

# Lessons Learned from Horizon Scanning Focusing on Research

Bryan W. Brooks

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# Sustainable Development Goals



[www.globalgoals.org](http://www.globalgoals.org)

# Food

BY 2030  
NO ONE WILL  
GO HUNGRY  
ANYWHERE  
IN THE WORLD

#GlobalGoals

# Energy

GOAL 7  
THE  
WORLD  
NEEDS A  
LIGHT-BULB  
MOMENT

#GlobalGoals



# Water



I SUPPORT  
GOAL 6  
CLEAN WATER  
AND SANITATION



**THE GLOBAL GOALS**  
For Sustainable Development



**THE GLOBAL GOALS**  
For Sustainable Development



**I SUPPORT**  
**GOAL 11**  
**SUSTAINABLE**  
**CITIES AND**  
**COMMUNITIES**



## THE GLOBAL GOALS

For Sustainable Development



### I SUPPORT GOAL 11 SUSTAINABLE CITIES AND COMMUNITIES

- 11.6 “By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management”

# Why Horizon Scanning?

What are the world's biggest issues?

Who is going to solve them?

theguardian | TheObserver

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News > Science

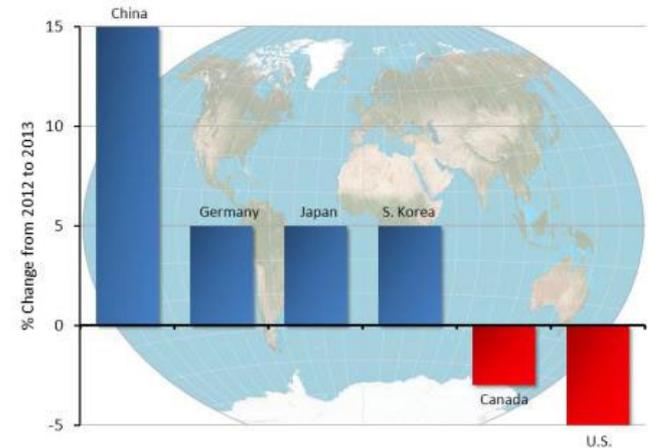
## The 20 big questions in science

From the nature of the universe (that's if there is only one) to the purpose of dreams, there are lots of things we still don't know – but we might do soon. A new book seeks some answers

Hayley Birch, Colin Stuart and Mun Keat Looi  
The Observer, Sunday 1 September 2013



## Scientific R&D Spending



Source: Cell, 2013 Jul 3;154(1):16-9.

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NATURE | COMMENT

## Policy: Set research priorities in a time of recession

Patrick Cunningham<sup>1</sup>

23 October 2013

Rigorous analyses are needed to establish the benefits of the knowledge economy, says former

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# Why Global Horizon Scanning?

- The Global Horizon Scanning Project aims to identify important and timely environmental quality research needs
- Research questions identified, if answered, would markedly advance toward more sustainable environmental quality over the next decade
- Unique partnership with SETAC (and ACS ENVR and AGRO Divisions in NA)



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*Global. Transparent. Inclusive. Multidisciplinary. Multisector.*

# Key Questions Approach

- Horizon scanning method
- Systematic way to identify major research and policy directions
- These are inherently bottom-up exercises

*Journal of Applied Ecology* 2006, 43, 617-627

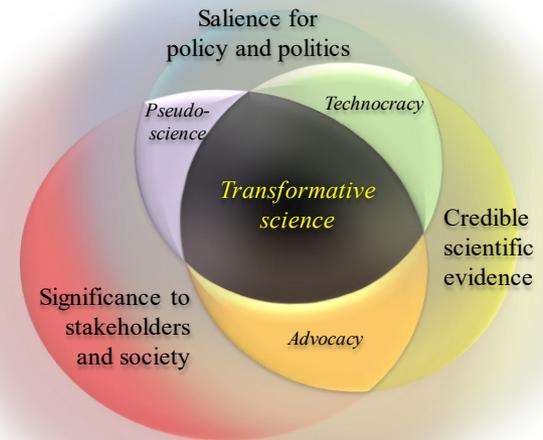
## FORUM

### The identification of 100 ecological questions of high policy relevance in the UK

WILLIAM J. SUTHERLAND,<sup>1</sup> SUSAN ARMSTRONG-BROWN,<sup>2</sup> PAUL R. ARMSWORTH,<sup>3</sup> TOM BRERETON,<sup>4</sup> JONATHAN BRICKLAND,<sup>5</sup> COLIN D. CAMPBELL,<sup>6</sup> DANIEL E. CHAMBERLAIN,<sup>7</sup> ANDREW I. COOKE,<sup>8</sup> NICHOLAS K. DULVY,<sup>9</sup> NICHOLAS R. DUSIC,<sup>10</sup> MARTIN FITTON,<sup>11</sup> ROBERT P. FRECKLETON,<sup>12</sup> H. CHARLES J. GODFRAY,<sup>13</sup> NICK GROUT,<sup>14</sup> H. JOHN HARVEY,<sup>15</sup> COLIN HEDLEY,<sup>16</sup> JOHN J. HOPKINS,<sup>17</sup> NEIL B. KIFT,<sup>18</sup> JEFF KIRBY,<sup>19</sup> WILLIAM E. KUNIN,<sup>20</sup> DAVID W. MACDONALD,<sup>21</sup> BRIAN MARKER,<sup>22</sup> MARC NAURA,<sup>23</sup> ANDREW R. NEALE,<sup>24</sup> TOM OLIVER,<sup>25</sup> DAN OSBORN,<sup>26</sup> ANDREW S. PULLIN,<sup>27</sup> MATTHEW E. A. SHARDLOW,<sup>28</sup> DAVID A. SHOWLER,<sup>29</sup> PAUL L. SMITH,<sup>30</sup> RICHARD J. SMITHERS,<sup>31</sup> JEAN-LUC SOLAMNET,<sup>32</sup> JONATHAN SPENCER,<sup>33</sup> CHRIS J. SPRAY,<sup>34</sup> CHRIS D. THOMAS,<sup>35</sup> JIM THOMPSON,<sup>36</sup> SARAH E. WEBB,<sup>37</sup> DEREK W. YALDEN<sup>38</sup> and ANDREW R. WATKINSON<sup>39</sup>

The top 100 questions of importance to the future of global agriculture

Jules Pretty<sup>1\*</sup>, William J. Sutherland<sup>2</sup>, Jacqueline Ashby<sup>3</sup>, Jill Auburn<sup>4</sup>, David Boulcombe<sup>5</sup>, Michael Bell<sup>6</sup>, Jeffrey Bentley<sup>7</sup>, Sam Bickerstaff<sup>8</sup>, Katrina Brown<sup>9</sup>, Jacob Burke<sup>10</sup>, Hugh Campbell<sup>11</sup>, Kevin Chen<sup>12</sup>, Eve Crowley<sup>13</sup>, Ian Crane<sup>14</sup>, Dirk Dobbelaere<sup>15</sup>, Gareth Edwards-Jones<sup>16</sup>, Fernando Funes-Monzote<sup>17</sup>, H. Charles J. Godfray<sup>18</sup>, Michel Griffar<sup>19</sup>, Pirek Gymanitsis<sup>20</sup>, Lawrence Haddad<sup>21</sup>, Srusika Halavata<sup>22</sup>, Hans Herren<sup>23</sup>, Mark Holderness<sup>24</sup>, Anne-Marie Izuel<sup>25</sup>, Manly Jones<sup>26</sup>, Paniz Kooliakan<sup>27</sup>, Rattan Lal<sup>28</sup>, Timothy Lang<sup>29</sup>, Jeffrey Molles<sup>30</sup>, Alexander Mueller<sup>31</sup>, Nicholas Nisbet<sup>32</sup>, Andrew Noble<sup>33</sup>, Prabhu Pingali<sup>34</sup>, Yvonne Pinto<sup>35</sup>, Rudy Rabbinge<sup>36</sup>, N. H. Ravindranath<sup>37</sup>, Agnes Raba<sup>38</sup>, Wils Roding<sup>39</sup>, Colin Sage<sup>40</sup>, William Settle<sup>41</sup>, J. M. Sita<sup>42</sup>, Luis Shininga<sup>43</sup>, Tony Simons<sup>44</sup>, Pete Smith<sup>45</sup>, Kenneth Strzepek<sup>46</sup>, Harry Swaine<sup>47</sup>, Eugene Terry<sup>48</sup>, Thomas P. Tomich<sup>49</sup>, Camilla Toulimir<sup>50</sup>, Eduardo Trigo<sup>51</sup>, Stephen Twomlow<sup>52</sup>, Jan Kees Vidi<sup>53</sup>, Jeremy Wilson<sup>54</sup> and Sarah Pilgrim<sup>55</sup>



# Key Questions Approach

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*potentially more legitimacy*

*Journal of Applied Ecology* 2006, 43, 617-627

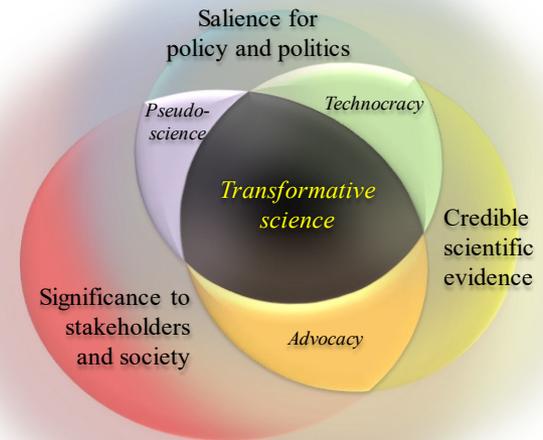
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The top 100 questions of importance to the future of global agriculture

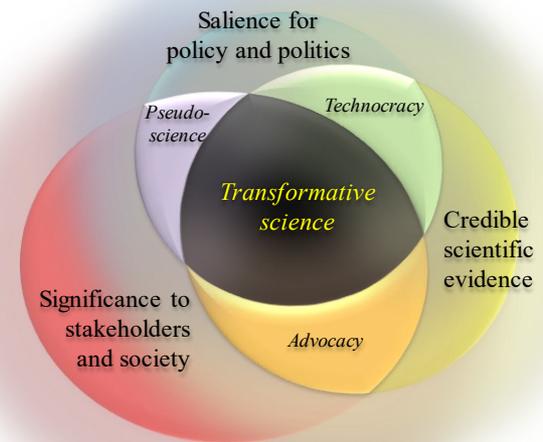
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# Key Questions Approach

Scientists and engineers should understand implications of various research strategies

- Scientists and engineers, policy-makers, stakeholders may hold very different perspectives on the ideal level of cooperation between decision-makers and scientists and engineers
- Research aligned with policy needs may have very different costs and benefits relative to unaligned ('blue skies') research



# Global Horizon Scanning

Environmental Toxicology and Chemistry—Volume 37, Number 9—pp. 2281–2295, 2018  
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2281

## Critical Review

### Toward Sustainable Environmental Quality: Priority Research Questions for Europe

Paul J. Van den Brink,<sup>a,b</sup> Alistair B.A. Boxall,<sup>c,\*</sup> Lorraine Maltby,<sup>d</sup> Bryan W. Brooks,<sup>e</sup> Murray A. Rudd,<sup>f</sup> Thomas Backhaus,<sup>g</sup> David Spurgeon,<sup>h</sup> Violaine Verougstraete,<sup>i</sup> Charmaine Ajao,<sup>j</sup> Gerald T. Ankleby,<sup>k</sup> Sabine E. Apitz,<sup>l</sup> Kathryn Arnold,<sup>m</sup> Tomas Brodin,<sup>n</sup> Miguel Canedo-Argüelles,<sup>o</sup> Jennifer Chapman,<sup>p</sup> Jone Corrales,<sup>q</sup> Marie-Agnès Coutellec,<sup>r</sup> Teresa F. Fernandes,<sup>s</sup> Jerker Fick,<sup>t</sup> Alex T. Ford,<sup>u</sup> Gemma Giménez Papiol,<sup>v</sup> Ksenia J. Groh,<sup>w</sup> Thomas H. Hutchinson,<sup>x</sup> Hank Kruger,<sup>y</sup> Jussi V.K. Kukkonen,<sup>z</sup> Stefania Loutseti,<sup>aa</sup> Stuart Marshall,<sup>ab</sup> Derek Muir,<sup>ac</sup> Manuel E. Ortiz-Santaliestra,<sup>ad</sup> Kai B. Paul,<sup>ae</sup> Andreu Rico,<sup>af</sup> Ismael Rodea-Palomares,<sup>ag</sup> Jörg Römbke,<sup>ah</sup> Tomas Rydberg,<sup>ai</sup> Helmut Segner,<sup>aj</sup> Mathijs Smit,<sup>ak</sup> Cornelis A.M. van Gestel,<sup>al</sup> Marco Vighi,<sup>am</sup> Inge Werner,<sup>an</sup> Elke I. Zimmer,<sup>ao</sup> and Joke van Wensem<sup>ap</sup>

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1606

## Critical Review

### Toward Sustainable Environmental Quality: Priority Research Questions for North America

Anne Fairbrother,<sup>a</sup> Derek Muir,<sup>b</sup> Keith R. Solomon,<sup>c</sup> Gerald T. Ankleby,<sup>d</sup> Murray A. Rudd,<sup>e</sup> Alistair B.A. Boxall,<sup>f</sup> Jennifer N. Apple,<sup>g</sup> Kevin L. Ambrus,<sup>h</sup> Bonnie J. Blalock,<sup>i</sup> Sarah R. Bowman,<sup>j</sup> Linda M. Campbell,<sup>k</sup> George P. Cobb,<sup>l</sup> Kristin A. Connors,<sup>m</sup> David A. Dreier,<sup>n</sup> Marlene S. Evans,<sup>o</sup> Carol J. Henry,<sup>p</sup> Robert A. Hoke,<sup>q</sup> Magali Houde,<sup>r</sup> Stephen J. Klaine,<sup>s</sup> Rebecca D. Klaper,<sup>t</sup> Signun A. Kullik,<sup>u</sup> Roman P. Lanno,<sup>v</sup> Charles Meyer,<sup>w</sup> Mary Ann Ottinger,<sup>x</sup> Elias Oziolor,<sup>y</sup> Elijah J. Petersen,<sup>z</sup> Helen C. Poynton,<sup>aa</sup> Pamela J. Rice,<sup>ab</sup> Gabriela Rodriguez-Fuentes,<sup>ac</sup> Alan Samel,<sup>ad</sup> Joseph R. Shaw,<sup>ae</sup> Jeffery A. Steevens,<sup>af</sup> Tim A. Verslycke,<sup>ag</sup> Doris E. Vidal-Dorsch,<sup>ah</sup> Scott M. Weir,<sup>ai</sup> Peter Wilson,<sup>aj</sup> and Bryan W. Brooks<sup>ak</sup>

Furley et al. 2018. *IEAM*; Van den Brink et al. 2018. *ET&C*;  
Fairbrother et al. 2019. *ET&C*; Gaw et al. 2019. *IEAM*;  
Leung et al. 2020. *ETC*

Integrated Environmental Assessment and Management — Volume 14, Number 3—pp. 344–357  
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## Environmental Policy & Regulation

### Toward Sustainable Environmental Quality: Identifying Priority Research Questions for Latin America

Tatiana Heid Furley,<sup>a</sup> Julie Brodeur,<sup>b</sup> Helena C Silva de Assis,<sup>c</sup> Pedro Carriquiriborde,<sup>d</sup> Katia R Chagas,<sup>e</sup> Jone Corrales,<sup>f</sup> Marina Denadai,<sup>g</sup> Julio Fuchs,<sup>h</sup> Renata Mascarenhas,<sup>i</sup> Karina SB Migloranza,<sup>j</sup> Diana Margarita Miguez Caramés,<sup>k</sup> José Maria Navas,<sup>l</sup> Dayanthi Nugegoda,<sup>m</sup> Estela Planes,<sup>n</sup> Ignacia Alejandra Rodriguez-Jorquera,<sup>o</sup> Martha Orozco-Medina,<sup>p</sup> Alistair BA Boxall,<sup>q</sup> Murray A Rudd,<sup>r</sup> and Bryan W Brooks<sup>s</sup>

Integrated Environmental Assessment and Management — Volume 00, Number 00 — pp. 1–19  
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1

## Workshop Synthesis

### Towards Sustainable Environmental Quality: Priority Research Questions for the Australasian Region of Oceania

Sally Gaw,<sup>a</sup> Andrew Harford,<sup>b</sup> Vincent Pettigrove,<sup>c</sup> Graham Sevicke-Jones,<sup>d</sup> Therese Manning,<sup>e</sup> James Ataria,<sup>f</sup> Tom Cresswell,<sup>g</sup> Katherine A Dafforn,<sup>h</sup> Frederic DL Leusch,<sup>i</sup> Bradley Moggridge,<sup>j</sup> Marcus Cameron,<sup>k</sup> John Chapman,<sup>l</sup> Gary Coates,<sup>m</sup> Anne Colville,<sup>n</sup> Claire Death,<sup>o</sup> Kimberly Hageman,<sup>p</sup> Kathryn Hassell,<sup>q</sup> Molly Hoak,<sup>r</sup> Jennifer Gadd,<sup>s</sup> Dianne F Jolley,<sup>t</sup> Ali Karami,<sup>u</sup> Konstantinos Kotzakoulakis,<sup>v</sup> Richard Lim,<sup>w</sup> Nicole McAra,<sup>x</sup> Leon Metzeling,<sup>y</sup> Thomas Mooney,<sup>z</sup> Jackie Myers,<sup>aa</sup> Andrew Pearson,<sup>ab</sup> Minna Saaristo,<sup>ac</sup> Dave Sharley,<sup>ad</sup> Julia Stuthe,<sup>ae</sup> Oliver Sutherland,<sup>af</sup> Oliver Thomas,<sup>ag</sup> Louis Tremblay,<sup>ah</sup> Waitangi Wood,<sup>ai</sup> Alistair BA Boxall,<sup>aj</sup> Murray A Rudd,<sup>ak</sup> and Bryan W Brooks<sup>al</sup>

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1485

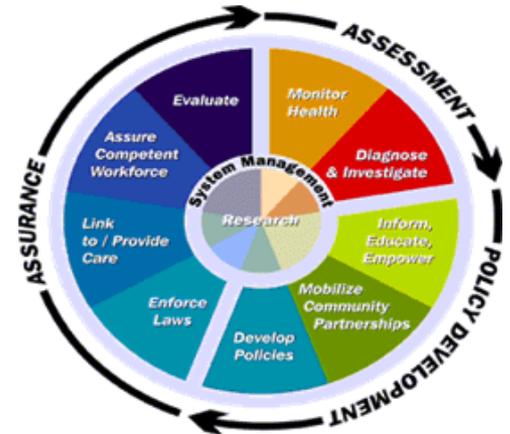
## Critical Review

### Toward Sustainable Environmental Quality: Priority Research Questions for Asia

Kenneth M.Y. Leung,<sup>a,b</sup> Katie W.Y. Yeung,<sup>c</sup> Jing You,<sup>d</sup> Kyungho Choi,<sup>e</sup> Xiaowei Zhang,<sup>f</sup> Ross Smith,<sup>g</sup> Guang-Jie Zhou,<sup>h</sup> Mana M.N. Yung,<sup>i</sup> Carlos Arias-Barreiro,<sup>j</sup> Youn-Joo An,<sup>k</sup> S. Rebekah Burket,<sup>l</sup> Robert Dwyer,<sup>m</sup> Nathalie Goodkin,<sup>n</sup> Yui Siang Hui,<sup>o</sup> Tham Hoang,<sup>p</sup> Chris Humphrey,<sup>q</sup> Chuleemas Boonthai Iwai,<sup>r</sup> Seung-Woo Jeong,<sup>s</sup> Guillaume Juhel,<sup>t</sup> Ali Karami,<sup>u</sup> Katerina Kynazi-Huber,<sup>v</sup> Kuan-Chun Lee,<sup>w</sup> Bin-Le Lin,<sup>x</sup> Ben Lu,<sup>y</sup> Patrick Martin,<sup>z</sup> Mae Grace Nillos,<sup>aa</sup> Katharina Oginawati,<sup>ab</sup> I.V.N. Rathnayake,<sup>ac</sup> Yenny Rijani,<sup>ad</sup> Mohammad Shoeb,<sup>ae</sup> Chin Hon Tan,<sup>af</sup> Maria Claret Tsuchiya,<sup>ag</sup> Gerald T. Ankleby,<sup>ah</sup> Alistair B.A. Boxall,<sup>ai</sup> Murray A. Rudd,<sup>aj</sup> and Bryan W. Brooks<sup>ak</sup>

# What are the key challenges and opportunities facing environmental public health practitioners?

- Environmental health is profoundly local
- 2<sup>nd</sup> largest public health workforce in the US
- Critical role in food, water and air quality, emergency response, vector control and disaster preparedness
- A “silent” profession until front page problems occur...
- Workforce status, challenges, needs and opportunities are poorly understood
- Fractured health delivery systems among States, Tribes and Territories



10 Essential Environmental Public Health Services

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What are the key challenges and opportunities facing environmental public health practitioners?



# Identifying Needs for Advancing the Profession and Workforce in Environmental Health

An ever-changing landscape for environmental health (EH) requires in-depth assessment and analysis of the current challenges and emerging issues faced by EH professionals. The Understanding the Needs, Challenges, Opportunities, Vi-

*Justin A. Gerding, DHA, MPH, Bryan W. Brooks, PhD, MS, Elizabeth Landeen, BA, Sandra Whitehead, PhD, MPA, Kaitlyn R. Kelly, BS, Amy Allen, BS, David Banaszynski, BS, Michael Dorshorst, MEd, Lane Drager, BS, Tammie Eshenaur, MPH, Jeff Freund, BS, Adam Inman, BS, Sandra Long, BS, Jessica Maloney, BS, Tammy McKeever, Tyler Pigman, BS, Nancy Rising, Sarah Scanlan, BS, Jennifer Scott, MS, Colin Shukie, MPH, Gary Stewart, BS, Danen Tamekazu, BS, Valerie Wade, BS, Carolyn White, MPH, and John Sarisky, MPH*



See also Künzli, p. 296, and the *AJPH* Environmental Health Workforce & Regulation section, pp. 284–298.

## 29 Priority Problem Statements to support the work of EH professionals for Common EH Programs

## Environmental Health Practice Challenges and Research Needs for U.S. Health Departments

*Bryan W. Brooks,<sup>1</sup> Justin A. Gerding,<sup>2</sup> Elizabeth Landeen,<sup>3</sup> Eric Bradley,<sup>4</sup> Timothy Callahan,<sup>5</sup> Stephanie Cushing,<sup>6</sup> Fikru Hailu,<sup>7</sup> Nancy Hall,<sup>8</sup> Timothy Hatch,<sup>9</sup> Sherise Jurries,<sup>10</sup> Martin A. Kalis,<sup>2</sup> Kaitlyn R. Kelly,<sup>1</sup> Joseph P. Laco,<sup>2</sup> Niki Lemin,<sup>11</sup> Carol McInnes,<sup>12</sup> Greg Olsen,<sup>13</sup> Robert Stratman,<sup>14</sup> Carolyn White,<sup>15</sup> Steven Wille,<sup>16</sup> and John Sarisky<sup>2</sup>*

## 29 Priority Problem Statements for Common EH Programs

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# What are the Key Research Needs for Onsite Wastewater?



## Needs for Onsite Wastewater Recycling Research

Unique Partnership with NOWRA

Steering Committee with Diverse Representation

Followed established survey and workshop synthesis methods

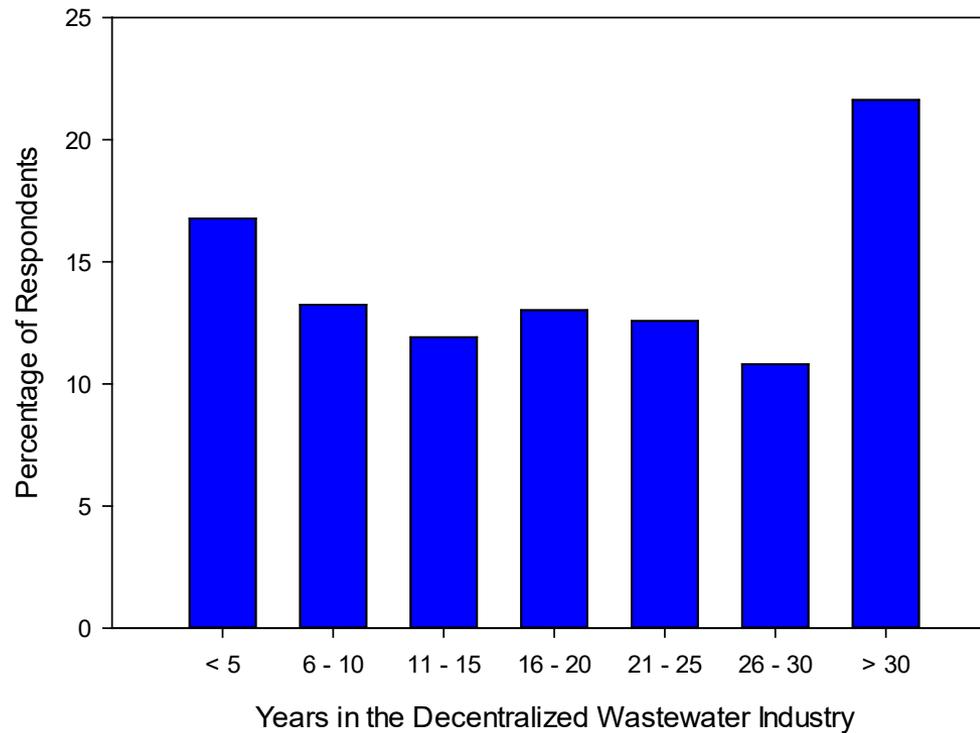
Phase 1: Survey

- input from hundreds in business, government, academic, NGOs

Phase 2: Synthesis workshop at 2021 NOWRA Mega-Conference

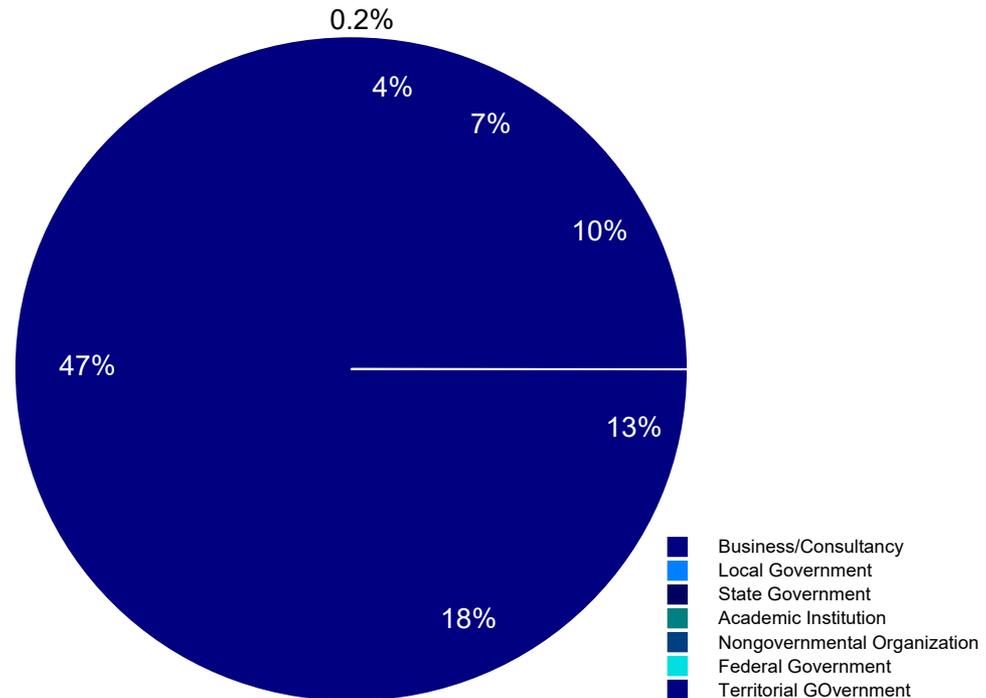


# Years of Experience in Decentralized Wastewater

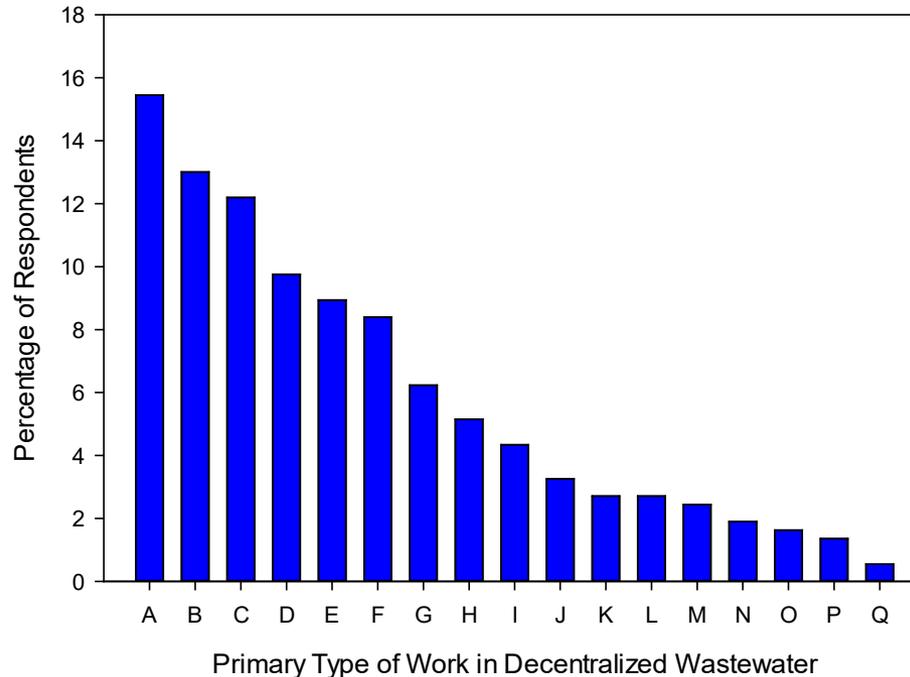


# Who is your employer?

Most respondents (47%) work in business, followed by governments (35%) and academia (10%)

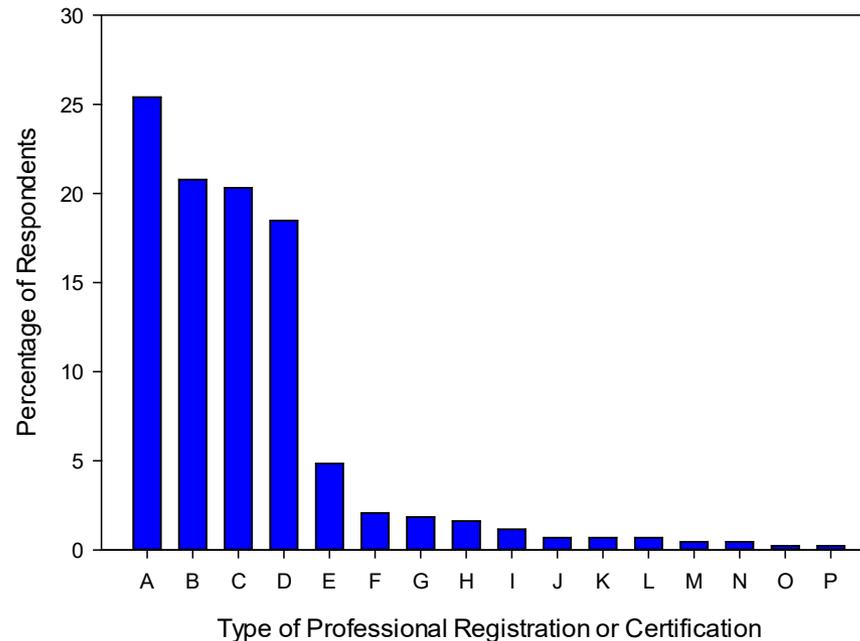


# What is the primary type of work you do in decentralized wastewater?



A: Engineer; B: Environmental Health; C: Installer; D: Designer; E: Regulator at tribal, territorial or state level; F: Academic researcher; G: Service provider; H: Public inspector; I: Academic educator; J: Soil scientist; K: Government researcher; L: Soil evaluator; M: Pumper; N: Operator; O: Private inspector; P: Regulator at federal level; Q: Funder

# Which of the following professional registrations and credentials do you hold?



A: none; B: Certified Installers of Onsite Wastewater Treatment Systems (CIOWTS); C: Professional Engineer (PE); D: Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS); E: Certified Professional Soil Scientist; F: Certified Environmental Professional; G: Certified in Public Health (CPH); H: Certified Professional Geologist (PG); I: Professional Land Surveyor; J: Board Certified Environmental Engineer (BCEE); K: Board Certified Environmental Scientist (BCES); L: Certified Hazardous Materials Manager (CHMM); M: Certified Safety Professional (CSP); N: Healthy Homes Specialist (HHS); O: Certified Health Education Specialist (CHES); P: Certified Industrial Hygienist (CIH)

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# Part 1: Identifying Key Research Questions

- Address important gaps in knowledge
- Be answerable through a realistic research design
- Have a factual answer that does not depend on value judgments
- Cover a spatial and temporal scale that could realistically be addressed by a research team (e.g., \$5-10M over 5 years)
  - Not a PhD thesis. Not a “moonshot”.
- Not be answerable by “it all depends” or “yes” or “no”
- If related to impact and interventions, should contain a subject, an intervention, and a measurable outcome

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## We asked professionals two questions...

*What technical scientific research question (e.g., innovation, design, resiliency, resource recovery), if answered, would substantially advance the science of decentralized wastewater over the next decade?*

*What environmental management (e.g., science-policy, implementation, enforcement) research question, if answered, would substantially advance the practice of decentralized wastewater over the next decade?*

33 Priority Research Questions Identified Across Six Themes

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# Treatment, Performance and Resource Recovery

How can we develop onsite systems that can be implemented and interfaced within broader circular economy/food-energy-water nexus efforts, while maintaining effectiveness and reliability across different economic conditions and geographic regions?

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# Treatment, Performance and Resource Recovery

How can we develop effective, efficient and economically viable treatment approaches with resource recovery (e.g., nutrients, septage, water) for diverse beneficial reuse applications?

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# Treatment, Performance and Resource Recovery

How can we adapt, develop and validate robust treatment approaches, which are effective for diverse constituents (e.g., PFAS, PPCPs, QACs, FOG), for various water reuse applications (e.g., fit for purpose)?

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# Resiliency, Efficacy and Sustainability

What innovation is needed related to onsite systems to increase effluent quality and social acceptance for water reuse?

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# Resiliency, Efficacy and Sustainability

Can we demonstrate how to implement onsite system to enhance resiliency considering climate change, natural disasters and economic challenges?

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# Resiliency, Efficacy and Sustainability

What innovation is needed related to onsite systems to increase effluent quality and social acceptance for water reuse?

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# Environmental Quality and Public Health

What is the quantifiable role and relative contribution of decentralized waste water compared to other contaminant sources on water quality?

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# Environmental Quality and Public Health

How does climate or extreme weather impact operation and performance of decentralized wastewater management systems infrastructure?

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# Environmental Quality and Public Health

What is the contribution of emerging contaminants (e.g., PFAS) from onsite waste water sources to groundwater contamination in the US?

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# Implementation

Which incentives are effective for better onsite wastewater installation and management?

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# Implementation

How do you develop regional asset management to decentralize to individuals and cluster sustainable solutions, and make responsible management economically viable?

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## Part 2: Identifying Problem Statements

- Assess the current and emerging challenges impacting decentralized wastewater and professionals working in the area.
- Identify essential information for ensuring decentralized wastewater is prepared and ready to address current and emerging challenges.
- Develop problem statements based on survey responses
  - Should be concise
  - Should be specific
  - Should be measurable
  - Should not include recommendations or identify interventions

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## We asked professionals two more questions...

*Within the next 5-10 years, what decentralized wastewater issues or challenges will require new or modified programs or technologies?*

*What resources or tools will you need to do your job in the future?*

Priority Problem Statements Identified Across Five Themes

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# Technology, Infrastructure and Reuse

Needs to address aging decentralized wastewater infrastructure exist, but community (e.g., individual, schools, small businesses) needs and locations are not understood within and among States and Territories

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# Technology, Infrastructure and Reuse

Decentralized technologies must advance to meet water conservation and reuse needs, particularly with clustered systems, but technologies are advancing faster than policies and community acceptance

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# Technology, Infrastructure and Reuse

Technology is not being consistently, efficiently and equitably employed to address differential conditions, including environmentally sensitive areas, soils, dynamic flows and strength

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# Technology, Infrastructure and Reuse

Site limitations and increasing regulations are increasing the cost of systems.

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# Technology, Infrastructure and Reuse

There are significant economic limitations to providing situationally appropriate solutions for adequate technology solutions, maintenance programs and regulations in the decentralized industry.

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# Information Systems and Data

A jurisdiction level inventory of the entities authorized to manage decentralized systems (e.g., co-ops, Private, local government) is lacking.

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# Information Systems and Data

Septic system data from the American Community Survey is not being leveraged to improve management within the onsite wastewater community.

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# Information Systems and Data

Home owners are the most responsible party for resilient decentralized systems and are the least knowledgeable about the operation and maintenance of these systems.

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## Emerging Issues

If wildfires are more prevalent, onsite systems increasingly made of plastic are susceptible to destruction, yet FEMA payouts for onsite systems are not sufficient.

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## Emerging Issues

Water shortages will require higher quality treatment for reclamation or reuse.

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## Emerging Issues

Communities impacted by climate change, coastal areas dealing with salt water intrusion, storm surge, and increased precipitation are not consistently, effectively and equitably adapting

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## Emerging Issues

Regional national resource shortages of necessary materials for construction (e.g., aggregate, sand, topsoil) is becoming a challenge for onsite wastewater.

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## Emerging Issues

Inequity of funding between centralized and decentralized wastewater recycling systems is not being addressed.

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# Garnering Support

In much of the US there are inadequate inventories, mechanisms and funding directed to upgrade decentralized properties.

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# Garnering Support

The decentralized industry is lacking sustainable funding mechanisms for enforcement programs to monitoring and manage systems.

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# Garnering Support

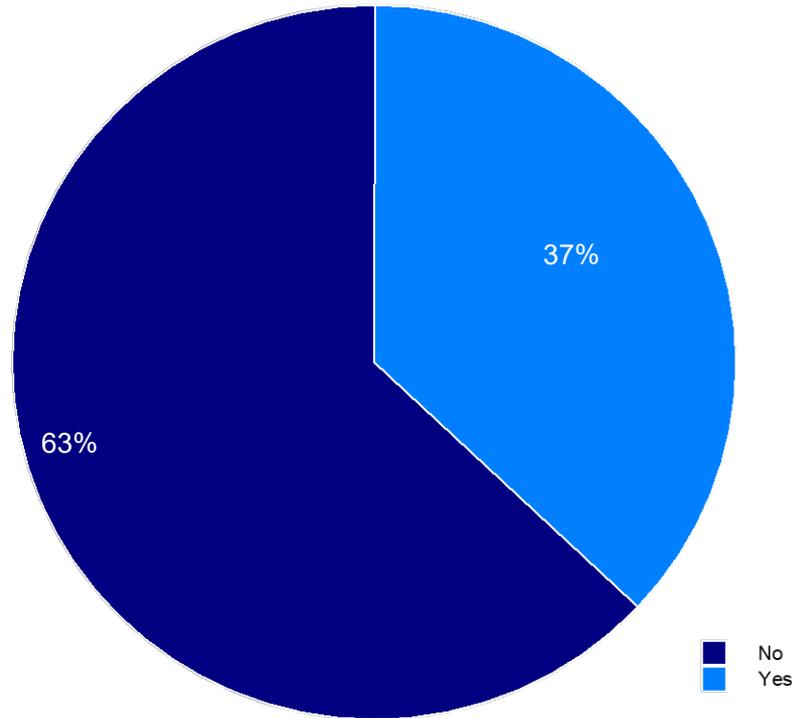
There is a deficiency in knowledge about benefits and drawbacks of decentralized systems and management among the public, users, policy makers, and related industries.

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# Education and Training

Do you plan to retire in the next five years?

37% of respondents plan to retire in 5 yrs



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# Education and Training

There is a decline of professionals in onsite wastewater recycling, due to an aging workforce and retirements.

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## Education and Training

Recruitment of early career professionals and awareness of employment opportunities in onsite wastewater recycling is limited.

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# Education and Training

A shortage of education and training programs limits the number of qualified, certified and experienced professionals in the onsite wastewater recycling workforce.

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## Education and Training

University-level programs in onsite wastewater that train new professionals and conduct critical research on decentralized systems are limited.



## Needs for Onsite Wastewater Recycling Research

Next steps...

Preparing manuscripts for publication

Dissemination of findings key stakeholders, funders

# NOW-R<sup>2</sup>

## Needs for Onsite Wastewater Recycling Research

| Track Topic  |         | Research   |
|--------------|---------|--|
| Track Number |         | 1  |
| Room         |         | <i>Oklahoma</i>  |
| Start        | Finish  |  |
| 1:30 PM      | 1:55 PM | NOW-R2 - Identifying Priority Education, Training and Outreach Needs (J. Holodak)                      |
| 2:00 PM      | 2:25 PM | NOW-R2 – Identifying Priority Research Questions for Onsite Wastewater Recycling Research (S. Heger)   |
| 2:30 PM      | 2:55 PM | NOW-R2 Identifying Priority Practice Needs on the Horizon for Onsite Wastewater Recycling (J. Stanley) |



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