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Environmental Sustainability in an Aging Society: A Research Agenda

Karl Pillemer, PhD[1], Nancy M. Wells, PhD[1], Linda P. Wagenet, PhD[1], Rhoda H. Meador, PhD[1], and Jennifer T. Parise, BA[1]

Abstract

Objectives. This article presents the results of a multidisciplinary consensus conference held to recommend a research agenda on the relationship between aging and environmental sustainability and conservation. The intersection of these two topics has important implications for the health and well-being of older persons but it has thus far received little scientific attention. **Methods.** The consensus conference was conducted with gerontological experts from various disciplines and environmental scientists. Using a structured methodology, participants achieved consensus on recommendations for a research agenda on aging and environmental sustainability. **Results.** Eight major recommendations for research are detailed in this article as well as cross-cutting research themes affecting all areas, including racial and economic diversity, geographical region, cohort, and intergenerational linkages. **Discussion.** Given the vulnerability of older persons to environmental threats detailed by the consensus conference,

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conferees recommended that research on these topics be urgently promoted, both by researchers and by funding agencies.

Keywords

environmental sustainability, aging population, health, climate change

Introduction

Environmental challenges are increasing as our society faces such problems as compromised water quality, air pollution, toxic waste, sprawl, energy shortages, and the negative consequences of climate change. However, scant attention has been paid thus far to the relationship between environmental sustainability and conservation and a second trend of critical importance in contemporary society: the dramatic growth in the older population. The number of people aged 65 and above is expected to double worldwide over the next two decades, and by 2040, more than 14% of the world's population will be age 65 or older, amounting to 1.3 billion older people (Kinsella & Velkoff, 2009). The ecological implications of this growth for the natural environment have only begun to be explored.

Our review of the literature uncovered only a few articles that have specifically examined the intersection of aging and environmental sustainability. To be sure, an extensive literature exists on "environmental gerontology," but this primarily refers to issues related to older adults' relation to the built environment, focusing on such issues as aging in place, design for dementia, and residential environments for older adults. In contrast, despite Wright and Lund's (2000) call a decade ago for gerontological research on issues such as sustainability, environmental stewardship, and ecological footprint, researchers have not yet taken on this topic in a substantial way. Furthermore, although attention to these concerns has begun on the part of the Environmental Protection Agency (Sykes, 2005), the limited research attention hampers policy and program development.

There are several reasons why studying the connections between environmental sustainability and aging is potentially of great importance. First, public health research suggests that environmental threats may disproportionately compromise the health of the older population. These risks are likely to increase as the effects of climate change are felt (Filiberto et al., 2010). The older population is at greater risk for adverse health effects from extreme temperatures, susceptibility to disease, stresses on the food and water supply, and reduced ability to mobilize quickly (Geller & Zenick, 2005; Haq, Whiteleg, & Kohler,

2008). Older people also have heightened vulnerability to environmental threats such as exposure to neurotoxins and air pollution (Cohn & MacPhail, 1996; Stein, Schettler, Rohrer, & Valenti, 2008). Studies of the health impacts of extreme heat waves show greater effects on older people (Bouchama, 2004; Diaz et al., 2002; Klinenberg, 2002; McGeehin & Mirabelli, 2001). In addition, extreme weather events place older people disproportionately at risk (Combs, Parrish, McNabb, & Davis, 1996; Fernandez, Byard, Lin, Benson, & Barbera, 2002; Hyer, Brown, Berman, & Polivka-West, 2006; Sherman & Shapiro, 2005).

Second, as the aging population grows, it may begin to play a larger role in contributing to environmental problems. To provide only a few examples, older people now use cars more frequently and are less likely to use mass transit than in the past (Rosenbloom, 2001). In addition, as people reach old age and relocate or restructure their lifestyles and housing, environmental implications arise with respect to living arrangements and changes in their levels of residential energy efficiency (Doteuchi, 2008). For example, the dramatic growth of independent and assisted living facilities can affect the environment, as such communities are sometimes built in areas that are environmentally sensitive (Wright, Caserta, & Lund, 2003). Another problem involves disposal of pharmaceuticals in the water supply, which has negative effects on aquatic life and possibly human health; evidence exists that older people, who use on average more medications than younger groups, contribute more heavily to this problem (Washington Citizens for Resource Conservation, 2006). Such issues suggest that programs to promote large-scale behavior change among older people may be effective in ameliorating environmental problems.

Third, older persons constitute an important source of solutions to environmental problems (Pillemer & Wagenet, 2008; Pillemer, Wagenet, Goldman, Bushway, & Meador, 2010). Environmental volunteerism creates opportunities for social integration in later life, offering meaningful civic engagement in productive activities while providing volunteer resources to promote environmental stewardship. Furthermore, preliminary research suggests that environmental volunteering may have particular health benefits for older persons in that it tends to involve physical activity and thus promotes health (Librett, Yore, Buchner, & Schmid, 2005; Pillemer, Fuller-Rowell, Reid, & Wells, 2010). The exposure to nature that characterizes environmental volunteering is likely to confer additional benefits (Takano, Nakamura, & Watanabe, 2002; Wells & Laquatra, 2010). On a societal level, due to their increasing numbers with the aging of the Baby Boom, the impact of the older population's collective behaviors could be enormous.

Despite this evidence for the potential importance of this issue, scientific attention to links between the older population and environmental sustainability, conservation, and energy use has been very limited. The paucity of firm findings makes organized, comprehensive policy and program development nearly impossible. Due to both the vulnerability of older people to environmental threats and the potential of the older population to be a major source of solutions, this is a critically important area of study. Given this set of circumstances, a vigorous program of transdisciplinary research should become a priority of the first rank for scientific investigators concerned with the quality of life of the older population, as well as for federal and private sources of funding for research.

A logical and important step is the development of a research agenda to guide empirical investigation over the coming years. To create such an agenda, we conducted a consensus conference to identify top priorities for the study of the intersection of aging and environmental sustainability. The purpose of this article is to present the consensus research priorities and to highlight specific questions that research should address. We briefly outline the consensus conference process and participants. We then detail the recommended research priorities and major research questions related to each priority. It is hoped that this consensus research agenda will be of assistance to future investigators as well as to funding agencies and organizations.

Method

The consensus conference process has been used by many scientific organizations and government agencies to achieve agreement on research priorities among scientists from a variety of disciplines (Black et al., 1999; Ferguson, 1993). Over several years, we have refined this process and used it to gain consensus among social scientists, medical researchers, and community stakeholders regarding a variety of issues relevant to older adults (Pillemer et al., in press; Sabir et al., 2006). The Aging and Environment Consensus Workshop process included three main phases.

Phase 1: Determine Key Focal Areas for the Research Agenda

The potential range of topics that might be studied under the rubric of "aging and environmental sustainability" is very large, ranging from clinical studies of health effects to large-scale behavior change interventions. For this reason, the first phase of the process was to convene an interdisciplinary working group of scientists at Cornell University to narrow the number of major thematic areas for the consensus workshop. A group of 23 researchers collaborated in

this phase of the project, representing the fields of sociology, psychology, natural resources, urban planning, design, climate science, biology, ornithology, economics, water quality, education, policy analysis, and management. Many of these participants had expertise in gerontology or geriatrics, but we deliberately included several environmental scientists who had not previously worked in the aging field but brought expertise on specific topics (e.g., climate change). Based on a series of meetings culminating in a day-long workshop, three core topics were determined as focal points for the research agenda: (a) the impact of climate change and other environmental risk factors on the health of older people, (b) civic engagement, volunteerism, and proenvironmental behaviors in later life, and (c) livable and green communities and housing alternatives for old people.

Phase 2: Preparation of Working Papers

Three interdisciplinary working groups were formed and each prepared a working paper on one of the three topics. The working papers reviewed relevant literature, identified gaps in the scientific base, and posed a set of high-priority questions for future investigation.[1] These papers were designed to provide a basic level of information on the specific topic (given that participants were purposefully selected from a variety of disciplines) as well as offering thoughts on promising research directions. All working papers were carefully reviewed by participants and served as the springboard for the deliberations of the consensus conference.

The working paper on "Climate Change, Vulnerability and Health Effects: Implications for the Older Population" reviewed the literature on the threat of climate change and examined how the resulting stressors to human habitability will be borne disproportionately by the most vulnerable human populations, including older people. It focused on several major themes, including a brief review of the scientific consensus on the impact of climate change on the environment, known environmental threats to the health of older persons, how the sequelae of climate change affect older people's health, and possible strategies to protect older people from environmental problems.

The working paper on "Environmental Volunteerism as a Form of Civic Engagement for Older Adults: Benefits, Motivations and Barriers" discussed research regarding how civic engagement and environmental volunteerism can be individually life-enriching to older adults, socially beneficial to the community, and improve environmental quality through citizen participation. The paper reviewed general trends in volunteerism in the United States, how environmental volunteerism benefits older adult participants,

how environmental organizations can benefit from older adult volunteer efforts, and research on motivations and barriers to such participation.

The third working paper, "Residential Environments for Older Americans and Their Sustainability" included a review of research relating to older adults' relationship to the local environment, including the potential environmental impact of aging in place, natural environments and green space, and energy efficiency and the built environment. The paper also examined the tension between age integration and age segregation, as well as issues of racial, cultural, and class equity and diversity.

Phase 3: The Consensus Conference

Phase 3 of the process was a 2-day consensus conference convened at Cornell University in July 2009. In addition to the original Cornell participants, 14 national experts on issues relevant to the topic of environment and aging were invited to provide an even greater range of expertise. This expanded group included representatives of major professional organizations (such as the Gerontological Society of America) and the Environmental Protection Agency, as well as experts in the fields of geriatric medicine, public health, architecture, psychology, and law. A list of participants, specialties, and affiliations appears in Table 1.

Facilitated discussions and small group sessions were conducted to generate key topics for a research agenda on aging and environment and recommendations were systematically recorded. A list of approximately 120 recommendations was refined and reduced through additional group discussion. In the final segment of the conference, participants voted on a set of highest priority areas for research. Based on the voting, some recommendations were eliminated because of lack of support or combined with other recommendations. Participants also generated specific questions that investigators in each area should pursue. All sessions were tape-recorded and transcribed, allowing us to provide narrative detail regarding the rationale for recommendations.

This consensus process yielded eight recommended topics for investigation. These topics were grouped into three major themes:

- Environmental threats to the health and well-being of older people,
- Proenvironmental behavior and volunteerism in later life, and
- Environmental impact of housing and living arrangements.

As shown in Table 2, four topics related generally to the area of health and well-being: health vulnerability, health care providers and community preparedness, risk communication, and resilience. Three topics fell in the area of

Table 1. Participants in Consensus Conference

Participant name	Specialty(ies)	Affiliation
Rosemary Bakker	Interior design, geriatrics	Weill Cornell Medical College
Don Bradley	Sociology, demography of aging	East Carolina University
Susanne Bruyere	Disability studies, policy	Cornell University
Janis Dickinson	Natural resources, animal behavior, citizen science	Laboratory of Ornithology, Natural Resources, Cornell University
Paula Dressel	Philanthropy, age-inclusive communities, racial equity	JustPartners, Inc.
Gary Evans	Environmental psychology, developmental psychology	Design and Environmental Analysis, Cornell University
David Feathers	Engineering, anthropology, rehabilitation technology	Design and Environmental Analysis, Cornell University
David Filiberto	Climate change, evaluation research	Bronfenbrenner Life Course Center, Cornell University
Ann Forsyth	Social factors in planning and design	City and Regional Planning, Cornell University
Esther Greenhouse	Aging in place, universal design	Design and Environmental Analysis, Cornell University
David Kay	Agricultural economics, land use, environmental conflict	Development Sociology, Cornell University
Lenard Kaye	Gerontological social work, safe drug disposal, aging policy	School of Social Work and Center on Aging, University of Maine
Nina Kohn	Elder law	College of Law, Syracuse University
Joseph Laquatra	Housing policy, energy use	Design and Environmental Analysis, Cornell University
Daniel Lichter	Sociology, demography, life course	Policy Analysis and Management, Cornell University
Robert MacPhail	Neurotoxicology, aging and environment	Neurotoxicology Division, National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency
Lorraine Maxwell	Environmental psychology, physical environment and behavior	Design and Environmental Analysis, Cornell University
Rhoda Meador	Adult education, gerontology	Bronfenbrenner Life Course Center, Cornell University

(continued)

Table 1. (continued)

Participant name	Specialty(ies)	Affiliation
Nora O'Brien-Suric	Philanthropy, aging	John A. Hartford Foundation
Greg O'Neill	Civic engagement and older Americans, policy	National Academy on an Aging Society
Pilar Parra	Sociology, nutritional sciences	CALS Nutritional Science, Cornell University
Karl Pillemer	Sociology, gerontology	Human Development, Cornell University
Cary Reid	Geriatric medicine	Division of Geriatrics, Weill Cornell Medical College
Barbara Reissman	Public health	Department of Public Health, Weill Cornell Medical College
Ted Schettler	Medicine, public health, environment and health	Science and Environmental Health Network
Rich Stedman	Natural resources, environmental sociology	Natural Resources, Cornell University
Kathy Sykes	Aging and the environment, public health, gerontology, policy	Environmental Protection Agency
Jennifer Sarah Tiffany	Community participation, health promotion, regional planning	Family Life Development Center, Cornell University
Pam Tolbert	Organizational sociology, life-course studies	Organizational Behavior, Cornell University
Linda Wagenet	Sociology, citizen participation and environment	Development Sociology, Cornell University
David Weinstein	Ecotoxicology and environmental chemistry, citizen science	Natural Resources, Cornell University
Nancy Wells	Environmental psychology, gerontology	Design and Environmental Analysis, Cornell University
Carol Werner	Environmental psychology, proenvironmental behavior	Department of Psychology, University of Utah
Elaine Wethington	Sociology, gerontology	Human Development and Sociology, Cornell University
Mark Wysocki	Climate science, air pollution, meteorology	Earth and Atmospheric Sciences, Cornell University

Table 2. Highest Priority Topics for Research on Aging and Environmental Sustainability

Health	Health vulnerability
	Health care and community preparedness
	Risk communication
	Resilience
Behavior	Environmental attitudes and behaviors
	Facilitate involvement
	Environmental footprint
Housing	Housing and settlement

proenvironment behavior and volunteerism: reducing the environmental footprint, environmental attitudes and behaviors, and facilitation of greater involvement of older people. The final topic relates to housing and living arrangements and includes a range of residential environment issues. It should be noted that consensus was achieved on these recommendations as having the highest priority for research and no dissenting opinions were registered.

In the remainder of this article, we elaborate on each of the eight research priority areas and provide examples of specific research questions in each area that are particularly important priorities for investigation. We conclude by presenting several cross-cutting themes that were highlighted by conference participants, which researchers should consider in studying any of these topics. Two caveats should be noted in this discussion. First, our goal is to detail the consensus recommendations of the conference and not to provide a literature review on each topic (which would be beyond the scope of this article). Second, we recognize that some topics were not recommended although they may appear important to the field. The consensus findings do not imply that other topics should not be researched but rather concluded that the issues summarized here are the most understudied and most urgent to address at present.

Recommendations From the Consensus Conference

Environmental Threats to the Health of Older People

Four topics for future research fell under the theme of health, namely, health vulnerability, health care and community preparedness, risk communication, and resilience, which are discussed in detail in the following section.

Health vulnerability: Improve understanding, assessment, and measurement of the vulnerability of older persons to environmental threats, including climate change. The consensus conference recognized the need to increase understanding, assessment, and measurement of the vulnerability of older persons to environmental threats, including climate change. Participants suggested that research take into account the fact that vulnerability will vary within the older population. Such variation is based on differences that include (a) region of the country and expected impact of climate change, (b) physiological response to given levels of environmental stressors, (c) probability of exposure based on individual behavior patterns, (d) social interaction patterns (e.g., greater isolation can lead to greater vulnerability), (e) probability of adequate adaptation and mitigation, and (f) probability of receiving timely and effective treatment. The disproportionate impact is therefore due to a combination of the geographical distribution of aging adults, community and institutional factors, social vulnerability, and their physiological susceptibility to climate change threats.

Participants recommended that research be conducted to specify the most geographically and socially vulnerable populations, as well as developing evidence-based methods for the identification and tracking of vulnerable older persons in communities. Research is needed on evacuation planning for frail older people. Specific research questions include the following:

Vulnerability—What constitutes "vulnerability" among older people specifically with regard to environmental hazards? How might vulnerability be quantified or analyzed (e.g., via a composite social vulnerability index)?

Differential effects—How are racial and ethnic minority older persons differentially exposed to environmental threats?

Strategies—How do adaptation to and mitigation of environmental threats operate differently for older people than younger people?

Health care and community preparedness: Develop and test ways of motivating and educating health care, social service, and other community agency providers to identify, prevent, and treat effects of climate change and other environmental problems. Participants recommended that both the engagement and the education of the medical community and other individuals who work with or care for older persons is of critical importance. A high priority should be given to developing and evaluating effective training of professionals in aging-related fields who will need to respond to environmental challenges that affect older persons. Involving older people in community preparedness will also be critically important. Specific research questions include the following:

Surveillance—What types of surveillance and monitoring systems work best for finding at-risk older persons in the event of an extreme weather event or similar situation? What is the role of professionals in monitoring and tracking effects of climate change? How can professionals be trained to respond to environmental hazards and their consequences?

Elder care—To what degree are staff in long-term care facilities—where the most vulnerable and immobile older persons reside—trained for risk evaluation and evacuation procedures? What kinds of training programs or curricula are needed to prepare elder care providers and their workers to deal with climate-change effects, as well as more broadly with issues of aging and environment?

Evacuation—How can information be provided to motivate people to evacuate or to understand the risks of relocating to particular areas? How should "accessible evacuation" be promoted? Furthermore, how might technology, such as geographic information systems or electronic medical records, assist in evacuations of older persons?

Risk communication. Studies should examine communication of environmental risk and promotion of behavior to reduce risk among older adults. Overall risk due to environmental problems is elevated for older persons in general and is likely to be even higher for certain subgroups of the older population. A key research task is to better understand such differences in risk. Furthermore, there was consensus that older people require better information regarding environmental threats (both those directly related to climate change, as well as more general health impacts). Research is needed on communication strategies around health risk. The specific research questions include the following:

Methods—What types of risk communication work best with older populations or subgroups of older people? What are effective methods of informing older people about possible risks? Similarly, what are the most effective methods of communication to professionals who work with older persons about environmental health risks?

Barriers—What do we know about resistance to disaster planning, evacuation efforts, and other attempts to reduce risk, given research evidence that some older people resist social services in general and assistance around potential disasters in particular? How might such barriers be overcome?

Solutions—How do we create evidence-based solutions for the dangerous outcomes of climate change (evacuation, health consequences, migration, and resettlement)?

Resilience. Research is needed to examine resilience in the face of environmental threats at individual, community, and societal levels. Resilience has been broadly defined as the capacity of a system to respond to external threats to its functioning. Despite a lack of consensus on the meaning of resilience and on measurable indicators of resilient systems, participants noted that research on resilience in various disciplines is growing rapidly. It was recommended that the resilience framework be applied to climate change and health, in tandem with the emphasis on understanding vulnerability of some older people. Specific research questions are as follows:

Indicators—What are the indicators of resilience that are most relevant to understanding the potential impacts of environmental stressors on older people?

Scale—How does resilience in the face of environmental problems vary by "scale"; that is, what are the conceptual and operational distinctions and similarities between resilient individuals, communities, and societies?

Community—What are communities doing now to generate solutions to address climate change–related vulnerability? Are there existing best practices for mitigation of risk and for promoting community and individual resilience in the face of environmental problems? How do we create evidence-based community and individual solutions for resilience and recovery from the dangerous outcomes of climate change?

Proenvironmental Behavior and Volunteerism in Later Life

Three research topics fell under the general theme of behavior, namely, environmental attitudes and behaviors, facilitating involvement, and reducing environmental footprint.

Environmental attitudes and behaviors: Investigate older adults' proenvironmental attitudes and behaviors (including behavior change). Participants noted that research is needed specific to later life that will increase understanding of the causes of proenvironmental attitudes and behaviors, with the goal of developing evidence-based interventions. Given the current size and anticipated future growth of the older population, a major priority should be to understand how

we can change behavior patterns of older people, both with the goal of lessening their contribution to climate change and reducing their risk of climate change–related health effects. Participants also suggested that research examine how environmental attitudes and behaviors vary over the life course. Specific research questions include the following:

Long-term consequences—What methods can be used to encourage individuals to consider long-term consequences of behaviors when they themselves may not see the benefit (i.e., short-term sacrifices to prevent climate change are not immediately reinforcing because of the long time frame to see any result)? What existing theories and bodies of research (e.g., from social psychology or behavioral economics) could be applied to encourage action now that may have results years or decades later?

Cohort versus age effects—Are there cohort or developmental differences that affect environmental attitudes and behaviors? That is, are the factors that predict such attitudes and behaviors different according to cohort values or life-course stage? If so, are programs that promote proenvironmental attitudes and behaviors among young people also effective with older people? Furthermore, what differences exist within cohorts of older people (e.g., young-old versus old-old)?

Motivation—To what extent is climate change and its effects a potential motivator for action by older people? Given the fact that the oldest-old are highly vulnerable, could increased awareness also spur concerned family members to civic engagement on the climate change issue? Do older and younger cohorts differ in terms of sensitivity to the needs of future generations?

Facilitating involvement. Studies are needed to identify factors that facilitate or deter becoming involved in environmental volunteerism or civic engagement in later life. It was recognized that increasing environmental volunteerism in the older population can be life-enhancing to the individual and beneficial to the community by potentially improving environmental quality. However, surveys show that this resource is largely untapped, with only a small percentage of older persons volunteering for environmental organizations and activities. Scientific evidence suggests that older people benefit by volunteering in a variety of domains, including physical, psychological, and social well-being. However, the benefits specific to environmental volunteerism for older adults have received very limited research

attention. A high priority is therefore to understand the causes and dynamics of later-life environmental engagement and barriers to such involvement. Specific research questions include the following:

Barriers—What are the barriers to environmental engagement among older people? What is the degree to which physical limitations more prevalent in the older population limit participation in environmental activities? How can barriers to environmental volunteerism or civic engagement be diminished in minority and low-income populations, who have been less likely to engage in such activities?

Strategies—How can programs transform environmental volunteerism into lasting proenvironmental behaviors? How can organizations structure environmental volunteer experiences to accommodate older persons with different levels of physical function and ability? What strategies can be used to encourage ethnic, cultural, and socioeconomic diversity in environmental volunteering?

Benefits—What are the measureable benefits to individuals, communities, and society from later life environmental engagement? Are there specific types of environmental volunteering that confer more health or well-being benefits to participants than others (e.g., is restoring a trail around a pristine lake more effective than working to clean up an urban brownfield)?

Reducing environmental footprint: Determine what incentives and mandates are effective in promoting healthy aging while minimizing older adults' environmental footprint. Participants recognized that the two goals of promoting optimal aging for individuals and doing what is best for the environment at times go hand in hand but may not always be compatible. They suggested that researchers identify and evaluate programs and policies that serve both goals. An important overarching issue research should address is how issues related to energy efficiency, carbon emissions, and water conservation factor into decisions older people make with respect to their housing options. Such information would inform the way in which policy makers develop incentives that would favor decisions to minimize energy use, water consumption, and carbon footprints. The specific research questions include the following:

Demand—What incentives or mandates are most effective in promoting housing that is situated in desirable, resource-rich settings and that simultaneously is environmentally sensitive? What factors influence

preferences or increased demand for environmentally friendly housing options?

Transportation footprint—What models and opportunities are there for reducing transportation-associated environmental impacts among the older population? What is the environmental impact of transportation patterns associated with current housing options (e.g., proximate to or distant from services and resources) and service options (e.g., transport for meals on wheels or home care), and how might this impact be mitigated?

Costs—What are the relative costs and benefits of various housing or environmental interventions? Under what circumstances will older people make decisions to spend money to improve their homes (either in terms of accessibility or energy efficiency)? What factors affect such decisions (e.g., expectations that they will not be in the dwelling for as long as a younger person; potential increase in home's value for energy-efficient home)?

Household ecological footprint—What policies, programs, and practices enable communities to dispose of pharmaceuticals and other toxic products in ways that do not contaminate fresh water supplies? How can we encourage older people to reduce their use of toxic home and garden products?

Environmental Impact of Housing and Living Arrangements

The final research topic dealt with housing issues.

Housing and settlement: Conduct interdisciplinary research (including design, demography, economics, and law among others) to examine the factors affecting older adults' housing and settlement practices as well as the environmental effects of those decisions. Participants noted that where and in what settings older people decide to live are likely to have a major impact on the environment. They agreed that research is needed on trends in migration patterns of older Americans to coastal and other ecologically sensitive areas. Studies could elucidate the implications such patterns have for planners and policy makers trying to anticipate the implications of climate change. Furthermore, participants recognized the importance of economic issues, calling for research on ways to insure that environmentally responsive housing is equally accessible to all older people. Participants recommended that aging in place be studied within an environmental context, to determine the optimal balance between older persons' desires and reducing their environmental footprint. Specific research questions include the following:

Motivation—What incentives (e.g., tax relief for home modifications) or disincentives (e.g. regulations and mandates) work to promote environmentally responsible housing choices? How do incentives or disincentives, such as those in the tax code, building code, and zoning laws, affect the construction of environmentally sensitive senior housing?

Impact—What is the differential environmental impact of various residential options for older persons, such as living alone, shared housing, assisted living, nursing home? How does urban/rural/exurban location affect the environmental footprint of different residential systems?

Aging in place—How does desire for aging in place change over time, based on age and physical and mental capacity? What might such changing attitudes mean for future generations of older Americans? What scientific knowledge is required by current policy makers plan for future trends in aging in place and migration? How do we create environmentally friendly supportive services for aging in place for individuals who desire to age in place (e.g., transportation networks)?

Migration—What has determined the migration patterns of current older people and will the next generation's choices differ? What is the impact of older people moving to environmentally sensitive regions inside and outside the United States?

Cross-Cutting Issues

As the preceding discussion of the eight research priorities makes clear, participants in the consensus workshop crafted a far-reaching and ambitious research agenda to address aging and environmental sustainability. In addition to these major recommendations, several themes emerged that cut across the eight recommended priority areas for investigation. In Table 2, we illustrate the area of aging and environment research in terms of the bidirectional relationships between older adults and the environment. The reciprocal direction of effects points to various important questions; for example: How do changes in the environment affect older adults' health? How do housing decisions affect environmental quality and contribute to climate change? And how do the environmental behaviors of older adults influence the local and global environment?

Equally important, the nature of relations between older adults and the environment will clearly differ depending on the specific characteristics of the target audience, the local context, or geographical region. The consensus

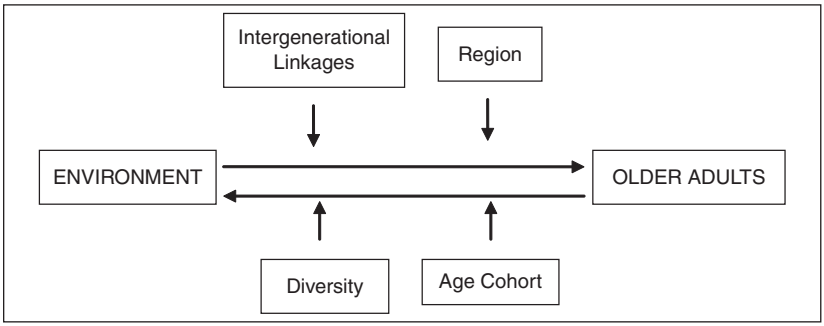

Figure 1. Cross-cutting themes for research agenda

conference participants identified four cross-cutting themes: *diversity*, *geographical region*, *age cohort*, and *intergenerational linkages*. These themes repeatedly emerged throughout the consensus conference and can be thought of as moderators or effect modifiers (Figure 1) that should be taken into account to understand the relationships between variables in a particular context. We will briefly elaborate on these four cross-cutting themes.

Diversity

Diversity and environmental justice themes such as racial and income disparities are relevant across the eight recommended topics. The research topics and questions may vary depending on racial, ethnic, or income group. What is relevant to a high-income White community is likely to be quite different from the environmental challenges and appropriate strategies for a low-income ethnic minority group. Concerns with diversity and justice are particularly critical with respect to health disparity and housing inequity. Issues include, How can sustainable housing be economically accessible to all older adults? and How can health disparities be taken into account in emergency preparedness?

Region

Geographical region is a second theme relevant across research areas. The impact of climate change will certainly vary in different parts of the United States and different regions of the world. In drier areas, fires, dust storms, and habitat loss are the most salient threats; whereas in other areas flooding, hurricanes, and tornados may be more likely. These weather events differ in terms

of the health risks they present and the appropriate preparedness strategies. Similarly, housing patterns and issues vary by region. What may be ecological or environmentally conscious in one area may not be in another area, depending on local or regional issues of habitat, water resources, transportation and other factors. Moreover, the relative impact of environmental behaviors could vary by region.

Cohort

Third, it is important to recognize the variability that exists across generational cohorts. Although it is common to refer to "older adults" as a homogeneous group, in reality older persons vary considerably by cohort. The World War II generation, for example, is likely to differ from the leading edge of the Baby Boom in terms of willingness to reduce consumption and in environmental attitudes. To most effectively develop strategies to encourage sustainable behaviors, to curb the health effects of climate change, or to address issues related to housing, the specific target audience must be considered in terms of both age and cohort.

Intergenerational Linkages

Another theme which was raised throughout the research topics is the need to link the generations, both conceptually and practically. The extent to which a policy, program, or empirical study is or is not intergenerational has important implications. In some cases, intergenerational strategies may help to leverage multiple participants or enhance the efficacy of an intervention; in other cases, involving a range of age groups may create a barrier. The degree to which solutions to environmental problems are intergenerational should be considered across the themes of health, housing, and behavior.

Conclusion

This consensus workshop was conducted to outline critical research priorities in the area of aging and the environment. Given that the field is in its infancy, a multidisciplinary group was convened to create a framework for future investigations and to generate research questions that can be fruitfully pursued over the coming years. Although no group of this kind can be entirely representative, a deliberate effort was made to involve a large range of disciplines. In addition, representatives of the policy and practice communities were included to bring a "real-world" context to the research recommendations.

The degree of consensus was remarkable, with unanimous agreement on the final set of priorities presented in this article.

In constructing the research agenda, one overarching theme was notable in every stage of the process: a sense of urgency. Regardless of discipline, participants were aware of research indicating that climate change is a major health issue, one that will affect older people equally or greater than other age groups (Costello et al., 2009). Gerontology and geriatrics, the participants believe, must play an integral part in developing evidence-based solutions to reduce the carbon footprint and to mitigate the effects of climate change. Research on this topic can contribute both to fundamental understanding of aging and health as well as to the development of effective solutions that may ameliorate environmental problems and their effects.

Note

1. The working papers are available online at www.citra.org

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