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## The Social Challenges of Global Change

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Time: Monday 27 April, 16:00 - 17:30. Session: A170

### Dynamics of Urbanization

Location: World Conference Center Bonn, Room A

Convenor: Henk Hilderink, Netherlands Environmental Assessment Agency

Urbanization is a phenomenon that can be observed worldwide. More than half of the world's population lives now in urban areas which are expected to increase further to 60% in 2030. This growth has major implications for, for example, land use patterns, energy and water consumption, but also socio-economic aspects as household composition and (income) inequalities. Characteristics of this urbanization process vary among regions and also the driving forces and the consequences differ. Understanding these factors of influence on urbanization dynamics can therefore help to better assess future trends of a/o energy use and land use, but also to support policy makers to counter unsustainable developments. In this session various aspects of these urbanization dynamics will be covered. Different modelling approaches at both the local, more detailed level of Hyderabad and Sao Paulo, as well as the global level of the 27 major world regions, will be presented. Applying agent-based modelling, systems dynamics and GIS these presentations provide insights into the state-of-the-art of urbanization modelling. In addition, the impact of urbanization on environmental aspects as environmental degradation, household energy use, waste, water consumption and greenhouse gas emissions will be addressed in several presentations.

### Modelling The Urbanization Of An Indian City Due To Globalization

Presenter: Gowtham Gollapalli, International Institute of Information Technology, Hyderabad, India

Authors: Gowtham Gollapalli (1), Rajan Krishnan Sundara (1)

*International Institute of Information Technology, Hyderabad, Andhra Pradesh, India (1)*

Due to globalization of economy Indian cities like Hyderabad, which have a concentration of the services sector, are growing at a very rapid rate-population increased by about 30% from 2001-07. In addition, the municipal area of the city was merged with the neighbouring suburban areas, leading to the GHMC covering 1864sqkm in place of 217sqkm of MCH. This change in economy and population will create demand for resources like land and water. Provision of urban infrastructure and services to the region will need a proper assessment of the current state and future demand.

In this paper, the authors propose a set of scenarios of this urbanization of Greater Hyderabad region up to 2025. The agent based land use model (AGENT LUC model) is used here to capture this urban process and simulate the changes in the urban land use patterns. Factors like infrastructure (roads, MRTS), economic changes, people's behaviour etc have been considered in designing the model. The agents in this model are the decision makers who cause the expansion of the city by migrating into or within the city. The temporal outcome of this research provides policy makers with scenarios that can be employed in effective planning of infrastructure. These outcomes will also be useful to understand the urban dynamics of modern Indian cities because of the prevailing economic globalization. GEC studies can benefit from such studies by integrating the model outputs with regional/meso-scale climate models for understanding the system dynamics in the region.

## Urban Sprawl, Land Markets and Environmental Degradation in São Paulo, Brazil

Presenter: Humberto Alves, Brazilian National Institute for Spatial Research (INPE), Brazil

Authors: Humberto Alves (1), Antônio Miguel Monteiro (1), Cláudia Gonçalves (1), John Sydenstricker-Neto (2), Haroldo Torres (2), Maria Aparecida Oliveira (3)

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While the central parts of São Paulo's Metropolitan Area are significantly losing population, the peri-urban areas are growing very fast. As a result, the region still demands strong public investments in terms of transportation and other urban infrastructure, followed by considerable environmental impacts.

The objective of this paper is to first understand why this intra-urban dynamic is happening by comparing spatial patterns of population growth and real estate investments. Secondly, we intend to explore some of the environmental consequences of this pattern of urban sprawl, including: 1) The occupation of parks and environmentally protected areas; 2) The degradation and pollution of water sources as a result of lack of sanitation in most of peri-urban areas - a product of both low infra-structure investments and misguided environmental legislation; 3) The occupation of environmental risk areas such as steep slopes and areas alongside watercourses, in which population is directly exposed to risks.

Most of these analyses will benefit from a GIS database, where census data (1991, 2000), satellite images and real estate data are all available in GIS format.

The results show that the demographic growth of the city is very uneven. While the centre of the city is losing population, its farthest suburbs are growing fast. Associated to this observation, we have also noted that those areas are the poorest and with less infrastructure of the region within the Metro Area and that they present high levels of deforestation and informality in terms of land use.

## The Impacts of Demographic Changes on Environmental Load Generation

Presenter: Yuko Kanamori, National Institute for Environmental Studies, Japan

Authors: Yuko KANAMORI (1), Takahisa YAMASHITA (2), Yuzuru MATSUOKA (3)

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It is important to consider impacts on environmental loads caused by lifestyle change. One of important factors influenced on lifestyle change is a composition of population and household.

In this study, we analyzed the effect of household attributes (household type, a number of family per household, and household income) and individual attributes (sex, age) on the environmental load generation using the family income and expenditure survey. Based on this analysis, the Population and household dynamic model and the environmental load generation Bottom-up model reflecting the household attributes and the individual attributes were developed. Using these models, the environmental load generation in Japan from 2000 to 2050 was estimated by 3 scenarios which have different compositions of population and household. Environmental load is classified into 3 categories; household garbage (11types), energy consumption (6 types), and water consumption. We obtained the following results. 1) The past energy consumption increases are strongly affected by the age composition change (increase factor). 2) The future energy consumption increases are affected by the population change (decrease factor), the age composition change (increase factor). 3) The past household waste generation increases are strongly affected by the population change (increase factor), the age composition change (increase factor), and the household composition change (increase factor). 4) The future household waste generation decreases are affected by the population change (decrease factor), the age composition change (decrease factor), and the household composition change (increase factor).

## Urbanization and household energy choices in developing countries

Presenter: Shonali Pachauri, International Institute for Applied Systems Analysis, Austria

Authors: Shonali Pachauri (1), Leiwen Jiang (2), Brian O' Neill (1), Katherina Zigova (1), Regina Fuchs (1)

*IIASA, Laxenburg, Austria (1), Brown University, Rhode Island, United States (2)*

Urbanization is a significant trend in rapidly growing developing countries. The importance of this trend and of the size of urban agglomerations for the types and amounts of energy consumed in households is well recognized. However, the complexity and diversity in energy transition pathways and the implications of this for human well being are less well researched. We make use of micro datasets from national household surveys for large developing countries like India and China to analyze the effects of the pace and nature of urbanization on the household energy transition. The implications of city size on the access to modern energy services and pace of household energy transition are explored. Key differences and similarities across countries are assessed. The implications of alternate urbanization scenarios for the household energy transition and human well being are also investigated. Results suggest household energy access to modern energy services is significantly correlated with city size. Both the share and quantities of modern energy use are higher in households of larger metropolitan cities. Larger urban areas imply higher energy demand. Their higher population densities and space limitations in fuel storage necessitate and also

make easier the delivery of higher-density fuels and electricity. The shift in use from self-collected lower density solid fuels like biomass and coal to higher density mass-supplied liquids and grids to meet household energy needs has significant implications for human well being. The magnitude of these changes varies by the relative pace and nature of urbanization across countries.

## The missing link: Modeling causes, effects and outcomes of urbanization dynamics

Presenter: Henk Hilderink, Netherlands Environmental Assessment Agency, Netherlands

Authors: Henk Hilderink (1), Johan Meijer (1), Paul Lucas (1)

*Netherlands Environmental Assessment Agency, Bilthoven, Netherlands (1)*

Urbanization is being recognized as one of the major facets of understanding development issues. Many socio-economic and environmental aspects have an apparent variation among urban and rural populations. However, these aspects have not been incorporated yet in a modeling framework to capture the broad spectrum of urbanization dynamics and explore future trends in urbanization. The UN's World Urbanization Prospects are one of the few available projections of global urbanization trends, though this methodology does not seize the underlying mechanisms of urbanization since only the growth of urban population is taken into account. Expanding the standard demographic cohort-component model in the Population & Health Model PHOENIX with the urban-rural dimension enables to describe the full demographic behavior of both urban and rural populations. The three pillars of demographic change, fertility, mortality and migration, have been specified for the urban dimension, and related to income levels and distribution, educational attainment and various health risks. In addition, the rural-to-urban migration flows had to be included. Historical data and changes in urbanization could be reproduced which provide a good basis for future long-term projections. These show that the process of aging takes place, both in rural and urban populations, though with a distinct difference in timing and magnitude. Other results show a convergence in health outcomes though some rigid health risks will remain. The possible consequences of the annual increase of urban populations with around 25 million persons are concerns that have to be dealt with.

## The Influence of Future Demographic Change on Global Greenhouse Gas Emissions

Presenter: Shonali Pachauri, Leiwen Jiang, National Center for Atmospheric Research, United States

Authors: Brian O'Neill (1), Michael Dalton (2), Regina Fuchs (3), Leiwen Jiang (4), Shonali Pachauri (3), Katja Zigova (3)

*NCAR, Colorado, United States (1), NOAA, Seattle, United States (2), IIASA, Laxenburg, Austria (3), Brown University, Providence, United States (4)*

Significant demographic change is anticipated over the coming decades in many parts of the world, including substantial growth in some regions, shrinking populations in others, aging, urbanization, and changes in other household characteristics such as size and composition. These changes can affect emissions of greenhouse gases either through their effect on economic growth and the scale of the economy, or by affecting the mix of consumption goods over time. We use a multi-region, multi-sector general equilibrium model of the global economy to develop

a set of scenarios that quantify the potential effects of demographic change on greenhouse gas emissions over the next 50-100 years. The scenarios are driven by a newly developed set of joint population-household-urbanization projections for multiple world regions. The economic model is calibrated with production data from national sources as well as from data from the Global Trade Analysis Project (GTAP), and with household consumption and income data from national surveys. Results show that accounting for demographic change can substantially affect projected greenhouse gas emissions, relative to scenarios that do not account for such change, with the sign and magnitude of these effects depending on the region and the relative importance of different demographic changes such as aging (which tends to reduce emissions) or urbanization (which tends to increase them). We also investigate the effect of a low population growth scenario that could be achievable at least in part through population-related policies, relative to a medium or higher growth scenario.

## Climate Change and Metrics of Environmental Sustainability, Social Equity and Economic Efficiency

Presenter: Hitomi Nakanishi, CSIRO, Australia

Authors: Author: John Black (1), Ken Doust (2)

*University of Sydney, Sydney, NSW, Australia (1), Atkins Global, Australia (2)*

Institutional drivers of the Australian Capital Territory's Government responses to climate change in Canberra's urban area (Weathering the Change), and the role of different actors and institutions are described, especially the Sustainable Communities Program, initiated in September, 2008. Its aim is "to put into effect a planning policy framework for more sustainable living that draws on the inherent qualities of Canberra and builds a greater sense of place, spirituality and responsibility". A critical objective of this 3-year program is cooperation and collaboration between actors to effectively establish better measures, solutions, and responses to climate change.

Here, the scope is limited primarily to our research on creating new indicators, especially in the area of the built form, transport and greenhouse gas emissions that respond to community concerns. A holistic assessment framework is presented for urban development and transport with innovative triple bottom line sustainability metrics that include greenhouse gas emissions from transport construction and operation, and residents' accessibility to employment and employers access to labour. This is combined with risk assessment. A rail case study of agency level impacts and sustainability (economic, equity and environmental) on local government assets, and power supply, are analysed. Economic aspects take into account the business risk to the agency due to such factors as infrastructure failure risk, revenue risk, political risks, maintainability risks, life cycle costs, insurance risk for assets damage and secondary damage to other assets. Social equity includes pricing due to changes in say longer distance commutes compared with shorter distance commutes.