Insights

Canadian
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Paleoecology – Contributing to Resource Management

Figure 1: Streamflow in the Koksilah River in March (photo: koksilahvalley.wordpress.com, 2011)

Terrestrial palaeoecology is the science of using plant remains preserved in sediment deposits to examine the origin, development and dynamics of vegetation communities through time. Given that plant distribution and abundance patterns are strongly influenced by climate, the records can also be used to examine changes in climate over time. Finally, by examining indicators of fire, such as charcoal fragments, it is also possible to evaluate how fire disturbance dynamics have changed in response to changes in climate and vegetation. In addition to impacting vegetation and soils, fire events can also affect aquatic systems. For example, post-fire watersheds may experience increased sediment loads and altered water chemistry, impacting water quality.

Kendrick Brown, a research scientist with the Canadian Forest Service, is developing a research program that examines how changes in climate, vegetation and fire disturbance may affect municipal reservoir watersheds, which represent a valuable community resource. In addition to assessing the fire-vegetation-climate linkage, Brown is also assessing how streamflow, which carries ash and sediment, has varied in response to changes in large-scale climate through time.

"As a palaeoecologist, I use a multidisciplinary approach in research, and enjoy combining methods from different disciplines. In this case, I realized that to understand how flow in rivers is affected by changes in climate I would have to include hydrological modeling," says Brown. To that end, Gerrit Schoups, a hydrologist at Delft University of Technology, The Netherlands, was recruited into the project. "Given that water resource issues will only increase in importance in the future, it is critical to develop methods that can be used to assess how hydrological systems respond to changes in climate," Schoups explains. "Combining palaeoevironmental reconstruction with water balance modeling is a valuable research approach that is capable of rendering relevant and unique perspectives on how systems respond to large-scale changes in climate. In the case of reservoirs, this type of data can be combined with fire reconstruction and other indicators to reveal how fire disturbance has changed through time in response to changes in climate and vegetation and to better assess the potential impact of fire events on water resources," adds Brown.

The streamflow component of the research focused on two adjoining watersheds on BC's Vancouver Island: the San Juan and Koksilah (Figure 2). Streamflow characteristics vary between the two watersheds, with the San Juan having overall higher flow. Thus, these watersheds can be used to examine how different hydrological systems have variously responded to climate change. The results show that there was seasonal streamflow variability in the two watersheds during that last 10,000 years, with greater flow in the winter relative to the summer.

However, the amount of discharge has changed markedly through time, with lowest simulated flow occurring in the warm early-Holocene interval (10,000–6,000 years ago). At that time, low-flow conditions began earlier in the year and extended later into the fall, with little or no flow during some or all of the summer months, indicating a lengthening of the dry season. Regional fire disturbance, reconstructed using charcoal fragments preserved in sediment cores from nearby watersheds, reveals an increased incidence of fire disturbance in response to the prevailing dry conditions. By 6,500 years ago, near-modern flow characteristics were established in the watersheds as regional precipitation increased, commensurate with a reduction in fire disturbance. During the last few millennia, fire disturbance increased again in response to human action and climate variability.

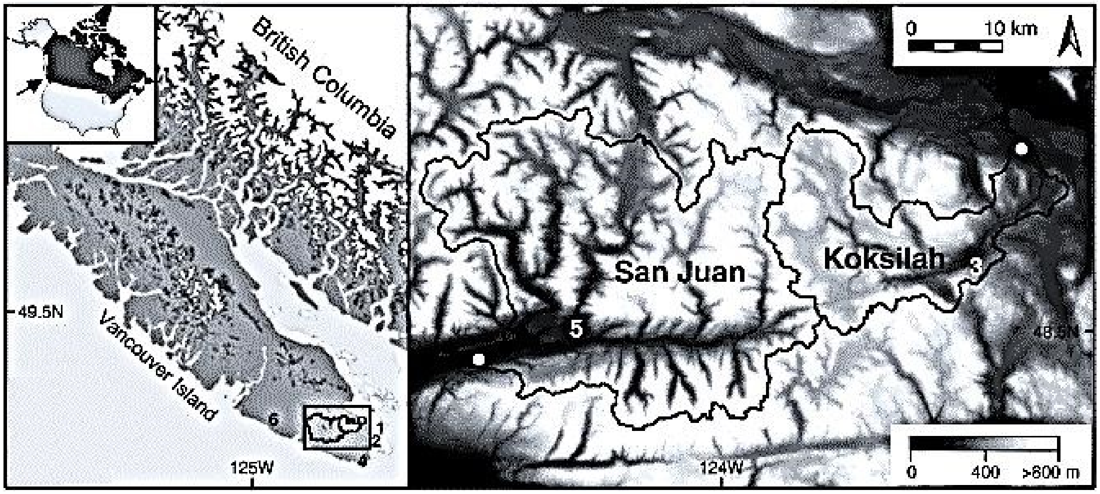

Figure 2: San Juan & Koksilah Watersheds (Photo: K. Brown & G. Schoups, 2015)

As climate changes in the future, the San Juan and Koksilah watersheds are expected to remain as rainfall-fed systems. However, they likely will differ from today in that they could experience extended low streamflow conditions in late spring, summer and early fall as well as increased fire disturbance, similar to the early-Holocene period. These observations are consistent with regional forecast models that likewise suggest extended low flow conditions and more frequent and intense fire disturbance in the future. Consequently, two independent lines of investigation (i.e. paleoecological data and modeling) are converging on similar conclusions, namely, that future conditions in the region will be characterized by an extended dry season, low flow conditions and increased fire disturbance. From a mitigation and adaptation perspective, such insight is valuable to those working with natural resources, such as the Capital Regional District (CRD), who manage the drinking water supply for the greater Victoria (BC) region, serving over 300,000 residents. Indeed, the CRD must plan for and manage against the impacts of drought and has identified fire as a serious threat to water supply. Results from studies such as this are providing new perspectives that may help many communities improve their planning and management strategies.

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