SENSORS: A NEW WAY TO COLLECT DATA FOR ENVIRONMENTAL DECISON-MAKING?

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Interstate Technology Regulatory Council Sampling Characterization and Monitoring Team

Process

Traditional Sampling

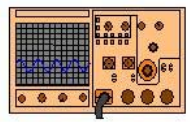
Travel to Site

Collect Sample

Pkg. Sample for Shipment

Mail Sample to Lab.

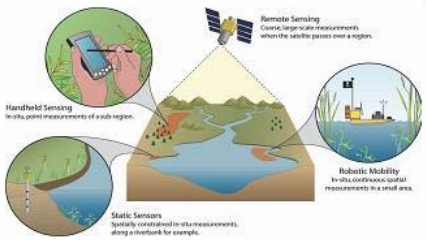
Prepare Sample for Analysis



Analyze Sample

Review Results

Sensors



Sensor Collects Data in Field; Transmits to Office

WHAT IF?

- it was possible to get real-time, continuous environmental data without having to physically obtain a sample
- What are the benefits of this type of data?
- What types of applications would this type of information be useful for?
- If the technology exists, what are some of the issues with the use of sensors?

CURRENT SENSOR ACTIVITY

☒Commercial marketplace is booming

☒Extensive academic and commercial research

☒EPA

- Strategic Plan 2006-2011: Goal 4

☒NSF

- National Ecological Observatory Network (NEON)
- Sensors for Environmental Observatories report: 2006

☒Interstate Technology Regulatory Council (ITRC)

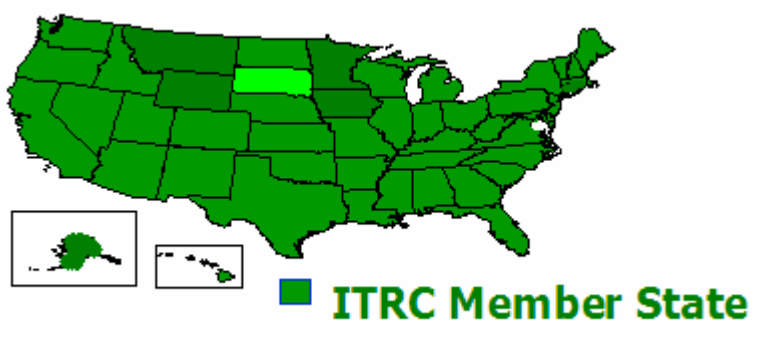
ITRC – Shaping the Future of Regulatory Acceptance

- **Documents**
  - Technical and regulatory guidance documents
  - Technology overviews
  - Case studies
- **Training**
  - Internet-based
  - Classroom
- **Network**
  - State regulators
  - Federal government
  - Industry
  - Consultants
  - Academia
  - Community stakeholders

Host Organization

ECOS

ITRC State Members



Federal Partners

DOE EPA DOD

WHAT DO I MEAN BY “SENSOR”?

- A sensor is any device that collects environmental data on water or soil in situ without the need to obtain a discrete sample. Sensors collect large amounts of data on a continuous basis over time, with the sensor often placed in one location.

- We are not considering applications for
  - Air
  - Homeland Security

TYPES OF SENSORS

Sensor Category	Parameter	Cost ($)	Field-Readiness
Physical	Temperature	50-100	High
	Moisture, Content	100-500	High
	Flow Rate, Flow Velocity	1,000-10,000	High
	Pressure	500-1,000	High
	Light Transmission (Turbidity)	800 -2,000	High
Chemical	Dissolved Oxygen	800-2,000	High
	Electrical Conductivity	800-2,000	High
	pH	300-500	High
	ORP	300-500	Medium
	Major Ions (Cl^-, Na^+)	500-800	Low-Med
	Nutrients ($NO3^-$, $NH4^+$)	500-35,000	Low-Med
	Heavy Metals	NA	Low
	Small Organic Compounds	NA	Low
	Large Organic Compounds	NA	Low

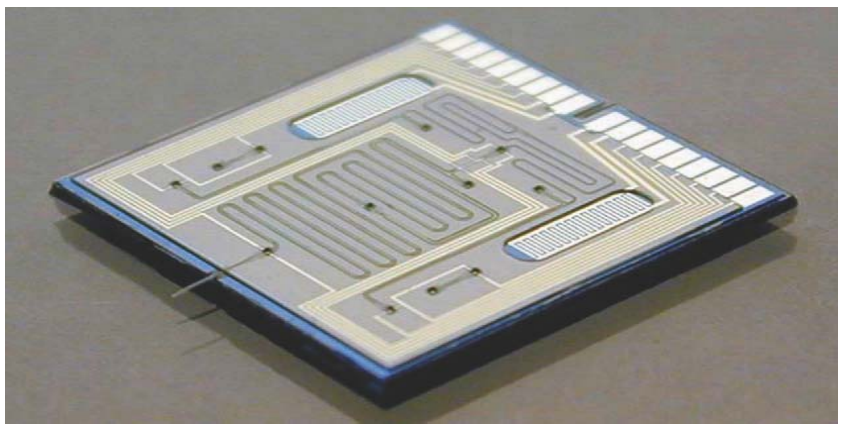
Examples of environmental sensors: cost (NA=Not Available). (From: Distributed Sensing Systems for Water Quality Assessment and Management, WWC &CENS)

EXAMPLES OF SENSORS: PHYSICAL & CHEMICAL

Physical Sensors

Chemical Sensors

Lab. On a Chip



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BENEFITS TO SENSOR DATA COLLECTION

- Real time data availability
- Lower analytical cost
- Ability to evaluate trends
- Timely response to public concerns
- Transparency to data presentations

AREAS OF APPLICATION: SEPTIC SYSTEMS

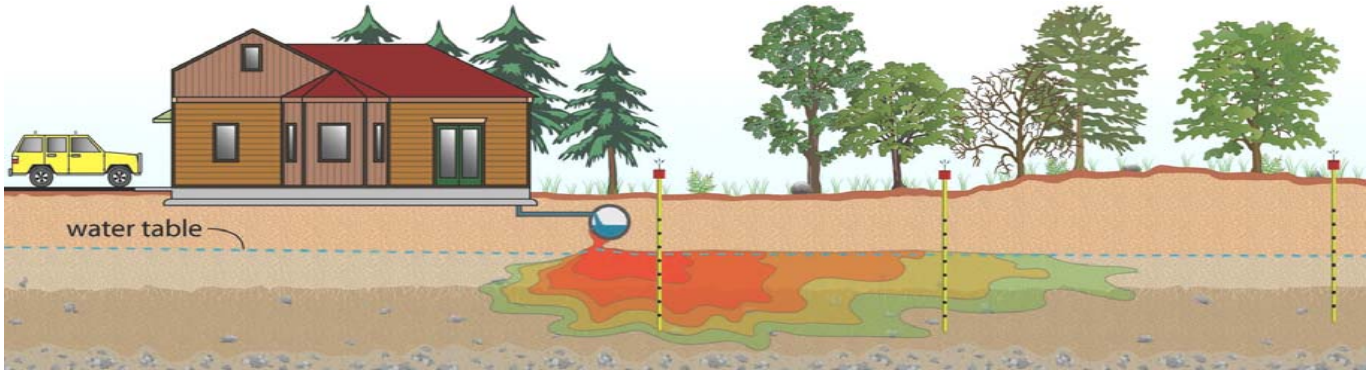

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Illustration of a sensing system used to monitor aqueous contaminants in soil and groundwater. Sensors embedded in the soil and groundwater monitor a chemical plume spreading from a source, such as a septic tank. If concentrations become too high, the system generates an alert. *Illustration: J. Fisher, UC Merced.*

- Septic Systems
  - Malfunctions are unpredictable & detrimental effects slow to accumulate
  - Temporal data provides info. on wastewater composition
  - “Meter Readers” could monitor septic systems

AREAS OF APPLICATION: NON-POINT SOURCE RUNOFF

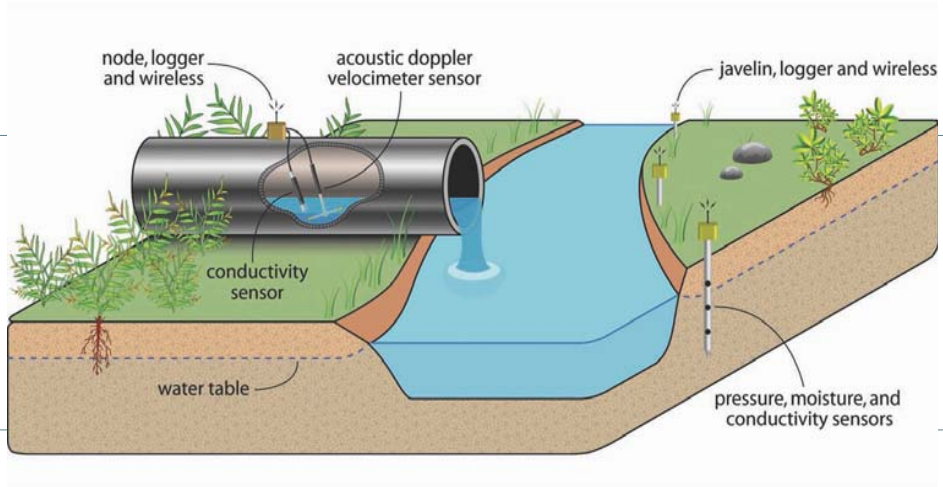

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Figure 4.2 Illustration of a hypothetical non-point source runoff drain and javeline-based monitoring system.
Illustration: J. Fisher, UC Merced.

- Non-Point Source Runoff
  - By its nature, NPS pollution is distributed over wide areas
  - Two scenarios: NPS discharges into ditches or through soils

AREAS OF APPLICATION: BEACH WATER QUALITY

Photo: G. Kleinheiz UW Oshosh

- Fecal levels do not correspond to actual pathogen levels
- Immunoassay promising; only detects live organisms
- More complete coverage will save $$$

AREAS OF APPLICATION: COMBINED SEWER OVERFLOWS

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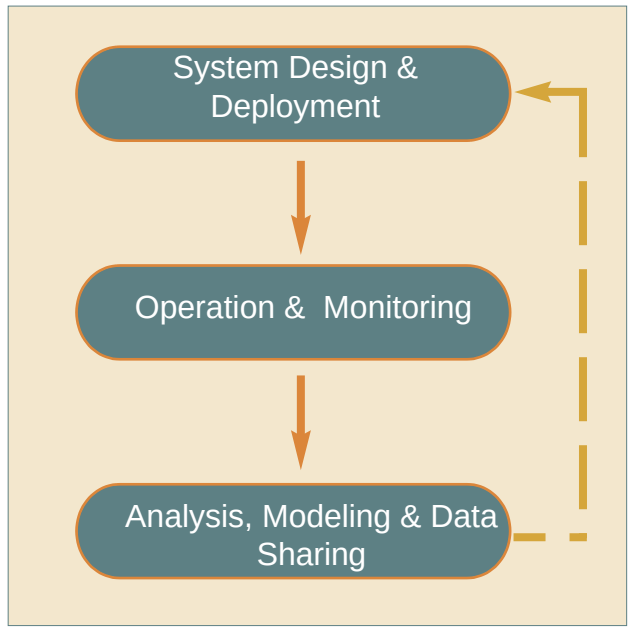
- Combined Sewer Overflows
  - Characterize effluent distribution
  - Actuation to minimize/avoid overflows

AREAS OF APPLICATION: GOLF COURSE MAINTENANCE

- Golf courses require lots of water, which is often a scarce resource
- Use of moisture sensors can minimize usage

OPERATIONAL ISSUES

- Where to deploy?
- Durability
- Reliability



DATA QUALITY ISSUES

- Data Acceptability
- Data Comparability
- Data Quality
  - Accuracy
  - Precision
  - Decision-quality vs. screening
- Quality Assurance
- Certification

REGULATORY ISSUES

- Do state and/or federal regulations allow the use of sensor data? If so, which program areas?
- Do regulatory agencies have the computer infrastructure to accept the large amounts of data that sensors can provide?
- Sensor data can be real-time, transparent and thus uncensored; is this OK with regulators?

WHERE DO WE GO FROM HERE?

- Continue to publicize the interest in sensors by regulatory agencies; they drive the market!!
- ID regulatory barriers and propose solutions: see ITRC
- Provide training on sensors: see ITRC
- **Conduct pilots where sensors are directly compared to traditional data acquisition systems**
- Highlight numerous advantages to sensor use
- Fund research on complex chemical sensor systems

CRITERIA FOR SENSOR RESEARCH PILOT(S)

- ☒ Must have broad national interest
- ☒ Highlight potential for long-term regulatory applications
- ☒ Sensor(s) chosen must be durable/reliable
- ☒ Sensor data must be comparable to traditional approaches
- ☒ Can address a regulatory deficiency

SENSOR RESEARCH PILOT(S): POTENTIAL APPLICATIONS

☒Groundwater Monitoring in NJ

- Anthropogenic nitrate inputs above 10 ppm DW std.

☒TCE Plume Delineation at Andrews AFB, MD

- In conjunction with ESTCP, use ORP, cond. & pH to help characterize a TCE plume

☒CAFOs. OK

- Examine impact of effluents from animal feeding operations for nitrate and ammonia to DW and GW sources

Questions?

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