Sustainable Climate Change Adaptation and Mitigation Options in the Future Megacity of Hyderabad/India: Scenario Development and Leverage Points on Influence Networks

Dr. Diana Reckien, Dr. Matthias K. B. Lüdeke, Dr. habil. Fritz Reusswig, Oleksandr Kit, Sonja Hofmann, Lutz Meyer-Ohlendorf, Ulrike Anders, Martin Budde, Antje Otto
Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

In this paper we highlight our ongoing work on adaptation to and mitigation of climate change within the BMBF-funded research network "Climate and Energy in a Complex Transition Process towards Sustainable Hyderabad – Mitigation and Adaptation Strategies by Changing Institutions, Governance Structures, Lifestyles and Consumption Patterns". Starting a complex transition towards more climate friendly and climate resilient city structures in a developing country's future megacity involves an assessment of the potential future climate in Hyderabad, the impacts of climatic changes on various subsystems, and an understanding of the emission pathways. It needs an integration of impact assessment, adaptation options and mitigation efforts on various levels (households, lifestyles, policy levels) to hinder maladaptations and find trade-offs between actions.

Our assessment of Hyderabad's future climate statistically analyses the currently available, but rather coarse AOGCMs outputs (IPCC, AR4:

exemplary A2 and B1 global CO_2-emission scenario) for the central south Indian region and combines them in a statistical downscaling process to receive a finer resolution of projections specified on the urban region of Hyderabad. Climate projections depend themselves on global development scenarios, e. g. social, technological, population and economic development, on the convergence between developing and developed countries, consumption choices, etc. Our analysis shows that a massive reduction of the global CO_2 emissions (B1 instead of A2) will certainly "buy" some time for Hyderabad to adapt to more intensive rainfalls (in the second instead of the first half of the 21st century) but will not spare the city to prepare for about a doubling of strong rain events. This is even worsened by the result that the subset of extreme events greater than 160 mm/day (like, e. g. in August 2000) will increase over-proportionally. For the total annual precipitation in the region around Hyderabad we have to expect changes between -4 % to +17 %, but the influence of the differences in the AOGCMs is currently still larger than the influence of the global emission scenarios. Regarding heat waves, the average number of days per year with night temperatures above 27 °C will approximately triple until 2050 relatively independent from the emission scenario but in 2100 A2-emissions will lead to an increase of almost 560 % (±50) of the current number while under B1-emissions we expect only 240 % (±50). The frequency of heat waves longer than one week will double to triple until 2050 and increase further until 2100. The mean annual temperature will develop monotonously in time and with a stronger trend in the high emission scenario up to +5 °C, which would definitely alter the natural water balance towards increased dryness, even under a (very uncertain) increase in total rainfall. Here a global emission reduction along the B1 scenario would ease impacts and the adaptation pressure.

The impacts of climate change on Hyderabad are serious. Extreme flood and drought events severely reduce the availability of quality water to the population, agriculture and industry by either contaminating existing water resources or generating severe surface and ground water scarcity. Depleting local groundwater resources may push the dependence of Hyderabad on external sources of water to rather unsustainable levels. Climate extremes adversely impact transport and communication

Old town of Hyderabad - Street view

infrastructure making them inaccessible, dysfunctional and damaged, unreliable or uncomfortable to use (Shukla et al., 2003). Impacts of climate change on the health risk can be the direct exposure to heat with the increased occurrence of heat waves and exposure to flooding with a potential increase in serious precipitation events. Flooding can also lead to contamination of freshwater with bacteria, chemicals or other hazardous substances (Young et al., 2004) and its consumption can result in diarrheal diseases, cholera and intoxication. The situation is particularly severe in areas of Hyderabad where sewage flows in open ditches close to water distribution pipes and where people live in industrial areas close to factories. Climate-sensitive diseases like Malaria, Dengue and Chikungunya might increase due to favourable climatic conditions of temperature, humidity and breeding places of water. In particular, Dengue cases have reached alarming levels in Hyderabad; while the trend of Dengue is going down in the state as a whole, it is going up in the city.

Although Hyderabad's contribution to global CO_2 emissions is small, these large impacts of climate change on the region put investments in mitigation options into another perspective. Hyderabad has to prepare for climate change without putting further stress on the atmospheric CO_2 content, and can thereby act as a role model for other cities in developing countries. For a more detailed view on the influences of climate on urban subsystems (climate impacts) and CO_2 emission sources in Hyderabad, we developed influence networks for three issue areas: transport and other infrastructures, water provision, food security and health (Reckien et al. 2009). Among others (see further down), they are used to educate and build capacities and as communication tool with stakeholders (Reusswig et al. 2009a).

Understanding urban processes is only part of achieving strategic goals, like climate change mitigation and sustainable adaptation options. Any strategic action involves target setting. To do so, we focus on a stakeholder-oriented scenario process that tries to map two contrasting scenarios for the future development of the greater Hyderabad municipality and functionally related adjacent regions: (1) A so-called 'worst case scenario', including ongoing nonmitigated global climate change with medium to severe negative local impacts and a couple of partly dependent, partly independent trajectories of relevant parts of the urban system (local economic growth, environmental goods and services, equity, governance, civil society). (2) A so-called 'sustainability scenario', including an ongoing, but slightly dampened global climate change, and with qualitatively different pathways of the urban systems parameters mentioned (Reusswig et al. 2009b). Such a scenario process involves the local actors, policy makers and lay people, to discuss and influence their future.

Finding targets and overcoming involved conflicts are challenging tasks. A well-planned stakeholder participation process is therefore vital for its success; it fosters discussions, helps to disseminate knowledge and builds capacities. Our influence networks can help to visualise the interrelated problems, supports in target setting and helps prioritizing adaptation and mitigation options. Influence networks are therefore a support tool for policy and plan making too. Putting leverage points, e. g. measures of adaptation

and mitigation on different influence levels makes consequences and ranges of influence clearer. The effectiveness and efficiency of measures can be discussed; regional, local or state-wide policy options can be reasoned, e. g. against the National Climate Action Plan, or the plan's appropriateness can be assessed against the city's particular background.

Future work involves the development of a quantitative urban assessment tool for Hyderabad (CATHY– Climate Assessment Tool for Hyderabad) supporting decision-making in terms of its spatial resolution and particular social targets (e. g. slum population). Moreover, we plan to conduct so-called socio-technical experiments in representative target households to evaluate options and conditions of change from a higher to a lower carbon-intensive pathway.

References

Lüdeke, M.K.B.; Budde, M. (2009): Evaluating climate change scenarios - From AOGCMs to Hyderabad. Project Report Nr. 1/2009, Sustainable Hyderabad Project.

Reckien, D.; Hofmann, S.; Kit., O. (2009): Qualitative climate change impact networks for Hyderabad. Project Report Supplement WP1/2009, Sustainable Hyderabad Project.

Reusswig, F.; Meyer-Ohlendorf, L.; Anders, U. (2009a): Partners for a low-carbon Hyderabad – a stakeholder analysis. Project Report Nr. 2/2009, Sustainable Hyderabad Project.

Reusswig, F.; Meyer-Ohlendorf, L.; Reckien, D.; Lüdeke, M.K.B.; Hofmann, S.; Kit, O. (2009b): Is a Low Emission Hyderabad Possible? Mapping Urban Transformations in a Climate Change Scenario Process. Paper for the IGU 2009 Conference "Emerging Urban Transformations: Multilayered Cities and Urban Systems". Hyderabad/India.

Shukla, P.R.; Sharma, S.K.; Ravindranath, N.H.; Garg, A.; Bhattacharya, S. (Eds) (2003): Climate Change and India, Vulnerability Assessment and Adaptation. Universities Press, Hyderabad/India.

Contact:

e-mails: reckien@pik-potsdam.de, matthias.luedeke@pik-potsdam.de, fritz.reusswig@pik-potsdam.de, okit@pik-potsdam.de, sonja.hofmann@pik-potsdam.de, martin.budde@pik-potsdam.de

website: www.pik-potsdam.de