

# Achieving Urban Climate Adaptation in Europe and Central Asia

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## Abstract

Many cities across Europe and Central Asia are experiencing the impacts of climate change, but most have not integrated climate adaptation into their agendas. This paper examines the threats faced and measures that can be taken by cities in the region to protect buildings, heritage sites, municipal functions, and vulnerable urban populations. In general, local governments must be proactive in ensuring that existing buildings are climate ready, paying particular attention to emerging technologies for retrofitting the prefabricated, panel style buildings that dominate the landscape while assessing the viability of homes situated in flood plains, coastal areas, and steep slopes. They also must ensure that new developments and buildings are designed in ways that account for climatic fluctuations. Although the resilience of all populations needs to be considered, historical

patterns of discrimination require that special provisions are made for the poor and for ethnic minorities such as the Roma because these groups will be most at risk, but are least likely to have access to adequate resources. Urban climate adaptation requires national-level support and local commitment. However, centralized planning and expert-led decision-making under the former regimes may affect the ability of cities to pursue programmatic approaches to adaptation. Therefore, while national governments need to make adaptation a policy priority and ensure that municipalities have adequate resources, local government agencies and departments must be transparent in their actions and introduce participatory and community-based measures that demonstrate respect for diverse stakeholders and perspectives.

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# **Achieving Urban Climate Adaptation in Europe and Central Asia<sup>1</sup>**

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## Achieving Urban Climate Adaptation in Europe and Central Asia

Whether they are situated in coastal or mountainous areas, in the north or the south, cities throughout Europe and Central Asia (ECA) are being affected by the global climatic transformations that are taking place. In ECA, about two-thirds of the population lives in urban areas (World Bank, 2007). Although cities and their residents are at risk, climate change efforts in the region generally have been at the sector (e.g., agriculture, energy, water, health) and national levels. While sound national and sectoral policy is important for setting priorities and advancing agendas, it does not account for the need to specifically address urban concerns and the associated local actions required to prepare cities, citizens, and urban output for the impacts of climate change (Stern, 2007; Satterthwaite, 2007). To promote the economic vitality of countries, and protect the well-being of their inhabitants, it is essential that national and local governments alike have strong commitment to preparing their cities for climate change. This paper focuses on key issues that city officials and agency representatives need to consider as the projected impacts of climate change become a reality.

Urban areas make a significant contribution to anthropogenic warming (C40 Cities). As a result, until recently, most urban efforts have focused on mitigation, or the implementation of policies that have the potential of reducing greenhouse gas emissions (IPCC glossary). In contrast to mitigation, adaptation includes “initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects” (IPCC glossary). While cities are places where synergies between adaptation and mitigation measures can take root, they differ in orientation and emphasis. Mitigation is linked to reducing emissions, either by developing clean technologies or changing demand. In contrast, in seeking to minimize the impacts of climate change on the built environment, urban ecology and ecosystems, and human populations, urban adaptation casts a wider net. It not only requires that municipal officials and agencies set policies and performance targets that foster reductions in emissions, but that they engage in comprehensive action to make their cities more sustainable and more resilient.

We begin by reviewing the major impacts of climate change projected across ECA and discussing how these can affect urban areas. We then focus on adaptation of the built environment, paying particular attention to housing, public buildings, and heritage sites. Since urban adaptation is an emerging issue, most literature offers conceptual frameworks and ideas as practical experience tends to be limited to isolated efforts and demonstration projects. We seek to balance theory and practice by drawing on examples, both from ECA and countries in other regions, to illustrate major considerations related to retrofitting existing buildings as well as those relevant to new construction. We then consider the character of vulnerable populations in cities in ECA and the types of government capacity and planning processes that are essential to initiate and sustain urban adaptation. While issues such as energy, infrastructure, health, and emergency services are critical to the functioning of cities, they are only noted rather than discussed in detail since they are the topic of other background papers in this umbrella report.

Climate vulnerability of cities is a function of exposure to climate factors, sensitivity to change, and adaptive capacity. While policy imperatives, as well as economic and financial resources, are required to achieve climate resilience, a critical challenge facing many ECA

cities is a lack of capacity and competency on the part of local governments. In the course of this paper, we emphasize that to effectively prepare for climate change, national governments must be committed to strengthening local government capacity to pursue a comprehensive course of action and empower municipalities to establish policies and programs that will address potential impacts of climate change on the built, natural, and human environments of cities. At the same time, municipal governments in ECA must acknowledge the potential for problems to occur and make a commitment to change. Since the capacity challenges governments face will continue well into the future, in addition to addressing the need for commitment and resources, we suggest that climate adaptation requires resourcefulness. In particular, for adaptation to be fully integrated into ongoing municipal practices, it is essential that local governments require that agencies establish performance targets that include adaptation measures and, at the same time, that agencies learn how to assess their current efforts and identify ways to readily extend their ongoing work so that they can achieve these targets with minimal additional capacity.

### **Anticipated Impacts of Climate Change in Urban Areas in ECA**

Changes in temperature and precipitation predicted to take place in urban areas throughout ECA will have direct impacts on buildings, monuments, and urban infrastructure. These changes have the potential to alter the viability of residences, offices, and public buildings as well as affect the provision of routine services and the overall quality of life for urban residents. For instance, higher temperatures throughout the region in the summer months not only will lead to increased pollution and heat in the outdoors, but will alter the indoor air quality and temperature of many buildings. While this may not be highly problematic in areas in the far north, the increased incidence of heat waves across southern and central Europe will require that buildings in these regions have better ventilation and cooling if they are to remain useable, not only for those individuals who are most vulnerable to health threats from the heat, such as the elderly, infants, and the infirmed, but for the general population.

Reductions in precipitation and higher temperatures predicted in the south will be linked to groundwater depletion. In addition to water shortages for urban dwellers, reductions in the moisture content of soils can affect the foundations of buildings. Most urban areas were built with surfaces that absorb the heat and parks and greenspaces populated with plants that are suited to the existing climate. As temperatures increase, plants will have difficulty surviving in the new climate. In combination with the amount of non-reflective surfaces in cities and the amount of heat generated through energy use, the city will become significantly warmer than its surrounding area. This is what is known as the urban heat island effect.

Melting permafrost from increased heat will place stress on coastlines as water levels rise. This has the potential to accelerate coastal erosion, increase the incidence of flooding, and lead to saltwater intrusion into groundwater aquifers in cities, particularly those along the Baltic and Adriatic Seas as these are projected to rise significantly. Turkey is an example of a country that is highly vulnerable as it is bordered by four seas (Mediterranean, Black, Aegean, and Marmara). With many people living in proximity to coasts, a 1m rise in sea level would affect approximately 30% of the nation's total population. Sea level rise not only has the potential to affect natural systems and housing and infrastructure, but also tourism and enterprise (Karaca and Nicholls, 2008).

Many cities in the region are situated along major waterways. Increased precipitation in the north will cause rivers to swell and place stress on dams. Cities have large areas of impervious surfaces. As precipitation increases and soils become waterlogged, existing stormwater drainage systems as well as sewage treatment plants and sewer lines will be overwhelmed. Sewers that carry both stormwater and sewage are common in many cities throughout the region. As was the case in 2002 in Prague, these systems were stressed when the floods occurred and many sewage treatment plants had to halt operations. A further impact is that flood waters will transfer contaminants from abandoned industrial sites and operational facilities to populated areas. Along with the other types of wastes that will wash up onto the shores, these conditions can pose threats to human health.

Higher levels of rainfall and intensity of storms will affect dwellings and other buildings that are situated in floodplains as well as to those on steep slopes affected by erosion. Urban dwellers in these areas likely will find that the cycle of destruction and reconstruction that they have relied on to maintain their properties are no longer feasible as attempts to hold back rising waters become unsuccessful. Outside of floodplains, residents may find that increased precipitation is affecting the stability and integrity of their dwellings and placing stress on roofing and seals on windows and doors.

Climate change has the potential to alter municipal economies through impacts on the built environment. For instance, corporations may seek new sites that are in less vulnerable locations while small business may start to migrate as urban densities begin to shift. These patterns are likely to have mixed impacts. While they may be devastating for the central business districts of some cities, they have the potential to enhance the vitality of other cities (including smaller cities and towns) and outlying areas that are perceived as locales with better climate resilience. Similarly, urban tourism is likely to be affected in potentially positive and negative ways. Some climates may become more attractive while others, particularly in areas where resources are likely to be scarce or where summer conditions may become unbearable and coastlines no longer appropriate to tourism, may suffer notable financial losses (Hunt and Watkiss, 2007).

### **Climate Adaptation for the Built Environment**

As the projected conditions suggest, it is imperative for urban municipalities to prepare for the impacts of climate change. This requires developing and implementing adaptation plans that address features of the built, natural, and human environments. This section focuses on the built environment, which typically includes both buildings and urban infrastructure. Since infrastructure is covered in depth in other background papers, the focus here is on adaptation of existing buildings, measures to ensure that new construction is pursued in ways that account for climate impacts, and the preservation of heritage sites and buildings.

Buildings account for a notable percentage of GHG emissions. For instance, it is estimated that at the present rate of growth, residential buildings will be the source of 21% of global GHGs by 2020 (Bressand, et. al, 2007). Measures that advance adaptation, by incorporating environmentally sustainable practices, can ensure that cities will remain livable and viable into the future. This section emphasizes the importance of building retrofits and, with this in mind, reviews associated best practices that simultaneously promote quality of life for

residents while contributing to reductions in urban greenhouse gas emissions. It also looks at energy efficiency in new construction as well as addresses the centrality of site planning, zoning, and building codes in adaptation planning. In addition, this section reviews a number of key concerns related to the preservation of historic buildings and heritage sites.

### **Adapting Existing Buildings for Climate Impacts in ECA**

Cities throughout ECA are host to buildings and heritage sites that boast architectural styles ranging from medieval to baroque to nouveau to deco. Along with serving as historical and cultural sites, these buildings house residences, offices, and public agencies. In the outlying areas of some of the major cities, there are remnants of small villages comprised of traditional family homes and villas that were swallowed up as cities expanded. While traditional buildings contribute to the character of many cities, one of the most distinctive features of the urban landscape in ECA is the multitude of prefabricated buildings erected in state-socialist times.

From the mid 1950s through the end of the 1980s, state enterprises built multi-story, multi-family housing units made from prefabricated concrete panels for urban dwellers across ECA (subsequently referred to in this paper as panel or panel-style buildings). The number obviously varies by country, but to provide a perspective, in Estonia and Latvia there are slightly more than 400,000 flats, the Czech Republic, Hungary, and Lithuania have between 750,000 and 790,000 flats, while the estimates for East Germany and Poland are 2.2 million and 5.2 million units respectively (Csoknyai, 2007; BEEN, 2007). An assessment of housing across SEE suggested that in 2004, approximately 55% of the population was living in urban areas and at least 30% of these individuals resided in flats in panel buildings. In about this same period, reviews of housing in urban areas in Romania estimated that there were approximately 76,000 panel-style buildings containing 2.9 million residential units (Hegedüs and Teller, 2004; Iliev and Yuksel, 2004). Since a large percentage of the urban population in ECA lives in these soviet-era panel-style buildings, they are an important consideration when planning for climate change in the region.

Most block flats, which were designed to have a lifespan of about thirty years, already were in disrepair at the time the regimes fell (Iliev and Yuksel, 2004). As countries across the region have shifted from central to free-market economies, many developed privatization schemes for housing, enabling residents to purchase their flats from their state and municipal owners. However, even with the shift to private and cooperative ownership, a large number of flats and buildings are still owned by local and national governments (EEA, 2007). Although public ownership makes it possible for a publicly funded-retrofit program to be initiated, only about 20% of these buildings have had structural, exterior, and common space renovations. As a result, Bulgaria, for instance, recently indicated that 10% of its panel dwellings were in need of urgent repairs (Iliev and Yuksel, 2004) while the Slovak Ministry of Construction estimated that it would cost over 10.3 billion Euros and take more than thirty years to complete the structural repairs necessary to ensure the safety of these buildings (CiJ, 2008). While some governments, as is the case in Romania, have implemented programs to help with the costs of reinforcing buildings, the investments required to bring buildings up to a basic structural and thermal standard will require notable investment (Hegedüs and Teller, 2004; Iliev and Yuksel, 2004).

Although they are in need of basic renovation, there is growing evidence that panel buildings, both block flats used for housing and public buildings of similar construction, have the potential to be efficiently renovated to provide comfort and protection from heat waves and extreme weather events and to incorporate energy-saving retrofits. Some of this evidence comes from demonstration projects supported by the EC. For instance, SOLANOVA, which was initiated in Hungary, resulted in the successful eco-renovation of a panel building that demonstrated how block flats could be redesigned to meet human needs while achieving resource efficiency and optimization of solar supply. Similarly, results from the Demohouse projects in Budapest and Warsaw, though still in the preliminary phase, suggest that the potential exists for improving energy savings and for introducing renewables when rehabilitating these types of buildings. These results have been further reinforced by the Baltic Energy Efficiency Network for the Building Stock (BEEN, 2007), a program that has been taking a comprehensive look at energy efficiency in block flats in five countries.

Complementary efforts have focused on the development of sustainable, high energy performance public buildings in ECA. Sustainable Architecture Applied to Replicable Public Access Buildings (SARA), which focuses on using advanced sustainable energy technologies, has resulted in successful retrofits of a community building in Uzbekistan and a supermarket in Ljubljana. An important aspect of the approach being adopted is that the project places an emphasis on cost effective technologies and in the development of techniques that will be replicable in diverse climatic regions. The Bringing Retrofit Innovation to Application in Public Buildings (BRITA in PUBS) project also is working to promote innovative retrofits at a reasonable cost. So far, nine demonstration projects that cut across different types of public buildings are in progress, including a student social and cultural center in Brno and the main university building in Vilnius. In addition to the EC demonstration projects noted here, a variety of other funders have supported successful conversions of panel-style apartment and public buildings throughout the region (EEA, 2007).

To date, large-scale retrofits of residential buildings have been limited in the ECA region, even in the new EU membership countries. Although they have not yet been attempted on a large scale, existing pilot support programs, including those with subsidies and state guarantees, show promising results. Table 1 provides a snapshot of the costs and structure of financing for housing retrofits in two countries participating in the Baltic Energy Efficiency Network for the Building Stock (BEEN). Due to complex ownership structures and associated legal responsibilities in countries in ECA, the Banking sector has been reluctant to enter this market. However, successful cases of larger-scale implementation have occurred, primarily in private sub-divisions and condominium communities.

**Table 1: Financing and Energy Savings in Housing Retrofit Programs**

	<b>Latvia</b>	<b>Eastern Germany</b>
Supplementary support programs (Pro 2)	Energy-saving pilot program	Combination of KfW and supplementary Berlin support program
Typical refurbishment sum per flat	€3,435	€29,000
<b>Financing</b>		
Own funds	€-	€-
Subsidy	€-	€-

Interest-reduced loan	€3,435	€14,500
Bank load required	€-	€14,500
<b>Value of support</b>		
Subsidies	€-	€-
Value of interest reductions	€-	€2,900
Supplementary interest subsidies	€1,120	€8,300
<b>Apportionments from credits</b>		
Typical running period of credits	20 years	25 years
Typical interest	9.10%	7.50%
Typical credit annuity (1 year)	14.10%	9.3% (1990s)
Credit annuity after interest reduction	9.40%	6.23%
Costs per flat monthly	€26.91	€150.58
<b>Refinancing using typically implemented energy savings</b>		
Monthly housing costs per flat - Before	€20.00	€40.00
Savings due to energy-saving measures	42.50%	50.00%
Heating costs saved per flat, per month	€8.50	€20.00
Monthly refurbishment apportionments (after reduction of heating cost saving)	€18.41	€130.58

Source: BEEN Project Results, Practical Manual, 2007

A World Bank funded energy efficient housing program in Lithuania offered one such successful example. Between 1996 and 2001 the Lithuania Energy Efficiency Housing Pilot Project offered advice to homeowners associations, financed loans, and provided technical assistance and information with the goal of increasing energy efficiency in multifamily buildings in Lithuania. The project also offered favorable terms for its loans, such as fixed interest rates and low down payments. Over 700 homeowners associations received advice on energy efficiency, 331 residential buildings received an energy audit, and 229 projects were implemented. Homeowners reported that, on average, they had energy savings of about 17 percent per year. More than 50 percent reported a decreases in their heating bills and 48 percent indicated that their housing quality was improved (Taylor, et al).

### Assessing the Suitability of Adapting Existing Buildings

Retrofitting will become an increasingly important issue as officials seek to ensure that there is suitable housing available to the residents of their cities. There are two critical issues that need to be addressed when considering whether or not to retrofit a building. The first is its site characteristics. Buildings that are situated in coastal zones and on steep slopes or other erosion prone areas are not good candidates for retrofitting. Neither are those where notable changes are anticipated in the water table or groundwater pressure as these conditions can affect the foundation of a building as well as its ability to maintain dry interior conditions. In addition, in areas where there will be hotter summers, the potential exists for soil to undergo greater levels of shrinkage than has been the norm. The foundations of buildings that are situated on soil that is primarily clay, for instance, may be particularly prone to problems and therefore are less suitable for renovation (Doornkamp, 1993). The second issue is the characteristics of the building. The general emphasis needs to be on improving cooling in buildings in the south and on ensuring water and storm resistance in the northern portions of

ECA. Therefore, buildings in sub-climatic regions need to be examined for the structural suitability and economic viability for the appropriate types of renovation and retrofit.

### Critical Elements of Retrofitting

The major aspects of retrofitting taking place in ECA and elsewhere focus on energy-saving measures. These include thermal insulation, replacement windows, and modernization of central heating systems. In addition to these measures, green roofing is being tested as a further means for improving the quality of living spaces as well as a way to manage fluctuations in precipitation. Since all of these elements are central to adapting buildings for the impacts of climate change, their relationships to housing retrofits in ECA are discussed briefly in the sections that follow.

Insulation. The exterior shell of a building, and the ways in which it is insulated, have a notable impact on the efficiency of heating and cooling systems in both residential and commercial buildings. Therefore improvements in the thermal properties of a building can reduce heating and cooling demand. Many buildings of traditional construction were built from stone and have thick walls, enabling them to better withstand short and medium-term temperature changes. In contrast, socialist panel-style buildings will be more vulnerable to anticipated temperature changes. As a result, those that meet the basic criteria for adaptation will need to be priority for retrofitting.

There are three general types of construction that characterize panel-style buildings. These are, in descending order of frequency, exterior wall construction of single layer concrete slabs, masonry and modular construction, and triple-layer concrete slabs with a thermal insulation core. The first two types tend to be more structurally sound and can be adapted by mounting thermally insulated facades without additional structural fortification. The third type is less stable and must be carefully assessed before mounting an insulated facade (BEEN, 2007). Thermal insulation facades on these buildings can eliminate some of the cold that radiates in from walls in winter months. More importantly, if windows are opened at night and closed and covered with blinds in the daytime, in the summer months the façade can function like air conditioning (BEEN, 2007).

Windows. Windows are a major source of heat transfer and therefore, are integral to insulation, energy efficiency, and comfort. Among the array of suggestions that have been advanced are to retrofit buildings with thermally coated, double-glazed windows. To offset higher outdoor temperatures, solar screening and windows tinted with reflective colors also have been recommended (Bullen, 2004). In addition, double paned windows with interior shading devices have been found to be effective and, when used in combination with interior blinds, have provided increased comfort levels (BEEN, 2007).

Heating, Ventilation, and Air Conditioning (HVAC) Systems. Hotter weather, particularly as anticipated in the south, is likely to give rise to the need for ways to improve cooling in buildings. The types of heating systems present throughout the region vary. Some homes rely on individual gas or electric heaters or on wood stoves. The majority of public buildings and panel-style apartment buildings either rely on a gas or coal boiler within the building or are connected to a one or two-pipe district heating system, most of which are inefficient and antiquated. For instance, one pipe-systems without valves, which are quite common, are not

equipped with a means for individuals to adjust the heat in their residence and they do not provide even heat distribution to all flats in a given building (BEEN, 2007). In general, district heating systems rely on central boiler stations, although they often are supplemented by additional smaller boilers and typically burn fossil fuels or, in some instances, waste or biomass (EEA, 2007).

As discussed in the energy paper, options are being considered for upgrading individual HVAC and central heating systems in ECA. For instance, solar water heating has been successfully tested in both of these contexts. In addition, efforts are being made to improve the overall efficiency of systems and to explore the potential for modifying existing systems so that they can support cooling in hot climates. While insulation and new windows can moderate some of the anticipated increases in temperature, it may be essential to consider installing high-efficiency air conditioners in units or in buildings. However, this should be seen as an option of last resort with priority for their use retained for select healthcare and public facilities.

**Green Roofing.** For panel-style buildings, retrofits that include new facades to improve insulation and new windows with tight seals should help moderate higher temperatures expected in southern cities in the summer and mitigate the impacts of increased rainfall expected in the north during the winter months. A further measure that can assist in further addressing these two impacts of climate change is green roofing. There are several approaches to green roofing, all of which can offer benefits to residents of existing buildings. The first, and one that is becoming most common, is the introduction of rooftop gardens. Preliminary studies of rooftop gardens suggest that they can decrease fluctuations due to air flow through the roof and therefore, help to control interior temperature. In other words, by decreasing the heat entering and exiting a building through the roof, energy demand will be offset since cooling needs will be reduced in the summer and heat loss can be moderated in the winter (Bass and Baskaran, 2001).

The benefits of rooftop gardens extend beyond the energy savings they can provide to individual households and municipalities. Hard surfaces in cities, such as asphalt and concrete, absorb radiation from the sun and cause the temperature to rise. Widespread introduction of gardens will add to urban greenspace and, in the process, help moderate heat island effects. These gardens also have the potential to absorb stormwater. In general, while new technologies are being developed, and while there are many cities in the region that rely on bricks and granite blocks to create roads and sidewalks, there are still many impervious surfaces with limited absorption properties. When severe rainfall occurs, the runoff can overwhelm existing storm drainage systems, resulting in sewer backups and flooding. While rooftop gardens will not counter the overall increase in precipitation anticipated in many cities in the region, particularly in the north, they can reduce the level of runoff and moderate the potential of flooding (Bass and Baskaran, 2001; Hadley and Carter, 2006).

Green roof designs also have been developed to assist in harvesting rainwater. The basic idea is that rainwater is filtered into storage tanks and then used for non-potable activities such as laundry, toilets, and watering plants. While the availability of rainwater will not offset scarcity in areas where drought is expected, it can provide modest assistance. Wealthier regions and areas can have full installation, including indoor pumps that will allow the water

to be automatically recycled. More modest approaches, often informally adapted at present, rely on tubs or other containers to catch rainwater from the roof.

The combination of a green roof, insulation, and the installation of new windows may provide an important step toward ensuring the habitability of buildings as temperatures rise. Of course, green roofs require appropriate investment to ensure that they perform properly. This includes ensuring appropriate waterproofing, drainage, and structural support. Because of these constraints, they often are thought to be better incorporated into new construction. However, given the need to renovate housing throughout the region and the potential limits to providing adequate cooling through central systems, consideration should be given to how green roofing can be made an integral aspect of the revitalization of panel buildings.

### **Reducing the Vulnerability of New Construction**

Traditional buildings and panel-style dwellings are interspersed with those from newer eras of construction. One of these eras is the period since the fall of the regimes. In the 1990s, construction booms were initiated in many cities throughout the region. Most new buildings were situated in the central business districts or in upscale areas with the intent of attracting businesses and wealthy residents. At the same time, new housing developments have been springing up in areas surrounding cities. Demand for new construction is expected to continue as people seek larger and more modern homes. In many instances, it also will become a necessity as those who are residing in buildings deemed unsuitable for renovation, either due to the present quality of the construction or the location of the building, need to find new housing or as those living in informal settlements situated in highly vulnerable locations need to be resettled.

In many countries throughout the region, the transition in governments signaled the shift to free markets and privatization. While this offered many benefits, it has had notable consequences for the built and natural environments. In previous times, building was highly regulated and planners, to a large degree, were able to control the growth of cities and surrounding areas. This led to dense urban areas and villages surrounded by open space and biocorridors. However, in recent years, the rise of single family homes and the creation of new suburban developments situated at the outskirts of cities have resulted in a transition from compact forms of development to a rise in urban sprawl (EEA, 2006; Nuissl and Rink, 2005). In many cases, this development has taken place with little consideration to maintaining natural features that create buffers against floods or protect buildings from the elements. As climate-driven migration and construction take place, city managers and planners will need to make decisions about whether they will continue to promote sprawl or whether they will alter this pattern and require more sustainable forms of development.

### **Land Use Planning, Site Planning and Zoning**

In advancing new construction, it is essential to adopt site planning and zoning policies that account for impacts of climate change as well as promote the long term sustainability of urban areas. Among those that are critical, the first is that zoning should not permit development in areas that are least likely to be affected by flooding, precipitation, or other weather-related events expected from climate change. Finland is an example where land use legislation has been passed that accounts for climate change. Rather than require that all plans be approved

by the Ministry of the Environment, the new law delegates this authority to municipalities. The Act enables the municipalities to determine the suitability of sites relative to the risk of flooding and landslides. The municipalities also are free to decide issues such as minimum elevation levels for buildings near shorelines and minimum distances from coasts (Peltonen, Haanpää, and Lehtonen, 2005). A second consideration is the type of soil where new construction is proposed and how anticipated seasonal changes will affect its properties.

Many cities in ECA that are prone to floods remain in close proximity to industrial areas, mining operations, or are host to brownfield sites. As a result, a significant risk to people and settlements in the region is the potential to be exposed to contaminated and toxic waters. For instance, in 2000, a flood in Baia Mare, Romania resulted in the breach of a tailings pond and of cyanide-laced waste from a gold mining operation being wasted into the Tiza and Danube Rivers. The accident not only affected the ecosystems of these rivers, but the drinking water of approximately two million people in Hungary. Similarly, flooding of a chemical plant in the Czech Republic in 2002 resulted in chlorine and other chemicals being washed into the Elbe and the deposition of dioxins on the shores of the River (Gautam and van der Hoek, 2003). As these examples suggest, development should be prevented in areas that are vulnerable to toxins, contaminants, or other health hazards that may arise as a consequence of the flooding of industrial and mining operations or brownfield sites. At the same time, concerted efforts need to be made to relocate existing industrial plants out of floodplains and to remediate brownfield sites.

Just as it is important to prevent building in vulnerable areas, it also is important to protect places and spaces that will enhance the resilience of a city. In general, land use and site planning should be based on sustainable design principles. Greenspaces and waterways are integral to urban resilience since they enhance hydrology and promote the environment's natural ability to adapt. Therefore, development should not be permitted in areas where there are wetlands, biocorridors, or dedicated greenspace and, at the same time, efforts should be made to maintain wetlands, ponds, lakes, and waterways. Smaller greenspaces also should be incorporated into new developments. This includes ensuring that there are trees along roadways and that open spaces and parks populated with low-water plantings are incorporated into the design of neighborhoods. Even if extreme temperatures or higher levels of precipitation are not presently anticipated, "cool" paving materials, permeable surfaces, and storm drains with greater capacity should be integral to the design of new developments.

## **Building Codes**

It is important to introduce new building codes and energy conservation ordinances that will require the construction of buildings that can accommodate the impacts of climate change. In general, most practices aligned with the principles of green design are appropriate. The EU has taken a leadership role in promoting energy efficiency in buildings. The Energy Performance of Buildings Directive (EPBD), which was adopted in 2002 and continued to be refined in subsequent years, prioritizes energy efficiency in the building sector. The Directive establishes a methodology for calculating the integrated energy performance of buildings, establishes minimum performance requirements of new buildings and large buildings slated for renovation, energy performance certification, and provisions for inspections of HVAC systems. It also ensures that performance information is available to residents and owners. Countries beyond the EU, such as Australia, also have adopted minimum energy performance

standards for all classes of buildings and developed schemes that make it possible for individuals to make informed decisions about purchases and renovations.

The EC and Canadian government both maintain that measures to reduce energy consumption in buildings, not only in new construction, but also in retrofitting have the potential to foster a substantial increase in jobs. These views have been echoed elsewhere. For instance, when Spain passed a building code that required the use of solar thermal energy in new and refurbished buildings, they estimated that in addition to addressing GHGs, the increased demand for solar energy was likely to result in the creation of 5,000 new jobs within a period of about four years (ETUC, 2007). The creation of jobs is not expected to be limited to professionals such as engineers and project managers, but to provide new employment opportunities for individuals in the building trades such as pipe fitters, sheet metal workers, HVAC technicians, electricians, and construction workers (Worldwatch, 2007; UNEP, 2008; Apollo, 2008).

Building codes and regulations can extend beyond the efficiency of HVAC systems to include a wide range of adaptation and mitigation measures. For instance, Tokyo has adopted a number of policies to promote reductions in the heat island effect, including the use of rooftop gardens. In particular, the Tokyo Metropolitan Government requires that new developments that are 1000m<sup>2</sup> or larger, and public buildings with a footprint of 250m<sup>2</sup> or greater, be equipped with green roofs and living wall surfaces. The government also offers a tax reduction to owners of existing buildings to encourage widespread installation of gardens and the Development Bank of Japan makes low-interest loans available to owners who wish to pursue this course of action (Shaw, Colley, and Connell, 2007).

The types of building codes in place across the ECA region vary widely. In some countries, such as Georgia, standards have not changed while other nations, including Russia and the Ukraine, have codes that are comparable to those in many western countries. Although countries in ECA have a long way to go to become energy efficient, there are signs that some proactive measures are being put into effect (Church and Malkova, 2008). Adopting building codes that promote energy efficiency will result in adaption and mitigation being simultaneously addressed. In general, a priority should be placed on codes that foster the construction of buildings with exteriors made from light colored, reflective materials. As suggested for retrofitting, buildings also should be required to have energy-efficient and climate appropriate HVAC systems as well as green roofing and high quality windows. In addition, consideration should be given to requiring energy efficiency appliances and grey water recycling.

Since the specific characteristics of long term changes are uncertain, it is appropriate to promote building designs that can be adapted as climatic conditions shift (Steemer, 2003; Camilleri et al, 2001). In other words, it is not sufficient to develop standards for buildings that account for conditions in the short term or for those that are anticipated in the medium term. Rather, building codes should be developed to encourage construction that can easily be retrofit as new circumstances arise. This will enhance the lifespan of buildings, the comfort of those who use them, and the impact that the buildings have on the natural environment.

## **Preserving Historic Buildings, Monuments, and Archives**

Cities throughout ECA are host to many historically and architecturally significant buildings. They also contain a multitude of national monuments and house a wealth of important documents and works of art. As with other types of buildings, heritage buildings, sites, and monuments are prone to many of the same issues arising from increased heat and humidity, desertification, pollution, and additional moisture. What is distinct in this context is that in addition to working to preserve structural integrity, in most cases it is desirable to protect aesthetic features and protect natural materials from the types of deterioration that can occur as a consequence of climate change.

Historic buildings made of stone tend to have relatively high energy performance. Characterized by thick walls and small windows, they are naturally able to remain warmer in winter and cooler in summer. However, fluctuations in weather conditions can put additional stress on these types of buildings. For instance, once a building becomes saturated with flood waters, it will be difficult for it to dry out on its own. While natural ventilation is preferable to alternatives, forced and mechanical ventilation can help reduce stress between the exterior and interior of building materials (Noah's Ark, 2007). Coping with moisture was an issue in the region after the floods of 2002. The town of Cesky Krumlov, for example, had to find ways to dry waterlogged walls and structures before the temperatures dropped in the winter so that there would not be additional damage to historical buildings (UNESCO, 2007).

In addition to stone and concrete structures, many historic buildings in the region are constructed from wood. These range from the medieval buildings at the Romulus Vuia Ethnographic Park on the outskirts of Cluj-Napoca to the neoclassical style wood buildings that are integral to the town center of Riga. Wood is highly responsive to changes in rainfall and groundwater. Increased rainfall can therefore result in structural stress as well as make the building prone to mold and mildew. Wood also is highly vulnerable to infestations. Routine maintenance may prolong these structures. At some point, however, the preservation of these structures may require adopting more aggressive measures, including the introduction of new materials or exterior features such as drains, even if they alter a site's traditional appearance (Noah's Ark, 2007). The tradeoff between historical integrity and prolonging the life of the building in an altered capacity will have to be carefully considered on a case by case basis before taking action.

Intricate building facades as well as statues and other monuments can deteriorate as a consequence of exposure to salts, pollutants, and changing weather patterns. In the short-term, routine care of these structures will need to be increased and their condition closely monitored. In addition to affecting building exteriors and outdoor monuments, changing weather patterns also can affect important objects and documents. Humidity and water damage from flooding pose the greatest threats. While many buildings that house historical materials already are dehumidified and some archives have been relocated to newer facilities located in areas outside of floodplains, just as many remain at risk.

## **Climate Adaptation for Vulnerable Urban Populations**

The goal of urban climate adaptation is to provide physically safe, environmentally sustainable, and socially just living alternatives for current and future residents of settlements. To this point, the emphasis in this paper has been on adaptation of the built environment. While structures matter, urban adaptation also is about safeguarding society. As the previous sections of this paper suggest, one of the most critical factors affecting individuals and families in urban areas is the quality and location of their residence. In particular, families who live in homes that can not accommodate changes in temperature, storms, and precipitation will be at risk as will those living in properties situated in floodplains, coastal areas, or on steep slopes. Some homes may be able to be climate-proofed while many others will be deemed inappropriate for renovation, particularly those that are situated in locales at great risk. Provisions may need to be made to provide short-term housing for families living in residences slated for renovation. Long-term housing alternatives will need to be developed for those families and individuals who need to relocate.

From a social point of view, climate vulnerability refers to the ability that individuals and groups have to adapt to anticipated and unanticipated change as a consequence of shifting climatic conditions. In general, the ability to cope with climate change will be contingent on the availability of resources, particularly financial assets, political power, social status, and personal and professional networks (Adger, 2006). Some people will have the resources to relocate, retain their livelihoods, and maintain their social networks; others will not. For instance, the elderly and infirmed may not have the financial or familial resources necessary to relocate to new housing. Those who are socially isolated may have difficulty adjusting to the changes taking place around them while immigrants and foreigners who do not speak the national language may be unable to learn about impending issues. While all inhabitants of urban areas in ECA will need to navigate a wide range of issues and challenges in response to climate change, those expected to be most at risk are ethnic minorities and the poor.

## **Vulnerability of Ethnic Minorities**

One of the legacies of the transformation in regimes and national borders over the course of history in ECA is that they have created multinational minorities. For instance, individuals of Hungarian descent have lived in the Transylvania region of Romania for generations. This also is the case with Russians in Estonia, Turks in Bulgaria, and Kyrgyz in Tajikistan. Even though families have lived in the same place for generations, they have a strong affinity toward their traditional identity, often continuing to speak in their native language and staying relatively separate from the national majority. In contrast to concentrated settlements populated by national minorities, the Roma are an ethnic group that historically has been disbursed throughout much of the region and that has been subject to a legacy of discrimination. Under the former regimes, socialist rhetoric stressed equality. However, in reality, these individuals generally were viewed with disdain and cordoned into well-defined slum areas within cities. Not only do many Roma neighborhoods continue to remain overcrowded, but a study conducted in 2000 in Hungary, Romania, and Bulgaria found that the majority of homes in these areas do not have hot running water or central heat and were characterized by an overall state of disrepair (Revenga, Ringold, and Tracy, 2002).

Minorities in ECA often receive unfair treatment in times of disaster. This was the case, for instance, when floods hit the Slovakian town of Jarovnice in 1998. Approximately 140 Roma homes were affected and 45 Roma died as compared with 25 non-Roma homes and 2 non-Roma deaths. Similarly, when the floods of 1997 hit the Czech city of Ostrava, white, non-Roma residents were offered opportunities to resettle in flats outside of the flood area while Roma families were offered small workers' cabins or sent back to their flooded homes, even though they were in an area deemed unfit for habitation (MRG, 2008; Bukovska, 2002). Some efforts have been made to reverse discrimination. For instance, in anticipation of EU accession, Bulgaria adopted a new health initiative as well as anti-segregation requirements in schools. Hungary also has made passed anti-discrimination laws, desegregation policies for schools, and a program aimed at legalization of unregistered settlements (Witte, 2008). Despite these and other efforts, explicit patterns of discrimination persist throughout the region (Witte, 2008).

### **Vulnerability of the Poor**

Under state-socialism, efforts were made to attract and resettle people in urban areas as these were the hubs of industrialization. Most of these urban dwellers were educated through the state system and, when they relocated, were provided with a job, a dwelling, and basic services such as water and sanitation, electricity, and heating. The regime change was followed by migration and population declines in some urban areas. However, cities still are home to the majority of the population in the region. Although urban life used to mean that basic provisions were available, the liberalization of markets has been accompanied by price inflation for household essentials and a loss of job security (World Bank, 2006; World Bank, 2000).

Wealth does not always reduce risk just as poverty does not necessarily lead to vulnerability to climate change. However, the urban poor are at a disadvantage when it comes to climate impacts and the capacity to adapt (Huq, Kovats, Reid, and Satterthwaite, 2007). For instance, many of the urban poor live in low quality residences, including those without adequate insulation or that have leaky roofs and windows. These not only include buildings in formal settlements, but also those in the informal settlements that have emerged in urban and suburban areas across ECA (UNECE, 2007a, 2007b). Most residences in these settlements have limited services and may result in people relying, for instance, on rainfall as a source of water. As temperatures increase and drought conditions emerge in the south, families in these situations will have greater difficulty obtaining access to potable water.

In the best of times, the poor have difficulty obtaining basic provisions and access to services. Given that their health and nutritional status often is compromised, the poor, along with the sick and elderly, will be at the greatest risk from illness and death from heat and humidity (Kasperson and Kasperson, 2001) as well as be most vulnerable to the emergence of new disease vectors. Some urban poor maintain subsistence lifestyles. As habitats are altered due to temperature, weather, or pollution, individuals may no longer be able to obtain fish from local rivers, streams, and ponds. They also may no longer be able to grow vegetables in local plots or procure local produce (Huq, Kovats, Reid, and Satterthwaite, 2007). Rather than retaining their present level of independence, they may find that they either have to relocate or seek out public assistance.

## **Assisting Vulnerable Populations**

The range of risks that are present and the various locales and groups vulnerable to the impacts of climate change need to be carefully assessed. Rather than waiting and providing compensation after disaster has struck, it is best for city managers and planners to take precautionary measures. This requires developing strategies that will reduce the risk to vulnerable populations and, at the same time, not shifting burdens to other places, people, or points in time (Dow, Kasperson, and Bohn, 2006). Of particular importance is assessing the quality of public housing and ensuring that it is not situated in vulnerable locales or fallen into disrepair. A further concern is the location of informal settlements. More often than not, these are situated in highly vulnerable locales or in wetlands, buffer zones, and floodplains. Residents either are at risk due to erosion and flooding or are living in areas that can obstruct drainage and limit the natural environmental capacity to cope with increased precipitation.

As efforts are made to clear settlements in vulnerable locations, residents who are unable to afford to relocate on their own may have difficulty finding suitable housing (Huq, 2007). Accordingly, it is necessary to ensure that appropriate housing and services are available to individuals who are relocated (Saiterwaite, et al 2007). In addition, when relocation is required, efforts also need to be made to integrate these individuals into society rather than moving them from one difficult situation to another or creating conditions in which they will be further marginalized. For instance, efforts need to be in place to make sure that individuals are not left behind or moved to low quality housing or undesirable locations. Of particular importance is considering the proximity of housing to the urban core where jobs are more plentiful and where there are greater opportunities for individuals to pursue meaningful livelihoods (Adger, 2001).

Many minorities and urban poor have little political influence, are prey to discrimination, and have insufficient financial and social resources to relocate without assistance. Programs that focus on slum upgrading and relocation of informal settlers have taken been tested in countries around the world. The findings from these programs suggest that representative organizations from these populations can effectively participate in decisions related to relocation. In addition, federations formed by slum dwellers and homeless groups have been able to promote and implement new housing developments (Patel, d'Cruz, and Burra, 2002; Menegat, 2002; Weru, 2004). Efforts in Bulgaria to improve housing conditions for the Roma have shown promise when local officials were committed to goals of the program and when they engaged members of the community in the decision process (Iliev and Yuksel, 2004). These patterns suggest that successful outcomes may be achieved if governments and funders provide housing and relocation options while engaging potential residents in related discussions and decision processes.

To date, there are few examples of climate adaptation policies and best practices that account for the needs of the poor and vulnerable minorities in urban areas. However, in addition to conducting assessments and making efforts to attend to the housing needs, most development agencies are recommending that climate adaptation activities should conform to measures associated with pro-poor development. In other words, efforts not only need to be made to ensure that the risk to vulnerable populations is minimized, but that efforts are made to enhance their capacity so that they can engage in independent action. These efforts can range

from inclusion in adaptation planning to attention to the employment implications of relocation strategies to building local capacity through educational and skill-development programs.

### **Building Urban Capacity for Climate Adaptation**

The range and scale of activities involved in preparing cities for the impacts of climate change are unprecedented. Table 2 summarizes the major aspects of urban climate adaptation for the built environment and for vulnerable populations, many of which have been discussed in this paper. As the Table suggests, a number of the approaches recommended for adapting buildings also promote mitigation and all of the measures, both alone and in combination, will foster greater urban sustainability.

Achieving transformation of this magnitude will not be easy to accomplish. Rather than mandating systemic change or imposing the adoption of best practices that may or may not be suitable to a particular locale, adaptation requires a pragmatic approach. This includes ensuring the presence of adequate capacity, the creation of new institutions, incentives, and regulatory protocols, the integration of adaptation measures into routine activities and ongoing decisions.

**Table 2: Urban Climate Change Impacts and Responses**

Predicted Change	Urban Impacts	Urban Responses
Increased temperature	Increased outdoor pollution Increased interior building temperature Reduced interior air quality Increased heat island effect Reduced groundwater Stress on plants, parks, gardens Increased heat-induced health problems	Retrofit buildings Monitor historic buildings and sites Building codes Greenspace and bluespace Rooftop gardens Reductions in paved surfaces Assisting vulnerable populations
Increased rainfall	Increased flooding Stress on stormwater and sewage systems Stress on building foundations and stability Stress on building waterproofing Exposure to flood-related toxins and wastes Stress on local governments Stress on emergency response systems	Improvements to stormwater systems Rooftop gardens Restoring wetlands Greenspace Reductions in impervious surfaces Relocating vulnerable industrial facilities Remediating brownfield sites Relocating vulnerable municipal facilities Relocating families living at vulnerable sites Climate-proof buildings and heritage sites Zoning and site planning Building codes
Reduced rainfall	Groundwater depletion and water shortages Stress on building foundations Stress on plants, parks, gardens, greenspace	Retrofit buildings Monitor historic buildings and sites Low-water plantings Water retention ponds Greywater recycling Rainwater storage tanks Equitable water availability and distribution

Sea level rise	Coastal erosion Saline intrusion Increased flooding Threats to building stability Stress on stormwater and sewage systems Exposure to flood-related toxins and wastes Stress on local governments Stress on emergency response systems Alternations in tourism Threats to coastal enterprise and industry	Improvements to stormwater systems Restoring wetlands Strengthening sea-walls Dune rebuilding Beach nourishing/re-vegetating Buffer zones Zoning Relocating vulnerable industrial facilities Remediating brownfield sites Relocating vulnerable municipal facilities Relocating families living in vulnerable sites Assisting vulnerable populations
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Municipal governments and government agencies must have sufficient capacity to plan for and implement adaptation measures. Capacity in this case refers to technology, expertise, financial resources, staffing, and inter-agency coordination. Given the nature of climate change, it also involves having strong ties to the scientific community so that information is received in a timely fashion and mechanisms that facilitate input from local communities so that officials can be aware of changes as they are taking place and therefore, can implement timely responses. At present, the capacity of government agencies is highly variable throughout ECA with some having routine access to advanced technology and sufficient resources and others having limited technology, staffing, and financial support. Efforts will need to be made to build local capacity. In addition to ensuring that agencies have adequate financial and technological resources, they also need to be staffed by individuals who have been properly educated and who are able to gain access to ongoing training so that they are able to respond to emerging and changing conditions.

Capacity is not limited to tangible resources, but extends to the resourcefulness of agency staff. Evidence from countries throughout the world suggests that many municipalities are finding ways to integrate climate adaptation efforts into new projects and routine activities. In some cases, local governments are raising the profile of adaptation by developing dedicated task forces, steering committees, and adaptation teams, both within and across agencies (Clean Air Partnership, 2007). While these efforts are important, gains also are being achieved by addressing adaptation on a case by case, project by project basis. These practices range from accounting for increased runoff when siting storm drains, to creating redundancies in water infrastructure, to allocating greenspace for community gardens. For instance, when the City of Vancouver was creating an Integrated Stormwater Management Plan, planners took climate variability into account as they were addressing watershed health more generally (Medhi, 2006). This did not require additional resources or expertise, just a commitment to addressing climate impacts in the course of everyday activities and the initiative of actors “on the ground” to make decisions based on their experience and familiarity with the local context.

Given the uncertainty that lies ahead, one of the practices advocated for municipal governments is that they adopt flexible approaches so that they can remain responsive as conditions change (Mehdi, 2006; Thompson, et. al, 2006). According to the IPCC (2001), adaptation is the “the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.” Adaptive climate governance therefore requires that public

officials engage in a process of trial and error, where decisions are made and implemented and then the outcomes are evaluated and adjusted as conditions change, as new information becomes available, and situations require different forms of action.

Innovation, risk taking, and decentralized decision making are critical to achieving climate adaptation. However, new activities will not pursued unless they are linked to municipal priorities and reward systems and supported by national government policies, programs, and resources. In particular, municipalities can foster the integration of adaptation into routine activities if performance measures have a climate filter and adaptation-oriented activities are rewarded. At the same time, national governments can promote the mainstreaming of adaptation measures in cities by establishing funds that support adaptation measures and by updating laws and regulations related to areas central to adaptation such as building codes, energy efficiency standards, and emergency management.

## **Urban Planning and Climate Adaptation**

From a practical standpoint, the involvement of urban planners is critical to preparing cities for physical, environmental and social impacts of climate change. After the fall of the regimes, planning had a generally poor reputation since it was linked to state-socialism as well as viewed as incompatible with the free market system (S'ykora, 1999). The result was that planning agencies in many countries and municipalities struggled to maintain their operations during the transition (Maier, 1998; Nedović-Budić, 2001). For many countries, the presence of private investment has shifted the focus of urban planning from guiding city growth to trying to monitor and control development. Urban planners have the potential to envision the future of their cities and to play important roles in climate adaptation. However, realizing this potential requires a fundamental revision in their approach. They will need to find a balance between regulating growth and supporting privatization and free market approaches. They also need to find a balance between the old style of command and control and democratic principles. In other words, they need to retain their efforts to envision and shape city growth, albeit in an environmentally sustainable fashion and in ways that are aligned with free market principles and democratic systems.

Climate adaptation planning requires familiarity with the particular weather and temperature shifts expected to take place in the city. From there, planners can draw on their standard toolkit to help decision makers and the public understand the types of vulnerability that are present. In particular, planners are well-equipped to prepare maps (using GIS) that highlight vulnerabilities in infrastructure, buildings, businesses, and communities due proximity to waterways, wetlands, floodplains and other potential stressors. Mapping provides a foundation for developing planning scenarios in light of different weather conditions. Since cities do not exist in a vacuum, mapping needs to account for impacts across the entire ecosystem and as well as attend to how features outside of the city boundaries, ranging from greenspace to industrial facilities, will affect risk and exposure of different communities.

Mapping facilitates the identification of high vulnerability areas and, therefore, populations and aspects of the built environment most at risk. At the same time, the information obtained from these processes can be used to create scenarios based on different climatic conditions and their local impacts. This process, in turn, establishes a foundation for setting priorities and

developing plans that address both mitigation and adaptation. Given the uncertainty that lies ahead, plans need to be designed with flexibility in mind as this is the only means for ensuring that decisions can be appropriately and rapidly revised as conditions change (Thompson, et. al, 2006). In other words, when planning for climate change, a range of different weather scenarios should be developed and narratives about the ways each will affect the built, natural, and human environments should be constructed. Drawing on these scenarios and narratives, policies should be developed in ways that are flexible so that as predictions change and climate impacts become evident, they can readily be reevaluated and refined. An adaptive approach such as this need not be limited to select policies or agencies, but can be used as a means to guide urban climate adaptation activities more broadly (Sheltair, 2003).

### **Participatory and Community-Based Approaches to Climate Adaptation**

One way that agency capacity can be extended and adaptation achieved is through participatory and community-based measures. The region is characterized by a history of government and expert-led decision making. While the transition to democracy in many countries was accompanied by provisions for public comment and participation, there have been varying degrees to which these processes have taken root in different countries. For instance, in addition to standard forums for input, such as public hearings, activities such as working groups and roundtables have been successful across Central and Eastern Europe. These efforts not only have fostered good relations among participants, but public input has helped identify sources of pollution, clarify ambiguities for officials, and generated information that led to better legislation (Bell, Stewart, and Nagy, 2002; Danube Watch, 2006a, 2006b). Alternatively, participation has been more limited in Central Asia since the 1990s when many countries began placing constraints on civil society organizations and the opportunity for them to participate in analysis and advocacy (UNDP, 2005). Although there is variability from one country to the next, reports from across the region suggest that this has led to decision-making that often is centralized and, in many instances, that is accompanied by limited government accountability, transparency, and appreciation for public participation (UNDP, 2005).

A limiting factor of government-initiated change is that agencies and officials often are unable to develop policies and promote practices that resonate with local preferences, build trust, and foster commitment. Planning for climate adaptation should therefore include provisions for participation and deliberation so that people have voice in the decisions that are being made. Participation should not be limited to the members of wealthy communities or the elite who need to relocate or adapt their housing, but should extend to processes oriented to relocation and service provision for minorities and the poor. Promoting involvement will increase the likelihood that an appropriate range of options will be considered and that plans will be compatible with the preferences and needs of the affected communities. Concurrently, efforts should work to increase the capacity of affected individuals and communities and to empower them to manage the implementation of their adaptation plan (Dow, Kasperson, and Bohn, 2006; Adger, 2001).

The goal of integrating a broad range of actors into the adaptation process is that it has the potential to enhance commitment to proposals as well as facilitate implementation. After the fall of the regimes, scholars in several countries noted how existing networks, as well as those

that were relatively new, served as a means for accomplishing activities in the region (e.g., Garbner and Stark, 1997). While national policies will set the stage and local governments will serve in critical roles, it may be possible to promote the process of climate adaptation by tapping into networks of expertise and promoting cooperation among diverse actors (Crabbé and Robin, 2006). According to Adger (2001), adaptation efforts must account for the culture and traditions associated with a given locality. This view was supported by the recent analysis of the Tiza river basin planning process where success was enhanced by promoting awareness and ensuring the integration of formal agencies and informal networks (Matczak, Flachner, and Werners, 2007).

The city of Tatabanya, which is about 50 kilometers from Budapest, offers an example of how community members can be an important driver and resource in climate adaptation.

Tatabanya has approximately 72,000 residents, including 6,500 individuals of school age. This former mining and industrial town was known for its high levels of pollution. The residents of Tatabanya have formed three groups, each involved in promoting local sustainability. The focus of the Inhabitants Group is to develop a new vision for the future of the city. They serve in a representative capacity in public decision making and through their efforts have helped to promote communication between residents and public officials by ensuring that local interests are known. The second group is the Local Council of Pupils. This is comprised of student representatives who engage in a variety of tasks, including participating in local decision making. The third group is the Local Climate Group which is comprised of individuals from all walks of life including students, pensioners, doctors, nurses, teachers, engineers, scientists, public officials, heads of companies, and inhabitants. Among their many accomplishments, they have implemented a heat and UV alert program, organized teams to assist in the development of a local climate strategy, initiated a call for tenders on energy efficient housing, established emissions reduction targets, and implemented educational and information programs (Moravcsik and Botos, 2007).

The case example of Tatabanya shows how local community groups can develop and advance a local climate adaptation agenda. It also suggests that an emerging approach, called community-based adaptation (CBA), can support government-initiated urban climate adaptation efforts. CBA is based on two premises. First, that vulnerability to the impacts of climate change will be influenced by the local capacity to innovate and change; and second, that local communities have the ability to assess conditions and adapt. The starting point is the community rather than a particular climate risk or threat. However, this approach is differentiated from other participatory and collaborative processes because it takes climate assessment and adaptation as its primary focus (Jones and Rahman, 2007). While CBA has been attempted at limited scales and often in rural locales, it has the potential to be a valuable asset in an urban climate adaptation toolkit. For instance, in a demonstration project funded by the European Commission, property owners and renters in Hungary and Bulgaria have been taught how to organize themselves and manage energy efficient renovation (Concerto, 2007). As this example suggests, CBA offers a way to draw on local knowledge and skills while providing a means to organize local communities and residents to aid in the adaptation process.

### **Implications for Multilateral Development Banks (MDBs)**

Despite its importance, climate change adaptation has yet to be elevated to the policy agenda of most ECA cities. In general, there is lack of awareness among both the public and decision-makers due to the following key factors: (i) the perception that the impacts of climate change are uncertain and in the distant future; (ii) the challenges posed by climate change are seen as marginal compared to the immediate socio-economic problems facing localities; and (iii) the costs of mitigation and adaptation are considered to be prohibitively expensive and likely to divert resources from more important development needs. MDBs can play a central role in advancing climate adaptation by disseminating information, providing Technical Assistance (TA), and making investments that improve urban resilience.

With respect to information, an emphasis needs to be placed in communicating the urgency and relevance of adaptation. National and, in turn, municipal governments may be more receptive to adaptation if they understand that many approaches are based on sound sectoral practices and development policies that they already are pursuing. Some examples include strengthening flood retention infrastructure, improving storm-water systems, preserving and extending urban green space, restoring wetlands, and adopting integrated river-basin and ecosystem-based planning. Other efforts in the area of information dissemination include translating global climate science and sector specific expertise to project applications and communicating the impacts of climate change through familiar events, such as floods, heat waves, and winter storms.

MDBs can support urban climate adaptation by providing TA to countries and cities across ECA. For instance, they can work with national governments to review and update their legal and regulatory frameworks, and sectoral technical minimum standards and guidelines, including land-use and site planning policies, building codes, and energy efficiency standards. At the sub-national level, MDBs can assist with vulnerability and adaptive capacity assessments of localities, support local and regional governments in making climate, climate variability, and climate change information available to the public, designing incentives for the private sector to engage in climate adaptation activities in urban areas, mainstreaming adaptation measures in local and regional development plans, and improving participatory processes and community involvement in decisions.

**Table 3 : Projected Housing Refurbishment Needs Relative to Support Programs**

	Latvia	Poland	Lithuania	Estonia	Eastern Germany
Number of flats in panel buildings, built 1950-1990	416,460	5,200,600	790,000	406,570	2,150,000
Assumed average refurbishment requirement per flat	8,000	8,000	8,000	8,000	20,000
Overall refurbishment requirement (millions of Euros)	3,332	41,605	6,320	3,253	43,000
Investments achieved with support programs (millions of Euros)	3	250	20	30	30,000

Refurbishment covered to date by support programs	0.10%	0.60%	0.32%	0.92%	69.77%
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Source: BEEN Project Results, Practical Manual, 2007

On the investment front, the needs for climate-proofing new infrastructure and major existing infrastructure and buildings in ECA cities are enormous. Given the limited availability of resources, priority should be given to key infrastructure in cities located in high risk sub-regions, retrofitting critical municipal facilities that are critical, such as public hospitals and schools, and remediating brownfields in high risk sub-areas as identified by climate-risk mapping. MDBs can help client cities tap into the newly established Climate Investment Funds, in addition to the existing GEF and Carbon Finance facilities.

MDBs can explore operations for retrofitting buildings to become energy efficient and climate-resilient. Table 3 provides an overview of the financial needs for refurbishing housing in select countries. Compared to the vast investment needs for housing refurbishment, the support programs available to achieve this goal are minuscule, signaling both challenges and opportunities for financial institutions. Although traditional projects aimed at climate mitigation in the building sector have been limited in scale and have not been highly successful in attracting demand from client countries, supporting retrofitting for climate adaptation may be viable for MDBs for number of reasons. First, compared to mitigation-focused pleas for energy efficiency, adaptation has local benefits and hence, may better motivate local politicians to upgrade panel-style apartment buildings to cope with climate-events. Second, given the number of panel-style multi-story buildings economies of scale could be achieved and solutions widely applied widely. Third, despite large scale privatization, many of these apartment blocks are still owned by local or national governments. This makes publicly funded retrofit programs possible. Fourth there is a need for EU accession countries to enhance energy performance of buildings to meet the European Performance Buildings Directive (EPBD). Fifth, there is added urgency due to the prevalence of district heating systems in larger cities in the region, which can be carried out in parallel with the building retrofits to achieve full benefits. These systems presently consume high levels of energy, but have the potential to be converted so that they can provide efficient heating and cooling in the future to become climate-resilient.

### **Implications for Future Research**

Even though it is essential for cities in ECA to initiate efforts at climate adaptation, our knowledge of the critical factors associated with ways to facilitate this process and achieve desired outcomes is limited. Therefore, it is important to initiate research on activities that have taken place to date as well as to assess both the capacity and desire to initiate adaptation planning in the short and long term.

One of the most critical questions that needs to be addressed is which cities in ECA are most vulnerable to the impacts of climate change. Climate data should be downscaled and used to assess which cities are most at risk. This effort should address uncertainty through the development of alternative climate scenarios. In addition, it is important for cities to assess the types and quality of data that they have available to guide their planning efforts. For

instance, floodplain maps have been updated in some parts of the region and localities, but not in others. The same is true for GIS layers. Internal assessments will help cities determine what information they need to obtain in the short term so that they can engage in long term planning.

It also is important to understand the adaptive capacity of municipalities. Adaptive capacity in this context refers to the ability of a city to prepare for or respond to the impacts of climate change. Drawing on ideas advanced in the literature, in light of case studies of successful and failed adaptation efforts, indicators of urban adaptive capacity should be developed and assessments conducted across relevant municipal agencies. Agency responses could then be integrated into a “government scorecard” so that urban municipalities will have an overview of their strengths and limits. This activity also would enhance climate awareness while increasing peer pressure among municipalities. A report card also will provide comparable information to the national government as well as the international community, enabling both to tailor their TA and capacity building efforts.

In addition to understanding general patterns of risk, it also is essential to assess where vulnerable subpopulations are located and what steps can be taken to reduce their risk. Existing maps can be used to identify populations located, for instance, in high risk coastal zones, flood plains, and erosion prone areas, as well as in locales that could be affected by contaminated flood waters. In the long run, GIS mapping is essential to answering this question. The stated policies of many countries include provisions for the welfare of citizens. While it appears that safety nets are in place in most of ECA countries, a related issue that needs to be addressed in this context is whether these provisions are being evenly applied across the entire population or whether institutional inequities have resulted in unequal access to services and other state-provisions.

Few systematic studies have been conducted of adaptation planning in the region. It would be helpful to gauge what is driving municipalities to initiate climate adaptation planning, how they vary from one country and city to the next, and what accounts for this variation. Assessments, drawing on surveys and interviews, should be conducted across municipal agencies and at multiple levels of administration in countries throughout the region to understand what factors drive or impede climate adaptation efforts. This information will provide insight into whether mandates are required to foster action, what capacity levels and needs are present, whether innovations and independent action are taking place, and how best to integrate adaptation into existing agency agendas.

Once adaptation activities have been identified, it will be possible to determine which have been most successful and what problems have been encountered. Qualitative assessments, followed by the dissemination of innovative practices and accomplishments, will provide information that municipalities throughout the region can use to inform their climate adaptation efforts. These assessments not only should examine high profile situations such as the accomplishments of early adopters, or the gains achieved in exceptional cases, but also should provide information about demonstration projects and routine innovations. This will ensure that agencies and officials have access to information about different approaches to

adaptation and can consider what means are best suited to meeting their priorities and goals while meshing with their capacity and capabilities.

Finally, it is important to understand what approaches to participation and civic engagement in climate adaptation are most appropriate and likely to be most effective. Given the history and culture of the region it may be difficult to foster widespread participation in adaptation activities. Case studies and interviews can be used to understand what approaches will be most effective for engaging different groups, both within and across countries. These methods will reveal what practices have been effective in the past and ascertain risk perceptions as well as approaches that are aligned with present expectations and preferences.

## Works Cited

- Adger W. N., S. Huq, K. Brown, D. Conway, and M. Hulme. 2003. "Adaptation to climate change in the developing world." *Progress in Development Studies* 3(3): 179–195.
- Adger, W. N. 2001. "Social capital and climate change." Norwich: Tyndall Centre Working Paper No. 8.
- Apollo Alliance and Green for All. 2008. "Green-collar jobs in America's cities: Building Pathways out of poverty and careers in the clean energy economy."
- Arnell, Nigel, Emma Tompkins, Neil Adger, and Kate Delaney. 2005. "Vulnerability to abrupt climate change in Europe." East Anglia: Tyndall Centre for Climate Change Research
- Baltic Energy Efficiency Network for the Building Stock (BEEN). 2007."BEEN Project Results, Including Detailed Findings and Recommendations." Berlin: Berlin Senate Department for Urban Development.
- Bass, Brad and Bas Baskaran. 2001. "Evaluating Rooftop and Vertical Gardens as an Adaptation Strategy for Urban Areas." National Research Council of Canada.
- Bukovska, Barbara. 2002 "Difference and indifference: Bringing Czech Roma ghettos to Europe's Court." URL:  
<http://www.eumap.org/journal/features/2002/may02/czechromaghettoes>
- Bulkeley, Harriett. 2001. "Governing climate change: the politics of risk society?" *Transactions* 26: 430-47.
- Bullen, Peter A. 2004. "Assessing sustainable adaptation of existing buildings to climate change." COBRA.
- Camilleri M, Jaques R and Isaacs N. 2001. "Impacts of climate change on building performance in New Zealand." *Building Research & Information* 29(6): 440-450.
- Church, Chris and Tamara Malkova. 2008. "Action on climate change: From a divided Europe to a common purpose." Northern Alliance for Sustainability, ANPED
- C40 Cities. 2008. "Cities and Climate Change." Website accessed on 17 June; Available at:  
<http://www.c40cities.org/climatechange.jsp>.
- CiJ. 2008. "Huge bill for tired housing in Slovakia – EU asked to help." Available at:  
<http://www.cijjournal.com/Main/Story.aspx?id=1565>
- Clean Air Partnership. 2007. *Cities Preparing for Climate Change: A Study of Six Urban Regions*. Toronto: Clean Air Partnership.

- Concerto. 2007. Project website available at:  
<http://concertoplus.eu/CMS/content/view/130/407/lang,en/>
- Crabbé P. and M. Robin. 2006. "Institutional adaptation of water resource infrastructures to climate change in Eastern Ontario." *Climatic Change* 78: 103–133.
- Csoknyai, Tamas. 2007. "Dunaújváros, Hungary." Section 3 in Report for Training for Renovated Energy Efficient Social Housing.
- Danube Watch. 2006a. "Tuzla armed with information." *Green Horizon* 3(2): 8.
- Danube Watch. 2006b. "Runoff remedies." *Green Horizon* 3(2): 8.
- Doornkamp, J. C. 1993. "Clay shrinkage induced subsidence." *Geographical Journal* 159: 196-202.
- Dow, Kristen, Roger E. Kasperson, and Maria Bohn. 2006. "Exploring the social justice implications of adaptation and vulnerability." Pp. 79–96 in W. N. Adger, J. Paavola, S. Huq, and M. J. Mace (eds), *Fairness in adaptation to climate change*. Cambridge: MIT Press.
- Du Plessis Chrisna, Daniel K Irurah and R. J. Scholes. 2003. "The built environment and climate change in South Africa." *Building Research & Information* 31(3-4): 240-256.
- ETUC. 2007. "Climate Change and Employment." ETUC.
- European Environment Agency (EEA). 2006. "Urban sprawl in Europe: The ignored challenge." Copenhagen: EEA.
- European Environment Agency (EEA). 2007. "Sustainable consumption and production in South East Europe and Eastern Europe, Caucasus and Central Asia: Joint UNEP-EEA report on the opportunities and lessons learned." Copenhagen: EEA.
- Feldman D.L., Mann D. 1991. "Policy Analysis and the Management of Climate Change: Institutional Adaptability in the Face of Scientific Uncertainty." *Policy Studies Journal* 19(2): 43-49.
- Fry, T. 2004. "Living in a changed climate: Design for the coming climate." Sydney: EcoDesign Foundation.
- Gautam, K. P. and E. E. van der Hoek. 2003. "Literature study on environmental impacts of floods." Netherlands: Delft Cluster.
- Grabher, Gernot and David Stark. 1997. *Restructuring networks in post-socialism: Legacies, linkages, and localities*. Oxford: Oxford University Press.
- Handley, John and Jeremy Carter. 2006. "Adaptation strategies for climate change in the urban environment." Draft final report to the National Steering Group. Manchester.

- Hegedüs, Jozsef and Nóra Teller. 2004. "The social and economic significance of housing management." In *Housing in South Eastern Europe solving a puzzle of challenges*. World Bank and Council of Europe.
- Hunt, Alistair and Paul Watkiss. 2007. "Literature review on climate change impacts on urban city centres: Initial findings." France: OECD.
- Huq, Saleemul, Sari Kovats, Hannah Reid and David Satterthwaite. 2007. "Editorial: Reducing risks to cities from disasters and climate change." *Environment and Urbanization* 19(1): 3-15.
- Iliev, Dimo and Ebru Yuksel. 2004. "A variety of issues at stake: the stock, its management, and its social and economic functions." *Housing in South Eastern Europe solving a puzzle of challenges*. World Bank and Council of Europe.
- Jones, Roger and Atiq Rahman. 2007. "Community-based adaptation." *Tiempo: A Bulletin on Climate and Development* 64: 17-19.
- Karaca, Mehmet and Robert J. Nicholls. 2008. "Potential implications of accelerated sea-level rise for Turkey." *Journal of Coastal Research* 24(2): 288–298.
- Kasperson, Roger E. and Jeanne X. Kasperson. 2001. "Climate change, vulnerability, and social justice." Stockholm: Stockholm Environment Institute.
- Lowe, R. J. 2001. "A review of recent and current initiatives on climate change and its impact on the built environment: Impact, effectiveness and recommendations." CRISP Consultancy Commission-01/04, Centre for the Built Environment, Leeds, UK.
- Lowe, R. J. 2001. "Really rethinking construction." *Building Research & Information* 29(5): 409-412.
- Lowe, R. J. 2004. "Lessons from climate change: a response to the commentaries." *Building Research & Information* 32(1): 75-78.
- Maier, K. 1998. "Czech planning in transition: Assets and deficiencies." *International Planning Studies* 3: 351–365.
- Matczak, Piotr, Zsuzsanna Flachner, and Saskia E. Werners. 2007. "Institutions for adapting to climate change." *Earth System Governance*.
- Bressand, Florian, Diana Farrell, Pedro Haas, Fabrice Morin, Scott Nyquist, Jaana Remes, Sebastian Roemer, Matt Rogers, Jason Rosenfeld, and Jonathan Woetzel. 2007. "Curbing Global Energy Demand Growth: The Energy Productivity Opportunity." McKinsey Global Institute: McKinsey & Company.

- Mehdi, Bano. 2006. "Adapting to climate change: An introduction for Canadian municipalities." Canadian Climate Impacts and Adaptation Research Network.
- Menegat, Rualdo. 2002. "Participatory democracy and sustainable development: integrated urban environmental management in Porto Alegre, Brazil." *Environment & Urbanization* 14(2): 181–206.
- Mills, E. 2003 "Climate change, insurance and the buildings sector: technological synergisms between adaptation and mitigation." *Building Research & Information* 31(3-4): 257–277
- Minority Rights Group International (MRG). 2008. *State of the world's minorities*.
- Moravcsik, Agnes and Barbara Botos. 2007. "Tatabanya: Local participation and physical regeneration of derelict areas." Presentation given in Krakow, Poland.
- Nedović-Budić, Zorica. 2001. "Adjustment of Planning Practice to the New Eastern and Central European Context." *Journal of the American Planning Association* 67(1): 38 – 52.
- Noah's Ark. 2007. Guidelines on adaptation of cultural heritage to climate change.
- Nuissl, H. and Rink, D. 2005. "The 'production' of urban sprawl in eastern Germany as a phenomenon of post-socialist transformation." *Cities*, 22(2):123–134.
- Peltonen, Lasse, Simo Haanpää and Samuli Lehtonen. 2005. The challenge of climate change adaptation in urban planning. FINADAPT Working Paper 13, *Finnish Environment Institute Mimeographs 343*, Helsinki, 44 pp.
- Patel, Sheela, Celine d'Cruz and Sundar Burra. 2002. "Beyond evictions in a global city; people-managed resettlement in Mumbai." *Environment & Urbanization* 14(1): 159–172.
- Revenga, Ana, Dena Ringold, and William M. Tracy. 2002. *Poverty and ethnicity: A cross-country study of Roma poverty in Central Europe*. Washington, DC: World Bank.
- Ringold, Dena, Mitchell A. Orenstein, Erika Wilkens. 2005. *Roma in an expanding Europe: Breaking the poverty cycle*. Washington, DC: World Bank.
- Rosenzweig, Cynthia and William D. Solecki. 2003. *Adaptation to climate in urban areas: Identification of research Needs*. Washington, DC: NOAA.
- S'ykora, L. 1999. "Transition states of East Central Europe." Pp. 161-192 in P. Balchin, L. S'ykora, & G. Bull (eds.), *Regional Policy and Planning in Europe*. London: Routledge.
- Sanders, Mark A. 1997. "Central and Eastern European floods of July 1997." London: Benfield Greig Hazard Research Centre.

- Satterthwaite, David, Saleemul Huq, Mark Pelling, Hannah Reid and Patricia Romero Lankao. 2007. *Adapting to climate change in urban areas: The possibilities and constraints in low- and middle-income nations*. International Institute for Environment and Development (IIED).
- Shaw, Robert, Michelle Colley, and Richenda Connell. 2007. *Climate change adaptation by design: a guide for sustainable communities*. TCPA, London
- Sheltair Group. 2003. “Climate change impacts and adaptation strategies for urban systems in Greater Vancouver.” Report Prepared for Natural Resources Canada.
- Steemers, K. 2003. “Towards a research agenda for adapting to climate change.” *Building Research & Information* 31(3-4): 291-301.
- Stern, Nicholas. 2007. *The economics of climate change: The Stern review*. Cambridge: Cambridge University Press.
- Taylor, Robert P., Chandrasekar Govindarajalu, Jeremy Levin, Anke S. Meyer, and William A. Ward. 2008. *Financing energy efficiency: Lessons from Brazil, China, India, and Beyond*. Washington, DC: The World Bank.
- Thompson, Alexander, Paul Robbins, Brent Sohngen, Joseph Arvai and Tomas Koontz. 2006. “Economy, politics and institutions: From adaptation to adaptive management in climate change.” *Climatic Change* 78: 1-5.
- UNDP. 2005. *Central Asia Human Development Report*. Bratislava: UNDP.
- UNECE, 2007b. Report on “Spatial information management toward legalizing informal urban development” and “Informal settlements – Real estate market needs for good land administration and planning.” Workshop held by the Committee on Housing and Land Management, 28-31 Sounio, Greece
- UNECE. 2007a. UNECE Weekly, 237: 17-21.
- UNEP. 2008. “Background paper on green jobs.” Nairobi: UNEP.
- UNESCO. 2007. *Case studies on climate change and world heritage*. Paris: UNESCO World Heritage Centre
- Weru, Jane. 2004. “Community federations and city upgrading: the work of Pamoa Trust and Muungano in Kenya.” *Environment & Urbanization* 16(1): 47–62.
- Witte, Eric. 2008. “Europe.” In Ishbel Matheson (ed.). *State of the world’s minorities: Climate change special*. London: Minority Rights Group International.
- World Bank. 2000. *Making transition work for everyone: Poverty and inequality in Europe and Central Asia*. Washington, DC: World Bank.

World Bank. 2006. "Dimensions of urban poverty in Europe and Central Asia Region." Washington, DC: World Bank.

World Bank. 2007. *World development report*. Washington, DC: World Bank

World Health Organization. 2002. *Floods: climate change and adaptation strategies for human health*. Copenhagen: World Health Organization.

Worldwatch Institute. 2007. "Green jobs: Towards sustainable work in a low carbon world." Nairobi: UNEP.