Revisiting the Environmental Kuznets Curve: An introduction to the special issue

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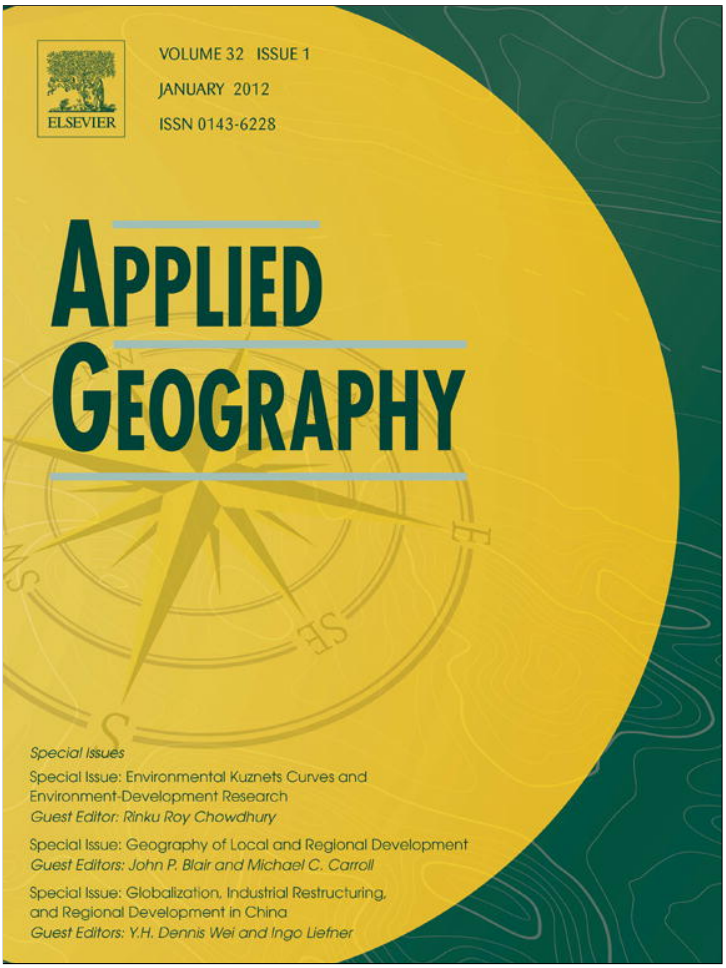

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Anthropogenic environmental change and the future of development are two of the greatest challenges facing human society today. The United Nations Millennium development goals center on multiple dimensions of social and economic development on the one hand, and environmental sustainability on the other (UN 2010). Public and scientific attention to international environmental and climate change issues has risen at unprecedented rates in recent years. Yet, little consensus exists on how to meet key global environmental challenges, and specifically, on the role of development in driving or ameliorating environmental degradation (WCED, 1987). The fundamental differences in the priorities and roles of developed and developing countries vis-à-vis the Kyoto Protocol and related Conference of Parties summits exemplify conflicting conceptualizations of the development–environment relationship.

Key to geographic theory and applications, the drivers and impacts of environmental changes vary dramatically from place to place. Yet, over the past three decades, the Environmental Kuznets Curve (EKC) has been posited by diverse disciplinary and interdisciplinary approaches as a general explanation of the relationship between economic development (specifically, per capita incomes associated with development) on the one hand, and environmental outcomes on the other. The EKC encapsulates historical trends at the national scale (initially observed for some developed nations) wherein environmental degradation first increases with rising incomes or development up to a certain point, then declines with further income/development gains, thus approximating an inverted-U shaped curve. EKC explanations center on an income effect (cleaner or better preserved environments become affordable) or a policy effect (environmental protection is instituted as degradation intensifies), and have been explored in multiple applications, particularly in national and cross-national analyses. Yet, numerous problems beset such explanations, not the least of which center on the methodological challenge of adequately modeling complex, multi-scalar environment-development relationships. Five papers in this issue of Applied Geography engage critically and anew with the potential heuristic and explanatory value of Kuznets approaches to examining environmental change at national, sub-national/regional and local scales. These papers were initially developed for a special session of the 2009 Open Meeting of the International Human Dimensions Programme held in Bonn, Germany.

The first paper by Roy Chowdhury and Moran undertakes a broad review of Kuznets approaches, placing them in historical context, and tracing them to a particular theoretical application in Geography and cognate disciplines, the Forest Transition Theory, an explanation of forest decline and recovery across regions. Roy Chowdhury and Moran identify five main challenges to EKC explanations: choice of indicators of environmental degradation, the modes of estimation of the Kuznets curve function, limitations of observations and the developmental range/temporal scale, the substitution of cross-sectional studies for time-series analysis, and inadequate attention to causal explanations. They draw from in-depth case studies of forest transitions in southern Mexico and the Brazilian Amazon to illustrate the potential and limitations of EKC-based frameworks in explaining forest change in those regional contexts. The second paper by Walker deepens our understanding of the Forest Transition Theory by considering multi-local and multi-sectoral economies in a spatialized general equilibrium model of land use. Walker's approach elegantly illustrates the driving roles of comparative advantage in regional agriculture/economy while evaluating the explanatory power of von Thünen approaches in modeling forest transitions. It further illustrates a fundamental scalar dynamic and a divergence between aggregate forest transitions where the entire area of a region increases with trade vs. regional/local forest transitions wherein forest recovery in one location is spatially dependent upon degradation or loss elsewhere. The displacement of such developmental externalities to distant landscapes is traced with reference to Brazil, where forest recovery in the Atlantic Rainforest occurs simultaneously with forest losses in Amazonia.

The next two papers by Dietz and colleagues and Franklin and Ruth evaluate the EKC hypothesis for cross-national and US datasets, respectively. Rather than using traditional measures of environmental degradation, Dietz et al. develop an index of the relative efficiency with which a nation produces human well-being compared to the stress it places on the environment, in the "Ecological Intensity of Well-Being" (EIWB). A panel analysis of 58 countries over the years 1961–2003 reveals that the EIWB follows the opposite of a Kuznets predicted relationship with per capita GDP: increases in affluence up to $2558 dollars per capita tended to reduce the ecological stresses of producing well-being, following which EIWB increased. Furthermore, time-series regressions of individual countries indicate only 50% of nations followed the inverted-U relationship while the others followed the opposite pattern. The paper highlights key differences among nations not in terms of their linked development-environment trajectories, but in the *relative efficiency* with which they negotiate shifts in those trajectories over time, and indicate the need for further studies of such higher-order relations.

The paper by Franklin and Ruth addresses an important gap in the EKC literature, a relative lack of attention to nations' demographic transitions as influencing their environmental transitions.

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They analyze the role of US national demographic and economic structure and how they mediate the long-term relationship between national income and CO_2 emissions. Their findings vary by time period; over the past 200 years, CO_2 emissions initially follow an inverted-U as predicted by the EKC, but display a rebound effect with continued economic growth. Per capita CO_2 emissions followed an EKC inverted-U over shorter time frames, but were correlated negatively to elderly dependency ratios and positively to youth dependency ratios. By decomposing demographic structure in their analyses, their results may indicate possible causal pathways influencing CO_2 trajectories in aging nations, as material and energy intensive lifestyles of younger populations are succeeded by an increased demand for services that may have lower carbon footprints. They further find higher emissions to be characteristic of a more unequal society (as measured by the Gini coefficient), lower composite fuel prices, and employment share of goods producing sectors.

The final paper in the set, authored by Guneralp and Seto, directs attention to the efficiency vs. magnitude of environmental impacts in the context of urban development. Akin to the first two papers in this set, they too focus their attention on a sub-national scale, examining whether land, material and energy use efficiencies associated with urbanization in China's Pearl River Delta increase over time, and whether any efficiency gains (in terms of CO_2 emissions) are then offset by expansion of urbanization. Their results combine satellite image analysis with elements of a materials flow analysis, and find that while efficiency gains over 1988–2008 reduced unit floor areal demands for materials and energy, these gains were outpaced by the scale and magnitude of urban development. Akin to the other papers, Guneralp and Seto emphasize the need to reconcile multiple scales of analysis in Kuznets approaches, from materials and energy demands at the building scale, to areal estimates of urban built environments at the scale of neighborhoods and metropolitan regions or beyond. Such approaches are necessary in assessing local-regional trajectories of development footprints and their associated emissions scenarios, which are critical to estimate accurately for national economies, such as those of China or India, that are witnessing explosive urban-economic growth as well as massive environmental degradation.

Despite broad empirical evidence, numerous challenges to the EKC hypothesis have come to suggest limits to its applicability as a general theory of environment–development relations. Each of the papers in this collection reflects on the difficulties of assembling adequate cross-sectional and panel data, the challenges of statistical-econometric estimation of the EKC models, and ultimately, the difficulties of interpreting and most significantly, explaining observed environmental trajectories over multiple spatiotemporal scales. Taken together, the contributions that these papers make show that as diverse nations and places progress across various developmental trajectories and rising per capita incomes, relative shifts in their environmental outcomes may remain remarkably difficult to predict, challenging theories that posit either positive or negative environmental impacts of specific indicators of economic development. Each of the papers herein emphasizes identifying the appropriate scale(s) of analysis as a key component of understanding development-environment dynamics. Improving environmental outcomes is a multi-scale challenge because the processes that generate environmental degradation originate in multiple locations, and at multiple scales ranging from the local to the global. Their collective contribution thus indicates the locally specific contexts and pathways in which development and environmental trajectories intersect, thus highlighting avenues for identifying the potential for sustainability transitions at various scales.

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