

Part of the expansion, as well as its enabler, will be an infrastructure boom—roads, water and sanitary plants, energy and transportation systems—that could cost up to \$30 billion by 2030. “Development often follows roads and the availability of resources” such as energy and water, says Hutyra. “We will be locked in to many of our infrastructure and energy choices for these new cities for many years to come.”

“Although urban land cover is a small fraction of the total Earth surface, urban areas drive global environmental change,” the authors write in their paper, published in September 2012 in the online *Proceedings of the National Academy of Sciences*. “Land-cover change could lead to the loss of up to 4 percent of the species in some of the most biologically diverse areas around the world.”

To spare the environment, Hutyra says, cities of the future should avoid urban sprawl and use environmentally friendly energy sources. “Unfortunately, there is no universal best formula for development,” she says. “Local availability, climate, ecology, and social preferences need to be considered for sustainable urban planning.”

The researchers, who looked at the history of urban growth and at population and gross domestic product forecasts by the United Nations and its Intergovernmental Panel on Climate Change, acknowledge the clouds in their crystal ball: “History has proven some past projections of population growth”—a key engine of urbanization—“to be grossly inaccurate, and there still remain large uncertainties around population-growth estimates.”

Hutyra cites the 1968 best seller *The Population Bomb*, in which Stanford biologist Paul Ehrlich cautioned, in a way reminiscent of Chicken Little, that the 1970s would see mass starvation, rampant disease, and social turmoil from overpopulation. “Thankfully,” she says, “many of the predictions did not come to pass. Population growth rates and dynamics are notoriously difficult to predict as a whole, much less in a spatially specific manner,” as in her study.

The researchers note that their findings exclude another, potentially significant engine of Africa’s urbanization—the continent’s hard-to-measure black-market economy. They also didn’t study urbanization’s potential indirect hits to the environment. For example, city dwellers eat more meat than rural residents, and meat production requires vast energy production.

Hutyra’s bottom line: the future health of the planet is up to us.

“Our choices in where and how we develop our future cities will determine the environmental impacts,” she says. “We certainly have opportunities to change the future.”

The Natural Design Default

WHY EVEN THE BEST-TRAINED SCIENTISTS SHOULD THINK TWICE

BY ART JAHNKE

Scientists pride themselves on the diamond-hard discipline of the objective observer, yet a recent study suggests that despite years of training, some of the most highly regarded researchers in the country can’t escape a deep-seated belief that natural phenomena exist for a purpose.

Deborah Kelemen, a College of Arts & Sciences associate professor of psychology, and coauthors Joshua Rottman (GRS’14) and Rebecca Seston, a CAS psychology lab manager, asked 80 scientists at research universities such as Harvard, Yale, and MIT to judge the truthfulness of statements about why natural events and objects occur. Two groups of scientists, one working under time pressure and one with no time restriction, were asked about the accuracy of assertions such as, “Trees produce oxygen so that animals can breathe” and “The Earth has an ozone layer to protect it from UV light.”

Two control groups, one made up of undergraduates and one of people with bachelor’s degrees and the same age as the scientists, were given the same test. The test consisted of 100 one-sentence explanations for “why things happen”; 30 of them were test sentences and 70 were control sentences, describing relationships, such as, “Conception occurs because sperm and eggs fuse together” or “Children wear mittens in the winter to keep their hands warm.” Using a laptop



The Earth has an ozone layer to protect it from UV light.

Germes mutate in order to become drug-resistant.

Trees produce oxygen so that animals can breathe.

Conception occurs because sperm and eggs fuse together.

The sun radiates heat because warmth nurtures life.

DEBORAH KELEMEN says advanced scientific training can't erase a tenacious human tendency to find purpose in nature.

Children wear mittens in the winter to keep their hands warm.

computer, some participants were given a response time of 3.2 seconds, and others had no time restriction.

The researchers discovered, unsurprisingly, that the trained veteran scientists were less likely than the control groups to find reasons in relationships where there were none. But they also found that under pressure from the clock, the scientists became increasingly likely to say that natural relationships exist to serve a purpose.

"It was quite surprising," says Kelemen, the lead author of the study, which was published in the October 2012 issue of the *Journal of Experimental Psychology*. "Even though advanced scientific training can reduce acceptance of scientifically inaccurate teleological explanations, it cannot erase a tenacious early-emerging human tendency to find purpose in nature. It seems that our minds may be naturally more geared to religion than science."

Kelemen, whose research was funded by the Cognition, Religion and Theology Project at Oxford University and the National Science Foundation, learned in earlier research that our "strong gut orientation to view natural objects and events as occurring for a purpose" emerges early in development and becomes so entrenched that

years of specialist education and expertise can't erase it. That is not to say, she asserts, that the tendency is innate or hardwired.

"We are not born with those ideas intact," she says. "Humans do have strong predispositions to construct beliefs about purpose and function in nature, but it's physical, social, and cultural environments that bring them out."

What those environments are exactly, and how potent they are, is the focus of Kelemen's current studies.

The research is helpful, Kelemen says, because "it tells us what we are up against when tackling the complexities of science education and how careful our language needs to be when trying to offer scientific explanations or foster scientific thought....It also sends out an alert to members of the scientific community. It's telling scientists that they are not as scientifically objective as they may think. Unconscious biases with deep developmental roots are affecting such things as our communications.

"On the positive side," she says, "it shows that those biases can be curbed if we compensate for them by thinking twice. But thinking twice is key." ■