Evaluation of the Contribution of Agricultural Activity to Nitrogen Concentrations in Several Small Lakes in the Khorezm Region of Uzbekistan

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Abstract
Cotton, rice, and wheat are grown extensively in the Khorezm province of western Uzbekistan. Run-offs from the Amu-Darya River. Approximately 150-300 kg of nitrogen per year are applied to these crops, although a minimum of 30% is utilized by plants (Michael et al. 2008). Runoff from fertilized fields and seepage from shallow groundwater provide water for 450 shallow lakes distributed across this arid region. Monthly water quality samples were collected from 13 lakes from 2006 to 2008 and compared to land use data to evaluate temporal variations between fertilizer loads and agricultural fields and nitrogen in the lake. Zooplankton were periodically collected and analyzed for δ15N to examine the effects of land use on aquatic systems.

Results
• Total nitrogen is dominated by ammonium in each lake (Figure 3). Despite differences in land use surrounding the lakes, nitrogen patterns between the lakes are very similar. Contrary to the pattern of nitrogen fertilizer application, lake water column nitrogen is generally lowest in the summer and spikes during the cold winter months. Ammonium in the Amu River shows a pattern similar to that seen in the lakes.

Introduction and Methods
• In the last decade, Uzbekistan has suffered environmental and human health problems related to the cotton monoculture established under the Soviet Union. The Khorezm province of northwest Uzbekistan in the Aral Sea Basin is an agricultural area under water use stress that exemplifies these issues.
• Cotton is the principal crop grown in the region at 46% of total agricultural use, followed by winter wheat and rice at 23% and 21%, respectively (Conrad 2006). Cotton and winter wheat production are mandated by the state, while rice is the principal cash crop in the region.
• This study examines the water quality and nutrient cycles in small lakes throughout the province to determine agricultural impacts on the lakes, as well as their potential as a water resource in an arid landscape.

Summary
• Seasonal nutrient loads in all lakes show a similar seasonal pattern, with highest nitrogen during the winter months. Many studies suggest that high ammonium typically results from anoxic lake conditions (Rygaard et al. 1994, Moore et al. 1992, Beutel 2006). However, dissolved oxygen in the lakes at the time of highest nitrogen suggests an outside source of nitrogen.
• Despite prevailing agricultural land use in the study region, lake nitrogen does not appear to immediately reflect localized patterns of nitrogen use.
• Lake water column nitrogen loads are very low when compared to growing season nitrogen fertilizer loads in the agricultural areas immediately surrounding the lakes. δ15N levels in zooplankton samples support the hypothesis that summer application of synthetic nitrogen fertilizer applied to the fields directly surrounding the study lakes is not responsible for the observed ammonium levels in the lake water.
• Water samples collected from the Amu River, which supplies the greatest portion of water used for agricultural activity in the region, show similar levels to those observed in the lake. Therefore, the high spring ammonium levels in the lakes may result from sudden input of Amu River water as agricultural activity begins in the spring.
• Alternatively, lake ammonium may be due to agricultural nitrogen from the previous year that is washed into the drainage channels during spring field leaching events. It is unlikely that lake nitrogen enters through groundwater input, since this source probably contributes only a very minor portion of the water balance (Scott 2009), at least during summer.

• More frequent sampling, especially during spring months, may yield a clearer picture of the inputs driving the nutrient cycles in these lakes.