Potential impacts to ecosystem health and water quality from Marcellus Shale drilling

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Pilot Study

As drilling for natural gas in the Marcellus Shale increases, so do the concerns for the welfare of the surrounding environment. In a July 2010 pilot study, biological and chemical indicators were used to assess the potential effects of gas extraction on streams in north eastern Pennsylvania. Sites ranged from streams draining areas with high well density and known violations to sites with no wells. Density of natural gas wells within a watershed was the main test variable (gradients in potential covariates such as land cover were controlled for). Stream health indicators were regressed against well density to determine possible impacts. Several stream health indicators had significant ($p<0.10$) negative (macroinvertebrates family, Shannon-Wiener diversity index of macroinvertebrates) or positive (water conductivity) correlations with well density. Multiple t-tests among groups of sites with high, low and no wells found that the correlations resulted from differences between sites with high well density and those with low density or no wells. Significant differences were not found between low density and reference sites.

Figure 1: Field team taking stream measurements (left), collecting benthic samples (middle), and collecting water (right).

Expanded Study

During summer and fall of 2011, 60 sites with varying well densities were sampled for water quality analysis. Wastewaters produced from drilling activities in the same region were also tested to identify a "produced water" signature. This signature, consisting of a particular combination of cations and anions, are being compared to samples from the 60 sites. Preliminary data, plotted as Stiff diagrams, suggests three sites have a produced water fingerprint. Two sites had documented spills, while the third site had the highest well pad density. In addition, concentrations of chloride ions increased with well density.

Future Research

Biota samples were also collected at 30 of the water quality sites. As in the pilot study, stream health analysis will be applied to this data in the near future. In 2012, previous sampling sites will be re-visited and new sites added for water quality and biota sample collection. Time transgressive sampling will provide additional information on the potential impacts of Marcellus drilling activities throughout the region.

High resolution aerosol sources and anthropogenic impacts in Central Europe during the Holocene

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Aerosol transport and deposition is a well-known indicator to assess environmental impacts due to climate changes (erosion, droughts…) and/or human activities (deforestation, quarries, mining…). In particular, sudden climate shifts have become a key issue to develop and test models dealing with recent and forthcoming climate change. Meanwhile, transient and rapid environmental fluctuations in landlocked continental regions cannot be resolved by means of the sole remote ice and marine (generally poorly discriminated at the scale of the Holocene) cores. Because ombrotrophic peatlands are fed by atmospheric deposition only they can archive a full suite of proxies (such as dust, pollens, carbon, trace elements including metals) to resolve climate uncertainties at a high temporal resolution during the Holocene [1]. They also uniquely trace human activities and its environmental effects [2].

Here we present proxy's imprints recorded from a 13,000 years old peat bog collected in Central Europe (Czech Rep.). The well-known Younger Dryas cold interval is clearly characterized with increased dust fluxes at 11.5-12.7 ky BP, a period that compares well to other continental records of this event. Another significant dust episode is identified at 9.3-8.8 ky BP while the marine 8.2 ky BP circum North Atlantic event is not detected. Other major multi-century dust episodes are recorded at 6.0 ky and 3.3-2.9 ky BP that fit cold events from Greenland ice cores and German tree rings. Pollen records are consistent with these findings and show the transition from Late Glacial to Boreal and Atlantic climate zones. In order to verify aerosol sources during these events and to better define successive identified dust peaks we have measured stable Pb isotope ratios that are key markers for the diversity of aerosol sources. We could clearly differentiate aerosol from various regions including the Gobi and Saharan deserts, the Chinese loess, the Scandinavia shield, and the local Czech Bohemian bedrock.

Pb enrichment and specific isotopic ratios could also indicate a long-range transport of pollutant Pb from the Mediterranean regions as early as 5.2 ky BP. This invasion of warmer Mediterranean airflows could explain the advent of warm deciduous species (hazel, elm, oaks) in our peat as also observed in German mires during the same climatic optimum. Mixed imprints of local bedrock and Bohemian ores are observed between 4.4 and 1.7 ky BP that demonstrate well-established regional mining activities.