The Resilience and Management of Arctic Wetlands (RAW) delivered in May 2021 to the meeting of the Foreign Ministers of the Arctic States a series of 13 Key Findings and 20 policy and management recommendations designed to act on these Key Findings. Key Finding 12 highlighted the need for new pan-Arctic wetland maps based on a uniform approach. Including a need to show the spatial extent of discrete wetland complexes at high resolution separating mineral soil wetlands from organic wetlands (peatlands). See the blue box for more information on high-resolution mapping.

In response as a first step to improve our knowledge and understanding of the extent and coverage of Arctic wetlands a series of raster images were developed which combine existing data to provide overview maps (10 km pixels). These data are combined to displays mineral wetlands, peatlands, and the extent of permafrost per pixel. These data can be used at broad scales to illustrate or analyze patterns of wetland extent north of 60° latitude. Figure 1 shows the total wetland extent of 2.7 M km\(^2\), equivalent to 16% of the land area in the region. Of this area ca. 1.8 km\(^2\) is comprised of peatlands and 0.9 km\(^2\) of mineral soil wetlands; 11% and 5% of the Arctic land area, respectively. Table 1 provides an overview of the mapped extent of different types of wetlands and permafrost. This table also shows the extent of Arctic wetlands that occurs in protected terrestrial areas (CAFF Protected Areas Indicator). In total, 12% of the Arctic wetlands are in protected areas, with 8% of peatlands protected and 2%+ of mineral wetlands protected.

See figures 2-6 for maps of individual wetland types as well and permafrost.

Further work is underway with the Arctic Spatial Data Infrastructure (Arctic SDI) to develop a Pan-Arctic Wetlands Inventory Map at higher spatial resolution, using a methodology to classify wetlands from satellite imagery. Arctic SDI and CAFF engage domain experts from each Arctic country on the governance, processes and steps necessary to create this new product. This three-year initiative will generate a wetland baseline dataset that includes the latest wetland data from each Arctic country, which will support longer-term efforts to monitor changes and measure the impacts of climate change.
Figure 1. Extent of Arctic wetlands, including both peatlands and mineral wetlands. Small open water surfaces are also included, but larger lakes are not (see methods section for more details).

<table>
<thead>
<tr>
<th>Land area &gt;60° lat</th>
<th>Area km²</th>
<th>% of Arctic (as defined by 60° lat)</th>
<th>% of mapped Arctic wetlands</th>
<th>Area protected wetlands</th>
<th>% of wetlands that is protected</th>
</tr>
</thead>
<tbody>
<tr>
<td>All wetlands</td>
<td>2,733,727</td>
<td>16%</td>
<td>100%</td>
<td>326,176</td>
<td>12%</td>
</tr>
<tr>
<td>Peatlands</td>
<td>1,856,587</td>
<td>11%</td>
<td>68%</td>
<td>156,394</td>
<td>8%</td>
</tr>
<tr>
<td>permafrost</td>
<td>1,350,864</td>
<td>8%</td>
<td>49%</td>
<td>132,392</td>
<td>10%</td>
</tr>
<tr>
<td>non-permafrost</td>
<td>505,723</td>
<td>3%</td>
<td>18%</td>
<td>24,503</td>
<td>5%</td>
</tr>
<tr>
<td>Mineral wetlands</td>
<td>877,140</td>
<td>5%</td>
<td>32%</td>
<td>175,938</td>
<td>20%</td>
</tr>
<tr>
<td>Permafrost extent</td>
<td>9,525,654</td>
<td>55%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(in all land cover types)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total land area</td>
<td>17,290,500</td>
<td>100%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1. Summary of areal extent of different mapped wetland complex types as well as the areas of wetlands that are protected (CAFF, Arctic Protected Areas Indicator 2021).
Figure 2. Extent of mineral soil wetlands.

Figure 3. Extent of peatlands (wetlands with organic soil).
Figure 4. Extent of peatlands with near surface permafrost

Figure 5. Extent of peatlands with no near surface permafrost
Figure 6. Extent of permafrost

Figure 7. Extent of all wetland types within protected terrestrial areas
The maps consist of gridded data with 10 km pixels of estimated percent coverage of wetlands. The data is divided into mineral soil wetlands, peatlands and also includes the extent of permafrost per pixel. The dataset consists of six raster files:

- All_Wetlands_LAEA10km_60deg: which shows per pixel percent cover of all wetlands;
- Permafrost_extent_LAEA10km_60deg: which shows per pixel percent underlain by near surface permafrost;
- Mineral_wetlands_LAEA10km_60deg: which shows per pixel percent cover of mineral wetlands (<40 cm of surface peat);
- Peatlands_All_LAEA10km_60deg: which shows per pixel percent cover of peatlands (wetlands with >40 cm of surface peat);
- Peatlands_Permfrost_LAEA10km_60deg: which shows per pixel percent cover of peatlands with near surface permafrost; and
- Peatlands_Non_permaf_LAEA10km_60deg: which shows per pixel percent cover of peatlands without permafrost.

The maps are created by combining three different input datasets: (i) peatland extent maps from soil maps (Hugelius et al., 2020) (ii) soil wetness based on remote sensing (Widhalm et al., 2015) and (iii) permafrost extent based on data-driven dynamic permafrost modelling (Obu et al., 2020). For more details on how these different studies derived the data used, we refer to the original sources.

The maps combine different input data and therefore are not strictly based on a common source or classification system. However, they follow the overarching definitions in the Canadian Wetland Classification System (National Wetlands Working Group, 1997) for separation of peatlands and mineral soil wetlands. The maps are at a scale where small, shallow, ponds in tundra or peatlands are included as wetlands, but larger lakes are not included as wetlands. However, there is no consistent size threshold to delineate where lakes or ponds have been included as wetlands because this differs between the national datasets used (Hugelius et al 2020). The maps only show terrestrial wetlands, shallow coastal seas or tidal flats are not included. All analyses were done in the Lambert Azimuthal Equal Area projection. The dataset extends across the Arctic down to 60 degrees north, which is the maximum joint extent of all three datasets.

Widhalm et al. (2015a; 2015b) maps soil wetness in four levels (ordinal data-scale of wettest to driest) at a resolution of 150 m. The wettest landscape class was used to make a binary wetland map at 150 m. This was aggregated and summed to estimate wetland percentage in 10 km pixels and combined with peatland maps from Hugelius et al (2020). That study mapped the extent of organic soils (Histosols and Histels in the U.S. soil Taxonomy definition) across the circumpolar north (>23° latitude) based on various soil map sources. The two maps (wet areas and peatlands) were combined by extracting the maximum value per pixel. This calculation assumes that the coverage of peatlands and wet pixels cannot be additive to avoid double counting of wetland areas. The maps further assume that any mapped wetlands in the combined map that are not included in the peatland maps are mineral wetlands (defined as < 40 cm surface peat). Permafrost extent was derived from the 1 km resolution model output presented by Obu et al. (v2, 2020b) where the modeled permafrost fraction was summed and aggregated to 10 km pixels. To account for the fact that permafrost in peatlands persists further south than mineral soil permafrost (due to insulation from the peat layer), the extent of permafrost in peatlands from Hugelius et al. (2020) was used, taking the per pixel maximum permafrost extent from Obu et al. (2020) and Hugelius et al (2020). Note that mineral wetlands were not separated into permafrost and non-permafrost wetlands. This is because there is no dedicated dataset that maps mineral wetland extent and it remains unknown to what extent the average pixel permafrost fraction mapped by Obu et al (v2, 2020b) is applicable to mineral soil wetlands. It is anticipated that future versions of this dataset will provide improved capabilities to differentiate between land cover types at the sub-pixel level. A user may multiply the permafrost extent raster with the mineral wetland grid to get an approximated value of mineral wetland permafrost extent.
REFERENCES


