The IAEA Project to Develop a Mobile Unit for Site Characterization

Horst Monken-Fernandes

Waste Technology Section – IAEA Department of Nuclear Energy

IAEA – Technical Meeting on In-situ Methods for Characterization of Contaminated Sites

IAEA

International Atomic Energy Agency

The Basics of Environmental Remediation (1/4)

- Remediation means: “Any measure that may be carried out to **reduce** the radiation exposure from existing contamination of land areas through actions applied to the contamination itself or to the exposure pathways to humans” (IAEA Safety Glossary 2007)
- Restoration and/or Rehabilitation are **not** appropriate concepts
- Clean-up
  - May lead to confusion
  - May be taken as removing all contamination

IAEA

Elements involved on Environmental Remediation projects

- ER projects can be very expensive
- Can affect great number of people/communities
- Trans-boundary issues may arise
- Regulatory framework is needed and technology must delivered
- Issues with different stakeholders will come to play (vested interests, political agendas, etc…)
- No one solution fits all

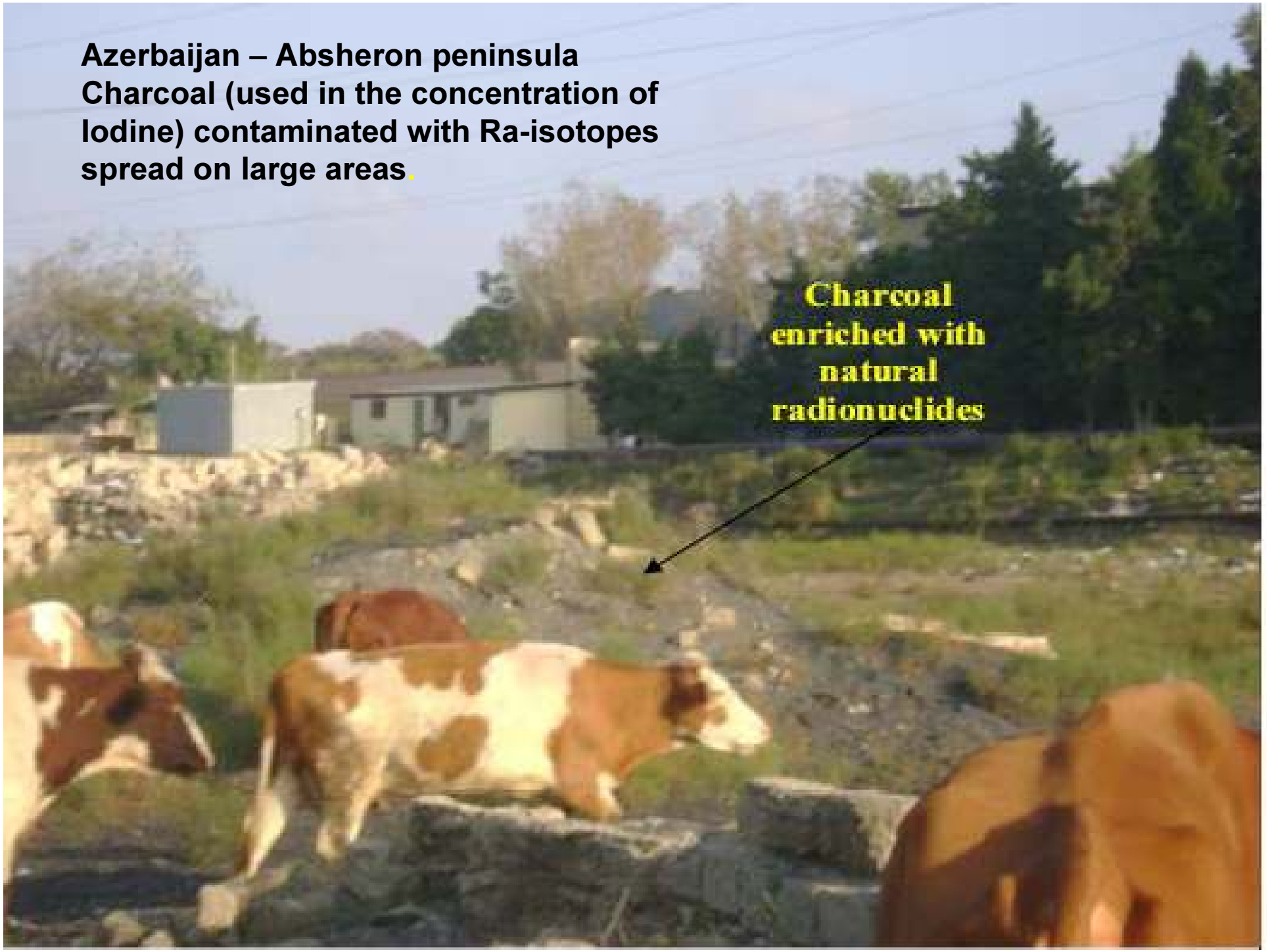
IAEA

When Environmental Remediation May Apply?

- Uranium mining and milling sites (Wismut sites, Rum Jungle, Pocos de Caldas)
- Sites affected by the discharges (routine and accidental) of radionuclides: Mayak facility (Russian Federation); Sellafield (UK)
- Nuclear weapons tests (Semipalatinsk, Maralinga, Nevada)
- Military sites
- Nuclear and Radiological Accidents: Chernobyl and Goiania respectively
- NORM sites: Absheron Peninsula - Azerbaijan

IAEA

Azerbaijan – Absheron peninsula
Charcoal (used in the concentration of Iodine) contaminated with Ra-isotopes spread on large areas.

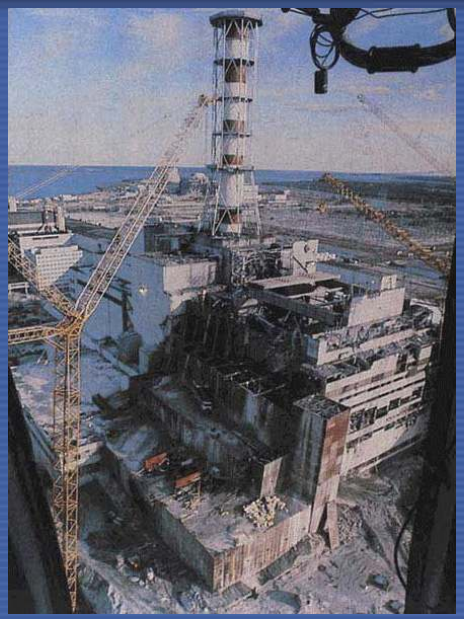


Backfilling of the Lichtenberg Open Pit, 1992

Backfilling of the Lichtenberg Open Pit, 2006

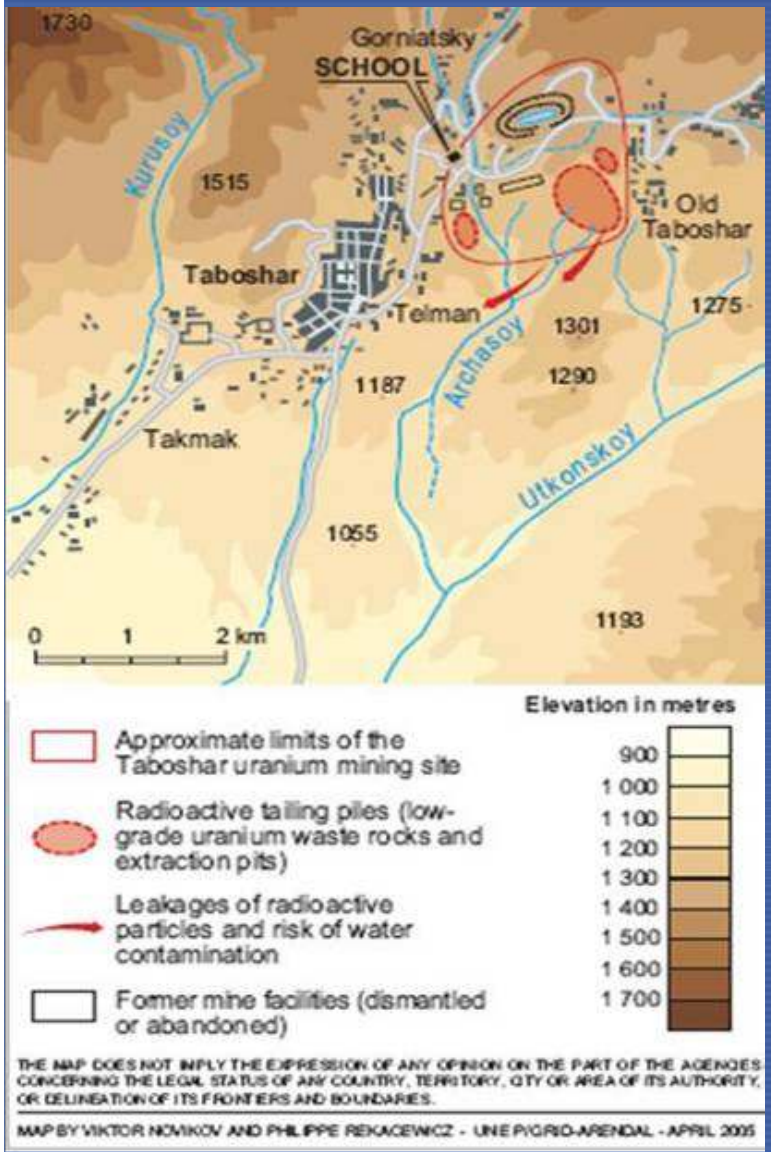
Chernobyl Accident

- The largest nuclear accident in history
- 22 years after, large areas on Ukraine and Belarus are still contaminated with long-lived radionuclides – ^{137}Cs and ^{90}Sr (restricted zones)
- Population resettlement, psychological trauma, unemployment, broken ties, fear and anxiety
- Enormous socio-economic impact on all areas: agriculture, transport, trade, etc.
- **Economic costs of Chernobyl programs - hundreds billions USD**



IAEA

Taboshar



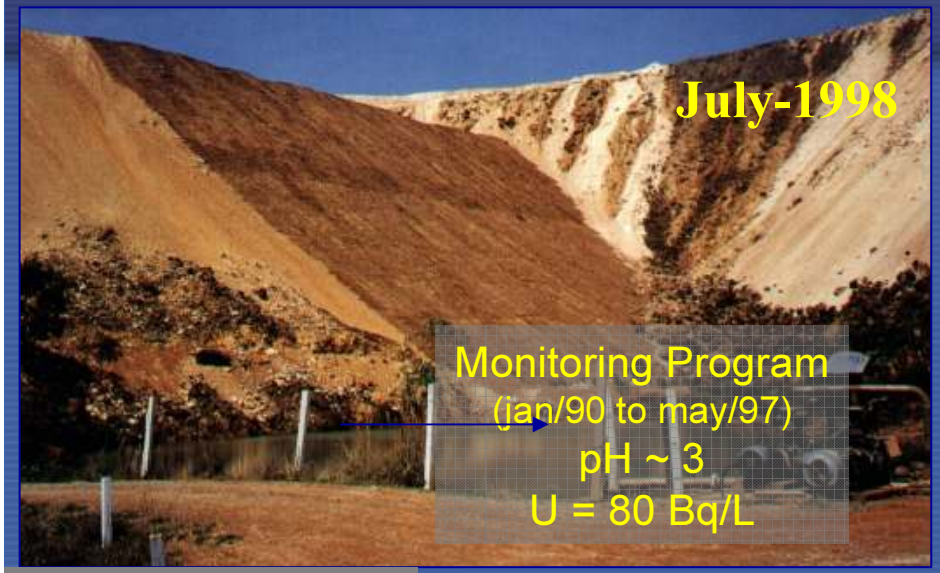
- Large volume of material with low U content and high Ra content
- Acid drainage from tailings piles
- Inadequate covers on tailings piles
- Pit is filled with water with relatively high uranium concentration
- Site completely accessible to the public

Maralinga

- UK fission bomb and dispersion tests 1956-7
- 1967 – initial clean-up
- 1984 – Royal Commission decided that the initial treatment of Pu contaminated land was considered inadequate

IAEA

Pocos de Caldas Mining Site - Brazil



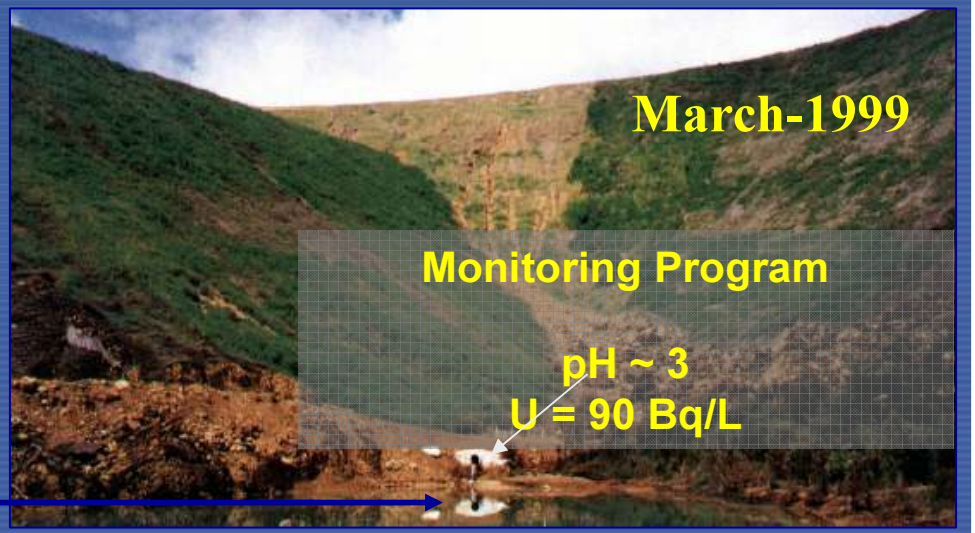
- Reshaping;
- Drainage work;
- Clay layer;
- Re-vegetation

Overall Costs

- Water treatment → US$ 2.6 millions
- Clay layer → US$ 0.171 millions
- Other costs → US$ 0.576 million

- Total US$ 3.347 millions

Reduction of volume of pumped water:
28% wet season and 15% Dry season

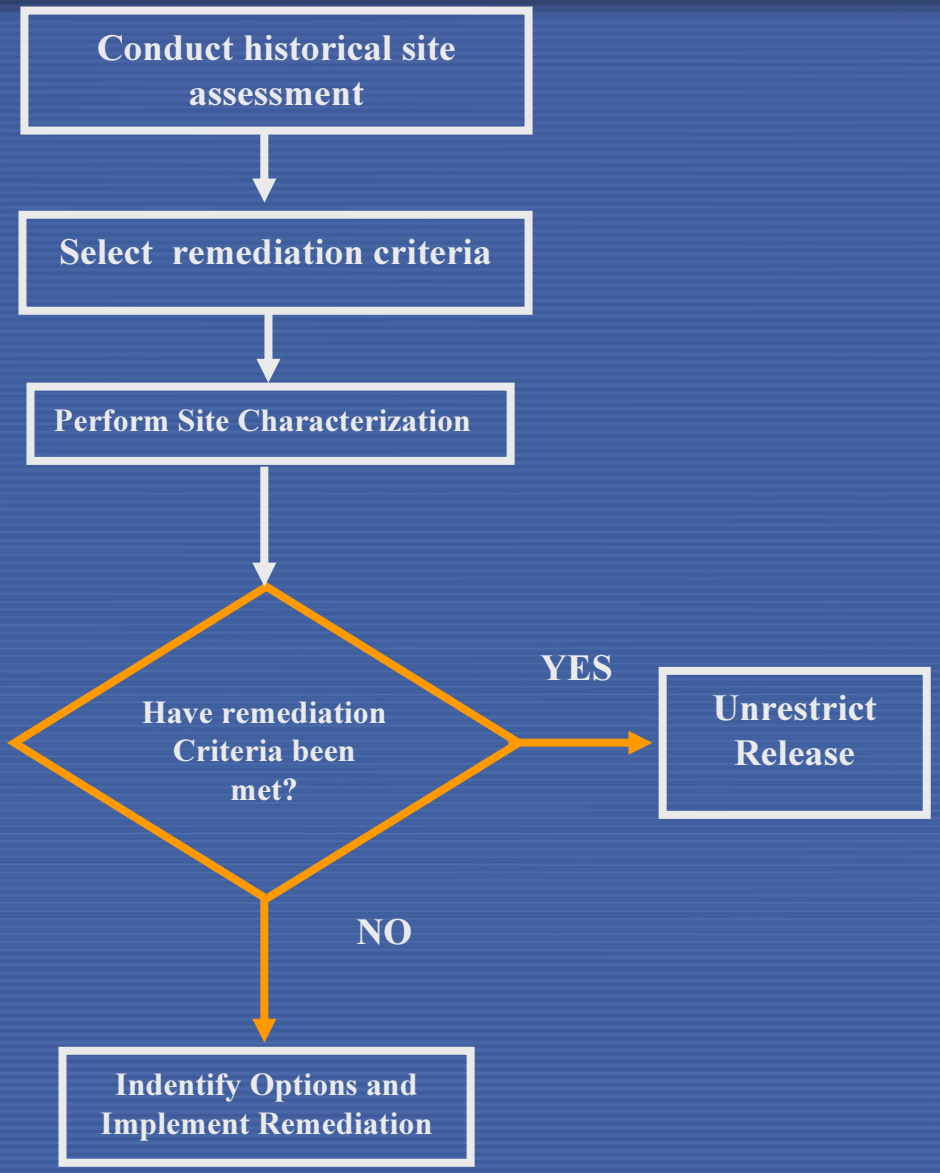


IAEA

IAEA Related Publications

- Remediation Process for Areas Affected by past Activities and Accidents – WS-G-3.1(IAEA Safety Guide)
- Remediation of Areas Contaminated by Past Activities and Accidents – WS-R-3 (IAEA Safety Requirement)
- Site Characterization Techniques Used in Environmental Restoration Activities – IAEA TECDOC 1148

The remediation process



IAEA

Consequences of Site Misclassification

- False negative: a land is erroneously classified as uncontaminated when it is really contaminated → Undue exposure of members of the public
- False positive: unnecessary remediation when the measured concentration is above the threshold value → Unnecessary money expenditure

Supporting guides

- Formal process of site sampling and survey for affected areas:
  - NUREG/CR-5849 “Manual for Conducting Radiological Surveys in Support of License Termination”
  - NUREG-1575 “Multi-Agency Radiation Survey and Site Investigation Manual” (MARSSIM)

Decision-Making Requires Data

- Instrumentation and analytical methods are the sourcesof data:
  - “Real-time” versus more traditional methods
  - Radionuclide-specific versus gross activitymeasurements
  - In situ versus ex situ measurements
  - “Cheap, fast, qualitative” versus “expensive, slow,definitive”

Basic Measurement Choices

- Soil samples with aboratoryanalyses
- Soil samples with field analyses
- Direct measurement techniques
- Scanning or survey techniques

IAEA

Soil Sampling and Laboratory Analyses

- Typically ~400 grams of soil collected
- Laboratory uses alpha or gamma spectroscopy or beta scintillation for analysis with accurate activity concentrations returned
- Costs are on the order of $200 per sample or more
- Turn-around times usually weeks

IAEA

Recall: Heterogeneity Dominates Decision Errors

- When contamination is present, there is typically significant heterogeneity present in soils
- Error in mean estimation is driven primarily by heterogeneity when only a few samples are collected
- Obtaining accurate estimates of average activity concentrations can require a lot of samples per exposure area (e.g., 30 or more)

Measurements: In Situ HPGe/NaI Systems

Works for gamma-emitting radionuclides (Ra-226, Th-232, Cs-137 and U-238)

- With proper geometry assumptions, provides activity concentration estimates
- Measurement times on order of 15 minutes with results immediately available
- Field of view considerations important
- **Per measurement cost on order of $100**

IAEA

Field Analytical Methods: XRF

Designed for inorganic analysis

- Measures total U and other metals (ppm)
- 2-minute count times or less
- Per measurement costs on order of $40 or less

IAEA

Scanning/Screening Detectors

- Gas-filled (gas amplification of ion pairs)
  - Gas flow proportional counter (GPC)
  - Geiger-Mueller (GM) counter
  - Pressurized ionization chamber (PIC)
- Solid Scintillator (fluorescence)
  - NaI (Tl)
  - ZnS (Ag)

Characterization Activities at Sites Can Generate enormous Amounts of Data

- Typical gamma walkover surveys, if logged, will produce as many as 400 data points per 100 m^2 area
- 100s or 1,000s of samples may be collected from a site and analyzed in a laboratory for a range of radionuclides
- Sites may have significant amounts of other data, such as:
  - Aerial photographs
  - On-site photographs
  - Non-intrusive geophysical surveys to look for subsurface anomalies
  - Mapping information (roads, fence lines, hydrology, buildingfootprints, etc.)

IAEA

Coordinates and Mapping Systems are Key to Understanding Results

- Mapping software such as Geographical Information Systems (GIS) are critical to proper understanding of data collection results
  - Good coordinate information is needed for all types of data in order for mapping software to be effective
  - Obtaining data in a digital format simplifies the work needed to work with, display, and analyze characterization information

IAEA

Data Management Systems

- Data management systems are important components of site characterization efforts
  - They preserve information over time and organize data in a manner that allows it to be presented, analyzed, and communicated effectively
  - They are typically based on relational databases to facilitate data handling
  - It is important to have well-defined rules and roles to ensure the integrity of data within a data management system is maintained
  - and to prevent intentional or accidental alterations

What is Meant by “Real-Time?”

Real time is within a time frame that allows the project team to react to the information while in the field

IAEA

Project proposal

- Make available a Mobile Unit for Site Characterization
- Help Member Sates to implement site characterization
- Use the same concept of Mobile Hot Cell
- Pool together resources and transfer the unit accordingly specific needs

IAEA

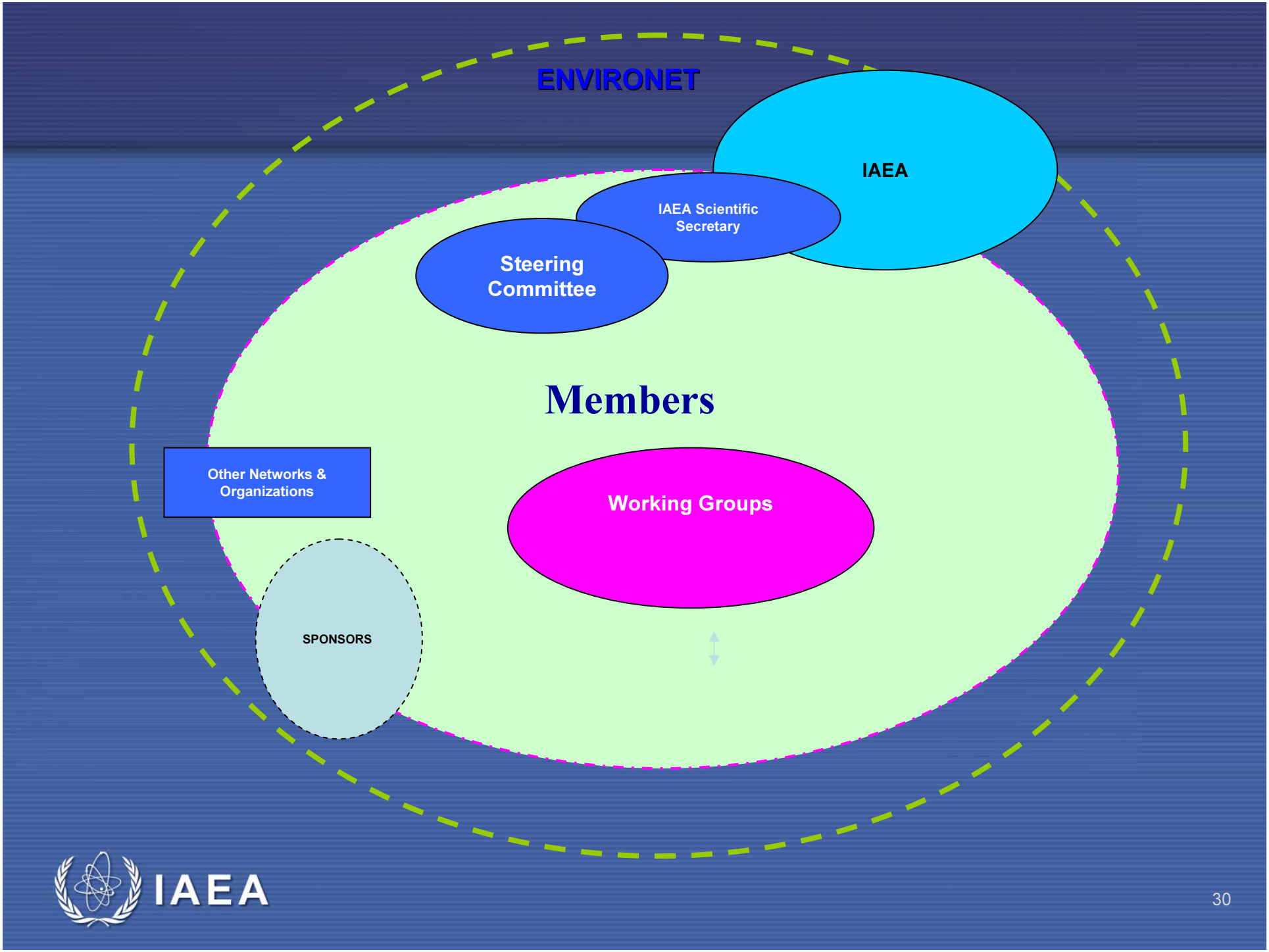
How to do?

- ENVIRONET – Network of Environmental Management and Remediation

The Structure (1/3)

- IAEA
- Scientific Secretary
- Members
  - Organizations/individuals that join the ENVIRONET to share and/or receive experience and knowledge
- Steering Committee
  - Provides advice oversight/ direction to the Sci. Sec.
- Other networks or organizations
- Sponsors/Funding Agencies:
  - Will provide either financial or technical support to ENVIRONET activities
- Working Groups:
  - Subsets of the ENVIRONET Members organized around a common topic;
- Regional Focal Groups
  - Organisations that can represent the needs and interests of countries within a specific region and impart this information to the Steering Committee and WG Coordinators;

IAEA


ENVIRONET
IAEA
IAEA Scientific Secretary
Steering Committee
Members
Other Networks & Organizations
Working Groups
SPONSORS

IAEA

ENVIRONET Topics

- Life-cycle planning
- Project design (planning, implementation, and management)
- Stakeholder involvement and communication
- Regulation and policy development (with the aid of WES)
- Risk communication
- Stewardship or institutional control
- Funding
- Data management, integration, and communication
- Site characterization
- Risk assessment
- Remediation approaches and technologies
- Monitoring
- Modelling
  - Fate and transport
  - Engineering design
  - Economic

IAEA

Member Organisations

- IRSN - France
- SCK-CEN - Belgium
- CEA – France
- ANL - USA
- AEC-Syria
- Savannah River – USA
- EM – USDOE
- INB – Brazil
- CAMECO – Canada
- AREVA - FRANCE
- ROS/RAO – Russian Federation
- ISTC
- EBRD
- NECSA – South Africa
- NRG – Netherlands
- WISUTEC/WISTUM – Germany
- WM/Symposium
- IFSOUP
- SAFEGUARDS
- EURSSEM

IAEA

Services x Products

- Website (Document repository (educational materials);
- Discussion forum;
- Member directory (online profiles);
- Schedule of events;
- Email subscriptions and updates;
- Wiki-style repository; Linked
- Workshops
- Conferences
- Training sessions
- Long-distance training
- Fellowships/internships
- Peer Review
- Databases

- Proceedings
- Publications
- Training materials
- Case studies
- Annual report (prepared by the Steering Committee)
- Newsletter
- Mobile Unit for Site Characterization

IAEA

Events of ENVIRONET in 2010

- 4 Technical Sessions in WM2010 – to promote the network and broaden partnership
- Training Course in Argonne National Laboratory – 1 (week 7 to 11 June 2010) - Life-cycle management and environmental remediation;
- Workshop on Education and Communication Outreach in Environmental Remediation – Kazakhstan
- Workshop on Lessons Learned with Environmental Remediation – Moscow along with AtomEco/2010. 28 and 29 October 2010
- ENVIRONET Forum – IAEA – 2nd week of November
- **Meeting to Design the Mobile Unit for Site Characterization – November 2010**

IAEA


Thank you for your attention
Join The ENVIRONET
"For a cleaner and Safer Environment"