of Vancouver.

It appears that the debris flow was caused by an outburst flood from a glacial lake, which itself was caused by a landslide entering the lake. The floodwaters carried millions of cubic metres of mud and debris into Elliot Creek. Much of the debris was deposited on a fan at the mouth of Elliot Creek where it flows into Southgate River. Some of the debris, including abundant woody material, was carried into Bute Inlet at the mouth of Southgate River. The event was found by a helicopter pilot days after it happened, although its time is precisely known from seismometer records.

Elliot Creek is a salmon spawning ground that is of particular importance to indigenous people on the central coast of BC. That ground has now been severely disrupted and the recovery process and timing are unclear.

**Story and aerial video (December 17, 2020)**


**Story and aerial video (December 15, 2020)**


**Story and news video (December 15, 2020)**


Announcements

**Theses**


Opportunities

**PICS Internship Program Call for Proposals.**

The deadline is fast approaching.

Submit your application by Monday, January 11, 2021.

The Pacific Institute for Climate Solutions (PICS) internships support the hiring of university students and recent graduates at the workplaces of governments, NGOs, industry, and communities within British Columbia that are pursuing climate-change mitigation and adaptation research, planning or implementation.

PICS will provide $12,000 to BC provincial, regional, and local governments, and BC-based non-
governmental agencies, indigenous communities, private companies and Crown corporations to hire a student intern for a minimum of 13 weeks. Successful applicants may top up this contribution to provide an appropriate wage for the student’s level of education and experience.

Eligible students must be enrolled in a full-time undergraduate or graduate program at one of the four PICS partner institutions: UVIC, UBC, SFU or UNBC. Students must either be returning to complete their degree programs following the internship or have completed their programs the semester prior to the start of the internship.

For information about this annual call please read the Internship Program Guide and submit an Internship Application Form, or visit the PICS website.

Pacific Institute for Climate Solutions, University House 1, 2489 Sinclair Rd. University of Victoria, Victoria, BC V8N 6M2 Canada

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**Meetings and such**

Risky Ground shares announcements of conferences, workshops and other meetings and talk programs on the themes of natural hazards and risk. Such announcements are suspended for physical gatherings during the COVID-19 pandemic, because of the uncertainty of evolving local restrictions of gatherings.
Risky Ground publishes stories and information on current topics of interest to researchers and practitioners in natural hazards and their risk to people, infrastructure and the environment. It is distributed by email as an electronic version, quarterly, near the start of each season, by the Centre for Natural Hazard Research at Simon Fraser University, Burnaby, British Columbia, Canada. Copies are hosted for download at http://www.sfu.ca/cnhr/news_events/newsletter.html

Opinions published in this newsletter do not reflect official positions of Simon Fraser University or its Department of Earth Sciences.

Submissions are accepted in digital word processor or ASCII format up to 2 weeks prior to publication, and should be sent by email to an editor for consideration. Articles can be up to 750 words and include pictures and graphics which must be 8 cm wide and 12 cm high or less at 300dpi (to fit within a column).

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Centre for Natural Hazard Research
The Centre for Natural Hazard Research (CNHR) is an SFU-based institute housed in the Department of Earth Sciences. Its mandate is to conduct innovative research on geophysical processes that are a threat to the population and economic infrastructure of Canada. CNHR has a western Canada focus, but the research findings and developed methodologies are applicable to the whole of Canada and to the international community. A key element of the Centre is the inclusion of public policy research on how to effectively transfer the results of scientific research to the people who need and can use it.

CNHR hosts talks at SFU by hazard and risk researchers and practitioners. We welcome your suggestions for potential speakers for the spring and fall of 2021. The Centre sponsors or co-sponsors workshops on a variety of topics of interest to professionals and students in British Columbia.

We welcome short updates from readers and members on their research activities and meetings of interest.

John Clague
Manager, Centre for Natural Hazard Research