Overview of the National-Scale Mercury Risk Assessment

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Science Advisory Board Meeting
June 15, 2011

Scope of the Risk Assessment-1

- Consistent with the Clean Air Act, we are trying to determine whether mercury released from U.S. EGUs represents a public health hazard to the U.S. population
  - Focus : estimate risk for *individuals within the U.S. expected to experience the highest exposures and risk from* ***exposure to Hg from U.S. EGUs***
  - Other air toxics covered in separate analyses
- Key factors considered in designing analysis:
  - Dominant pathway associated with Hg air emissions – consumption of fish that have bioaccumulated methylmercury (MeHg) originally deposited to waterbodies and watersheds
  - High risk population – children born to mothers who were exposed to MeHg during pregnancy through fish consumption
  - Type of fish consumption likely to reflect highest contribution from U.S. EGU-sourced Hg involves consumption of self-caught fish from inland rivers/lakes in areas of high deposition
    - Ocean and coastal-sourced fish are impacted primarily by global Hg (of which U.S. EGUs represent a relatively small fraction)

Scope of the Risk Assessment-2

- Focus of analysis - model potential risk to fishers active at inland rivers and lakes with fishing behavior that places them at greater risk from exposure to U.S. EGU-sourced Hg:
  - Higher self-caught fish consumption rates (subsistence behavior)
  - Fishing activity at watersheds with higher fish tissue MeHg levels and/or higher rates of U.S. EGU-sourced Hg deposition
    - Interested in watersheds located in areas of elevated Hg deposition from U.S. EGUs (result in larger fraction of fish tissue MeHg levels being attributed to U.S. EGUs)
  - Fishing activity focused at a single watershed (less dilution of high-MeHg locations)
  - Targeting somewhat larger fish to supplement diet (which may have greater bioaccumulation of MeHg)

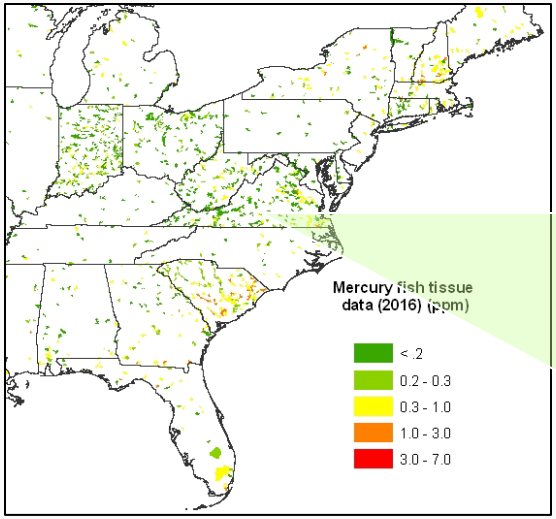
- While it is not possible at this time to definitively state which watersheds have subsistence fisher activity or to enumerate those populations, we do believe that this type of subsistence fishing activity could reasonably be expected to occur across some fraction of the 2,461 watersheds included in the analysis (based on published survey data).

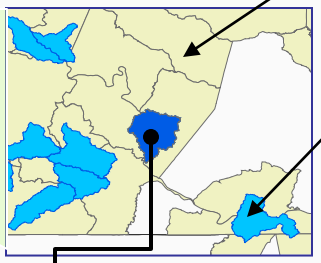
Scope of the Peer Review

- As noted in the charge questions to the SAB, this review is focused on elements of the risk assessment which have not previously been subject to peer review

- EPA's methylmercury Reference Dose (MeHg RfD) and the CMAQ air quality model have received extensive peer review; they are not the focus of this review and we are not seeking SAB advice on them

Illustration of Technical Approach

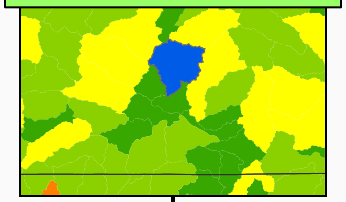




US Census tracts
(with >25 poor individuals – potential for subsistence fishing activity)

Watershed (with fish tissue MeHg data – use 75th% estimate)

Total and U.S. EGU Hg deposition over watershed (CMAQ)



Proportionality assumption (based on Mercury Maps modeling)

Self-caught freshwater fish consumption rates (for specific fishing population)

RISK MODEL: estimate total MeHg risk for high-end female consumer (subsistence) risk

Estimate of **total risk** (HQ and IQ loss)

- MeHg RfD
- IQ-loss CR function
  - Factor for translating MeHg intake to hair Hg

U.S. EGU contribution to total risk

Overview of Technical Approach - 1

Watershed-focused analysis – estimate risk to subsistence-level fishers for each watershed where we (a) have measured fish tissue MeHg data and (b) believe this type of fishing activity could occur

Key technical elements:

- Analysis focuses on 2,461 of ~88,000 watersheds that have measured fish tissue MeHg data
- Spatial scale of watersheds – Hydrologic Unit Code (HUC)12 watersheds vary in size, but generally range from 5-10km on a side
  - HUC12's are the most spatially-refined watershed with national coverage
  - This scale also reflected in studies examining response of freshwater systems to changes in Hg deposition

Overview of Technical Approach - 2

- Fish tissue MeHg data
  - Three sources of data:
    1. EPA's National Listing of Fish Advisory (NLFA) database
    2. USGS's compilation of Hg datasets managed as part of its Environmental Mercury Mapping and Analysis (EMMA) program
    3. EPA's National River and Stream Assessment (NRSA) study (smaller number of samples from randomly sampled set of waterbodies)
  - Used data collected between 2000 and 2009 (focus on data more likely to reflect recent patterns of Hg deposition)
  - Excluded watersheds near gold mines or other sources of industrial non-air mercury emissions
  - 2,461 of ~88,000 watersheds meet these criteria and have MeHg data
  - Use higher percentile fish tissue value (75th%) for risk modeling at each watershed - reflecting potential for subsistence fisher to target somewhat larger fish

Overview of Technical Approach - 3

- Characterizing subsistence fishing activity:
  - Use US Census tract-level data to assess potential for subsistence fishing activity at each of the 2,461 watersheds (poverty + ethnicity status)
    - Modeled 7 fishing populations
      - Primary focus – high-end female consumer (assessed nationally)
      - Additional populations (e.g., poor blacks in southeast, poor Hispanics, Vietnamese, Great Lakes Tribes)
  - Fish consumption rates: given focus on high-end consumption, focused on upper percentile (subsistence) consumption rates (90th to 99th%)
    - Self-caught fish meal every few days to a meal every day – based on studies characterizing high-end fish consumption for each of the populations assessed

Overview of Technical Approach - 4

- Two risk metrics:
  a) Compare exposure estimates with the MeHg RfD to generate a hazard quotient (HQ)
     - An HQ > 1.0 reflects exposures above the MeHg RfD, which represents a potential public health hazard
     - MeHg RfD eflects full range of potential neurodevelopmental impacts, including effects on IQ, educational development, motor skills and attention
     - The RfD has been subject to extensive peer-review
  b) Estimate the number of IQ points lost in children born to mothers exposed in the scenarios modeled
     - Represents a health effect that can be readily quantified in terms of incidence and is clearly of public health significance (depending on magnitude of loss)
     - Literature and available data supporting quantitative analysis is strong
     - IQ loss estimates of 1 to 2 points or more were considered to represent a potential public health hazard

Overview of Technical Approach - 5

- Uses proportionality assumption (based on Mercury Maps modeling) to link mercury deposition (CMAQ-derived) over watersheds to fish tissue MeHg levels
  - Under near steady-state conditions, a change in mercury deposition produces a proportional change in MeHg fish tissue levels
    - Critical factor – assumes aerial Hg deposition is main source of loading to the watershed
  - CMAQ 12km grid cell air quality modeling used to characterize Hg deposition together with HUC12 watersheds
  - Two applications of the proportionality assumption:
    1) Apportion total risk between U.S. EGU-sourced mercury and “other” Hg sources
    2) Project changes in total fish tissue MeHg levels (and hence risk) due to changes in Hg deposition
  - Given national-focus, proportionality assumption provided tractable approach
    - Uncertainties are recognized and qualitatively evaluated (e.g., variability between waterbodies in temporal response linked to differences in methylation potential and historical mercury reservoirs)
    - Sensitivity analyses focused on assessing impact of potential uncertainty related to Mercury Maps analysis on risk estimates

Overview of Technical Approach - 6

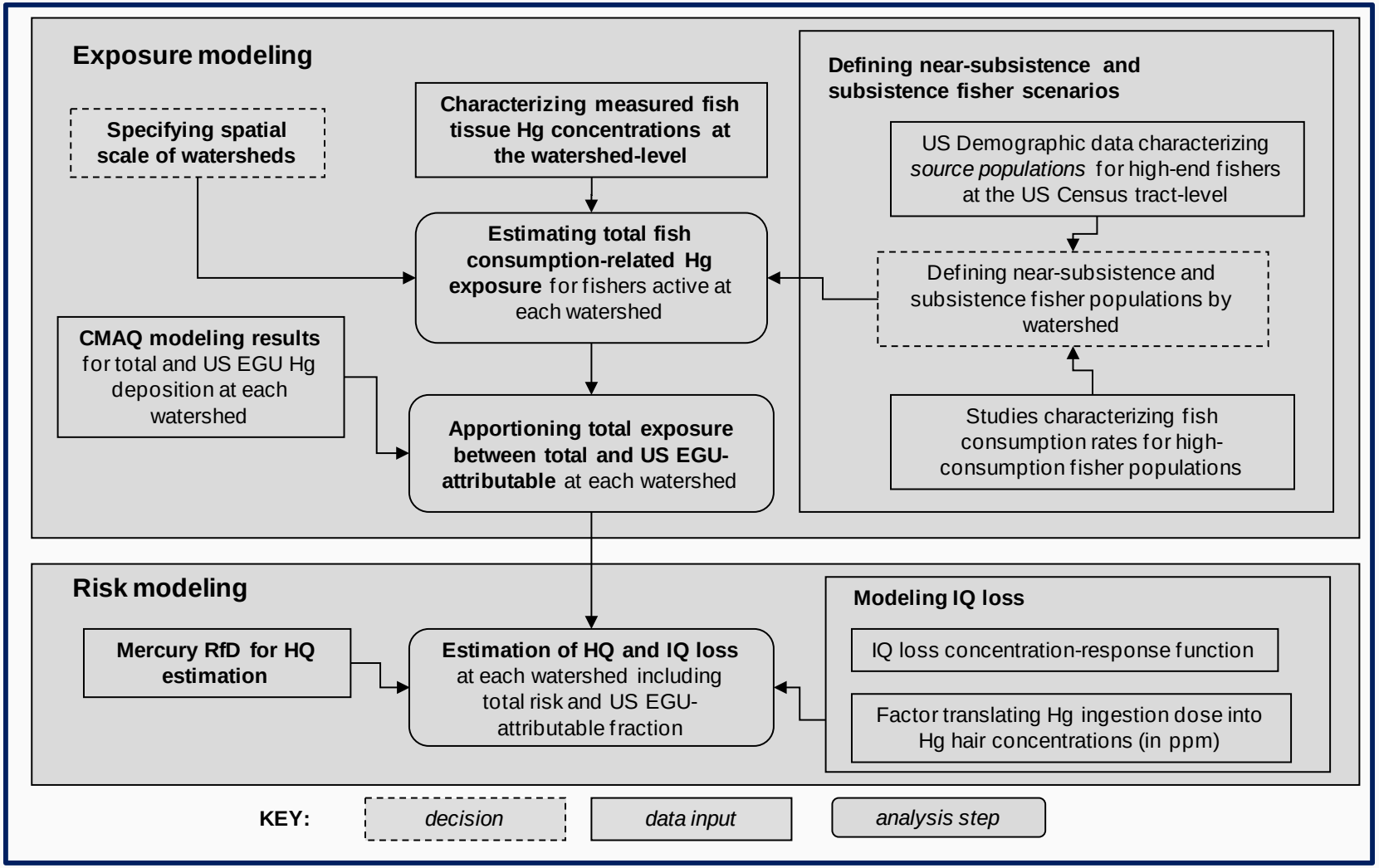
- Treatment of uncertainty and variability
  - Analysis designed to reflect key sources of variability:
    - Pattern of U.S. EGU-sourced Hg deposition
    - Fish tissue MeHg levels
    - Type of high-end subsistence fishing activity
  - Uncertainty – includes qualitative discussion of key sources of uncertainty
    - Characterize potential magnitude and direction of impact on risk estimates
  - Sensitivity analyses (focused on Mercury Maps model-based proportionality assumption):
    - Areas of country with potential for elevated loadings from other sources (e.g., LA, SC)
    - Potential for Mercury Maps to perform better with stationary waterbodies

Risk Characterization Framework

- 3-stage risk characterization framework goal: identify watersheds where U.S. EGU contributions to total MeHg risk is considered to represent a potential hazard to public health
  - Uses the MeHg RfD-based HQ risk estimates
    - MeHg RfD reflects full range of potential neurodevelopmental impacts, including effects on IQ, educational development, motor skills and attention

Stage 1: number of watersheds where:
(a) total MeHg exposure exceeds an HQ of 1 and (b) U.S. EGUs contributed a specific fraction of exposure (e.g., >5%, >10%).

Stage 2: number of watersheds where U.S. EGU-sourced Hg would result in exceedance of the MeHg RfD even without consideration of additional exposure from non-U.S. EGU Hg

Stage 3: Merge Stage 1 and Stage 2 results to get total number of watersheds with populations potential at risk from exposure to U.S. EGU-sourced Hg

Attachment: Major Analytical Steps and Associated Modeling Elements