Geographic Information Systems as an Opportunity for Public Engagement in Environmental Data Analysis for Nuclear Waste Management – 17505

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ABSTRACT

For half a century, scientists across government agencies, industry, academia and other research organizations have been using geographic information system (GIS) tools to display data collected for a wide variety of programs. Recent technology advances have made it possible for the public to also use GIS tools to display data. Meanwhile, around the world, volunteers are increasingly participating in citizen science activities that involve collecting environmental observations and measurements. Considering themes of broad interest to which citizen science and GIS tools could be applied, integrated nuclear waste management represents a potential opportunity for public engagement in environmental data analysis.

In the United States, the Department of Energy's (DOE's) goal is to develop solutions for the long-term, sustainable management of the nation's spent nuclear fuel (SNF) and high-level radioactive waste (HLW) from commercial electricity generation, as well as national defense activities. The DOE has been exploring options for an integrated waste management system to transport, store, and dispose of SNF and HLW. To support its efforts, DOE has been exploring ways to seek broad input from the public.

Literature was reviewed to assess recent advances in GIS technology and citizen science that could contribute to public engagement in waste management planning. Results identified a variety of promising tools and applications that are readily accessible online, including QGIS and the U.S. Environmental Protection Agency's (EPA's) Real Time Geospatial Data Viewer (RETIGO). For example, interested members of the public could illustrate air quality, water quality, and other environmental data in GIS plots to visually represent local conditions over time. This paper highlights potential opportunities for those interested in citizen science and GIS tools as part of exploring options for public engagement in planning for an integrated waste management system.

INTRODUCTION

Federal agencies and other organizations in countries with nuclear reactors have been working for decades to address the challenge of managing spent nuclear fuel (SNF) and high-level radioactive waste (HLW). In the United States, the

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The DOE has been exploring options for an integrated waste management system to transport, store, and dispose of SNF and HLW. Potential options include siting, constructing, and operating one or more pilot and larger interim storage facilities (ISFs) for SNF and related radioactive waste produced by commercial nuclear reactors. Associated operations would include transporting these materials from commercial reactor sites to such ISFs, should they be deployed.

In 2015, the DOE began seeking input from the public, communities, states, Tribal Nations, and interested parties on designing a process for siting facilities to manage SNF and HLW. The Department published an Invitation for Public Comment in the Federal Register to solicit input on important considerations in designing a fair and effective approach for siting such nuclear waste management facilities [1].

Part of exploring options for an integrated waste management system includes considering opportunities for enhancing public awareness and engagement. While the technical knowledge regarding building storage and disposal facilities is well established, community outreach and sharing information regarding related issues can be important in addressing social and policy aspects. Recent advances in citizen science and geographic information system (GIS) tools offer a potential opportunity for public engagement efforts. Brief background on these two topics is provided below.

Citizen Science

Citizen science is an evolving phenomenon that involves individuals and community groups collecting and analyzing environmental and other scientific data for projects that contribute to scientific knowledge and benefit local communities. Around the world, millions of volunteers are participating in projects that involve collecting and reporting environmental measurements and observations and other data.

The U.S. government has recognized the potential of citizen science through its Open Government National Action Plans, which encourage Federal agencies to increase public participation and citizen contributions to addressing scientific and societal challenges [2, 3]. As a result, Federal programs have been actively seeking and implementing citizen science activities. Citizen science could thus represent a potential opportunity for community engagement as part of exploring options for integrated waste management.

Geographic Information Systems

Since the early 1960s when geographic information system (GIS) technology was introduced [4], scientists across government agencies, industry, academia and other research organizations have used these tools to display data collected for a

wide variety of programs. Recent advances have made it possible for the public to also use GIS technology to display data.

APPROACH

A literature search was conducted to explore potential opportunities provided by advances in citizen science and GIS technology to support public engagement. Standard online databases were searched via the Argonne Library System, using search terms such as *citizen science*, *technology*, *waste management*, *facility*, *environmental monitoring*, *geographic information system*, *GIS*, *data display*, and *data visualization*.

RESULTS AND DISCUSSION

The literature search identified a variety of tools and applications relevant to citizen science and the use of GIS tools to support public engagement in exploring waste management options. A review of these tools indicates that more than 100 technologies are being used in citizen science projects to collect and display a variety of data. Example projects and tools are highlighted below.

Environmental Data Collection to Support Agency Programs

Stream Watch is an example of a citizen science initiative that involves members of the public collecting environmental data to support government agency programs [5, 6]. In this program, volunteers collect local stream water quality data to support state environmental monitoring efforts. Scientists then analyze the data and present the findings to decision-makers as well as the general public. Through this type of community involvement, collaborative data collection and evaluation for managing local stream water quality is strengthened.

Online Resource for Environmental and Waste Management Data

The U.S. Environmental Protection Agency (EPA) has established an online resource, Envirofacts, to make environmental data relevant to waste management programs broadly available [7]. Envirofacts synthesizes information from several databases about air, land, water, waste, toxic substances, radiation, facilities, and environmental releases. The public can readily access this resource and conduct simple searches to find and display data for their locations and topics of interest.

GIS Tools for Public Use

While collecting data is an important element of environmental characterization to support waste management planning, being able to display the data in a manner that conveys the significant aspects is also essential. The U.S. EPA has designed the Real-time Geospatial Data Viewer (RETIGO) as a web-based tool the public can use to display data [8]. Released in summer 2016, this GIS tool enables people engaged in collecting air quality data, including citizen scientists, to display those data by location. This includes plotting data collected while the individual is in

motion, e.g., while walking, biking, or in a vehicle. RETIGO can also be used to display data over time, e.g., to assess location-specific trends.

Similar to RETIGO, QGIS is a free, open-source tool the public can use to display and analyze geospatial information [9]. Online training modules offer a comprehensive overview of how to use QGIS [10], from creating maps to working with raster data and vector data. In considering how these materials might be customized for members of the public interested in collecting and displaying data relevant to nuclear waste management, complementary materials could be developed that streamline the existing documentation and tailor it for this potential application arena. For example, a “how-to” overview could be prepared that includes examples of environmental data displays relevant to options being explored for an integrated waste management system.

Example Types of Environmental Data

Different types of environmental data relevant to waste management planning could be collected and displayed by interested members of the public. Potential data types include air quality (e.g., particulate matter), water quality (e.g., suspended solids), soil characteristics (e.g., soil moisture), and visual resources (e.g., landscape elements). A number of smartphone apps exist that facilitate data collection, across categories ranging from air, water, soil and biota to physical measurements such as temperature, wind speed, noise (sound), and motion (seismicity). For example, a smartphone-based optical dust sensor could be used to measure ambient particulate matter. These data could then be displayed in a GIS plot that visually represents local air quality conditions. Other environmental data that can be collected by simple sensors, such as water quality, soil characteristics, and seismicity data, could also be displayed on a GIS plot. Topographic information can be displayed as raster data, while locations of nearby structures and vegetation could be shown as vector data. Information for these geospatial data can be stored in attribute tables, and GIS tools such as buffers, queries, and intersections can be used for map analyses. These plots can also be used to illustrate temporal changes, e.g., from days to years, to reflect data collected over time. Thus, GIS tools have emerged as a valuable resource for members of the public interested in displaying environmental data.

Geographic Display of Citizen Science Projects and Technologies

In exploring options for public engagement, existing citizen science activities could offer useful insights. To support this consideration, an example GIS plot that illustrates the distribution of citizen science projects in the contiguous Unites States was created to indicate active areas. Such plots could provide framing context for exploring public engagement opportunities as part of planning for an integrated waste management system.

CONCLUSION

Public engagement in research is growing, with millions of volunteers around the world collecting environmental measurements and other data that contribute to scientific knowledge and benefit their communities, including to support various agency programs. Online resources such as EPA's Envirofacts and RETIGO, as well as QGIS, represent public tools for obtaining location-specific information relevant to waste management and the environment, and for displaying geospatial data. Advances in citizen science and GIS technologies provide opportunities for public engagement that can be explored as part of planning for an integrated waste management system for SNF and HLW.

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