Cold and Mountain Region Hydrological Systems Under Climate Change: Towards Improved Projections
Proceedings of H02, IAHS-IAPSO-IASPEI Assembly, Gothenburg, Sweden, July 2013 (IAHS Publ. 360, 2013) 155-160.

Changes in eco-hydrological systems under recent climate change in eastern Siberia

TETSUYA HIYAMA[1], TAKESHI OHTA[2], ATSUKO SUGIMOTO[3], TAKESHI YAMAZAKI[4], KAZUHIRO OSHIMA[5], HITOSHI YONENOBU[6], KAZUKIYO YAMAMOTO[2], AYUMI KOTANI[2], HOTAEK PARK[5], YUJI KODAMA[7], SHIGEMI HATTA[8], ALEXANDER N. FEDOROV[9] & TROFIM C. MAXIMOV[10]

1 Research Institute for Humanity and Nature, Japan
hiyama@chikyu.ac.jp
2 Graduate School of Bioagricultural Sciences, Nagoya University, Japan
3 Faculty of Environmental Earth Science, Hokkaido University, Japan
4 Graduate School of Science, Tohoku University, Japan
5 Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Japan
6 Department of Health and Living Sciences Education, Naruto University of Education, Japan
7 Arctic Environment Research Center, National Institute of Polar Research, Japan
8 Department of Civil Engineering, Tomakomai National College of Technology, Japan
9 Melnikov Permafrost Institute, Russian Academy of Sciences, Russia
10 Institute for Biological Problems of Cryolithozone, Russian Academy of Sciences, Russia

Abstract Global warming is likely to transform Siberian environments. Recent eco-hydrological evidence indicates that water and carbon cycles have been changing rapidly, with potentially serious effects on the Siberian flora and fauna. We have comprehensively analysed dendrochronological, hydrological, and meteorological data and satellite remote sensing data to track changes in vegetation and the water and carbon cycles in the Lena River Basin, eastern Siberia. The basin is largely covered with larch forest and receives little precipitation. However, from 2005 to 2008 the central part of the basin experienced an extraordinarily high level of precipitation in late summer and winter. This resulted in the degradation of permafrost, forest, and hydrological elements in the region. Dendrochronological data implied that this event was the only incidence of such conditions in the previous 150 years. Based on data collected before and after the event, we developed a permafrost-ecosystem model, including surface soil freeze-thawing processes, to better represent the heat, water, and carbon fluxes in the region. We focused on the surface soil layer, in which an increased thawing depth is now apparent, surface soil moisture, and net primary production. An analysis of observed and model-simulated data indicated that the annual maximum thawing depth (AMTD) had increased gradually on a decadal scale and deepened abruptly after 2005. Climatological analyses of atmospheric water circulation over the region indicated that the recent increases in precipitation over the central Lena River Basin were partly related to cyclone activity. Consequently, the increased precipitation from late-summer to winter resulted in increases in soil moisture, soil temperature, and AMTD in the region.

Key words global warming; Lena River Basin, Siberia; extraordinarily high precipitation; permafrost-ecosystem model; annual maximum thawing depth (AMTD)