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Public involvement in waste management research and decision-making: A case study

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Abstract. A collaborative effort between researchers at Washington State University and a small US town is used to highlight the challenges of community involvement in waste management decision-making. The role of the US land-grant co-operative extension system in achieving effective community engagement around waste management and other challenging issues is also explored. Four concepts for resilient decision-making are used as a framework for examining the merits of this project. The case study includes information gathered through in-depth data collection and analysis over 32 months by engaging in participant observation and conducting a mail survey of 374 households.

JEL classification: Z130, Z19

Key words: Biosolids, waste, case study, community engagement, extension

1 Introduction

Presented here is a case study of a collaborative research effort between a small town in Washington State and scientists at Washington State University (WSU). The full research effort included several different projects. Field trials were established to study the agricultural use of locally produced biosolids compost on specialty potatoes, vegetable seed crops and winter wheat. A soil health workshop was organized for local farmers and agricultural professionals. The fate of the antibiotic ciprofloxacin in compost was studied *in situ* at the local waste water treatment plant (WWTP) and compost yard (Youngquist et al. 2014). A mail survey was conducted to improve our understanding of public perception of the use of biosolids on farms and in the community, public support for the composting activities at the La Conner WWTP, residents' interest in using biosolids compost as a soil amendment and residents' desire to participate in local waste management decision-making processes. The survey results and insight gained through participant observation are presented in the following case study.

Residential sewage handled through municipal wastewater treatment systems in the US is on the order of 100 gallons per person per day (Outwater 1996). This includes human bodily waste

(black water) and wash water from sinks, laundry, etc. (grey water). Waste removed from septic tanks and portable toilets also contributes to the municipal wastewater system, along with processing and manufacturing waste. Biosolids (also called sewage sludge) is the solid, or semi-solid, byproduct of this wastewater treatment process and a valuable source of soil carbon and plant nutrients (Brown et al. 2011). In the US alone, over seven million dry tons of biosolids are produced each year, with a little over half used as a soil amendment in agriculture or the remediation of contaminated sites (NEBRA 2007). Modern wastewater treatment and municipal solid waste management systems have been highly effective at meeting our short-term need for protecting human health and quality of life. However, many of these systems do not contribute to our long-term need of maintaining the critical ecosystem goods and services on which we rely. For example, in the US alone almost half of the human waste treated in municipal systems, 40 per cent of yard waste and 97 per cent of food waste (US EPA 2008) is disposed of by incineration or landfill, making organic waste a vastly underutilized resource.

Scientists are just beginning to fully understand that we are facing a "soil crisis" unlike any before. On a global scale "a fully functioning soil lies at the heart of solving the big issues of food security, biodiversity, climate change and fresh water regulation" (Koch et al. 2014, p. 437). Our ability to change course and begin the process of rebuilding world soil stocks hinges in no small part on our waste management practices. It is well understood that changes in levels of soil carbon over time are a key indicator of soil health and, in general, soils with higher levels of carbon are more resilient (Doran et al. 1996; Reeves 1997; Doran and Zeiss 2000; Koch et al. 2014). Therefore, appropriate management of soil carbon on a global scale is critical to maintaining the myriad of benefits provided by healthy soil systems.

The good news is that organic wastes contain carbon. The process of regenerating soil health and thus rebuilding our soil stocks, is directly supported through the addition of high-carbon organic waste to soil – thereby restoring a critical link in the waste cycle. Success in this endeavour will require innovative waste management strategies that focus on beneficial re-use of organic wastes instead of disposal.

While new waste management strategies that go beyond maintaining and proactively contribute to improving social, economic and environmental conditions do exist (Marks 2006; Gen 2010; Goven et al. 2012), the rate of adoption is slow. New social strategies are needed if we are to aggressively confront the challenges of maintaining critical ecosystem services while also feeding and keeping healthy the rapidly growing human population. Critical to this mission is a paradigm shift from best disposal options to best recovery options (Guest et al. 2009; Lono-Batura 2009; Brown 2012) and the development of skills and tools needed to "identify and deploy the most sustainable solution in a given geographical and cultural context" (Guest et al. 2009, p. 6127). The risks and costs of failed waste management projects are high; thus successful implementation of new technologies and practices that focus on resource recovery will be more readily achieved by working with a fully engaged public in research, development and decision-making processes.

While most will agree that beneficial reuse and recycling of waste products is a worthy objective, many questions remain about how to maximize benefits while minimizing economic, social and environmental costs. Historically this has been a topic left to the 'experts'(i.e., scientists, policy-makers, WWTP managers) with little input from the public (Beecher et al. 2005). There is strong federal and state regulatory support for land application of biosolids (US EPA 1994) and general agreement within the scientific community that this practice is safe for the public and beneficial to the environment (National Research Council 2002).

However, scientific and regulatory enthusiasm for biosolids recycling (i.e., land application) is often met with strong opposition from individuals and communities (e.g., St. John 2012; Henderson 2013; Matarrese 2013). Public concern about biosolids recycling primarily revolves around the issue of contaminants (e.g., www.sludgenews.org). Any product that is excreted by

the human body, disposed of with wash water, or included in processing or manufacturing waste has the potential to end up in the WWTP and eventually the soil or water. A tremendous amount of information has been published on the fates, impacts and risks of the many classes of compounds that may be found in biosolids or treated wastewater effluent (Kinney et al. 2006; Jjemba 2006; Haynes et al. 2009; Higgins et al. 2011; Hundal et al. 2011; Langdon et al. 2011). There is still much to learn about long-term impacts of specific compounds on environmental or human health, but considerable effort has been made to quantify potential risks and contextualize research findings to make them useful to policy-makers, biosolids managers and the public (Overcash et al. 2005; Hundal et al. 2011). Nevertheless, some scientists and members of the public doubt the safety of biosolids as a soil amendment in agriculture, especially on food crops (Harrison et al. 1999; Pardini et al. 2001; Rideout and Teschke 2004; Tollefson 2008; Musee 2011).

Waste production and management within society have a direct impact on public health, quality of life, economic and agricultural productivity, environmental quality and social and environmental justice (Janis 2002; Jones 2011; Foote and Mazzolini 2012; Gordon 2012). Some consider these complex relationships between waste and human values to be a central issue of our time (Janis 2002; LeBlanc et al. 2006; Guest et al. 2009; Foote and Mazzolini 2012). However, the process of developing and implementing innovative organic waste management strategies within a community is not without its technical, social and economic challenges. Perhaps most pressing are the sociopolitical challenges faced by planners and decision-makers working towards innovative human waste (i.e., excrement) management strategies.

2 Biosolids management in the United States

In 1972, passage of the Clean Water Act limited pollutant discharges to waterways and provided funding for the construction of new WWTPs around the country (US EPA 1972). As a result, biosolids recycling programmes in the US expanded from about 20 per cent of the total WWTPs in the 1960s to almost 60 per cent by 2002 (Beecher et al. 2004). Throughout the 1970s and 1980s, US land-grant university researchers made significant contributions to the literature on both the risks and best uses for biosolids in agriculture. Research and university extension efforts were focused on providing technical information to farmers and other end users, rather than the general public. The topic of biosolids management stayed primarily between professionals in the wastewater industry and a few scientists and policy-makers. Nonetheless, 'public acceptance' was recognized as an important factor in the success of biosolids recycling projects and emphasis was placed on educating the public about the facts and scientific basis for biosolids recycling from the perspective of the industry. For the most part, conflicts over recycling programmes were local issues tied to particular events. Project managers or regulators typically responded to these conflicts with more technical or scientific information to reinforce their policies and decisions (Beecher et al. 2004, 2005).

In the early 1990s the US Environmental Protection Agency (EPA) developed federal standards for all biosolids recycling programmes known as the Part 503 Rule (US EPA 1993). Around this same time the Water Environment Federation (WEF), a not-for-profit technical organization representing water quality professionals, commissioned a private research firm to develop a communication strategy for the industry. The result was widespread adoption of the word 'biosolids' to replace 'sewage sludge' (Beecher et al. 2004).

A thorough peer-review and risk assessment of the Part 503 Rule published a few years later by the National Research Council (NRC) found that the use of biosolids in food crop production "presents negligible risk to the consumer, to crop production and to the environment" (National Research Council 1996b, p. 13) as long as existing federal guidelines and regulations were

followed. The report acknowledged that in some cases public concern about health and environmental risks associated with biosolids use in agriculture may not be scientifically valid and therefore should be addressed with educational programmes (National Research Council 1996b).

The debate around biosolids recycling gained momentum throughout the 1990s and into the 2000s and the industry continued to respond to public concern with fact sheets, public education efforts and "rebuttals and corrections of scientific facts" (Beecher et al. 2004). These early public relations efforts in the biosolids industry were based on the belief that any public opposition was a product of ignorance or misunderstanding (Beecher et al. 2004; Snyder 2005; Gen 2010), something that was "politically real but cognitively empty" (Goven and Langer 2009, p. 922). Biosolids managers and policy-makers commonly felt the need to "control the message" in order to "educate" the public and "prevent irrational public reactions" (Goven and Langer 2009, p. 923).

There was also an assumption that it was the job of experts to define, evaluate and manage risks (Beecher et al. 2005). Similar to technical experts in other fields, biosolids managers put a great deal of effort into convincing the public that their decisions were good ones. The result was a one-way communication process intended to educate the public about the scientific and rational basis for decisions that had already been made. In this paradigm, the public is seen as "information poor" or "knowledge deficient and misguided" (Petts 1997, p. 359). Little or no value is placed on the knowledge, experience, or expertise of the public.

The problems caused by this approach, wherein public opposition is regarded as a nuisance or obstacle, are compounded by failure of formal public participation methods commonly required by law (i.e., review-and-comment periods and public hearings) to achieve genuine and meaningful participation in public planning processes (Innes and Booher 2004). Petts (2004, p. 129) concludes that this "proceduralization culture" makes true deliberative process more difficult because there is a lack of regulatory support for any processes that involve more than consultation on decisions that have already been made by the experts.

This communication and decision-making strategy led to many failed and stalled waste management projects through lack of community support, expensive and lengthy legal battles and loss of public trust and credibility of decision-makers (Hostovsky 2000; Cash et al. 2003; Beecher et al. 2004; Bridgeman 2004; Innes and Booher 2004; Snyder 2005; Goven et al. 2012). Hostovsky (2000, p. 305) places much of the responsibility for a waste planning system "prone to failure" squarely on the shoulders of waste planners and their "general ignorance or intellectual neglect regarding fundamental planning models and theory." Considering the history of failed projects, the nature of public opposition to biosolids and the pressing need for innovative waste management strategies, new decision-making models are needed. The most resilient models will likely be those that effectively incorporate risk theory and communication, expert and public knowledge, fully engaged communities, and regulatory and institutional support.

3 Concepts for resilient waste management decision-making

3.1 Risk communication and management

Progress in the social science study of risk perception, risk assessment, risk communication and risk management coincided with the growth of biosolids recycling programmes in the US since the 1980s (National Research Council 1996a; Beecher et al. 2005; Krewski et al. 2011). While the science of risk assessment is based on a 'scientific' determination of risk, risk management is a process in which decision-makers "combine analysis with deliberation, broaden the range of outcomes potentially subject to analysis and broaden participation in activities that were

previously restricted to analytic experts and a few decision-makers" (National Research Council 1996a, p. 133). It is logical that the people most affected by a risk should be the ones to determine not only what level of risk is acceptable, but also what research should be done to elucidate the nature of the risk and what mitigation strategies are appropriate. Petts (2004, p. 119) calls this "participatory risk assessment" and challenges us to open the process sufficiently to "admit into the important initial framing a wider range of understandings than merely that of the expert." Full public engagement in risk management and decision-making requires that risk be determined through public processes, not before (Petts 2004).

People perceive and evaluate risks based on values and belief systems, previous experiences, personal stake in the outcome, specific fears, gender, and education, among other factors (Beecher et al. 2005; Krewski et al. 2011). Effective risk communication about controversial risk issues (e.g., biosolids recycling) must take into account many of the factors listed above. A communication strategy that ignores the fact that differences of opinion are rooted not in ignorance but in people's values and belief systems is likely to fail. The development of an effective risk management strategy is both an analytical and a deliberative process that includes full engagement of all stakeholders (Petts 2004; Krewski et al. 2011).

The public has access to a wide range of cultural and experiential resources; thus their definition of risk is generally broader than that of the experts and may include physical, economic, social and psychological impacts. The tendency for the techno-scientific community to frame risk more narrowly than the general public can be challenging to scientists and technical experts who may be unaware that their statements are evaluated in multiple frames of reference by the general public (Horlick-Jones et al. 2007; Petts 1997; Yamamoto 2012).

3.2 Public knowledge systems

By incorporating public, or lay, knowledge into the decision-making process planners and decision-makers can tap into the collective intellect. Operating from a limited point of view greatly restricts insight and the ability to cope with challenges, but incorporating a wide range of views improves resiliency in decision-making processes (Seltzer and Mahmoudi 2012). Lay knowledge can enhance the use of expert knowledge by "*contextualizing* and *re-framing*, abstract, general knowledge" to take into account social, political, or geographical realities (Horlick-Jones et al. 2007, p. 260, emphasis original).

Unlike information, knowledge is not transferred between individuals, therefore the process of "gathering, presenting, disputing and agreeing, framing and re-framing" knowledge is central to the decision-making process (Horlick-Jones et al. 2007, p. 261). Fully utilizing public knowledge will require a shift away from a model of public communication and decision-making, in which the public are seen as "information poor" and expert knowledge is considered "privileged and legitimate" (Petts 1997, p. 359).

3.3 The public-expert interface

Proficiency working at the public-expert or technical-democratic interface requires holding a broader view of the role of science and understanding that technical and scientific knowledge and expertise are not the only kind of 'specialized' knowledge. The role of the expert at the interface is to provide information, but also to be tested and challenged by members of the public. Therefore an expert's credibility is at least as important, if not more so, than their knowledge (Petts 1997). Expertise can be defined as a "learning process resulting from interactions between people in a decision-making context" (Petts 1997, p. 360) and is therefore

shaped through public questioning. It is this process that defines the role of expert knowledge and determines which individuals are looked to for expertise in decision-making processes (Petts 1997).

One of the greatest challenges in local decision-making processes is to "provide on-going opportunities for rational discourse" (Petts 1997, p. 379), as it is this rational discourse that allows decision-makers to change the terms of engagement and reach conclusions that meet the needs of all involved. Reframing the debate in the face of divergent positions is a tool that can be used to reach common ground when opposing sides have chosen entrenched positions. In the words of Innes and Booher (2004, p. 421), "when dilemmas dominate, it is time to reframe." Ury (1991, p. 61) highlights the pitfalls of negotiation based on positions instead of interests and defines "reframing" as recasting what is said in such a way that attention is directed "back to the problem of satisfying both sides' interests." Changing the terms of engagement can make conversations more productive. Thus, a debate between people holding divergent positions can often be shifted towards a discussion of shared interests and goals (Foote and Mazzolini 2012).

3.4 Visibility of waste and awareness of waste issues within communities

Effective community engagement in waste management decision-making is often limited by both lack of public interest and the low visibility of waste within a community. According to Gen (2010), the greatest challenges to public participation in wastewater decision-making are:

1. waste treatment is not visible;
2. the belief that wastewater treatment has already been addressed and there are more pressing problems; and
3. people do not want to think about it.

Shipley and Utz (2012, p. 27) add to this list with their observation that the "choice to participate is made at the margin," only after people have already addressed what they consider to be the essentials. Similar to other non-crisis issues facing a community, public participation in waste management decision-making in the United States may be limited to people of a relatively narrow socio-economic class. As a result, it may be difficult to draw on the full collective intellect of a community and develop solutions that are resilient in the face of changing political, social and environmental pressures.

One approach to addressing some of the challenges listed above is to reframe the conversation about 'waste', with all of its negative or boring connotations, into a conversation about 'resource recovery.' The conversation is certainly shifting among researchers, biosolids managers and other specialists as evidenced by articles in industry magazines (Brown 2012), trends at regional and national conferences (e.g., 'Residuals and Biosolids 2014: Facilitating Resource Recovery') and biosolids marketing campaigns (e.g., www.loopforyoursoil.com). However, there is still the challenge of engaging the public in this conversation. One approach is to develop local soil campaigns alongside local food campaigns in urban and suburban areas. Local soil resources include the biosolids, food waste, and green waste composts produced at municipal and commercial waste management facilities (Brown 2013).

A basic knowledge of the wastewater treatment processes is a prerequisite for meaningful public participation in the decision-making process. While a higher level of knowledge about wastewater treatment systems within a community will generally lead to more support for development and improvement of systems, a lack of understanding or inaccurate information can lead to mismanagement (Gen 2010). Bridgeman (2004, p. 4) reminds us that "it is unreasonable to expect people to grasp one concept (i.e., water recycling) when they have little or no

understanding of the fundamental concept (i.e., the water cycle) which underpins it." Similarly, environmental author Alice Outwater (1996, p. 172) points out that people have to understand "their toilets are connected to the waterways" before any behavioural change will occur. If a basic understanding of WWTP systems is required in order to participate in effective decision-making, so then is a basic knowledge of chemistry and biology necessary to understand and evaluate risks of toxins or pathogens in biosolids. Without this knowledge it is difficult to contextualize the findings of the multitude of scientific studies on the topic and assess the true human health and environmental risks and benefits of biosolids recycling (e.g., Hale 2010; Hundal et al. 2011).

Unpleasant odours from a waste management or processing facility will rapidly increase awareness and visibility of waste within the surrounding communities (Coker 2012). Odours are often strongly associated with negative events. As a result, the odours associated with a "natural vector of disease such as fecal matter, rotten food, or decaying organic material often acquire all of the aversive characteristics of the vector" (Dalton 2003, p. 27). People's response to odours, and beliefs about the effects of the odour, are influenced by many different factors including social cues from the media and other individuals and their own attitudes and expectations (Dalton 2003). It is not uncommon for people who experience odours from a waste facility to jointly complain and express serious concern as a group, but be much more accepting of the odour when interacting with facility managers individually (Dalton 2003; Coker 2012). While repeated odour complaints from residents can be challenging for waste managers and public planners, there may also be an opportunity to engage the community in the problem-solving process and increase awareness about local waste issues (Coker, 2012).

4 Role of the US land-grant university extension system in developing innovative waste management solutions

Cash et al. (2003, p. 8086) argue that as a society we lack a critical understanding of the "knowledge systems" that would allow us to effectively leverage science and technology to "[protect] human development needs while protecting the earth's life support systems." While knowledge, science and technology do make significant contributions to solving a wide range of problems, the authors warn that "unless that contribution can be dramatically increased . . . it seems unlikely that the transition to sustainability will be either fast or far enough to prevent significant degradation of human life and the earth system" (Cash et al. 2003, p. 8089). Decision-making tools and strategies are needed that will result in waste management practices effective at meeting the health, social and economic needs of the community, while at the same time maintaining ecosystem balance by protecting soil, air and water resources.

The US land-grant university co-operative extension system (Extension) has the potential to work effectively where democracy and science interface by leveraging both public and expert knowledge to address some of our most daunting challenges (McDowell 2003; Majee et al. 2014). Extension is a national research and educational network charged with providing "useful, practical and research-based information to agricultural producers, small business owners, youth, consumers and others in rural areas and communities of all sizes" (http://www.csrees.usda.gov/Extension/). Extension faculty can help reconcile the theoretical framework of democratic problem-solving with the practical realities of effective community engagement. With faculty and staff stationed at over 100 land-grant institutions and in approximately 2,900 local and regional offices, the Extension system could become a valuable resource for developing innovative and resilient waste management strategies nationwide.

The role of Extension faculty within a community goes well beyond providing technical and scientific information; they increase the capacity of individuals and communities to solve

problems. Citing historical documents Peters (2014, p. 4) points out that "the most important purpose of Extension education is the development of people, the fostering of attitudes of mind and capacities that will enable them better to meet the individual and civic problems with which they are confronted." A similar perspective is shared by Jacob (2013, p. 3): the land-grant model may be "one of the last best hopes for empowering widespread citizen participation and deliberation" in an increasingly complex world.

Checkoway (2001, p. 315) calls for a "civic renewal" of public research institutions that allows people to participate in "the knowledge development decisions that affect them." It is the responsibility of research universities to support this process (Checkoway 1997, p. 307) and see communities as "a unit of solution in society." By including the community in the process of defining the problem, collecting the data and discussing possible actions, university researchers go against the paradigm of detached, unbiased and dispassionate scientists. Instead of focusing on the scholarship of "discovery," researchers would emphasize the scholarships of "integration," "application" and "teaching" (Checkoway 1997, p. 310).

Frickel (2004, p. 361) uses the term "embeddedness" to explain the "reciprocal loyalties" that develop among interconnected individuals (e.g., university and industry scientists, community activists and local government) working together to achieve common goals. When applied to the collaboration between scientists and community activists in environmental debates, "embeddedness confounds standard accounts of expert-layperson relationships" and as a result leads to "interwoven networks that are neither public nor private, but that span the gap between these two spheres" (Frickel 2004, p. 362).

Scientists and experts within Extension can and should learn to see the community as a "unit of solution," work to increase community capacity for problem solving, leverage public and expert knowledge through "embedded" networks and emphasize the scholarship of community engagement (i.e., integration and application). By doing so, Extension faculty could become strong allies to communities involved in challenging decision-making processes about controversial and emotional subjects such as waste.

5 Case study: The town of La Conner

The most effective solutions to the interconnected challenges of waste management, soil health and food production will be local and managed by the people living, working, eating and producing waste within a given region. What works in one community may not work for other communities with different climates, population densities, economic drivers and land-use. There is no universally appropriate solution.

5.1 Why La Conner?

The Town of La Conner has a population of approximately 900 people and a median income of $36,800. It is located in Skagit County, Washington, a rural agricultural county with a population of approximately 118,000 (US Census Bureau 2014). The primary agricultural products in Skagit County include specialty potatoes, vegetable seed, berries, fresh market vegetables, cut flowers and bulbs, and dairy. The total farm gate value for all agricultural products is more than $250 million annually (Skagit County Extension 2012). There is a thriving local food movement in the region and many residents have direct access to farmers and farm products, understand where their food comes from, and appreciate the role of agriculture in the local community.

With farms to the east and the Swinomish Channel to the west, the town of La Conner has a vibrant downtown attracting thousands of visitors to shops, lodging and restaurants during the spring and fall. Directly across the channel is the Swinomish Indian Tribal Community, home to approximately 800 tribal members.

Fig. 1. The La Conner Waste Water Treatment Plant (A) is located at the main entrance to town and only 200 feet from Sullivan Slough (B). It is also adjacent to a large organic farm with a busy on-farm retail business during summer and fall (C)

The La Conner waste water treatment plant (WWTP) is located at the main entrance to town and produces a Class A biosolids compost[1] that is available free of charge to residents and sold in bulk to local landscaping and topsoil companies. The WWTP is only 200 feet from Sullivan Slough, which drains directly into Skagit Bay, and adjacent to an organic farm with a retail stand 500 feet from the nearest biosolids compost bay (Figure 1).

In 2009, the mayor requested that the WWTP increase acceptance of outside septage as a way to increase revenue. This led to an increase in the volume of compost produced and stored onsite. With this increase in volume, the established compost turning cycle and curing times were inadequate and as a result there was an increase in odour events. In response, WWTP managers increased the initial aerated composting time and decreased the turning frequency. At the same time, they lengthened the curing time to increase the market quality of the end product. The curing process involves storing the compost in large uncovered piles to age after the primary compost phase is complete.

From the public's perspective, this gave the impression that the town was having difficulty selling the compost and the added impression that the large piles were the primary odour source (Baker 2011; Stokes 2011). This led to an increase in odour complaints within the community and growing concern about compost management and storage at the WWTP. Throughout this time period, compost sales did not significantly change, only public perception. WWTP managers and town staff worked with community members to identify the management practices that were causing odour issues and make the necessary changes.

[1] Any biosolids derived product that will be land applied in the US must meet strict Class A or Class B standards based on processing methods, pollutants, and allowable pathogen levels. Class B products are commonly used in agriculture, silviculture, and remediation of contaminated industrial sites and there are restrictions on public access and pre-harvest intervals. There are no restrictions for land-application of Class A biosolids, which are commonly used on turf and landscaping. Composting is an acceptable method of biosolids processing to meet Class A requirements, provided that certain time-temperature requirements are met (US EPA 1994).

During this time the town council also contracted with a local consulting firm to research and demonstrate the use of biosolids compost in nursery production as well as to develop bio-retention soil mixes using their compost. The initial success of these projects prompted the town council to reach out to local agricultural associations and farmers to assess interest in using biosolids compost on local farms. The initial response was ambivalent. While some farmers were interested in using the product, many did not see clear benefits and were concerned about public opinion and possible contaminants. Farmers who saw the potential value of the product but were uncertain about the risks requested the involvement of scientists from the local Washington State University (WSU) Research and Extension Center to conduct research on agricultural use, public opinion and potential contaminants. In response, the town council agreed to provide funding for a three-year research project focused on these topics.

In 2012, the town of La Conner was the recipient of the annual 'Excellence in Biosolids Management Award' from the Northwest Biosolids Management Association (NBMA), which represents public sewerage districts and private companies in the biosolids management industry across the northwestern US and Canada. The award recognized the town of La Conner for collaborating with researchers, farmers, schools and citizens; funding research to address questions from the community; and making community outreach a priority (NBMA 2012).

A small rural town with a highly visible WWTP recognized for excellence in management, a recent history of odour complaints and citizen concern, a strong connection to local agriculture, and collaboration with private and public researchers were all factors that combined to create a unique scenario for a case study.

5.2 The La Conner biosolids compost

The La Conner WWTP treats sewage from town residents and businesses and the nearby Swinomish Village (approximately 250 households) and accepts septage from residential and commercial septic tanks and portable toilets. It also accepts treated biosolids from other small regional WWTPs. Acceptance of outside septage is the primary revenue source from the WWTP and contributes to an annual budget surplus for the town. A private company (Water & Waste Water Services, LLC) is contracted to manage the WWTP and produce a Class A biosolids compost.

The La Conner WWTP produces 200 to 300 tons of Class A biosolids compost annually and has been composting on-site since 1994. The compost is made from a 1:2 mixture of biosolids and bulking agent (sawdust and/or shredded yard waste). The compost bays are aerated to ensure that time-temperature requirements are met for pathogen and vector reduction. After 35 days of active composting, the compost is removed from the aerated bays and then cured on-site in large piles for a minimum of 60 days before final quality testing by the Skagit Health Department and the Washington Department of Ecology.

5.3 Research methods

Our La Conner case study involved in-depth data collection and analysis over a period of 32 months. The first author engaged in participant observation at town council meetings, attended meetings with groups of concerned citizens and organized a local soil health workshop for farmers. Relevant interactions and personal observations were recorded during and after project-related activities. These interactions and observations provided valuable insight into the challenges of community-engaged decision-making about waste management and the frustrations that community members had with the decision-makers and researchers (i.e., the experts).

To supplement the participant observation findings, a mail survey of 374 single-family households served by the La Conner WWTP[2] was conducted following the tailored design method (Dillman 2007). Each selected household received up to four contacts by mail: (*i*) a pre-notification letter; (*ii*) a first mailing with cover letter, paper questionnaire and postage-paid return envelope; (*iii*) a postcard reminder; and (*iv*) a second mailing (for non-respondents only) with cover letter, paper questionnaire and postage-paid return envelope. A link to the electronic version of the survey was included in all mailings. To increase interest among the survey population, an article was published about the survey in the local newspaper prior to the first mailing (Stokes 2013). The survey response rate for La Conner households was 52 per cent.

The first part of the survey focused on respondents' concerns about various environmental issues, desire to participate in local waste management decision-making and familiarity with wastewater treatment and the term 'biosolids'. All respondents were then asked to read brief definitions of composting, biosolids and Class A biosolids. The second set of questions were used to ascertain respondents' opinions about the use of Class A biosolids in agriculture, level of interest in using locally produced Class A biosolids compost, level of support for the WSU biosolids compost research project and opinions about composting operations at the La Conner WWTP.

5.4 Reconciling theory with reality

The resources within the university Extension system can be leveraged to help community members, policy-makers and waste managers reconcile the ideals of democratic problem-solving with the realities of effective community engagement. The results of participant observation and the mail survey are examined through the framework of the four concepts for resilient waste management decision-making presented previously.

5.4.1 Risk communication and management

People want to be involved in deciding acceptable levels of risks to themselves, their families and their communities. When La Conner residents were asked if they thought the government should create new labelling standards for food grown using biosolids-based fertilizer, approximately half of respondents replied 'Yes' (Table 1a). There was a similar response to the question of labelling food products containing genetically modified organisms (GMOs) in a 2013 ballot initiative in Washington State, with 49 per cent of voters voting in favour of labelling (WA Secretary of State 2013). Comments from survey respondents illustrate this sentiment: "If used it needs to be labeled so we can all make informed choices. Ditto GMO!" and "The public should have the information for an intelligent choice."

Risk assessment and risk management are analytical-deliberative processes. Differences in opinion often arise from differences in peoples' values and belief systems, not solely ignorance. In the 2011 La Conner mayoral campaign, the compost operation was a central topic. The incumbent mayor was in support of the expanded compost operation and investment in university research and favoured accepting biosolids from other municipalities. His opponent (a member of the town council) was strongly opposed to the expanded compost operation and

[2] An identical survey questionnaire was mailed to 1,000 households in Skagit County at large (excluding La Conner). The purpose of this paper is not to compare the responses from the two survey populations. However, selected comparisons will be presented when relevant to the discussion. The survey instrument and complete survey results are available on the WSU Biosolids Management website: http://puyallup.wsu.edu/soils/biosolids/.

Table 1a. Responses of La Conner residents to WSU biosolids opinion survey conducted in 2013

Do you support the use of Class A biosolids on farmland in Skagit County? (on a scale of 1 = 'do not support' to 5 = 'strongly support')	
Do not support (1)	14.8
Low/moderate support (2-3)	25.6
Strong support (4-5)	59.6
Some food crops are grown using Class A biosolids. How do you feel about this?	
Very negative or somewhat negative	26.8
Neutral	24.6
Very or somewhat positive	48.6
How interested would you be in using Class A biosolids as a fertilizer and soil conditioner if it saved you money?	
Not interested	21.1
Somewhat interested	28.1
Very interested	43.4
Not applicable	7.4
WSU is researching biosolids compost produced at the La Conner WWTP. Do you support this activity? (on a scale of 1 = 'do not support' to 5 = 'strongly support')	
Do not support (1)	4.2
Low/moderate support (2-3)	9.1
Strong support (4-5)	86.7
Should the government create new labelling requirements for food grown using biosolids-based fertilizers?	
Yes	54.5
No	25.9
Don't know	19.6

Note: All results presented as percentage of respondents.

Table 1b. Responses of La Conner residents to WSU biosolids opinion survey conducted in 2013

To what degree do you agree or disagree with the following statements?	
I support the biosolids composting activities at the WWTP.	
Disagree or strongly disagree	7.0
Neither agree nor disagree	19.5
Agree or strongly agree	73.5
Unpleasant odours come from the La Conner biosolids compost.	
Disagree or strongly disagree	28.3
Neither agree nor disagree	27.8
Agree or strongly agree	43.9
Composting turns a waste product into a valuable resource.	
Disagree or strongly disagree	11.6
Neither agree nor disagree	13.8
Agree or strongly agree	74.6

Note: All results presented as percentage of respondents.

bringing in waste from other places. He also questioned the rationale of paying for a consultant and university research. This difference in perspective and values is illustrated in guest columns written by each candidate for the La Conner newspaper during the election campaign (Hayes 2011; Welch 2011). Both columns acknowledged the history of the WWTP and compost operation and the revenue it generates.

The incumbent mayor wrote: "Continued research is needed. Therefore, the town has entered into a study with [WSU] to provide information from current research; identify gaps in

the research pertaining to La Conner's compost; propose research to fill the gaps; analyze the composition and concentration of La Conner's compost; evaluate applications and uses; and finally document the results." He went on to say that the composting operation at the La Conner WWTP reduced expenses and created a revenue stream that benefited residents, and then highlighted the transparency of both the budgeting process and the contract with the private firm that operates the WWTP (Hayes 2011).

In contrast, the opposing mayoral candidate expressed concern about expanding a composting operation that has created a "mountain of compost" and was done with "no business plan, no marketing plan and only recently a patchwork of ideas of how to deal with the stink." He questioned the value of the WSU study ("if this product is good stuff why do we need an academic study to help us sell it?"), hiring a consultant and the impacts of odour on the tourism in town. He stated that "the scale of this operation and its location is inappropriate for our town" and if elected Mayor he would "stop accepting any outside sewage and clean up this boondoggle" (Welch, 2011). In this case, differences of opinion between candidates were more likely based on values, experiences and belief systems, rather than lack of knowledge.

In effective risk management, risk is determined through public process, not before. At one of the community meetings a concerned citizen asked, "Are you at least willing to test the water in Sullivan Slough [for contaminants]?" The response from a town council member in attendance was a decisive "no" because, according to the experts, this was a "non-issue." The result was that two groups with divergent positions ('safe' vs. 'not safe') moved further apart, collaborative discourse became more difficult and shared interests were not identified. The public's lack of trust in decision-makers and experts is exacerbated by the refusal to give credibility to their concerns and to resolve what they feel are important issues. This was illustrated by another comment from a town resident at the same meeting: "We don't have a sense of confidence that the issues have been addressed." Regardless of whether or not the concern about water quality in Sullivan Slough had a valid scientific basis, the unwillingness to investigate it contributed to the lack of trust in decision-makers and frustration with the process.

In many cases, the general public frames risk more broadly than technical or scientific experts. A microbiologist might look at the results from an antibiotic trial and conclude the compost is safe. A public health official might verify the compost met requirements for pathogen and vector reduction and conclude it is safe. A water quality specialist might look at water quality in the slough and conclude the compost is not a risk. But a farmer or other member of the public might take all of this into consideration, as well as other factors and decide the risk is still too high. This broader framing of risk is illustrated by a conversation with a farmer who called the first author with questions about the risks of using La Conner biosolids compost on his fields and had already done some of his own research. He listened to a brief explanation of our research with antibiotics, the evidence that compost is highly effective at breaking down most contaminants in organic waste, the standards that all biosolids compost facilities must meet and the fact that the EPA does not require any testing for dioxins or other chemicals. He asked a few clarifying questions and then replied with "Well, I don't think I will ever regret *not* using it." His evaluation of the risks was quite broad compared to the researchers and his assessment was that the potential risks outweighed the benefits.

5.4.2 Public knowledge systems

The town council and WWTP managers did not host any public forums or town hall style meetings beyond regularly scheduled town council meetings because of resistance from individual council members. However, attempts were made to engage with the public about the expansion of the composting operation, accepting biosolids from other municipalities, and investment in a

collaborative university research project. These activities were successful in addressing the concerns of many community members, as evidenced by the cessation of complaints filed at Town Hall or with the WWTP manager.

One example of effective collaboration with the community occurred in response to odour complaints by students and teachers at the local secondary school. The WWTP managers and town administrators worked closely with school staff to record the time and severity of odour events. This allowed the WWTP staff to identify and correct the particular management practices that were causing odour events. Other efforts to engage with the community included tours of the WWTP for school groups and other residents.

More community involvement in the early phases of decision-making may have led to greater resiliency in the decision-making and public-communication process, which in turn may have reduced the amount of time and resources spent on mitigating odour concerns, addressing accusations of mismanagement and preparing for and attending emotionally intense community meetings. However, achieving a high level of community engagement can be very difficult because in many cases people will not participate in the public process until they have very strong negative feelings. Thus, public planners and decision-makers are faced with the dilemma of how to increase public engagement on an issue before people care enough about it to become upset.

Despite efforts to engage the community, a small but dedicated group of town residents self-organized around their concerns about the La Conner WWTP and compost yard. While there was interest among some meeting attendees in getting more information about specific issues (e.g., steps taken to control odours or type of tests conducted on the compost), there was also a strong desire to feel heard and know that their opinions and concerns mattered. While some concerns may not have been based on technically accurate information, this did not make them any less real or important to the people who held them. This desire to be consulted was also reflected in many of the survey comments such as "Thanks for taking the time to do this!", "Thank you for the opportunity to contribute" and "Thank you for asking."

5.4.3 The public-expert interface

Work at the public-expert or technical-democratic interface requires a broader view of the role of science and scientists. This research project gave the first author the opportunity to be a scientist and a community member at the same time, to work within the context of the university as a community resource and to explore the role of researchers as scholars of integration and application (Checkoway 1997). There was strong support among La Conner residents for the WSU research efforts; 86 per cent of survey respondents strongly support the collaborative La Conner-WSU research efforts (Table 1a). This support was also apparent in survey comments such as "This issue requires a thoughtful unbiased and cautious approach. I'm counting on [WSU] to do that" and "I appreciate making a useful product from waste . . . hopefully the research will continue."

There were many opportunities during this project to provide information to various groups and individuals about biosolids in general and La Conner biosolids compost specifically. The public's experience of the first author's credibility and expertise, or that of other experts, was often affected by information dissemination strategies rather than the quantity of information available. Credibility was enhanced by presenting information in a way that did not sound like an exercise in persuasion. Defensiveness or anger on the part of an expert appeared to decrease the public's trust. Admission of ignorance on the part of the expert, appreciation of the complex nature of the topic and the willingness to consider different perspectives also appeared to greatly increase public perception of credibility and expertise. This was illustrated by a conversation with a fourth generation Skagit Valley farmer about using biosolids compost in local agriculture. He explained how many times farmers have been told by experts that something is safe, only to

find out later that it is not. He wanted to know that scientists truly understand and value the complexity of this issue and respect the range of opinions within the community. The collective knowledge of farmers in Skagit County is substantial and most are evaluating risks in terms of generations, not years.

One can find similarities between the debates around biosolids, GMOs, vaccines and other highly emotional and controversial issues that are directly connected to our health, involve biological and chemical processes that the general public may not fully understand and involve presentation of 'facts' and 'science' by experts on both sides of the debate. Biosolids recycling in particular may be one of the most challenging topics because it puts food and feces in the same sentence. One survey comment illustrates this quite well: "It seems to me that Monsanto, ADM, etc., are trying to put things in my mouth without my consent . . . Now someone is telling me it's okay to eat my own shit. I'm very hesitant to agree with that!"

During this case study research, La Conner town council meetings were held twice per month; all meetings were open to the public and the agenda and minutes were published on the town website (www.laconner.net). There were 11 news articles or editorial columns published in the *La Conner Weekly News* and one article in the regional newspaper (*Skagit Valley Herald* 2012) about the La Conner biosolids compost and/or the WSU research project. Our field research was highlighted at annual university field days, to which members of the town council were personally invited. Project leaders communicated their willingness to speak with anyone interested in the research, or with specific concerns, when attending town council and community meetings. On only one occasion did a concerned citizen attend a town council meeting at which a research update was given. This individual expressed concern about the risks of contaminants in the La Conner compost and referenced a study showing trace levels of heavy metals and toxic organic compounds in biosolids from another state. An offer by the first author to provide information about current research on the safety of biosolids compost did not address this individual's fear. The same question was brought up repeatedly at subsequent meetings of the concerned citizens group. This scenario illustrates the limitations of the strategy of experts to provide 'more and better' techno-scientific information when people are scared or angry about what they see as a threat to their health and their community.

Despite the accessibility of the project researchers, the transparency of town council decision-making about WWTP management and funding of both private and university research, the highly visible nature of the WWTP and generous local press coverage, curiosity or concern about the research project among town residents appeared to be very limited. For example, the first author was not contacted by a town council member at any point during this project outside of town council meetings and received only one phone call from an interested citizen. This lack of engagement confirms observations put forth by Gen (2010) and Shipley and Utz (2012) that waste is something most people either do not want to think about, or do not see as a pressing issue.

There was not an effective venue for highly concerned individuals to participate in the decision-making or risk-assessment process and feel heard by the experts. The citizens group that organized to fill this vacuum was dominated by individuals who did not appear to be focused on finding solutions. Based on an understanding of the nature of the issue and observations of this group it appeared that most participants wanted to feel heard and to know that the decision-makers and scientists saw their concerns as valid. Emotions ran high, with angry and scared community members and a defensive WWTP manager and town council member. The meeting facilitator chosen by this group was ineffective and at times even contributed to the confrontational nature of the meetings. The meetings did not appear to meet the needs of citizens or town officials, and responding to the demands of this group was very time consuming. Without a robust process that provides an opportunity for people to participate in conversations and problem solving about the issues that affect their homes and families it is very difficult, if not impossible, to bring all parties together and reconcile divergent views. Such a process

requires local government and institutional support (Petts 1997), strong leadership, facilitation skills, and community members with both the desire and the resources to participate (Shipley and Utz 2012).

As suggested by Checkoway (1997, 2001), public scientists and research institutions have an important role to play in the process of including the community in both defining and solving problems. Successful inclusion of the public in this process requires that they have access to information that is relevant and accurate and that scientists and other experts have the training and skills necessary to effectively work at the public-expert interface.

5.4.5 Visibility of waste and awareness of waste issues

Basic knowledge of soil and water systems is a prerequisite for meaningful participation in conversations about waste within a community. This challenges researchers, public planners and waste managers to provide information in a manner that engages and empowers people to participate in local decision-making processes. Applying the concept of "embeddedness" (Frickel 2004) to this challenge suggests that in order to successfully achieve meaningful public participation, researchers and waste managers will need to accept a more flexible boundary between the spheres of 'expert' and 'public' and embrace the scholarships of application and teaching in addition to discovery.

The survey was a valuable tool not only for learning more about opinions and attitudes, but also served as a way to increase respondents' knowledge and interest in waste management. This was illustrated through survey comments from La Conner and Skagit County respondents such as:

- I didn't know [about] biosolids composting. I also hadn't thought of . . . pharmaceuticals in biosolids. I'll have to look into this
- Found this very interesting. I learned! Glad there is concern!
- Will do some personal research on positive and negative repercussions of biosolids usage.

Lack of interest and knowledge among the general public, or a belief that the issue is already solved or best left to experts, can greatly limit public engagement in problem solving and decision-making. On the other hand, negative experiences or feelings can greatly increase the public's desire to participate. In the case of La Conner, a temporary increase in unpleasant odours and visibly larger piles of compost may have increased the interest and concern about biosolids and led to a stronger desire in some individuals to get involved in the decision-making process. Town administration and WWTP staff made the necessary management changes to address much of the odour problem. Nevertheless, odour remained the central issue at community meetings and was especially important to the individuals who operated businesses near the WWTP.

The survey did reveal concerns about odour among La Conner residents. Forty-four per cent of La Conner residents 'agreed' or 'strongly agreed' that unpleasant odours come from the La Conner biosolids compost, while only 28 per cent 'disagreed' or 'strongly disagreed' (Table 1b). Respondents who perceived unpleasant odours from the WWTP were much less likely to have an interest in using the biosolids compost themselves, or support its use on local farms. Respondents who felt that the WWTP was a source of 'unpleasant odours' were significantly less interested in using Class A biosolids as a fertilizer and soil conditioner and less supportive of the use of Class A biosolids on farm land in Skagit County.

There was strong support among survey respondents for composting activities at the WWTP and most respondents were of the opinion that composting biosolids turns a waste into a valuable

Table 2. Responses from La Conner residents and Skagit County residents to WSU biosolids opinion survey conducted in 2013

	La Conner	Skagit County
Number of respondents	191	279
Survey response rate (%)	52	32

Before receiving this survey, how familiar were you with the term 'biosolids'?

	La Conner	Skagit County
Not familiar	10.3	38.9
Somewhat familiar	58.9	47.2
Very familiar	30.8	13.9

Are you interested in working with your neighbors and local government to develop a county-wide waste management strategy?

	La Conner	Skagit County
Not interested	42.3	46.5
Somewhat interested	44.0	42.8
Very interested	13.7	10.7

Note: All results presented as percentage of respondents

resource (Table 1b). More visibility of waste and waste issues within the La Conner community than in Skagit County at large likely led to more interest in and knowledge about the topic. The survey response rate for La Conner respondents was 52 per cent compared with 32 per cent for Skagit County respondents (Table 2). There was slightly more interest in participating in a countywide waste management effort and a considerably higher level of familiarity with the term 'biosolids' among La Conner residents compared with Skagit County residents (Table 2). Considering awareness of the biosolids composting activities, newspaper articles and the recent controversial nature of the topic, this increased knowledge and interest among La Conner residents was as expected.

When the town of La Conner was recognized with the 'Excellence in Biosolids Management Award' from NBMA in 2012, articles were published in the regional and local newspapers (Jennings 2012; *Skagit Valley Herald* 2012). However, only 42 per cent of survey respondents in La Conner were aware of the award. There is a strong local food movement in La Conner and the surrounding area and appreciation of local farmers and farmland preservation. Supporting the WSU biosolids compost research project was a way in which the town council, town staff and WWTP staff felt they could strengthen the connections between biosolids and soil quality, long-term agricultural productivity and economic vitality. However, the NBMA award may have been a missed opportunity to more fully engage the local community, develop pride in local waste management and make the connection with local soil, agriculture and food.

6 Conclusion

This project serves as an example of the benefits of high waste visibility and awareness within a community. Without community awareness about the La Conner WWTP, due in part to odour concerns and strong ties between the town and the agricultural community this project would not likely have come to fruition. This project also illustrated the value of collaborative projects in building this capacity within an institution for effective work at the public-expert interface. Contained in this case study are examples of both effective and ineffective work at the public-

expert interface. There is more work to be done in this area, as well as improvement in risk communication and management with town residents and farmers.

Other forms of community-university engagement may also be possible. For example, the university Extension system is well suited for hosting community forums and public meetings and Extension faculty and graduate students can be trained as facilitators. Not only would this serve the community but it would also provide valuable experience for students and faculty, broaden the role of public scientists and strengthen public-expert relationships within the local community. Because of an ineffective facilitator and angry, defensive participants, the meetings of concerned citizens in La Conner did not yield real solutions. In this case, facilitation services offered by Extension faculty may have helped changed the outcome.

Lacking an effective venue for public participation, this project did not fully utilize public knowledge systems. Public forums could have provided an opportunity for positive public-expert interaction and direct public involvement in identifying and framing risks and solutions. Meeting these objectives would require: (*i*) involvement of diverse stakeholders; (*ii*) support of local government and the university; (*iii*) use of a skilled facilitator; (*iv*) providing the public with accurate, concise and relevant information so they are better equipped to participate in the discussion; and (*v*) willingness on the part of scientists, biosolids managers and other experts to understand that members of the public may frame risk more broadly and opposition may not be solely due to ignorance. Considering the localized, controversial nature of this project, it is possible that engaging the local community in the early phases of research could have increased both local interest and impact, especially among the 14 per cent of survey respondents who indicated that they were very interested in working with neighbours and local government to develop waste management strategies.

While in many cases there is a sincere intention on the part of policy-makers to fully engage the community in problem solving, the challenges can sometimes be too great to overcome without additional training or expertise. Even so, some individuals will still choose not to engage in an honest discussion, or seek solutions. Regardless of the strategy of policy-makers or experts there will likely be people who choose to take a contrary view, or are invested in a project's failure. The challenge to policy-makers and experts is to address their concerns without the expectation of resolution and not allow this often small yet vocal faction to detract from the sincere concerns of others, or constructive community engagement.

Members of the public want to test and challenge experts and rightly so. By learning to appreciate and value this process and their role in it, experts may become more effective communicators about controversial techno-scientific topics. As suggested by Cash et al. (2003), scientists and technical experts often lack the social and communication skills required to solve the critical problems facing humanity as we move into the 21st century. Technical innovation will no doubt continue at a rapid pace, but it is dedication to the science and practice of community engagement that will allow scientists and other decision-makers to effectively implement necessary solutions.

Research on land-application of biosolids and the associated risks based on what scientists and other experts see as most critical is certainly valid. However, a broader perspective may be helpful if the objective is sound waste management solutions that (*i*) address the needs of the local community, (*ii*) improve ecosystem services and (*iii*) are resilient to changing social, political and environmental pressures. Reframing the debate about waste can help us see it not as a liability but as a publicly managed asset and one that directly connects to issues of clean water, healthy soil, and food security. By incorporating multiple perspectives, supporting solutions that account for geographic, political and social variation and focusing on collaborative problem-solving, we may find that the planning and decision-making process is more challenging in the short-term but more effective and more resilient over the long-term.

This project addressed challenges inherent in conducting research on a politically and socially controversial topic while developing a new collaborative research model. By building and improving upon what we have learned in La Conner, similar projects in other communities have the potential to contribute greatly to the development of effective and resilient regional waste management solutions.

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