

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/294893158>

# Integrating New Perspectives to Address Global Soil Security: Ideas from Integral Ecology

Chapter · January 2016

DOI: 10.1007/978-3-319-43394-3\_28

CITATIONS

6

READS

252

7 authors, including:



**Sabine Grunwald**  
University of Florida

189 PUBLICATIONS 5,831 CITATIONS

[SEE PROFILE](#)



**Christopher Clingensmith**  
University of Florida

7 PUBLICATIONS 76 CITATIONS

[SEE PROFILE](#)



**Katsutoshi Mizuta**  
University of Florida

7 PUBLICATIONS 40 CITATIONS

[SEE PROFILE](#)



**Renita Kay Wilcox**  
University of Florida

3 PUBLICATIONS 36 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Use of MIR and VNIR Diffuse Reflectance Spectroscopy for Soil Carbon Quantification in Subtropical Soils [View project](#)



Pedomorfologia e espectroscopia de solos para detalhamento de atributos e classes de solos da região Centro Oeste do Brasil. [View project](#)

## Chapter 28

# Integrating New Perspectives to Address Global Soil Security: Ideas from Integral Ecology

Sabine Grunwald, Christopher M. Clingensmith, Carla P. Gavilan, Katsutoshi Mizuta, R. Kay Kastner Wilcox, Érika F.M. Pinheiro, Marcos B. Ceddia, and C. Wade Ross

**Abstract** Global soil security is complex, encompassing technical, socioeconomic, and political issues and people's beliefs and values. Our thesis is that global soil security and the soil health crisis we face today are due to a lack of awareness and understanding of prominent values and benefits soils provide to sustain humanity. In this paper, we use the integral lens to explore global soil security. The integral ecology model uses four interconnected perspectives (the individual-interior, collective-interior, individual-exterior, and collective-exterior) to study wicked environmental issues. We assert that cognizance is the key integrator to bring forth awareness, knowledge, and understanding within and across the four equally important perspectives. It has profound significance for global soil security because it reveals the underlying causes that jeopardize the security of soils and identifies chasms that constrain the sustainability of soil ecosystems. Cognizance is the (i) awareness and perceptions held by individuals and people (interior perspectives), (ii) the facts, knowledge, and understanding of external phenomena (exterior perspectives), and (iii) their interactive effects (i.e., integration across all four perspectives of the integral map). Importantly, cognizance is preceding any other dimension of soil security (connection, codification, capital, condition, and capability). Reductionist approaches that are one-sided (e.g., "soil science will fix the global soil security crisis") ignore people's beliefs and values and are non-cognizant of interconnected perspectives are doomed for failure. Ecological awareness is composed of exterior "scientist/observer/3rd person" qualities and interior "people/subjective" qualities. To achieve global soil security, it is necessary to grow ecological awareness evoking to value, care for, and secure the natural world including soils. Recognizing the

---

S. Grunwald (✉) • C.M. Clingensmith • C.P. Gavilan • K. Mizuta • R.K.K. Wilcox • C.W. Ross  
Soil and Water Sciences Department, University of Florida, Gainesville, FL, USA  
e-mail: [sabgru@ufl.edu](mailto:sabgru@ufl.edu)

É. F.M. Pinheiro • M.B. Ceddia  
Soil Department, Institute of Agronomy, Universidade Federal Rural do Rio de Janeiro (UFRRJ), Seropédica, RJ, Brazil

significance of global soil security is closely linked to moral values and ethical beliefs people hold relative to soils. These beliefs provide the motivation and appropriate actions needed within cultural, social, environmental, and institutional contexts to secure soils.

**Keywords** Integration • Cognizance • Awareness • Connectivity • Global soil security • Integral ecology

## 28.1 Significance and Rationale

Globally, soils are at risk to degradation from improper management, erosion, salinization, and desertification, as well as domestication (Amundson et al. 2015). Soil degradation has been recognized as a global existential risk to humanity, and policy for ecological and human sustainable development has not kept pace with rapid growth and development (Koch et al. 2013). Sustainable development has become a universal concern, but the complexity, wickedness, and scale of problems call for new approaches that can overcome specialized, disciplinary thinking that has been prevalent in the soil science community (Bouma and McBratney 2013). Due to the wickedness of complex environmental problems, ecology has brought forth various new integrative frameworks. For example, human ecology bridges the gap between natural and social sciences and studies human-environmental interactions from a “whole-system” perspective (Marten 2008). Likewise, integral ecology aims to integrate human and natural domains with a holistic perspective (Esbjörn-Hargens and Zimmerman 2009). These emerging approaches in ecology have not been recognized in the global soil science community. Yet, they provide transformative potential to synthesize across geographic, environmental, and human domain boundaries.

Lines-Kelly (2004) argues that inherently all humans have a cultural, sensual, and spiritual attachment to soil, but an urbanizing Western society has lost this connection to soils due to a focus on material wealth. This has led to a disconnection from the land and a scientific culture that has fractured soil and its meaning for non-soil scientists. Globally, 54 % of the population lives in urban areas and is expected to increase to 66 % by 2050 (United Nations 2014), and in the United States, out of 249.3 million people, about 80.7 % of the population lives in urban areas and only 19.3 % in rural areas (U.S. Census Bureau 2010). These trends are raising concerns about our ability to secure soils that provide multiple services and benefits to humanity, such as food production, biodiversity and bioenergy, among many others. Most recent frameworks that have been proposed to address global soil security are segregated among dimensions (condition, capability, codification, connectivity, and capital) (McBratney et al. 2014) and are eminently agro-centric. These approaches are still in their infancy to interlink dimensions and inherently lack formalized

integration pathways that would bring forth inter- and transdisciplinary approaches to solve the wicked global soil security problem.

Our thesis is that global soil security and the soil health crisis we face today are fundamentally due to a lack of awareness and understanding of prominent values and benefits soils provide to sustain humanity. This has caused threats to the sustainability and resilience of soils to withstand land use, climate, social, cultural, and technological changes that have been accelerating at rapid speed over the past decades. We posit that the core issue of environmental and soil security is due to compartmentalized approaches that are limiting integration. We postulate that cognizance is the key to integrate interactions between (i) our awareness and perceptions that define values and beliefs of people about soils and the natural world in general and (ii) facts, knowledge, and understanding of soils embedded in complex interacting social, economic, cultural, and political ecosystems.

## 28.2 Objectives

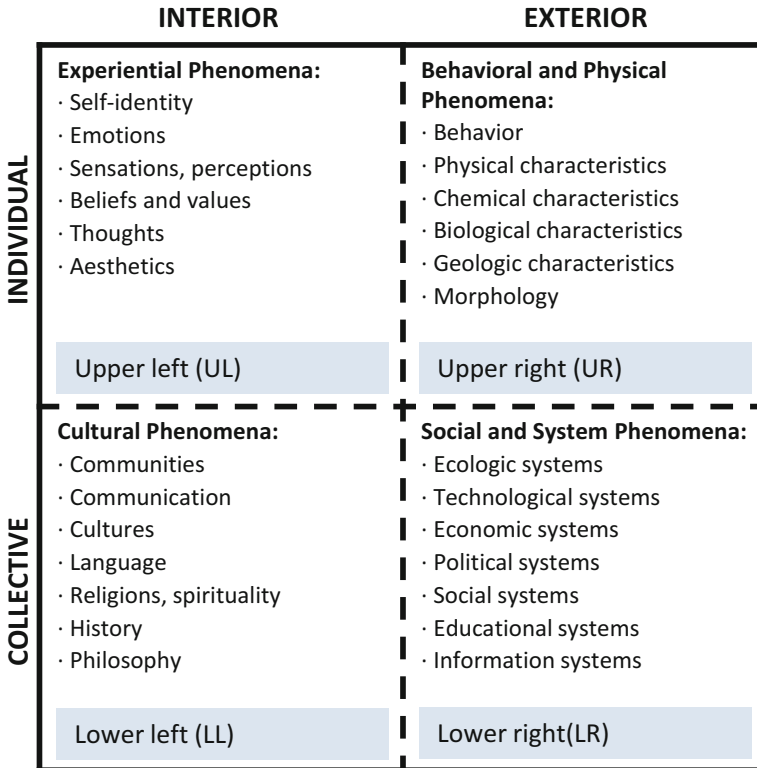
Our aim is to probe into the possible causes that have limited contemporary security of soils at global scale. Our specific objectives are to:

1. Expand the soil security concept to better address integration of the personal, interpersonal, and socioeconomic-political aspects of soil/soil ecosystems through the use of integral theory
2. Explore the critical role of cognizance for global soil security

## 28.3 Approach

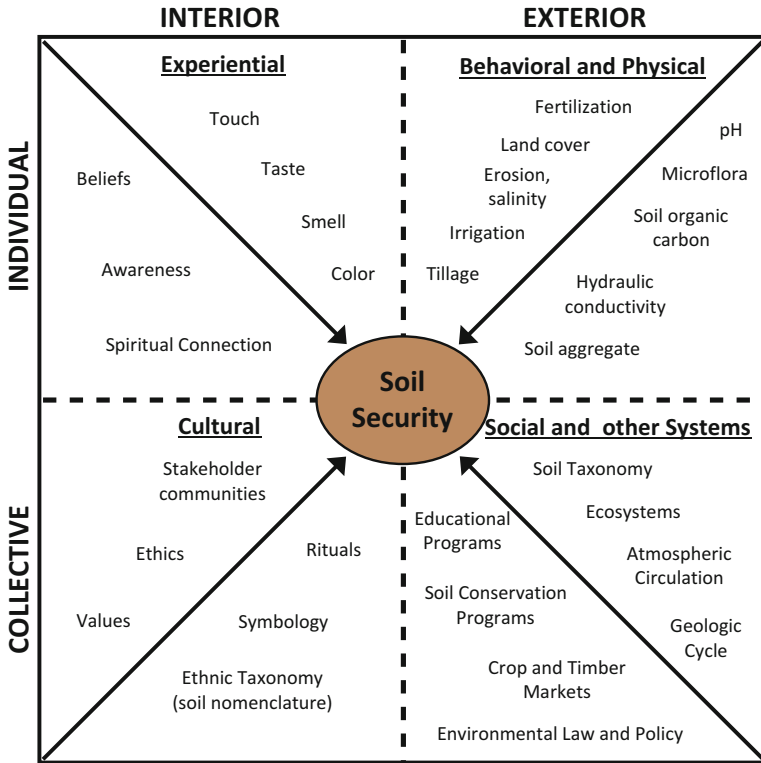
### 28.3.1 *Integral Ecology and Soil Security*

We build on the ideas put forth in integral ecology to address the human and environmental aspects of soil security. Integral ecology was developed out of the realization that environmental issues are not only scientific issues but are also human issues that need to be viewed from multiple perspectives to provide adequate solutions (Esbjörn-Hagens and Zimmerman 2009). Here, we utilize the integral theory framework that integrates four perspectives (quadrants): the individual-interior (upper left, UL), the collective-interior (lower left, LL), the individual-exterior (upper right, UR), and the collective-exterior (lower right, LR) (Fig. 28.1; Wilber 2000a). Integral theory facilitates to see beyond disciplinary boundaries, e.g., soil scientists just talking to other soil scientists. Its assets go beyond technical/scientific solutions because it explicitly incorporates cultural, social, regulatory, political, economic, and ecological realms. Therefore, integral ecology is poised to provide a solution-oriented approach to overcome the global soil security crisis.



**Fig. 28.1** The four perspectives (quadrants) of the integral framework with associated phenomena (After Esbjörn-Hargens and Zimmerman 2009; Wilber 2000a)

According to Esbjörn-Hargens and Zimmerman (2009), the interior space, on the left side of Fig. 28.1, is filled with subjective and intersubjective phenomena, such as selfhood, culture, and morality, which are understood by subjective methods. The UL quadrant is the individual-interior perspective, which can also be thought of as the first-person singular perspective. It represents experiential phenomena related to consciousness, experience, and aesthetics. Garcia (2014) put it bluntly: “Most people are soil blind. They walk on soil, they gaze at it on the horizon, they gain pleasure and sustenance from its bounty, but soil itself goes unseen, unappreciated. Modern life conspires to remove us from any connection to or awareness of soil.” The individual-interior perspective can be investigated through introspection and the use of personal accounts, including letters/emails, journals, testimony, and self-reports. Applied to soil security (Fig. 28.2), the individual-interior perspective reveals individual’s awareness (sense), perceptions, and experiences related to soils from key individuals in a region facing a soil security problem (e.g., a farmer, urban dweller, scientist, politician, and housewife). Ideally, the perspectives from individuals with different roles, societal function, cultural background, and persona (character traits) are considered. The level of awareness about the importance of



**Fig. 28.2** Examples for the four perspectives (quadrants) of the integral model applied to soil security

soils to sustain their families, regional community, and humanity at global scale differs widely. For example, the awareness related to securing soils of an individual in an indigenous community in Peru, in a metropolitan area, or in a farm community is likely to vary depending on their living conditions, cultural setting, and personal family experiences (Postigo 2014). These determine the individual’s proximity to soils and the goods, services, and benefits derived from them.

The LL quadrant is the collective-interior perspective, which is akin to the first-person plural perspective, and it represents cultural phenomena related to communication, values, beliefs, ethics, and motivations (Esbjörn-Hargens and Zimmerman 2009; Wilber 2000a). In this “We” perspective, people exchange and share their intersubjective perceptions and thoughts, like being in a “circle of friends” with mutual shared beliefs and understanding (e.g., “we care about this neighborhood or this farmland”). This perspective is resembled by groups and communities, cooperating stakeholders or people that share common interest (e.g., Facebook soil security site). The LL perspective can be investigated through hermeneutics and ethno-anthropologic methods to determine different cultural perspectives including nature, beauty, justice, and fairness (Esbjörn-Hargens and Zimmerman 2009).

Although some research in the field of ethnopedology has examined the individual and cultural values in relationship to the local environment to some degree, these studies have mainly focused on small indigenous or rural communities (Barrera-Bassols and Zinck 2003).

Together, these two left-hand quadrants provide an understanding of how people and communities relate to the environment and how environmental issues affect them. These quadrants disclose moral values and environmental ethical viewpoints that may range from respect for nature (“sacredness”), appreciation of natural beauty, deep connection with nature (e.g., deep ecology), ecofeminism, stewardship, holistic human ecology, indifference about the natural world, dominance of earth, and dissociation from nature (Marten 2008; Schmitz and Willott 2012; Sessions 1995). Importantly, depending on these individual and cultural flavored values, different views emerge; e.g., soils (i) and the soul touch-evoking sacredness (Patzel 2010) (ii) are perceived as aesthetically sublime (Toland and Wessolek 2010), (iii) specifically farmland soils need to be protected on moral ground to sustain humanity (Fouke 2011), or (iv) are a major wild card in the global carbon cycle (Petit 2012). These ethical views matter, in fact determine, if people are motivated to care and secure soil or not. Values, beliefs, and ethics related to soil, as a common global good, land and nature are profoundly relevant to soil security because they reveal peoples’ attitude toward soil health, how soils are used, degradation, protection, and ultimately soil security. The ethical underpinnings toward soil are directly related to the willingness to pay for soil ecosystem services, care about the protection of soils from threats, and motivation to preserve soil resources at global scale (Schmitz and Willott 2012). Kidd (1992) posits that the attitudes that people hold toward economic growth, sustainability, and humanity determine their motivation to secure common goods, such as soils. In the interior-collective perspective, the awareness of groups and communities toward soils plays a pivotal role in securing them. Hillman (2004) pointed out ten excuses for inaction of people to address the global climate change phenomena, including denial, indifference, dissociation, blame, individualism, and projection onto others. Likewise, demotivation and inaction of people and institutions to secure soils play a crucial role to be explored in the future.

The UR quadrant is the individual-exterior perspective, or the third-person singular perspective, and represents behavioral and physical phenomena known by measurement and empiricism (Fig. 28.1). This perspective examines the characteristics and behaviors of individual objects that form the basis of reductionist fields of science such as chemistry, biology, mineralogy, physics, pedology, and psychology. Here, the exteriors (e.g., a pedon) are seen through a third-person perspective (e.g., a soil chemist investigating decomposition mediated by microbes or site-specific land use management).

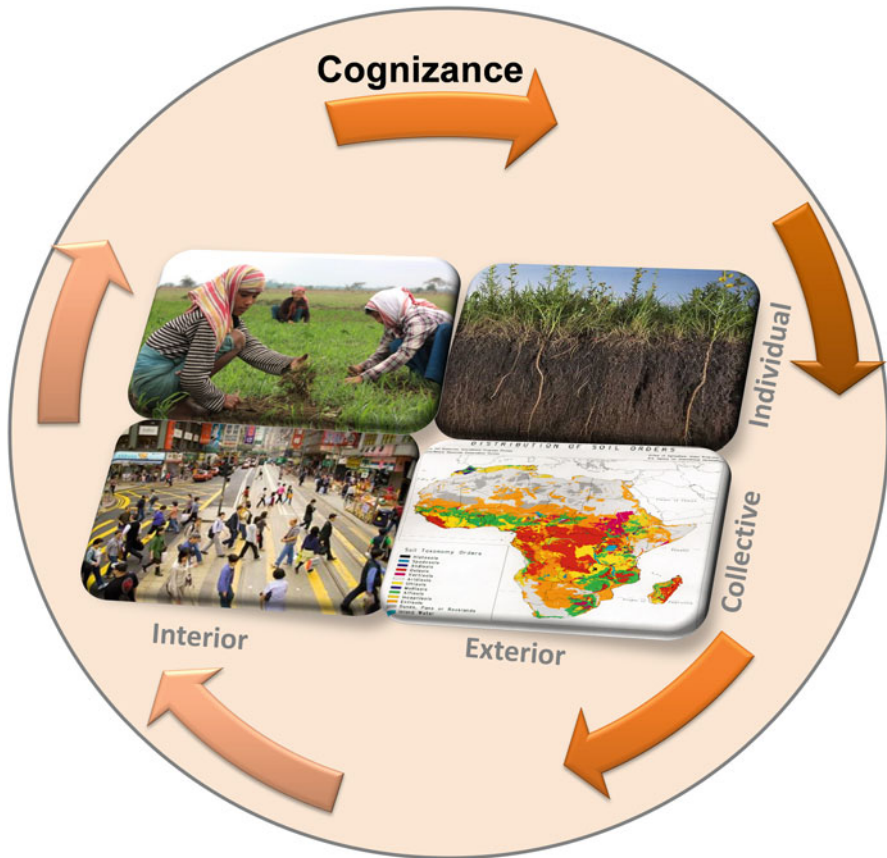
The LR quadrant is the collective-exterior perspective or the third-person plural perspective. It represents social and system phenomena, such as economics, politics, climate, education, and ecology and is known by modeling and systems analysis (Esbjörn-Hargens and Zimmerman 2009). In both right-hand quadrants, the cognizance from a third-person (e.g., scientist, investigator, and observer)

perspective, which objectifies soils and soil ecosystems, is relevant to infer on soil security. Facts about soils, soil science textbook knowledge, research findings related to soil ecosystems, and their transformation as measured, monitored, mapped, modeled, and simulated fall into this realm. Currently, this is the most prominent perspective voiced by soil scientists around the world. In their totality, the exterior perspectives provide a comprehensive characterization and analysis of the environment within which an issue arises. In summary, the integral framework is multi-perspectival and, thus, provides different interconnected viewpoints to capture the many perspectives needed to fully understand, maintain, and enhance soil security.

### 28.3.2 *Cognizance and Soil Security*

The premise of integral ecology and integral theory is that the less perspectives are included in an analysis the more partial our knowledge and understanding (Esbjörn-Hargens and Zimmerman 2009; Wilber 2000a). In fact, they both strive for non-exclusion suggesting that the totality of an issue, such as global soil security, can only be disclosed by including all four perspectives that are interconnected. This is inherently so, because even with “better” available knowledge about soils (e.g., an accurate, fine resolution global soil map, a comprehensive global soil database, or the most precise chemical measurement of a soil aggregate – all LR and UR exterior perspectives), it is unlikely that we could reveal or change people’s values and beliefs about soils. This change in perspective and realization of understanding the global and local threats to soils and their effect on humanity and local communities is rooted in the individual and collective domains of cognizance (UL and LL interior perspectives). Similarly, subjectively perceiving soils from a phenomenological point of view (e.g., taking a striking walk in a national park with beautiful soil landscape) or talking about soils (e.g., in a group of soil enthusiasts) would not bring forth objective measurable facts about soils and soil ecosystems (UR and LR exterior perspectives). Cognizance within the right-hand quadrants is a crucial necessity to disclose knowledge and realize understanding (e.g., soil erosion monitoring, soil health mapping at regional scale, and impact of global climate change on soil carbon sequestration). Generally speaking, cognizance *within* and *across* the four quadrants serves as the key integrator where each perspective is revealed through specific methodologies (approaches) to address a complex problem, such as soil security (Fig. 28.3). We define cognizance as the (i) awareness and perceptions held by individuals and people (UL and LL), (ii) the facts, knowledge, and understanding of external phenomena (UR and LR), and (iii) their interactive effects (i.e., integration across all four quadrants). We assert that cognizance has profound significance for global soil security because it reveals the underlying causes that jeopardize the security of soils and reveals chasms that constrain the sustainability of soil ecosystems. For example, at the moment, there is no legally binding global entity that has power to impose protective regulations onto soils at the national level, even if soils





**Fig. 28.3** Cognizance serves as an integrator within and across the four quadrants of the integral map: individual-interior, collective-interior, individual-exterior, and collective-exterior perspectives

in a region are not managed in sustainable manner and thus, face severe degradation. Other dichotomies may be cogently revealed among people's valuation of soils that stand in sharp opposition to the actual condition of soils by looking through an integral lens.

Bouma and McBratney (2013) argued for participatory approaches to achieve soil security where knowledge brokers connect stakeholders and policy makers facilitating joined value development. We like to emphasize that cognizance precedes the connection and codification dimensions and not the other way round. Individuals and groups may communicate, participate, and connect but may not be cognizant of an underlying issue constraining soil security. In short, there is no true connection and codification without cognizance. Bluntly speaking, politicians, entrepreneurs, land managers, or others may be completely unaware of their nonactions to secure soils although they may participate in a discussion/meeting about

soils. Kahan (2010) pointed to a critical compounding issue related to cultural cognition where people tend to reject scientific information that is not in line with their cultural and moral views. Means to inform the public without threatening their values include presenting information in a manner that affirms their values and having information vouched for by a diverse set of experts that represent multiple perspectives. Understanding how people become aware of environmental issues and why they may reject new information and proposed policy changes is critical to future actions on soil security.

Cognizance is about awareness and congruence that keeps the balance among perspectives as shown in “integral soil security” (Grunwald et al. 2016). This suggests that if one perspective is predominant and overpowers the others, security of soils is threatened. For instance, contemporary soil science research from a chemical, physical, and biogeochemical perspective predominates the global soil science community. Although there are different divisions in the International Union of Soil Science (IUSS), with Div. 1 “Soil in Space and Time,” Div. 2 “Soil Properties and Processes,” Div. 3 “Soil Use and Management,” and Div. 4 “The Role of Soils in Sustaining Society and the Environment” that superficially seem to reflect the four perspectives of the integral model, it is abundantly clear that all of these topics, among them soil-human, soil-sociological, soil-economic, and others, are looked at mainly from a third-person “scientist/observer” exterior (UR and LR) perspective.

Siegel (2012), a world renowned neurobiologist, defines awareness (synonymously with consciousness) as “the fundamental aspect of mental experience with which we have the subjective sense of knowing or being conscious of something.” He suggests that awareness is a process that involves at least three aspects: a subjective felt sense, a knowing, and a known (object). When we share something in awareness with another person, it changes the nature of that experience (e.g., a student-teacher shared experience studying soils). This awareness may include many giving rise to “cultural awareness” or a “collective consciousness.” According to Siegel (2012), awareness is empowering in that it allows a person to have choice, juxtaposes things, and moves us toward integration. Damasio (2000) describes consciousness as the part of mind concerned with the apparent sense of self and knowing (about the world). Both, Siegel and Damasio, stress awareness from interior-individual and collective perspectives, while Greco (2010) describes knowing and understanding from an epistemic perspective (UR and LR). He bases the acquisition of knowledge in epistemic normativity that is different from mere beliefs of people. Importantly, he perceives knowledge as distinctly different from understanding, whereby the latter requires grasping of explanatory and other coherence-making relationships in a large and comprehensive body of information (Greco 2010). This suggests that meaning arises along the trajectory of data, facts, knowledge, understanding (“meaning making”), and clarity/wisdom – all exterior qualities (right-hand quadrants). Wilber (2000b) brings it all together; he points out that consciousness is situated and coevolves in all four quadrants of the integral model. He asserts that human’s self (UL), individual organisms/behavior (UR), culture (LL), and social/environments (LR) cause and are caused by one another; they tetra-evolve. Wilber (2000b) poignantly stresses that if we reduce knowledge gained

from an observer/scientist perspective, we lose all values, meaning, and depth falling flat into subtle reductionism. Integral awareness of developmental dynamics and the capacity to take multiple perspectives are crucial elements in achieving behavioral changes and altering our current treatment of the bio- and physiosphere (Esbjörn-Hargens and Zimmerman 2009). Integral ecology stresses that awareness in and across all four perspectives is critical, including exploration of developmental psychology, and its relationship to the self (subjectivity, UL), culture (intersubjectivity, LL), individual organisms, behavior, physical aspects (objectivity, UR), and the systems members is embedded in (interobjectivity, LR). According to Esbjörn-Hargens and Zimmerman (2009), ecological awareness is composed of “knowledge by description” (UR and LR) and “knowledge by acquaintance” (UL and LL) involving transformation (growth) into wider identities where people and communities evolve to higher eco-selves that at higher levels are able to map the complexity of relationships within and between ecosystems and integrate multiple perspectives that evoke to value, care for, and secure the natural world including soils.

## 28.4 Final Remarks

We ascertain a wide variety of perspectives is needed to solve a problem as complex as global soil security. We demonstrated that cognizance is the key integrator to bring forth awareness, knowledge, and understanding within and across the four equally important perspectives of integral theory to address the complexity of global soil security. Recognizing the significance of global soil security is closely linked to moral values and ethical beliefs people hold relative to soils. These culturally flavored beliefs provide the motivation and appropriate actions needed within cultural, social, environmental, and institutional contexts to secure soils. Raising cognizance and forming partnerships are crucial to build a global community that finds deeper meaning in securing soils that go beyond ivory towers in Australia, the United States, and Europe. Such segregation could be construed as environmental imperialism, which would be detrimental to globally securing soils.

## References

- Amundson R, Berhe AA, Hopmans JW, Olson C, Sztein AE, Sparks DL (2015) Soil and human security in the 21st century. *Science* 348:261071–1–1261071–6
- Barrera-Bassols N, Zinck JA (2003) Ethnopedology: a worldwide view on the soil knowledge of local people. *Geoderma* 111:171–195
- Bouma J, McBratney A (2013) Framing soils as an actor when dealing with wicked environmental problems. *Geoderma* 200–201:130–139
- Damasio A (2000) *The feeling of what happens: body and emotion in the making of consciousness*. Mariner Books, New York

- Esbjörn-Hargens S, Zimmerman ME (2009) *Integral ecology: uniting multiple perspectives on the natural world*. Integral Books Publ, Boston
- Fouke (2011) Humans and the soil. *Environ Ethics* 33:147–161
- Garcia DK (2014) Seeing soil. In: Churchman GJ, Landa ER (eds) *The soil underfoot – infinite possibilities for a finite resource*. CRC Press, New York, pp 75–82
- Greco J (2010) *Achieving knowledge – a virtue-theoretic account of epistemic normativity*. Cambridge University Press, Cambridge
- Grunwald S, Mizuta K, Ceddia MB, Pinheiro EFM, Kastner-Wilcox RK, Gavilan CP, Ross CW, Clingensmith CM (2016) Chapter 10: The meta soil model: an integrative multi-model framework for soil security. In: Field DJ, Morgan C, McBratney AB (eds) *Global soil security*. Springer, New York (*in review*)
- Hillman M (2004) *How we can save the planet*. Penguin, London
- Kahan D (2010) Fixing the communications failure. *Nature* 463:296–297
- Kidd CV (1992) The evolution of sustainability. *J Agric Environ Ethics* 5:1–26
- Koch A, McBratney A, Adams M, Field D, Hill R, Crawford J, Minasny B, Lal R, Abbott L, O'Donnell A, Angers D, Baldock J, Barbier E, Binkley D, Parton W, Wall DH, Bird M, Bouma J, Chenu C, Flora CB, Goulding K, Grunwald S, Hempel J, Jastrow J, Lehmann J, Lorenz K, Morgan CL, Rice CW, Whitehead D, Young I, Zimmermann M (2013) Soil security: solving the global soil crisis. *Glob Policy* 4:434–441
- Lines-Kelly R (2004) Soil: our common ground – a humanities perspective. *SuperSoil 2004: 3rd Australian New Zealand Soils Conference*, 1–15
- Marten GG (2008) *Human ecology – basic concepts for sustainable development*. Earthscan Publ, New York
- McBratney A, Field DJ, Koch A (2014) The dimensions of soil security. *Geoderma* 213:203–213
- Patzel N (2010) Part III section 13: the soil scientist's hidden beloved: archetypal images and emotions in the scientist's relationship with soil. In: Landa ER, Feller C (eds) *Soil and culture*. Springer, New York, pp 205–226
- Petit C (2012) Soil's hidden secrets: shocking discoveries from the underground may shake up climate science. *Sci News* 181:16–20
- Postigo JC (2014) Perception and resilience of Andean populations facing climate change. *J Ethnobiol* 34:383–400
- Schmidt D, Willott E (2012) *Environmental ethics – what really matters, what really works*. Oxford University Press, New York
- Sessions G (1995) *Deep ecology for the 21st century – readings on the philosophy and practice of the new environmentalism*. Shambhala Publ, Boston
- Siegel DJ (2012) *Pocket guide to interpersonal neurobiology – an integrative handbook of the mind*. W.W. Norton & Company, New York
- Toland A, Wessolek G (2010) Part III section 15: core samples of the sublime – on the aesthetics of dirt. In: Landa ER, Feller C (eds) *Soil and culture*. Springer Publ, New York, pp 239–260
- United Nations (2014) *World's population increasingly urban with more than half living in urban areas*. United Nations. <http://www.un.org/en/development/desa/news/population/worldurbanization-prospects-2014.html>
- U.S. Census Bureau (2010) *U.S. census population data in 2010*. United States Census Bureau. <http://www.census.gov/2010census/>
- Wilber K (2000a) *Sex, ecology, spirituality – the spirit of evolution*. Shambhala Publ, Boston
- Wilber K (2000b) *Integral psychology – consciousness, spirit, psychology, therapy*. Shambhala Publ, Boston