Need for a wetland guide for Northern Quebec

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Global warming speeds up the development of northern regions of Canada where multiple resources, for a large part mining and energy resources, become more readily available. In the Province of Québec, the Provincial government created the "Société du Plan Nord" that aims at promoting projects in the north of the province including mining projects and the construction of infrastructures such as transportion facilities. Despite a recent slowdown caused by low market prices, some mining projects are being developed. The first stage of these projects involve a permitting process such as Environmental Impact Assessments, which includes wetland identification, delineation and classification.

In Canada, the environmental permitting process is a provincial jurisdiction except for designated projects that are under federal jurisdiction. For example, projects that involve activities in more than one province fall under federal rules. In Quebec the provincial regulation (Environment Quality Act) requires compensation for wetland losses if they cannot be avoided or minimized. So far, protection of wetlands or buffer zones around wetlands, ecological enhancement, restoration and creation were the preferred compensation options. However the Quebec Environment Quality Act is being revised and compensation options may be modified. For instance, monetary compensation could become favored while protection of wetland and buffer zones around wetlands might no longer be accepted.

Quebec Wetland Delineation Guide

The compensation level determination is primarily based on the lost of wetland areas, which makes wetland delineation a crucial factor in establishing the compensation. In order to better implement this regulation, the Québec Department of Sustainable Development, Environment, and Fight against Climate Change (DSDEFCC) published a wetland classification and delineation guide (Bazoge *et al.*, 2015). That guide recognizes four wetland classes: shallow water (pond), marsh, swamp and peatland. It also integrates the concept of "mosaic" that includes terrestrial "islands" being more or less surrounded by wetlands.

Botanical, hydrologic and soil criteria are used along with other wetland features to delineate wetlands:

- Botanical criteria are based on the presence of wetland obligatory (OBL), facultative (FACH) and non-indicative (NI) plant species according to the plant list included in the guide. The dominance of OBL and FACH plant species lead to the classification of a site as wetland.
- Drainage, organic layer thickness and degree of decomposition, and hydromorphic features (gleysation and mottles) in mineral soils are the main soil criteria used to classify wetlands.
- Features associated to hydric conditions such as the presence of black litter, sediments and mosses on tree trunks are also taken into account in the classification process.

Boreal Forest Wetlands

The current wetland guide was developed for the meridional part of the Québec territory that is dominated by deciduous and mix forests. However, rules of the guide can hardly be applied in the boreal forest, where these rules may lead to incorrect wetland classification and delineation. The main reason leading to such a situation is that some wetland indicative plant species are commonly found in dry habitats in northern conditions. The best example is Labrador tea (*Rhododendron groenlandicum*) that is considered as an obligatory wetland species in the south but that is almost ubiquitous in the boreal forest. Black spruce (*Picea mariana*), a facultative species in the wetland guide is the dominant tree species in the north where it grows in hydric, mesic and xeric conditions. Actually, a large part of the boreal forest is split into two categories, the Black spruce moss forest (humid) and the Black spruce lichen forest (xeric) that are both obviously dominated by black spruce. On the other hand Balsam fir (*Abies balsamea*) a species that is restricted to wet stations in the north is not indicative of wetlands in southern Québec. An explanation for this situation is that some species are restricted to particular habitats when they are at the limit of their range, so that boreal species are found in wetlands in the temperate forest while some widespread southern species are confined to wet depressions in the north.

Problems that could be misleading also occur in regards to soil criteria. For example, an organic horizon of a minimum thickness of 30 cm must be present to categorize a site as a peatland. As we move north, climatic conditions reduce biologic productivity that, in turn, decreases organic matter accumulation rate in peatlands with the consequence that some peatlands cannot be classified as such because of peat thickness lower than 30 cm. This is especially true for fens (namely spring-fens) that can even develop on more or less sloping conditions due to runoff water supply for a large part of the summer. On the other hand, folisol deeper than 30 cm composed of moss debris can be found in mesic and hydric stands within the spruce moss forest that covers extended area in the boreal forest. Although folisol are not considered as hydromorphic soils, their identification as such maybe problematic. When associated with the presence of black spruce and Labrador tea, two wetland indicator species according to the current guide, such a combination may wrongly lead to classify terrestrial habitat as wetland.

Consequently, these factors (plant and soil indicators) can, in many cases, lead to over or under estimation of wetland surface and even lead to the classification of terrestrial habitats as wetlands or the opposite. A review of plant wetland status and defining an organic soil depth for northern Québec would help solve the problem without requiring important efforts at least for the boreal forest.

Arctic and Subarctic Wetlands

Problems more specific to the subarctic and arctic tundra zone are the lack of knowledge by practitioners and analysts as well as access to reliable data. Both can lead to misinterpretation as to the presence of wetland and negatively affect some projects. For example, the simple presence of *Carex* species has been wrongly interpreted as indicators of wetland. Few biologists have a functional knowledge of northern plant species and most of them have not been categorized in regards to their wetland status. Similar situations may happen with some periglacial wetland features. While the current wetland guide uses botanical, hydrologic (drainage) and soil criteria, in northern environment soil and hydrology are controlled by geomorphologic processes that are simply not taken into account in the wetland evaluation process for the meridional zone. In the subarctic zone, ground frost is the driving force of a great diversity of geomorphological processes directly responsible for the spatial distribution of wetlands. These processes depend largely on the nature of the surficial deposits and the level of water saturation in the ground. Geomorphological processes are also extremely dynamic and can

cause rapid fluctuations in water conditions during a year. For example, tundra mud boils may be sporadically water saturated at the beginning of thawing of the active layer over permafrost in summer, but quickly take on a hard, compact consistency after only a few weeks (thixotropy). In contrast, areas on some slopes may be continuously water saturated throughout the summer season, due to the presence of solifluxion lobes. A similar situation exists down slope from snowbeds and snow patches that supply water as they melt over the summer. These factors lead to the formation of wetlands that can easily be classified as marsh or low shrub swamp based on the dominant vegetation (herbaceous or shrubs species) but there is a lack of knowledge about plant communities composition and processes that characterize them and that would allow a more precise identification and classification. Hence there are no criteria to help delineate these wetlands.

Impact Assessment

The global warming poses new challenges for the preparation of environmental impact assessments in northern latitudes like northern Québec especially in regards to wetlands. Wetlands can cover extensive areas in cold regions because the presence of permafrost impedes drainage and creates waterlogged soil conditions. On the other hand the global warming is more pronounced at these latitudes resulting in higher temperatures and a longer frost free season that directly affect permafrost by inducing thawing and increasing the depth of the active layer. Permafrost degradation increases available water in immature and non-organized drainage network. When thermokarst ponds cover an important proportion of an area, the drainage network does not have the capacity to efficiently evacuate the water. Excess of water, generated by snowmelt and permafrost thawing, stagnates on the terrain and could transfer additional heat into the ground. Hence a non-organized drainage networks allows water accumulation that contributes to the fast soil warming in the watershed. That leads to an increase of groundwater movement and storage capacity in the soils and the drainage networks must adapt to these new hydraulic conditions. As long as a frozen layer is present at shallow depth, this effect can favor the presence of wetlands because more water becomes available, but in the longer term, the drainage network development can induce disappearance of permafrost that will facilitate drainage and lead to dryer conditions and important change to wetland.

Global warming also affects plants by lengthening growing season and increasing available energy (degree-day). Better plant growth will favor snow accumulation that in turn will protect plants against frost.

These effects of global warming already create highly dynamic conditions in the arctic and subarctic zones that complicate the description of a rapidly evolving environment. In addition, the assessment of impacts and elaboration of mitigation measures require the integration of factors and processes that are occurring or are likely to occur in a near future whose effects are not well understood. In some cases the lack of knowledge is an obvious problem. Major difficulties arise when trying to assess the impact of a project on wetlands. It may be difficult to discriminate between the effect of a warmer climate and (that of infrastructure such as civil linear infrastructures or mining facilities) human activities.

This situation can be illustrated by a project aiming at selecting the best road location among a few options for a mining project in Northern Québec. The road construction was subject to an environmental authorization certificate that required a description of wetlands and the assessment of impact of the road on the environment and the impact of environment on the road. The Québec wetland classification and evaluation system proved to be inapplicable (unadapted) in this arctic context. For instance, it was not clear if some periglacial features such as tundra mud boils should be considered as wetlands. Evaluation of impact and mitigation measures took

into account the effect of snow ploughing that could affect permafrost and create ground disturbance locally. The presence of nearby snow patches was taken into account as they may present a threat to the road if they increase in size due to more abundant precipitation and/or induce permafrost thawing and increased runoff. In the end, despite a deep analysis of the situation, lot of uncertainties remained.

In such conditions, it becomes obvious that a wetland identification and delineation guide should be developed properly for the subarctic and arctic zones of Québec to take into account the specificity of soil, hydrology and vegetation of cold regions. Such a guide should include a reliable list of indicator plant species. In fact, the current wetland identification and delineation guide provides wetland affinity for about 1280 taxa out of the 2854 species found in Québec, i.e. less than half of the total number of plant species. Hydrological and soil criteria should also be adapted to subarctic and arctic conditions and consider the influence of the global warming on the dynamic of wetland and permafrost. The increase of knowledge about northern plant species, geomorphology and arctic environmental conditions are leading to the preparation of such a guide. This work should be conducted by a team of specialists including biologists and geomorphologists with a good deal of experience in cold regions.

References

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