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# Response to climate change within northern Asian tree line

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The purpose of this report is to analyze the climate driven changes along the northern Asia tree line at the world's northernmost tree stand located at Ary-Mas, ( $72^o28\prime$ N, $101^o40\prime$E). We consider tree position, growth increment and stand densitification to be the principal indicators of climate impact. The investigation was based on remotely sensed data [Landsat (1973, 2000 yrs), "CORONA" (1965), (airborne images (1970, 198), and ground truth data (years 1969, 1972, 1990 and 2000).

It was found that permafrost thawing depth is increasing with test site elevation. ($r$ = 0.55, $\tau$ = 0.51). This is caused by moss and lichen cover height and closure decrease ($r$ = -0.88, $r$ = -0.83 $\tau$ = -0.66, $\tau$ = -0.75, correspondingly).

Radial growth increment is increasing with permafrost thawing depth increase ($r$ = 0.63, $p > 0.9$; $\tau$=0.46, $p > 0.9$), and decreasing with stands density increase ($r$ = -0.52, $p > 0.8$; $\tau$ = -0.48, $p > 0.95$). Radial increment positively correlates with summer temperature ($r$ =0.65, $\tau$ = 0.39), and negatively – with summer and winter precipitations ($r$= -0.53, r = 0.62; $\tau$ = -0.41, $\tau$ =-0.48, correspondingly). The effect caused by (1) insolation reduction due to clouds, and

(2) "thermal inertia": vegetation period decrease caused by snow accumulation.

The regeneration amount depends on winter ($\tau$ = 0.53, $p > 0.8$) and summer ($r$ = 0.98, $p > 0.99$, $\tau$=0.9, $p > 0.99$) temperatures, and the date of vegetation period begin ($r$ = -0.60, $p > 0.99$; $\tau$ = -0.4, $p >$0.99). Summer precipitation negatively

affects regeneration amount ($r$ = -0.56, $p > 0.99$, $\tau$ = -0.38, $p > 0.99$).

It was found that tree densities of the Ary-Mas stand increase about 65% during the last 30 years. Closed stands occupies primary steeper slopes (12˚ - 13˚), whereas maximum of sparse larch distribution observed on gentler ($\sim$ 6˚) slopes. This reflects the protective role local topography, especially significant during winter time.

During the last few decades larch propagated into tundra with a rate of about 3-10 m/yr. The result of larch migration into tundra may be expansion of larch forests to the Arctic shore, a phenomenon that has happened in the past, whereas the traditional area of larch dominance will transform into mixed taiga zone.