

Overview of a project aiming to assess environmental impacts of oil and gas activities in the Fox Creek area (AB)

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Summary

A multidisciplinary and multi-institutional project was initiated in the Fox Creek area, in west-central Alberta, in 2019 to study environmental impacts of hydrocarbon exploration and production activities. The initial objective was to specifically study potential impacts on shallow groundwater. However, different Sectors within NRCan later identified the Fox Creek area as a region of interest for developing regional cumulative effects evaluation methods in support of new impact assessment legislation. Therefore, the project scope is now much larger and includes studies on vegetation, forest, woodland caribous, wetlands, landscape and atmospheric emissions, and involves many collaborators from the federal and provincial governments, and academia.

Introduction

Environmental concerns related to industrial resource development have arisen in the last decade. These concerns are notably related to water contamination and depletion, induced seismicity, atmospheric emissions, wetland disturbance, forest fragmentation and modification of the vegetation cover. A multidisciplinary project on the characterization of non-saline aquifers and assessment of potential impacts of oil and gas (O&G) development activities on these aquifers in the Fox Creek area started in April 2019. It was recently decided to build on this project to study cumulative environmental effects, as this region is the site of significant industrial activities. Therefore, components were added to this initial project, including studies on vegetation, forest, peatland and landscape changes, as well as a specific study on how to improve the assessment of cumulative effects within the framework of environmental assessments. Other components will likely be added in 2020.

The Fox Creek area, in west-central Alberta (Figure 1), was selected because it is one of the most active regions for unconventional resource production in Canada. This area comprises numerous recent unconventional gas/condensates wells and older conventional oil wells. It has thus been disturbed by the acquisition of seismic surveys, and the construction of pipelines, roads and well pads. Fox Creek is also the region in Canada where some of the largest induced seismic events ($M_L > 4.5$) related to hydraulic fracturing have been reported. The Little Smoky caribou range, to the south-west of the study area, is infamous for being the most critically disturbed boreal caribou habitat in the country. It has a declining population trend that is very unlikely to recover (ECCC, 2012).

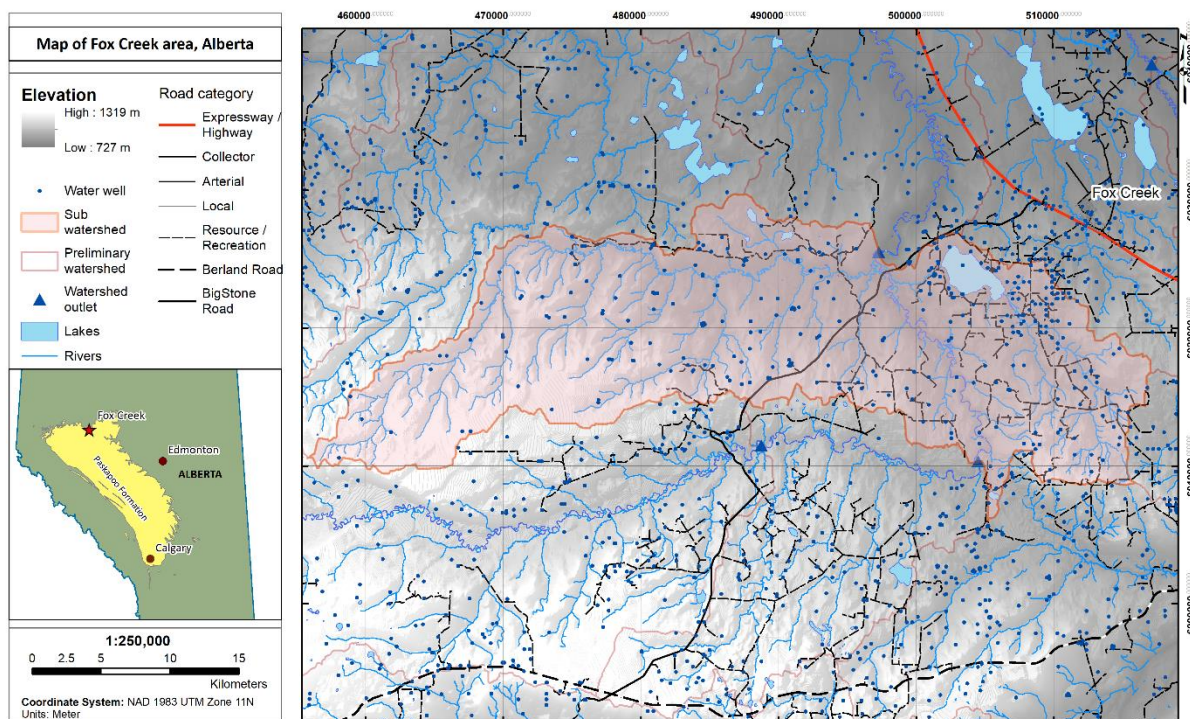


Figure 1: Location of the Fox Creek area for the hydrogeological study showing existing shallow wells that all belong to O&G operators. Larger areas will be used for studies involving remote sensing, while some of the sites selected to study vegetation might be located outside this 700 km² watershed, but within the same region. The Paskapoo Formation is shown in yellow in the inset.

Description of the study area

The general area is currently in production phase with minimal active drilling. The producing unit consists of the Upper Devonian Duvernay Formation, which is commonly found between 2.5 to 3.5 km deep. Overlying the Duvernay Formation, other organic rich shales, sandstones, carbonate rocks and coals are present in the stratigraphy. The bedrock geology is complex with four unconformities within Permian and Mesozoic strata, Devonian reef structures, but with limited tectonic deformation.

The regional bedrock aquifer is located in the Paleocene Paskapoo Formation, which is a non-marine unit comprised of sandstone, sandy mudstone and siltstone. The Paskapoo Formation is the most important groundwater supply in the province, as well as the most important aquifer system in the Canadian Prairies. However, in the Fox Creek area, water use is essentially restricted to the O&G industry, except for the Town of Fox Creek itself. The region is essentially forested and contains many wetlands. No farms are present within the selected watershed.

Work to be carried out

The Fox Creek project will comprise fieldwork, laboratory analyses, data interpretation, and numerical modelling and will likely include the following activities:

- expansion of the hydrogeological characterization of the non-saline aquifers recently completed by the Alberta Geological Survey (Smerdon et al., 2019) using existing shallow wells and newly-drilled observation wells
- development of a coupled surface water / groundwater model
- baseline groundwater geochemical study
- identification of source (thermogenic or microbial) and provenance (geological unit) of hydrocarbons present in groundwater and rocks, if any, in part based on available composition and isotopic signature of mud gas from this area from historical wells and new data
- snow study including thickness of the snowpack, its density and its geochemistry
- literature review of the current status of different wetland classes and key wildlife habitat and of the current understanding of disturbance impacts in central-northern Alberta
- geomechanical study of shallow units using CPTs (cone penetration tests)
- assessment of geomechanical and hydrogeological properties using core samples
- study of the mechanisms that could induce pressure changes in shallow aquifers in association with hydraulic fracturing and re-injection through the development of a 3D geomechanical model using multiple sources of data (borehole deformation, well logs, passive seismic, etc.)
- evaluation of potential ecological stress and the assessment of landscape changes over time using satellite imagery
- spectral characterization of shallow fresh water bodies, wetlands, and outcrops, with synergies developed with SAR (synthetic aperture radar) datasets
- mapping of potential impacts and resulting changes on ecosystem services at the landscape scale
- study of functional and structural recovery of forest subsequent to O&G activities
- study on how to improve the process of cumulative effects assessment that is being carried out during environmental assessments (EAs) through a literature review and interviews with consultants doing EAs to identify main obstacles.
- definition of the local stratigraphy based on the lithostratigraphic logging of cores from new observation wells drilled in the study area
- petrographic characterization from historical wells of organic matter types and thermal maturity of known source rocks from the Duvernay shale to the Paskapoo coals.

Conclusion

Extensive oil and gas activities have taken place in the Fox Creek area since the 1950s, affecting the landscape ecosystem services, mainly through the degradation or removal of forest cover by non-permanent disturbances (e.g. resource exploration activities) and/or permanent disturbances (e.g. construction of infrastructure). Water resources have been poorly characterized at this scale, and data on groundwater are scarce. This project aims to assess the cumulative environmental effects of these industrial activities by studying surface water, groundwater and snow quality, intermediate zone integrity, atmospheric emissions, forest recovery, and changes in the landscape (including wetlands, lakes and lineaments) and plant community and growth (including lichen) that affect, among other things, the caribou habitat.

References

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