

---

# HUMAN ECOLOGY REVIEW

---

Volume 21, Number 2, 2015

---

## RESEARCH AND THEORY IN HUMAN ECOLOGY

---

- Two Kinds of Economy, Two Kinds of Self—Toward More Manageable, Hence More Sustainable and Just Supply Chains 3  
Carleton B. Christensen
- Nutrient Balances and Management of Soil Fertility Prior to the Arrival of Chemical Fertilizers in Andalusia, Southern Spain 23  
Manuel González de Molina, Roberto García-Ruiz, David Soto Fernández, Gloria Guzmán Casado, Antonio Cid, and Juan Infante Amate
- Climate Change and Society: Toward Online Pedagogy 49  
Jennifer Kelly, Aaron McCright, and Thomas Dietz
- An Examination of Behavior Change Theories to Predict Behavioral Intentions of Organisms-in-Trade Hobbyists 65  
Jessica Mayer, Erin Seekamp, Jonathan Casper and Gary Blank
- Who Is For or Against the Park? Factors Influencing the Public's Perception of a Regional Park: A Slovenian Case Study 93  
Mojca Nastran and Majda Čerňič Istenič
- Are There Relationships Among Racial Segregation, Economic Isolation, and Proximity to Green Space? 113  
Salvatore Saporito and Daniel Casey
- Current Cultures in Threatening, Comforting, and Challenging Ecologies 133  
Evert Van de Vliert

---

## BOOK REVIEWS

---

- Ecologia Humana Uma Visao Global 157  
By Ronaldo Gomes Alvim, Ajibola Isa Badiru, and Juracy Marques  
Reviewed by Karl Bruckmeier and Luc Hens
- Structural Human Ecology: New Essays in Risk, Energy, and Sustainability 161  
Edited by Thomas Dietz and Andrew Jorgenson  
Reviewed by Erik L. Bond

Understanding Human Ecology: A Systems Approach to Sustainability	167
By Robert Dyball and Barry Newell	
Reviewed by Liesel Carlsson	
 The Garden of God: Toward a Human Ecology	 171
By Benedict XVI (Maria Morciano, ed.)	
Reviewed by Robin van Tine	
<hr/> Contributors to This Issue	<hr/> 179

---

# **Research and Theory in Human Ecology**

---



# Two Kinds of Economy, Two Kinds of Self—Toward More Manageable, Hence More Sustainable and Just Supply Chains

Carleton B. Christensen<sup>1</sup>

School of Philosophy, College of Arts & Social Sciences  
The Australian National University, Canberra, Australia

## Abstract

Contemporary systems of production, distribution, and retail provide many end-consumers, although certainly not all, with an unprecedentedly wide choice of cheap, high quality goods and services. Yet this bounty comes at ever higher, ultimately unsustainable environmental and social cost. Something must change but what and how? Simply how production, distribution and retail are organized? Simply patterns of consumption, that is, *overconsumption* on the part of some, who must be convinced to consume less? Or must the target be production, distribution, retail, and consumption *in their totality*, that is, economic life as a whole? This paper sketches a basis and general framework for answering these questions.

## Introduction: The new economic order

As Conca 2002 points out, the contemporary economic order, which offers at least some an unprecedented combination of choice, quality, and price, is only very superficially characterized in terms of ‘globalization’—as if its bounty were simply the result of massively increased cross-border transactions. Whether in pursuit of competitive advantage or merely in response to competition, enterprises have used both technological innovation and political clout to create a web of supply chains characterized by what Princen (2005) has described as a logic of efficiency. This logic is an ongoing dynamic of *rationalization* in Weber’s sense which selects for processes and procedures of greater efficiency, that is,

---

<sup>1</sup> Author contact: carleton.christensen@anu.edu.au.

processes and procedures for which the ratio of outputs to inputs is higher. As a result, the truly distinguishing feature of the new economic order has emerged: very long chains of production, distribution, and retail, often indeed spanning the globe, along which goods and services flow with increasing rapidity and with an unparalleled capacity for the rapid re-routing of these flows.

Crucially, what counts as greater efficiency at any node along a supply chain is ultimately determined by what counts as efficiency at the final node prior to consumption in the literal sense of use, namely, consumption in the economist's sense of sale. Efficiency at the retail end consists in being able to offer what the end-consumer will regard as the best possible mix of choice, price, and quality. Consequently, competition will combine with technology and politics to yield a system of production, distribution, and retail given over to optimizing for efficiency in this sense, that is, for choice, price, and quality, and this dynamic will in turn make supply chains longer, faster flowing, and more flexible.

The emergence of an economy given over to optimizing for efficiency in the sense just indicated involves a redistribution of economic power. As Conca points out, there has been a rearrangement of "the balance of power among the economic agents in a [supply] chain and between those agents and the regulatory state." This rearrangement renders:

regulatory and technological approaches to environmental protection much less effective. As a result, these traditional approaches are increasingly likely to target the weakest nodes in the chain rather than the strongest. (Conca, 2002, p. 144)

Note that the problem of regulatability to which Conca is alluding does not arise because of the international or global character of supply chains—as if international agreement or even world government could provide a regulatory or technological answer. The problem is not one of jurisdictional or regulatory reach. It is rather that contemporary supply chains have assumed a form which makes them intrinsically difficult to regulate, whatever the regulatory instance, whether a state regulating by passing and enforcing law or an individual regulating by asserting his or her will politically.<sup>2</sup>

Note further that the rearrangement of which Conca speaks involves a shift of economic power away from producers toward the retail end of supply chains. New technologies give retailers unprecedented access to a diversity of suppliers and the new politics and public policies give them unprecedented opportunities

---

2 That the problem is not one of (absent) jurisdictional reach, of, say, an international agreement or even world government, is shown by the fact that problems of regulatability arise even with long, highly complex and shifting supply chains *within* national borders. This is illustrated by the case of labor supply to the farms providing the Australian food mega-retailers with produce—see [www.abc.net.au/news/2015-05-04/supermarkets-food-outlets-exploit-black-market-migrant-workers/6441496?WT.mc\\_id=Innovation\\_News-Fo](http://www.abc.net.au/news/2015-05-04/supermarkets-food-outlets-exploit-black-market-migrant-workers/6441496?WT.mc_id=Innovation_News-Fo)urCorners | LabourExploitation,SlaveLikeConditionsFoundOnFarmsSupplyingBiggestSupermarkets\_FBP | abc.

to use these technologies to play suppliers off against one another according to who can supply the higher quality at lower cost. Inevitably, in a competitive environment retailers *able* to exploit these opportunities *will* exploit them. In consequence, there arises a tendency to monopsony toward the retail end which explains the rise of the mega-retailers now found in many if not all supply chains. Mega-retailers, sometimes of global reach, now dominate numerous supply chains, for example, food, fast food, furniture, hardware, clothing, to some extent sportswear, and even bookselling. Many of these mega-retailers are retailing own brands, hence now possess product design capacity yet they do not actually produce these brands.<sup>3</sup>

Note finally that this redistribution of power toward the retail end is simultaneously an enhancement of its economic power across the supply chain. The capacity to play suppliers off against one another gives retailers the capacity to undercut their competitors in offering end-consumers higher quality at lower cost. Precisely for this reason the redistribution is a tendency to monopsony, as less-effective retailers, for example, local shop owners, fall victim to the lower prices offered by their competitors. Consequently, competition intensifies and the whole supply chain becomes explicitly organized around providing wider choice and higher quality at lower cost. As indicated above, it becomes rational in Weber's sense, that is, explicitly given over to enhancing efficiency, the ratio of outputs to inputs. And the desired output is ultimately an optimal mix of choice, quality, and cost.

Evidently, the unregulatability of supply chains entails that achieving environmental sustainability and social justice requires more than mere regulatory and technological tinkering with the current system. A radical transformation is needed. In particular, supply chains must become shorter (Renting et al., 2003), slower, and less flexible in order to make them more manageable with regard to such issues as sustainability and social justice. But what could this mean? Some think that it means *going back*—going back to earlier forms of economic organization, in which things did not move as far, as quickly, and as unpredictably. We must go back to more nationally and indeed locally based modes of production, distribution, and retail, hence to more nationally and locally specific modes of consumption, as exemplified by the small town economy, with its purely local stores, workshops and farms, and its slower pace of life. This will involve less choice at lower quality and higher price for consumers. But the undoing of economic rationalization will bring alternative rewards which, once tasted, will convince everyone that the renunciation was

---

3 Even information and communication technology is subject to such tendencies: Apple is arguably more a distributor and retailer with product design capacity than a producer.

worth it. For these older forms of economic organization involved, or so it is thought, a degree of transparency, community, and solidarity now lost to us. Recovering this will compensate for the material sacrifice.

For two reasons such 'localist' or (bio-)'regionalist' thinking is naive. Firstly, it is not obviously true either that older forms of economic organization were more environmentally benign or that they possessed greater degrees of transparency, community spirit, and social solidarity. Certainly, they were often more racist and sexist, possibly just as ageist, and frequently small-minded. Secondly and more importantly, the current economically rationalized economic order arose out of the older forms, as individuals naively explored the possibilities of new technologies, perhaps in order to secure their own economic advantage, perhaps simply because these new technologies seemed to them to offer numerous undeniable gains without any serious losses. The older forms of organization thus lacked any institutional capacity to identify in what direction innovations and improvements in numerous undoubted goods—for example, in comfort, cleanliness, and convenience (Shove, 2003)—were taking us. Yet it is precisely this capacity one is calling for when, in response to contemporary problems of environmental destruction and social injustice, one demands a form of economic organization in which supply chains are shorter, slower, and stiffer, hence more manageable. The real problem with 'localist' or (bio-)'regionalist' thinking is thus that it does not answer the question posed by the inherent unmanageability of the new economy. Shortness, slowness, and stiffness of supply chains is merely a necessary, not sufficient condition for their manageability. One must therefore shorten, slow, and stiffen in such a way that institutional oversight is created and for this the bygone provides no model. 'Localist' or (bio-)'regionalist' thinking fails to see this.

It would, however, be equally naive simply to dismiss such thinking as entirely wrong-headed. The idea of the local is not an answer to the question of how to shorten, slow, and stiffen supply chains in a way which makes them more manageable but it does provide a clue to where one might look for an answer. The appeal to the local is in fact a muddled attempt to specify two crucial features of an answer: firstly, the kind of economic order required for manageability; and secondly, the kind of economic order which could offer such alternative rewards to beneficiaries of the current unmanageable order that they would be prepared to forgo their benefits and embrace an alternative, more manageable one.

We need, therefore, to investigate the idea of the local economy in order to determine what makes it so attractive as an answer to *two* problems: the problem of manageability and the problem of motivation. We may suspect that what makes the idea attractive is the perceived interrelation of these problems: what accounts for the shortness, slowness, and stiffness of highly localized supply chains is also inchoately perceived to be what accounts for those features of



them which plausibly appear to be alternative rewards consumers could enjoy if only they renounced their current profligate ways. So we must analyze the kind of economic interaction in which individuals engage when they assume the role of consumers, retailers, and/or producers in highly localized, small-scale economies and bring out the difference when they assume these roles in the new economic order of long, fast-flowing, flexible supply chains.

## Thick and thin conceptions of the economy and its actor

Supply chains are woven together by relations of exchange. Workers sell their labor time; producers sell their products; distributors, lawyers, and agents sell their services and skills; and finally retailers sell their wares to end-consumers. In the older, more local forms of economy displaced by the new economic order the exchange relation typically, if not necessarily always, takes place between individuals who live and mutually know one another to live in the same community, hence share and mutually know one another to share a common background of norms and values. This common background enables trust and goodwill, which in turn ensures good faith, at least as a rule, in the conduct of exchange, so much so, indeed, that often no explicit legal regulation is needed. As such, each party to exchange may rationally assume that, even if occasionally the other party might not desire a fair exchange, *as a rule* this latter does—perhaps because he or she is concerned about the longer-term damaging effects, for example, to reputation, which unfair exchange might have, but often enough simply because he or she prefers to be fair.

Such points have often been noted. Less noted, however, is the presence within such localized exchange relations of what I shall call *a normatively thick conception of rational agency*. In order to get at this, let us move from the real, from actual socioeconomic reality, to the ideal, the classical tradition of reflection on such reality. For a normatively thick notion of rational agency is presupposed by the classical political economists Smith,<sup>4</sup> Ricardo, and Marx<sup>5</sup> in their accounts of the exchange relation. When theorizing about the nature of exchange relations, such thinkers typically proceed by envisaging idealized situations, often of simple barter, in which the parties to exchange are assumed to be acting, and to mutually know themselves to be acting, in good faith. In effect, these thinkers

4 See Smith (1759/1981, II, ii, iii, p. 125).

5 It would be a misunderstanding, both of the point made here and of Marx himself, to object to Marx's inclusion here. Marx's whole point is that capitalist exchange, particularly the exchange of labor power for wages, is so to speak *ontologically* or *structurally hypocritical*. In capitalist exchange, when it is ideally functioning, both parties seek a fair exchange *yet even then, indeed precisely then, distinctively capitalist exploitation (extraction of surplus value) and alienation take place*.

abstract from real *local* exchange relations, of which, of course, in their day there were many more, to an idealization thereof in order to identify the concepts and principles operative in real exchange relations.

But why do they do this? Because they believe, or rather unreflectingly assume, that the relevant concepts and principles of economics and politics can only be identified in this way. In one way, even highway robbery is an exchange relation: the robber receives money, the robbed continued life. So, too, is the situation in which sellers compel buyers to pay too much, or buyers compel sellers to accept too little. Yet classical political economy rightly regards neither highway robbery nor extortion as the kinds of exchange by studying and reflecting on which one could effectively identify the mechanisms by which markets operate, that is, prices are determined in the economy. This is not because classical political economy regards no economy as possible unless as a rule parties to exchange acted, and mutually knew themselves to act, in good faith. A general pattern or practice of human behavior such as an economic system is only possible if the individual acts in which it is realized occur *as a rule*, that is, according to a rule. Acts of robbery are, however, by definition exceptions to a rule. Trivially, no economy could consist of acts of robbery. The case is, however, different with extortive buying and selling. An economy is conceivable in which many, possibly even most acts of exchange were extortive. It could display some durability and resilience as a system although not as much as an economy in which most parties to exchange acted, and mutually knew themselves to act, in good faith. So an economy *is* possible in which parties to exchange did not act, and did not mutually know themselves to act, in good faith.

So when classical political economists assume a concern for fairness in the idealized depictions of exchange from which they extract economic concepts and principles, they are not thinking of the economy as a system which requires for any kind of durability and resilience that its component acts be conducted as a rule in a spirit of fairness. They in fact have a deeper reason for their assumption. From the outset, they assume that the point of economic activity, hence of exchange, is not simply to service the needs and desires, whatever they might be, of economic actors, but rather to contribute to the existence of these latter as free rational agents, respected as such by others. Economic interaction is understood from the outset as given over to serving the *legitimate* needs and desires of economic actors *for whom being fair is a value in and of itself, indeed a value most mostly adhere to*.

In other words, the classical political economists assume from the outset that economic interaction possesses those general patterns of behavior which make it a possible object of study for them by virtue of its being essentially oriented not simply toward satisfying human need and desire but toward enabling human beings to exist most fully as the self-conscious, rational beings they

essentially are—as what Kant calls ends in themselves. In this sense, they are assuming a normatively thick concept of economic life and interaction. And in assuming this, they are assuming a correspondingly thick concept of the human beings who participate in such life and interaction. Human beings are understood to be rational agents, that is, beings condemned by nature—by *their* nature—to satisfy need and desire by use of reason. But for the classical political economists this understanding goes hand in hand with another: *that human beings are rational agents is understood to mean that they are also moral agents*, that is, beings who (a) understand what it is to be fair and equitable in one's dealings with others and that one is morally required to be so, and (b) are as a rule concerned to be so, typically because one is morally required to be so. For classical political economists such as Marx, Ricardo, and Smith, it is constitutive of being a rational agent that one can understand and apply moral concepts in moral judgments and that as a rule—psychopaths are, of course, an exception—one has a sense of decency and self-respect which makes one capable of conscience, shame, and guilt. The idealized economic actor one must presuppose in order to understand economic order is someone who from the outset prefers to do the right thing and, at least as a rule, actually does the right thing.

Not by chance, then, do the idealized exchange relations described and elaborated particularly by Smith and Ricardo look like the kinds of exchange relation one finds in small-scale economies—relations one has to the butcher, baker, and candlestick maker. Both the idealized exchange relations of politically economic theory and the real ones of a highly localized, small-scale community, for example, a small country town, tacitly presuppose a certain conception of what the individual at least ideally is who enters into an exchange relation with another. Parties to exchange are assumed to be rational not just in the sense of being able to order courses of action according to the degree to which these courses of action are desired or preferred. They are assumed to have more structure than this. In particular, the desires of each party to exchange are assumed to be governed, and known by the other party to be governed, by a master desire to act fairly and equitably—provided, of course, that the other party can be relied upon similarly to act fairly and equitably. In short, as a self-conscious, rational agent, any party to exchange is willing, and is understood by the other to be willing, to do the right thing by the other, at least as a rule if not always; each is willing, and is understood by the other to be willing, to temper private or personal interest<sup>6</sup> by considerations of fairness—a willingness grounded in respect for the other as deserving of fair treatment.

---

6 Private or personal interest must not be identified simply with self-interest. A private or personal interest need not be selfish but rather, say, an interest in the good of one's children or even an interest in an ethical cause to which one is personally committed.

Moreover, the reason why in both the idealized cases considered by classical political economy and real cases of local exchange this richer, indeed somewhat Kantian conception of self is presupposed is the same: *de facto* the same understanding of the point and purpose of exchange is operative, namely, that it is there to permit decent people to live decently. So in both theory and reality the assumption is that the defining point of exchange and of economic interaction generally is to enable beings prepared to give others their due to receive their due, hence to receive some *fair* degree of desire-satisfaction, that is, to have, as far as possible, their *legitimate* desires and preferences satisfied. Economic interaction takes place not just to ensure efficient allocation of resources, and thereby efficient satisfaction of desire. Rather, it takes place in order to enable those who participate in it to be happy without doing wrong and to do right without being unhappy—to live well in Aristotle's sense.

This is a crucial result. For what conception of the rational agent is implicit in the kinds of exchange relation which have displaced the highly localized kind? Let us consider, in particular, the *retail* exchange relation since as we have seen retailing has become so powerful in the new economic order. Mega-retailers have replaced the friendly neighborhood grocer and hardware shop owner because they are more competitive with regard to choice, price, and quality. They are more competitive because they have greater capacity to shop around for suppliers who can offer *them* wider choice, lower cost and/or higher quality, which they can then pass on to their customers. Thereby they progressively select for retail exchange relations which are no longer embedded in and carried by any common community or background familiarity between buyer and seller. In this sense, the retail exchange relation has been rendered purely efficient, purely a means–ends transaction.

Evidently, this development leads to retail exchange relations which are now *as a rule*, and not just as an exception, impersonal and unfamiliar—the kind of retail exchange relation which late modern shoppers experience as they push their shopping trolleys around the mega-retail outlet. Note, however, that corresponding to this development is a shift in how both the rational agent, whether buyer or seller, and economic life and interaction in general are understood. In selecting for economically rationalized, more efficient exchange relations, economic competition also selects for new conceptions of the economic actor, that is, of the economically rational agent and of economic life and interaction in general. In one's role as an economic actor, that is, when taking part in the exchange relations which hold supply chains together, in particular, retail exchange relations, one is acting as a rational agent if and only if one subjects a range of *prima facie* desirable actions to a cost-benefit analysis through which one orders them according to how efficiently they are realizable. In this picture, then, economic actors are not to assumed to have as a rule a master

desire to act, or preference for acting, fairly and equitably which constrains this cost-benefit analysis. Relatedly, the economy is understood to be a domain of interaction given over simply to satisfying need and desire effectively or, as it is more usually put, to allocating resources efficiently.

In short, in selecting for new, economically rationalized exchange relations, the logic of efficiency selects for a new conception of what it is for human beings to comport themselves rationally in exchange relations, hence of what the economy ideally accomplishes, given this economically rationalized conception of the economic actor. Clearly, these new conceptions correspond well to how the economic actor and the economy are conceived in much of the economic theory which has superseded classical political economy. But what is the practical and political significance of these points, particularly with regard to the issue of how supply chains might be shortened, slowed, and stiffened in way which addresses *both* the problem of manageability *and* the problem of motivation?

## Breaking the hegemony of the economic

If the source of unsustainability is ultimately an economic system given over to the pursuit of efficiency for the sake of ever wider choice, ever higher quality, and ever lower price, then what must change is the system as a whole. It will not do simply to target production, distribution, and retail exchange, as if technological solutions involving no change in levels of consumption sufficed.<sup>7</sup> Nor will it do simply to target consumption, as if exhortation about the imprudence and injustice of current consumption<sup>8</sup> sufficed. Such exhortation would provide no guidance as to how the beneficiaries of current patterns of consumption could live well in a radically more sustainable and more just way and so, because no radically more sustainable and radically more just social order can be *imposed* upon these beneficiaries, it would be pointless. Those who currently benefit must be offered a genuine alternative, one which could make them want social transformation toward significantly greater sustainability and social justice *because it enabled them themselves to live well*, perhaps indeed *better*.

This imposes a strong condition of adequacy on any putative solution to the interconnected problems of unsustainability and social injustice. Achieving sustainability and social justice requires that supply chains be made more manageable, hence shorter, slower, and stiffer. But the considerations just adduced show that such shortening, slowing, and stiffening will mean less choice, lower quality, and higher price. In other words, it will deny consumers,

7 As Hawken et al. (1999) believe. For all the rhetoric about a radically new approach to design, natural capitalism remains firmly focused on the production side alone.

8 As exemplified by Ewen (1976), Schor (1998), Hamilton and Denniss (2005), and many others.

particularly but not exclusively in the First World, a considerable slice of the benefits they currently enjoy. Consequently, no such shortening, slowing, and stiffening will be viable in the long term unless, in addressing the problem of manageability, it also addresses the problem of motivation. The solution to the problem of manageability must therefore also plausibly constitute a solution to the standing problem of human existence, namely, how to live well.

But what has made supply chains so long, fast flowing, and flexible is the relentless dynamic of rationalization according to criteria of efficiency. So one part of the solution to the problem of *motivation* will consist in showing that and how this dynamic impacts negatively upon all dimensions of life. Specifically, it must be shown that and how it distorts the realization of what economic actors essentially are *on the thick conception of them*, namely, finitely rational agents, in other words, rational animals in a recognizably Aristotelian sense, essentially oriented toward living not just happily and not just virtuously, but both simultaneously—toward living *well*. Evidently, this is to assume that the thick conceptions of the economic actor, hence of the economy, are correct. But if this assumption is correct; and if it can be shown that and how the hegemony of the economic distorts the realization of the thick conceptions, then one will have shown that and how an economic order subject to unceasing economic rationalization tends toward dissatisfaction and indeed unhappiness even for those who benefit materially from it.

The other part of the solution to the problem of motivation would consist in showing that and how the putative solution to the problem of *manageability* better realizes the regulative ideal of living well, understood as a life of *contentment* because in it justice and personal happiness are unified. Evidently, here, too, the assumption is operative that the thick conceptions of the economic actor, hence of the economy, are correct. But if they are correct, then the putative solution to the problem of manageability would have been shown to be a genuine, that is, *genuinely motivating* alternative to the current economic order, even for those who currently benefit from the latter. The problems of manageability and of motivation would have been, as required, simultaneously solved.

Clearly, accomplishing all this cannot be undertaken in this paper, not the least because it would involve validating the thick conceptions of the economic actor and the economy. For this reason, I will in the next section simply make some suggestions as to the general form a solution to the problem of manageability would take, intimating along the way how, under the assumption that the thick conceptions are correct, this solution also solves the problem of motivation. Then, in conclusion, I will intimate how one might make good this assumption.

## The politicization and democratization of supply chains

Let us consider one particular supply chain, namely, the food supply chain, as a case to work from. This supply chain is chosen not just because it constitutes a good example but because when one works with thick conceptions of the economic actor and the economy it turns out to be a fundamental one, that is, at the very core of an economy whose defining purpose is to enable finitely rational beings to live well. Other examples of core supply chains would be education, health, and housing. The basic principle governing the effort to make food supply chains manageable is that the end-consumer, retailer, and producer should become, precisely in their roles as end-consumer, retailer, and producer, political. More precisely, supply chains must be structured in such a way that individuals in them, in their roles as end-consumer, retailer or producer, can collectively determine, in political fashion and according to political criteria, e.g., criteria of sustainability and justice, how the supply chain functions. What would this look like in our representative case of the food supply chain?

We should start with phenomena to which environmentalists already appeal as presaging new practices of food production, distribution, retail, and consumption in the literal sense. Around the world diverse efforts are being made to find alternatives to the existing system of industrial agriculture, from farmers' markets through community gardens to urban and labor-intensive agriculture which bring people back to the land. Possibilities for small-scale, labor-intensive food production, both in urban, suburban, and rural contexts, need to be explored. This would require development of arguments against urban consolidation, which is frequently and often disingenuously promoted as a strategy for sustainability. In particular, these efforts need to recognize an underlying, unifying goal: blurring the distinction between city and country, in an effort to keep people on land and land around people. To this end, strategies of decentralization and distribution of the population through the landscape, connected by rapid mass transit, would be needed.

Farmers' markets should, of course, be promoted since they bring urban end-consumers into face-to-face contact with food producers. At the same time, it must be acknowledged that farmers' markets are relatively superficial phenomena: not only are many of the products currently sold at such markets indistinguishable in terms of their sustainability from what one can buy in a conventional supermarket, the knowledge they impart of food production is actually minimal. Nonetheless, they could provide an important line of communication between end-consumers and producers on the basis of which, given the right support, more ambitious measures could be grounded. Thus, the

contact they enable could be utilized for creating arrangements of mutual support between rural and urban communities. This could lead to arrangements with urban residents and municipalities which give farmers access to urban green space in order either to produce themselves or to mentor urban residents in urban agriculture. Conversely, it could lead to arrangements where urban residents work part time or casually in rural production in return for produce.

But perhaps most significant would be the idea of extending aspects of the principle of food consumer cooperatives to standard food retail. The idea behind this would be to exert pressure on standard food retail from both ends of the supply chain, from the producers and the end-consumers. One could imagine representative bodies of producers and end-consumers jointly insisting, from opposite ends of the supply chain, on certain kinds of environmentally friendly and socially just retailer behaviors. Goals would not be restricted to such low hanging fruit as bans on plastic shopping bags, palm oil products, and excessive packaging. Ideally, one would seek to empower end-consumers and producers to work with retailers, beginning at the local level, in order to change the character of retail itself. For example, consumer representatives might insist that there be greater representation of bulk ingredients for preparation at home rather than highly processed dishes for the microwave, that products be sourced locally, and that less emphasis be placed on highly packaged individual portions.

The impacts of these changes would begin in patterns of consumption (in the literal sense) and ramify down the supply chain to producers. In particular, they would mean more retail handling and serving; even checking out would take longer so retailers would be less able to push customers through their stores. Such inefficiencies would contribute significantly to shortening, slowing, and stiffening supply chains. But these impacts would engender other environmental and social goods currently sacrificed at the altar of efficiency. For example, there would be a considerable reduction in the use of plastic, something which would itself contribute to shortening and slowing supply chains since plastic packaging is essential for transporting produce over long distances, for moving goods quickly, and for the individual portions which make self-serve possible. The impacts would thus extend to the very layout and look of retail outlets: less freezers and shelves, more counters and staff. Last but not least, these changes would reduce retail choice since retail choice is not simply a function of how many suppliers a retailer can access but also of packaging and portioning: without plastic packaging and individual portions it becomes harder to offer many brands of the same kind of product.

Of course, in order to accomplish this, there would have to be a significant reorientation in the understanding of commercial enterprise. The idea that companies exist simply in order to enhance shareholders' value would have to be renounced. This would in turn require a change in the culture of investment,



away from the idea that investment is simply a way of using capital to generate more capital. Alternative forms of commercial enterprise would therefore have to assume a larger role, for example, producer and retailer cooperatives alongside the cooperatives of end-consumers already mentioned.<sup>9</sup> Their economically cooperative rather than competitive goals make cooperatives more likely to embrace ethical constraints on capital accumulation. A development of the idea of a cooperative would be to extend the already familiar idea of, for example, food *consumer* cooperatives to include selected producers in a single cooperative body. End-consumers could thereby help producers in the distribution and retail of produce while producers could respond directly to consumer concerns about food quality and environmental and social issues generally. In addition, cooperatives involving urban end-consumers and rural producers would facilitate the extension of production into urban landscapes and, conversely, the engagement of urban end-consumers in production. Nor need the producers be strictly local; one could imagine First World consumer cooperatives linking up with producer cooperatives in the Third World in the name of fair trade.

Evidently, any such politicization and democratization of the food supply chain would require end-consumers, retailers, and producers alike to think and act ethically, not just prudentially, when performing their respective roles within the supply chain. So the implementation of strategies for a more political and democratic food supply chain would lead to the chain's adapting to 'fit' the kind of economic actor which enacts it: just as the current supply chain maintains and is itself maintained by economic actors thinking and acting in terms of what most effectively and efficiently realizes their individual desires and preferences, so, too, a transformed, politicized and democratized supply chain would maintain and be itself maintained by economic actors who think and act in the light of a common interest in a supply chain which delivers produce at acceptable levels of choice, quality, and price while being constrained by considerations of sustainability and social justice. In short, the supply chain comes to implement the thick conception of the economic actor *qua* finitely rational agent.

Furthermore, if, as I am tacitly assuming, the thick conception is correct, then a politicized and democratized food supply chain will, given sufficient visceral experience of and habituation to it, appear more desirable than one which operates *simply* according to criteria of choice, quality, and price for the consumer. For rational agents in the thick sense have a concern to do the right thing which makes them able to moderate the satisfaction of their desires and preferences once they become aware of others to whom they harbor no ill will who would suffer if they pursued desire-satisfaction simply according

---

9 An interesting example of this is the Earthworker Cooperative in the Latrobe Valley of Victoria, Australia—see <http://earthworkercooperative.com.au/>.

to criteria of what desires and preferences they can effectively realize in the circumstances and how efficiently. This concern is all the more effective in moderating the satisfaction of desire and preference the more individual consumers are supported by and work together with other actors in the supply chain. For this reason, it is crucial that the alternative supply chain envisaged have mechanisms embedded in it which support solidarity and communication along it. For the capacity to create and maintain such support is an essential component of the capacity to provide the alternative rewards which make the alternative supply chain more desirable in the longer run. In other words, such support mechanisms are an essential part of the alternative rewards which would compensate for narrower choice, lower quality, and higher price, in particular, for more frequent unavailability, increased seasonality, and greater regionality.

Last but not least, politicization and democratization of the food supply chain would require that people have more time to think and act more reflectively—even at the cost of what, by current standards, would count as inefficiency. It would thus be essential to break with the tendency of the current economic order to subordinate time to its imperatives. For most people this is experienced as the primacy of work: no time off from work, whether merely for rest and recreation; for familial, social, or political engagement; or indeed for reflective thinking about the point and purpose of time on is sacrosanct. If the economy requires it, then these activities and the socially appointed times for and durations of them must be renegotiated. Thus, the weekend in the sense of a socially appointed period during which all regular work ceases in order that there might be collective time off for collective non-work activity is increasingly undermined. Increasingly, indeed, one must be prepared to work whenever required during the day; other activities must be rescheduled to fit. Increasingly, too, one is expected to move to where the work is, even to relocate when work relocates. Sometimes one must be prepared to travel thousands of miles to work, hence be absent from one's family, friends, and community for several weeks on end, as illustrated by the fly-in/fly-out workplace.

The subordination of time to economic imperatives undermines the capacity to act freely and think reflectively. Thus, one would prefer to use environmentally friendlier public transport but must choose to use the private car because one's schedule is so tight and fragmented *vis-à-vis* the schedules of others. Moreover, the increasingly individualised character of work induced by its increasingly temporally and geographically fragmented character gives individuals less opportunity to reflect collectively with others, which is the process through which one best learns how to compare one's own needs and desires with those of others, hence to moderate the former in the light of the latter. The capacity of individuals to gain critical distance to their needs and desires is thus impaired, such that it becomes harder for each to say, "I thought I really wanted that but

now I see that I can go without it.” In general, when temporal and geographic fragmentation forces individuals back upon themselves, their wants becomes less negotiable, so to speak less fungible, and so it becomes harder to envisage and accept alternatives. Lastly, it becomes harder to reflect meaningfully on what the nature of one’s work is and on what effects it is having on oneself and one’s society.

A food supply chain defined by a concern not simply to optimize for choice, quality, and price but also and primarily to constrain such optimization by considerations of sustainability and justice could not afford such truncation of practical reason. It therefore cannot operate at such speeds that practical deliberation is impeded in the ways indicated. In particular, a politicized and democratized food supply chain would positively require individuals to have time and capacity to reflect on what the effects of work and of the economy in general are and especially on whether, as currently organized, work and the economy serve the purpose of economic life adequately. Work would thus be regulated in its speed and flow by the requirements of such reflection rather than the other way around.

This is a crucial point: a politicised and democratised food supply chain would involve end-consumers, retailers and producers working together to determine the operation of the entire supply chain. The supply chain must therefore have the capacity to allow time off from regular work activity in order to participate in oversight of other nodes in the chain. Similarly, end-consumers whose regular work activity occurs in other supply chains would have to have time off from their own work activity in order to be able to participate in the regulation of the food supply chain. Naturally, the converse would also apply: end-consumers must be able to choose to participate in the regulation of (aspects of) other supply chains. This does not entail, of course, that everyone must be involved in *every* supply chain in which they participate, either as producer, retailer or end-consumer; this would be absurd. But it does entail that the pace and character of *all* supply chains must be such as to permit individuals to choose to participate in the regulation of a given supply chain *if* they want to do so. The food supply chain and supply chains generally must have the freedom and capacity to offer participation at different points along them. This would require a much more leisurely pace for supply chains overall.

## Conclusion: A critically theoretic interdisciplinary research agenda

Clearly, implementing ideas such as those outlined in the previous section would amount to a radical transformation—all the more so when one considers that one cannot change the food supply chain in accordance with them without changing all supply chains in their totality, that is, the whole economy. All the greater is the need, therefore, for substantial empirical research. For example, it would be crucial to investigate the issue of just how much and in what way urban agriculture could contribute to food production in advanced capitalist countries. Relatedly, it would be essential to investigate whether and to what degree agriculture in general can and should be rendered more labor intensive: contemporary capital-intensive agriculture only achieves its great labor efficiencies on the basis of cheap energy, both for fuel and for fertilizer, and the current source of this, oil, is running out with no substitute in sight. Moreover, there are many social and political benefits to be had from increasing the labor intensity of the economy: provided it can be done without impoverishing people materially or culturally, more labor-intensive agriculture would revitalize regions and reverse the depopulation of city hinterlands. One starting point for such empirical investigation would be the literatures on urban agriculture,<sup>10</sup> the “new peasantries” (van der Ploeg, 2009), and the Cuban experience (Premat, 2009) because these provide evidence that labor-intensive and small-scale urban agriculture can make a genuine economic contribution in some areas even if some activities, for example, grain production, must always require non-local or large-scale broad acre farming (see Dyball & Newell, 2015, pp. 194–195).

Further empirical and theoretical research would be required in order to investigate how other supply chains might be politicized and democratized, for example, furniture and hardware. Such politicization and democratization would potentially be far more effective than certification or even producer-responsibility legislation in monitoring the harvesting of timber and the materially intensive production of low-price but low-quality tools which rapidly end up in landfill. Moreover, the idea of extending principles developed for the representative case of the food supply chain to other supply chains provides an opportunity for addressing a crucial theoretical issue in radical environmental politics. As already intimated, it need not and indeed cannot be the case that all individuals will be involved in all supply chains in which they appear as either producer, retailer, or end-consumer. This suggests that the politicization and democratization of supply chains enables a kind of social engagement and solidarity which is not

---

10 See, for example, [www.sustainable-everyday-project.net/urbact-sustainable-food/](http://www.sustainable-everyday-project.net/urbact-sustainable-food/).

totalizing in the manner implicit in much green romanticizing about community and direct democracy. For it is a conception of highly local, direct democratic engagement which is not concerned with the affairs of the whole but merely with those of that aspect of the supply chain in which a citizen happens to be interested. The picture painted here is thus not of all citizens gathering together in order to decide, in direct democratic fashion, the affairs of society as a whole. As far as the political sphere is concerned, this can remain representatively democratic and therefore a domain protective of standard liberal rights, up to and including the right not to be involved, that is, to be a purely private citizen. The politicization and democratization of supply chains would be consistent with a less emphatic, low key kind of social solidarity and support, along the lines of what Miller and Woodward (2012, p. 10) call the silent community. This more modest form of community is arguably more practically consistent with the reality of mass society and more ethically consistent with modernity's distinctive emphasis on individual autonomy.

There is also a necessary philosophical dimension to the theoretical research clearly required by the idea just sketched of politicizing and democratizing supply chains. For the thick conceptions of the economic actor and the economy presupposed by this idea require justification. At first, one might think that such justification is a perfectly empirical issue. Has not much recent empirical investigation shown or at least strongly suggested that many human beings, although certainly not all, have a propensity to act in a spirit of fairness if others act similarly; and that in general they bear goodwill to others, at least within certain bounded domains of familiarity? (See, e.g., Fehr & Fischbacher 2003.) Why, then, should any distinctively philosophical grounding of this conception be needed?

Empirical investigation can certainly show that many or even most human beings incline to fairness and goodwill, just as it can show that many or even most swans are white. But the thick conception of the economic actor *qua* rational agent makes a claim stronger than this. It is not simply a statistical claim to the effect that, as a matter of brute fact more than fifty percent of human beings incline to fairness and goodwill. Rather, it claims that humans do so *as a rule*. This means that although there certainly are some humans who are not thus inclined, these individuals are derivative upon rest—derivative in the sense that they are exceptions which presuppose, hence prove the rule. That is, in a sense which must, of course, be further specified, an individual can only exist as *not* inclined to fairness and goodwill because and insofar as there are others who *are* thus inclined. The thick conception asserts something which cannot be established in the empirical fashion in which one establishes that many or most swans are white or indeed that many or most humans incline to fairness and goodwill.

But now one might ask whether the thick conception is needed at all. Perhaps from the strictly practical point of view of the environmental activist all one needs is simply the weaker general claim that many people are inclined to be fair and display goodwill. Is this not enough to work from in the effort to reorder the economic order away from its orientation simply toward providing goods and services as efficiently as possible? No, it is not enough; the necessity expressed by the claim that humans *as a rule* are disposed favorably toward the right and toward others is essential because it permits one to argue that *all possible* human beings and not just certain actual ones are as a rule oriented toward living well, hence not toward unconstrained desire-satisfaction. Thereby it permits one to argue that even those who deny the claim that human beings are as a rule oriented toward living well, indeed even those whose behavior contradicts it, are not truly happy even though they feel perfectly comfortable, have lots of pleasant experiences and few painful ones. Consequently, the thick conception, when justified, gives one confidence that in the long run anyone who is fully and sufficiently rational could be brought by argument or personal experience to acknowledge that the claim is right and that they would be happier if their lives, as agreeable as they currently are, could also be that much more ethical without (significant) loss. This points to a powerful result: *precisely in order for it to provide a rational basis for activists to believe that beneficiaries of the current economic order can be rationally brought to regard, indeed to experience, their current life as suboptimal, the thick conception must be understood to be truly and irrevocably philosophical, such that it can only be justified philosophically.*

Actually providing this philosophical justification would require some heavy duty philosophy which cannot be undertaken here. Arguably, however, it would take Kantian form. That is, in order to establish the crucial conceptual link between rational and moral agency in which the thick conception consists, one would seek to show that the capacity for first-person thinking presupposed by the concept of rational agency—the capacity to think, for example, “I am 6 foot tall” or “I see Mount Everest”—requires a unity of the self which does this thinking that is only possible if this self has an understanding of who and what it is, an understanding which involves a grasp of itself as measuring up, to one degree or another, to norms and values that matter to it. It thus does not just have knowledge of norms and values, it cares about them, hence suffers guilt and shame insofar as it fails to live up to them. In particular, it possesses some degree of self-respect and self-esteem. If, however, this is so, then underpinning all explicit commitment to the *concrete* norms and values of one’s epoch, culture, peer group, etc., there is implicit commitment to a principle of fairness and equity. With this, we have reached the thick conception of the finitely rational agent.

## References

- Conca, K. (2002). Consumption and environment in a global economy. In T. Princen, M. Maniates, & K. Conca (Eds.), *Confronting consumption* (pp. 133–153). Cambridge, MA: The MIT Press.
- Dyball, R., & Newell, B., (2015). *Understanding human ecology: A systems approach to sustainability*. London: Earthscan.
- Ewen, S. (1976). *Captains of consciousness: Advertising and the social roots of the consumer culture*. New York: McGraw-Hill.
- Fehr, E., & Fischbacher, U. (2003). The nature of human altruism. *Nature*, 425, 785–791.
- Hamilton, C., & Denniss, R. (2005). *Affluenza: When too much is never enough*. Crows Nest, NSW: Allen & Unwin.
- Hawken, P., Lovins, A., & Lovins, L. H. (1999). *Natural capitalism: Creating the next industrial revolution*. New York: Little, Brown and Company.
- Miller, D., & Woodward, S. (2012). *Blue jeans: The art of the ordinary*. Berkeley, CA: University of California Press.
- Premat, A. (2009). State power, private plots and the greening of Havana's urban agriculture movement. *City & Society*, 21(1), 28–57.
- Princen, T. (2005). *The logic of sufficiency*. Cambridge, MA: The MIT Press.
- Renting, H., Marsden, T., & Banks, J. (2003). Understanding alternative food networks: Exploring the role of short supply chains in rural development. *Environment and Planning A*, 35(3), 393–411.
- Schor, J. B. (1998). *The overspent American: Upscaling, downshifting, and the new consumer*. New York: Basic Books.
- Shove, E. (2003). *Comfort, cleanliness and convenience: The social organization of normality*. Oxford: Berg Publishers.
- Smith, A. (1759/1981). *The theory of moral sentiments*. D. D. Raphael & A. L. Macfie (Eds.). Indianapolis, IN: Liberty Fund.
- Van der Ploeg, J. D. (2009). *The new peasantries: Struggles for autonomy and sustainability in an era of empire and globalization*. London: Earthscan.





# Nutrient Balances and Management of Soil Fertility Prior to the Arrival of Chemical Fertilizers in Andalusia, Southern Spain

Manuel González de Molina,<sup>a</sup> Roberto García-Ruiz,<sup>1b</sup>  
David Soto Fernández,<sup>a</sup> Gloria Guzmán Casado,<sup>a</sup> Antonio Cid,<sup>a</sup>  
and Juan Infante Amate<sup>a</sup>

<sup>a</sup>Department of Contemporary History  
Pablo de Olavide University, Seville, Spain

<sup>b</sup>Department of Animal and Plant Biology and Ecology  
University of Jaén, Spain

## Abstract

Studies on the role of nutrient balances in the socioecological transition of agriculture are scarce, particularly in the Mediterranean region where manure availability was low. The role of nutrient balance in this transition was evaluated in three representative localities of the inland Mediterranean region of southern Spain from 1750 to 1900. Changes in cropland distribution, population, manure availability and demand, and nutrient balance at cropland and aggregated scales were assessed. Data suggest that agriculture development around 1750 was limited by manpower. During this period manure availability was higher than demand and municipal balances for nitrogen were positive, whereas they were slightly negative for phosphorus and potassium. During the 19th century, the population increased while livestock numbers and manure availability decreased. Nutrient balances become negative at crop and aggregate scales, indicating that productivity was based on soil mining. This territorial imbalance and soil mining were the main reasons behind the turn-of-the-century crisis which led to the agrarian socioecological transition.

**Keywords:** nutrient balances, socioecological transition, soil fertility replenishment, historic organic agricultures

---

1 Corresponding author: rgarcia@ujaen.es.

## Introduction

Over the past two centuries, exceptional changes in the natural environment attributed to human activities have attached renewed importance to the study of society–nature interactions. The socioecological transition from a solar-based agriculture lacking in synthetic fertilizer to an industrial-based one fueled by synthetic fertilizer, breeding, pesticides, and machinery has been a topic frequently discussed by historians (Fischer-Kowalski & Haberl, 2007; Krausmann, 2001, 2004; Krausmann et al., 2008; McNeill & Winiwarter, 2006; Pfister, 1990; Sieferle, 2001; Smil, 2001). In fact, before the first quarter of the 20th century, European agriculture operated within a fundamentally different framework from that existing today. Before fossil fuels and appropriate technology became available to power agricultural machinery and synthesize mineral fertilizer, agriculture largely relied on input from human and animal labor, biomass, and sunlight (Pimentel & Pimentel, 1996; Smil, 2008). Pre-industrial agriculture was potentially sustainable, but in practice there were several factors limiting sustainable agriculture in the long term. There is sufficient evidence to suggest that the degree of pre-industrial agricultural intensification was close to maximum because of the impossibility of soil fertility replacement. The pre-industrial agriculture of the Great Plains is a paradigmatic case (Cunfer & Krausmann, 2013) and the use of multiple strategies to increase input of organic sources of nutrients in northern Spain is an example of the search for soil fertility replacement possibilities (Tello et al., 2012).

In addition, many studies have highlighted the fact that current industrialized agriculture causes major environmental problems, leading to a new socioecological transition toward a more sustainable agriculture. The study of traditional agricultural systems based on organic fertilization could be a starting point and a useful tool for the optimum design of this transition. However, studies on the role of nutrient balance are scarce, despite the fact that the replenishment of soil fertility was a critical factor for the long-term stability of harvests. The replenishment of soil fertility must have been a key feature at the beginning of the socioecological transition toward industrialization. Most of the studies on this transition have been carried out in a western and northern European or North American context and have mainly analyzed changes in the distribution of cropland and crop intensification (i.e., productivity) and extensification relating to changes in population and distribution (Allen, 2008; Barles, 2007; Brassley, 2000; Campbell & Overton, 1991; Cunfer, 2004, 2005; Shiel, 2006; Van Zanden, 1991).

This paper assesses the first steps of the soil fertility transition in the Mediterranean region, where agroecological conditions are extremely different to those of western and northern Europe. The possibilities for developing and

specializing agricultural production in the Mediterranean region during the 18th and 19th centuries were strongly dependent on the adequate replenishment of soil fertility. The low net primary production of Mediterranean agroecosystems reduced the chances of having plentiful livestock and, therefore, enough organic matter to replenish all the nutrients harvested. Under these conditions, the soil fertility of a significant portion of the agricultural land had to be replaced by natural means, that is, through fallow. Both production of manure and fallow required a significant proportion of land (i.e., high land cost; Guzmán Casado & González de Molina, 2009) that had to be “paid for” by agricultural systems based on organic fertilization, especially in the Mediterranean region. As a consequence of this land cost, overall productivity per unit surface area was relatively low. Therefore, soil fertility was the major limiting factor for the development of Mediterranean agriculture, especially when the rural and urban population grew. This led to relative stagnation of land productivity and might have contributed to the so-named *fin de siècle* crisis<sup>2</sup> (Abel, 1980; Williamson, 2006). To corroborate this hypothesis, we studied soil fertilization techniques in southern European farming systems throughout the 18th and 19th centuries, immediately preceding the extensive use of synthetic chemical fertilizers. This paper also shows the usefulness of nutrient balance tools applied to history.

## Materials and methods

### Description of the three case studies

Three case studies representative of three inland regions of Andalusia (southern Spain), but with different degrees of isolation, were selected: Montefrío (Granada), Baena (Córdoba), and Castilleja de la Cuesta (Sevilla) (Figure 1, web link).<sup>3</sup>

Baena covers an area of 420 km<sup>2</sup> of rugged terrain in Guadalquivir Valley. The climate is continental with average annual rainfall and potential evapotranspiration (PET) of 641 mm and 1,378 mm, respectively. Montefrío (254 km<sup>2</sup>) is situated in the central sector of the Baetic system, northwest of the province of Granada. The climate is Mediterranean–continental, with annual rainfall similar to that of Baena, 654 mm, but with considerably lower PET (760 mm). The main feature of the Montefrío landscape is that the gradient

<sup>2</sup> The *fin de siècle* crisis, which lasted from the end of the 19th century up to World War I, was caused by massive imports of cheap cereal from the United States and other non-European countries, leading to the “first globalization” of food markets (Abel, 1980; Williamson, 2006).

<sup>3</sup> For map, see [www.historiambiental.org/descarga-de-datos/nutrient-balances-and-management-of-soil-fertility-prior-to-the-arrival-of-chemical-fertilizers-in-andalusia-southern-spain-human-ecology-review/](http://www.historiambiental.org/descarga-de-datos/nutrient-balances-and-management-of-soil-fertility-prior-to-the-arrival-of-chemical-fertilizers-in-andalusia-southern-spain-human-ecology-review/).

of most of the territory is more than 10%. Agriculture management is typical of medium-mountain regions. Finally, Castilleja de la Cuesta is situated in the western sector of Seville province, 5 km from the city of Seville. It has a surface area of just 2.23 km<sup>2</sup> spread over a small plateau near the right bank of the Guadalquivir River. The climate is Mediterranean with oceanic influences and has an average annual rainfall of 574 mm and PET of 1,392 mm. The gradient of most of the territory is less than 7% and only 16% has gradients of between 7% and 15%.

Both Castilleja de la Cuesta and Montefrío were predominantly farmed by small peasant owners during the 18th and 19th centuries. Baena, however, was characterized by the predominance of large farms (*latifundios*), and cultivation was mainly rented out during this period. In the period studied, Montefrío was a relatively isolated area, with limited possibilities of exchanging energy and materials with the outside world so that agricultural expansion was highly dependent on domestic demand. In contrast, Castilleja de la Cuesta was heavily linked not only to national demand but also to the American market due its proximity to the Seville River port. A significant portion of its production was sold outside its territory. Finally, Baena was in an intermediate position and part of its production was sold elsewhere thanks to the proximity of the rail network, although the possibility for exchange was more limited than in the case of Castilleja de la Cuesta.

Three periods of study were selected according to their importance in the socioecological transition and the reliability of historical sources. These periods have been chosen to show the situation before the changes which led to liberalism (1752), that which might show the consequences of these changes (1856) and, finally, the period of the *fin-de-siècle* crisis (1897–1904), which we identify as the turning point in the transition process to agricultural industrialization.

## Data sources

To assess land-use changes, population, livestock numbers, manure production, and yields for the different periods, for 1752 The Ensenada Cadastre was used as a source, both the General and Specific Responses. For the 19th century we used Amillaramientos de la Riqueza Rústica (similar to a land register for the payment of land taxes), Cartillas Evaluatorias (assessment notebooks), and Trabajos Agronómicos de la Comisión Central de Evaluación y Catastro (agronomic reports by the Agrarian Advisory Board). All these sources are kept in the public archives of Castilleja de la Cuesta, Montefrío, and Baena. In addition, the notary documents included in the provincial historical records of Seville, Córdoba, and Granada were used. Finally, the wealth documents of the Servicio Agronómico Provincial (Provincial Agronomic Service, 1880–1916) were also analyzed.

Data from the Instituto Geográfico y Estadístico (Geographic and Statistical Institute, 1871–1873), published in the *Statistical Yearbook of Spain* (1888) was taken into account to compare land uses and agrarian surface areas.

## Nutrient balances

### Input analyses

Nitrogen (N), phosphorus (P), and potassium (K) balances were performed at two different scales: at crop or rotation scale to determine their level of sustainability through the observed variability in land use, and at an aggregate scale (whole territory) to test for the degree of sustainability of the whole system.

N, P, and K balances for both scales were determined using the methodology of García-Ruiz et al. (2011). Changes in state (from liquid to solid) and in form (from inorganic to organic) of N, P, and K already present in the agroecosystems were not considered to be input or output. In addition, dust-borne N, P, and K leaving the agroecosystems were not quantified, as we had no basic information to feed the model in order to estimate these inputs and outputs for the period 1752–1898. Nevertheless, the magnitude of these processes was probably low because most of the time soil was covered due to the very low population and working livestock which prevented a high tillage regime. N and P inputs via rainfall were calculated from the 100-year annual average of rainfall and the weighted annual average of total N and P analyzed in field rainwater collectors. Total K concentration in the rainwater was assumed to be 0.5 g/m<sup>3</sup>, according to the annual grand mean value analyzed by Bellot and Escarre (1989) in rainwater for many sites of Spain. N, P, and K inputs via rainfall are negligible and therefore fixed to the type of crop or rotation or the periods of time considered.

The entries of P and K due to soil weathering were calculated from an estimate of the annual soil formation rate for Mediterranean regions and total P and K soil contents. Values differed for each crop or rotation according to the soil type in which they were cultivated.

Crop or rotation symbiotic N fixation were estimated from:

- amount of N harvested (based on historical information of the yield and an estimate of the grain and straw N content);
- amount of harvested N which came from the atmosphere (Gathumbi et al., 2002);
- amount of N in the root system (Wichern et al., 2008);
- amount of N in the root system which came from the atmosphere; and
- N rhizodeposition (Wichern et al., 2008).

We adopted a value of 4 kg N/ha/yr for the atmospheric N fixed by free microorganisms, following the extensive literature review by Boring et al. (1988) covering a wide range of ecosystems. The influence of tillage for this entry was incorporated by reducing input according to the tillage regime and using a categorical scale.

The entries for N, P, and K via irrigation were calculated as the product of the irrigation water input ( $\text{m}^3/\text{ha}/\text{yr}$ ) for each crop and the stream water concentration of N, P, and K ( $\text{g}/\text{m}^3$ ) measured in unpolluted streams.

The annual inputs of N, P, and K through seed application for seeded crops such as wheat, barley, beans, and chickpeas were estimated from the annual seed application rates ( $\text{kg}/\text{ha}$ ) taken from historical records and seed species' total N, P, and K content of traditional crops.

The amount of N, P, and K entering via organic fertilization was calculated from the annual dose of application ( $\text{kg}$  fresh manure/ha/yr) for a given crop and the weighted mean of N, P, and K ( $\text{kg}$  element in fresh manure/kg of fresh manure) content in the manure. The weighted mean was calculated according to the livestock distribution in each period and the mean total N, P, and K in fresh manure.

In the balances, we did not consider the nutrients which might have been returned to the cropland by night soil as there were no statistics on the extent to which human-excreted N, P, and K were collected and where they were applied. Nevertheless, it is reasonable to assume that these nutrients were applied mainly to gardens for home consumption and/or to constant and occasional irrigation, and the *ruedo* crops which were usually located near the village center. Thus, nutrient inputs of these specific crops and inputs of the aggregate balances may have been underestimated.<sup>4</sup>

## Output analyses

The main processes considered to quantify nutrient outputs were crop harvest, denitrification (only N), ammonia volatilization (only N), leaching (only N), and soil loss from erosion.

---

4 According to Del Porto and Steinfeld (1999), current annual N, P, and K human feces excretion ranges were 2.1–4.0 kg N, 0.3–0.6 kg P, and 1.0–2.0 kg K, with lower values observed for poor countries in Africa and Asia. Discounting N losses by ammonia volatilization and leaching, and P and K by leaching during human feces storage and handling, and assuming all human-produced feces in Montefrío were applied, about 9.1, 14.2 and 18.1 tons of N-derived human feces would have been applied. These amounts would not have changed the sign of the balance (see Results and Discussion sections), nor the conclusions of this study. Magnitude of the N, P, and K recycled as human feces would have been much lower if we had assumed that only a proportion of the feces produced were collected and applied, and the child population considered.

The annual depletion of N, P, and K by harvesting was assessed from the harvest (kg fresh harvest/ha/yr) of each crop and rotations and the contents of N, P, and K (on a wet basis) at harvest. Crop harvesting information was obtained from historical records and was therefore subject to change at different periods in time.

Farming basal N loss by denitrification was calculated using the model developed by Vinther and Hansen (2004), based on a combination of average values of N loss and manipulative experiment in field conditions. N loss by denitrification directly linked to organic fertilizer was assumed to be 2.5% of N applied as manure according to Kasimir Klemetsson and Klemetsson (2002). N loss through this process was basal loss plus that linked to fertilizer application rate, both of which were sensitive to crop and rotation.

Following the review of numerous studies by Holtan-Hartwig and Boeckman (1994), basal N loss by ammonium volatilization was assumed to be 1.5 kg N/ha/yr. As for denitrification, we calculated fertilized-based N volatilization as being 20% of that applied as manure following the European guide for emissions inventory (EEA, 1999).

To estimate N leaching we used the empirical model proposed by Di and Cameron (2000), which uses a quadratic function to relate the amount of N lost by leaching (per 100 L/m<sup>2</sup> of lixivate) with the amount of potentially leachable nitrogen. In addition, the amount of potentially leachable nitrogen was calculated as the sum of all N inputs (rainfall, nitrogen fixation, irrigation, and input of organic fertilizer and seeds) minus the partial outputs (harvest, denitrification, ammonia volatilization, and erosion).

Annual N, P, and K losses by soil erosion were estimated based on the area occupied by the crops, the vegetation cover pattern of the crops, the current slope and landscape mapping of the area studied, and the current soil total N, P, and K. Annual soil loss was negligible for the irrigated croplands as they were located in plains with permanent or temporary streams. Cereals and rotations of cereals with legumes occupied small valley areas with low to moderate slopes and, therefore, the annual rate of soil loss would have been relatively small. Finally, olive groves and vineyards occupied less productive sites in areas of moderate to high slopes.

Nutrient balance aggregation (i.e., total nutrient balance for each locality) was calculated taking into account the nutrient balance for each single crop or rotation type and its area.

## Results

### Changes in land use, crop distribution, population, and livestock numbers

The main features of the crops and rotations studied are summarized in Table 1. Table 2 shows the changes in land use for the three sites studied. From 1752 to 1897 cropland increased by 20% in Baena, more than doubled in Montefrío, but declined by 13% in Castilleja de la Cuesta. Irrigated crops accounted for a low percentage of cropland overall. Land for the *ruedo* rotation increased more than tenfold for Montefrío, nearly sixfold for Baena and occupied 22% of the cropland area in Castilleja de la Cuesta. In Baena a modification of the *ruedo*, the *trasruedo*, appeared in the mid-19th century, reaching almost 5,000 ha at the end of the century. The one-third rotation decreased in Baena and Castilleja de la Cuesta but increased in Montefrío. Olive groves increased in the three sites to the 1850s and continued to increase only in Montefrío thereafter. Vineyards also increased significantly in Montefrío over 150 years but decreased in Baena and Castilleja de la Cuesta.

Table 1. Main characteristics of the major crops at the three sites, 1752–1897

Crop/rotation	Main features
Constant irrigation	Vegetables and fibers harvested annually. Intensive management with manure application. Crop found at all three sites.
Occasional irrigation	Annual crop of cereals, legumes, and vegetables. Very intensive management, which included manure. Not used at Castilleja de la Cuesta.
<i>Ruedo</i>	4-year rotation, alternating cereals with legumes. Medium-intensity management which included some manure and at all three sites.
<i>Trasruedo</i>	3-year rotation, alternating cereals with legumes. No manure application and medium-intensity management. Used only at Baena.
<i>Año-y-vez</i>	2-year rotation of wheat or barley alternating with fallow. Medium degree of intensification, lacking manure. Used only at Baena.
One-third rotation	3-year rotation of wheat or barley alternating with fallow. Not very intensive and lacking manure. Found at all three sites.
Olive groves	Annual harvest of olives to produce olive oil, without manure and with very low-intensity management. Found at all three sites.
Vineyards	Annual harvest of grapes to produce table grapes and wine, without manure and with very low-intensity management. Found at all three sites.
Fruit trees	Annual harvest of fruit with medium degree of intensification and some manure. Used only at Castilleja de la Cuesta.

Source: González de Molina (2002).



**Table 2. Land-use changes (hectares) in the three case studies, 1752–1897**

	Montefrío			Castilleja de la Cuesta			Baena		
	1752	1852	1897	1752	1854	1897	1752	1858	1897
Constant irrigation	62.2	145.3	39.3	1.7	2.1	5.0	132.1	314.0	314.0
Occasional irrigation	9.0	26.8	58.1	–	–	–	25.8	40.0	40.0
<i>Ruedo</i>	24.2	1,324.3	2,934.3	–	–	36.4	588.9	3,267.9	3,501.8
<i>Trasruedo</i>	–	–	–	–	–	–	–	3,618.1	4,958.8
<i>Año-y-vez</i>	–	–	–	–	–	–	3,428.3	2,666.7	3,074.5
One-third rotation	7,348.0	11,616.4	12,311.0	74.2	28.8	–	21,978.0	17,673.6	15,811.3
Olive groves	117.7	441.6	718.4	38.6	119.0	99.0	4,897.6	9,912.0	9,912.0
Vineyards	57.8	196.4	246.1	69.3	20.1	10.2	1,836.6	1,569.0	1,569.0
Fruit trees	–	–	–	6.8	31.0	14.9	–	–	–
Cropland	7,618.9	13,750.8	16,307.2	190.6	201.0	165.5	32,887.3	39,061.3	39,181.4
Unproductive	1,060.6	1,060.6	1,060.6	32.5	21.9	57.4	480.0	480.0	480.0
Total area	25,537	25,537	25,537	223	223	223	42,064	42,064	42,064

Production increased by 68% in Baena, doubled in Castilleja de la Cuesta, and tripled in Montefrío (Table 3). Productivity increased by around 40% in both Montefrío and Baena, and by 130% in Castilleja de la Cuesta. Population roughly doubled for all three sites across the 150 years studied (Table 3).

Total livestock numbers reduced between 1752 and 1897 in Baena and Montefrío (Table 3), but remained about the same in Castilleja de la Cuesta. At the end of the 19th century, livestock numbers in Baena and Montefrío were 35% and 14% of what they were in the mid-18th century. The reduction was greater for revenue-producing livestock (sheep, goats, and pigs) and much lower for working animals (cattle, horses, donkeys, and mules). There was also a net reduction in the fertilization capacity (i.e., manure production) for Montefrío and Baena, although it remained almost unchanged in Castilleja de la Cuesta.

Table 3. Population, agrarian production, and number of working (cattle, donkeys, horses, mules) and revenue-producing (sheep, pigs, goats) animals for the studied sites, 1752–1897

	Montefrío			Castilleja de la cuesta			Baena		
	1752	1852	1897	1752	1854	1897	1752	1858	1897
Production (tons dry weight)	3,157	7,387	9,470	127	268	255	25,718	37,782	43,420
Number of inhabitants	5,108	7,938	10,404	920	1,200	1,852	8,000	13,291	14,539
Population density (km2)	20	31	41	413	538	830	19	32	35
Production/inhabitant (kg dry weight)	618	931	910	138	223	138	3,215	2,843	2,986
Productivity (kg dry weight/ha)	414	537	581	666	1,333	1,541	782	967	1,108
Working livestock (heads)	2,979	1,588	1,983	134	174	124	5,310	4,339	3,355
Revenue-producing livestock (heads)	42,747	10,539	4,374	23	114	28	19,325	6,432	5,260
Manure availability per cropland (tons/ha)	2.7	0.8	0.6	1.5	2.3	1.6	0.6	0.5	0.3

Note. Production refers to food and feed production and industrial plants harvested in croplands. Biomass from pastures and forests is not included. Cropland in 1752 in Montefrío included permanent pastures through shifting cultivation management.

# Nutrient balances

Tables 4, 5, and 6 show the N, P, and K balances for the periods studied for Castilleja de la Cuesta, Montefrío, and Baena, respectively. Irrigated vegetables showed a negative balance for N in Castilleja de la Cuesta and Montefrío during the 1750–1850 period, mainly because they were not fertilized, although productivity was quite high and comparable to that of the late 19th century when historical sources explicitly recorded organic fertilization. The occasional irrigated biennial rotation of beans and wheat showed a positive balance for N throughout the period studied, except for Baena late in the 19th century. The N balance for the four-year rotation (*ruedo*) of beans–wheat–chickpeas–wheat for Baena was more negative throughout the 19th century, but changed from negative to positive in Montefrío. The one-third rotation showed a negative balance for Castilleja de la Cuesta, was slightly negative for Baena, and slightly positive for Montefrío. There was no clear temporal trend for Baena and Montefrío, whereas the balance was more negative throughout the 19th century in Castilleja de la Cuesta. The *año-y-vez* rotation, exclusive to Baena, showed a negative balance for N, without any major changes over time. The N balance for olive groves and fruit trees was positive for the three sites, except for Baena in the late 19th century. Finally, the balance for vineyards was negative for all three sites, and during the periods studied the magnitude of the negative balance increased in Baena, remained unchanged in Montefrío, and decreased in Castilleja de la Cuesta due to organic fertilization in the late 19th century.

P and K balances for crops in Castilleja de la Cuesta were negative (Table 4) due to the decrease in the manure application rate, except for constantly irrigated vegetables and P in vineyards at the end of the 19th century. Generally, the magnitude of the negative balance increased slightly throughout the period studied. The negative balance for K was, in general, higher than that for P.

Table 4. Net balances of nitrogen, phosphorus, and potassium (kg element/ha/yr) for Castilleja de la Cuesta, 1752–1897

	Constant irrigation	One-third rotation	Olive groves	Vineyards	Fruit trees
Nitrogen (N)					
1752	-25.7	-0.5	12.0	-5.9	14.7
1854	-32.6	-4.6	4.0	-16.6	10.7
1897	33.9	-17.6	7.3	-0.1	–
Phosphorus (P)					
1752	-16.3	-1.1	-0.9	0.7	-0.6
1854	-16.9	-2.7	-2.1	-3.4	-1.2
1897	8.3	-5.8	-1.6	3.5	–

	Constant irrigation	One-third rotation	Olive groves	Vineyards	Fruit trees
Potassium (K)					
1752	-29.7	-12.9	-15.8	-13.7	-12.7
1854	-30.2	-19.5	-20.8	-35.4	-22.5
1897	46.2	-39.4	-21.4	-22.1	–

Note. “–” means that a crop or rotation did not exist for this period.

**Table 5. Net balances of nitrogen, phosphorus, and potassium (kg element/ha/yr) for Montefrío, 1752–1897**

	Constant irrigation	Occasional irrigation	Ruedo	One-third rotation	Olive groves	Vineyards
Nitrogen (N)						
1752	-13.6	7.8	-3.6	0.7	15.2	-3.7
1852	-6.0	5.0	6.2	5.0	5.5	-8.9
1897	6.1	–	2.1	0.1	4.3	-8.9
Phosphorus (P)						
1752	-3.1	2.6	0.8	-0.6	-1.2	-1.1
1852	-1.2	1.9	-0.2	-1.5	-2.7	-3.4
1897	3.6	–	-0.4	-1.4	-2.9	-3.5
Potassium (K)						
1752	9.1	18.0	-5.3	-12.1	-27.8	-23.2
1852	13.0	7.1	-7.4	-17.2	-53.2	-53.4
1897	29.9	–	-12.8	-17.2	-54.1	-53.4

Note. “–” means that a crop or rotation did not exist for this period.

**Table 6. Net balances of nitrogen, phosphorus, and potassium (kg element/ha/yr) for Baena, 1752–1897**

	Constant irrigation	Occasional irrigation	Ruedo	Trasruedo	Año-y-vez rotation	One-third rotation	Olive groves	Vineyards
Nitrogen (N)								
1752	-1.33	–	1.2	–	-3.3	-0.3	0.7	-7.1
1858	9.79	2.98	-4.7	-4.4	-2.9	1.5	0.3	-9.1
1897	-7.78	-1.96	-9.8	-4.4	-3.4	-0.9	-3.4	-16.8
Phosphorus (P)								
1752	1.74	–	3.6	–	-2.4	-1.5	-2.8	-1.5
1858	-12.40	-2.25	0.1	-1.3	-2.9	-1.6	-2.8	-2.0
1897	-3.26	6.91	-2.1	-1.3	-3.3	-2.1	-3.4	-3.5

	Constant irrigation	Occasional irrigation	Ruedo	Trasruedo	Año- y-vez rotation	One- third rotation	Olive groves	Vineyards
Potassium (K)								
1752	15.95	–	3.4	–	-16.5	-13.1	-38.3	-30.6
1858	13.12	15.36	-12.6	-10.6	-16.5	-12.8	-38.7	-34.4
1897	27.22	30.34	-21.8	-10.6	-22.9	-23.5	-42.3	-45.8

Note. “–” means that a crop or rotation did not exist for this period.

In Montefrío, the *ruedo*, one-third rotation, olive groves, and vineyards all showed negative balances for P and K, which increased throughout the 19th century (Table 5). As occurred in Castilleja de la Cuesta, only irrigated cropland achieved positive balances for both nutrients. Similar trends were observed for Baena. P and K balances for all rotations and woody cropland were negative and tended to be more negative during the 19th century, whereas the balance was positive for irrigated cropland from the mid-19th century onwards.

To relate the magnitude of the negative balances to long-term crop sustainability, the time in which a reduction of the annual soil availability of N, P, and K due to that negative balance equaled the crop annual demand for N, P, and K was calculated only for Montefrío. For historical long-standing crops such as *ruedos* and one-third rotations, more than 500 years were needed for the negative balances of P and K to affect the harvest. However, for olive groves and vineyards the number of years was less than 500 and decreased throughout the 19th century, so that woody crops were not sustainable in the long term (i.e., < 300 years) from the mid-19th century.

# Manure and nutrient aggregated balances

In 1752, the quantity of manure applied was lower than that available for the three sites (Figure 2). However, all the available manure was used from the mid-19th century onward for Baena and Montefrío. In Castilleja de la Cuesta, manure availability was higher than that used for the first two thirds of the 19th century but was closer to parity at the end of that century.

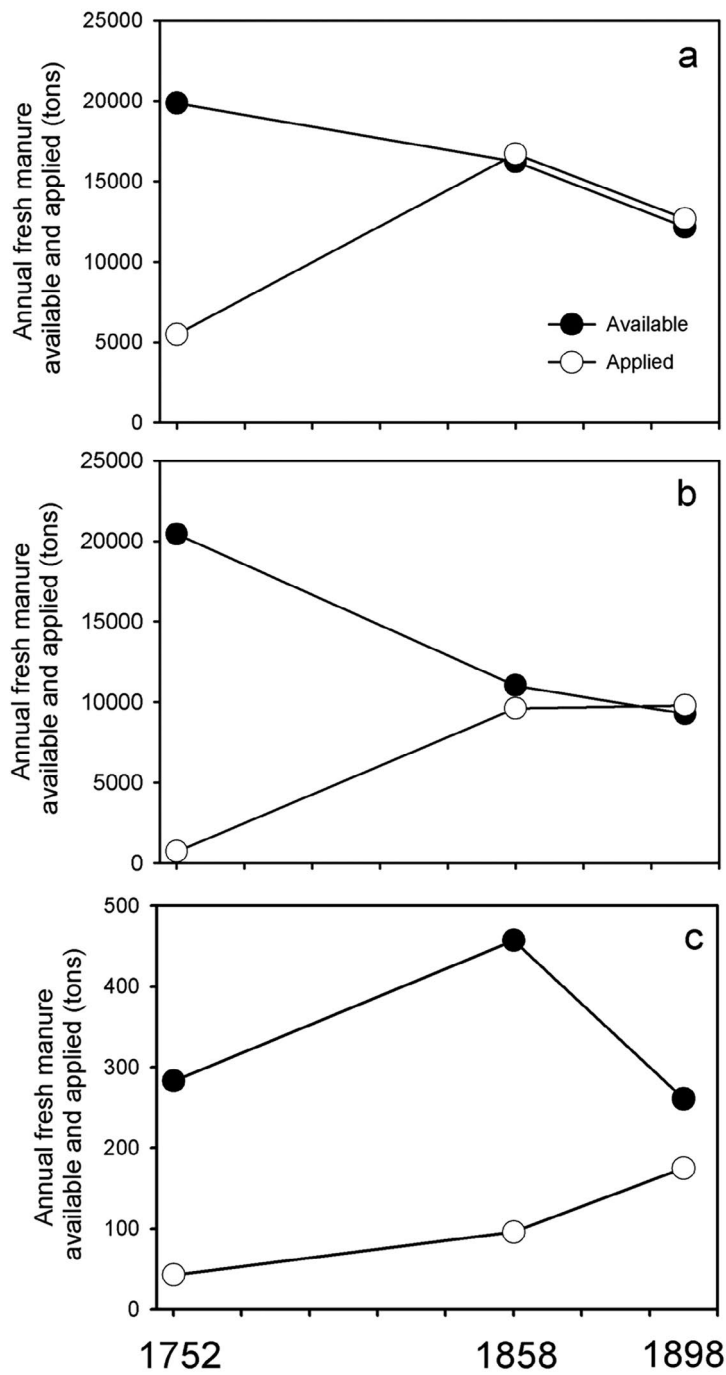


Figure 2. Annual fresh manure availability (full circles) and applied (empty circles) in (a) Montefrío, (b) Baena, and (c) Castilleja de la Cuesta, 1752–1897

Changes in the aggregated net balances for N, P, and K are shown in Figure 3. For Baena and Montefrío, the aggregate N balance was positive for the period corresponding to 1752, and still positive in the mid-19th century in Castilleja de la Cuesta. However, from 1858 the aggregated balance for N was increasingly negative and by the end of the 19th century it accounted for an annual net loss of 150 tons and 15 tons of N for Montefrío and Baena, respectively.

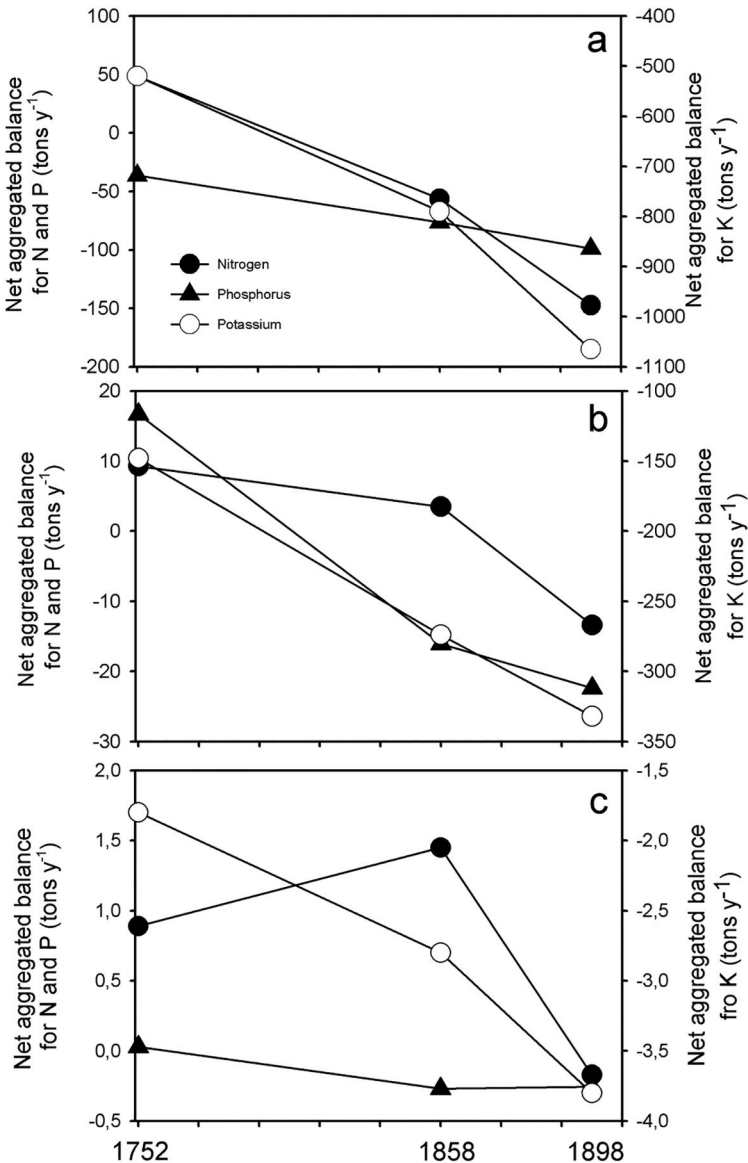


Figure 3. Aggregated net balance for nitrogen (full circles), phosphorus (full triangles) and potassium (empty circles) for (a) Montefrío, (b) Baena, and (c) Castilleja de la Cuesta, 1752–1897

In Baena, the aggregated net balance for the three nutrients for the 1750–1900 period was markedly negative. A similar trend was observed for N and K in Montefrío, while the decline in P was less severe. In Castilleja de la Cuesta, K declined steadily, P remained relatively stable, and N declined significantly from 1858.

## Discussion

### Changes in land use, production, and manure fertility capacity

Between 1752 and 1897 both production and productivity increased markedly in the three sites (Table 3), indicating that the accepted idea in Spanish historiography that agriculture was developed extensively rather than intensively over this period (Llopis Agelán, 2004) should be viewed with caution. The increase in productivity only became possible through the expansion of irrigated areas and the extension of more intensive crop rotation. Therefore, the main strategy to increase productivity in the Mediterranean inland areas in the late 19th century was the combination of an increase in cropland extension and intensification, although the former was heavily restricted by the availability of labor and the latter by fertilizers.

The very low population density in Baena and Montefrío was probably the main reason for the low production and productivity in those sites in the 18th century. The availability of arable land or fertilizer did not seem to be limiting factors for production, although the shortage of manpower was. Indeed, a significant part of the arable land in Montefrío (96%), Castilleja (39%), and Baena (67%) was devoted to non-fertilized cereal crops in a one-third rotation, characterized as subsistence crops. Fertilized intensive production, which took place during the 19th century, occupied relatively small areas. A combination of vegetables and fruits, and in some cases cereals, were the main crops grown intensively on irrigated land, together with the *ruedo* rotation, which was located in rainfed land near the villages, where the application of intensive work and fertilization was more feasible.

Population density steadily increased during the 19th century, probably due to the relative ease of cultivating new lands and the increased degree of specialization or intensification of areas already cultivated. Therefore, labor was no longer the main factor limiting production. The increase in population density had major socioeconomic and cultural consequences, and the land devoted to food was expanded at the expense of territory for feeding livestock. Revenue-producing livestock decreased significantly between 1752 and 1897 in



Montefrío (90%) and Baena (73%), probably because these animals (sheep, pigs, and goats) used parts of the agroecosystem that could not then be used for human food production or working animals. The number of working animals did not fall as sharply, given the net increase in demand for animal traction and the increase in cultivated land. As a consequence of the overall loss of livestock, the availability of manure per cultivated hectare was consistently low (Table 3).

These results suggest that the very low increase in productivity from the middle to the end of the 19th century (8%, 14%, and 18% for Montefrío, Baena and Castilleja de la Cuesta, respectively) in the Mediterranean region was due to a decrease in organic fertilization capacity. The decline in agrarian production per capita (data not shown) could be explained by this fact. It seems clear that the imbalance between cultivated land and that dedicated to animal feed affected fertilization capacity at a time when large shipments of grain, straw, and manure were limited.

The potential development of agriculture practiced in the 19th century in the agroecosystems of these three sites representative of the Mediterranean inland was close to its limit in the last decade of the 19th century, as the possibilities of increasing cultivated land were very limited. In general terms, there was stagnation or even a reduction in yields, with the exception of the woody crops.

These considerations suggest that the aforementioned rise in production between the mid and late 19th century was only achieved at the expense of the pool of soil nutrients (i.e., soil mining). The generalized decline in the amount of available manure per hectare of cultivated land supports this idea.

## Changes in crop nutrient balances

Results of the nutrient balances showed similar trends for the three sites. Crops or rotations with access to manure showed generally positive balances (i.e., surpluses of nutrients), and unfertilized areas tended to be negative, only lessened in the case of N by N-fixing from legumes or weeds (olive groves and cereals in the fallow third). However, the magnitude was different for various crops or rotations with different significances from short-, medium-, and long-term viability of the crop. Crop types or rotations that included legumes and/or a year of fallow with natural weeds or woody crops with natural weeds for most of the year (such as olive and fruit groves) displayed a positive balance for N.

As expected, nutrient balance for the irrigated land showed slight deficits or positive balances, given that most of the manure was applied to these crops. Occasional irrigation crops showed positive balances, mainly because these crops were rotated on a biennial basis with cereals and legumes. In this rotation model, legumes were a key element of N balance.

Non-irrigated land was divided into three distinct parts following a concentric pattern. The territory near villages was used to grow cereals as the main subsistence crop. The one-third rotation, which changed slightly depending on the site and period, consisted of wheat, rest, and seeded fallow in a three-year cycle and occupied significant arable land in Montefrío and Baena. The predominance of the one-third rotation was declining in Castilleja de la Cuesta and Baena as the agroecosystems specialized in woody crops, especially olive groves and the *ruedos*, but increased in Montefrío, probably because the uncultivated land was far from the useful area for crop production. The low population density in 1752 could explain the large scale and extensive nature of this system, generally poor in yield and associated with subsistence crops. The balance for N was near neutral for Montefrío and Baena but negative for Castilleja de la Cuesta. The balances for P and K were negative, strongly so for the latter. The harvest of this rotation was based on the removal (soil mining) of considerable amounts of P and K from the soil. This rotation, probably the consequence of a manure shortage which was resolved at the expense of a high land cost, displayed a negative balance for P and K from the very beginning. This situation must have been fairly common throughout the rainfed cereal lands of Andalusia with an equilibrated N balance, mainly due to the natural weed legumes in the year of rest, and significant deficits for P and K. A rotation as widespread as this was only possible due to the soil's P and K reservoir, that is, through mining.

Another grain crop cultivated relatively near villages was the *ruedo*. In Montefrío, the *ruedo*, also fertilized, displayed negative—although not very significant—balances for N and K during the 1752 period, due to low intensification. The nutrient balances for Baena in this period were more equilibrated (positive or near zero), because of the contribution of the legumes together with relatively low yields and some manure. Throughout the 19th century, the balance became more negative in Baena and remained unchanged or even slightly positive in Montefrío due to the use of higher doses of manure (15 tons) in Montefrío, and because of the alternation of wheat with beans to the detriment of chickpeas (for human consumption only), which have a relatively limited symbiotic N-fixation capacity. The P and K deficits were probably due to a shortage of manure, which, as we shall discuss later, affected arable land in the area. The rotation systems used in both municipalities combined cereals with legumes, thereby increasing inputs of N to the soil and food per unit area for both man and livestock. We believe that this rotation, which eliminated fallow due to the application of manure, represented the specific “agrarian revolution” of southern Spain and spearheaded the intensification of production experienced by Andalusia in the 19th century. In the mid-19th century, the specific agrarian revolution of southern Spain had demonstrated its benefits and this rotation was multiplied by 5.4, accounting for 3.268 ha in Baena.

The existence only in Baena of the *año-y-vez* rotation model, which alternated wheat and barley without fertilization with fallow in the second year, can be explained by the increasing interest in intensification. Yields increased during the late 18th century to mid-19th century then remained unchanged until the late 19th century. Due to the lack of fertilization, this rotation could only be maintained following the constant removal of the reservoir of soil nutrients. Recognition of this mining is important because this rotation was believed to be the peasant alternative to the extensive one-third rotation of large farms in Andalusia, given their high labor intensity. We strongly believe that this rotation was not sustainable, at least in Baena. It also existed in Castilleja de la Cuesta, but required manure, which was severely limited by livestock numbers.

The rest of the rainfed land was used for woody crops including grapevines and olive groves. There is no record of any fertilization in any of the historic sources, except for grapevines in the late 19th century. Throughout the period studied, olive groves were becoming increasingly important. Both are representative of the edapho-climatic conditions of inland Andalusia, where specialization in woody crops gained importance during the 19th century, a prelude to the main productive orientation of the 20th century. During the 18th century the degree of intensification was generally fairly low but increased significantly from the mid-19th century. N balances were positive, probably as a result of natural weeds, which included forage legumes that contributed to the replenishment of N removed by harvesting and pruning. The balance for P and especially K registered significant net losses. The intensification of olive farming during the 19th century by increasing tree density not only increased the net extraction of soil P and K, but meant that the balance for N was also less positive (in Montefrío) or even changed from positive to negative (in Baena).

Grapevines were important in the mid-18th century in Castilleja de la Cuesta and Baena but declined significantly throughout the 19th century. Over the same period in Montefrío, however, there was a fourfold increase in vineyard croplands. In general, yields increased significantly from the mid-18th century to the late 19th century. This clear intensification could only give rise to a significant deficit in the balances of K, P, and especially N, since manure was not applied. Not surprisingly, the rise in yields in several decades at the end of the 19th century was possible only through the application of a significant amount of manure (up to 32 tons) every five years. N balances were negative during the 18th and most of the 19th century, mainly because of the lack of natural weed cover with N-fixation capacity. Phosphorus was negative and K balances strongly negative throughout the periods studied for the three sites, indicating that this form of cultivation was linked to soil nutrient mining, and as the

intensification of crops increased, so did mining. There was a decrease in natural capital at the expense of vine exportation. The specialization of vineyards to produce table grapes was possible only through the application of manure.

## Significance of net nutrient extractions for long-term agrarian sustainability

The significance of deficits is largely dependent on the type of rotation and nutrient concerned. N deficiencies usually limit productivity in the short term and affect crop yield sooner, as the only significant route of input is via the atmosphere. Furthermore, in addition to soil loss and yield there are other output processes, such as denitrification, ammonia volatilization, and N leaching, that do not apply to P and K. In addition, P deficits had medium-term effects on yields because bedrock continuously supplied available P and soil has high P-retention capacity through complex processes. The amount of P taken up by crops is also much lower than N. Negative balances for K can be viable in the long term even though harvested K is similar to N, because the short-, medium-, and long-term pool of soil K available is usually vast.

In order to get an approximate idea of the consequences of such deficits, in the case of Montefrío, the number of years in which nutrient deficiencies affected crop yields (i.e., the number of years in which N, P, and K available in soil met crop demand for nutrients) were calculated (Table 7, web link).<sup>5</sup> One-third cereal rotations or more intensive crops such as the *ruedo* in Montefrío, with net nutrient extractions, were nutrient sustainable (> 500 years, Table 7) from an agrarian point of view. However, for woody crops such as olives and especially vines, the period for which annual P and K available in soil was lower than nutrient removal (harvest) was shorter. For both crops, if chemical P and K had not been applied early in the 20th century, it is probable that symptoms of nutritional deficiencies would have appeared today or even earlier. The grapevine was the only crop in the three case studies which showed a clear negative balance for N (Tables 4–6). It was the only crop with no input of organic matter and no N input from atmospheric N. As a consequence, the soil nitrogen pool progressively dwindled. The results clearly suggest that the vineyards of inland Spain can be considered unsustainable without the aid of fertilizers.

## The aggregate balance: Toward unsustainability

One of the most important attributes that should be taken into account when measuring the sustainability of agricultural systems is stability. This roughly encompasses the long-term maintenance of an agroecosystem's net primary

---

<sup>5</sup> Available at <http://www.historiambiental.org/descarga-de-datos/nutrient-balances-and-management-of-soil-fertility-prior-to-the-arrival-of-chemical-fertilizers-in-andalusia-southern-spain-human-ecology-review/>.

production. The territory had to maintain and even expand the aforementioned rotations—especially the most intensive ones—with its own resources, and this can be analyzed when aggregate balance is performed. This is particularly relevant for periods in the past, when importing nutrients from outside was heavily restricted and harnessing available biological energy required specific amounts of land (land cost) to replenish the harvested nutrients.

Around 1752, the availability of manure was enough to sustain crop demand, indicating that other factors, such as economics, led to an underutilization of abundant organic matter produced by livestock. The intensification of production that took place between the mid-18th and 19th centuries was possible through an increased use of manure. As a result, manure availability declined significantly. At some point in the mid-19th century, the maximum use of available manure was reached. Data clearly indicate that in the last few decades of the 19th century, all three territories had practically reached their limit for further crop intensification based on the resources of the agroecosystem. This fact might have contributed to the drop in yields and the negative balances of the three nutrients, despite the lower yields.

From a theoretical point of view, the presence of legumes in some rotations meant there was no shortage of N in either of the periods around 1752 or 1854. However, this was not the case for P, with slightly higher losses than inputs, and K, with clear mining. When a territory specialized in fruit trees, olive groves, and grapevines, nutrient removal not compensated with manure was generalized for all nutrients. In Castilleja de la Cuesta, chemical fertilizers were essential to further progress in terms of crop intensification and specialization and also to maintain the productive effort achieved in previous decades. This circumstance is significant in the context of the *fin-de-siècle* crisis, just before the extended use of chemical fertilization in Spain, when European farmers were forced to further increase yields per unit of land in order to compete in the national and international food markets. The results for Baena and Montefrío (Figure 2) confirm the findings for Castilleja de la Cuesta: a decline in fertilization capacity over the time period studied, which was greater in Baena and Montefrío, probably due to the reduction of land allocated to livestock feed. As a consequence, the territorial balance previously maintained was broken. It was also found that, in the late 19th century, the three sites all reached maximum possible crop intensification with their own resources and available technology. In fact, the negative aggregated balance observed for 1897 in Montefrío reveals that this capacity had been exceeded and that without the aid of synthetic chemical fertilizers, the level of intensification had to be reduced.

The intensification of cereals and specialization in olive groves and vineyards were responsible for the deficit of nutrients. The net reduction in nutrient availability resulting from the decrease in livestock meant that intensification

was based on the soil pool of nutrients (i.e., mining), especially for P and K. Even the effect of forage legumes in weed cover, which until the mid-19th century had made it possible to sustain a positive nitrogen balance, could not be maintained in subsequent years. The soil nutrient reservoir was key to increasing yields and maintaining productive efforts during the 19th century.

## Conclusions

The extensive cropland, the presence of fallow, and the low yields can be interpreted as an adaptive strategy by farmers to the structural shortage of manure. Thus, nutrient extraction was minimal for crops and rotations that were not fertilized. Nevertheless, the increase in food demand meant that arable land for food had to be expanded at the expense of land used to produce animal feed, and in turn this led to a clear decline in livestock numbers and a net reduction in the capacity to fertilize. As a result, the possibilities for further crop intensification were severely limited. It is clear that the intensification of unfertilized crops and rotations was based on the extraction of nutrients from the soil reservoir.

During the final decades of the 19th century, the three sites studied had reached or were close to the upper limit in terms of their possibilities for further intensification of agrarian production. Human and livestock carrying capacities were exceeded for the three territories studied. For some crops where production increased, especially woody crops, this was only possible at the expense of the soil nutrient reservoir and it made them even more unsustainable in the medium to long term. The scope of these deficits contrasts with the sustainability of woody crop specialization, which has been proposed as a plausible strategy for agrarian growth during the 19th century. However, it was based on the export of natural capital. The fact that the expansion of land allocated to vineyards and olive groves was preferably made on uncultivated land with a virtually untouched reservoir of nutrients might explain why this phenomenon was not noticed until recently.

This study confirms that the replacement of soil fertility has become the key factor in the sustainability of agrarian metabolism based on solar energy. In addition, we firmly believe that this replacement played a key role in the start of the transition toward industrial metabolism in agriculture (Fischer-Kowalski & Haberl, 2007).

## Acknowledgments

This investigation was possible thanks to the financial support from the Spanish Ministry for Education and Science (National R&D&i Programme HAR2009-13748-C03-03) for a project titled The Environmental History of Mediterranean Agrarian Landscapes, 1752–2008: A Contribution on Study of Socio-ecological Transition in Andalusia.

## References

- Abel, W. (1980). *Agricultural fluctuations in Europe: From the thirteenth to the twentieth centuries*. London: Methuen.
- Allen, R. C. (2008). The nitrogen hypothesis and the English agricultural revolution: A biological analysis. *Journal of Economic History*, 68(1), 182–210.
- Barles, S. (2007). Feeding the city: Food consumption and flow of nitrogen, Paris, 1801–1914. *Science of the Total Environment*, 375, 48–58.
- Bellot, J., & Escarre, A. (1989). Contribución del quimismo del agua de lluvia, de la deposición seca y la lixiviación, sobre la química de los flujos de trascolación y escorrentia cortical en el encinar mediterráneo. *Options Méditerranéennes*, 3, 211–214.
- Boring, L. R., Swank, W. T., Waide, J. B., & Henderson, G. S. (1988). Sources, fates, and impacts of nitrogen inputs to terrestrial ecosystems: Review and synthesis. *Biogeochemistry*, 6, 119–159.
- Brassley, P. (2000). Plant nutrition. In J. Thirsk (Ed.), *The agrarian history of England and Wales, VII, 1850–1914* (Part I, pp. 533–548). Cambridge: Cambridge University Press.
- Campbell, B. M. S., & Overton, M. (1991). *Land, labour and livestock: Historical studies in European agricultural productivity*. Manchester: Manchester University Press.
- Cunfer, G. (2004). Manure matters on the Great Plains frontier. *Journal of Interdisciplinary History*, 34, 539–567.
- Cunfer, G. (2005). *On the Great Plains: Agriculture and environment*. Texas: Texas A&M University Press.

- Cunfer, G., & Krausmann, F. (2013). Sustaining agricultural systems in the old and new worlds: A long-term socio-ecological comparison. In S. J. Sing, H. Haberl, M. Chertow, M. Mirtl, & M. Schmidt (Eds.), *Long term socio-ecological research: Studies in society-nature interactions across spatial and temporal scales* (pp. 269–296). Berlin: Springer.
- Del Porto, D., & Steinfeld, C. (1999). *The composting toilet system book*. Concord, MA: The Center for Ecological Pollution Prevention.
- Di, H. J., & Cameron, K. C. (2000). Calculating nitrogen leaching losses and critical nitrogen application rates in dairy pasture systems using a semi-empirical model. *New Zealand Journal of Agricultural Research*, 43, 139–147.
- EEA (European Environment Agency). (1999). *Atmospheric emission inventory guidebook* (2nd ed.). Copenhagen: EMEP/CORINAIR.
- Fischer-Kowalski, M., & Haberl, H. (2007). Conceptualizing, observing and comparing socioecological transitions. In M. Fischer-Kowalski & H. Haberl (Eds.), *Socioecological transitions and global change* (pp. 1–30). Cheltenham: Edward Elgar.
- García-Ruiz, R., González de Molina, M., Guzmán, G., Soto, D., & Infante-Amate, J. (2011). Guidelines for constructing nitrogen, phosphorus and potassium balances in historical agricultural systems. *Journal of Sustainable Agriculture*, 36, 650–682.
- Gathumbi, S. M., Cadisch, G., & Giller, K. E. (2002). <sup>15</sup>N natural abundance as a tool for assessing N<sub>2</sub>-fixation of herbaceous, shrub and tree legumes in improved fallows. *Soil Biology & Biochemistry*, 34(8), 1059–1071.
- González de Molina, M. (2002). The environmental constraints on agricultural growth in 19th century Granada (southern Spain). *Ecological Economics*, 41, 257–270.
- Guzmán Casado, G., & González de Molina, M. (2009). Preindustrial agriculture versus organic agriculture: The land cost of sustainability. *Land Use Policy*, 26(2), 502–510.
- Holtan-Hartwig, L., & Boeckman, O. C. (1994). Ammonia exchange between crops and air. *Norwegian Journal of Agricultural Sciences*, (Suppl. 14).
- Kasimir Klemetsson, Å., & Klemetsson, L. (2002). A critical analysis of nitrous oxide emissions from animal manure. In S. O. Petersen & J. E. Olesen (Eds.), *Greenhouse gas inventories for agriculture in the Nordic countries* (DIAS Report 81, pp. 107–121). Foulum, Denmark: Danish Institute of Agricultural Sciences.



- Krausmann, F. (2001). Land use and industrial modernization: an empirical analysis of human influence on the functioning of ecosystems in Austria 1830–1995. *Land Use Policy*, 18, 17–26.
- Krausmann, F. (2004). Milk, manure and muscular power: Livestock and the industrialization of agriculture. *Human Ecology*, 32, 735–773.
- Krausmann, F., Fischer-Kowalski, M., Schandl, H., & Eisenmenger, N. (2008). The global sociometabolic transition: Past and present metabolic profiles and their future trajectories. *Journal of Industrial Ecology*, 12(5/6), 637–656.
- Llopis Agelán, E. (2004). España, la revolución de los modernistas y el legado del Antiguo Régimen. In E. Llopis Agelán (Ed.), *El legado económico del Antiguo Régimen en España* (pp. 11–76). Barcelona: Crítica.
- McNeill, J. R., & Winiwarter, V. (Eds.). (2006). *Soils and societies: Perspectives from environmental history*. Isle of Harris: The White Horse Press.
- Pfister, C. (1990). The early loss of ecological stability in an agrarian region. In P. Brimblecombe & C. Pfister (Eds.), *The silent countdown: Essays in European environmental history* (pp. 37–55). Berlin: Springer.
- Pimentel, D., & Pimentel, M. (1996). *Food, energy and society*. Niwot, CO: University Press of Colorado.
- Shiel, R. S. (2006). Nutrient flows in pre-modern agriculture in Europe. In J. R. McNeill & V. Winiwarter (Eds.), *Soils and societies: Perspectives from environmental history* (pp. 216–242). Isle of Harris: The White Horse Press.
- Sieferle, R. P. (2001). *The subterranean forest: Energy systems and the industrial revolution*. Cambridge, UK: The White Horse Press.
- Smil, V. (2001). *Enriching the earth: Fritz Haber, Carl Bosch and the transformation of world food production*. Cambridge, MA: The MIT Press.
- Smil, V. (2008). *Energy in nature and society: General energetics of complex systems*. Cambridge, MA: The MIT Press.
- Tello, E., Garrabou, R., Cussó, X., Olarieta, J. R., & Galán, E. (2012). Fertilizing methods and nutrient balance at the end of traditional organic agriculture in the Mediterranean bioregion: Catalonia (Spain) in the 1860s. *Human Ecology*, 40, 369–383.
- Van Zanden, J. L. (1991). The first green revolution: The growth of production and productivity in European agriculture, 1870–1914. *Economic History Review*, 2, 215–239.

- Vinther, F. P., & Hansen, S. (2004). *SimDen – A simple empirical model for quantification of  $N_2O$  emission and denitrification* (DIAS Report 104, pp. 1–47). Foulum, Denmark: Danish Institute of Agricultural Sciences.
- Wichern, F., Eberhardt, E., Mayer, J., Joergensen, R. G., & Müller, T. (2008). Nitrogen rhizodeposition in agricultural crops: Methods, estimates and future prospects. *Soil Biology & Biochemistry*, 40(1), 30–48.
- Williamson, J. G. (2006). *Globalization and the poor periphery before 1950*. Cambridge, MA: The MIT Press.

# Climate Change and Society: Toward Online Pedagogy

Jennifer Kelly,<sup>1</sup> Aaron McCright, and Thomas Dietz  
Michigan State University, East Lansing, United States

## Abstract

Climate change, one of the most important social problems of the twenty-first century, challenges pedagogy to incorporate complex themes from social and biophysical sciences. We propose an approach to a course on “Climate Change and Society” grounded in pedagogical research. Integrating the development of higher-level learning skills into course learning objectives, we suggest such a course be implemented online to take advantage of the virtual teaching and learning tools available to educators of climate change and as a way to actively engage the learner, thus using online pedagogy as a key element in learning that spans social and biophysical sciences.

Keywords: biological sciences, climate change, learning, pedagogy, physical sciences, social sciences, teaching

## Introduction

Knowledge of climate science and understanding of climate change among the United States’ (U.S.) general public (e.g., Marquart-Pyatt et al., 2011; McCright & Dunlap, 2011; Reynolds et al., 2010), among U.S. college students (e.g., Hartley et al., 2011), and even among U.S. college students in the STEM disciplines of science, technology, engineering, and mathematics (e.g., Sterman & Sweeney, 2007) is weak at best. This has much to do with the fact that the science of climate change is exceedingly difficult for educators and other communicators to teach and for students and audiences of all ages to learn (e.g., Boyes & Stanisstreet, 2001; Coyle, 2005; U.S. National Research Council, 2007, 2011). A recent study finds that instructors of undergraduates need ongoing pedagogical support to effectively teach climate change (Kirk et al., 2014). These challenges are heightened for climate change courses grounded primarily in the social sciences. While such courses are clearly needed, social science instructors rarely have sufficient expertise in the biological and physical science aspects of climate change.

---

<sup>1</sup> Corresponding author: kellyj24@msu.edu.

Recently the scientific community has refocused to explicitly integrate the physical, biological, and social sciences for the study of climate change (U.S. National Research Council, 2010a, 2010b). At the same time, public discourse on climate change is shifting more toward “real-time Internet and news media communication” (Hamilton, 2012). This raises important challenges and opportunities for pedagogy in social science, an area with considerable scholarship on climate change but with little cohesion and consistency in its teaching on the topic. The opportunity to teach insights on the social drivers, dynamics, and impacts of climate change to post-secondary students is appealing. Yet, a social science course on climate change brings with it some complexities that are different from those faced in many other social science courses. One of these is the biological and physical science content that must also be conveyed in such a course. We cannot expect social science instructors to become experts in the complex physical and biological aspects of climate change, but neither can these topics be ignored. For an undergraduate course to integrate biophysical and social science information, methods, and skills is rare at best, but that does not discount the fact that such efforts are crucial for students to have a more holistic understanding of climate change.

One emerging way to address this challenge in a social science course is to integrate online education modules dealing with climate change from the physical and biological sciences. Clark-Ibáñez and Scott (2008) note that a key advantage to online teaching is that many valuable learning materials are already online. Examples relevant to a course on climate change and society are abundant, as the U.S. National Aeronautics and Space Administration (NASA) ([climate.nasa.gov/resources/education](http://climate.nasa.gov/resources/education)), U.S. National Oceanic and Atmospheric Administration (NOAA) ([www.climate.gov/#climateWatch](http://www.climate.gov/#climateWatch)), U.S. National Science Foundation ([www.exploratorium.edu/climate/](http://www.exploratorium.edu/climate/)), U.S. National Climate Assessment ([www.climate.gov/teaching/2014-national-climate-assessment-resources-educators](http://www.climate.gov/teaching/2014-national-climate-assessment-resources-educators)), and U.S. National Academies ([nas-sites.org/americasclimatechoices](http://nas-sites.org/americasclimatechoices))—including Koshland Science Museum’s Earth Lab ([koshland-science-museum.org/explore-the-science/earth-lab](http://koshland-science-museum.org/explore-the-science/earth-lab))—have made robust investments in climate change education resources in recent years.<sup>2</sup> Thus, what was otherwise a major challenge—incorporating non-social science material into a social science course—becomes an opportunity to make effective use of existing online resources.

---

2 The list of internet resources is focused on the U.S. While climate change is a topic that inevitably engages discussions of global issues and an international perspective, we have designed our course assuming the majority of students will be from the U.S. and thus need examples grounded in the U.S. to complement international perspectives. But the basic pedagogical ideas we present can be generalized. Indeed, having a significant number of non-U.S. students in the course can aid in showing the variation across world regions in the effects of and possible responses to climate change.

Here we consider how effective pedagogy in the social sciences can be developed while using such materials. Our focal question is: How can we best cultivate higher-order thinking skills using online climate change education modules? While there is very little literature on effective social science climate change education, we aim to develop an initial set of concepts and approaches by drawing on existing literature from social science and STEM education.

## The special challenges of climate change pedagogy

Howard (2010, p. 91) identifies the essence of the pedagogical challenges we face:

How do we go about changing students' definitions of the classroom from a passive environment to an active one? How do we create a shift from surface learning to deep learning? We will need an interdisciplinary approach and to learn from the successes and failures of other disciplines in promoting learning.

For our online course on "Climate Change and Society," we meet these challenges through a critically engaged approach that intentionally integrates the physical and biological sciences with the social sciences. Given much scholarship of teaching and learning is disciplinary in nature, we recognize both the challenges and opportunities of teaching a course on climate change and society (e.g., McCright, 2012).

Contemporary assessments of climate science emphasize the necessity of interdisciplinary understanding (U.S. National Research Council, 2010a). The seven principles of climate science literacy developed by NOAA and NASA convey this interdisciplinarity (Table 1). The first five principles listed in the table must be addressed during social science instruction, as they provide context for understanding the human dimensions of the problem (the last two principles).

**Table 1. Seven principles of climate science literacy**

1.	The sun is the primary source of energy for Earth's climate system.
2.	Climate is regulated by complex interactions among components of the earth system.
3.	Life on Earth depends on, is shaped by, and affects climate.
4.	Climate varies over space and time through both natural and human-made processes.
5.	Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
6.	Human activities are impacting the climate system.
7.	Climate change will have consequences for the earth system and human lives.

Source: U.S. Global Change Research Program (2009).

Any course guided by these principles will have to integrate social, physical, and biological sciences into its pedagogy. We agree with Hartley and colleagues (2011, p. 65) that a grounding in the physical and biological science principles of climate change are “essential skill[s] for scientific literacy,” and these principles cannot be ignored in social science courses on climate change. Yet, we know that biophysical science educators still grapple with how best to teach vital but complex subjects such as the carbon cycle (Hartley et al., 2011) and the dynamics of stocks and flows (Sterman & Sweeney, 2007). We suggest that online materials—especially simulations that students can manipulate, such as those at the Koshland Science Museum’s Earth Lab<sup>3</sup>—are likely to prove quite useful for such subjects, complementing the skills of the social science instructor with those of pedagogical efforts of climate science educators.

To make effective use of these materials and advance the social science pedagogy of climate change, social science educators must draw upon the best practices in biophysical science and online pedagogy. We note that while we have developed this approach around an entirely online course, the use of online materials and our general points follow for a course that is either a hybrid of online and face-to-face materials or a face-to-face course that uses some online materials. We are not arguing that online only is inherently superior for integrating climate change into a social science course, merely that online materials, properly deployed, can help meet some of the core challenges of a social science course that must incorporate physical and biological science materials.

## Effective climate change pedagogy in an online classroom

We emphasize two pedagogical “best practices”—teaching critical-thinking skills and engaging with our learners—as guides for how online modules can be used to integrate key climate change concepts into a social science course. These principles are already deployed in many social science classrooms, but we highlight them here as both special and essential for teaching climate change online.

### Critical-thinking skills

Although educators often acknowledge the importance of critical thinking, this does not easily translate into skills taught to students. In fact, in a study assessing critical thinking in California universities, Paul and colleagues (1997, p. 18) found that although 89% of education, arts, and science faculty reported the

---

3 [koshland-science-museum.org/explore-the-science/earth-lab](http://koshland-science-museum.org/explore-the-science/earth-lab).

importance of critical thinking in their instruction, only 19% could explain it, and only 9% were teaching it. In response to pedagogical gaps in teaching critical-thinking skills, Anderson and Krathwohl (2001) developed a taxonomy of cognitive learning, based on earlier work by Bloom (1956). This taxonomy can be translated into educational objectives, with application, analysis, synthesis, and evaluation as the basis of critical-thinking skills. In addition, knowledge and comprehension, while not critical-thinking skills in themselves, are necessary for competence and to move into higher-order thinking. Importantly, using, valuing, and teaching critical-thinking skills are all distinct actions. For institutions, departments, and faculty to help students develop critical-thinking skills and dispositions, it would be helpful to implement a specific model of critical thinking that then would be used consistently in instruction. Such a model is necessary if students are to be able to change their deep-seated patterns of thinking and develop true critical-thinking behaviors.<sup>4</sup>

Part of critical thinking requires the ability to synthesize, connect, and coherently integrate new knowledge within pre-existing paradigms. Climate change educators urge a move toward a more comprehensive approach to teaching and learning, where concepts are understood in connection with one another rather than as individual units (Hartley et al., 2011; McCright et al., 2013). Within social science, connections among prior knowledge, life experiences, and course content are a sign of deep learning and are encouraged in the classroom (McKinney et al., 2004, p. 45). Godfrey (2015) uses an earth community paradigm in her course on Society and Climate Change to underscore the interconnectedness of the social and natural world. She implemented creative learning activities such as the problem tree, a concept-mapping activity designed to encourage in-depth discussions and collective decisions through interactive analytical processes in a group setting.<sup>5</sup> Dole and Bloom (2009, p. 9) apply an online inquiry-based design to encourage higher-order learning outcomes, finding that it enables students to collaborate, reflect, mentor, and problem solve and “require[s] learners to integrate past experience and current knowledge with new knowledge and experience to reflect on and create meaningful connections with course content.” Finally, others find peer learning to facilitate the connection of different knowledge systems (Batzli et al., 2006).

4 Resources to foster such an endeavor can be found at [www.criticalthinking.org](http://www.criticalthinking.org).

5 For more ideas on a Society and Climate Change course see Godfrey (2015), who implemented creative activities in her face-to-face classroom that could be transformed for an online course. Her teaching approach is holistic and promotes active learning in the context of climate change.

## Engaging with our learners

Faculty and administrators increasingly promote active learning in which students learn by doing something (e.g., Christiansen & Fischer, 2010; Godfrey, 2015; Obach, 2009; Pedersen, 2010; Persell, 2004), while the best practices of online learning in social science urge instructors to “increase motivation and engagement” among learners (McKinney, 2010, p. 1). In addition to fostering active rather than passive students, engaged learning may facilitate the development of analytical skills for higher-order learning. For example, Dowell (2006) engages students on waste issues by having them collect garbage, analyze it, and write an essay based on their analysis—linking theory to everyday life. Dowell (2006, p. 155) finds that the exercise “leaves a lasting impression and may pique interest in viewing the world through a sociological lens.” As a best practice of online learning, Boettcher and Conrad (2010) suggest that a course address core concepts in a way that requires students to re-apply them in different contexts, at different levels of comprehension, and with different online tools. Batzli and colleagues (2006) propose that students gather their own data when attempting to solve complex real-world problems. This provides a foundation for students to connect their pre-existing conceptual framework with new knowledge.

Not surprisingly, scholars identify online discussions as a best practice (Boettcher & Conrad, 2010, p. 37; McKinney, 2010, p. 1). Online discussions provide an additional way for students to interact with each other and engage with a course—supplementing and extending in-class activities. For example, Pearson (2010) highlights the importance of an online classroom where knowledge is shared and meanings are renegotiated in online discussions. This is different from much of the writing that occurs in a traditional course design and in many online approaches, whereby students’ writing is read mostly—if not entirely—by the instructor alone. In their review of best practices of online discussions, Boettcher and Conrad (2010, p. 37) suggest that successful student posts should invite responses, questions, discussions, and reflection. Persell (2004) finds that online discussions produce greater participation, engagement, and interaction compared to the traditional course design. Students spend more time analyzing and reflecting on the questions being posed before providing written feedback and are more likely to feel as though they are part of a classroom dialogue (Clark-Ibáñez & Scott, 2008). This suggests that online discussions have the ability to create supportive online communities—another best practice of online learning (Boettcher & Conrad, 2010, p. 37). Additional research suggests that benefits of online discussions are more likely to occur when these forums are graded (Swan et al., 2006).



Enhanced learning outcomes may be achieved in the online classroom with a more frequent, reflective, and enriched dialogue (Wright & Lawson, 2005). For example, Roper (2007) found that students receiving high grades in an online course claimed that their success was due, in part, to making the most of online discussions, asking questions useful to learning, and making connections with fellow students. Finally, Kortemeyer (2007) finds that online discussions can be a diagnostic tool in assessing student beliefs, attitudes, expectations, and approaches to course content, enabling these forums to serve as more than a teaching strategy.

These tenets of best practices guide us when designing a course on climate change and society. From this brief review of pedagogical literature we know that higher-level cognitive skills help students learn about complex, real-world problems such as climate change. Further, this review makes clear the importance of actively engaging students. Instructors of more traditional topics in the social sciences have spent years developing ways to actively engage students. Climate change, a subject that involves the biophysical sciences as well as social sciences, will require a special effort to ensure learning that meets the criteria not only for engagement, but critical-thinking skills as well.

## Climate change and society: The course

We now explain a design for integrating these best practices for online teaching and learning into an online course on climate change and society. Using Bloom's taxonomy of education objectives (Anderson & Krathwohl, 2001) and the seven principles of climate change literacy (U.S. Global Change Research Program, 2009), we propose a set of specific learning objectives to guide instructors (Table 2). Following Biggs (1999), these objectives begin with action verbs, signaling to instructors and students alike how such objectives may later be assessed. While we acknowledge there are various ways to implement these objectives, we outline examples of learning activities that could be used in an online class on climate change and society. While we urge instructors to design their own tailored assessments, we suggest how student learning may be assessed for each of these activities. We note that peer review may serve as the first stage of assessment (Phelan, 2012) and that some of the assignments meet more than one course objective.

**Table 2. Course objectives for climate change and society**

1.	Identify, classify, and assess the key biophysical and social processes driving the climate.
2.	Identify and explain key vulnerabilities and/or adaptation potential for a selected relevant case.
3.	Apply learned insights to a new case.
4.	Assess the costs and benefits for relevant stakeholder groups of the major strategies for limiting climate change.
5.	Explain decision-making under uncertainty and how it is relevant in analyzing policy choices.
6.	Evaluate local, state, regional, national, and global roles in the context of climate change.
7.	Using higher-order thinking skills, explain climate change.

## **Objective 1: Identify, classify, and assess the key biophysical and social processes driving the climate**

Since social science students may be inclined to be passive during a focus on biophysical science content, climate change and society course instructors should therefore work especially hard to promote active learning during that time. Thus, while a mini lecture on the carbon cycle may be necessary to identify the key biophysical processes driving the climate, it can easily be supplemented with think-pair-share activities (Bataineh, 2015) or online one-minute papers (Erickson & Erickson, 2013) to spur student engagement. We suggest that students then identify—and classify (e.g., land use, fossil fuels consumption)—their personal life activities that drive climate change.

After doing so, students would complete an ecological footprint quiz, which calculates individuals' personal impact on the ecosystem with answers to questions about their living, transport, and dietary behaviors, for example.<sup>6</sup> Students would then reflect upon the results of their ecological footprint quiz. They would compare these results, which are based on scientific research, to their earlier estimates to better understand their prior knowledge in this area. Reflection upon this comparison may also help students better understand how their personal behaviors (e.g., consuming processed versus local food) impact ecological change. Further, students would identify three behavioral changes that would significantly reduce their ecological footprint. This assignment is similar to what Christiansen and Fischer (2010) call “walk the talk” in their course “Sustainable Cities in North America.”

6 For an overview of ecological footprints including definitions, measures, and calculators, see Čuček et al. (2012). With a population of undergraduate students, it is important to use ecological footprint calculators—such as [www.earthday.org/footprint-calculator](http://www.earthday.org/footprint-calculator)—that relate moderately well to common student living conditions (e.g., dorm/rental residences, cafeteria dining). Note that while we endorse footprint calculators for their pedagogical value, we are also aware that there is considerable variation across such calculators in their assessment of individual impacts on the environment.

Obach (2009) has students post their ecological footprint quiz results and reflections on a discussion board for peer review and commentary, and we also recommend this. Further, students would respond to the posts of two other students for additional experience in analyzing the processes driving climate change. Such activities can help students see the impact of their (and their peers') individual choices and behaviors on the climate and evaluate which choices and behaviors have a greater or lesser impact on the climate. The peer review process serves as a stage of formative assessment reflections. Record-keeping activities produced from this project are tools to help students understand how social structural and cultural factors impact the carbon cycle. Students would be assessed on how well they accomplish the objectives of identifying, classifying, and assessing key processes driving the climate. This activity also provides an opportunity for students to consider their role as consumers and as citizens.

**Objective 2: Identify and explain key vulnerabilities and/or adaptation potential for a selected relevant case; Objective 3: Apply learned insights to a new case; Objective 4: Assess the costs and benefits for relevant stakeholder groups of the major strategies for limiting climate change**

After lecturing on key vulnerabilities and adaptation potential using case studies, we suggest that students work in a team with an example problem (e.g., invasive species; Batzli et al., 2006) as part of the instruction as yet another way to promote critical thinking. The Colorado River Water Supply Module (CRWSM) from the Encyclopedia of Earth website<sup>7</sup> is an example problem that could be used to meet Objective 2. In this module, students would become acquainted with the Colorado River watershed by looking at a summary of graphs, charts, and data. The assignment built around the module asks the students to assess the data to determine if the climate is changing and then explain their answer. Students then would be asked to review, reflect upon, and assess water allocation, enabling them to connect society, policy, and science by explaining the outcomes, while assessing who is using the water for which purposes.

Next, the student teams would work with a new case<sup>8</sup> in order to apply their learned knowledge from the lecture and the CRWSM. This exercise will meet Objectives 3 and 4. To meet Objective 3 students would proceed through the same steps as in the CRWSM, but this time with a new case of their choice. To meet Objective 4, students would assess the costs and benefits for limiting

<sup>7</sup> The module is found at [www.eoearth.org/resources/view/166680/?topic=54424](http://www.eoearth.org/resources/view/166680/?topic=54424).

<sup>8</sup> UNESCO has a list of case studies from which students can choose: [whc.unesco.org/en/news/319](http://whc.unesco.org/en/news/319).

climate change from the perspective of the relevant stakeholder groups in their specific case study. The student teams would then post their analyses for their new case to the class discussion forum. Each student would then individually review and provide feedback (via clarifying and analytical questions) on one other team's post, again using the peer review process as a form of formative assessment (Phelan, 2012). Students would be assessed based on their effective use of higher-order thinking skills stated in the objectives: identifying, explaining, applying, and assessing in connections with key vulnerabilities, adaptation, and mitigation strategies of coupled human and natural systems to climate change.

### **Objective 5: Explain decision-making under uncertainty and how it is relevant in analyzing policy choices**

Following a lecture that defines and identifies issues in “decision-making under uncertainty” using case studies, we suggest one way to implement an active lesson is to have students examine media coverage of climate change. For example, following Dowell's (2006) lesson design, students would collect, analyze, and write about the content of comments by political officials and scientists in climate change news articles found in major newspapers or other media. After analysis, students would explain the issues in decision-making under uncertainty and how those decisions impact policies. Such explanations would then be posted to the discussion board where they would be reviewed by two peers. This allows students to work on their problem-solving and analytical reasoning skills in a communicative and engaged way, and practice their skills of providing and receiving feedback, while applying what they learned in the lecture to other contexts. Students would be assessed on their ability to explain, in their own words, the scientific uncertainty underlying one or more policy decisions, the concerns with scientific uncertainty, and how the concerns and uncertainty impact policy.

### **Objective 6: Evaluate local, state, regional, national, and global roles in the context of climate change**

Following a lecture that defines, identifies, and evaluates economic and policy (adaptation and mitigation) solutions to climate change, students would be encouraged to review information on these solutions using the Encyclopedia of Earth website to generate ideas for a paper.<sup>9</sup> In this paper, they would make

---

9 The Encyclopedia of Earth has the structure of a wiki with opportunities for viewers to comment. But article content is peer reviewed and suggested changes are not made unless the editors and peer reviewers concur that such changes are scientifically appropriate ([www.eoearth.org/topics/view/51cbfc8cf702fc2ba812cc93/](http://www.eoearth.org/topics/view/51cbfc8cf702fc2ba812cc93/)).

a case for a policy/practice that will facilitate adaptation to and/or mitigation of climate change at one of the following scales: local, state, regional, national, and global. The students would identify the specific scale/scope of the solution, evaluate its costs and benefits, and provide evidence/reasoning to evaluate the practicality and feasibility of this solution. For example, students may write about the abilities of local communities to provide mitigation strategies by hosting farmers' markets all year round to reduce the carbon footprint of produce. Students again would peer review a colleague's paper to provide feedback for revision. Students would be assessed on how well they explain and evaluate the costs and benefits of such a policy or practice. Such an exercise would allow the students to use evaluation skills (critical in higher-order thinking) in the context of climate change solutions and would also help them in course Objective 7.

## **Objective 7: Using higher-order thinking skills, explain climate change**

Some forms of engagement focus on helping students cultivate their citizenship skills, where the application to real-life settings is important. One example of this is to have the students develop an outreach program or an informational pamphlet as proposed in Pranc's (2011) course on eating disorders. After offering many creative ideas, students finally agreed on conducting a student-run campus awareness week, in which the students in the course could demonstrate their newfound knowledge in a useful way. We suggest that an assignment requiring students to explain climate change using a medium of their choice (e.g., public service announcement, short Internet ad, comic book, digital story) is one way to approach this objective and could be developed as a final assignment for the class. A successful explanation would need to include one or more higher-order thinking skills: application, analysis, synthesis, and/or evaluation. Students yet again would peer review a colleague's product to provide feedback for revision. Students would be assessed on how effectively they explained climate change while using all seven principles learned in the course. The students' ability to use more critical-thinking skills in their explanation and improve the quality of their product through the peer review process would result in a higher performance level.

## **All seven course objectives met**

Dole and Bloom (2009) designed an online course drawing on "how people learn" (U.S. National Research Council, 1999), a pedagogical framework grounded in empirical evidence about the efficacy of teaching and learning. In their design, students write up a short description of their initial thoughts, ideas, and opinions on the topic as the first task for the course—labeled as the

“generating ideas” phase. Next, modules provide an iterative writing process in which students reflect on those initial short papers after they engage in the readings, lectures, online learning activities, interviews, and discussion forums. This allows students to reflect on pre-existing knowledge and experiences from their initial short papers and provides an opportunity to replace prior knowledge with new knowledge (or synthesize where appropriate)—encouraging the development of critical-thinking skills and the acquisition of in-depth knowledge of the topic. Such an exercise also avoids the learning barrier identified by Hartley and colleagues (2011, p. 65) in which many students draw on informal reasoning and personal experience when asked to synthesize or apply concepts by asking them explicitly to link their initial personal views with new material from the course.

In a course on climate change and society, the first module would cover natural and anthropogenic drivers of climate change. Students would be asked to identify and classify key biophysical processes driving climate change and then explain how their own behaviors, such as the foods they eat, may impact the climate. Next, students would be asked to engage in the peer review of each other’s work, as a stage of formative assessment. This can be done using an online discussion forum, thus preventing the isolated writing that takes place in a traditional course design, as consistent with Pearson’s suggestions (2010). Finally, based on peer and instructor comments, students would revise their paper and resubmit it for a grade. These iterative mechanisms are opportunities for students to learn the principles of problem solving and critical thinking, much in the way that inquiry is traditionally approached in academic scholarship. In such a course, each module would focus on a course objective with the last module, building on all other modules, requiring students to explain climate change to a lay audience (see Objective 7, above).

## Conclusion

Climate change educators are faced with the daunting task of making complex scientific research accessible to students in a succinct way. In order for students to be climate literate, they need to understand social, physical, and biological processes. Further, given that climate change and society is a new pedagogical topic, most of the educational investment to date has been in online tools and activities. Such resources can be a great advantage for fostering social science students’ learning of biophysical and social aspects of climate change. Therefore, we believe an online setting is a valuable design for climate education in the social sciences. Here we have sketched an initial approach making use of exercises supported by research in the literature and in many cases making use of online resources for learning about climate change. Of course, the literature

and the online tools will continue to evolve. But we believe our general points are robust. The challenges of incorporating material from the physical and biological sciences into a social science course make active learning especially valuable, and online materials can be useful tools for facilitating this learning.

## References

- Anderson, W. L., & Krathwohl, D. R. (2001). *Taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.
- Bataineh, M. Z. (2015). Think-pair-share, co op-co op and traditional learning strategies on undergraduate academic performance. *Journal of Educational and Social Research*, 5(1), 217.
- Batzli, J. M., Ebert-May, D., & Hodder, J. (2006). Bridging the pathway from instruction to research. *Frontiers in Ecology and the Environment*, 4(2), 105–107.
- Biggs, J. (1999). What the student does: Teaching for enhanced learning. *Higher Education Research & Development*, 18(1), 57–75.
- Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals*. New York: McKay.
- Boettcher, J. V., & Conrad, R. M. (2010). *The online teaching survival guide: Simple and practical pedagogical tips*. San Francisco, CA: Jossey-Bass.
- Boyes, E., & Stanisstreet, M. (2001). Plus ca change, plus c'est la meme chose?: School students' ideas about the 'greenhouse effect' a decade on. *Canadian Journal of Environmental Education*, 6, 77–101.
- Christiansen, L., & Fischer, N. (2010). Teaching urban sociology and urban sustainability on two feet, two wheels, and in three cities: Our experience teaching sustainable cities in North America. *Teaching Sociology*, 38(4), 301–313.
- Clark-Ibáñez, M., & Scott, L. (2008). Learning to teach online. *Teaching Sociology*, 36(1), 34–41.
- Coyle, K. (2005). *Environmental literacy in America: What ten years of NEETF/Roper Research and related studies says about environmental literacy in the U.S.* Washington, DC: National Environmental Education and Training Foundation.

- Čuček, L., Klemeš, J. J., & Kravanja, Z. (2012). A review of footprint analysis tools for monitoring impacts on sustainability. *Journal of Cleaner Production*, 34, 9–20.
- Dole, S., & Bloom, L. (2009). Online course design: A case study. *International Journal for the Scholarship of Teaching and Learning*, 3(1), 1–11.
- Dowell, W. (2006). Throwing the sociological imagination into the garbage: Using students' waste disposal habits to illustrate C. Wright Mills's concept. *Teaching Sociology*, 34(2), 150–155.
- Erickson, L. E., & Erickson, P. A. (2013). Predicting student performance using online one-minute papers. *Journal for Economic Educators*, 13(1), 6–13.
- Godfrey, P.C. (2015). Teaching society and climate change: Creating an 'earth community' in the college classroom by embodying connectedness through love. *Journal of Sustainability Education*, March.
- Hamilton, L. (2012). Communicating climate science, the Internet may be the key. *Climate Science & Policy*. Retrieved from [www.climatescienceandpolicy.eu/2012/03/communicating-climate-science-the-internet-may-be-the-key](http://www.climatescienceandpolicy.eu/2012/03/communicating-climate-science-the-internet-may-be-the-key)
- Hartley, L. M., Wilke, B. J., Schramm, J. W., D'Avanzo, C., & Anderson, C.W. (2011). College students' understanding of the carbon cycle: Contrasting principle-based and informal reasoning. *BioScience*, 61(1), 65–75.
- Howard, J. R. (2010). 2009 Hans O. Mauksch address: Where are we and how did we get here? A brief examination of the past, present, and future of the teaching and learning movement in sociology. *Teaching Sociology*, 38(2), 81–92.
- Kirk, K. B., Gold, A. U., Ledley, T. S., Sullivan, S. B., Manduca, C. A., Mogk, D. W., & Wiese, K. (2014). Undergraduate climate education: Motivations, strategies, successes, and support. *Journal of Geoscience Education*, 62(4), 538–549.
- Kortemeyer, G. (2007). Correlations between student discussion behavior, attitudes, and learning. *Physical Review Special Topics – Physics Education Research*, 3, 010101.
- Marquart-Pyatt, S., Shwom, R. L., Dietz, T., Dunlap, R. E., Kaplowitz, S. A., McCright, A. M., & Zahran, S. (2011). Understanding public opinion on climate change: A call for research. *Environment*, 53(4), 38–42.



- McCright, A. M. (2012). Enhancing students' scientific and quantitative literacies through a sociological inquiry-based learning project on climate change. *Journal of the Scholarship of Teaching and Learning*, 12(4), 86–102.
- McCright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *The Sociological Quarterly*, 52, 155–194.
- McCright, A. M., O'Shea, B. W., Sweeder, R. D., Urquhart, G. R., & Zeleke, A. (2013). Promoting interdisciplinarity through climate change education. *Nature Climate Change*, 3, 713–716.
- McKinney, K. (2010). Distance learning in sociology: Some example SoTL work. *Teaching/Learning Matters: ASA's Newsletter for the Section on Teaching Learning in Sociology*, 39(1), 1–2.
- McKinney, K., Howery, C. B., Strand, K. J., Kain, E. L., & Berheide, C. W. (2004). *Liberal learning and the sociology major updated: Meeting the challenge of teaching sociology in the twenty-first century*. A Report of the ASA Task Force on the Undergraduate Major, Washington, DC: American Sociological Association.
- Obach, B. K. (2009). Consumption, ecological footprints and global inequality: A lesson in individual and structural components of environmental problems. *Teaching Sociology*, 37(3), 294–300.
- Paul, R. W., Elder, L., & Bartell, T. (1997). *California teacher preparation for instruction in critical thinking: Research findings and policy recommendations* (California Commission on Teacher Credentialing). Sacramento, CA: Foundation for Critical Thinking.
- Pearson, F. A. (2010). Real problems, virtual solutions: Engaging students online. *Teaching Sociology*, 38(3), 207–214.
- Pedersen, D. E. (2010). Active and collaborative learning in an undergraduate sociological theory course. *Teaching Sociology*, 38(3), 197–206.
- Persell, C. H. (2004). Using focused web-based discussion to enhance student engagement and deep understanding. *Teaching Sociology*, 32(2), 61–78.
- Phelan, L. (2012). Assessment is a many-splendoured thing: Fostering online community and lifelong learning. *European Journal of Open, Distance and E-Learning*, 2012/I. Retrieved from [www.eurodl.org/index.php?p=archives&year=2012&halfyear=1&article=488](http://www.eurodl.org/index.php?p=archives&year=2012&halfyear=1&article=488)

- Prancl, M. (2011). Raising awareness: Incorporating a student-run campus awareness week in course objectives. *Teaching Sociology*, 39(1), 88–102.
- Reynolds, T. W., Bostrom, A., Read, D., & Morgan, M. G. (2010). Now what do people know about global climate change?: Survey studies of educated laypeople. *Risk Analysis*, 30(10), 1520–1538.
- Roper, A. (2007). How students develop online learning skills. *Educause Quarterly*, 1, 62–65.
- Sterman, J. D., & Sweeney, L. B. (2007). Understanding public complacency about climate change: Adults' mental models of climate change violate conservation of matter. *Climatic Change*, 80(3–4), 213–238.
- Swan, K., Shen, J., & Hiltz, S. R. (2006). Assessment and collaboration in online learning. *Journal of Asynchronous Learning Networks*, 10(1), 45–62.
- U.S. Global Change Research Program. (2009). *Climate literacy: The essential principles of climate science—A guide for individuals and communities*. Washington, DC: Change Research Program.
- U.S. National Research Council. (1999). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academies Press.
- U.S. National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K-8* (Committee on Science Learning, Kindergarten through Eighth Grade). Washington, DC: National Academies Press.
- U.S. National Research Council. (2010a). *Advancing the science of climate change*. Washington, DC: National Academies Press.
- U.S. National Research Council. (2010b). *Climate stabilization targets: Emissions, concentrations, and impacts over decades to millennia*. Washington, DC: National Academies Press.
- U.S. National Research Council. (2011). *Climate change education: Goals, audiences, and strategies—A workshop summary* (Board on Science Education, Division of Behavioral and Social Sciences and Education). Washington, DC: National Academies Press.
- Wright, E. R., & Lawson, A. H. (2005). Computer mediated communication and student learning in large introductory sociology classes. *Teaching Sociology*, 33(2), 122–134.

# An Examination of Behavior Change Theories to Predict Behavioral Intentions of Organisms-in-Trade Hobbyists

Jessica Mayer

Duke Energy Corporation

Charlotte, North Carolina, United States

Erin Seekamp<sup>1</sup>

Department of Parks, Recreation and Tourism Management

North Carolina State University, Raleigh, United States

Jonathan Casper

Department of Parks, Recreation and Tourism Management

North Carolina State University, Raleigh, United States

Gary Blank

Department of Forestry and Environmental Resources

North Carolina State University, Raleigh, United States

## Abstract

This study examined the effects of theoretical constructs from the theory of planned behavior (TPB) and value-belief-norm theory (VBN) on intentions to perform purchase and disposal behaviors that help prevent aquatic invasive species (AIS) spread by organisms-in-trade (OIT) hobbyists. More specifically, the goals of this study were to explore (1) the predictive ability of theoretical constructs on intention to perform desired behaviors and (2) differences in the strength of the constructs on future purchase and disposal behaviors. Regression analyses from survey research conducted at OIT events in the Great Lakes region ( $n = 542$ ) revealed that VBN constructs have direct, positive effects on likelihood of performing future purchase and disposal behaviors; one TPB construct (perceived behavioral control) also predicted likelihood of performing future disposal behaviors. Seemingly unrelated regression results demonstrate differing effects of theoretical constructs between purchase and disposal behaviors. Findings suggest tailoring messages to target specific behaviors.

---

1 Corresponding author: erin\_seekamp@ncsu.edu.

Keywords: aquatic invasive species, behavior change theories, organisms-in-trade hobbyists, theory of planned behavior, value-belief-norm theory

## Introduction

Non-native species have been deliberately introduced for centuries, as the wilderness was tamed, economic benefits realized, and mistakes made (Gozlan, 2008; Kareiva et al., 2007). However, shifts in desired environmental conditions to more “natural” flora and fauna (Hull, 2006) have occurred, particularly in freshwater ecosystems (Hermoso & Clavero, 2013). Furthermore, environmental managers’ concerns about deliberate (with some exceptions in the case of sport fisheries), accidental, and uninformed human behaviors that result in the establishment of non-native fish, reptile, amphibian, and plant species in aquatic ecosystems have increased as biological invasions continue to accelerate (e.g., Cucherousset & Olden, 2011; Vander Zanden & Olden, 2008).

Aquatic invasive species (AIS) threaten natural ecosystems by outcompeting native species and creating significant biodiversity losses (Stiers et al., 2011), reducing recreational opportunities by altering sport fisheries and damaging infrastructure, boats, and water conveyance structures (ANS Task Force, 2012). Much attention has been directed toward the Great Lakes region, northeastern United States, where more than 180 non-native and invasive species have been identified (NOAA, 2015) and aggregated costs for mitigation and management are estimated at more than US\$100 million annually (Rosaen et al., 2012). Numerous pathways (i.e., vectors) exist for AIS to gain access to the Great Lakes, for example, commercial shipping, recreational boating, angling or bait fishing, aquaculture, commercial and home aquaria and water gardens, canals, and rivers (National Research Council, 2008).

Within the United States, participants in the organisms-in-trade (OIT) industry (namely aquarium hobbyists, water gardeners, and outdoor pond hobbyists; hereafter known as “OIT hobbyists”) account for about one quarter of fish and amphibian releases and nearly three quarters of aquatic reptile releases (Fuller, 2003; Padilla & Williams, 2004). The OIT pathway has resulted in the introduction of 21 documented species in the Great Lakes (Rothlisberger, 2009). Although the OIT industry accounts for only about six percent of AIS establishment in the Great Lakes region (Mills et al., 1994), management efforts are needed to control any and all human vectors of dispersal (Ruiz & Carlton, 2003). Managers fear aquarium and water garden species (e.g., *Misgurnus anguillicaudatus* and *Myriophyllum hertophyllum*) will become established in the Great Lakes region (Rixon et al., 2005), and thus support eradication of non-native species (Johnston & Marks, 1997). However, management techniques, such

as trade restrictions, have been considered ineffective, increasing the need for self-regulation (Selge et al., 2011). General awareness of environmental impacts caused by invasive species is relatively low (Bremner & Park, 2007), suggesting that an educational outreach campaign may increase hobbyists' AIS awareness and lead to adoption of behaviors—specifically, aquatic species purchase and disposal behaviors—known to prevent the establishment and spread of AIS.

To date, limited knowledge exists concerning OIT hobbyists' awareness of AIS release consequences or concern about resulting environmental impacts. Previous research suggests that OIT hobbyists in four municipalities in the Great Lakes region (Duluth, Minnesota; Rochester, New York; Allentown, Pennsylvania; and Erie, Pennsylvania) are engaging in behaviors that lead to AIS establishment despite recognizing that it was not good for the environment (Green & Armson, 2005). Therefore, the purpose of our study was to identify the best predictors of responsible OIT hobbyist behavior.

Constructs known to predict behavioral intentions were identified from previous studies of private-sphere environmentally responsible behaviors (i.e., “the purchase, use, and disposal of personal and household products that have environmental impact,” as opposed to public-sphere behaviors, such as policy support, environmental citizenship, and environmental activism; Stern, 2000, p. 409). In particular, the theory of planned behavior (TPB) and value-belief-norm theory (VBN) have explained between 17 and 66 percent of the variance explaining intentions to engage in such private-sphere behaviors as wastepaper recycling and using high-efficiency light bulbs (Cheung et al., 1999; Chu & Chiu, 2003; Harland et al., 1999). Furthermore, these theories have previously been applied in studies of other leisure behaviors related to the spread of AIS (e.g., boating; Cottrell, 2003) and to other actors in the OIT industry (e.g., horticulturalists; Burt et al., 2007). This study integrates constructs from these theories that have had previous direct relationships to behavioral intentions. As previous research suggests that individuals who partake in “green” purchasing behaviors also participate in “green” disposal behaviors (van Birgelen et al., 2008), we also examined whether the effect of the theoretical constructs differs when predicting the type of behavior OIT hobbyists intend to perform (i.e., purchase behaviors versus disposal behaviors). Ultimately, identifying the most important predictors of responsible OIT hobbyist behaviors can inform future educational outreach strategies aimed at increasing self-regulation.

## Theoretical framework

Integrating constructs from both VBN and TPB has been shown to increase the variance explained when predicting environmentally responsible behavior (Stern, 2000). In VBN, values held by an individual influence a set of beliefs (namely an ecological world view, awareness of consequences, and ascription of responsibility) that activate personal norms (Stern et al., 1999). Personal norms (also referred to as moral obligations) have been shown to directly influence responsible environmental behavioral intention in studies of energy conservation behaviors (Sahin, 2013) and personal car use (Nordlund & Garvill, 2003). The TPB is composed of three constructs that predict responsible environmental behavioral intention, such as wastepaper recycling (Cheung et al., 1999) and household energy conservation (Midden & Ritsema, 1983). Ajzen (1991) identified these constructs as attitudes (whether the individual views the behavior as negative or positive), subjective norm (alleged pressure from the individual's peers to perform the action), and perceived behavioral control (whether the individual feels that performing the action is within their ability).

In studies of private-sphere environmentally responsible behavior, such as household energy use, reducing meat consumption, and using unbleached paper (Abrahamse & Steg, 2011; Harland et al., 1999), including personal norms with TPB constructs has substantially increased the explanatory power. We expand these studies by including all VBN constructs previously demonstrated to have a direct effect on private-sphere environmentally responsible behavioral intentions. Specifically, we postulate that awareness of AIS, concern for the environment, ascription of responsibility, internalized feelings to prevent the spread of AIS, perceived social pressures to engage in desired behaviors, and perceived control over engaging in future OIT behaviors will be positively related to intentions to perform responsible OIT purchase and disposal behaviors (Figure 1).

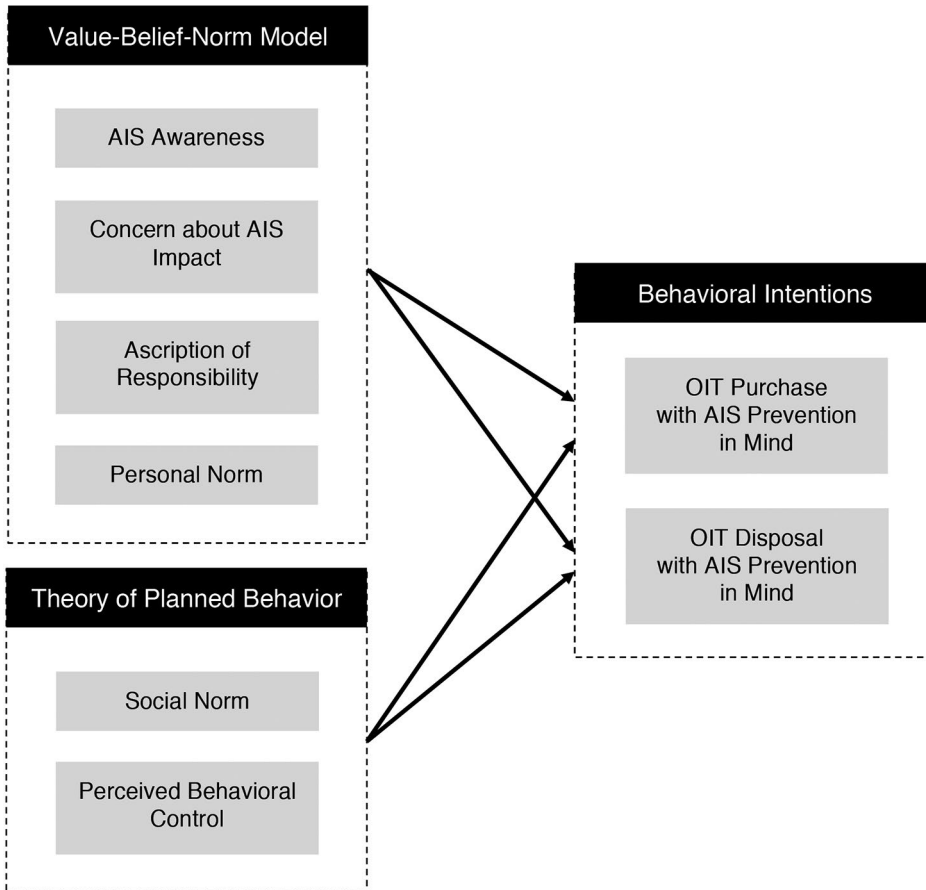


Figure 1. Integrated model to predict OIT hobbyists' intentions to make purchase and disposal behaviors with AIS prevention in mind

## Value-belief-norm model

We were specifically interested in constructs that may directly influence behavioral intention; therefore, we included only behavior-specific belief constructs and did not include values in our model. For example, previous research has demonstrated that the new ecological paradigm has not had a direct effect on behavioral intention when other VBN constructs are included in a model (Abrahamse & Steg, 2011; Steg et al., 2005). Additionally, as values (e.g., biospheric, altruistic, and egoistic) are postulated to predict new ecological paradigm beliefs in the VBN path to behavioral intentions, we did not include them in our integrated model.

Given that VBN is traditionally conceived as a path model (Stern, 2000; Stern et al., 1999), we explored not only the direct effects on behavioral intentions but also the paths between the behavior-specific beliefs and from

these beliefs to personal norms. Our conceptualization of behavior-specific included environmental concern, awareness of consequences, and ascription of responsibility. Environmental concern is not typically a construct portrayed in VBN; however, it is oftentimes considered to be implicitly expressed in awareness of consequences and, thus, included in its measurement (Stern et al., 1993). Although Stern (2000, p. 409) explains that “environmental concerns are within awareness and may therefore be influential” in studies of public-sphere behaviors, he also states that “private-sphere behaviors are unlike public-sphere environmentalism in that they have direct environmental consequences” but that the impact of an individual’s private-sphere behavior is small and, as such, “individual behaviors have environmentally significant impact only in the aggregate” (ibid., p. 410). Given the potential for direct, and potentially substantial, environmental consequences from AIS release, we postulated that environmental concerns would directly influence OIT hobbyists’ intentions to perform environmentally responsible behaviors (particularly disposal behaviors, such as donating instead of releasing an unwanted fish, amphibian, or reptile species, or burning aquatic plants after weeding colonizing plants from ponds or water gardens).

Ecological problem awareness has been shown to have significant, direct effects on both personal norms and intention to engage in general environmentally responsible behaviors (Nordlund & Garvill, 2002), conservation behaviors (Kaiser et al., 2005), and environmentally responsible boating behavior (Cottrell, 2003). However, current research has suggested that while the general public is aware of the term invasive species, they may not be aware of the effects that non-native species have on the environment (Sharp et al., 2011). Similar to problem awareness, environmental concern has been shown to have significant, direct effects on both personal norms (Nordlund & Garvill, 2002) and behavioral intention (Mehmetoglu, 2010). Research on household energy conservation has demonstrated that environmental concern can also be mediated through ascription of responsibility to activate personal norms (Black et al., 1985). In a study of horticultural professionals, awareness of the invasive species problem was a significant predictor of participation in measures to prevent the spread of invasive species (Burt et al., 2007). Therefore, we propose the following hypotheses:

- H1.1: Awareness of AIS and environmental concern have direct, positive effects on ascription of responsibility to prevent the spread of AIS.
- H1.2: Awareness of AIS and environmental concern have direct, positive effects on personal norms.
- H1.3: Awareness of AIS and environmental concern have direct, positive effects on intentions to perform purchase and disposal behaviors with preventing AIS spread in mind.



Like ecological problem awareness and environmental concern, ascription of responsibility is a belief construct in VBN. When an individual assumes some responsibility of the action, personal norms are activated and explain more of the variance in behavioral intention (Schwartz, 1968). Yet, not only has ascription of responsibility been shown to directly influence personal norms (Bamberg & Schmidt, 2003; Kaiser et al., 2005), it has also had a positive, direct effect on intention to engage in recycling behaviors (Guagnano et al., 1995). Therefore, we propose the following hypotheses:

- H1.4: Ascription of responsibility to prevent the spread of AIS has a direct, positive effect on personal norms.
- H1.5: Ascription of responsibility has a direct, positive effect on intention to perform purchase and disposal behaviors with preventing AIS spread in mind.

Personal norms are indicative of the moral obligation one feels to perform specific behaviors (Schwartz, 1977). Personal norms, as theorized in VBN, have had positive, direct effects on behavioral intentions to perform conservation behaviors (e.g., environmental organization membership, recycling, energy conservation, purchasing eco-labeled products, alternative transportation; Kaiser et al., 2005; Nordlund & Garvill, 2002). Therefore, we hypothesize that:

- H1.6: Personal norms have direct, positive effects on intention to perform purchase and disposal behaviors with preventing AIS spread in mind.

## The theory of planned behavior

Research employing TPB constructs has predicted environmentally responsible behavioral intentions such as recycling (Cheung et al., 1999; Chu & Chiu, 2003) and conservation behaviors (Kaiser et al., 2005). However, the effect of constructs (individually or collectively) on behavioral intention varies depending on the target behavior (Ajzen, 1991). Although the effect of attitudes on behavioral intentions is typically significant, the inclusion of personal norms in TPB studies has decreased the individual effect of attitudes but increased the variance explained by either model singularly (Harland et al., 1999). That is, a more robust set of psychological variables can “increase clarity,” particularly by capturing moral considerations, in studies of environmentally responsible behavior (ibid., p. 2523). As the personal norm construct is an evaluative measure of moral obligation to perform the desired behavior (Corraliza & Berenguer, 2000; Stern, 2000), we did not include attitudes in our integrated model. That is, we assumed that personal norm captures an individual’s attitude toward performing the desired behavior.

Subjective norms refer to the social pressure felt by the individual to perform the desired action (Ajzen, 1991). Subjective norms have been shown to have a significant effect on intention to engage in environmentally responsible behaviors, (e.g., recycling behaviors; Cheung et al., 1999). However, the unique influence of subjective norms on behavioral intention tends to be weaker than personal considerations (Ajzen, 1991) and the effect was also found to become insignificant when personal norms was added to the TPB models of four out of five distinct conservation behaviors (Harland et al., 1999). Given the potential for differences between perceived social pressures related to responsible OIT purchase and disposal behaviors, we included the subjective norm construct in our integrated model. As such, we postulate that:

- H2.1: Subjective norms have direct, positive effects on intention to perform purchase and disposal behaviors with the prevention of AIS spread in mind.

Perceived behavioral control (i.e., an individual's perception of having the ability to perform the desired behavior) has been shown to have a positive, direct effect on behavioral intention (Ajzen, 2002; Cheung et al., 1999; Harland et al., 1999). Research on responsible environmental behaviors has demonstrated that constraints such as time, money, and knowledge frequently impact perceptions of behavioral control (Steg & Vlek, 2009). Effectively, the more control an individual feels over performing an action, the more likely they will be to engage in the action (Ajzen, 2002). For example, Harland et al.'s (1999) study demonstrated that the effect of perceived behavioral control on intentions to perform three of the five conservations behaviors was greater than other TPB predictors and personal norms. Therefore, we hypothesized that:

- H2.2: Perceived behavioral control has direct, positive effects on intention to perform purchase and disposal behaviors with the prevention of AIS spread in mind.

## **Future purchase and disposal decisions**

To date, research on OIT behaviors has explored predictors of OIT purchasing intentions (e.g., horticultural professionals' willingness to engage in purchase behaviors that prevent the establishment of invasive species; Burt et al., 2007) and disposal intentions (e.g., aquarium hobbyists' involvement in practices known to increase the spread of AIS; Duggan, 2010) separately. However, little is known about whether the influence of the predictors differs between purchase and disposal behaviors. Research on more general "green" purchase (packaging) and disposal (recycling) behaviors has documented positive correlations between purchase and disposal decision-making (van Birgelen et al., 2008). Given the dearth of research comparing purchase and disposal decisions, van

Birgelen et al.'s (2008) study suggests that the effect of theoretical constructs included in our integrated model may be the same for both future OIT purchase and disposal decisions. Therefore, we propose the following hypothesis:

- H3.0: The effect of theoretical constructs on intention to perform future purchase behaviors will not be significantly different than on intention to perform future disposal behaviors.

## Methods

### Study design

In this study, we used survey research methodology to collect self-reported data from OIT hobbyists. The survey instrument was informed by focus groups and key-informant interviews conducted in fall 2012 (Mayer & Seekamp, 2013), previous OIT surveys (Green & Armson, 2005), and consultation with AIS specialists. That is, project researchers conducted focus groups and key-informant interviews with OIT hobbyists and reviewed other OIT survey instruments to determine questionnaire items, as well as had AIS specialists review the instrument. We administered a questionnaire through voluntary recruitment to a sample of self-identified OIT hobbyists at 16 OIT events in the Great Lakes region. Researchers attended one aquarium hobbyist and one water garden/outdoor pond owner event—auctions, trade shows, festivals, and expos—in each of the eight Great Lakes states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin).

Events were strategically selected based on relevance to the OIT industry, date of event within study time frame (February–September 2013), and event coordinators' willingness to allow researchers to interact with attendees. Sampling days depended upon event length and ranged from one day (approximately 4 hours) to three days (approximately 27 hours). We obtained permission from event coordinators to set up a booth for survey administration. A poster advertising an iPad raffle (i.e., incentive for participation) was hung at the booth to make attendees aware of the study and encourage participation.

Researchers stayed at the booths and did not directly approach event participants; however, event coordinators were asked to make a brief announcement to attendees about the study and provide the location of the booth. Adults (over the age of 18) who approached the booth and self-identified as an OIT hobbyist were asked to participate in the study. Respondents had the option of completing the survey on paper, on an iPad, or via email. We used a modified version of Dillman's (2007) tailored design method for the email version of the

survey. A Kruskal Wallis test indicated that no differences existed between survey types in regard to age ( $\chi^2 = 1.45, p = .49$ ) or hobbyist classification ( $\chi^2 = 4.81, p = .09$ ).

## Respondents

A total of 654 qualified individuals were asked to participate in the study and 542 surveys were completed (111 iPad surveys, 381 paper surveys, 50 email surveys), yielding an 83% response rate. After removing surveys (a) completed by individuals who were not current hobbyists but intended to be in the next three years and (b) with more than 50% of the theoretical questionnaire items missing responses, 481 valid surveys were retained for analysis. Remaining missing data were replaced with the series median (Acuña & Rodriguez, 2004). Missing values ranged between zero and 33 cases for each independent and dependent variable, with an average of five missing cases per variable.

Within the valid data set, 48% of participants identified as primarily aquarium hobbyists, 22% identified as primarily water garden or outdoor pond hobbyists, and 30% owned both an aquarium and outdoor pond or water garden (Table 1). The majority of respondents were male (61%) and the median age group was 50–59 years of age. More than half the respondents had a bachelor’s degree or higher (51%) and 57% of respondents had an annual household income greater than \$60,000 per year.

Table 1. Demographic results of participants

	Frequency	Percent
Hobbyist type		
Aquarium hobbyist	233	48
Outdoor pond/water garden owner	103	22
Both aquarium and outdoor pond/water garden owner	145	30
Gender		
Male	290	61
Female	183	39
Age		
18–29	54	12
30–39	60	13
40–49	99	21
50–59	157	33
60 and older	101	21

	Frequency	Percent
Education level		
Less than high school	2	< 1
High school diploma or General Education Development high school equivalency credential	54	12
College	113	24
2-year degree (associate)	60	13
4-year degree (bachelor)	137	29
Master's degree	67	14
Professional degree	12	3
Doctoral degree	26	6
Annual household income		
Under \$20,000	30	7
\$20,000–\$39,999	51	11
\$40,000–\$59,999	113	25
\$60,000–\$79,999	74	16
\$80,000–\$99,999	71	16
Over \$100,000	111	25

## Sampling bias

Individuals who approached the research booth and qualified for the study but declined to participate were asked to answer a series of six questions to determine if nonrespondents were statistically different from respondents. The questions included measures of age, hobbyist type, familiarity with AIS, level of concern with AIS spread, and past behaviors made with AIS prevention in mind. Twenty-one hobbyists answered the nonresponse bias check questions and no significant differences between respondents and nonrespondents were found.

## Survey questionnaire

Questionnaire items were measured on a five-point Likert-type scale that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*) (unless otherwise noted). When applicable, items were reverse coded so higher-scale scores reflected higher associations with corresponding constructs. Based on the theoretical framework, a six-factor solution (i.e., AIS awareness, concern about AIS impacts, ascription of responsibility, personal norms, subjective norms, and perceived behavioral control) was specified during a principal component analysis with Varimax rotation. However, after removing items loading less than 0.60 (see Appendix A), a five-factor solution emerged (Table 2). Based on these components, we created a mean rating of each construct.

**Table 2. Mean and standard deviation of theoretical constructs and factor loadings after Varimax rotation**

Question	Mean	SD	Factor				
			1	2	3	4	5
Personal norm	4.22	0.62					
I am willing to put extra effort into preventing the spread of AIS.			0.842				
I feel a strong, personal obligation to prevent the spread of AIS.			0.807				
I feel that I should perform behaviors that prevent the spread of AIS to protect local waterways and environments.			0.787				
Awareness and concern	4.27	0.62					
I am aware of the effects of AIS.				0.797			
AIS have a negative impact on native species in my region.				0.703			
I have a general concern for the environment.				0.753			
Perceived behavioral control	3.82	0.78					
I do not have enough time to perform behaviors that prevent the spread of AIS.					0.731		
I do not have enough information to know how to prevent the spread of AIS.					0.764		
Performing behaviors that prevent the spread of AIS costs too much money.					0.771		
Ascription of responsibility	4.07	0.75					
Hobbyists like me can reduce the spread of AIS.						0.738	
It is possible for me to prevent the spread of AIS.						0.866	
Subjective norm	4.05	0.69					
As part of the aquarium, outdoor pond, or water garden community, it is expected of me to perform behaviors that prevent the spread of AIS.							0.844
Most people who are important to me would want me to perform behaviors that prevent the spread of AIS.							0.686
Eigenvalue			4.90	1.32	1.20	1.00	.82
Explained variance			37.5	10.2	9.2	7.7	6.3
Cronbach's alpha			.88	.69	.69	.64	.60

Note. Only factor loadings greater than 0.60 are shown. All perceived behavioral control questionnaire items were reverse coded.

## Value-belief-norm variables

The principal component analysis merged awareness and concern into one component, creating a three-item factor, with two questionnaire items measuring awareness (“I am aware of the effects of AIS” and “AIS have a negative impact on native species in my region”) and one questionnaire item measuring concern (“I have a general concern for the environment”). Overall, respondents reported a high level of awareness and concern ( $\alpha = .69$ ,  $\bar{X} = 4.3$ ,  $SD = .62$ ).

Two items were extracted that reflected the construct ascription of responsibility (“Hobbyists like me can reduce the spread of AIS” and “It is possible for me to prevent the spread of AIS”). The reliability of the scale was satisfactory ( $\alpha = .64$ ,  $\bar{X} = 4.07$ ,  $SD = .75$ ).

Personal norm included measures of respondents’ moral obligation to perform behaviors to prevent the spread of AIS (“I am willing to put extra effort into preventing the spread of AIS,” “I feel a strong, personal obligation to prevent the spread of AIS,” and “I feel that I should perform behaviors that prevent the spread of AIS to protect local waterways and environments”). Respondents tended to agree that they held a high personal norm for AIS prevention ( $\alpha = .88$ ,  $\bar{X} = 4.2$ ,  $SD = .62$ ).

## Theory of planned behavior variables

Two questionnaire items measuring subjective norm were extracted during the principal component analysis (“Most people who are important to me would want me to perform behaviors that prevent the spread of AIS” and “As part of the aquarium, outdoor pond, or water garden community, it is expected of me to perform behaviors that prevent the spread of AIS”). On average, respondents reported strong agreement in regard to subjective norm ( $\alpha = .60$ ,  $\bar{X} = 4.0$ ,  $SD = .69$ ).

Perceived behavioral control referred to the extent that respondents could participate in behaviors known to prevent the spread of AIS (“I do not have enough time to perform behaviors that prevent the spread of AIS,” “I do not have enough information to know how to prevent the spread of AIS,” and “Performing behaviors that prevent the spread of AIS costs too much money”). Items were reverse coded to associate higher agreement with higher perceived control. Overall, respondents tended to perceive that engaging in behaviors known to prevent the spread of AIS was in their control ( $\alpha = .69$ ,  $\bar{X} = 3.8$ ,  $SD = .78$ ).

## Dependent variables

Global measures of behavioral intention were used, based on the variability of hobbyist type and intended behavior. For example, a questionnaire item related to freezing aquatic plants before disposal is hobbyist-specific (i.e., hobbyists who only own aquatic fauna would not intend to engage in this behavior in the future). Responses were measured on a five-point Likert-type scale from 1 (*not at all likely*) to 5 (*extremely likely*). Specifically, respondents were asked “In the future, how likely are you to make decisions about purchases with preventing the spread of AIS in mind.” Respondents tended to agree that they would be very likely to engage in the behavior in the future ( $\bar{X} = 3.7$ ,  $SD = 1.1$ ). Respondents were also asked about future disposal decisions (“In the future, how likely are you to make decisions about disposal with preventing the spread of AIS in mind”). Again, respondents tended to agree that they would be very likely to engage in this behavior in the future ( $\bar{X} = 4.2$ ,  $SD = 0.93$ ).

## Analysis

We used linear regression to determine the relationship between variables in the proposed model. Additionally, we used Zellner’s (1962) seemingly unrelated regression (SUR) technique to conduct a joint estimation of two regression equations (each having the same independent variables with different dependent variables). The SUR technique was performed to test whether the unique effects of the theoretical constructs differed for future purchase decisions and future disposal decisions with preventing the spread of AIS in mind. This estimation technique allows for correlation among residuals (i.e., the interrelated nature of purchase and disposal behaviors), using the Breusch-Pagan test to determine whether the residuals from the two equations are independent.

## Results

A series of linear regression analyses were conducted to test the first eight hypotheses (H1.1–H2.2). First, we present results of the relationship between VBN variables, specifically hypotheses H1.1, H1.2 and H1.4. We then present the results of the integrated model, including the relationship between personal norms (from VBN) and perceived behavioral control and subjective norms (from TPB) on future purchase and future disposal decisions (i.e., H1.6, H2.1, H2.2). Additionally, we present a significant improvement in the model with the addition of awareness and concern and ascription of responsibility (H1.3, H1.5). Finally, we present results from the SUR analysis, comparing the net effect of the theoretical constructs on each of the dependent variables (H3.0).



## Relationships between VBN variables

Although the model was significant, the awareness and concern composite variable explained only 8 percent of the variance in ascription of responsibility ( $R = .28$ ,  $R^2 = .08$ ,  $F(1, 479) = 40.62$ ,  $p < .001$ ). However, awareness and concern had a greater positive, significant effect on personal norm ( $R = .48$ ,  $R^2 = .28$ ,  $F(1, 479) = 142.78$ ,  $p < .001$ ) (Table 3).

Ascription of responsibility explained a moderate amount of variance in personal norm ( $R = .44$ ,  $R^2 = .19$ ,  $F(1, 479) = 114.89$ ,  $p < .001$ ); however, the inclusion of awareness and concern increased the variance explained in personal norm ( $R = .58$ ,  $R^2 = .33$ ,  $F(2, 478) = 118.31$ ,  $p < .001$ ) (Table 4). Respondents with high awareness and concern ( $\beta = .33$ ,  $t = 8.52$ ,  $p < .001$ ) and high ascription of responsibility ( $\beta = .39$ ,  $t = 9.92$ ,  $p < .001$ ) reported higher personal norms. This finding justified our inclusion of ascription of responsibility and awareness and concern in the final model (i.e., testing direct effects of ascription of responsibility and awareness and concern on future purchase and future disposal behaviors).

Table 3. Regression results of awareness and concern with ascription of responsibility and awareness and concern with personal norm

	AWCO→AR					AWCO→PN				
	$\beta$	t	R	$R^2$	F	$\beta$	t	R	$R^2$	F
			.28	.08	40.62***			.48	.23	142.78***
AWCO	.28	6.37***				.48	11.95***			

Note. AWCO = awareness and concern, AR = ascription of responsibility, PN = personal norm.

\*\*\*  $p < .001$ .

Table 4. Regression results of ascription of responsibility and awareness and concern on personal norm

	AR→PN					AR, AWCO→PN				
	$\beta$	t	R	$R^2$	F	$\beta$	t	R	$R^2$	F
			.44	.19	114.89***			.58	.33	118.31***
AR	.44	10.72***				.33	8.52***			
AWCO						.39	9.92***			

Note. AWCO = awareness and concern, AR = ascription of responsibility, PN = personal norm.

\*\*\*  $p < .001$ .

## Relationships between VBN variables, TPB variables, and future purchase and future disposal behaviors

We first explored the relationship between personal norm, subjective norm, and perceived behavioral control. Next, we added the theoretical constructs from VBN (i.e., awareness and concern, and ascription of responsibility) that had a positive, direct effect on behavioral intention. In the first model that tested the effect of personal norm, subjective norm, and perceived behavioral control, personal norm was the only significant construct in the model when predicting behavioral intention of future purchase decisions ( $R = .46$ ,  $R^2 = .21$ ,  $F(3, 477) = 41.41$ ,  $p < .001$ ; Table 5). Specifically, the first model illustrated that the higher the personal norm reported by respondents, the more likely they reported making future purchase decisions with preventing the spread of AIS in mind ( $\beta = .43$ ,  $t = 8.16$ ,  $p < .001$ ). When awareness and concern and ascription of responsibility were entered into the regression model, 24% of the variance in intention to make future purchase decisions to prevent the spread of AIS was explained ( $R = .49$ ,  $R^2 = .24$ ,  $F(5, 475) = 30.10$ ,  $p < .001$ ). All VBN composite variables had a significant, positive effect on intention to make purchase decisions with AIS prevention in mind (personal norm,  $\beta = .34$ ,  $t = 6.18$ ,  $p < .001$ ; ascription of responsibility,  $\beta = .11$ ,  $t = 2.24$ ,  $p < .05$ ; awareness of AIS and environmental concern,  $\beta = .18$ ,  $t = 3.93$ ,  $p < .001$ ).

Variables from the TPB and personal norm were significant when predicting behavioral intention of future disposal decisions ( $R = .52$ ,  $R^2 = .27$ ,  $F(3, 477) = 57.66$ ,  $p < .001$ ; Table 6). Higher personal norms ( $\beta = .34$ ,  $t = 6.68$ ,  $p < .001$ ), perceived behavioral control ( $\beta = .20$ ,  $t = 4.47$ ,  $p < .001$ ), and subjective norm ( $\beta = .09$ ,  $t = 2.03$ ,  $p < .05$ ) had significant, positive effects on making future purchase decisions with preventing the spread of AIS in mind. When awareness and concern and ascription of responsibility were entered into the model ( $R = .56$ ,  $R^2 = .31$ ,  $F(5, 475) = 43.31$ ,  $p < .001$ ), the effect of subjective norms disappeared. Respondents with higher perceived behavioral control ( $\beta = .14$ ,  $t = 3.23$ ,  $p < .001$ ), higher personal norm ( $\beta = .23$ ,  $t = 4.39$ ,  $p < .001$ ), higher ascription of responsibility ( $\beta = .20$ ,  $t = 4.38$ ,  $p < .001$ ), and higher awareness and concern ( $\beta = .15$ ,  $t = 3.45$ ,  $p < .001$ ) were related to increased likelihood of performing future disposal decisions with preventing the spread of AIS in mind.

**Table 5. Regression results of TPB and VBN variables on likelihood of making future purchase decisions with preventing the spread of AIS in mind**

	PN, PBC, SN→ Future purchase					PN, PBC, SN, AR, AWCO→ Future purchase				
	$\beta$	t	R	R <sup>2</sup>	F	$\beta$	t	R	R <sup>2</sup>	F
			.46	.21	41.41***			.49	.24	30.10***
PBC	-.03	-.67				-.07	-1.60			
SN	.07	1.45				.03	.64			
PN	.43	8.16***				.34	6.18***			
AR						.11	2.24*			
AWCO						.18	3.93***			

Note. AWCO = awareness and concern, AR = ascription of responsibility, PBC = perceived behavioral control, PN = personal norm, SN = subjective norm.

\*  $p < .05$ . \*\*\*  $p < .001$ .

**Table 6. Regression results of TPB and VBN variables on likelihood of making future disposal decisions with preventing the spread of AIS in mind**

	PN, PBC, SN→ Future disposal					PN, PBC, SN, AR, AWCO→ Future disposal				
	$\beta$	t	R	R <sup>2</sup>	F	$\beta$	t	R	R <sup>2</sup>	F
			.52	.27	57.66***			.56	.31	43.31***
PBC	.20	4.47***				.14	3.23***			
SN	.09	2.03*				.05	1.02			
PN	.34	6.68***				.23	4.39***			
AR						.20	4.38***			
AWCO						.15	3.45***			

Note. AWCO = awareness and concern, AR = ascription of responsibility, PBC = perceived behavioral control, PN = personal norm, SN = subjective norm.

\*  $p < .05$ . \*\*\*  $p < .001$ .

## Seemingly unrelated regression results

The dependent variables were found to be interdependent. The bivariate correlation between purchase intentions and disposal intentions was .50 ( $p < .001$ ). Moreover, the Breusch-Pagan test was significant ( $\chi^2$  (1df) = 55.74,  $p < .001$ ), indicating that the use of the SUR technique was valid.

With the exception of subjective norm, all variables were significantly different in regard to their effect on likelihood of making future purchase and future disposal decisions with preventing the spread of AIS in mind (Table 7). Personal norm ( $\chi^2 = 44.37, p < .001$ ) and ascription of responsibility ( $\chi^2 = 27.64, p < .001$ ) had significantly larger effects on likelihood of making future purchase decisions with preventing the spread of AIS in mind, while perceived behavioral control ( $\chi^2 = 18.62, p < .001$ ) and awareness and concern ( $\chi^2 = 12.96, p < .01$ ) had significantly larger effects on likelihood of making future disposal decisions with preventing the spread of AIS in mind.

**Table 7. Likelihood of making future purchase and disposal behaviors with preventing the spread of AIS in mind by TPB and VBN variables—SUR results**

Independent variable	Future purchase decisions		Future disposal decisions		$\chi^2$ test of equation differences (1df)
	Coefficient	SE	Coefficient	SE	
Perceived behavioral control	-.11	.07	.17**	.05	18.62***
Subjective norm	.05	.08	.06	.06	.13
Personal norm	.62***	.10	.35***	.08	44.37***
Ascription of responsibility	.27***	.07	.24***	.05	27.64***
Awareness and concern	.19*	.08	.23**	.07	12.96**
$R^2$	.24		.31		

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

## Discussion

This study provides evidence that OIT hobbyists' intentions to make future purchase and disposal decisions with AIS spread prevention in mind are partially explained by variables from the TPB and VBN. Additionally, we found direct effects on behavioral intentions from VBN variables, which are traditionally mediated through other variables to predict behavioral intention. Finally, we documented that these psychological variables had different effects on both purchase and disposal intentions.

Theoretically, this study provides evidence for VBN constructs as better explanatory predictors of behavioral intention than TPB constructs, suggesting that internalized feelings have a more powerful influence than external or knowledge-based resources and social pressures when predicting private-sphere, environmentally responsible behavioral intentions. As shorter campaign

messages are more powerful in reaching leisure audiences (Ham, 2013) and finite resources may limit campaign material development, it is important to understand these differing effects on OIT purchase and disposal behaviors, particularly in outreach campaign development. Thus, this study identifies specific theoretical constructs that should drive educational outreach messages to enhance adoption of behaviors that may prevent the spread of AIS.

In line with our first hypothesis (H1.1), awareness and concern (as a single construct) had a direct, positive effect on ascription of responsibility. Additionally, awareness and concern, along with ascription of responsibility, explained a considerable amount of variance in personal norm (in line with our second (H1.2) and fourth (H1.4) hypotheses). Interestingly, these two belief constructs (i.e., awareness and concern) are indeed related (supported by the principal component analysis). Additionally, the VBN constructs (awareness and concern, ascription of responsibility) as conceptualized and measured in this study are better predictors of personal norm (an attitudinal construct) than increasingly specific beliefs (e.g., a causal relationship of ecological awareness and environmental concern predicting personal ascription of responsibility). This suggests that, in the case of OIT hobbyists, awareness and concern have a direct effect on personal norms and the construct is not just mediated by ascription of responsibility. These findings confirm Nordlund and Garvill's (2002) study on pro-environmental behavioral intention (i.e., recycling behavior and energy conservation) where ecological problem awareness was first found to have a direct effect on personal norms. Further, these findings suggest that future educational outreach campaigns will likely activate greater moral obligation by including messages to promote awareness and concern, not just ascription of responsibility.

Our third (H1.3) and fifth (H1.5) hypotheses were confirmed, as awareness and concern and ascription of responsibility had positive, direct effects on intention to make both future purchase and disposal decisions with preventing the spread of AIS in mind. Other studies have also found that environmental concern (Mehmetoglu, 2010) and awareness of ecological issues (Cottrell, 2003) have direct effects on responsible environmental behavioral intention, indicating that increasing awareness of AIS (through various campaign outlets), fostering concern for the environment by demonstrating negative ecological impacts of AIS, and personalizing OIT hobbyists' responsibility to prevent the spread of AIS may yield greater adoption of recommended behaviors.

In regard to our sixth (H1.6) hypothesis, personal norms was the only significant predictor of future purchase decisions and was associated with a greater standardized coefficient than perceived behavioral control for future disposal decisions. Previous studies have indicated that personal norms may play a larger role than other constructs in explaining behavioral intention (Minton & Rose,

1997), indicating that fostering a moral obligation to perform desired behaviors may be an effective campaign strategy to elicit behavior change. Further, our findings confirm that intentions to perform different behaviors are influenced by different theoretical constructs (Stern, 2000); thus, OIT outreach strategies may be more effective if they address purchase and disposal behaviors separately.

Our seventh (H2.1) hypothesis was not supported. The fact that the subjective norm construct did not significantly predict OIT hobbyists' purchase intentions (and was associated with a relatively low standardized coefficient for disposal intentions) calls for future research. Given that there are OIT hobbyist forums and clubs, some of which are species specific, would suggest that subjective norms could play a substantial role in behavioral intentions. It is important to note that our findings may be related to poor questionnaire item construction, as only two measures were retained during the principle component analysis and the factor was associated with a low eigenvalue. Although we retained the subjective norm construct to fully test our integrated model, more robust measures of subjective norms are needed to determine the true influence among OIT hobbyists' purchase and disposal behaviors.

The fully integrated model (i.e., awareness and concern, ascription of responsibility, and personal norm from VBN, and subjective norm and perceived behavioral control from TPB) significantly predicted both intentions to make future purchase and disposal decisions with preventing the spread of AIS in mind. However, only constructs from VBN were significant in explaining future purchase decisions and explained more variance in future disposal decisions than significant TPB constructs. While the literature does not explore differences in the explanatory power of the two theoretical models, as represented in this study, previous research has shown that adding personal norms to a model of the TPB decreases the variance explained by the TPB constructs (Harland et al., 1999). In our study, subjective norm was not significant in either model and perceived behavioral control was not significant in predicting purchase behaviors (i.e., H2.2 was not supported in regard to purchase behaviors, but was supported in regard to disposal behaviors) when awareness and concern and ascription of responsibility were introduced. These results (not taking into consideration the possibility of design issues with the subjective norm construct discussed above) suggest that OIT hobbyists' behaviors are best explained by internalized feelings (and to a lesser extent perceived ability) than by social pressure, confirming previous research that found behavior-specific knowledge and personal norms have greater influence over private-sphere behaviors, such as "green consumerism" and environmentally friendly waste disposal, than public-sphere behaviors (Stern, 2000).

It is interesting to note that perceived behavioral control's significant effect on future disposal decisions but not future purchase decisions is opposite to van Birgelen et al.'s (2008) findings on "green" purchase and disposal decisions relating to beverages. These authors suggest that perceived control is likely lowest (i.e., highest burden on individuals) with "green" beverage container disposal decisions because of the effort required (e.g., driving to a waste management location to recycle beverage containers). In the case of OIT hobbyists, the burden (i.e., lowest perceived control) may be experienced during the purchasing process due to the presence of aquatic "hitchhikers" (Keller & Lodge, 2007) that attach to desired species, or the sale of mislabeled species (Maki & Galatowitsch, 2004).

The SUR analyses resulted in the failure to prove our tenth hypothesis (H3.0); significant differences existed between the effect of theoretical constructs on purchase and disposal intentions. Specifically, personal norm and ascription of reasonability had a greater effect on future purchase decisions, while awareness and concern, as well as perceived behavioral control, had a greater effect on future disposal decisions. This finding confirms an early study of energy conservation in which Midden and Ritsema (1983) suggested that behaviors need to be clearly defined and cannot be treated as homogenous because the influence of constructs will differ based on the desired behavior. This finding has important practical implications for developing future OIT hobbyist education campaigns. Specifically, different outreach messages should be developed to target purchase and disposal behaviors independently, as shorter messages are more effective at reaching audiences engaging in leisure behavior (Ham, 2013). Therefore, future education campaigns aimed at OIT hobbyists should:

- a. focus on attributing responsibility for AIS spread to hobbyists and fostering personal obligations to stop AIS spread when targeting aquatic species purchasing decisions; for example, campaign messages should focus on hobbyists' responsibility to purchase from reputable retailers that accurately identify species and avoid purchasing species that are not legal in their region (Maki & Galatowitsch, 2004); and
- b. appeal to a personal expectation to protect the environment from AIS by emphasizing that they (the hobbyist) are in charge of their own purchasing decisions.

When targeting future disposal decisions, campaign strategies should reduce perceived effort of disposal practices and focus on environmental consequences of invasive species establishment and spread. For instance, campaign messages could provide examples of the negative impacts of AIS (i.e., loss of biodiversity and impacts on recreation; ANS Task Force, 2012) that can result when hobbyists release their aquatic species into the environment. Additionally, while awareness

and concern are related to more altruistic value orientations (and those with biospheric value orientations may share similar moral obligations), Schultz and Zelezny (2003) suggest that reframing environmental messages to appeal to those with more egoistic value orientations (e.g., self-enhancing values) can increase the effectiveness of educational messages aiming to change behavior. For example, future campaigns targeting disposal decisions can enhance awareness and concern for AIS by informing hobbyists about instances of AIS “taking over” their outdoor pond or water garden and outcompeting their other aquatic species.

## Study limitations

A few study limitations exist, which should be taken into consideration when interpreting the study findings. The results may not be representative of all OIT hobbyists, particularly those who are novice hobbyists, because the sample population was OIT hobbyist event attendees. Hobbyists who attend trade shows, auctions, and expos may be more specialized and more likely to make a personal effort to engage in activities to sustain their hobby. A study by McFarlane and Boxall (1996) found that more-experienced birders were more willing than less-experienced birders to engage in conservation behaviors, suggesting that any future studies of OIT hobbyists should include an array of hobbyist levels. Nevertheless, given the high response rate (83%) and absence of nonresponse bias, our results are generalizable to hobbyists who attend OIT events in the Great Lakes region.

## Conclusions

This study’s findings have both theoretical and managerial implications. Theoretically, we found that VBN constructs were better predictors of intention to perform OIT purchase and disposal behaviors with AIS prevention in mind than TPB constructs. This finding is strengthened when all VBN constructs were modeled to have direct, positive effects on behavioral intentions. That is, the belief constructs theorized in our model (i.e., ecological problem awareness, environmental concern, and ascription of responsibility), which are traditionally viewed as causal predictors of behavioral intention in VBN, directly predicted behavioral intention. Furthermore, the inclusion of those belief constructs enhanced the explanatory power of the integrated model, despite the fact that they reduced or eliminated the effects of TPB constructs (i.e., perceived behavioral control and subjective norms, respectively). Additionally, our study suggests that future research should explicitly include environmental concern questionnaire items within the awareness of consequences construct.



Related to environmental management, this study's findings suggest strategies to reduce the release of AIS by OIT hobbyists through effective educational outreach campaigns. To increase campaign effectiveness, this study identified that activating moral obligations and ascription of responsibility to OIT hobbyists may increase the likelihood that they will make purchase decisions with AIS prevention in mind. Additionally, this study identified that increasing AIS awareness and general environmental concern, as well as reducing perceived burdens, may increase the likelihood that OIT hobbyists make disposal decisions with AIS prevention in mind. Understanding differences in the unique effects of theoretical constructs on separate behaviors (i.e., making future purchase and future disposal decisions with preventing the spread of AIS in mind) may improve the success of potential campaigns by focusing on constructs that are most relevant to OIT hobbyists when performing specific types of behaviors. If successful, OIT hobbyists may no longer be a vector of AIS spread and, thus, biodiversity may be less threatened, environmental managers may be able to reduce their AIS mitigation efforts, recreational water users (particularly anglers) may not lose recreational access and valued sports fisheries, and the public may experience a decline in the absorbed cost of infrastructure damage caused by AIS.

## Acknowledgments

This project was conducted in collaboration with Illinois-Indiana Sea Grant. Project funding was provided by the United States Environmental Protection Agency's Great Lakes Restoration Initiative and the Illinois Department of Natural Resources from a U.S. Fish & Wildlife Service award.

## Appendix A

### Questionnaire items removed during principal component analysis (factor loadings < .60)

Questionnaire item
Based on the given definition, to what extent are you aware of AIS? <sup>a</sup>
To what extent are you concerned about the spread of AIS? <sup>b</sup>
I avoid releasing species into the environment because I am concerned about the environment. <sup>c</sup>
I feel a sense of responsibility to prevent the spread of AIS. <sup>c</sup>
Other aquarium, outdoor pond, or water garden hobbyists whose opinions I value perform behaviors that prevent the spread of AIS. <sup>c</sup>

<sup>a</sup> Measured on a 5-point Likert-type scale from *not at all aware* to *extremely aware*.

<sup>b</sup> Measured on a 5-point Likert-type scale from *not at all concerned* to *extremely concerned*.

<sup>c</sup> Measured on a 5-point Likert-type scale from *strongly disagree* to *strongly agree*.

## References

- Abrahamse, W., & Steg, L. (2011). Factors related to household energy use and intention to reduce it: The role of psychological and socio-demographic variables. *Human Ecology Review*, 18(1), 30–40.
- Acuña, E., & Rodriguez, C. (2004). The treatment of missing values and its effect in the classifier accuracy. In D. Banks, F. R. McMorris, P. Arabie, & W. Gaul (Eds.), *Classification, clustering, and data mining applications* (pp. 639–647). Berlin, NY: Springer.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179–211.
- Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology*, 32(4), 665–683.
- ANS Task Force (Aquatic Nuisance Species Task Force). (2012). What are ANS? Retrieved from [www.anstaskforce.gov/ans.php](http://www.anstaskforce.gov/ans.php)
- Bamberg, S., & Schmidt, P. (2003). Incentives, morality, or habit?: Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. *Environment and Behavior*, 35(2), 264–285.
- Black, J. S., Stern, P. C., & Elworth, J. T. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Social Psychology*, 70(1), 3–21.
- Bremner, A., & Park, K. (2007). Public attitudes to the management of invasive non-native species in Scotland. *Biological Conservation*, 139(3–4), 306–314.
- Burt, J. W., Muir, A., Piovia-Scott, J., Veblen, K. E., Chang, A. L., Grossman, J. D., & Weiskel, H. W. (2007). Preventing horticultural introductions of invasive plants: Potential efficacy of voluntary initiatives. *Biological Invasions*, 9, 909–923.
- Cheung, S. F., Chan, D. K.-S., & Wong, Z. S.-Y. (1999). Reexamining the theory of planned behavior in understanding wastepaper recycling. *Environment and Behavior*, 31, 587–612.
- Chu, P., & Chiu, J. (2003). Factors influencing household waste recycling behavior: Test of an integrated model. *Journal of Applied Social Psychology*, 33(3), 604–626.

- Corraliza, J. A., & Berenguer, J. (2000). Environmental values, beliefs, and actions: A situational approach. *Environment and Behavior*, 32(6), 832–848.
- Cottrell, S. P. (2003). Influence of sociodemographics and environmental attitudes on general responsible environmental behavior among recreational boaters. *Environment and Behavior*, 35, 347–375.
- Cucherousset, J., & Olden, J. D. (2011). Ecological impacts of non-native freshwater fishes. *Fisheries*, 36(5), 215–230.
- Dillman, D. A. (2007). *Mail and Internet surveys: The tailored design method* (2nd ed., 2007 update). Hoboken, NJ: John Wiley & Sons.
- Duggan, I. C. (2010). The freshwater aquarium trade as a vector for incidental invertebrate fauna. *Biological Invasions*, 12, 3757–3770.
- Fuller, P. L. (2003). Freshwater aquatic vertebrate introductions in the United States: Patterns and pathways. In G. M. Ruiz & J. T. Carlton (Eds.), *Invasive species: Vectors and management strategies* (pp. 123–151). Washington, DC: Island Press.
- Gozlan, R. E. (2008). Introduction of non-native freshwater fish: Is it all bad? *Fish and Fisheries*, 9(1), 106–115.
- Green, A., & Armson, R. (2005). *A survey about aquarium, outdoor pond, and water garden issues: Results and technical report* (Technical Report #05-02). Minnesota Center for Survey Research.
- Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on attitude-behavior relationships: A natural experiment with curbside recycling. *Environment and Behavior*, 27(5), 699–718.
- Ham, S. H. (2013). *Interpretation: Making a difference on purpose*. Golden, CO: Fulcrum Publishing.
- Harland, P., Staats, H., & Wilke, H. A. M. (1999). Explaining proenvironmental intention and behavior by personal norms and the theory of planned behavior. *Journal of Applied Social Psychology*, 29(12), 2505–2528.
- Hermoso, V., & Clavero, M. (2013). Revisiting ecological integrity 30 years later: Non-native species and the misdiagnosis of freshwater ecosystems. *Fish and Fisheries*, 14(3), 416–423.
- Hull, R. B. (2006). *Infinite nature*. Chicago, IL: University of Chicago Press.

- Johnston, M. J., & Marks, C. A. (1997). *Attitudinal survey on vertebrate pest management in Victoria*. Frankston, Australia: Government of Victoria Department of Natural Resources and the Environment.
- Kaiser, F. G., Hubner, G., & Bogner, F. X. (2005). Contrasting the theory of planned behavior with the value-belief-norm model in explaining conservation behavior. *Journal of Applied Social Psychology*, 35(10), 2150–2170.
- Kareiva, P., Watts, S., McDonald, R., & Boucher, T. (2007). Domesticated nature: Shaping landscapes and ecosystems for human welfare. *Science*, 316, 1866–1869.
- Keller, R. P., & Lodge, D. M. (2007). Species invasions from commerce in live aquatic organisms: Problems and possible solutions. *American Institute of Biological Sciences*, 57(5), 428–436.
- Maki, K., & Galatowitsch, S. (2004). Movement of invasive aquatic plants into Minnesota (USA) through horticultural trade. *Biological Conservation*, 118, 389–396.
- Mayer, J., & Seekamp, E. (2013). *Addressing aquatic invasive species in Illinois: Focus groups and interviews with organisms-in-trade participants*. Raleigh, NC: North Carolina State University.
- McFarlane, B. L., & Boxall, P. C. (1996). Participation in wildlife conservation by birdwatchers. *Human Dimensions of Wildlife*, 1(3), 1–14.
- Mehmetoglu, M. (2010). Factors influencing the willingness to behave environmentally friendly at home and holiday settings. *Scandinavian Journal of Hospitality*, 10(4), 430–447.
- Midden, C. J. H., & Ritsema, B. S. M. (1983). The meaning of normative processes for energy conservation. *Journal of Economic Psychology*, 4, 37–55.
- Mills, E. L., Leach, J. H., Carlton, J. T., & Secor, C. L. (1994). Exotic species and the integrity of the Great Lakes. *BioScience*, 44(10), 666–676.
- Minton, A. P., & Rose, R. L. (1997). The effects of environmental concern on environmentally friendly consumer behavior: An exploratory study. *Journal of Business Research*, 40, 37–48.
- National Research Council, 2008. *Great Lakes shipping, trade, and aquatic invasive species* (Special Report 291). Washington, DC: Transportation Research Board.

- NOAA (National Oceanic and Atmospheric Administration). (2015). *Great Lakes Restoration Initiative, Invasive Species*. Retrieved from [www.regions.noaa.gov/great-lakes/index.php/great\\_lakes-restoration-initiative/invasive-species/](http://www.regions.noaa.gov/great-lakes/index.php/great_lakes-restoration-initiative/invasive-species/)
- Nordlund, A. M., & Garvill, J. (2002). Value structures behind proenvironmental behavior. *Environment and Behavior*, 34, 740–756.
- Nordlund, A. M., & Garvill, J. (2003). Effects of values, problem awareness, and personal norm on willingness to reduce personal car use. *Journal of Environmental Psychology*, 23(4), 339–347.
- Padilla, D. K., & Williams, S. L. (2004). Beyond ballast water: Aquarium and ornamental trades as sources of invasive species in aquatic ecosystems. *Frontiers in Ecology and the Environment*, 2(3), 131–138.
- Rixon, C. A. M., Duggan, I. C., Bergeron, N. M. N., Ricciardi, A., & Macisaac, H. J. (2005). Invasion risks posed by the aquarium trade and live fish markets on the Laurentian Great Lakes. *Biodiversity and Conservation*, 14, 1365–1381.
- Rosaen, A. L., Grover, E. A., & Spencer, C. W. (2012). *The costs of aquatic invasive species to Great Lakes states*. East Lansing, MI: Anderson Economic Group.
- Rothlisberger, J. D. (2009). *Human-mediated dispersal of aquatic nonindigenous species: Impacts and interventions* (Doctoral dissertation, University of Notre Dame). Retrieved from <http://etd.nd.edu/ETD-db/theses/available/etd-08302009-164109/unrestricted/RothlisbergerJ082009.pdf>
- Ruiz, G. M., & Carlton, J. T. (2003). Invasion vectors: A conceptual framework for management. In G. M. Ruiz & J. T. Carlton (Eds.), *Invasive species: Vectors and management strategies* (pp. 459–504). Washington, DC: Island Press.
- Sahin, E. (2013). Predictors of Turkish elementary teacher candidates' energy conservation behaviors: An approach on value-belief-norm theory. *International Journal of Environmental and Science Education*, 8(2), 269–283.
- Schultz, P. W., & Zelezny, L. (2003). Reframing environmental messages to be congruent with American values. *Human Ecology Review*, 10(2), 126–136.
- Schwartz, S. H. (1968). Words, deeds, and the perception of consequences and responsibility in action situations. *Journal of Personality and Social Psychology*, 10(3), 232–242.
- Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 10, pp. 221–279). New York, NY: Academic Press.

- Selge, S., Fischer, A., & van der Wal, R. (2011). Public and professional views on invasive non-native species: A qualitative social scientific investigation. *Biological Conservation*, 144, 3089–3097.
- Sharp, R. L., Larson, L. R., & Green, G. T. (2011). Factors influencing public preferences for invasive alien species management. *Biological Conservation*, 144, 2097–2104.
- Steg, L., Dreijerink, L., & Abrahamse, W. (2005). Factors influencing the acceptability of energy policies: A test of VBN theory. *Journal of Environmental Psychology*, 25(4), 415–425.
- Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, 29, 309–317.
- Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, 56(3), 407–424.
- Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human Ecology Review*, 6(2), 81–97.
- Stern, P. C., Dietz, T., & Kalof, L. (1993). Value orientations, gender, and environmental concern. *Environment and Behavior*, 25(5), 322–348.
- Stiers, I., Crohain, N., Josens, G., & Triest, L. (2011). Impact of three aquatic invasive species on native plants and macroinvertebrates in temperate ponds. *Biological Invasions*, 13, 2715–2726.
- van Birgelen, M., Semeijn, J., & Keicher, M. (2008). Packaging and proenvironmental consumption behavior: Investigating purchase and disposal decisions for beverages. *Environment and Behavior*, 41(1), 125–146.
- Vander Zanden, M. J., & Olden, J. D. (2008). A management framework for preventing the secondary spread of aquatic invasive species. *Canadian Journal of Fisheries and Aquatic Sciences*, 65(7), 1512–1522.
- Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association*, 57(289), 348–368.

# Who Is For or Against the Park? Factors Influencing the Public's Perception of a Regional Park: A Slovenian Case Study

Mojca Nastran<sup>1</sup> and Majda Černič Istenič  
University of Ljubljana, Slovenia

## Abstract

To effectively organize cooperation with stakeholders in the planning and management of protected areas, it is important to understand their perception of the protected area and the factors influencing that perception. This study identifies the factors and their impact on locals' perceptions of the Kamniško-Savinjske Alps Regional Park in designation, Slovenia. The results of discriminant analysis show that the local population that supports the park has significantly different views of its potential from the population that opposes it. In addition, the local population that supports the park was personally notified by the founders about the plans, while the opposing population was not. Therefore, the former is more trustful of the founders' procedures and there is more cooperation with all interest groups than with the opposing population. Contrary to our expectations, higher education, place of residence, and gender do not affect the population's support for the park. These results confirm that a consideration of the factors that affect the local population's perception of the protected area contributes to more effective involvement of stakeholders in the process of park creation, which is important for the successful management of protected areas.

Keywords: attitude, local stakeholders, park–people relationship, park in designation, perceptions, protected areas

## Introduction

During the past decade increased emphasis has been given to the role of different stakeholders in the process of founding and operating protected areas (PAs). Among the most important stakeholders are the local populations (Nastran, 2013). The outcome of PA founding and operating depends significantly on

---

<sup>1</sup> Corresponding author: [mojca.nastran@bf.uni-lj.si](mailto:mojca.nastran@bf.uni-lj.si).

these stakeholders' perceptions and involvement. However, countries that have to implement national and international nature protection goals set up PAs quickly and without thinking the process through fully, and they tend to neglect the importance of local community involvement (e.g., Alonso-Yañez & Davidsen, 2014). Several cases of PA founding in Slovenia have been halted in recent years. For example, establishment of the Snežnik Regional Park, after a promising informal start, came to a standstill during the formal phase of the founding process, mostly due to opposition from local stakeholders (Nastran & Pirnat, 2012). Local opposition has also resulted in the failure to open Karst Regional Park (Fakin Bajec, 2009) and Kočevje Regional Park (Erhatič Širnik, 2003). The common problems in these situations were mostly due to a top-down approach to the establishment of the PA, a lack of direct participation of local inhabitants, a lack of clear support from the local authority, and the opposition of local industry. There has been, however, some positive experience with local stakeholders' perceptions of PAs, and this is mostly the result of the stakeholders being involved in the park founding process. The initiative to found the Goričko Nature Park came from the local population, using the bottom-up principle (Grošelj, 2008; Rodela, 2010). When the Ljubljana Marsh Nature Park was being planned, great emphasis was placed on including different stakeholders and using their local knowledge and information. It seems this type of practice contributes greatly to the local population's positive perception of PAs, as demonstrated by cases in other parts of the world (Conrad & Hilchey, 2011; Toomey & Domroese, 2013). Due to negative experiences in the past, special attention is now given to informing and striving for cooperation with stakeholders. Currently, several PAs are in designation in Slovenia and their founding is not being carried out hastily. Parks in designation are planned but not yet formally established through government regulations. At the beginning of the establishment process an agreement is signed among the actors (founders can be government; local authority, i.e., municipality; or the government along with a municipality). Well-thought-through cooperation with stakeholders and the bottom-up principle are being applied. As the idea of a PA takes time to mature, the in-between stage of the park "in designation" has frequently proven itself to be the appropriate time to include local stakeholders in the planning of the park and its contents (Mikuš, 2006). A new regime should be introduced gradually, its consequences monitored, and findings fed back to further refine the process of development.

Based on this short overview of different results pertaining to the establishment of PAs in Slovenia, indicating the profound importance of the stakeholders' opinions, the aim of this article is to determine the factors and their extent in influencing the local population's perception toward the PA. For this purpose, the Kamniško-Savinjske Alps Regional Park (KSARP) in designation, Slovenia,



is used as a case study that follows and intends to contribute to the already existing discussion about the nature of population attitudes toward PAs in various parts of the world.

## Research background

Research shows that the stakeholder's perception of the PAs provides important information (Arnberger et al., 2012; Swim et al., 2014) when it is communicated to the planners and the refined proposal is represented to the stakeholder in a process of ongoing collaborative participation regarding methods and time of inclusion in the PA designation and management process (Flints, 2010; Hu et al., 2010; Kos, 2002). In this way, in later stages such as planning the service of the park, managers are already acquainted with the interests and needs of the locals; this knowledge enables them to more easily convince the locals to participate in the activities the park has to offer. This is in line with procedural justice theory (Lind & Tyler, 1988), where the ability to participate, to be heard, and to be treated with respect is even more important than the outcomes of the process.

There is no general consensus in the literature regarding what influences the local population's perception of a PA (Triguero-Mas et al., 2009). The most frequently mentioned are socioeconomic influences such as age (Karanth & Nepal, 2012; Shibia, 2010; Tomicevic et al., 2010), gender (Allendorf & Allendorf, 2013; Karanth & Nepal, 2012), education (Shibia, 2010; Tomicevic et al., 2010; Triguero-Mas et al., 2009), wealth and land size (Allendorf, 2010; Karanth & Nepal, 2012; Kideghesho et al., 2007), group membership (e.g., farmers, entrepreneurs) (Arnberger & Schoissengeier, 2012; Bonaiuto et al., 2002; Kideghesho et al., 2007; Shibia, 2010), ethnicity (Mehta & Heinen, 2001), and place of residence (Bonaiuto et al., 2002; Triguero-Mas et al., 2009; Vodouhê et al., 2010). Positive perception of the PA is most strongly associated with higher education, higher income, and living outside the park boundaries. For gender and age the literature provides no uniform view on their importance in terms of PA support. The impact of group membership on perception mostly appears because of different interests and activities of individual groups. Other factors that have been measured several times include participation (Arnberger & Schoissengeier, 2012; Hirschnitz-Garbers & Stoll-Kleemann, 2011; Macura et al., 2011; Niedzialkowski et al., 2012; Sirivongs & Tsuchiya, 2012; Toomey & Domroese, 2013), perceived benefits and costs of the PA (Ezebilo & Mattsson, 2010; Hirschnitz-Garbers & Stoll-Kleemann, 2011; Karanth & Nepal, 2012; Macura et al., 2011; Niedzialkowski et al., 2014; Shibia, 2010; Sirivongs & Tsuchiya, 2012; Stringer & Paavola, 2013; Vodouhê et al., 2010), perception of the park management or manager (Allendorf et al., 2007; Macura et al., 2011; Vodouhê et al., 2010), trust in managers (Abbas et al., 2014; Macura et

al., 2011), local population's attitude toward nature conservation (Arnberger & Schoissengeier, 2012; Tomicevic et al., 2010), and the degree to which the local population is informed about the PA and their knowledge about the PA (Htun et al., 2012; Macura et al., 2011; Niedziałkowski et al., 2012). These factors have very different effects on perception. In the abovementioned studies, they are found to have a significant impact on the perception of a PA, and this impact is not always positive. Some qualitative studies show the importance of more psychological factors such as regional identity, place attachment (Bonaiuto et al., 2002), and psychological reactance (Arnberger & Schoissengeier, 2012); these frequently coincide with the previously mentioned factors. It seems that these factors are more significant (or better researched) in developed countries. In developing countries, other factors, such as income and obtaining vital goods from a park area (perceived benefits and costs or wealth), have a greater influence on local populations' perceptions of PAs.

In contrast to the studies reported above that consider parks which have operated for years, this study is special because KSARP is still in the designation process. Since stakeholders' perceptions can change quickly based on the way the PA is being founded, the study results presented here can be seen as an example when stakeholder involvement in further phases of the park's establishment is planned. With knowledge of the perceptions and factors influencing the stakeholders' attitudes in the initial stage of PA formation, this study can offer recommendations for considering stakeholder involvement in the successful establishment and management of PAs.

## Study area

Extensive PAs are to expand and cover one third of Slovenia's surface in order to preserve biodiversity (Government of Republica Slovenia, 2006). Extensive PAs are not only connected with conservation but with development goals as well. Successful cooperation with local stakeholders can be an important guideline in founding a PA and achieving its goals. Slovenian parks are divided into three categories: national (IUCN category II), regional (IUCN II, V), and landscape park (IUCN V). Permitted or prohibited activities, such as driving, camping, or lighting fires, are specified for each park in its Act. Regional parks can be divided into several conservation zones. A strict conservation zone is primarily intended for preservation of natural values, primeval nature, favorable status of protected species and their habitats, and natural development of ecosystems. Agricultural and forestry use, if consistent with the conservation objectives, is admissible. The less strict conservation zone, in addition to nature protection, also encourages the hitherto use of natural resources through the implementation of agriculture and forestry and, with the protection objectives, tourist and

recreational activities. This type of zone is designed to maintain the diversity of the landscape. Settlements with tourist facilities and local crafts are usually located in this zone. In landscape parks (natural parks), in addition to the protection of nature, strong emphasis is placed on protecting the landscapes, which has benefits from an ecological, biological, and landscape-oriented point of view. They were created along with high-quality and long-term interaction between man and nature.

The KSARP has officially been in the designation process since 2005 when the founders, the Ministry of Agriculture and the Environment and five municipalities in the area of the planned park (Jezersko, Preddvor, Kamnik, Luče, and Solčava), signed an agreement on the founding of the park. The park designation has been at a standstill since 2010. Since then, expert reports have been compiled, the population has been notified about the park designation and its contents, communication with some large landowners in the park has taken place, and draft regulation on its founding has been discussed. The park's founders are responsible for the establishment process, while the manager of the established park will be defined later.

The planned regional park encompasses the Kamniško-Savinjske Alps (KSA) mountain range and its valley edges, where a majority of the park area population is concentrated. KSA is an extensive mountain range connected to the Southern Limestone Alps. Together with the Karavanken Mountains, it forms the mountain range between Slovenia and Austria (Figure 1). In the past, people cleared the forests and lowered the tree line to form a cultural landscape, but forest still cover two thirds of the surface of the proposed park area. The main economic sectors in the area are forestry, animal husbandry, and recently developed tourism (Nastran, 2015).

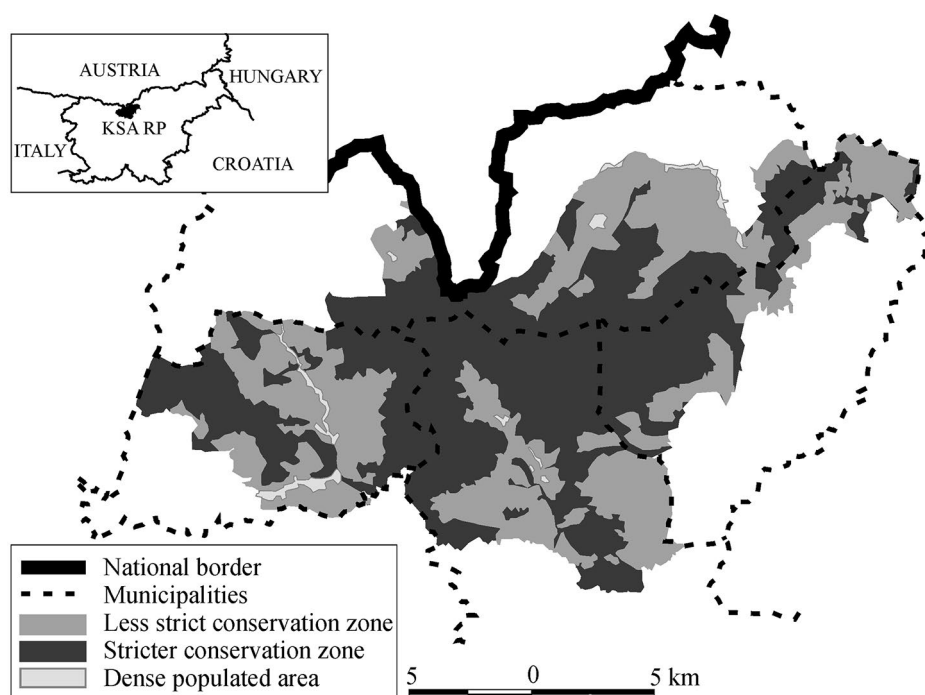


Figure 1. Location of the Kamniško-Savinjske Alps Regional Park in designation, Slovenia

Note. Boundaries of the park and conservation zones are still the subject of discussion.

Source: Image created by Mojca Nastran.

The PA is planned to encompass 264 km<sup>2</sup>. Due to its great significance to the European Union (EU), a large portion of this area is part of Natura 2000, an EU-wide network of nature parks aimed at assuring the long-term survival of Europe's most valuable and endangered species and habitats (European Commission, 2015). The primary natural values of this area are birds species (e.g., *Glaucidium passerinum* and *Tetrao urogallus*), dwarf pines (*Pinus mugo*), the area above the tree line, and rare alpine animal and plant species. Smaller individual parts of the area have already been proclaimed as extensive PAs (Logarska Valley Nature Park, 24 km<sup>2</sup>, and Robanov kot, 14 km<sup>2</sup>). Approximately 650 people live in this area which includes 30 farms (Nastran, 2013). The park's objectives, as cited in the draft regulation, are conservation (the preservation of unspoiled nature, natural heritage, Natura 2000 sites, biodiversity, a favorable status of protected flora and fauna, landscape diversity, and sustainable use of natural resources) and development (the residents' quality of life and preserving population numbers by encouraging sustainable development consistent with local tradition). Foreseeable advantages for the local community are mostly economic, social, and cultural (Niedziałkowski et al., 2014), such as tourist visibility, infrastructure improvement, and target project money intended for, for example, agriculture and forestry support, settlement preservation, social integration, and employment.

In the draft regulation, development policies and measures are defined, as well as some prohibitions. Activities in the park that may worsen the hydrological, geomorphological, or ecological conditions in the park are not permitted, nor are activities which could worsen the status of endangered and internationally protected species and their habitats. Such activities include introducing alien species, intensive aquaculture, camping and parking outside designated areas, and releasing genetically modified organisms into the environment and using them. In the less strict conservation zone, it is not permitted to build holiday homes, to open a quarry, or to drive a vehicle except for the purpose of public service, intervention, agriculture, or forestry work. In the strict conservation zone, prohibited activities include creating new grazing areas, building new objects, creating new recreational areas, cycling, and horse riding off-road.

## Methods

In order to get insight into the various factors and their extent in influencing the local population's perception toward the PA, a questionnaire was designed that included various topics such as the establishment process; stakeholders' involvement and their perceptions about it; attitudes toward nature conservation, PAs, and the park; and expected changes after the park's establishment.

### Questionnaire and data

Through its opinion and perception of a park in designation, the local population contributes greatly to a park's founding and its later operation, which is why local inhabitants are recognized as key stakeholders (Nastran, 2013). Therefore, the total sample ( $n = 128$  households) includes inhabitants with permanent residence in the planned KSARP ( $N = 67$ ) and people living just outside the park boundary but in the founding municipalities ( $N = 47$ ). Every household within the park boundary was sent a questionnaire in the mail while people living outside the park boundary filled out an identical online questionnaire. Only one adult member of the household had to fill out the questionnaire. Data was collected from August to October 2011.

In the statistical analysis of the data, the dependent variable is the binary variable "opinion of the park." The independent variable group includes socioeconomic variables which are often applied to similar studies (municipality, place of residence, gender, education, age, size of land) and variables we recognized as potentially influencing perception (perceiving the park as having development potential, participation in the founding of the park until its standstill in 2010, wish for participation in park planning and management in the future) (Table 1).

**Table 1. Dependent and independent variables included in statistical analyses**

	Variable	Category	F (n = 128)	%
1	Opinion of the park	I support the park	77	60.2
		I oppose the park	36	28.1
		Missing values	15	11.7
2	Municipality	Solčava	26	20.3
		Kamnik	48	37.5
		Jezersko	8	6.3
		Luče	2	1.6
		Preddvor	32	25.0
		Other	11	8.6
		Missing values	1	0.8
3	Place of residence	Inside the park	67	52.3
		Outside the park	47	36.7
		Missing values	14	10.9
4	Gender	Female	58	45.3
		Male	66	51.6
		Missing values	4	3.1
5	Education	Secondary, vocational school or less	66	51.6
		College, university or more	54	42.2
		Missing values	8	6.3
6	Age	Ordinal variable	114	89.0
		Missing values	14	10.9
7	Size of land	Ordinal variable	44	34.4
		Missing values	84	65.6
8	Perceiving the park as having development potential	Ordinal variable	112	87.5
		Missing values	16	12.5
9	First source of information on the founding of the park	Media	19	14.8
		Public presentation	17	13.3
		Information from the founders themselves	19	14.8
		Friends and acquaintances	21	16.4
		Foresters	3	2.3
		Missing values	49	38.3
10	Participation in the founding of the park until the standstill of foundation in 2010	Active participation	9	7.0
		Passive participation	70	54.7
		Missing values	49	38.3
11	Wish for participation in park planning and management in the future	Active participation	51	39.8
		Passive participation	63	49.2
		Missing values	14	10.9
12	Satisfaction with the cooperation	Interval variable (7-point Likert scale)	77	60.2
		Missing values	51	39.8

# Who Is For or Against the Park? Factors Influencing the Public's Perception of a Regional Park

	Variable	Category	F (n = 128)	%
13	Trust in the founders	Interval variable (7-point Likert scale)	115	89.8
		Missing values	13	10.2
14	Meaning of land in the park	Solely as property	20	15.6
		Main source of income	8	6.3
		Additional source of income and source of raw materials for private use	16	12.5
		Safety net for times of crisis	0	0.0
		Place for relaxation and leisure time	9	7.0
		Missing values	75	58.6

## Notes.

- In the statistical analysis of gained data, the dependent variable is the binary variable "opinion of the park," which was remodeled from a nominal variable with four categories in the following manner: the category "I support the park" combines the answers "I support the idea of the park" and "I support the park being founded with certain changes," whereas the category "I oppose the park" combines the answers "nature needs to be preserved, but not in the form of a regional park" and "I oppose any kind of nature protection in this area."

- "Perceiving the park as having development potential" is the result of a factor analysis procedure. One of the two factors combines six variables which describe the local population's change of expectation toward the KSARP in designation, using a 7-point Likert scale (from 1 *completely disagree* to 7 *strongly agree*). The six variables were: people will start moving out of the park area, the park will limit agriculture and farm development, local infrastructure will improve, the park will result in increased tourist numbers and job vacancies in the tourist field, the park will turn into wilderness without human activity, the possibility for the development of crafts and businesses will improve.

Kaiser-Meyer-Olkin test and Bartlett's test were used to test factor reliability and characteristics. Both showed reliable results: KMO (0.729), Bartlett (chi-square 173.890, df 15,  $p < 0.000$ ).

- The variable "participation in the founding of the park until the standstill of foundation in 2010" is based on eight nominal values gathered into two categories:

(a) Passive participation: "I was only notified about the park being founded or acquainted with the idea," "I made a suggestion to the municipality that a park should be founded in the KSA," "I participated in choosing the name and the logo for the regional park," "I participated in notifying locals about the park being founded," "I came to the public discussion of the regional park draft regulation."

(b) Active participation: "I helped the planners determine the park area (i.e., the borders)," "I took part in determining development guidelines and measures for the park," "I wrote down or spoke about my views on the park contents."

If the interviewee had actively participated in at least one activity, they were classified as having taken active participation in the founding of the park thus far.

- The variable "wish for participation in park planning and management in the future" is formed based on 10 nominal values. It combines both the passive and active approach to future planning of the park and its operation:

(a) Passive: "I wouldn't wish to participate in park planning," "I would make a suggestion to the municipality or the state that a park should be founded in the KSA," "I would participate in choosing the name and the logo for the regional park," "I would come to the public discussion of the regional park draft regulation," "I would help aligning the park contents with the local population."

(b) Active: "I would help the planners determine the park area (i.e., the borders)," "I would take part in determining development guidelines and measures for the park," "I would help draft a management plan after the park has been founded," "I would take part in park management as a member of the management board and the park council, as well as the person implementing the measures," and "as a member of the supervisory board, I would participate in supervising park management and its management plan execution."

If the interviewee would take active participation in at least one of the abovementioned activities, it was regarded that the interviewee would take active participation in park planning and its operation.

## Statistical analysis

To determine what factors influence the local population's perception of the park, discriminant analysis was used. Its aim is to determine the variables or factors that best distinguish two or more groups. This information is provided through the discriminant function, a new variable whose interpretation needs to take into consideration the eigenvalue and canonical correlation, Wilks's lambda test, Box's M test, and standardized canonical discriminant function coefficients. Box's M test is used to test the null hypothesis for homogeneity of covariance matrices between groups, which has to be taken into consideration in smaller samples. The eigenvalue indicates the proportion of variance explained, Wilks's lambda test is used to express discriminant function characteristics and determine the total share of unexplained variability. Standardized canonical discriminant function coefficients are used to express the relative importance of individual variables when distinguishing among groups and their prefixes determine the path of the variables' influence on group classification (Kastelec & Košmelj, 2008). All statistical analyses were performed with the SPSS program.

In the first phase of the analysis, discriminant analysis was carried out separately, taking into consideration the variables for individual thematic groups: (1) population's conservation affinity, (2) population's inclusion in the founding process and population's trust in the founders, and (3) population's socioeconomic status. The aim was to determine which thematic group best defines the population's inclination for or against the park being founded. Since the models, taking into consideration the thematic groups, did not show any significant results, we excluded from each group the variables that showed the largest influence when classifying units within a group. Based on results from previous discriminant analyses, the following variables were excluded from further analysis: "perception of the park," "municipality," and "active participation in the founding of the park thus far." Due to covariance matrix inequality among the groups (Box's M test), the variables "size of land" and "meaning of land in the park" were also excluded from further analysis.

The final discriminant analysis model (Table 2) includes nine variables which were previously determined as having weak correlation among each other ( $R < 0.3$ ). Since Box's M test result did not prove to be significant ( $p = 0.877$ ), the results presented further on are reliable. Eigenvalue shows that the discriminant function explains 74.3% of the between-group variance. Since Wilks's lambda value is statistically significant ( $p = 0.000$ ), we can claim an important difference between the two groups. With its regression coefficients, its estimated canonical correlation coefficient ( $R = 0.74$ ), group centroid distance, and the results of the predicted initial group classification (88.1%), discriminant analysis is relatively good at distinguishing the groups' support of and opposition to the park being founded.



## Results and discussion

Results show that some of the stakeholders' characteristics can affect their support of or opposition to the planned park in a generalized way. Those supporting the park differed from those opposing it in the fact that they see development potential in the park, that they were informed about the plan to found the park by the founders, and that they trust them to lead the founding process in cooperation with all interest groups (Table 2).

**Table 2. Factors forming the opinion for or against KSARP being founded: standardized canonical coefficients and other discriminant function tests**

	<b>D1</b>	<b>Sig.</b>
Perceiving the park as having development potential	0.803	0.000
First source of information about the park was personal contact with the founder	0.514	0.021
Trust in the founders	0.485	0.002
Age	-0.484	0.102
Place of residence – inside the park	0.228	0.255
Satisfaction with the cooperation	0.134	0.157
Education – college, university or more	0.121	0.014
Wish for participation in park planning and management in the future	0.081	0.042
Gender – male	-0.039	0.480
Canonical correlation	0.743	
Wilks's lambda – significance	0.000	
Group centroids		
Support the park	0.752	
Oppose the park	-1.584	
Original grouped cases correctly classified (%)	88.1	

The highest value of the regression coefficient (0.80) is expressed in the variable “the stakeholders perceive the park as having development potential.” There is an important difference between the two groups in the way they were informed about the plans for the park and how much they trust the founders: “the first source of information about the park was personal contact with the founder” (0.51) and “trust in the founders” (0.49). The influence on classification within a group is expressed through the variable “age” (-0.48), but this variable shows no statistically significant correlation with the dependent variable, along with the variables “place of residence,” “gender,” and “satisfaction with the cooperation.”

## Development potential

The population's classification into the groups opposing or supporting the park is mostly influenced by them perceiving the park as having development potential. This means that they see some direct or indirect economic and lifestyle benefits such as improvement of local infrastructure, increased tourist numbers and job vacancies, agriculture and farm development, new possibilities for crafts and businesses, and preserved settlements.

Several studies have shown that a positive perception of a PA is influenced by reaping or perceiving benefits from the founded PA (e.g., Ezebilo & Mattsson, 2010; Htun et al., 2012; Karanth & Nepal, 2012; Macura et al., 2011; Niedziałkowski et al., 2014; Tomicevic et al., 2010; Vodouhê et al., 2010). Since KSARP has not yet been founded, the inhabitants reap no benefits from the park, but the support for the park is heavily influenced by the idea of the park having benefits for the area's development. Because the KSARP, as well as other PAs, has not only conservation but also development objectives, the local stakeholders should be encouraged to express their wishes and ideas in relation to local sustainable development. Managers should provide an environment that encourages stakeholders to participate in development projects (Hirschnitz-Garbers & Stoll-Kleemann, 2011; Sirivongs & Tsuchiya, 2012). This way, locals can be better integrated in PA management and can also receive some benefits.

The results clearly show that the development objective of the park is, along with nature conservation, very important. This is what could convince people to support the park. People who are satisfied with their environment and their situation in it are part of the social capital of the region and their social self-esteem increases. Park development also depends on trust among people and it is a necessary precondition to achieve positive results in biodiversity (Pretty & Smith, 2004). This way, we can say that conservation and development are interlinked and interdependent.

## Information about the park and trust in the founders

The way in which the park was presented to the local inhabitants was very important for them. This has an important connection with the first information that the population was given regarding the founding of the park. The higher the trust that the founders will lead the founding process in cooperation with all interest groups, the more support for the park. The population feels it is important for the founders to contact them personally and inform them personally about the status of the founding process. Niedziałkowski and colleagues (2012, 2014) recognize that the lack of clear information about managing led to diminished trust in the founders of the Białowieża National Park in Poland. In keeping with our results, Stern (2008) also notes that trust

is one of the most consistent predictors of exercised restraint across PAs. Trust is a basic need for successful cooperation between local stakeholders and founders (Abbas et al., 2014; Schmidt et al., 2014). Low confidence in a park's founders (state and municipalities) is a result of past negative experiences with them, such as insufficient communication, top-down environmental decisions, lack of transparency, and land nationalization. Direct communication, local participation, and some good practices could appreciably improve trust. Contrary to our expectations, the population's active participation in the founding of the park until the standstill of foundation in 2010, its satisfaction with inclusion in the processes, and its wish for active participation in the future play no significant role in its classification as supporting or opposing the park. Previous studies give different results regarding participation. Hirschnitz-Garbers and Stoll-Kleemann (2011), Sirivongs and Tsuchiya (2012), and Toomey and Domroese (2013) record some positive effects on attitudes and perceptions, while Macura et al. (2011) and Niedziałkowski et al. (2012) show the negative consequences of participation. Our results show that the population's perception is much more influenced by the way they were informed about the park being founded than their active participation in the founding of the park or their wish to participate in the founding. The results of research among the local stakeholders in Slovenia (Nastran, 2013, 2015) also confirm that the local population wish to participate in the park activities but in a passive rather than an active way. One possible explanation could be the request of the local population for procedural justice (Gross, 2008; Kerselaers et al., 2013; Niedziałkowski et al., 2014), which is not so much about opposing the park as it is about their wish to be heard, informed, and respected as a stakeholder, and to have an opportunity to contribute to the results. This could also be easily connected with trust and sources of information. It does not refer just to the outcomes of the process but also to the process of designation itself; who and how do the founders inform about the park or invite to be part of the designation process. Gross (2007) reports that perceptions of fairness do influence how people perceive the legitimacy of the outcome in a case of wind energy in Australia. In our case, trust is a crucial factor which stakeholders consider to be of high priority. Direct information from the founders and a sense of fair cooperation in the designation process have an evident impact on a park's perception.

## Other influences

Most of the population living within the park boundary (55%) or outside (75%) supports the founding of the park. Contrary to other studies (Bonaiuto et al., 2002; Shibia, 2010; Triguero-Mas et al., 2009; Vodouhê et al., 2010), living within or outside the park boundary has no significant influence on interviewees' perceptions of the park in designation. This phenomenon could be explained by the fact that the people in the main populated areas are closely connected

and have similar experiences from the past, the park founder's consistent communication strategy in the founding process thus far, or that the population has not yet been divided into those living inside and outside the park boundary as the park has not been formally founded.

Support for the KSARP is not significantly connected with the population's age, which is in contrast to other studies' results which found older people less favorable to PAs (e.g., Shibia, 2010; Tomicevic et al., 2010). Gender had no significant influence on the park's perception, a similar finding to other studies (e.g., Burn et al., 2012; Carrus et al., 2005; Shibia, 2010). However, some studies have found that women have less positive perceptions of PAs than men (Allendorf & Allendorf, 2013; Tomicevic et al., 2010). Contrary to most previous studies, higher education is not connected with support for the park in our case. Further studies are necessary to explain these discrepancies.

## Conclusion

The aim of this study was to determine the factors that influence the support of or opposition to the founding of the KSARP and the extent to which they do so. In contrast to similar studies, our study was conducted when the park was still being founded, not after it had been founded. Results show that there is a greater chance of opposition in the inhabitants who do not see the park as having development potential and who were not informed about the founding of the park directly from the founders. The latter result is connected with the fact that the population opposing the park being founded is more likely to not trust the park founders.

A study of the characteristics that define stakeholders' perceptions of the park is particularly important in designing further cooperation of founders with local stakeholders and in the subsequent management of the park. An understanding of the factors influencing the stakeholders' position makes it easier to find partners in the establishment of PAs. The research reveals the most common opponents to the park and the reasons for their opposition. This knowledge can lead to more targeted and effective participation. The findings can also inform the best methods for stakeholder involvement, since different groups of stakeholders require different participatory methods. To sum up, understanding the factors that affect the perception of PAs contributes to more effective stakeholder involvement, which is accepted to be one of the most important influences on the successful management of PAs.

Belief that the park will bring development is the most important factor for the local population. This confirms that the park's further development and management needs to be linked to projects that are compatible with nature conservation and lead to the sustainable development of the local community. The second focus is to work on creating a positive relationship between the founders (and managers later) and the local stakeholders. Managers will need to establish a relationship that will encourage locals to participate, and accept that the desires and needs of the population are an indisputable part of the park and the key to the success of sustainable development and nature conservation.

The results of this study can be a guideline in planning cooperation with stakeholders in other places, but one has to take into consideration the unique natural and social characteristics of a given area. Finally, the results leave space for further qualitative research and for a comparison examining the processes of founding other PAs.

## Acknowledgments

This research was conducted independently, without contract or the support of the founders of KSARP in designation. The opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the founders of KSARP or any other agency. We would like to thank the anonymous reviewers for their constructive comments on earlier versions of the paper.

## References

- Abbas, N. H., van der Molen, I., Nader, M. R., & Lovett, J. C. (2014). Citizens' perceptions of trust relationships in the environmental management process in North Lebanon. *Journal of Environmental Planning and Management*, 1–19. doi: 10.1080/09640568.2014.935757
- Allendorf, T. D. (2010). A framework for the park–people relationship: Insights from protected areas in Nepal and Myanmar. *International Journal of Sustainable Development & World Ecology*, 17(5), 417–422.
- Allendorf, T. D., & Allendorf, K. (2013). Gender and attitudes toward protected areas in Myanmar. *Society & Natural Resources*, 26(8), 962–976.
- Allendorf, T. D., Smith, J. L. D., & Anderson, D. H. (2007). Residents' perceptions of Royal Bardia National Park, Nepal. *Landscape and Urban Planning*, 82(1–2), 33–40.

- Alonso-Yañez, G., & Davidsen, C. (2014). Conservation science policies versus scientific practice: Evidence from a Mexican biosphere reserve. *Human Ecology Review*, 20(2), 3–29.
- Arnberger, A., Eder, R., Alex, B., Sterl, P., & Burns, R. C. (2012). Relationships between national-park affinity and attitudes towards protected area management of visitors to the Gesäuse National Park, Austria. *Forest Policy and Economics*, 19, 48–55.
- Arnberger, A., & Schoissengeier, R. (2012). The other side of the border: Austrian local residents' attitudes towards the neighbouring Czech Šumava National Park. *Journal for Nature Conservation*, 20(3), 135–143.
- Bonaiuto, M., Carrus, G., Martorella, H., & Bonnes, M. (2002). Local identity processes and environmental attitudes in land use changes: The case of natural protected areas. *Journal of Economic Psychology*, 23(5), 631–653.
- Burn, S. M., Winter, P. L., Hori, B., & Silver, N. C. (2012). Gender, ethnic identity, and environmental concern in Asian Americans and European Americans. *Human Ecology Review*, 19(2), 136.
- Carrus, G., Bonaiuto, M., & Bonnes, M. (2005). Environmental concern, regional identity, and support for protected areas in Italy. *Environment and Behavior*, 37(2), 237–257.
- Conrad, C. C., & Hilchey, K. G. (2011). A review of citizen science and community-based environmental monitoring: Issues and opportunities. *Environmental Monitoring and Assessment*, 176(1–4), 273–291.
- Erhatic Širnik, R. (2003). *Public participation in the establishment of the Kočevsko – Kolpa regional park* (Unpublished master's thesis). University of Ljubljana, Slovenia.
- European Commission. (2015). Natura 2000 network. Retrieved from [http://ec.europa.eu/environment/nature/natura2000/index\\_en.htm](http://ec.europa.eu/environment/nature/natura2000/index_en.htm)
- Ezebilo, E. E., & Mattsson, L. (2010). Socio-economic benefits of protected areas as perceived by local people around Cross River National Park, Nigeria. *Forest Policy and Economics*, 12(3), 189–193.
- Fakin Bajec, J. (2009). Kraški regijski park – realnost ali utopija? Začetki nastajanja projekta in razmišljanja o njegovi nadaljnji usodi. *Izvestje Raziskovalne postaje ZRC SAZU v Novi Gorici*, 2009(6), 27–34.
- Flints, R. W. (2010). Seeking resiliency in the development of sustainable communities. *Human Ecology Review*, 17(1), 44–57.

- Government of Republica Slovenia. (2006). *Resolution on National Environmental Action Plan 2005–2012*.
- Grošelj, A. (2008). *An evaluation of methodology in creating nature parks in Slovenia* (Unpublished master's thesis). University of Ljubljana, Slovenia.
- Gross, C. (2007). Community perspectives of wind energy in Australia: The application of a justice and community fairness framework to increase social acceptance. *Energy Policy*, 35(5), 2727–2736.
- Gross, C. (2008). A measure of fairness: An investigative framework to explore perceptions of fairness and justice in a real-life social conflict. *Human Ecology Review*, 15(2), 130–140.
- Hirschnitz-Garbers, M., & Stoll-Kleemann, S. (2011). Opportunities and barriers in the implementation of protected area management: A qualitative meta-analysis of case studies from European protected areas. *Geographical Journal*, 177(4), 321–334.
- Htun, N. Z., Mizoue, N., & Yoshida, S. (2012). Determinants of local people's perceptions and attitudes toward a protected area and its management: A case study from Popa Mountain Park, Central Myanmar. *Society & Natural Resources*, 25(8), 743–758.
- Hu, J., Ping, X., Cai, J., Li, Z., Li, C., & Jiang, Z. (2010). Do local communities support the conservation of endangered Przewalski's gazelle? *European Journal of Wildlife Research*, 56(4), 551–560.
- Karanth, K. K., & Nepal, S. K. (2012). Local residents perception of benefits and losses from protected areas in India and Nepal. *Environmental Management*, 49(2), 372–386.
- Kastelec, D., & Košmelj, K. (2008). Discriminant analysis and classification: Theory and illustration. *Acta Agriculturae Slovenica*, 91.
- Kerselaers, E., Rogge, E., Vanempten, E., Lauwers, L., & Van Huylenbroeck, G. (2013). Changing land use in the countryside: Stakeholders' perception of the ongoing rural planning processes in Flanders. *Land Use Policy*, 32, 197–206.
- Kideghesho, J. R., Røskft, E., & Kaltenborn, B. P. (2007). Factors influencing conservation attitudes of local people in western Serengeti, Tanzania. *Biodiversity and Conservation*, 16(7), 2213–2230.

- Kos, D. (2002). Načela komunikacijskega delovanja. In D. Kos & M. Marega (Eds.), *Aarhuška konvencija v Sloveniji* (pp. 135–141). Ljubljana: Regionalni center za okolje za srednjo in vzhodno Evropo.
- Lind, E. A., & Tyler, T. R. (1988). *The social psychology of procedural justice*. New York: Plenum Press.
- Macura, B., Zorondo-Rodríguez, F., Grau-Satorras, M., Demps, K., Laval, M., Garcia, C. A., & Reyes-García, V. (2011). Local community attitudes toward forests outside protected areas in India: Impact of legal awareness, trust, and participation. *Ecology and Society*, 16(3), Art. 10.
- Mehta, J. N., & Heinen, J. T. (2001). Does community-based conservation shape favorable attitudes among locals? An empirical study from Nepal. *Environmental Management*, 28(2), 165–177.
- Mikuš, T. (2006). *The state and perspectives of landscape parks in Slovenia* (Unpublished master's thesis). University of Ljubljana, Slovenia.
- Nastran, M. (2013). Stakeholder analysis in a protected natural park: Case study from Slovenia. *Journal of Environmental Planning and Management*, 57(9), 1359–1380.
- Nastran, M. (2015). Why does nobody ask us? Impacts on local perception of a protected area in designation, Slovenia. *Land Use Policy*, 46, 38–49.
- Nastran, M., & Pirnat, J. (2012). Stakeholder participation in planning of the protected natural areas: Slovenia. *Sociologija i Prostor*, 50(2(193)), 141–164. doi: 10.5673/sip.50.2.1
- Niedziałkowski, K., Blicharska, M., Mikusiński, G., & Jędrzejewska, B. (2014). Why is it difficult to enlarge a protected area? Ecosystem services perspective on the conflict around the extension of the Białowieża National Park in Poland. *Land Use Policy*, 38, 314–329.
- Niedziałkowski, K., Paavola, J., & Jędrzejewska, B. (2012). Participation and protected areas governance: The impact of changing influence of local authorities on the conservation of the Białowieża Primeval Forest, Poland. *Ecology and Society*, 17(1), Art. 2.
- Pretty, J., & Smith, D. (2004). Social capital in biodiversity conservation and management. *Conservation Biology*, 18(3), 631–638.
- Rodela, R. (2010). *A bottom-up rural regeneration initiative: A social learning analytical perspective*. Paper presented at the 9th European IFSA Symposium, Vienna.



- Schmidt, L., Gomes, C., Guerreiro, S., & O'Riordan, T. (2014). Are we all on the same boat? The challenge of adaptation facing Portuguese coastal communities: Risk perception, trust-building and genuine participation. *Land Use Policy*, 38, 355–365.
- Shibia, M. G. (2010). Determinants of attitudes and perceptions on resource use and management of Marsabit National Reserve, Kenya. *Journal of Human Ecology*, 30(1), 55–62.
- Sirivongs, K., & Tsuchiya, T. (2012). Relationship between local residents' perceptions, attitudes and participation towards national protected areas: A case study of Phou Khao Khouay National Protected Area, central Lao PDR. *Forest Policy and Economics*, 21, 92–100.
- Stern, M. J. (2008). The power of trust: Toward a theory of local opposition to neighboring protected areas. *Society and Natural Resources*, 21(10), 859–875.
- Stringer, L. C., & Paavola, J. (2013). Participation in environmental conservation and protected area management in Romania: A review of three case studies. *Environmental Conservation*, 40(2), 138–146.
- Swim, J. K., Zawadzki, S. J., Cundiff, J. L., & Lord, B. (2014). Environmental identity and community support for the preservation of open space. *Human Ecology Review*, 20(2).
- Tomicevic, J., Shannon, M. A., & Milovanovic, M. (2010). Socio-economic impacts on the attitudes towards conservation of natural resources: Case study from Serbia. *Forest Policy and Economics*, 12(3), 157–162.
- Toomey, A. H., & Domroese, M. C. (2013). Can citizen science lead to positive conservation attitudes and behaviors? *Human Ecology Review*, 20(1).
- Triguero-Mas, M., Olomí-Solà, M., Jha, N., Zorondo-Rodríguez, F., & Reyes-García, V. (2009). Urban and rural perceptions of protected areas: A case study in Dandeli Wildlife Sanctuary, Western Ghats, India. *Environmental Conservation*, 36(3), 208–217.
- Vodouhê, F. G., Coulibaly, O., Adégbidi, A., & Sinsin, B. (2010). Community perception of biodiversity conservation within protected areas in Benin. *Forest Policy and Economics*, 12(7), 505–512.



# Are There Relationships Among Racial Segregation, Economic Isolation, and Proximity to Green Space?

Salvatore Saporito<sup>1</sup>

Department of Sociology, College of William & Mary  
Williamsburg, Virginia, United States

Daniel Casey

Institute for Health Metrics and Evaluation  
University of Washington, Seattle, United States

## Abstract

Prior research has investigated differences in exposure to green space between racial and economic groups across the United States. Results have generally shown that people of color and lower-income groups tend to live in neighborhoods with less green space than their more-advantaged counterparts. Our research extends existing studies by measuring the association between racial and economic differences in exposure to green space and racial or economic segregation across neighborhoods within cities. Findings show that cities with lower levels of racial segregation exhibit smaller racial disparities in exposure to green space. By contrast, in cities with greater racial segregation, white people tend to live in neighborhoods with more green space than do people of color. This difference is more pronounced between white and Hispanic people. Finally, there is a strong association between segregation among different income groups and differences in exposure to green space between lower- and higher-income people. Consistent with much of the literature on racial and economic segregation—and studies of environment (in)justice—we find that lower-income people and members of minority groups live in neighborhoods with much less vegetation than their wealthier, white counterparts and these differences are exacerbated in racially and economically segregated cities.

**Keywords:** economic segregation, green space, racial segregation

---

<sup>1</sup> Corresponding author: [sjsapo@wm.edu](mailto:sjsapo@wm.edu).

## Are there relationships among racial segregation, economic isolation, and proximity to green space?

It is well known that racial segregation within a city increases exposure to poverty among members of minority groups (Massey & Fischer, 2000). Studies have also shown that, in general, minorities and lower-income people live closer to noxious land uses than do white and higher-income people. These social ills include proximity to waste dumps, superfund sites, incinerators, air pollution, traffic (Bullard, 2000; Crowder & Downey, 2010; Wing et al., 2000), food deserts (Wrigley et al., 2003; Zenk et al., 2005), fast-food chains (Boone-Heinonen et al., 2011; Kwate, 2008), social disorganization, crime, police surveillance and incarceration (Goffman, 2014; Sampson, 2012), and deteriorating and abandoned buildings (Adelman, 2004).

More recently, scholars have expanded their research to include analyses of unequal proximity to social amenities such as playgrounds and recreational facilities (Cradock et al., 2005), banks (Squires & O'Connor, 1998), and restaurants, grocery stores, coffee houses, movie theaters, and clothing stores (Duncan et al., 2012). In particular, researchers have examined the proximity of different racial and economic groups to *green space* such as urban parks, street trees, greenways, and tree canopy cover. Urban green space has been identified as an environmental amenity by a variety of scholars and urban planners because it typically has two qualities: the presence of vegetation and social upkeep (Heynen, 2003; Heynen et al., 2006; Landry & Chakraborty, 2009; Lindsey et al., 2001; Sister et al., 2010; Troy et al., 2007; Wen et al., 2013; Wendel et al., 2011).

As studies of urban tree canopy cover highlight, municipalities often use trees and other vegetation to alter the urban landscape. These alterations take the form of green medians, parks, greenways, and similar features (Heynen et al., 2006; Landry & Chakraborty, 2009; Lindsey et al., 2001; Wen et al., 2013). In these cases, the presence of green space is not necessarily “natural.” Instead, its existence is created and maintained by urban planners, municipal departments of transportation, local environmental groups, and other organizations. Given its social and political foundations, an important question is whether the production and maintenance of green space by municipalities is distributed evenly—particularly when the distribution of racial and economic groups is distributed unevenly.

This is a key question since green space provides numerous benefits, including improving water conservation, reducing carbon dioxide, enhancing air quality, increasing biodiversity, and limiting runoff (Heynen & Lindsey, 2003;

Heynen et al., 2006). It is also associated with socioeconomic benefits, including higher property values, greater aesthetics, and social cohesion (Landry & Chakraborty, 2009). Finally, exposure to greater vegetation and parks has been shown to improve health outcomes by reducing stress and increasing physical exercise (Chiesura, 2004; Maas et al., 2006; Maller et al., 2006; Mitchell & Popham, 2008; Nielsen & Hansen, 2007; Ward-Thompson et al., 2012).

Many of these same studies examine the density of green space across neighborhoods that vary in their racial and economic composition. Findings generally show that lower-income people and racial minorities live closer to a patch of green space than white people but live in neighborhoods with lower densities of green space. For example, Landry and Chakraborty (2009) used high-resolution imagery (i.e., one square meter) to determine the density of publicly planted trees on sidewalks and similar public spaces in Tampa, Florida. They found that lower-income people and members of minority groups were exposed to less green space than were higher-income and white people. A case study of Milwaukee showed that the proportion of census tract areas that were covered by tree canopy was negatively correlated with concentrations of lower-income and minority people (Heynen et al., 2006). Still other studies examined the density of green space in the form of public parks and found that, in Philadelphia, non-whites and renters lived near less green space overall than whites and homeowners (Heckert, 2013). Similarly, findings from Baltimore indicate that a higher proportion of African Americans have access to parks within walking distance than whites, but whites have access to more acreage of parks within walking distance than African Americans (Boone et al., 2009). Findings from these intensive cases studies of specific cities have been replicated on a national scale and show that members of disadvantaged groups live closer to green space such as parks but live in census tracts with less green space (Wen et al., 2013).

We add to the existing literature in several ways. First, we use the most recent estimate of vegetative cover based on 2012 satellite imagery. This imagery estimates the intensity of vegetation inside cells of a 30 by 30 meter grid allowing us to generate a reasonably accurate indication of green space within a relatively small area. Second, the grid covers the continental United States. Thus, like case studies of cities, we use relatively high-resolution land cover data to determine vegetative densities but, unlike case studies, our analysis is at a national scale. Third, we use block group data derived from the United States Census Bureau's 2008–2012 American Community Survey; the use of block groups is important since they are a much more reasonable definition of “neighborhood” than are census tracts. Finally—and most importantly—we explore two new questions: First, what is the association between racial segregation across cities and

differences in the exposure to green space between white and non-white people? Second, what is the correlation between economic segregation across cities and differences in exposure to green space among different economic groups?

By definition, when members of different racial groups live in the same, small neighborhoods they are all equally exposed to grass, shrubs, trees, and other vegetation. However, when advantaged and disadvantaged people live in different neighborhoods within a city it may be that advantaged people live in neighborhoods with higher densities of vegetation than members of disadvantaged groups. Yet, no study has investigated whether racial segregation within a city is associated with greater racial and socioeconomic disparities in exposure to green space. This is an open question since it may be that a variety of factors may mitigate the otherwise deleterious effects of segregation. For example, municipalities with greater racial and economic segregation may try to ensure that all neighborhoods—irrespective of their demographic makeup—have their fair share of greenways, parks, sidewalk trees, and the like. Or it may be that racial minorities and those with lower incomes plant urban gardens in empty lots, seek low-cost housing adjacent to green space, or live outside the urban core. While a cross-sectional study such as ours cannot determine why a link between segregation and green space disparities exist, an important first step is to explore the strength of this association.

## Data and measures

We linked data from several sources. The first was a composite mosaic of Landsat 7 imagery from the 2012 growing season. These data were processed and distributed by a consortium comprising the University of Maryland Department of Geographical Sciences, Google, USGS, and NASA (Hansen et al., 2013). From these data we created “normalized difference vegetation index” (NDVI) values. For some portions of the country, cloud-free satellite imagery for 2012 was not available. In these cases, data from the time frame closest to the 2012 summer was used. Imagery covers the continental United States and is available at a resolution of 30 by 30 meter raster (or grid).<sup>2</sup>

---

2 Although our research question is different from that of Wen et al. (2013), our national study differs from theirs in two other respects. First, they used classified land use data in which every cell in a raster is classified into a single category. Cells that may have had some vegetation may have been classified as “urban” or “residential.” Classifying cells into discrete categories may be problematic in urban areas where verdancy likely coexists with other land uses (e.g., pavement, rooftops) within a cell. Our study ensured that verdancy was measured even if it was relatively sparse. Second, we used block groups while they measured neighborhoods using larger areas (i.e., census tracts).

The NDVI score is derived from the proportion of visible light (VIS) and near-infrared light (NIR) that is absorbed or reflected by plants (and by non-plant matter) on or near the earth's surface. The chlorophyll in vegetation absorbs most VIS with wavelengths between 400 and 700 nanometers. Low proportions of VIS reflected from an area of the earth's surface indicate that the area is covered by dense, living vegetation. When an area is barren of live leaves, most incoming VIS is reflected and values of VIS are close to 1. Higher densities of leaves reflect greater amounts of NIR, at wavelengths around 700–1100 nanometers.

NDVI is calculated by subtracting the proportion of VIS reflected from the earth's surface from the proportion of NIR reflected and dividing this value by the sum of the proportions of NIR and VIS:

$$NDVI = \left( \frac{NIR - VIS}{NIR + VIS} \right) \times 10,000$$

We multiplied NDVI scores by 10,000 for ease of reporting. A 30 by 30 meter raster cell with an NDVI value between 2,000 and 4,000 typically indicates the presence of grass, shrubs, and sparse tree cover; such values in urban settings often indicate a park, large garden, golf course, playing field, or streets with trees. Values above 4,000 represent denser tree canopy (with values close to 10,000 indicating rainforests). For example, Seattle, Washington, has parks (e.g., Westcrest and Schmitz) that contain numerous pixels with NDVI values well above 4,000. Values of -10,000 represent water (and these cells are excluded from our calculations).

We took the NDVI scores of each cell and averaged them across neighborhoods—which in our study are represented by 2012 census block groups (CBGs).<sup>3</sup> Using 2012 CBGs has two advantages. First, 2012 CBGs precisely correspond with the 2012 satellite imagery. Second, CBGs are reasonable approximations of urban neighborhoods, particularly in scale. Most people can traverse an urban CBG by walking. Thus, people living in a CBG are likely within walking distance of any significant patch of green space (although they might not necessarily see the greenery by peering out their windows). We argue that CBGs are more reasonable approximations of neighborhoods than are census tracts or zip codes—which have been used in other national studies of greenspace.

---

3 Since many urban neighborhoods contain bodies of water—which is, like vegetation, soothing and valuable—our calculations do not include cells that contain water since they would lower the mean NDVI score. In addition to calculating the mean NDVI score of cells within each CBG, we also determined the proportion of raster cells within a CBG that had an NDVI score above various thresholds. This is an indication of the proportion of a CBG area that is covered in dense greenery. For example, we observed the proportion of raster cells within a CBG that were above 3,000. Using these thresholds did not produce substantively different results than using the mean value of NDVI within CBGs. For the sake of parsimony, we use one measure of verdancy in our statistical analysis.

A CBG containing a mix of residential neighborhoods, parks with dense tree cover, grass-covered playgrounds, tree-lined streets, cemeteries, golf courses, and the like will typically have a mean NDVI cell value between 1,000 and 3,000 (with values greater than 3,000 indicating a CBG with large swaths of dense greenery). Scores hovering around zero may have some grass and trees, while scores less than -1,000 will typically consist of residential areas with very little greenery.

These scores will, of course, vary across the country. For example, a CBG in Seattle that contains a sizable, tree-covered park will have a higher NDVI score than, say, a similar-sized CBG in Chicago with a sizable, tree-covered park (and, overall, Chicago will be more verdant than Phoenix or Las Vegas). National variation in NDVI did not affect our analysis for two reasons. First, we compared group differences in exposure to green space. Second, we did this within cities. Our approach assessed whether white people are surrounded by more (or less) green space than African American or Hispanic people *in the same city*. As we discuss more extensively below, our unit of analysis was a city—and we compared groups within a city. It is not an issue if, say, white people in Seattle are surrounded by more verdancy than white people in Phoenix. The issue is whether white people in Seattle fair better than people of color in Seattle.

We integrated CBG data of greenery with CBG-level 2012 American Community Survey data describing the racial and economic characteristics of people. We determined the number of people by race within each CBG. The racial categories we analyzed were non-Hispanic white, non-Hispanic African American, Hispanic, and non-white. To measure the economic characteristics of people we used poverty status—an ordinal variable consisting of the following seven categories: 0 to 50 percent of poverty, 51 to 100 percent of poverty, 101 to 125, 126 to 150, 151 to 185, 186 to 200, greater than 200.<sup>4</sup>

## Creating city-level measures for racial groups

We integrated NDVI data with 2012 American Community Survey data to create city-level variables for our analysis. The dependent variables in our analysis were *differences in exposure* to verdancy between racial groups or among economic groups within a city. Creating these measures requires several steps. To measure racial differences in exposure to verdancy, we first created exposure to the mean NDVI scores for each racial group by city. We did this by multiplying the number of people of a given racial group (e.g., non-Hispanic white) within a CBG by the CBG's mean NDVI score, giving us a weighted NDVI score for each CBG. For each city, we then summed the weighted NDVI scores

---

4 For 2012, a family of four with earnings of \$23,050 or less was beneath the poverty line. We also examined educational status. Results were substantively similar to those for poverty status.



and divided the sum by the total number of people in a given racial group. This resulted in average exposure to green space for each racial group within a city. We then took the difference in exposure to green space for pairs of racial groups. Specifically, we subtracted African American exposure from white exposure and Hispanic exposure from white exposure. (We also compared white and non-white exposure.) Higher positive values indicate that the typical white person is exposed to greater amounts of green space compared with the typical African American, Hispanic person, or person of color. Negative values indicate that non-white people have greater exposure to green space than white people.

In our analysis of racial differences to exposure, our main independent variable was racial segregation across CBGs within cities. Because we measured segregation between pairs of racial groups, we used the index of dissimilarity. The formula for the index of dissimilarity is:

$$D = \left( \frac{1}{2} \sum_{i=1}^n \left| \frac{x_i}{X} - \frac{y_i}{Y} \right| \right) 100$$

Where  $x_i$  and  $y_i$  are the number of people of racial group  $x$  and  $y$  in CBG  $i$ ;  $X$  and  $Y$  represent the total number of people of these racial groups in the city. Values of dissimilarity range from 0 to 100. A value of 0 represents perfect integration. This arises when the proportion of people of each racial group are the same for each neighborhood and the entire city. For example, if 65 percent of the people in a city are white and 35 percent are African American, each neighborhood within a city would have the same 65/35 racial composition. A value of 100 represents complete segregation (i.e., each of the two racial groups live in completely different CBGs).

## Creating city-level measures of segregation for economic groups

The dependent variable for economic groups is the association between exposure to green space and poverty status. This measure is created in several steps. As with racial groups, we first calculated exposure to green space for each of the seven categories of poverty. We did this by multiplying the number of people in a poverty classification (e.g., people less than half of the poverty threshold, people between half and 100 percent of the poverty threshold, and so on) within a CBG by the CBG's mean NDVI score. This resulted in a weighted NDVI score for each CBG and each poverty classification. For each city, we summed the weighted NDVI scores and divided the sum by the total number of people of a given poverty classification. This resulted in average exposure to green space for each poverty classification within a city.

For each city, we then measured the association between each group's poverty classification and their exposure to greenness. We treated poverty classification as an interval variable in which zero represented the lowest category of poverty and six the highest. We calculated a regression coefficient (i.e., the slope) between poverty classification and exposure to green space for each of the poverty groups. These slopes are a way to summarize differences in exposure to verdancy among multiple income classifications. If there is no association between poverty classification and exposure to green space (i.e., the slope is zero), then different poverty groups are, on average, exposed to equal amounts of green space in their neighborhoods. Positive, higher coefficients (i.e., steeper slopes) indicate that a city's higher-income people are, on average, exposed to greater amounts of verdancy than its lower-income people.

After calculating our dependent variable, we calculated an ordinal measure of segregation—the ordinal entropy index—to determine the spatial distribution of poverty groups across a city (Reardon, 2009). Ordinal entropy (HO) measures the extent to which higher-income groups are spatially segregated from lower ones. Unlike most segregation indices that rely on nominal categories, HO is based on the cumulative proportion of people below a given poverty level. It is calculated as follows:

$$HO = \sum_{i=1}^i \frac{t_i}{T} * \frac{v - v_i}{v}$$

where  $T$  is the total population in a city and  $t_i$  is the population in CBG  $i$ . Here  $v$  and  $v_i$  are the values of entropy for the city and each CBG within the city, respectively. The value  $v$  is calculated as follows:

$$v = -\frac{1}{M-1} \sum_{m=1}^{M-1} c_m \log_2 c_m + (1 - c_m) \log_2 (1 - c_m)$$

where  $M$  represents the number of poverty groups,  $m$  represents ordered poverty categories and, as shown below,  $c_m$  is the cumulative proportion ( $p$ ) of a city's population in poverty groups  $k$  that are less than and equal to each poverty category  $m$ :

$$c_m = \sum_{k=1}^m p_k$$

Note that  $c_m$  is not calculated for the highest poverty group since it equals 1; also, following Reardon (2009), zero to the log of base 2 is treated as zero. Once entropy for the city is calculated for cumulative poverty shares it is necessary to calculate entropy for each CBG (as indexed by  $i$ ):

$$v_i = -\frac{1}{M-1} \sum_{m=1}^{M-1} c_{im} \log_2 c_{im} + (1 - c_{im}) \log_2 (1 - c_{im})$$

Values of HO range from 0 to 100 (we multiplied HO by 100 for ease of interpretation). When HO is 100, each poverty group is located in CBGs that have no other poverty groups within them; thus, these ordered poverty groups are completely segregated from one another. When HO equals zero the proportion of people in all poverty classifications in every CBG is the same as the proportion of poverty groups for the city as a whole.

In addition to measures of racial and economic segregation, we also included several control variables. These included a city's population size and population density—measured by the number of people per square mile of land area. We also included the proportion of each city's population that was African American or Hispanic.

Since segregation is more meaningful in cities with many neighborhoods and a mix of racial groups, we assessed cities with seven or more CBGs. We also analyzed larger cities since it is impossible to reach the maximum level of economic segregation among the seven poverty groups unless there are at least seven CBGs. The final data set we analyzed contained 1,528 cities, all of which contained more than 25,000 people.

We used ordinary least squares regression to determine whether racial segregation increases the disparities in exposure to verdancy between white people and African American people (or white people and Hispanics). We also used ordinary least squares regression to determine whether disparities in green space among economic groups grow as economic segregation increases. Linear regression models were weighted by each city's population<sup>5</sup> and robust standard errors based on the Huber/White Sandwich estimates are reported (Huber, 1967; White, 1980). We analyzed four dependent variables: disparities in green space

---

5 To test for robustness of our results, we ran linear mixed regression models in which a state-level random effect was included to adjust for within-state correlations among cities from the same state. These models produced results substantively similar to linear models and, for the sake of simplicity, we report the regular regression results here. We also ran non-weighted regression models (in which each city was not weighted by its population). These results were nearly identical to those with population weights. Results are available upon request.

between (1) white and African American people, (2) white and Hispanic people, (3) white and non-white people, and (4) among poverty classifications. The most important covariates are the various segregation measures described above.

## Results

Table 1 shows basic descriptive statistics for the exposure to green space for African American, Hispanic and white people. As expected, the average city dweller (regardless of their race) lives in a CBG with little green space. This is indicated by the negative values for mean exposure to green space among all racial groups, which can be seen in the first three rows of Table 1. These low values can be interpreted to mean that most people live in a CBG dominated by cells with little to no vegetation. Still, this basic finding has some nuance. First, some cities have people who live in CBGs with a great deal of green space—as indicated by the maximum score for exposure to green space that is over 3,000. For example, the city with highest mean exposure to green space is Westport, Connecticut, which has mean exposure to green space of 2,928 for African American people, 3,035 for Hispanic people and 3,144 for white people. The typical Westport resident lives in a CBG in which much of the landscape is verdant. Half of Westport’s CBGs have mean NDVI scores above 3,000 (and many of the areas within these CBGs have NDVI scores above 5,000). Still, most urbanites reside within CBGs with little green space.

Table 1. Characteristics of cities with more than 25,000 people

Contact with green space	Mean	Standard deviation	Minimum	Maximum
African American	-890	1,578	-5,064	3,070
Hispanic	-906	1,588	-5,081	3,035
Non-white	-878	1,581	-5,067	3,068
White	-639	1,638	-5,012	3,144
African American/white difference	251	331	-1,286	2,341
White/Hispanic difference	267	321	-678	2,475
White/non-white difference	239	288	-1,015	2,353
0–50% of poverty	-785	1,606	-5,008	3,168
51–100% of poverty	-795	1,611	-5,027	2,994
101–125% of poverty	-768	1,618	-4,969	3,302
126–150% of poverty	-748	1,625	-5,049	3,213
151–185% of poverty	-727	1,627	-5,017	3,152
186–200% of poverty	-706	1,635	-5,029	3,087
Greater than 200% of poverty	-580	1,659	-5,004	3,095

Contact with green space	Mean	Standard deviation	Minimum	Maximum
Slope of poverty	46	58	-180	393
African American/white dissimilarity	36	13	8	84
White/Hispanic dissimilarity	29	12	3	75
Poverty segregation (HO)	.12	.04	.02	.32
Population (10,000s)	9.31	27.15	2.50	817.06
People per square mile (1,000s)	3.63	3.59	.05	51.76
Percent African American	12.68	15.99	.09	96.94
Percent Hispanic	19.72	20.19	.51	97.45

Despite the relative lack of vegetation in the typical person's CBG, the typical white person lives in a CBG with higher average NDVI scores than the typical African American or Hispanic person. These mean differences appear to be modest—about 267 between white and Hispanic people, 251 between white and African American people, and 239 between white and non-white people. Still, in some cities, the difference in mean NDVI scores is substantial. For example, Menlo Park, California, has a difference in NDVI scores between white and African American people of nearly 2,341. The difference between white and Hispanic people is 2,109.

Similar patterns are found among poverty groups—people with greater income are exposed to more green space. In particular, people whose income is greater than twice the poverty threshold live in CBGs with NDVI indices that are slightly over 300 points higher than people who are at less than 50 percent of the poverty line. For example, in Tallahassee, Florida, the typical person whose poverty status is less than half of the poverty threshold lives in a CBG with a mean NDVI value of 1,000. By contrast, a person who lives in a family that earns more than twice the poverty threshold lives in a CBG with an average NDVI score of about 2,000—a very substantial difference.

Although our findings are consistent with previous literature (Wen et al., 2013), our main question is whether racial and economic segregation in cities is associated with racial and economic differences in exposure to greenery. In some cities, segregation between white and African American people is quite low—as is segregation among poverty groups. For example, Vancouver, Washington, has an African American/white dissimilarity score of 0.20. Given that many members of these two racial groups live in many of the same neighborhoods, the typical white or African American person is exposed to the same amount of green space. By contrast, in a highly segregated city such as Chicago—which has an African American/white dissimilarity score of 0.84—there may or may not

be differences in exposure to green space among racial groups. It is conceivable that in racially segregated cities people of color and white people live in different neighborhoods but are surrounded by the same amounts of verdancy.

Indeed, the regression analyses indicate that there are relatively strong correlations between racial disparities in exposure to green space and racial segregation. Specifically, for every 1-point increase in racial segregation in a city, the African American/white difference in exposure to green space increases by nearly eight points; this can be seen in Model 1 of Table 2. While this may not seem large, in a city that is extremely segregated (e.g., one with a dissimilarity score of 80), African American/white differences in average NDVI scores will be, on average, 600 points. Still, as indicated by an explained variance of 0.09, there is considerable variation in exposure to green space between African American and white people and segregation across cities. Nevertheless, of the 47 cities in which there is a 1,000-point African American/white difference in NDVI values, in 38 (or 80 percent) of them, white people live in much more verdant CBGs than African American people.

Table 2. Regressions of racial differences in exposure to green space

	Model 1			Model 2		
<b>African American/white differences</b>	<i>b</i>	se	$\beta$	<i>b</i>	se	$\beta$
Dissimilarity African American/white	7.9**	1.1	.39	7.9**	1.4	.29
Poverty segregation (HO)				9.7**	2.6	.12
Population (1,000s)				-4.0*	1.2	-.05
People per square mile (1,000s)				-3.4	3.6	-.03
Percent African American				-1.7	.8	-.08
Percent Hispanic				-.9	.5	-.05
Constant	-20.8	32.6		-65.7	37.5	
R-squared	.09			.11		
<b>Hispanic/white differences</b>	<i>b</i>	se	$\beta$	<i>b</i>	se	$\beta$
Dissimilarity Hispanic/white	14.1**	1.0	.52	15.7**	1.2	.58
Poverty segregation (HO)				0.2	2.6	.00
Population (1,000s)				-3.6*	1.1	-.05
People per square mile (1,000s)				4.0	3.6	.04
Percent African American				-2.5**	.7	-.13
Percent Hispanic				-2.0**	.4	-.12
Constant	-128.1**	23.0		-104.8**	31.0	
R-squared	.27			.29		

	Model 1			Model 2		
<b>Non-white/white differences</b>	<b>b</b>	<b>se</b>	<b>β</b>	<b>b</b>	<b>se</b>	<b>β</b>
Dissimilarity non-white/white	8.8**	.98	.35	10.0**	1.1	.41
Poverty segregation (HO)				6.7**	2.3	.10
Population (1,000s)				-3.6**	1.1	-.06
People per square mile (1,000s)				4.1	3.4	.05
Percent African American				-3.2**	.9	-.18
Percent Hispanic				-.97*	.4	-.07
Constant	-18.0	21.0		-79.0**	30.0	
R-squared	.12			.16		

Note. \*  $p = .05$ . \*\*  $p = .01$ .

To explore factors that may account for African American/white differences in NDVI values, we included several covariates, as shown in Model 2 of Table 2. The inclusion of control variables does not diminish the effects of African American/white segregation. While Model 2 explains slightly more variance than Model 1, results indicate that control variables have little bearing on African American/white differences in NDVI values.

Our exploration of Hispanic/white segregation revealed that it has a strong influence of differences in Hispanic/white NDVI values—about twice as strong as African American/white segregation. Specifically, for every 1-point increase in Hispanic/white dissimilarity, there is a 14-point difference in Hispanic/white NDVI values. In cities that are highly segregated—those with Hispanic/white dissimilarity scores of 75—average differences in NDVI values are 930. In cities such as Birmingham, Alabama, the typical white person lives in a CBG with a mean NDVI value of 1,012. The comparable value for Hispanic people is -0.63. This roughly 1,000-point difference in NDVI values is about what one would expect given that Birmingham's white/Hispanic dissimilarity is 58. Several other results suggest the robust nature between segregation and differences in exposure to green space. Explained variance in Model 1 is 0.27—a fairly high number given that Model 1 incorporated only one covariate. Also, Model 2 incorporated a number of covariates as controls but these had little influence on the coefficient for dissimilarity between Hispanic and white people.<sup>6</sup>

<sup>6</sup> For the sake of brevity, we do not discuss non-white/white differences in exposure to green space since the results are quite similar to those between black and white people and between Hispanic and white people.

## Economic segregation and exposure to green space

The last models explored the association among poverty groups' exposure to green space and economic segregation. Again, we found fairly strong correlations. As Model 1 of Table 3 shows, there is a 5-point increase in the association between poverty category and NDVI scores for every 1-point increase in segregation among poverty groups. Since the measures themselves are a bit complicated, it is useful to provide examples that represent these associations. Meadow Woods, Florida, is a city with low segregation among poverty groups ( $HO = 0.07$ ) and there is little association between poverty status and neighborhood NDVI scores (i.e., the slope between poverty classification and CBG NDVI values is 8). In essence, all poverty groups live in CBGs with the same amount of green space—and that is largely because they are not segregated. Specific NDVI values for Meadow Woods's poverty groups are shown in Table 4.

Table 3. Regressions of economic differences in exposure to green space

	Model 1			Model 2		
	<i>b</i>	Se	B	<i>b</i>	Se	$\beta$
Dissimilarity Hispanic/white				.06	.16	.01
Dissimilarity African American/white				.99**	.18	.19
Poverty segregation (HO)	5.18**	.44	.37	4.01**	.51	.28
Population (1,000s)				-.44	.18	-.03
People per square mile (1,000s)				.08	.51	.00
Percent African American				-.27*	.10	-.07
Percent Hispanic				-.42**	.08	-.14
Constant	-17.17**	4.84		-19.50*	6.45	
R-squared	.14			.17		

Note. \*  $p = .05$ . \*\*  $p = .01$ .

Table 4. Contact with green space among poverty groups

City	HO	Slope	0–0.50	0.51–1.00	1.01–1.25	1.26–1.50	1.51–1.85	1.86–2.00	200+
Meadow Woods	0	4	778	803	865	832	797	844	811
Franklin Town	18	269	1428	1989	1701	2245	2270	3387	2814

In contrast to Meadow Woods, Franklin, Massachusetts, has a high level of segregation among poverty groups and there are large differences in exposure to green space between the lowest and highest poverty groups; these differences are reasonably close to the predicted values based on the regression models.



For example, the difference in NDVI values between the lowest and highest income categories is nearly 2,000—and there is usually an increase in NDVI values between adjacent income categories.

## Study limitations

There are several important limitations with available data, and these limitations restrict the conclusions that can be drawn from our analyses. We used cross-sectional data and no robust causal inferences can be made regarding race/economic segregation and differences in exposure to green space between racial and economic groups. The challenge of endogeneity introduced a number of questions we cannot answer. Do members of different racial and economic groups seek more green space than others? Or do municipalities locate fewer trees, flowers, parks, golf courses, greenways, and the like in neighborhoods with established populations of minorities and lower-income people? Researchers would need to assemble and analyze several decades of quality longitudinal data (probably semi-annually) to unpack the relationships among changes in green space and shifts in racial and economic composition across neighborhoods. This may be possible in the near future as more waves of American Community Survey data become available—along with future waves of national land cover data.

Beyond the question of which came first—the people or the trees—there are related questions regarding the mechanics of how green space is distributed. It may be that more green space exists in neighborhoods with greater shares of white people, but a national-level study cannot determine whether white people and people with higher incomes plant more trees, shrubs, and grass than minorities and lower-income people—or whether more-advantaged people are more likely to demand and obtain green space from their municipal leaders. Such questions are better addressed with studies that can track change over time at a very fine scale and combine qualitative and quantitative data.

There are a few other weaknesses with the data. One is that we do not distinguish between various ethnic groups (e.g., Hispanics who are white or African American). Future studies can provide more detail regarding specific racial groups. Moreover, available data do not allow us to determine the exact proximity of households to greenness. It may be that a New York City penthouse is located across the street from Central Park; still, the use of CBGs as proxies for neighborhoods may indicate that the penthouse is located in a neighborhood with little green space. To determine whether this is the case, researchers would need access to data of residential addresses—data that do not exist nationally. Similarly, it may be possible to use census blocks (rather than block groups) and distribute racial populations over a raster to approximate their residential

locations.<sup>7</sup> While such an approach might restrict the number of cities that can be analyzed, it may further validate the basic results we produce here. A final weakness is that satellite imagery does not necessarily capture the quality of vegetation in a neighborhood. Vacant lots overrun with thick weeds and poisonous plants are not the same as well-maintained public parks with walking paths, flowers, and playgrounds. It is not possible to measure the quality of vegetation while conducting a national study; still, we do not simply assume that patches of greenery with the same NDVI values are equally pleasant.

## Conclusions and future research

We found relationships between city-level racial and economic segregation and differences in exposure to green space between the members of different racial and income groups. Such findings indicate how racial and economic segregation affect a person's quality of life with respect to verdancy. The more racially segregated a city is, the more likely it is that people of color will live in neighborhoods with less greenery than their white counterparts. The same patterns hold among poverty groups. These findings yield new information. Green space is not distributed evenly across neighborhoods within cities. Theoretically, this uneven distribution need not inevitably lead to a situation in which one racial or economic group is, on average, exposed to more or less green space than another. But our findings show otherwise. Consistent with much of the literature on racial and economic segregation—and studies of environmental (in)justice—we find that lower-income people and members of minority groups live in neighborhoods with much less vegetation than their wealthier, white counterparts but, on average, these differences are exacerbated in racially and economically segregated cities.

Our analyses do not fully explore the relative importance of racial or economic segregation in predicting exposure to green space. Future research can address this question by examining the relationship between economic segregation and differences to exposure to green space among poverty groups *within the same racial group* (or racial differences within the same economic group). We suspect that income differences are more powerful than are racial categories—but this is an open question.

---

7 Counts of people by poverty status or income level are available only at the block group level.

## References

- Adelman, R. (2004). Neighborhood opportunities, race, and class: The black middle class and residential segregation. *City & Community*, 3(1), 43–63.
- Boone, C., Buckley, G., Grove, M., & Sister, C. (2009). Parks and people: An environmental justice inquiry in Baltimore, Maryland. *Annals of the Association of American Geographers*, 99(4), 767–787.
- Boone-Heinonen, J., Gordon-Larsen, P., Kiefe, C., Shikany, J., Lewis, C., & Popkin, B. (2011). Fast food restaurants and food stores: Longitudinal associations with diet in young to middle-aged adults: The CARDIA study. *Archives of Internal Medicine*, 171(13), 1162–1170.
- Bullard, R. (2000). *Dumping in Dixie: Race, class, and environmental quality*. Boulder, CO: Westview Press.
- Chiesura, A. (2004). The role of urban parks for the sustainable city. *Landscape and Urban Planning*, 68(1), 129–138.
- Cradock, A., Kawachi, I., Colditz, G., Hannon, C., Melly, S., Wiecha J., & Gortmaker, S. (2005). Playground safety and access in Boston neighborhoods. *American Journal of Preventive Medicine*, 28(4), 357–363.
- Crowder, K., & Downey, L. (2010). Interneighborhood migration, race, and environmental hazards: Modeling microlevel processes of environmental inequality. *American Journal of Sociology*, 115(4), 1110–1149.
- Duncan, D., White, K., Aldstadt, J., Castro, M., Whalen, J., & Williams, D. (2012). Space, race, and poverty: Spatial inequalities in walkable neighborhood amenities? *Demographic Research*, 26(17), 409–448.
- Goffman, A. (2014). *On the run: Fugitive life in an American city*. Chicago: University of Chicago Press.
- Hansen, M., Potapov, P., Moore, R., Hancher, M., Turubanova, S., Tyukavina, A., Thau, D., Stehman, S., Goetz, S., Loveland, S., Kommareddy, A., Egorov, A., Chini, L., Justice, C., & Townshend, J. (2013). High-resolution global maps of 21st-century forest cover change. *Science*, 342(6160), 850–853.
- Heckert, M. (2013). Access and equity in greenspace provision: A comparison of methods to assess the impacts of greening vacant land. *Transactions in GIS*, 17(6), 808–827.
- Heynen, N. (2003). The scalar production of injustice within the urban forest. *Antipode*, 35(5), 980–998.

- Heynen, N., & Lindsey, G. (2003). Correlates of urban forest canopy cover: Implications for local public works. *Public Works Management & Policy*, 8(1), 33–47.
- Heynen, N., Perkins, H., & Roy, P. (2006). The political ecology of uneven urban green space: The impact of political economy on race and ethnicity in producing environmental inequality in Milwaukee. *Urban Affairs Review*, 42(1), 3–25.
- Huber, P. J. (1967). The behavior of maximum likelihood estimates under nonstandard conditions. In L. M. Le Cam & J. Neyman (Eds.), *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability* (pp. 1, 221–233). Berkeley, CA: University of California Press.
- Kwate, N. (2008). Fried chicken and fresh apples: Racial segregation as a fundamental cause of fast food density in black neighborhoods. *Health & Place*, 14(1), 32–44.
- Landry, S., & Chakraborty, J. (2009). Street trees and equity: Evaluating the spatial distribution of an urban amenity. *Environment and Planning A*, 41(11), 2651–2670.
- Lindsey, G., Maraj, M., & Kuan, S. (2001). Access, equity, and urban greenways: An exploratory investigation. *The Professional Geographer*, 53(3), 332–346.
- Maas, J., Verheij, R., Groenewegen, P., De Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: How strong is the relation? *Journal of Epidemiology and Community Health*, 60(7), 587–592.
- Maller, C., Townsend, M., Pryor, A., Brown, P., & St Leger, L. (2006). Healthy nature, healthy people: “Contact with nature” as an upstream health promotion intervention for populations. *Health Promotion International*, 21(1), 45–54.
- Massey, D., & Fischer, M. (2000). How segregation concentrates poverty. *Ethnic and Racial Studies*, 23(4), 670–691.
- Mitchell, R., & Popham, F. (2008). Effect of exposure to natural environment on health inequalities: An observational population study. *The Lancet*, 372(9650), 1655–1660.
- Nielsen, T., & Hansen, K. (2007). Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators. *Health & Place*, 13(4), 839–850.

- Reardon, S. (2009). Measures of ordinal segregation. *Research on Economic Inequality*, 17(1), 129–155.
- Sampson, R. (2012). *Great American city: Chicago and the enduring neighborhood effect*. Chicago: University of Chicago Press.
- Sister, C., Wolch, J., & Wilson, J. (2010). Got green? Addressing environmental justice in park provision. *Geojournal*, 75(3), 229–248.
- Squires, G., & O'Connor, S. (1998). Fringe banking in Milwaukee: The rise of check-cashing businesses and the emergence of a two-tiered banking system. *Urban Affairs Review*, 34(1), 126–149.
- Troy, A., Grove, J., O'Neil-Dunne, J., Pickett, S., & Cadenasso, M. (2007). Predicting opportunities for greening and patterns of vegetation on private urban lands. *Environmental Management*, 40(3), 394–412.
- Ward-Thompson, C., Roe, J., Aspinall, P., Mitchell, R., Clow, A., & Miller, D. (2012). More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning*, 105(3), 221–229.
- Wen, M., Zhang, X., Harris, C., Holt, J., & Croft, J. (2013). Spatial disparities in the distribution of parks and green spaces in the USA. *Annals of Behavioral Medicine*, 45(1), 18–27.
- Wendel, H., Downs, J., & Mihelcic, J. (2011). Assessing equitable access to urban green space: The role of engineered water infrastructure. *Environmental Science & Technology*, 45(16), 6728–6734.
- White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, 48(4), 817–838.
- Wing, S., Cole, D., & Grant, G. (2000). Environmental injustice in North Carolina's hog industry. *Environmental Health Perspectives*, 108(3), 225–231.
- Wrigley, N., Warm, D., & Margetts, B. (2003). Deprivation, diet, and food-retail access: Findings from the Leedsfood deserts' study. *Environment and Planning A*, 35(1), 151–188.
- Zenk, S., Schulz, A., Israel, B., James, S., Bao, S., & Wilson, M. (2005). Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. *American Journal of Public Health*, 95(4), 660–667.



# Current Cultures in Threatening, Comforting, and Challenging Ecologies

Evert Van de Vliert<sup>1</sup>

Faculty of Behavioral and Social Sciences  
University of Groningen, The Netherlands

## Abstract

Places of residence have multiple, yet largely unintegrated, cultural characteristics. Here I make a distinction between human environments that offer demanding winters or summers together with collective poverty (*threatening ecologies*), undemanding temperate climates irrespective of income per head (*comforting ecologies*), and demanding winters or summers together with collective wealth (*challenging ecologies*). After reviewing prior research into cultural characteristics under these environmental conditions, I am reporting a climato-economic study of we/they discrimination across 95 nations. Together, these investigations show that threatening ecologies are prone to mental ill-being, bureaucratic organizing, press repression, autocratic politics, survival goals, societal collectivism, and relatively strong we/they discrimination. By contrast, challenging ecologies are prone to mental well-being, organic organizing, press freedom, democratic politics, self-expression goals, societal individualism, and relatively weak we/they discrimination. In between these extremes, comforting ecologies are prone to intermediate cultural realities.

Keywords: challenges, climato-economic theory, cultural anthropology, threats, human ecology

## Introduction

Dotted around the globe are many ancient buildings and structures left behind by societies that collapsed or vanished. Not infrequently, these monuments provide stark evidence of the indisputable fact that all living species can easily be frozen or boiled to death, and of the broader reality that humans thrive in temperate climates and are in danger to the extent they are living in colder or hotter regions of the planet. Colder-than-temperate winters and hotter-than-temperate summers entail larger deviations from physiological homeostasis and

---

<sup>1</sup> Author contact: E.Van.de.Vliert@rug.nl.

thermal comfort, fewer nutritional resources due to poorer flora and fauna, and greater health problems (Van de Vliert, 2009, 2013a). In these harsher climates, humans must ceaselessly solve problems of extreme temperatures, shrinking food and drink supplies, and lurking diseases.

In order to adapt culturally to thermal climate and other ecological conditions, our ancestors started to obtain and store property. With the advent of agriculture this was first in the form of stores of food and domesticated animals. Property allowed trading. Trading led to the invention of money, which can be stored longer and more easily than agricultural products, and which can solve a fantastic variety of climatic problems. The miraculous achievements of money as a climate-compensating tool are in no way tied to a specific ethnic group, a particular geographic area, or a certain period in time. As a rule, liquid cash and illiquid capital can buy all the necessities of life, including clothing and housing, heat and cold, food and drink, cure and care. Slowly but surely, the availability of wealth resources has become the essential solution for the basic problem of survival when living away from temperate climates.

This paper takes stock of recent progress in predicting adaptations of national cultures to climato-economic ecologies, and then seeks an empirical answer to the question whether this line of theory building can be extended to the highly relevant phenomenon of we/they discrimination. First, I propose that threatening, comforting, and challenging interactions of climatic demands and wealth resources be studied as partial roots of human functioning. Second, I provide an overview of study results that established links between the three types of habitats and three patterns of characteristics of culture. The empirical section, finally, describes how I integrated separate measures of ingroup love and outgroup hate into a single estimate of the degree of we/they discrimination, and conducted a further climato-economic analysis across 95 nations, the results of which are reported here for the first time.

## Climato-economic ecologies

### Theory: Threats versus challenges

*Points of departure.* This article is not about evolution by natural selection. Nonetheless, it has deep roots in the human habit to continuously appraise the environmental situation with respect to its significance for well-being (e.g., Bandura, 1997; Lazarus & Folkman, 1984; LePine et al., 2004; LePine et al., 2005; Podsakoff et al., 2007). *Primary appraisals* assess the extent to which a situation is either comforting or stressfully demanding because existential needs for thermal comfort, nutrition, and health cannot be satisfactorily



met. *Secondary appraisals* assess the extent to which a stressfully demanding situation is threatening or challenging given the available resources to meet the demands. *Tertiary appraisals* assess the extent to which various adaptations are functional in regard to satisfying existential needs in a comforting, threatening, or challenging situation.

Evolutionary psychologists (e.g., Buss, 1999; Tooby & Cosmides, 1992) refer to outcomes of these appraisal processes as evoked culture—differences in human functioning explained by universal needs that are differentially expressed and satisfied across populations. Primary appraisals of demands evoke stress responses, secondary appraisals of resources evoke general motives, and tertiary appraisals of adaptations evoke specific ways of being and acting. As a spin-off of these widely accepted insights, climato-economic theorizing (Van de Vliert, 2009, 2013a, 2013b) proposes that primary appraisals of climatic demands, secondary appraisals of wealth resources, and tertiary appraisals of cultural adaptations shape human functioning.

*Climatic demands.* Primary appraisals assess the extent to which winters and summers are comforting or stressfully demanding given existential needs for thermal comfort, nutrition, and health; and also given that acclimatization through long-term adjustment in anatomy and physiology has negligible compensating effects (Parsons, 2003). These assessments are broadly relevant because unmet existential needs tend to proliferate into frustration of social needs and growth needs (Alderfer, 1972; Kenrick et al., 2010; Maslow, 1954). No matter how much focal attention processing is involved, temperate climates are almost always appraised as relatively comfortable. Colder winters and hotter summers are experienced as relatively stressful because they require more and better clothing, shelter structures, and heating or cooling systems, increasing investments of time and effort in the pursuit of foods and drinks, and more measures to safeguard family health.

*Wealth resources.* Secondary appraisals assess the extent to which stressfully demanding winters or summers are threatening or challenging given the available wealth resources (cash, capital, education, inspiring work, longevity) to meet the climatic demands. The seldom explicitly posed, yet implicitly answered, question is how well owning, buying, and inventing climate-compensating goods and services can help prevent and dispel discomfort, hunger, thirst, and illness by satisfying existential needs. All inhabitants of a certain area are exposed to the same winters, summers, and standard of living; are assessing and discussing this situation frequently; and are gradually pushing and pulling each other toward a predominantly shared appraisal of climato-economic livability.

Poorer populations in climates with colder-than-temperate winters, hotter-than-temperate summers, or both are expected to appraise livability as stressful because the climatic demands are high and as threatening because the wealth resources to cope with the high stress are insufficient (*threatening ecologies*). Experienced stress is expected to be low in comforting temperate climates irrespective of income per head, because wealth resources do not make much difference for how well existential needs are satisfied in those climates (*comforting ecologies*). Richer populations in climates with colder-than-temperate winters, hotter-than-temperate summers, or both are expected to appraise livability as stressful because the climatic demands are high and as challenging because the wealth resources to cope with the high stress are sufficient (*challenging ecologies*).

The main idea is that greater climatic demands make wealth resources increasingly important for survival and a decent quality of life. In otherwise equal circumstances, cash and capital resources are least useful in comforting ecologies. But in colder-than-temperate or hotter-than-temperate conditions, wealth is an extraordinarily ingenious tool for turning threatening ecologies into challenging ecologies. This argument has been criticized because climate may help generate wealth (e.g., Ainslie, 2013). However, climatic demands do not plausibly account for collective wealth ( $r = .37$ ,  $n = 175$ ,  $p < .001$ ; Van de Vliert, 2011a). Even more important, conceptual boundaries are a basic requirement of any theory. It is thus a strength rather than a weakness to state that climatic demands and wealth resources influence each other's impact on daily life, and to not sidetrack into main effects of cold, heat, and wealth.

*Cultural adaptations.* Tertiary appraisals assess the extent to which the activation of certain goals, means, or outcomes helps or hinders livability in a threatening, comforting, or challenging ecology. For example, in essence discussing adaptations to threatening ecologies, Milgram (1974, pp. 123–124) convincingly argued that “the formation of hierarchically organized groupings lends enormous advantage to those so organized in coping with dangers of the physical environment.” By striking contrast, the cultural syndrome of self-expression in goals, means, and outcomes, which characterizes challenging ecologies (Van de Vliert, 2009), provides a “social force that operates in favor of democracy, helping to establish democracy where it does not yet exist, and strengthening democracy where it is already in place” (Inglehart & Welzel, 2005, p. 299).

## Method: Measures and analyses

*Climatic demands.* Annual mean temperature is an inadequate predictor of daily life because this indicator averages cold demands and heat demands, and overlooks seasonal variations in temperature. Nowadays, 22 °C (about 72 °F) is adopted as a point of reference for optimal climatic livability because existential

needs for thermal comfort, nutrition, and health are met more easily in temperate climates varying around a base range of, say, 17–27 °C. Climates are more demanding to the extent that seasons are colder than 22 °C or hotter than 22 °C. Climatic demands are operationalized across each country's major cities, weighted for population size, as the sum of the absolute deviations from 22 °C for the average lowest and highest temperatures in the coldest month and in the hottest month (for details, see Van de Vliert, 2009, 2013a, 2013b).

*Wealth resources.* Income per head is measured with reference to the capacity of a country's currency to buy a given basket of basic goods and services (purchasing power parity in Geary-Khamis dollars, log transformed to reduce the skewed cross-national distribution).

*Analyses.* Seven characteristics of culture were regressed on standardized climatic demands, standardized wealth resources, and their climato-economic interaction, while controlling for variables representing rival explanations.

## Ecology of current cultures

Ecological explanations of the origins of national cultures have been sought in annual mean temperature (Fought et al., 2004; Georgas et al., 2004; Vanhanen, 2009), parasitic-disease burden (Fincher & Thornhill, 2012; Schaller & Murray, 2011), voluntary settlement in frontier regions (Kitayama et al., 2010; Kitayama et al., 2006), and economic development (Inglehart & Baker, 2000; Inglehart & Welzel, 2005). Aiming to replace and go beyond such single-factor explanations, climato-economic research has related national cultures to interactions of the negative climatic anchors of cold and heat and the positive economic anchors of cash and capital.

Following is a brief overview of the research results. The keyword summary in Figure 1 may serve as a reader's guide. Climato-economic ecologies are mapped out in the three rows at the top. The first row underneath the three arrows indicates that stresses in these ecologies are appraised as threatening, comforting, and challenging, respectively. Listed and italicized lower down in the column to the left are eight cultural characteristics crudely ordered from micro-level to meso-level to macro-level. The remaining keywords help interrelate and explain patterns of cultural manifestations in terms of threatening, comforting, and challenging climato-economic ecologies. To avoid false inferences of causality, these manifestations are called cultural covariations instead of cultural adaptations.

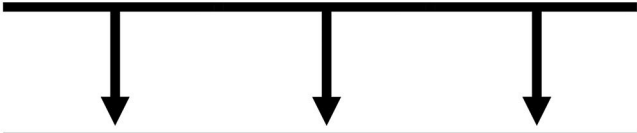
<i>Thermal climate</i>	Cold or hot	Temperate	Cold or hot
<i>Climatic demands</i>	Demanding	Undemanding	Demanding
<i>Wealth resources</i>	Poor	Poor or rich	Rich
<i>Cultural covariations</i>			
<i>Ecological appraisal</i>	Threatening	Comforting	Challenging
<i>Mental health</i>	Ill-being	Mixed	Well-being
<i>Organizing</i>	Bureaucratic	Mixed	Organic
<i>Outgroup treatment</i>	Rejection	Mixed	Tolerance
<i>Media culture</i>	Press repression	Mixed	Press freedom
<i>Political system</i>	Autocratic	Mixed	Democratic
<i>Societal goals</i>	Survival	Mixed	Self-expression
<i>Societal culture</i>	Collectivism	Mixed	Individualism

Figure 1. Cultural covariations of threatening, comforting, and challenging combinations of climatic demands and wealth resources

### Mental health: Ill-being versus well-being

Across 58 nations, climatic demands (0%), wealth resources (17%), and their climato-economic interaction (21%) accounted for 38% of the variation in mental health (Fischer & Van de Vliert, 2011). Anxiety, depression, burnout, and perceived ill health appeared to be most prevalent in poor populations residing in climates with more-demanding winters or summers (e.g., Iranians and Serbs), intermediately prevalent in populations residing in undemanding temperate climates irrespective of income per head (e.g., Hong Kongers and Sri Lankans), and least prevalent in rich populations residing in climates with more-demanding winters or summers (e.g., Finns and Swiss). The observed prevalences of mental ill-being in threatening ecologies but mental well-being in challenging ecologies, both contrasting with more of a mix of ill-being and well-being in comforting ecologies, form a first confirmation of the storyline in Figure 1.

## **Organizing: Bureaucratic versus organic**

Across 58 nations, climatic demands (5%), wealth resources (21%), and their interaction (11%) predicted 37% of the country-level differences in how organizations are structured (Van de Vliert, 2009). Food-processing organizations, financial-service organizations, and telecommunication-service organizations are bureaucratically structured using relatively large degrees of formalization and centralization in threatening ecologies (e.g., China and Poland). By contrast, these organizations are made relatively organic with little formalization and centralization in challenging ecologies (e.g., Germany and Sweden). More of a structural mix is observed in comforting ecologies (e.g., Colombia and Japan). An interesting yet speculative implication here is that if we were to compare the bureaucratic templates of all McDonald's fast-food restaurants around the globe, we would find thousands of small adaptations in challenging and comforting ecologies. Does even the McDonaldization of the world (Ritzer, 2004) have to obey the rules of climato-economics?

## **Outgroup treatment: Rejection versus tolerance**

Across 85 nations, climatic demands (2%), wealth resources (35%), and their climato-economic interaction (5%) accounted for 42% of the extent to which randomly sampled citizens tend to reject rather than tolerate members of outgroups including people of a different race, immigrants/foreign workers, and homosexuals (Van de Vliert, 2013a). A visual plot of the results leads to the conclusion that rejection of outgroup members is strongest among populations in threatening ecologies (e.g., Bosnians and Turks), moderately strong among populations in comforting ecologies (e.g., Maltese and Peruvians), and weakest among populations in challenging ecologies (e.g., Dutch and Icelanders). Apparently, there is a real-life connection between harsher environments and harsher treatment of categories of people whom we don't want to link up with.

## **Media culture: Press repression versus press freedom**

Across 175 nations, climatic demands (0%), wealth resources (31%), and their interaction (8%) predicted 39% of the uneven worldwide distribution of press repression (Van de Vliert, 2011a). The specifics and particulars of this finding are very robust, holding up for each of three subsequent years, and for separate indices constructed by Freedom House (perpetrator perspective), World Economic Forum (relational perpetrator-victim perspective), and Reporters Without Borders (victim perspective). Nine tests consistently revealed that journalists and media assistants are bullied most in threatening ecologies

(e.g., Sudan and Uzbekistan), to a moderate extent in countries where citizens are comforted by undemanding climates (e.g., Honduras and Seychelles), and least in challenging ecologies (e.g., Denmark and Switzerland).

## **Political system: Autocratic versus democratic**

Across 174 nations, climatic demands (6%), wealth resources (22%), and climate and wealth in concert (7%) accounted for 35% of the systemic differences in political governance (Van de Vliert & Postmes, 2012). Our visualization of the effects illustrated that autocratic systems thrive among inhabitants of threatening habitats (e.g., Afghans and Swazis), that democratic systems thrive among inhabitants of challenging habitats (e.g., North Americans and Czechs), and that neither of them has priority among inhabitants of comforting habitats (e.g., Bahamians and Sierra Leoneans). More detailed analyses (Van de Vliert, 2013b) showed that autocratic systems peak in poor populations coping with both cold winters and hot summers, and that democratic systems peak in rich populations coping with cold winters and temperate summers.

## **Societal goals: Survival versus self-expression**

Across 77 nations, climatic demands (0%), wealth resources (52%), and their interaction (20%) accounted for 72% of the variation in the World Values Surveys dimension of survival versus self-expression (Van de Vliert, 2009). As predicted, survival goals prevail in poorer populations threatened by more-demanding thermal climates (e.g., Armenians and Latvians), self-expression goals prevail in richer populations challenged by more-demanding thermal climates (e.g., Canadians and Finns), and more easygoing goals prevail in populations comforted by undemanding climates irrespective of their wealth (e.g., Ghanaians and Singaporeans). As a noteworthy consequence, during 8- to 19-year periods, populations in more threatening ecologies moved away from self-expression goals toward survival goals to the extent that they were exposed to economic decline.

## **Societal culture: Collectivism versus individualism**

Across 121 nations, climatic demands (4%), wealth resources (33%), and the interaction of these climatic and economic factors (10%) predicted 47% of the variance in a composite index of favoritism shown to one's own relatives and the larger family of locals (Van de Vliert & Postmes, 2012). Societal collectivism is strongest in the threatening ecologies of lower-income countries with more-demanding thermal climates (e.g., Tajiks and Mongolians), moderate in the comforting ecologies of countries with undemanding temperate climates (e.g., Barbadians and Beninians), and weakest in the challenging ecologies of

higher-income countries with more-demanding thermal climates (e.g., North Americans and Scandinavians). Perhaps it should not come as a surprise that these results reflect the results for outgroup treatment because cultural collectivism, characterized by ingroup favoritism, tends to move in tandem with outgroup rejection.

## Ecology of we/they discrimination

Ingroup love and outgroup hate are indeed flip sides of the same coin, both referring to one of the world's most vexing problems: large-scale discrimination between people. Not only are *we* and *us* unthinkable without the existence of *they* and *them*, but stronger positive discrimination of one's own group inside an intergroup boundary also tends to go hand in hand with negative discrimination of at least one other group outside that boundary. Conversely, a given extent of discriminatory outgroup hate tends to elicit a similar extent of discriminatory ingroup love. In consequence, it is hard to tell one from the other, let alone tell which one comes first and causes the other (for causality, see Brewer, 1999; Halevy et al., 2012; Van de Vliert, 2013a). Therefore, this section reports a unique first attempt to integrate indices of ingroup love and outgroup hate into an index of we/they discrimination, and to scrutinize the degrees of discrimination between groups in relation to the ecologies visualized in Figure 1.

## Theoretical framework

Applied to intergroup relations, climato-economic theorizing (Van de Vliert, 2009, 2013a, 2013b) proposes that we/they discrimination is shaped by (a) primary appraisals of winter and summer demands in terms of how stressful it is to meet existential needs for thermal comfort, nutrition, and health; (b) secondary appraisals of how threatening or challenging stressful winters and summers are given the available wealth resources to meet the climatic demands; and (c) tertiary appraisals of how helpful or harmful we/they discrimination is for dealing with the threatening, comforting, or challenging ecology. Relatively strong we/they discrimination is expected to predominate in threatening ecologies, where it is consistent with bureaucratic organizing, press repression, autocratic politics, and survival goals. By contrast, relatively weak we/they discrimination is expected to predominate in challenging ecologies, where it is consistent with organic organizing, press freedom, democratic politics, and self-expression goals. In between, comforting ecologies are expected to be characterized by moderately strong degrees of we/they discrimination. These expectations were tested in a secondary analysis of cross-national data.

## Sampling

*Countries.* Ninety-five nations from all inhabited continents were included, for which sufficient data on we/they discrimination were publicly available for analysis (for details, see Table 1). From a worldwide viewpoint, there was an underrepresentation of countries with undemanding climates ( $t = 5.24$ ,  $p < .001$ ) and poorer economic resources ( $t = 3.97$ ,  $p < .001$ ), which ensured a conservative test of the climato-economic model.

*Respondents.* International bodies, mentioned below, used nationally representative sampling methods to recruit over 200,000 participants who answered questions about either positive ingroup discrimination ( $N = 133,163$ ) or negative outgroup discrimination ( $N > 95,000$ ).

## Dependent variable

We/they discrimination was measured with three indicators of positive discrimination of insiders (familism, nepotism, compatriotism) and five indicators of negative discrimination of outsiders (different races, foreigners, homosexuals, AIDS patients, criminals).

*Familism.* Survey participants in 57 countries ( $N = 17,370$ ) were asked about the advantageous treatment of one's closest relatives in the form of mutually beneficial exchanges of housing benefits and pride between parents and children (1 = strongly disagree, 7 = strongly agree; source: House et al., 2004; for intraclass correlation, internal consistency, interrater reliability, and construct validity, see Van de Vliert, 2011b).

*Nepotism.* Top executives in 94 countries ( $N = 10,932$ ) responded to the item, "Senior management positions in your country are usually held by ... [1] professional managers chosen based on superior qualification ... [7] relatives" (source: World Economic Forum, 2005; for intraclass correlation, test-retest reliability, and construct validity, see Van de Vliert, 2011b).

*Compatriotism.* In the 1999–2002 wave of the World Values Surveys covering 74 countries (sources: [www.worldvaluessurvey.org](http://www.worldvaluessurvey.org); Inglehart et al., 2004), interviewers of 104,861 interviewees were instructed to substitute their own nationality for "British" when asking, "Do you agree or not agree with the following statement? When jobs are scarce, employers should give priority to [British] people over immigrants" (agree, disagree, neither; for interrater reliability and criterion validity, see Van de Vliert, 2011b).

*Negative outgroup discrimination.* Discrimination of outsiders was derived from the fourth and fifth waves of the World Values Surveys (sources: [www.worldvaluessurvey.org](http://www.worldvaluessurvey.org); Inglehart et al., 2004). In face-to-face



interviews covering 95 countries, at least 1,000 adults per country were asked, "On this list are various groups of people. Could you please sort out any that you would not like to have as neighbors? ... People of a different race ... Immigrants/foreign workers ... Homosexuals ... People who have AIDS ... People with a criminal record" (0 = not mentioned, 1 = mentioned). These five internally consistent indicators (Cronbach's  $\alpha = .79$ ) were standardized and then averaged to represent negative outgroup discrimination.

*Overall index.* The above country-level estimates of familism, nepotism, compatriotism, and negative outgroup discrimination were standardized and then averaged into an overarching index of the degree of we/they discrimination ( $R^2 = .77$ ; Cronbach's  $\alpha = .90$ ).

## Predictors

*Independent variable: climatic demands.* The sum of the absolute deviations from 22 °C for the average lowest and highest temperatures in the coldest month and in the hottest month (source: Van de Vliert, 2009).

*Independent variable: wealth resources.* The natural logarithm of the purchasing power product per capita in 2002 (source: UNDP, 2004).

*Control variable: land borders.* Unlike islanders, inhabitants of landlocked areas are physically surrounded by outgroups from neighboring countries, with the potential consequence that national borders are more strongly turned into social boundaries and we/they discrimination. To test this rival explanation, I controlled for the extent to which a country is sharing land borders rather than sea borders with other countries (1 = island; 2 = borders < coastlines; 3 = borders > coastlines; 4 = landlocked; source: Parker, 1997).

*Control variable: parasitic diseases.* According to the parasite-stress theory (Fincher & Thornhill, 2012; Fincher et al., 2008), boundaries between ingroups and outgroups will be emphasized more and guarded better in regions where it is more likely that outgroup members transmit infectious diseases to ingroup members. Therefore, the prevalence of nonzoonotic parasitic diseases (source: Fincher & Thornhill, 2012) as a potential confounding determinant of we/they discrimination was also taken into account.

*Control variable: natural disasters.* Another competing explanation is that environments also differ in the occurrence of natural disasters, and that disaster threats may co-occur with climato-economic threats. This potential validity problem I addressed by controlling for the national logarithm of the average part of the population affected by earthquakes, volcanic eruptions, droughts, wildfires, floods, storms, and the like, during the first decade of this century (source: UNDP, 2010).

**Table 1. Scores, means, and standard deviations of dependent, independent, and control variables for 95 nations**

<b>Countries</b>	<b>We/they discrimination</b>	<b>Climatic demands</b>	<b>Wealth resources</b>	<b>Geographic borders</b>	<b>Parasitic diseases</b>	<b>Natural disasters</b>
Albania	.82	62	8.48	3	-1.88	9.97
Algeria	.84	55	8.66	3	1.26	6.43
Argentina	-.25	65	9.29	3	1.26	7.58
Armenia	.79	89	8.05	4	-1.28	9.28
Australia	-1.43	76	10.25	1	-1.12	6.13
Austria	-.71	83	10.28	4	-1.72	6.71
Azerbaijan	1.19	89	8.07	4	-1.13	6.16
Bangladesh	.82	44	7.44	3	.07	10.81
Belgium	-1.02	79	10.22	3	-1.73	3.33
Bolivia	1.13	51	7.81	4	1.85	9.79
Bosnia and Herzegovina	-.45	80	8.69	4	-1.74	9.29
Brazil	-.15	43	8.96	3	3.95	8.27
Bulgaria	.94	78	8.87	3	-1.44	5.32
Canada	-1.39	105	10.29	2	-1.87	4.16
Chile	-.27	62	9.19	2	-.08	8.47
China	.58	82	8.43	3	1.85	11.15
Colombia	-.26	35	8.76	3	3.97	9.33
Costa Rica	.09	39	9.09	2	1.55	9.34
Croatia	.59	83	9.23	3	-1.59	3.97
Cyprus	.56	57	9.81	1	-1.73	.00
Czech Republic	-.18	91	9.67	4	-1.88	7.76
Denmark	-1.80	83	10.34	2	-1.87	.00
Dominican Republic	.02	35	8.80	2	.53	8.11
Ecuador	.89	52	8.18	2	2.00	9.12
Egypt	.54	60	8.25	3	.81	1.10
El Salvador	.69	55	8.49	3	.21	10.60
Estonia	-.66	98	9.41	2	-1.58	2.20
Ethiopia	.50	54	6.66	3	3.81	10.53
Finland	-1.10	98	10.17	3	-2.02	2.20
France	-1.11	75	10.20	3	-1.13	4.69
Georgia	.70	65	7.72	3	-.98	9.85
Germany	-1.28	84	10.21	3	-2.02	6.11
Ghana	.09	34	7.66	3	3.24	8.08
Greece	.04	56	9.84	2	-.99	5.28

Countries	We/they discrimination	Climatic demands	Wealth resources	Geographic borders	Parasitic diseases	Natural disasters
Guatemala	.42	43	8.31	3	1.71	10.21
Hong Kong	.83	40	10.20	2	-1.26	4.43
Hungary	.39	84	9.50	4	-1.89	6.23
Iceland	-1.07	73	10.30	1	-1.87	3.81
India	.39	53	7.89	3	2.16	10.93
Indonesia	.71	30	8.08	2	3.35	8.50
Ireland	-.53	69	10.50	2	-1.87	3.85
Israel	-.69	59	9.88	3	-1.59	2.30
Italy	-.12	59	10.18	2	-1.43	4.85
Japan	-.59	52	10.20	1	-.85	7.23
Jordan	1.30	60	8.35	3	-.69	7.88
Kazakhstan	.64	104	8.68	4	-1.59	6.35
Kuwait	.78	55	9.70	2	-1.14	.00
Latvia	-.21	98	9.13	3	-1.73	1.79
Lithuania	.44	98	9.24	3	-1.73	.00
Luxembourg	-1.30	85	11.02	4	-2.02	.00
Macedonia	.75	80	8.77	4	-1.74	11.01
Malawi	.67	50	6.36	4	2.03	11.16
Malaysia	-.25	33	9.12	3	1.85	7.42
Mali	.83	56	6.84	4	3.82	9.16
Malta	.59	39	9.78	1	-1.69	
Mexico	.37	49	9.10	2	2.31	8.79
Moldova	.27	87	7.29	4	-1.43	11.37
Montenegro	.62	83	8.76	3	-1.44	5.61
Morocco	1.29	63	8.25	3	.07	7.05
Namibia	-.53	56	8.73	3	1.12	10.66
Netherlands	-1.86	77	10.28	3	-1.87	.00
New Zealand	-1.60	53	9.99	1	-1.87	5.25
Nigeria	.52	37	6.76	3	4.73	6.07
Norway	-1.49	89	10.51	2	-1.87	3.91
Pakistan	-.36	59	7.57	3	.82	9.10
Peru	-.11	35	8.52	3	2.30	9.80
Philippines	.57	36	8.34	1	1.55	11.00
Poland	.49	90	9.26	3	-1.73	4.13
Portugal	-.27	51	9.81	2	-1.14	7.35
Qatar	.01	53	9.90	2	-.97	
Romania	.32	93	8.79	3	-1.13	6.98

Countries	We/they discrimination	Climatic demands	Wealth resources	Geographic borders	Parasitic diseases	Natural disasters
Russia	.36	101	9.02	2	.52	7.33
Serbia	.62	83	8.76	4	-1.44	5.18
Singapore	-.16	29	10.09	2	-.85	3.97
Slovakia	.32	96	9.46	4	-2.03	5.39
Slovenia	.04	83	9.83	3	-1.59	3.53
South Africa	-.36	63	9.22	3	1.41	10.43
South Korea	.79	79	9.74	2	.21	7.12
Spain	-.54	69	9.97	2	-.99	3.04
Sweden	-2.17	89	10.17	3	-1.72	1.61
Switzerland	-1.23	83	10.31	4	-1.72	4.69
Taiwan	.33	49	10.06	1	-.54	
Tanzania	.05	43	6.36	3	2.92	9.50
Thailand	.36	45	8.86	3	2.59	10.74
Trinidad and Tobago	-.49	46	9.15	1	-.07	4.99
Turkey	.69	85	8.76	2	.06	6.86
Uganda	.58	38	7.24	4	4.41	9.30
Ukraine	.29	87	8.49	3	-.98	7.35
United Kingdom	-1.23	67	10.17	2	-2.02	6.53
United States	-1.36	79	10.48	2	-.69	8.90
Uruguay	.16	65	8.97	3	-1.28	8.48
Venezuela	.30	42	8.59	3	3.22	6.23
Vietnam	.41	48	7.74	3	1.98	10.15
Zambia	.70	48	6.73	4	2.48	11.06
Zimbabwe	.07	52	7.77	4	1.43	11.23
Mean	.01	65.23	9.00	2.76	-.07	6.73
Standard deviation	.79	20.40	1.08	.88	1.91	3.20

## Results and discussion

*Descriptives.* Country scores, mean scores, and standard deviations of the study variables are provided in Table 1. The zero-order correlations in Table 2 show that we/they discrimination is weaker among populations residing in more-demanding climates ( $r = -.26, p < .01$ ), and in poorer countries ( $r = -.65, p < .001$ ); and stronger among populations residing in more enclosed countries ( $r = .24, p < .05$ ), and in areas with a larger parasitic-disease burden ( $r = .36, p < .001$ ) or natural-disaster burden ( $r = .42, p < .001$ ). An additional finding is that climatic demands have a negligible association with we/they discrimination

( $r = -.05, ns$ ) after controlling for wealth resources. This is a theoretically important observation as it moves us away from the myopic single-factor explanation of culture offered by proponents of climatic determinism (e.g., Huntington, 1945; Taylor, 1937; Vanhanen, 2009).

**Table 2. Intercorrelations of dependent, independent, and control variables across 95 nations**

Variable	1	2	3	4	5
1. We/they discrimination					
2. Climatic demands	-.26**				
3. Wealth resources	-.65***	.34***			
4. Geographic borders	.24*	.26**	-.44***		
5. Parasitic diseases	.36***	-.67***	-.67***	.12	
6. Natural disasters	.42***	-.41***	-.64***	.25**	.57***

Note. Scores are missing for natural disasters in Malta, Qatar, and Taiwan ( $N = 92$ ).

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

*Extension of the storyline.* The first three regression models in Table 3 show that climatic demands (7%), wealth resources (35%), and their climato-economic interaction (15%) accounted for 57% of the cross-national variation in we/they discrimination. The fourth model reveals that land borders, parasitic diseases, and natural disasters predicted 24% of the differences in discrimination. However, when the two sets of predictors were combined, land borders, parasitic diseases, and natural disasters could not additionally account for any variation in we/they discrimination over and above the climato-economic influence (see last model in Table 3).

**Table 3. Climatic demands, wealth resources, and control variables predicting we/they discrimination**

Predictor	B	B	B	B	B
Land borders				.18*	.04
Parasitic diseases				.08	.01
Natural disasters				.07*	-.02
Climatic demands (CD)	-.23**	-.04	.14*		.14
Wealth resources (WR)		-.53***	-.37***		-.40***
CD $\times$ WR			-.42***		-.42***
$\Delta R^2$	.07**	.35***	.15***	.24***	.34***
Total $R^2$	.07**	.42***	.57***	.24***	.58***

Note.  $N = 95$  in the first three prediction models.  $N = 92$  in the last two models. There was no multicollinearity ( $VIFs < 3.81$ ) and there were no outliers (Cook's  $Ds < .19$ ).

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

Figure 2 visualizes the details of the regression results. The upper slope indicates that populations in more-demanding climates tend to discriminate more in favor of ingroups and against outgroups if they are poor ( $B = .57$ ,  $p < .001$ ). The lower slope indicates that populations in more-demanding climates tend to discriminate less in favor of ingroups and against outgroups if they are rich ( $B = -.28$ ,  $p < .001$ ). When the two slopes are read and interpreted together, they extend the overall storyline in Figure 1: we/they discrimination is most prevalent in poor populations residing in more-demanding climates (e.g., Azerbaijanis and Montenegrins), intermediately prevalent in populations residing in undemanding temperate climates irrespective of income per head (e.g., Indonesians and Singaporeans), and least prevalent in rich populations residing in more-demanding climates (e.g., Australians and Luxembourgers).

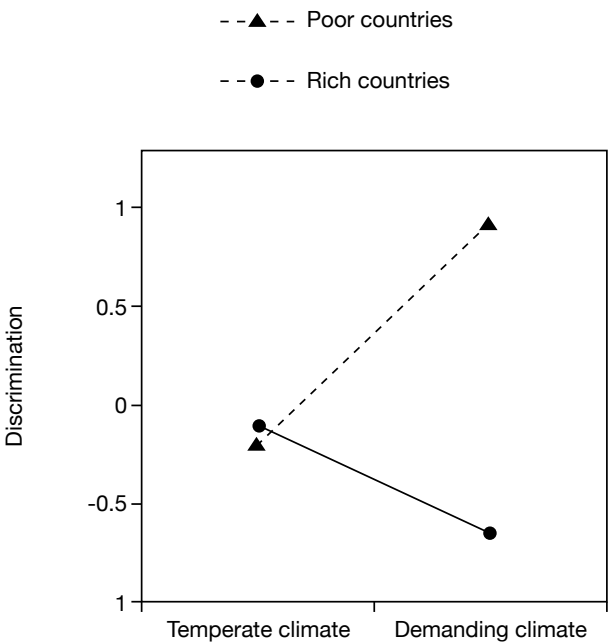


Figure 2. Interactive effects of climatic demands and wealth resources on we/they discrimination in 95 poorer and richer countries

The extended storyline of the ecology of national cultures implies that economic prosperity does not necessarily propel human functioning in the direction of less centralization, formalization and discrimination, and more individualization, as the World Values group would have it (e.g., Inglehart & Baker, 2000; Inglehart & Welzel, 2005; Welzel, 2013). Populations in undemanding temperate climates are relatively insensitive to the level of national wealth when making decisions about achieving goals by means of oneself or members of ingroups or outgroups. Only populations in more-demanding climates seem to propel away from

bureaucratization and we/they discrimination toward self-expression and social equality when they get richer. This may be an especially important point for the Human Development Programme of the United Nations because positive ingroup discrimination and negative outgroup discrimination often go hand in hand with unintended re-routing of money streams and redistribution of rights and duties.

Self-evidently, climato-economic theorizing provides a partial explanation of we/they discrimination at best. For a number of countries studied, ethnic diversity, social upheaval, and illegal or unwanted immigration also play important roles in shaping ingroup love and outgroup hate. Nevertheless, the reported accumulating results make it increasingly difficult to escape the impression that cultures are also shaped differently in threatening, comforting, and challenging ecologies (but see Ainslie, 2013; Arantes et al., 2013; Chang et al., 2013; Murray, 2013). We should keep in mind, however, that the climato-economic paradigm is no exception to the rule that each theory has a domain where it does apply, a domain where it may or may not apply, and a domain where it does not apply at all (for details, see Van de Vliert, 2013b). The upshot of the present study is that we/they discrimination seems to belong to the domain where climato-economic theorizing does apply.

*Refinement of the storyline.* Obviously, the bipolar structure of colder-than-temperate and hotter-than-temperate climates is not necessarily symmetrical. On the contrary, it is unlikely that climatic demands, measured in degrees Celsius as absolute deviations from 22 °C, are approximately the same on the cold side and the hot side. De Oliveira Chen and Kitayama (2013) rightly observe that winters on this planet are generally more problematic than summers, with the consequence that cultures are shaped by winters rather than summers. Winter demands range from an absolute deviation of 1 on the Marshall Islands to a relatively high peak of 87 in Mongolia, whereas summer demands range from 2 in Colombia to a relatively low peak of 44 in Sudan (Van de Vliert, 2009). The smaller range of summer demands is caused by more direct and more concentrated sun rays, as well as more sun exposure because of the many daylight hours in summer.

In order to map the differential effect of winters and summers, the above analysis was refined using cold demands and heat demands (source: Van de Vliert, 2013b) as separate conditions that influence the impact of wealth resources on we/they discrimination. The results in Table 4 reveal that heat demands do not play a significant part in predicting discrimination. Nonetheless, as illustrated by the two upper slopes in Figure 3, greater cold in poor countries has a more convincing positive effect on discrimination if heat demands are low (upper left slope:  $B = .67$ ,  $p < .001$ ) rather than high (upper right slope:  $B = .42$ ,  $ns$ ). Consistently, as illustrated by the two lower slopes in Figure 3, greater cold

in rich countries has a more convincing negative effect on discrimination if heat demands are low (lower left slope:  $B = -.23, p < .05$ ) rather than high (lower right slope:  $B = -.19, ns$ ). Continuing global warming may influence these effects, making the right-hand picture in Figure 3 at least as pronounced as the comparable left-hand picture.

Table 4. Cold demands, heat demands, and wealth resources predicting we/they discrimination

Predictor	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>
Cold demands (CoD)	-.14	-.06	.07	.18*	.17
Heat demands (HeD)	.20	.19	.11	.14	.12
CoD × HeD		.16	.14	-.01	-.05
Wealth resources (WR)			-.50***	-.34***	-.31***
CoD × WR				-.41***	-.38***
HeD × WR				-.00	-.00
CoD × HeD × WR					.07
$\Delta R^2$	.14***	.02	.29***	.14***	.00
Total $R^2$	.14***	.16***	.45***	.59***	.59***

Note.  $N = 95$  in all prediction models. There was no multicollinearity ( $VIFs < 4.51$ ) and there were no outliers (Cook's  $Ds < .46$ ).

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

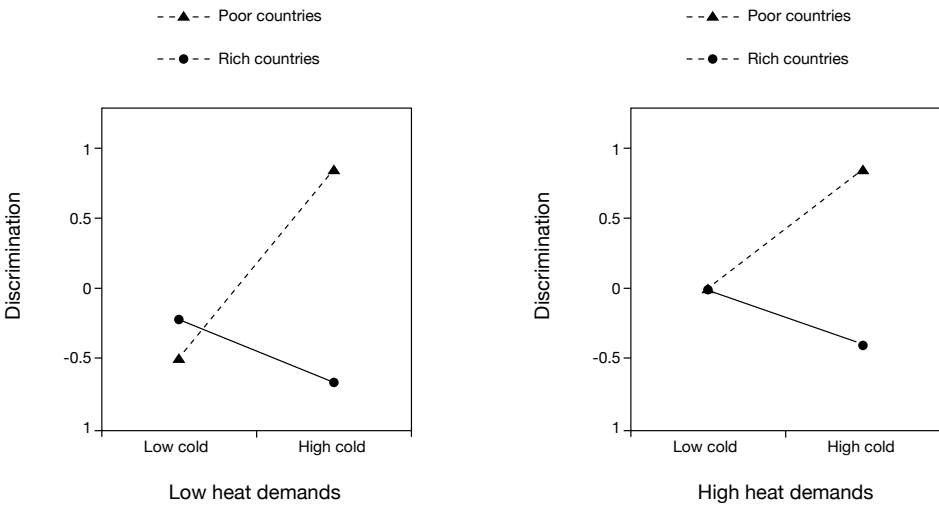


Figure 3. Interactive effects of cold demands, heat demands, and wealth resources on we/they discrimination in 95 poorer and richer countries



## Concluding perspective

Taken together, the results of the present and prior research suggest that mutually entwined ingroup love and outgroup hate, and other aspects of national culture (listed in Figure 1) are shaped differently in threatening, comforting, and challenging places of residence. Poorer populations in climates with colder-than-temperate winters, hotter-than-temperate summers, or both (*threatening ecologies*) are prone to relatively strong we/they discrimination, mental ill-being, bureaucratic organizing, press repression, autocratic politics, and survival goals. Richer populations in climates with colder-than-temperate winters, hotter-than-temperate summers, or both (*challenging ecologies*) are prone to relatively weak we/they discrimination, mental well-being, organic organizing, press freedom, democratic politics, and self-expression goals. Comforting ecologies in between these extremes tend to be home to intermediate cultural realities.

Although this article perhaps raises more problems than it answers, especially about the natural way in which our species has developed throughout history to ultimately create the cultures that we know today, it does make a point. The climato-economic covariations of culture reviewed here seem to render it impossible to sketch a convincing picture of present-day creation of culture if we continue to neglect or underemphasize the crucially important part played by the interaction of winter demands, summer demands, and wealth resources to meet these climatic demands. A good deal of the still unsolved ecology-of-culture puzzles can be summarized in the following question for further research: In what domains, in what ways, and to what extent have cultural adaptations in humans contrived to integrate climatic and economic underpinnings?

## Acknowledgments

For helpful suggestions and critical comments on draft versions of this article, I thank Huadong Yang and two anonymous reviewers of this journal.

## References

- Ainslie, G. (2013). Cold climates demand more intertemporal self-control than warm climates. *Behavioral and Brain Sciences*, 36, 481–482.
- Alderfer, C. P. (1972). *Existence, relatedness, and growth: Human needs in organizational settings*. New York: Free Press.
- Arantes, J., Grace, R. C., & Kemp, S. (2013). Press freedom, oil exports, and risk for natural disasters: A challenge for climato-economic theory? *Behavioral and Brain Sciences*, 36, 483.

- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Brewer, M. B. (1999). The psychology of prejudice: Ingroup love or outgroup hate? *Journal of Social Issues*, 55, 429–444.
- Buss, D. M. (1999). *Evolutionary psychology: The new science of the mind*. Boston, MA: Allyn and Bacon.
- Chang, L., Chen, B. B., & Lu, H. J. (2013). Cultural adaptation to environmental change versus stability. *Behavioral and Brain Sciences*, 36, 485–486.
- de Oliveira Chen, S., & Kitayama, S. (2013). Frontier migration fosters ethos of independence: Deconstructing the climato-economic theory of human culture. *Behavioral and Brain Sciences*, 36, 486–487.
- Fincher, C. L., & Thornhill, R. (2012). Parasite-stress promotes in-group assortative sociality: The cases of strong family ties and heightened religiosity. *Behavioral and Brain Sciences*, 35, 61–79.
- Fincher, C. L., Thornhill, R., Murray, D. R., & Schaller, M. (2008). Pathogen prevalence predicts human cross-cultural variability in individualism/collectivism. *Proceedings of the Royal Society B*, 275, 1279–1285.
- Fischer, R., & Van de Vliert, E. (2011). Does climate undermine subjective well-being? A 58-nation study. *Personality and Social Psychology Bulletin*, 37, 1031–1041.
- Fought, J. G., Munroe, R. L., Fought, C. R., & Good, E. M. (2004). Sonority and climate in a world sample of languages: Findings and prospects. *Cross-Cultural Research*, 38, 27–51.
- Georgas, J., Van de Vijver, F. J. R., & Berry, J. W. (2004). The ecocultural framework, ecosocial indices, and psychological variables in cross-cultural research. *Journal of Cross-Cultural Psychology*, 35, 74–96.
- Halevy, N., Weisel, O., & Bornstein, G. (2012). “Ingroup-love” and “outgroup-hate” in repeated interaction between groups. *Journal of Behavioral Decision Making*, 25, 188–195.
- House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (Eds.). (2004). *Culture, leadership, and organizations: The GLOBE study of 62 societies*. Thousand Oaks, CA: Sage.
- Huntington, E. (1945). *Mainsprings of civilization*. New York: Wiley.
- Inglehart, R., & Baker, W. E. (2000). Modernization, cultural change, and the persistence of traditional values. *American Sociological Review*, 165, 19–51.

- Inglehart, R., Basáñez, M., Díez-Medrano, J., Halman, L., & Luijkx, R. (Eds.). (2004). *Human beliefs and values: A cross-cultural sourcebook based on the 1999–2002 values surveys*. Mexico: Siglo XXI Editores.
- Inglehart, R., & Welzel, C. (2005). *Modernization, cultural change, and democracy*. New York: Cambridge University Press.
- Kenrick, D., Griskevicius, V., Neuberg, S., & Schaller, M. (2010). Renovating the pyramid of needs: Contemporary extensions built upon ancient foundations. *Perspectives on Psychological Science*, 5, 292–314.
- Kitayama, S., Conway, L. G., Pietromonaco, P. R., Park, H., & Plaut, V. C. (2010). Ethos of independence across regions in the United States: The production-adoption model of cultural change. *American Psychologist*, 65, 559–574.
- Kitayama, S., Ishii, K., Imada, T., Takemura, K., & Ramaswamy, J. (2006). Voluntary settlement and the spirit of independence: Evidence from Japan's "northern frontier." *Journal of Personality and Social Psychology*, 91, 369–384.
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal and coping*. New York: Springer.
- LePine, J. A., LePine, M. A., & Jackson, C. L. (2004). Challenge and hindrance stress: Relationships with exhaustion, motivation to learn, and learning performance. *Journal of Applied Psychology*, 89, 883–891.
- LePine, J. A., Podsakoff, N. P., & Lepine, M. A. (2005). A meta-analytic test of the challenge stressor–hindrance stressor framework: An explanation for inconsistent relationships among stressors and performance. *Academy of Management Journal*, 48, 764–775.
- Maslow, A. H. (1954). *Motivation and personality*. New York: Harper & Row.
- Milgram, S. (1974). *Obedience to authority: An experimental view*. London: Tavistock.
- Murray, D. R. (2013). Cultural adaptations to the differential threats posed by hot versus cold climates. *Behavioral and Brain Sciences*, 36, 497–498.
- Parker, P. M. (1997). *National cultures of the world: A statistical reference*. Westport, CT: Greenwood Press.
- Parsons, K. C. (2003). *Human thermal environments: The effects of hot, moderate and cold environments on human health, comfort and performance* (2nd ed.). New York: Taylor & Francis.
- Podsakoff, N. P., LePine, J. A., & LePine, M. A. (2007). Differential challenge stressor–hindrance stressor relationships with job attitudes, turnover intentions, turnover, and withdrawal behavior: A meta-analysis. *Journal of Applied Psychology*, 92, 438–454.

- Ritzer, G. (2004). *The McDonaldization of society* (rev. ed.). Thousand Oaks, CA: Pine Forge Press.
- Schaller, M., & Murray, D. M. (2011). Infectious disease and the creation of culture. In M. J. Gelfand, C. Chiu, & Y. Hong (Eds.), *Advances in culture and psychology* (pp. 99–151). New York: Oxford University Press.
- Taylor, T. G. (1937). *Environment, race, and migration*. Chicago, IL: University of Chicago Press.
- Tooby, J., & Cosmides, L. (1992). The psychological foundations of culture. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 19–136). New York: Oxford University Press.
- UNDP (United Nations Development Programme). (2004). *Human development report 2004*. New York: Oxford University Press.
- UNDP (United Nations Development Programme). (2010). *Human development report 2010*. New York: Palgrave Macmillan.
- Van de Vliert, E. (2009). *Climate, affluence, and culture*. New York: Cambridge University Press.
- Van de Vliert, E. (2011a). Bullying the media: Cultural and climato-economic readings of press repression versus press freedom. *Applied Psychology: An International Review*, 60, 354–376.
- Van de Vliert, E. (2011b). Climato-economic origins of variation in ingroup favoritism. *Journal of Cross-Cultural Psychology*, 42, 494–515.
- Van de Vliert, E. (2013a). Climato-economic habitats support patterns of human needs, stresses, and freedoms. *Behavioral and Brain Sciences*, 36, 465–480.
- Van de Vliert, E. (2013b). White, gray, and black domains of cultural adaptations to climato-economic conditions. *Behavioral and Brain Sciences*, 36, 503–521.
- Van de Vliert, E., & Postmes, T. (2012). Climato-economic livability predicts societal collectivism and political autocracy better than parasitic stress does. *Behavioral and Brain Sciences*, 35, 94–95.
- Vanhanen, T. (2009). *The limits of democratization: Climate, intelligence, and resource distribution*. Augusta, GA: Washington Summit Publishers.
- Welzel, C. (2013). *Freedom rising: Human empowerment and the quest for emancipation*. New York: Cambridge University Press.
- World Economic Forum (2005). *The global competitiveness report 2004–2005*. New York: Palgrave MacMillan.

---

# Book Reviews

---



# Ecologia Humana Uma Visao Global

By Ronaldo Gomes Alvim, Ajibola Isa Badiru,  
and Juracy Marques

Feira de Santana, Brazil: UEFS Editora, Associação Brasileira das Editoras  
Universitarias, 367 pp., 2014

ISBN: 978-85-99799-91-8

Reviewed by Karl Bruckmeier<sup>1</sup> and Luc Hens<sup>2</sup>

This book was presented at the “Second International Seminar on Human Ecology” at the State University of San Salvador de Bahia, Brazil, on September 11–14, 2014. Part of the global human–ecological discourse, it includes chapters in Portuguese, Spanish, and English that show the rapid development of human ecology in the Ibero-American countries. Because of the practical problems it discusses, the book is also of interest for a broader audience.

The respective chapters connect to a number of rapidly accelerating problems in the human–environmental realm: the effects of climate changes and mitigating or adapting to them; declining biodiversity; the prevention of chemical spills. There is increasing awareness of ways to address these, and answers are necessary.

As these are complex problems, the conviction grows that the answers require integrated, holistic, and transdisciplinary approaches where scientists and non-scientists cooperate. Moreover, the discussion is in need of transformative knowledge that avoids the fragmentation and compartmentalization of existing academic disciplines. It is also important to address deficits in dissemination and application of the knowledge available. This new knowledge is also required to deal with the overused and over-interpreted idea of sustainable development that is gradually losing its capacity as a guiding idea for social transformation. It needs to be renewed and rethought, even as it is integrated with other concepts. Human ecology offers such an avenue. It includes approaches such as the new social ecology, and offers new transdisciplinary cooperation and synergy to address contemporary problems. In so doing, it stands a good chance to achieve a better quality of life and improved human–environment relations.

---

1 National Research University—Higher School of Economics, Moscow, Russia.

2 Vlaamse Instelling voor Technologisch Onderzoek, Belgium.

The book describes, analyses, and demonstrates the potential of human ecology as an area of training and research in the interaction between social and ecological systems. The 10 chapters illustrate the multidisciplinary origins of human ecology and provide examples of contemporary applications.

The first three chapters are about the origins of human ecology, its scope and subject area, and its differences to other, related scientific disciplines. Next to its historical roots, human ecology is situated in the interaction between anthropology, planning and architecture, economy, epidemiology, psychology, and sociology, providing a context of economic, social, and environmental analyses that can be applied by decision-makers on a wide array of quality-of-life issues.

The other chapters show how human ecology dovetails in the social, planning, and medical sciences. Of particular interest is Chapter 10, which identifies nine ecosystem services directly influencing human health. They illustrate the importance of improving the relation between local communities and in-situ biodiversity conservation. The chapter adds to the idea that equitable environmental and public health measures are mutually supportive.

Four chapters illustrate the added value of human ecology approaches to issues in sustainable development. Problems on food security, natural resources, quality of life, and risk analysis are discussed. Chapter 6 provides a human ecology analysis of the environmental and social consequences of the tsunami disaster in Japan (May 11, 2011). Different time (from immediately after the disaster to the long term) and geographical (from local to international) scales matter. The chapter integrates data on environmental quality, health effects, human behavior, everyday life, and social and economic aspects of the tsunami disaster. The result is an integrated view, indicating how to deal with disasters and environmental problems in the 21st century.

The 10 chapters have been written by 12 authors who are active in teaching and/or research in human ecology. The book primarily serves the training of their students. Seven chapters are written in Portuguese or Spanish, and three in English. The publication of large parts of the book in Portuguese and Spanish indicates the origin and geographical spread of the discussion, with up-to-date information on the state of human ecology in large parts of Latin America. It shows also the social reality and practice of the human ecology discourse in the era of globalized science. International scientific discourse is not confined to the scientific “lingua franca” of English, but is rooted in other languages that show the original culture of the ideas and the participating scientists.



The value of the book for teaching is evident from its accounting of the history and development in human ecology and its application for the study of present problems. It shows how new concepts are taken up and new problems addressed, making use of the breadth of human ecology thinking in the multiple themes it investigates. In this way it is a valuable addition to Marten's (2001) *Human Ecology*. It equally provides updated information which is scattered over the literature (e.g., Gomes, 2012; Pires et al., 2010). This "integrated multiplicity" of human ecology simultaneously shows its epistemic strengths and weaknesses.

An epistemic strength in all phases of the century-long development of human ecology was the ability to integrate, synthesize, and apply knowledge from a variety of social and natural scientific disciplines and specialized fields of research. The value for this reaching across disciplinary boundaries is visible in the discussion of Lawrence (p. 71): people–environment relations cannot be fully understood from a few disciplines and from specialized disciplinary knowledge. Rather, a wide range of concepts and methods are required.

This does, however, touch on an inherent weakness in human ecology from an epistemological standpoint. Human ecologists continuously struggle with the difficulties of integrating a mass of knowledge that originates from different disciplines, so far working with "weak ties."

The weakness of methods for knowledge synthesis, conceptual integration, formulating new frameworks, and integrating different theories is as evident in human ecology as in other interdisciplinary discourses—and is not addressed further in this book. Also, when complex or wicked social problems are discussed (Chapter 4, Pires), the epistemological and methodological difficulties are visible. As in other contributions in this volume, the integrative potential of human ecology is seen in holistic thinking, global visions, ethical reflections about the relations between humans and other species, systems theory and systems thinking, and (what is called by Pires) building bridges between knowledge fields and knowledge bearers.

This shows, in a nutshell, the intellectual toolbox of human ecology. One would have wished for further discussion that takes up the integrative potential in more systematic epistemological, theoretical, and methodological analysis and reflection. Some of that did in fact take place in the recent discourse and research in social ecology in German-speaking countries (much of that published in English). Yet it is not discussed systematically in this book. Like a confirmation of "here ends the discourse," the broader reflections end abruptly after the chapter of Pires, and the subsequent chapters dive into the manifold themes of applied human ecology, and also a discourse on sustainable development (in Chapter 9, by Castellano and Alvim).

Castellano and Alvim go again through a broad debate, showing the ramification of the sustainability idea and the limits of the debate. They shed light also on the dilemmas and multifaceted problems of population growth and development, asking for a unifying holistic vision (p. 278f). Yet after that, the chapter glides over to a more politically critical discussion of sustainable development, especially for the countries of the global South, suggesting that education alone cannot solve the problems. This end of the debate is like a confirmation that human ecology reflection has not reached its potential.

This book can also be seen as an invitation to look at human ecology in a fresh way—one that addresses the progress of human ecology, not only accounting for its achievements, but also discussing more systematically the challenges of its future development and how to overcome its weaknesses. These weaknesses include the blind spots and “terra incognita” of interdisciplinary theory, problems in methodology and knowledge synthesis, and the limited knowledge on human–environment interactions. Yet, human ecology is informed by many disciplines. It invites methodologically disciplined forms of knowledge synthesis.

## References

- Gomes, A. R. (2012). *Ecologia humana: Da visao academica aos temas atuais*. Alagoas: Editora da Universidade Federal de Alagoas.
- Marten, G. G. (2001). *Human ecology: Basic concepts for sustainable development*. London: Earthscan.
- Pires, I. M., Gibert, M., Hens, L. (Eds.). (2010). *Studies in human ecology*. Hanoi: Publishing House for Science and Technology.

# Structural Human Ecology: New Essays in Risk, Energy, and Sustainability

Edited by Thomas Dietz and Andrew Jorgenson

Pullman, WA: Washington State University Press, 227 pp., 2013

ISBN: 978-0-87422-317-0

Reviewed by Erik L. Bond<sup>1</sup>

Eugene Rosa was a pioneering researcher who spent much of his career establishing links between the social sciences and the ecological and biophysical disciplines. *Structural Human Ecology* collects papers from a conference held at Washington State University celebrating Rosa's life and body of work. The text follows in Rosa's footsteps with its focus on intersections of human and non-human processes that help us unpack environmental risks both complex and lacking in precedent.

In the preface, Paul Ehrlich highlights Rosa's profound contributions to the early days of human ecology research. Ehrlich recounts the ways that Rosa and his collaborators expanded upon existing bodies of work, such as the IPAT model, which framed environmental [I]mpacts as the product of [P]opulation processes enacted under varying levels of A[ffluence] and [T]echnology. Rosa and others built upon this formulation to produce the stochastic, iterated or STIRPAT model that (as Ehrlich recounts) "has been used to measure such things as the impacts of growing populations and expanding consumption on environmental variables, and [to refute] a variety of claims that those impacts will be handily reduced by economic factors and technological innovation." Rosa was also a key actor in the Millennium Alliance for Humanity and the Biosphere and, for both his leadership and resoundingly prescient work in many of the most pressing problems of modernity, is dearly missed.

In the introductory chapter, Thomas Dietz and Andrew Jorgenson give a brief account of human ecology's development as a field. Beginning with its early days in the Chicago School, human ecology distinguished itself from sociology with its concern for the biophysical environment and concepts such as spatial patterning and succession more commonly found in the ecological and evolutionary sciences.

---

1 University of Oklahoma, United States.

Although Dietz and Jorgenson acknowledge human ecology as a heterogeneous field whose actors are sometimes only loosely connected, they nonetheless identify three core themes by which its academic community may be characterized. The first is a concern with metatheory, or how problems may be known and identified, particularly when (as is the case with modern environmental issues) such problems are often novel in character, broad and complex in scope, and difficult or impossible to reliably replicate. The second core theme of *Structural Human Ecology* concerns attention to risk and uncertainty—concepts which are inherently difficult to model or predict in systems of human–environmental exchange. The third and final core theme of the book is an expanding repository of macrocomparative research on human–environment impacts that has only truly become available in recent decades. Although Dietz and Jorgenson note that no overarching paradigm dominates or defines *Structural Human Ecology*, they cite Rosa for three points that are inescapable in the field: context matters, theory must be disciplined by data, and progress requires careful thought about concepts and premises. The rest of this chapter outlines the subsequent sections of the book, which are organized around the three core themes above: metatheory, risk analysis, and quantitative analysis of impact drivers. The closing section of the chapter focuses on fertile directions for future research.

The first section of the book contains essays by Thomas Dietz and Richard York on issues of metatheory. A common thread between these essays is Rosa's seminal paper "Metatheoretical Foundations for Post-Normal Risk" (Rosa, 1998). "Meta" (as both Dietz and York refer to the paper) concerns both the ontology and epistemology of risk analysis. The paper outlined what later became known as Rosa's HERO framework: [H]ierarchical [E]pistemology applied to a [R]ealist [O]ntology. The framework endorses approaching uncertain or unclear problems from the view that some objective reality does exist, but that we must approach such problems with full acknowledgment of the profound informational and social constraints to our understanding.

York discusses the nature of risk in areas of uncertainty and "post-normal" science (Funtowicz & Ravetz, 1992). He delineates between risks found in simple systems such as those of engineering, and those that are found in more complex social, ecological, and human–natural systems. The former he likens to the models of classical physics, wherein measurement error is a well-known and predictable presence. The latter, York argues, contains levels of both measurement and specification error that are difficult to account for. Such roadblocks may be attributed in large part to the singularity and magnitude of anthropogenic environmental impacts found in late modernity. As contemporary issues of global climate change, resource consumption, and pollution are precisely the subjects with which *Structural Human Ecology* concerns itself, researchers are compelled to use great care in defining the boundaries of their knowledge.

In the next chapter, Thomas Dietz elaborates on issues of ostensibility and repeatability and extends them from the scientific enterprise to questions of value. Dietz tells us that, in addition to values perpetually influencing science, environmental science must grapple with assessment of facts whose value to society is almost entirely uncertain. The phenomena studied by human ecologists may be singular in history (low repeatability), and values related to novel phenomena may be difficult to identify (low ostensibility). The involvement of the market further fractures the field between production (re: growth-oriented) science and impact science, which studies the consequences of the former. Dietz's chapter (channeling Rosa) highlights the growing conflict between these subfields and lays out steps to reconnect science with public discourse.

The second major section of the book focuses on risk as it relates to emergent technologies and the scope of human impacts on the natural environment. The section opens with a chapter by Renn et al. on climate engineering, the theory and practice of altering the environment to limit the scope and rapidity of climate change. As anthropogenic impacts increase in magnitude, the call for large-scale solutions intensifies. Renn et al. provide input on fostering integrated public–scientific dialogue on such solutions.

The next chapter contains a discussion by Roger Kaspersen on the intersection of emerging technology with three types of uncertainty: aleatory uncertainty, model-parameter uncertainty, and deep uncertainty. In each of these types, further data and research are progressively less likely to be helpful. Kaspersen advises strategies of adaptive management and resilience building for bridging the gap between uncertainty and decision-making. However, the author notes that these strategies are not quick fixes, and elaborates a series of dilemmas that impede their implementation.

The final chapter of this section, written by Paul Stern, discusses public perception of recent high-risk technologies such as nuclear power, radioactive waste management, and DNA manipulation. Summarizing a considerable body of research, he asserts that while scientific analysis focuses on the probability of certain outcomes, public discourse tends to center on the nature of potential consequences (rather than the likelihood of actually encountering them). From these conclusions, Stern lays out a set of design principles for managing new technologies.

The third section of the book explores the body of macrocomparative work on human–environment interactions, including the stresses and well-being of both parties. This body of work owes considerable thanks to Rosa's role in developing the STIRPAT model. The section opens with a chapter by Allan Mazur on the relationships between energy consumption and human quality of life. Although

energy availability does raise standard of living, the relationship decouples at higher levels of consumption. Mazur concludes with a discussion of what drives increasing levels of energy consumption.

Andrew Jorgenson authors the next chapter, wherein he applies the STIRPAT framework to both previous and new analyses on the relationships between population, affluence, and environmental stress. Jorgenson's work supports previous literature (e.g., Burns et al., 1997; Inglehart, 1995; Kidd & Lee, 1997) findings that population, urbanization, and affluence levels all predict environmental stress (in this case as greenhouse gas emissions). However, Jorgenson highlights both regional and over-time variability in these relationships.

The following chapter, written by Sandra Marquart-Pyatt, looks at the ways that structural human ecology may operate across multiple levels of social organization to address complex relationships. Both social levels (households, communities, nation states) and ecological levels (ecosystems, landscapes, biomes) add nuance to the human–environment relationship, and yet the available data seldom transcend these levels. Marquart-Pyatt utilizes an approach advocated by Rosa that involves using comparable data from diverse regions to help integrate macro- and micro-level effects. Keeping with the section's theme, Marquart-Pyatt links this approach with the STIRPAT model to produce a functional research paradigm.

The concluding chapter of *Structural Human Ecology* is also written by Dietz. He summarizes and reinforces the lessons that are Gene Rosa's legacy. He recites tenets about the importance of context, the need to approach knowledge production cautiously, and the dialectical nature of theory and data and the relationship of both to public discourse. Rosa's body of work exemplified a truly integrative approach to tackling complex problems. Equally important, he provided (and continues to provide) an exemplary model for aspiring human ecology scholars.

*Structural Human Ecology* does justice to both the life and work of Gene Rosa and to the titular discipline which serves as his legacy. It integrates a diverse body of scholarship that will provide a facile framework for tackling human–ecological problems we have only begun to properly frame and understand. Students and scholars of environmental sociology, of human ecology, and of the broader social sciences will wish to reference this text frequently as they seek to develop firm grasps of their respective fields.

## References

- Burns, T. J., Kick, E. L., & Byron, D. (1997). Position in the world-system and national emissions of greenhouse gases. *Journal of World-Systems Research*, 3, 432–466.
- Funtowicz, S. O., & Ravetz, J. R. (1992). The good, the true and the post-modern. *Futures*, 24, 963–976.
- Inglehart, R. (1995). Public support for environmental protection: The impact of objective problems and subjective values in 43 societies. *PS: Political Science and Politics*, March, 57–71.
- Kidd, Q., & Lee, A.-R. (1997). Post materialist values and the environment: A critique and reappraisal. *Social Science Quarterly*, 78(1), 1–15.
- Rosa, E. A. (1998). Metatheoretical foundations for post-normal risk. *Journal of Risk Research*, 1(2), 111–115.





# Understanding Human Ecology: A Systems Approach to Sustainability

By Robert Dyball and Barry Newell

London and New York: Routledge, 214 pp., 2015

ISBN: 978-1-84971-383-2

Reviewed by Liesel Carlsson<sup>1</sup>

Already endowed with praise from influential thinkers and educators in sustainability from around the world, including the United Nations University and Stockholm Resilience Centre, this review adds one more voice of praise for the role of *Understanding Human Ecology* as a critical contribution that brings clarity to a path forward on a subject that is gaining critical mass in the geopolitical landscape—*sustainability*.

The interdisciplinary nature of sustainability work often means those involved run into friction that is a result of differing ideologies, worldviews, methodologies, and, moreover, a common vision of success. This friction is paralyzing progress at a time when scientists finally agree that the Anthropocene may be an elegant term for a period of planetary destruction. What Dyball and Newell contribute to the (hopefully) early Anthropocene, and to the field of sustainability in general, is to bring together their extensive expertise in human ecology and physics to first unpack and then bring together social and cognitive sciences, communications theory, and systems dynamics theory. The result is an accessible text that brings the reader to a new understanding of how to overcome this paralysis to act strategically despite the complexity of the sustainability challenge, and collaboratively in an inherently interdisciplinary process.

Part 1 provides an illustration of the sustainability challenge through the lens of a human ecologist, weaving the human behavior–ecosystem response threads together in the Snowy Mountains of Australia, where sociopolitical decisions made over the course of a century made permanent ecological changes which in turn, of course, had sociopolitical implications. This illustration is presented in a way that global readers can easily translate the core concepts into similar examples more local to their context and, furthermore, apply the systems approach elaborated in Part 2.

---

<sup>1</sup> Acadia University, Nova Scotia, Canada.

The second part of the book focuses on bringing the reader up to par on the theoretical grounding of the paradigm to be proposed in Part 3. Dyball and Newell borrow from cognitive sciences to clarify the human nature of developing cultural worldviews, or mental models, which not only direct our thinking and actions, but our unconscious expectations of others' behavior, and the environment. Complicating global progress to sustainability is that these worldviews differ geographically, culturally, and across disciplines. The authors propose that truly transdisciplinary, or "comprehensive" approaches to sustainability challenges require communication frameworks that rise above this barrier to build bridges across worldviews. And true to the accessible nature of the book, they make practical suggestions to guide practitioners and thinkers alike toward developing universally effective metaphors, called "powerful ideas," to do just that. As tools, powerful ideas facilitate critical transdisciplinary and cross-cultural understanding while still allowing healthy diversity in ideology, worldviews, and methods for action.

Layering in systems dynamics theory, the authors go on to utilize powerful ideas to illustrate how humans and ecosystems interact in ways that are indeed relatively predictable. How we accumulate water in reservoirs, regulate the level of that water through inflows and outflows, and how human intervention in those flows can influence the volume of water, provides a good example of a universally accepted, and relatively predictable idea. Perhaps less well understood are how human behaviors interact with ecosystems in complex ways that generate unexpected delays, oscillations and collapse in otherwise predictable systems, such as water reservoirs. Part 2 lays the groundwork for a theoretical framework that borrows from systems theory and Boyden's transition framework to unravel complexity and develop a framework for cultural adaptation based on the idea that expected or unexpected (i.e., regardless of worldview) social and ecological responses in a system (e.g., delays in, volume of, or collapse of the water stock) create feedback loops in the system that ultimately feed into cultural shifts in worldviews, or cultural paradigms shifts. Perhaps even more important is that this application of system dynamics lends versatility that makes it applicable to broad global challenges (e.g., "limitless growth paradigm") equally well as to more narrow, localized issues (use of air conditioning units).

Part 3 takes the reader through a historical and anthropological journey of how cultural paradigms have adapted through time, to affect our food production and consumption systems. We have moved from a dominant worldview that working with nature we can procure food, to a worldview that domination over nature will produce *more* food. This shift was a logical (to the time) change in cultural paradigm in part due to the feedback loop coming from increasing technological advances in our culture.

We are now sitting at a historical juncture where the feedback loop coming from increasing damage to ecosystem and human health is forcing a new cultural paradigm. Part 3 follows up with clear summaries of the current state of knowledge of how the dominant development paradigm, framed as “limitless growth,” is affecting the ecosystem that sustains us and, subsequently, our own health and well-being. Also explained is how globalization has caused “delays” in the feedback mechanisms for this self-destruction, damage that might otherwise have caused us to alter our course at an earlier juncture, and how high levels of food-system vulnerability (through damage to ecological and social mechanisms) can be traced back to the state of a country’s cultural paradigms (e.g., belief in global markets).

Finally, the authors offer an alternative cultural paradigm, which embeds concepts of sufficiency (vis-à-vis growth) and biosensitivity as a solution for unified progress toward sustainability. They then provide examples of how cultural adaptations, through transformative learning, can be game changers.

*Understanding Human Ecology* is a particularly valuable contribution toward the practice and scholarship of building sustainable food systems. It exceeded my expectations in balancing theoretical and practical without idyllically ignoring the complexity of human behavior and motivations that smudge the edges of the pathways that lead us toward “living well in the Anthropocene.”



# The Garden of God: Toward a Human Ecology

By Benedict XVI (Maria Morciano, ed.)

Washington, DC: The Catholic University of America Press, 218 pp., 2014

ISBN: 978-0-8132-2579-1

Reviewed by Robin van Tine<sup>1</sup>

Alongside the ecology of nature, there exists what can be called a “human” ecology, which in turn demands a “social” ecology. All this means that humanity, if it truly desires peace, must be increasingly conscious of the links between natural ecology, or respect for nature, and human ecology. (Pope Benedict XVI)

The degradation of nature is closely linked to the cultural models shaping human coexistence: consequently, when “human ecology” is respected within society, environmental ecology also benefits. (Pope Benedict XVI)

Is Emeritus Pope Benedict XVI a human ecologist?

In this collection of religious writings, sermons, talks, letters, and encyclicals collected and edited by Maria Morciano, Emeritus Pope Benedict XVI lays out a vision of a sacred human ecology which aligns very well with many if not most of the tenets of academic human ecology. He has been called “The Green Pope,” and the writings in this book substantiate that moniker. The Catholic Church is well known for its stand and work for social justice, and it appears that social justice, equity, and environmental sustainability are woven together by Pope Benedict in this work. Of particular interest is Benedict’s (and John Paul II’s) use of the term “human ecology” to stand for the inclusion of humans and their communities, institutions, and civilizations when considering ecological, environmental, and sustainability issues.

The book is divided into three parts: “Creation and Nature;” “The Environment, Science, and Technology;” and “Hunger, Poverty, and the Earth’s Resources.” Each is a set of mostly edited excerpts from sermons, speeches, encyclicals, and essays created by Benedict during his tenure as Pope, which focus on environmental, ecological, and sustainability issues. There is an excellent forward by Jean-Louis Bruguès, which analyzes the work in the context of other Popes’ ecological writings, especially John Paul II.

---

1 Saint Leo University and GreenFaith Fellow, Florida, United States.

In Part 1, "Creation and Nature," Benedict points out that, "In contact with nature, individuals rediscover their proper dimension ... they perceive the mark of goodness and divine Providence in the world that surrounds them and open themselves almost spontaneously to praise and prayer" (p. 3), which is reminiscent of Rabbi Heschel's concept of radical awe (1965) and "Gaeologian," Thomas Berry's (2000) reminders that creation is the primary revelation of God. Benedict, in the chapter titled "Creation Is a Gift So That It Might Become the Garden of God and Hence a Garden for Men and Women," states that Christians who "believe in the Creator Spirit become aware of the fact that we cannot use and abuse the world and matter merely as material for our actions and desires; that we must consider creation a gift that has not been given to us to be destroyed, but to become God's garden, hence, a garden for men and women" (p. 4). This is a recurrent theme in the book, and has become an important teaching in more and more Christian denominations in recent years. Benedict claims that Christians encounter God in nature: "we have discovered an initial answer to the question as to what the Holy Spirit is, what he does, and how we can recognize him. He comes to meet us through creation and its beauty" (p. 5).

In a letter to Eastern Orthodox Patriarch Bartholomew, Benedict proclaims, "The joint effort to create awareness on the part of Christians of every denomination, in order to show 'the intrinsic connection between development, human need and the stewardship of creation,' is truly proving more important than ever" (p. 11), making a plea for ecumenical cooperation in fostering a healthy human ecology. "Alongside the ecology of nature, there exists what can be called a 'human' ecology, which in turn demands a 'social' ecology. ... humanity, if it truly desires peace, must be increasingly conscious of the links between natural ecology, or respect for nature, and human ecology" (p. 13). This understanding of the deeply interdependent web of existence—including individual humans and their communities, as well as all of nature—pervades the book.

Benedict connects protection of nature, development, and human dignity in ways that an academic human ecologist would recognize:

respect for nature is closely linked to the need to establish, between individuals and between nations, relationships that are attentive to the dignity of the person and capable of satisfying his or her authentic needs. The destruction of the environment, its improper or selfish use, and the violent hoarding of the earth's resources cause grievances, conflicts, and wars, precisely because they are the consequences of an inhumane concept of development. (p. 14)

For example, compare that statement with the ideas presented in Dyball and Newell's (2015) textbook, *Understanding Human Ecology*: "Ultimately, human ecology addresses what it would take to live well in a humane world. Whether approached via social pathways or environmental ones, eventually the same destination is reached" (Dyball & Newell, 2015, p. 205).

If we interpret "The Creator's Plan," as Benedict puts it, as representing the laws of physics and chemistry, and the principles of geology, biology, oceanography, and atmospheric dynamics, we can understand the power of his statement that, when "man turns his back on the Creator's plan, he provokes a disorder which has inevitable repercussions on the rest of the created order" requiring that "the entire human community—children and adults, industry sectors, states and international bodies—must take seriously the responsibility that falls to each and every one of us" (p. 20). Benedict writes that our use of the environment:

entails a personal responsibility toward humanity as a whole, and in particular toward the poor and toward future generations ... the Church is not only committed to promoting the protection of land, water, and air as gifts of the Creator destined to everyone but above all she invites others and works herself to protect mankind from self-destruction. In fact, when "human ecology" is respected within society, environmental ecology also benefits. (p. 33)

There has been much academic discussion by environmental scientists, environmental philosophers, and human ecologists about the role of the Christian doctrine of "stewardship" in causing or solving environmental issues. Some, such as Lynn White, Jr., in his seminal 1967 article in *Science*, claimed that the doctrine of stewardship may be one of the root causes of our environmental crisis, positing a "power over," ownership mentality regarding nature. However, Pope Benedict writes, "we cannot consider ourselves creation's absolute master. We are called, rather, to exercise responsible stewardship of creation, in order to protect it, to enjoy its fruits, and to cultivate it, finding the resources necessary for everyone to live with dignity" (p. 34). He advocates a responsible relationship with nature and each other, imploring that "The economic and social costs of using up shared environmental resources must be recognized with transparency and *borne by those who incur them, and not by other peoples or future generations*" (p. 34, emphasis added). He emphatically states, "it is essential that the current model of global development be transformed through a greater, and shared, acceptance of responsibility for creation: this is demanded not only by environmental factors, but also by the scandal of hunger and human misery" (p. 35). Additionally, Benedict warns against "absolutizing" technology and human power, which would result in "a grave assault not only on nature, but also on human dignity itself" (p. 51). Despite giving humans a special

place which denies an ecocentric worldview, the Pope's (and most Christians') worldview of stewardship is powerful: *man must not abuse God's Creation, and is charged by God to care for it.*

Throughout the book, Benedict emphasizes that we need to substantially revise our current destructive industrial model of development:

Can we remain indifferent before the problems associated with such realities as climate change, desertification, the deterioration and loss of productivity in vast agricultural areas, the pollution of rivers and aquifers, the loss of biodiversity, the increase of natural catastrophes, and the deforestation of equatorial and tropical regions? Can we disregard the growing phenomenon of 'environmental refugees,' people who are forced by the degradation of their natural habitat to forsake it—and often their possessions as well—in order to face the dangers and uncertainties of forced displacement? Can we remain impassive in the face of actual and potential conflicts involving access to natural resources? All these are issues with a profound impact on the exercise of human rights, such as the right to life, food, health, and development ... Prudence would thus dictate a *profound, long-term review of our model of development.* (p. 41)

The above quote could have come from a human ecology textbook! Perhaps Pope Benedict *is* a human ecologist.

Benedict also calls for, in essence, whole-cost pricing, stating that "economic activity needs to consider the fact that every economic decision has a moral consequence and thus show increased respect for the environment. When making use of natural resources, we should be concerned for their protection and consider the cost entailed—environmentally and socially—as an essential part of the overall expenses incurred" (p. 44), not only to protect nature but also human beings and communities, and to eliminate "sacrifice zones" where people and nature are abused for the benefit of the few. Environmental and ecological economists and ecophilosophers have been promoting whole-cost pricing for decades as a way to use the power of the marketplace to help solve environmental and social problems, for example, *For the Common Good* (Daly & Cobb, 1994).

Benedict urges "A greater sense of intergenerational solidarity" (p. 44), reminiscent of the Native American concept of consideration for the seventh generation into the future (Lyons, 1994). "Future generations cannot be saddled with the cost of our use of common environmental resources" (p. 44). He shows an understanding of the limits imposed by the natural rates of resource replenishment and warns that using them faster would be stealing from future generations. "*The ecological crisis shows the urgency of a solidarity [intra-generational] which embraces time and space*" (p. 45). He points out that this crisis is a historical opportunity for the world community to retool efforts to create sustainable societies by a more



equitable distribution of resources, “more sober” lifestyles in the developed nations, and a “greater respect for creation.” Included in this plan is a great concern for local farming communities, their values, and the connection between climate change and poverty. “We can no longer do without a real change of outlook which will result in *new lifestyles*” (p. 48). The work needed to be accomplished to make this change a reality “should be ever more deeply anchored in respect for ‘human ecology’” (p. 49).

In the essay “Human Ecology Is an Imperative Need,” the Pope expresses his fear that “the human family risks disappearing” unless it “shifts its mentality” and reviews its entire approach to nature. Isn’t this one of the major goals of academic human ecology? “Nature is not a place solely for exploitation or for play. ... A human ecology is an imperative need. One of our political and economic priorities must be to adopt in every way a manner of life that respects the environment ... This is fundamental for us” (p. 73).

Benedict warns us against a blind belief in technological fixes to our problems and also warns us about the potential dangers of “progress.” He cautions us that “technology that dominates human beings deprives them of their humanity” (p. 74). Part 1 of the book, “Creation and Nature,” ends with an admonition that “there will be no good future for humanity on earth unless we teach everyone a lifestyle that is more responsible toward creation,” and furthermore, “Respect for the human being and respect for nature are one and the same” (p. 86).

Part 2 of the book, “The Environment, Science, and Technology,” further explores some of the themes presented in Part 1. Science is affirmed as a vital way of finding solutions to the difficult problems of sustainable development and environmental issues: “it is the duty of all peoples to implement policies to protect the environment in order to prevent the destruction of that natural capital whose fruits are necessary for the well-being of humanity. To meet this challenge, what is required is an interdisciplinary approach” (p. 97). He makes a strong case for the moral necessity of promoting social and environmental justice and adds, “In meeting the challenges of environmental protection and sustainable development, we are called to promote and safeguard the moral conditions for an authentic ‘human ecology’” (p. 98).

In a chapter titled “The Irresponsible Exploitation of the Environment Reflects an Inhumane Concept of Development,” he explains that such exploitation “or hoarding of land or marine resources ... affect[s] the poorest countries most” (p. 101). In subsequent chapters in Part 2, he further develops themes of the rights of the poor and future generations to “the fruits of earth,” and admonishes the developed nations to ensure that the less-developed societies are treated fairly, “Respecting the environment ... means not selfishly considering nature to be at the complete disposal of our own interests, for future generations

also have the right to reap its benefits and to exhibit toward nature the same responsible freedom that we claim for ourselves. Nor must we overlook the poor, who are excluded in many cases from the goods of creation" (p. 104). He is particularly concerned with energy issues, and warns "The problems looming on the horizon are complex and time is short" (p. 105). He makes an impassioned plea for cultural transformation: "Environmental degradation can only be slowed down by spreading an appropriate behavioral culture entailing more modest ways of living" (p. 110). He strongly supports a paradigm shift away from the "business as usual" model of growth. "We can no longer do without a real change of outlook which will result in new lifestyles. In fact we are all responsible for the protection and care of creation" (p. 117). He quotes St. Augustine, from *The City of God*, "Without justice—what else is the state but a great band of robbers" (p. 126).

Part 3 of the book, "Hunger, Poverty, and the Earth's Resources," continues to expand on the relationships between failure to consider the poor or the finite nature of natural resources by the industrial, developed world. He addresses international efforts to cooperate to foster sustainable development, and the need for a moral approach which combines environmental protection with a human ecology which considers the needs and rights of the poor to an equal share of Earth's resources.

In a chapter titled "Nourishing the World's Population with Respect for Biodiversity," Benedict points out that "famine is not entirely due to geographical and climatic situations or to the unfavorable circumstances linked to harvests. It is also caused by human beings themselves and by their selfishness, which is expressed by gaps in social organization, by rigidity in economic structures all too often oriented solely to profit" (p. 139); this is one of the consistent themes throughout the book. "In fact it is a question of adopting an inner attitude of responsibility, able to inspire a different lifestyle, with the necessary modest behavior and consumption, in order thereby to promote: the good of future generations in sustainable terms; the safeguard of the goods of creation; the distribution of resources" (p. 208).

He is aware of the limited, finite nature of natural resources, stating that "by their nature the goods of creation are limited: they therefore require responsible attitudes capable of encouraging the sought-after [food] security, thinking likewise of that of future generations" (p. 196). This is also an oft-repeated theme in the book—the obligation to consider the needs of the poor and of future generations.

Benedict also shows a consistent concern for the importance and protection of the rural family in agricultural development schemes; for example, "The *rural family* needs to regain its rightful place at the heart of the social order. The moral

principles and values which govern it belong to the heritage of humanity, and must take priority" (p. 143). He is also a strong proponent of the universal right to food, water, air, and work "for all human beings, without distinction or discrimination" (pp. 152, 179). The eradication of hunger is a moral imperative to him, and he asks the world community to "take into account the cycles and rhythm of nature known to the inhabitants of rural areas, thus protecting the traditional customs of the indigenous communities, leaving aside egotistical and exclusively economic motivations" (p. 152). He decries that "food itself has become an object of speculation or indeed is linked to the development of a financial market which, with no set rules and practically no moral principles, seems attached to the single goal of profit" (p. 202). To insure food security "means protecting natural resources from frenzied exploitation, since the consumer race and consequent waste appear to pay no attention at all" (p. 205).

He is concerned about the plight of climate change refugees: "climate change contributes to endangering the survival of millions of men, women, and children, forced to leave their country in search of food" (p. 157), and recognizes the complex relationship between poverty and globalization, stating that "when the demands of a true 'human ecology' are not respected, the cruel forces of poverty are unleashed" (p. 162). He warns that "immense military expenditure, involving material and human resources and arms, is in fact diverted from development projects for peoples, especially the poorest who are most in need of aid" (p. 165).

Benedict claims that the major reasons for the increased disparity between the global rich and poor are "on the one hand, advances in technology, which mainly benefit the more affluent, and on the other hand, changes in the prices of industrial products, which rise much faster than those of agricultural products and raw materials in the possession of poorer countries" (p. 166), which doubly impacts the poor. In the chapter "An Equitable Access to the Earth's Resources Should Be Guaranteed to Everyone," he expresses concern about the plight of agricultural workers dependent on international agricultural markets; "their labor is greedily exploited, and their produce is diverted to distant markets, with little or no resulting benefit for the local community itself ... A truly humane society will always know how to appreciate and reward appropriately the contribution made by the agricultural sector" (p. 176). He declares that local communities must always be involved in choices and decisions which affect the use of their lands.

He adamantly criticizes short-term, profit-only thinking, and outsourcing in the international business world, "*business management cannot concern itself only with the interests of the proprietors, but must also assume responsibility for all the other stakeholders who contribute to the life of the business: the workers, the clients, the suppliers of various elements of production, the community of reference*"

(p. 180, emphasis Benedict's). He would undoubtedly be a proponent of the "B" corporation, which requires corporate responsibility for *all* stakeholders. "What should be avoided is a speculative *use of financial resources* that yields to the temptation of seeking only short-term profit, without regard for the long-term sustainability" (p. 181). He calls for a "profound revision of the model of global economic development" (p. 198), and reminds us that his predecessor, John Paul II, taught that "*investment always has moral, as well as economic significance*" (p. 180, emphasis Benedict's).

So, is Pope Benedict, "The Green Pope," a human ecologist? Certainly so—although his interpretation is that of a sacred human ecology that puts humans squarely in charge of "God's Creation," as directed by God in giving humans stewardship responsibilities. His writings show a deep commitment to the principles of academic human ecology—tying together environmental protection, sustainable development, and social and environmental justice, all within an ethical framework grounded in Catholic and Christian doctrine and theology. I believe that the Catholic Church is and will continue to be an excellent ally in applied human ecology.

... respect human ecology, in the knowledge that natural ecology will likewise benefit, since the book of nature is one and indivisible. Prayer of Pope Benedict XVI (p. 61)

## References

- Berry, T. (2000). *The great work*. New York: Broadway Books.
- Daly, H. E., & Cobb, J. B. (1994). *For the common good*. Boston, MA: Beacon Press.
- Dyball, R., & Newell, B. (2015). *Understanding human ecology: A systems approach to sustainability*. New York: Routledge.
- Heschel, A. (1965). *Who is man?* Redwood City, CA: Stanford University Press.
- Lyons, O. (1994). An Iroquois perspective. In C. Vecsey & R. Venables (Eds.), *American Indian environments: Ecological issues in Native American history* (pp. 173–174). Syracuse, NY: Syracuse University Press.
- White, L., Jr. (1967). The historical roots of our ecological crisis. *Science*, 155(3767), 1203–1207.

## Contributors to This Issue

Gary B. Blank is an associate professor in the Department of Forestry and Environmental Resources, North Carolina State University. He teaches environmental impact assessment, natural resources management, and historical ecology while advising research in affiliated topics. He also directs the department's undergraduate programs and leads a study abroad course every summer.

Erik Bond is a PhD candidate in sociology at the University of Oklahoma. He received his master's degree in human ecology from the College of the Atlantic in 2012. His research focuses on the relationships between socioeconomic stratification and three major phenomena: attitudes toward environmental preservation, family-formation practices, and intergenerational transmission of human capital.

Karl Bruckmeier studied sociology, philosophy, and economics and received a PhD in sociology from the Free University of Berlin, Germany. He is a professor in the Department of Sociology, National Research University, Moscow. His research interests are environmental policy and natural resource use in agriculture and fisheries. He has taught environmental sociology and human ecology in several European countries.

Liesel Carlsson is a dietitian and lecturer in the School of Nutrition and Dietetics at Acadia University. She holds a Master of Science in Applied Human Nutrition and is a doctoral candidate in strategic sustainable development at Blekinge Tekniska Högskola. She is a member of Food Secure Canada and the Agriculture, Nutrition and Health Academy (LCIRAH). Her research and professional activities center on food security and sustainable food systems.

Daniel Casey is a post-bachelor fellow at the Institute for Health Metrics and Evaluation working on the Global Burden of Disease project's estimates for dietary risk factors. Beyond this work, his main research interest is the application of remotely sensed information to examine social and ecological disparities at local and global scales.

Jonathan Casper is an associate professor in the Department of Parks, Recreation and Tourism Management in the College of Natural Resources, North Carolina State University. He is internationally recognized as a leading researcher on sport and the natural environment. Specific to this project his expertise lies in leveraging large events as informal educational settings (or platforms) and influencing behavior change.

Majda Črnič Istenič holds a PhD in sociology and is a professor of rural sociology at the University of Ljubljana, Slovenia. Her research focuses on rural sociology, rural gender studies, and rural demography.

C. B. Christensen, BA (Hons), MA, and Dr. Phil., works in German philosophy of the late 19th and early 20th centuries, with emphasis on the phenomenology of Husserl and Heidegger; and in the philosophy of technology and sustainability. He has also worked in analytical philosophy, on the history of philosophy (Descartes, Kant, Hegel, and Marx) and on critical theory.

Antonio Cid has a degree in environmental science from Pablo de Olavide University, Seville, Spain, and a specialization in environmental engineering from the University of Concepción, Chile. He is currently a research fellow and doctoral student of environmental studies at Pablo de Olavide University.

Thomas Dietz holds a PhD in ecology from the University of California, Davis. He is currently a professor of environmental science and policy, sociology and animal studies at Michigan State University. He is past-president of the Society for Human Ecology and has won the Gerald R. Young Book Award. His research interests include structural human ecology and environmental decision-making.

Roberto García-Ruiz holds a PhD in ecology from the University of Málaga. He worked for several years at the University of Durham (UK), Imperial College of London (UK), and University of California, San Diego (US). He is a professor of ecology at the University of Jaén, Spain, where he specializes in the biogeochemistry of carbon, nitrogen, and phosphorus in natural and managed ecosystems, and agroecosystems from current and historical perspectives.

Manuel González de Molina holds a PhD in modern history from the University of Granada where he worked as a professor until he joined the University Pablo de Olavide, Seville, Spain, in 2001. He specializes in agrarian history, environmental history, and agroecology. He currently directs research projects studying the historical evolution of countryside using the methodologies of social metabolism.

Gloria Guzmán Casado is an agronomist with a PhD from the University of Córdoba. She has taught in courses, seminars, and postgraduate programs in several universities and was managing director of CIFAED in Granada (2002–2009). She now works as a researcher and associate professor at Pablo de Olavide University, Seville, Spain.

Luc Hens, emeritus professor, holds a PhD in biology from the Vrije Universiteit Brussel (VUB), Belgium. Until 2010 he was chair of the Human Ecology Department, VUB. His research interests concern the elucidation of interdisciplinary instruments for sustainable development. He gives expert

advice in environmental policy on several councils in Belgium and also lectures at universities in Bulgaria, Greece, and Portugal. He is the European editor for *International Journal of Environment, Development and Sustainability*.

Juan Infante Amate is an associate professor of contemporary history at Pablo de Olavide University, Seville, Spain, and member of Agroecosystems History Laboratory. His research interests are related to agriculture, ecology, and history. His PhD studied the environmental history of olive orchards in Andalusia.

Jennifer Rebecca Kelly holds a PhD in sociology and specializations in animal studies and environmental science and policy from Michigan State University, where she is currently an assistant professor of sociology. Her pedagogical work has been published in *International Journal for the Scholarship of Teaching and Learning* and in a book chapter from *Making Sense of Beliefs and Values: Understanding the Global Implications of Human Nature*.

Jessica E. Mayer is a senior market research analyst at Duke Energy Corporation. She earned a Master of Science in Natural Resources within the College of Natural Resources, North Carolina State University, in 2014.

Aaron M. McCright is an associate professor of sociology in Lyman Briggs College, the Department of Sociology, and the Environmental Science and Policy Program at Michigan State University (MSU). He was named a 2007 Kavli Frontiers Fellow in the National Academy of Sciences, served as a 2008–2009 Lilly Teaching Fellow at MSU, and received the 2009 Teacher-Scholar Award and the 2009 Curricular Service-Learning and Civic Engagement Award at MSU.

Mojca Nastran is a researcher and pursuing a doctoral degree in biosciences at the University of Ljubljana, Slovenia. Her research interests include stakeholder participation and management of protected areas, urban green infrastructure, and ecosystem services.

Salvatore Saporito is an associate professor of sociology at the College of William & Mary, Virginia, United States, and studies the causes and consequences of racial and economic segregation in urban settings. He is the founder of the School Attendance Boundary Information System (SABINS), a database of tabular and spatial data consisting of elementary, middle, and high school attendance zones across the United States.

Erin Seekamp is an associate professor in the Department of Parks, Recreation and Tourism Management in the College of Natural Resources, North Carolina State University. Her research focuses on conservation behaviors, partnerships, and community capacity within the human dimensions of natural resource

management and sustainable tourism fields. She has collaborated with Illinois-Indiana Sea Grant on numerous aquatic invasive species prevention projects within the Great Lakes region.

David Soto Fernández is an associate professor of contemporary history at Pablo de Olavide University, Seville, Spain. He holds a PhD in contemporary history from the University of Santiago de Compostela with a thesis read in 2003 entitled *Productive Transformations in Contemporary Galician Agriculture: Organic Agriculture to the Green Revolution (1752–1986)*.

Evert Van de Vliert is professor emeritus, Faculty of Behavioral and Social Sciences, University of Groningen, The Netherlands. He has published more than 200 articles, chapters, and books including *Climate, Affluence, and Culture* (Cambridge University Press, 2009). His current research concentrates on the interactive impacts of climatic cold and heat, wealth resources, and parasitic diseases on creativity, freedom, and other aspects of human culture.

Robin van Tine is a professor of biology and GreenFaith Fellow, teaching environmental studies, human ecology, evolution, global climate change, and energy courses at Saint Leo University, Florida, United States. He holds a PhD in marine ecology from the College of William & Mary. His research interests include systems ecology and modeling, ecopsychology, ecotheology, environmental economics, sustainability, environmental and social justice, environmental philosophy, environmental literature, environmental ethics, and comparative cultural cosmology.



---

# Human Ecology Review

---

## **ANU** PRESS

*Human Ecology Review* is published by ANU Press  
The Australian National University  
Acton ACT 2601, Australia  
Email: [anupress@anu.edu.au](mailto:anupress@anu.edu.au)  
This title is available online at [press.anu.edu.au](http://press.anu.edu.au)  
ISSN 1074-4827 (print)  
ISSN 2204-0919 (online)  
Printed by Griffin Press  
Cover design and layout by ANU Press.  
Cover image by Josh Winer, College of the Atlantic

### **Editor**

Robert Dyball  
Human Ecology Program  
Fenner School of Environment and Society  
The Australian National University

### **Founders**

Jonathan G. Taylor & Scott D. Wright

### **Philosophy Papers Editor**

Carleton B. Christensen  
School of Philosophy  
Research School of Social Sciences  
The Australian National University  
Contact: [humanecologyreviewjournal@gmail.com](mailto:humanecologyreviewjournal@gmail.com)  
Follow us @humanecology

### **Book Review Editor**

Thomas J. Burns  
Department of Sociology  
University of Oklahoma

### **Assistant Editors**

Rachael Wakefield-Rann  
University of Technology, Sydney  
Mihnea Tanasescu  
Free University of Brussels

### **Copy Editor**

Tracy Harwood

### **Editorial Board**

**Annie Booth** University of Northern British Columbia  
**Richard J. Borden** College of the Atlantic  
**Lee K. Cervený** USDA Forest Service  
**Debra Davidson** University of Alberta  
**Federico Dickinson** Cinvestav-Merida  
**Thomas Dietz** Michigan State University  
**Alan Ewert** Indiana University  
**Myron F. Floyd** North Carolina State University  
**R. Scott Frey** University of Tennessee  
**Pablo García-Serrano** Universidad Autónoma de Madrid  
**Bernhard Glaeser** German Society for Human Ecology (DGH)

**Catherine Gross** The Australian National University  
**Luc Hens** Flemish Institute for Technological Research (VITO)  
**Cassandra Johnson Gaither** USDA Forest Service  
**Andrew Jorgenson** Boston College  
**Ardehsir Mahdavi** Vienna University of Technology  
**Angela Mertig** Middle Tennessee State University  
**Liam Phelan** University of Newcastle  
**Joanne Vining** University of Illinois, Urbana  
**Michael Welsh** Keene State College  
**Richard York** University of Oregon

*Human Ecology Review* is the official journal of the Society for Human Ecology and is published in open access online format by ANU Press ([press.anu.edu.au](http://press.anu.edu.au)). It is also available to member and institutional subscribers in hard copy format. *Human Ecology Review* is indexed or abstracted in *Environment Abstracts*, *Environment Index*, *Environmental Periodicals Bibliography*, *Linguistics and Language Behavior Abstracts*, and *Sociological Abstracts*. Archived back issues are available from the Society for Human Ecology website, [societyforhumanecology.org](http://societyforhumanecology.org), and via ProQuest.

Send submissions in electronic format to <http://mstracker.com/submit1.php?jc=her>.

Please see instructions to authors on inside back cover.

© Society for Human Ecology

## Information for contributors to *Human Ecology Review*

*Human Ecology Review* is a semi-annual journal that publishes peer-reviewed interdisciplinary research on all aspects of human–environment interactions (Research in Human Ecology). The journal also publishes essays, discussion papers, dialogue, and commentary on special topics relevant to human ecology (Human Ecology Forum), book reviews (Contemporary Human Ecology), and letters, announcements, and other items of interest (Human Ecology Bulletin). *Human Ecology Review* also publishes an occasional paper series in the Philosophy of Human Ecology and Social–Environmental Sustainability.

### Author instructions

Send submissions, following the guidelines below, to [mstracker.com/submit1.php?jc=her](http://mstracker.com/submit1.php?jc=her)

### Title page, abstract and authorship

When you access the *Human Ecology Review* manuscript submission portal at [mstracker.com/submit1.php?jc=her](http://mstracker.com/submit1.php?jc=her) you will be presented with a manuscript submission form. You will be instructed to enter the title of your manuscript, an abstract, and your and any co-authors names and contact details. The abstract should be 150 words or fewer and include four to six keywords. The abstract information will be used when soliciting for reviewers and should not contain any author identification.

### Reviewers

Please use the manuscript submission form's cover letter section to provide the names and contact information of three suggested reviewers for your manuscript.

### Manuscript

The manuscript should not exceed 6,500 words.

Do not include author information. Please limit references to 50 or fewer.

The manuscript should be in the form of a single Word document file that includes tables and figures rather than sending multiple files. It should be in 12 point font, line spacing 1.5. The entire manuscript should be free of underlining or boldface type; use italics only for emphasis and in references (see below). Headings and subheadings should be flush left, sentence capitalization.

Style followed is that of the *Publication Manual of the American Psychological Association* (APA style; [www.apastyle.org](http://www.apastyle.org)). The dictionary used is Merriam-Webster.

### Footnotes

Footnotes, not endnotes, should be used.

### Tables and figures

Tables should be clear and concise and able to stand alone, that is, complete headings and table notes should be used to clarify entries. Figures may be in color, but authors should be mindful of loss of resolution or clarity if figures are printed in black and white. All tables and figures must be referred to in the text. Authors must obtain copyright permission to reproduce any material that is not their own.

Although figures should be embedded in the original submitted paper, if your manuscript is accepted you will be required to provide professional quality, high resolution (at least 300 dpi) images in separate files.

### References

References should conform to APA style. See below; also see [www.apastyle.org](http://www.apastyle.org)

The list of references should be arranged alphabetically by author. Multiple citations by the same author(s) should be listed by name.

Citation of references in the text should follow the format Henry (1998) or (Henry & Wright, 1997) or (Henry et al., 1996, pp. 22–24) or (Henry, 1995, 1998; Wright, 1994). In-text citations should be in alphabetical order, in the same order in which they appear in the reference list. Papers with three or more authors should use et al. This is an exception to APA style.

### Sample references

Altman, I., & Low, S. (Eds.). (1992). *Place attachment*. New York: Plenum.

Cohen, J. (1995). *How many people can the Earth support?* New York: W. W. North.

Schoenfeld, A. C., Meier, R., & Griffin, R. J. (1979). Constructing a social problem: The press and the environment. *Social Problems*, 27, 38–61.

Varner, G. (1995). Can animal rights activists be environmentalists? In C. Pierce & D. VanDeVeer (Eds.), *People, penguins, and plastic trees* (2nd ed., pp. 254–273). Belmont, CA: Wadsworth.