EXECUTIVE SUMMARY

The climate is changing; and the Europe and Central Asia (ECA) region is vulnerable to the consequences.[1] Many of the region's countries are facing warmer temperatures, a changing hydrology and more extremes—droughts, floods, heat waves, windstorms, and forest fires. Already the frequency and cost of natural disasters have risen dramatically in the region. And the concentration of greenhouse gases already in the atmosphere guarantees that similar or greater changes are yet to come—even if the world completely stopped emitting CO_2.

Now, and at least for the near future, ECA's vulnerability is being driven more by its existing sensitivity than by the severity of the climate impacts. In fact, ECA already suffers from a serious adaptation deficit even to its current climate. This derives from a combination of socio-economic factors and the Soviet legacy of environmental mismanagement.

Chronic environmental mismanagement is perhaps the most dangerous holdover from the past, massively increasing vulnerability to even modest global warming. Thus, the expected decrease in the level of the Caspian Sea means that the population will come into contact with a range of dangerous substances (pesticides, arsenic) presently locked in coastal sediments. Rising temperatures and reduced precipitation in Central Asia will exacerbate the environmental catastrophe of the disappearing Aral Sea.

The region also bears the burden of poorly constructed, badly maintained, and aging infrastructure and housing—a legacy of both the Soviet era and the transition years. These are ill-suited to cope with storms, heat waves, or floods, let alone protect populations from the impacts of such extreme events. And while Turkey does not carry the same legacy issues, it suffers from demographic pressures on fragile natural resources and inadequate and vulnerable infrastructure.

This report has four key messages:

Contrary to popular perception, ECA faces significant threats from climate change, with a number of the most serious risks already in evidence. Average temperatures across ECA have already increased by 0.5ºC in the south to 1.6ºC in the north (Siberia), and overall increases of 1.6 to 2.6ºC are expected by the middle of the century. This is affecting hydrology, with a rapid melting of the region's glaciers and a decrease in winter snows. Many countries are already suffering from winter floods and summer droughts—with both Southeastern Europe and Central Asia at risk for severe water shortages. Summer heat waves are expected to claim more lives than will be saved by warmer winters.

Vulnerability over the next ten to twenty years will be dominated by socio-economic factors and legacy issues—notably the dire environmental situation and the poor state of infrastructure—rather than by the changing climate itself. A flood in Baia Mare, Romania in 2000 brought cyanide-laced waste from a gold mining operation into the Tiza and Danube Rivers, poisoning the water of 2 million people. And in sub-regions threatened with water shortages, poor water management dwarfs the likely climate change impacts anticipated for the next 20 years.

[1] The ECA region covers all the former Eastern Bloc countries (excluding East Germany), plus Turkey.

Even countries and sectors that stand to benefit from climate change are poorly positioned to do so. Many have noted that warmer climate and abundant precipitation in the northeastern part of ECA (Kazakhstan, Russia, and Ukraine) will open up a new agricultural frontier. However, any potential benefit pales in comparison to the costs of the region's relative inefficiency and low productivity. While world grain yields have been growing on average by about 1.5 percent per year, they have been falling or stagnant in these three countries, where productivity is far below that of Western Europe or the US.

The next decade offers a window of opportunity for ECA countries to make their development more resilient to climate change while reaping numerous co-benefits. While some impacts of climate change are already being felt, they will likely remain manageable over the next decade. This offers the ECA region a short period to increase its resilience by focusing on "no-regret" beneficial actions. Regardless of climate change, ECA will gain a lot by improving its water resource management, fixing its disastrous environmental legacy, upgrading neglected infrastructure and housing, and strengthening disaster management.

But the region should also develop strategies to reduce vulnerability to future changes—focusing on infrastructure but also capacity-building and stronger institutions to support adaptation. And forward-looking decisions today help avoid locking countries or settlements into unsustainable patterns of development. Experiences from other countries, regions, or cities now developing and implementing adaptation plans offer valuable lessons and methodologies.

This report presents an overview of what adaptation to climate change might mean for ECA. It starts with a discussion of emerging best practice adaptation planning around the world and a review of the latest climate projections. The report then discusses possible actions to improve resilience organized around impacts on natural resources (water, biodiversity, and the coastal environment), health, the "unbuilt" environment (agriculture and forestry), and the built environment (infrastructure and housing). The last chapter concludes with a discussion of two areas in great need of strengthening given the changing climate: disaster preparedness and hydrometeorological services.

Adaptation to climate change is a nascent field, much less studied and understood than mitigation (which describes actions to reduce emissions of greenhouse gases).[2] Hence the focus of this report on adaptation, as opposed to mitigation, which is addressed in a number of other World Bank projects and reports.[3]

Climate change—a major threat to ECA

Both temperatures and precipitation are projected to change significantly over the coming decades in the ECA countries. Temperatures will continue increasing everywhere in the region, with the greater changes occurring in the more northern latitudes. The north is projected to see greater temperature changes in winter, while southern parts of the region are expected to see the greatest changes in summer. Overall in the region, the number of frost days is projected to decline by 14 to 30 days over the next 20 to 40 years (map 2.2), with the number of hot days

[2] Tellingly adaptation was not part of the Kyoto negotiations in 1992. It now stands as one of the four pillars (along with mitigation, finance and technology) of the negotiations underway within the United Nations Framework Convention on Climate Change, which will culminate at the Climate Change Conference in Copenhagen in December 2009. See http://unfccc.int for more details.

[3] See http://go.worldbank.org/7OOC1E7AU0 for more details.

increasing by 22 to 37 days over the same period. This warming trend is significant: by mid-century, countries such as Poland or Hungary are expected to experience the same number of hot days (>30^{o}C) as today's Spain or Sicily.

Water availability is projected to decrease everywhere but Russia, as increased precipitation in many regions, except Southeastern Europe, is offset by greater evaporation due to higher temperatures (map 2.4b). The most dramatic decreases are likely to occur in Southeastern Europe (–25%). Even in Russia, most of the precipitation increase is expected to occur in winter; therefore, it is still possible that higher summer temperatures could offset precipitation and lead to drought conditions.

Yet even as much of the region is faced with possible droughts, floods are expected to become more common and severe. This is because precipitation intensity will increase across the region—notably through more frequent storms. And while models cannot predict floods per se —as they are events brought on by many factors other than precipitation, such as land use—ECA is in fact already experiencing more severe and frequent floods. Without substantial adaptation measures, the new weather pattern is likely to result in yet more floods.

Warmer temperatures also mean that glaciers are receding and that less winter precipitation falls and is stored in the form of snow. This complicates hydrology and makes it more likely for ECA to experience more winter flooding. And while in the short term basins that rely on glacial melt for summer water may see increased water flow from melting glaciers, the long-term implications for summer water availability are troubling—particularly in irrigation-dependent Central Asia.

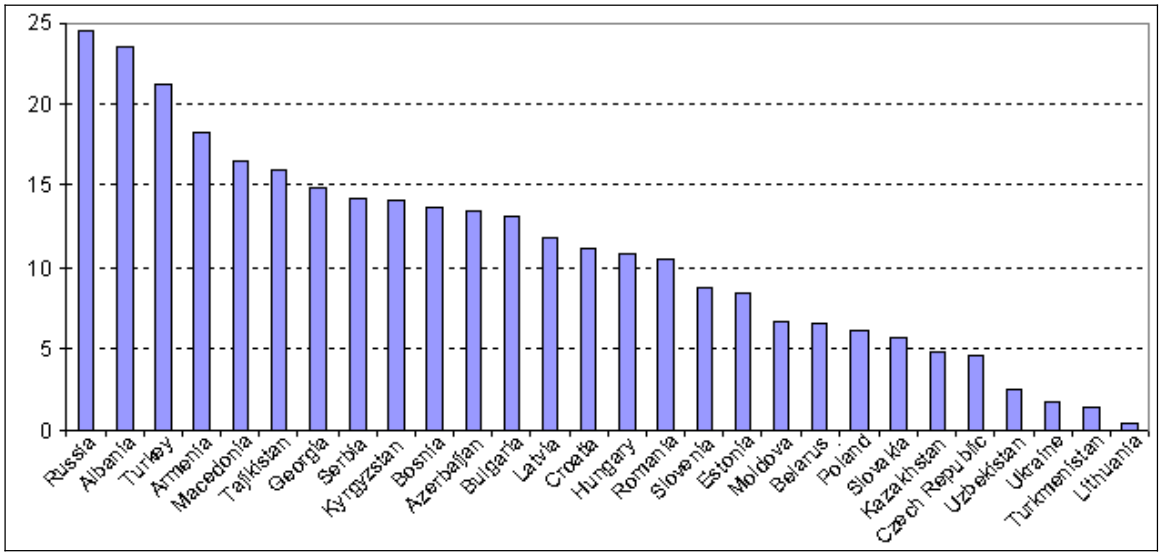
In the Arctic, temperatures have been warming at about twice the global average with significant impacts on arctic ice, the tundra, and permafrost. Ice cover in September (when the ice is at its minimum) is projected to decline 40 percent by mid century. Some models project that by the end of the century the Arctic will be completely ice-free in the summer. Russia's permafrost line is receding and seasonal thaw depths are projected to increase by 30 to 50 percent by 2050. The melting of ice and permafrost is affecting biodiversity, as well as leading to coastal erosion and the collapse of exposed buildings and infrastructure.

Changes in sea level, another impact of climate change, will affect ECA's four basins (the Baltic Sea, the East Adriatic and Mediterranean coast of Turkey, the Black Sea, and the Caspian) and the Russian Arctic Ocean. On the Baltic, Poland, with its heavily populated low-lying coast, is especially vulnerable to sea level rise. Along the Adriatic and the Mediterranean, storm surge and saltwater intrusion into aquifers threaten parts of the Croatian, Albanian, and Turkish coasts. Sea level rise has been highest in the Black Sea, where it is threatening the numerous ports and towns along the Russian, Ukrainian, and Georgian coasts. In the Caspian Sea, water levels are projected to drop by approximately six meters by the end of the twenty-first century, due to increased surface evaporation. This will imperil fish stock and affect coastal infrastructure.

An index designed to capture the strength of future climate change relative to today's natural variability (Baettig et al. 2007) suggests that the ECA countries most exposed to increased climate extremes are Russia, Albania, Turkey and Armenia, and, to a lesser extent, Macedonia and Tajikistan. Relative to the rest of the world, these countries are in the middle tier of

exposure. However, this is not necessarily reflected in a concern for climate change: only 40 percent of Russians think climate change is a serious issue; in contrast 70 percent of Turks do (Pew Global Attitudes Project 2007).

FIGURE ES.1 ECA COUNTRIES LIKELY TO EXPERIENCE THE GREATEST INCREASES IN CLIMATE EXTREMES BY THE END OF THE 21ST CENTURY: RUSSIA, ALBANIA AND TURKEY



Source: Baettig et al. (2007). *Notes:* The index combines the number of additional hot, dry and wet years; hot, dry and wet summers; and hot, dry and wet winters projected over the 2070–2100 period relative to the 1961–1990 period. As such, countries already experiencing substantial variability and extremes are less likely to rank highly on this index (e.g., India and the Czech Republic have about the same score).

Increased temperatures and changing hydrology are already affecting ECA's forestry and agriculture. Extreme events combined with earlier snowmelt and hot, dry summers have caused substantial tree loss and degradation. In Russia, 20 million hectares were lost to fire in 2003 alone. The warming climate is also allowing the northward migration of pests and harmful plant species. For agriculture, net losses are likely for Southeastern Europe and Turkey, the North and South Caucasus, and Central Asia. The projected impacts are mixed or uncertain in Central and Eastern Europe, Kazakhstan, and the Central and Volga region of Russia.

Warmer weather and other factors associated with climate change are also affecting health. Malaria, which had been eradicated from Europe, is making a comeback as are a number of once rare infectious diseases; meanwhile, allergies related to pollen are projected to increase, particularly in Central Europe. Hundreds of deaths were attributed to the 2001 heat waves in Moscow and across Croatia, Slovenia and the Czech Republic. Such heat waves will occur much more frequently in the future.

Vulnerability over the next ten to twenty years will be dominated by socio-economic factors and legacy issues

Resilience to a changing climate—whether to a climate shock or to changing averages—depends heavily on the current state of the system it impacts, be it human, physical, or ecological. Thus, a small drought may be manageable for a farmer coming out of a prosperous year but ruinous if it follows another dry spell that exhausted the household's savings. Similarly, declining water

runoff will be catastrophic for a region that already relies too much on its underground water resources, but may be manageable for another whose agriculture is sustainable in current conditions.

Decades of environmental mismanagement have diminished ECA's natural resilience. Under the Soviet system, economic growth was pursued in blatant disregard to natural conditions. When water was needed for irrigation, the rivers feeding the Aral Sea were diverted to the desert to produce rice, fruit, and cotton. Uzbekistan became one of the world's largest exporters of cotton, but at the cost of destroying the Aral Sea in the process. Today, the sand and salt blown from the dried-up sea bed onto the surface of Central Asian glaciers is accelerating the heat-induced melting of the glaciers—the source of most of the region's water. And Uzbekistan's agriculture and hugely wasteful irrigation system is extremely vulnerable to climate change.

The environmental legacy of central planning is particularly dramatic for agriculture, and greatly increases the sector's vulnerability to climate change. Uzbekistan is not the only country to have specialized in producing a small number of crops ill-suited to the local environment; other countries and sub-national regions have as well. Poor management of soil erosion, water resources, pest control, and nutrient conservation makes the agricultural system especially vulnerable.

Over the next couple of decades non-climatic factors, such as legacy issues and continuing unsustainable demand, will be the main drivers of water stress in Europe and Central Asia (Vörösmarty et al. 2000). Floods cannot be explained by increased precipitation alone, but result from a combination of heavy precipitation and poor land use and river basin management. Overall climate-related changes to freshwater systems have been small compared to factors such as pollution, inappropriate regulation of river flows, wetland drainage, reduction in stream flow, and lowering of the groundwater table (mostly due to extraction for irrigation). Clearly, more sustainable practices will be needed over the next decade before global warming's impacts become even more severe.

Pollution is another legacy issue that magnifies the impact of climate change. While Estonia's coast is not generally vulnerable to sea level rise, one danger persists: the leaching of radioactive waste at the Sillamae industrial center is separated from the sea by a narrow dam that is threatened by coastal surge. Coastal landfills around the Black Sea, notably in Georgia, have been identified as pollution hotspots, and coastal erosion could increase the amount of pollutants flushed to sea, threatening a fishing industry already struggling with the consequences of overfishing and pollution.

In many parts of ECA, dangerous facilities or dump sites were often located close to weather-sensitive sites or heavily settled areas. This means that floods or extreme events can cause far greater damage here than would be the case in other parts of the world.

Poor quality housing will raise the human toll of climate change as heat waves turn poorly ventilated buildings into furnaces, and heavy rains brings leaks and mold. This is a special problem for ECA's cities—most of which have a glut of aging Soviet-era buildings made with prefabricated concrete panels and in desperate need of refurbishment.

Meanwhile, during the transition from central planning, ECA's abundant and over-dimensioned infrastructure has suffered from years of under-investment. Poor management often

compounds the situation—especially in water and sanitation utilities. Global warming has an especially negative effect on water systems—exacerbated by the inefficiency of most water utilities, which under-price and suffer severe physical losses. This translates into high consumption and limited funding for upgrades and investments.

Elsewhere across ECA, the power sector is hard pressed to respond to the peaks in electricity demand linked to rising summer temperatures, and is badly in need of upgrade and expansion. Warmer summers, with periods of intense heat, have strained the transmission networks of Turkey, Azerbaijan and Kazakhstan, as well as systems throughout Southeastern Europe. In addition, extreme weather threatens the ability of networks to function as intended—especially aging and poorly maintained facilities.

ECA's transport infrastructure, with poorly maintained roads and structures, is also at risk. More intense precipitation will make sub-grade pavement less stable and weaken retaining walls. Long periods of droughts can lead to settling of the earth beneath the structures. More extreme temperatures will add to road deterioration as has already happened in Kazakhstan, where truck travel has to be limited on hot summer days when the asphalt softens.

It is tempting, though incorrect, to expect growth and prosperity to increase resilience to climate change. And this is especially untrue in ECA, where growth has typically occurred at the expense of the environment, thereby increasing vulnerability. In fact, growth and economic development are in some cases exacerbating vulnerability—such as coastal developments around the Black Sea, where buildings are being erected on sites exposed to coastal surge and storms.

Even countries and sectors that could stand to benefit from climate change are poorly positioned to do so

Higher latitudes could benefit from improved conditions for agriculture: the Baltics, parts of Kazakhstan and Ukraine, and most of Russia (except for the North Caucasus). However, the potential for gain is unclear since it could be offset by increased variability and extreme events. Most countries will face a mix of losses and gains.

Nevertheless, many global studies about future food production assume ECA countries will help offset the decline in world food production resulting from decreasing yields in lower latitudes. In particular, Kazakhstan, Russia, and Ukraine are often mentioned as the countries with the world's greatest unrealized food production potential.

The fact is that the current gap between potential and actual yields in ECA is significantly higher than any potential gains from climate change. In particular, the current yield gap for the former Soviet countries in Europe (including Ukraine and European Russia) is 4.5 times higher than the potential increase in production from climate change by 2050 (Olesen and Bindi 2002). In other words, unless current inefficiencies are addressed, the world's greatest unrealized food production potential will remain unrealized.

Forests show a similar pattern to agriculture. Estimates indicate that the largest share of potential forest stock increases in Europe would be from improved management (60–80%)

rather than climate change (10–30%) (Easterling et al. 2007). Improved management requires strong forest institutions, which are often lacking in the transition countries.

The inability of Kazakhstan, Russia, and Ukraine to close the productivity gap or respond to recent crop price increases does not bode well for their capacity to adapt to and benefit from climate change. Indeed, the key challenge will be to close the existing productivity gap rather than ride the climate change wave to a new time of prosperity. That will depend on technology, policy, investment, support services, and crop management—and not simply on climate conditions.

Northern areas will see intense competition between forestry and agriculture for land. The relative feasibility of field crops, tree crops, and livestock may further alter land-use patterns. A program of increasing farm outputs by expanding cultivation into newly temperate lands would require large investments in land-clearing, production, marketing, and transport infrastructure—suggesting that improving the productivity of land currently under cultivation is more attractive.

The next decade offers a window of opportunity for ECA countries to make their development much more resilient to climate change while reaping numerous co-benefits

Much of the adaptation needed to make ECA more resistant to climate change will have substantial co-benefits. Improved water resource management, better performing water utilities and energy systems, and upgraded housing and transport infrastructure are crucially needed independent of climate change. The gains from improved agricultural practices are much more significant than the changes expected from climate change. In any case, the region must clean up environmental hotspots, accelerate disaster management, and expand hydromet services.

Climate change does expose ECA's weaknesses and the costs and risk-implications of these weaknesses. But where to start? Consistent with the advice of many experts on climate change adaptation, ECA should focus on areas and sectors already vulnerable to today's climate conditions and on actions that have immediate positive impacts for the population. In fact, much of what is discussed in this report falls into the category of "no-regret" actions—that is, actions that are beneficial, whatever the climate change scenario.

But some decisions about long-term investments have to be made now—under conditions of uncertainty. For example, Albania, which currently derives 97 percent of its electricity from hydroelectric plants, but cannot rely on it as a future source, must think through its long-term electricity strategy. And Central European countries such as Poland, with over 5 million flats in poor Soviet-era buildings, need renovation plans given the predicted increases in both rainfall and temperatures.

Uncertainty can be paralyzing. It is one of the reasons that high *potential* for adaptation does not guarantee adaptation action. A recent study of the US—often assumed to have a high capacity for adaptation given its wealth, technical resources, and large size (allowing for both diversification and spreading of climate risk)—shows that many at-risk organizations and individuals are failing to adapt (Repetto 2008): the Army Corps of Engineers is rebuilding

Louisiana's levees to the same standards that failed during Katrina; many Southwestern states are failing to incorporate climate change in their drought preparedness plans. In most cases, the reason for not changing standards or continuing to build in the same exposed location is uncertainty about "what to adapt to."

However, some countries and communities are not waiting. Australia and the UK have developed methodologies, standards, and databases to help organizations and individuals develop adaptation plans (UKCIP 2003, Australian Government 2005).

One approach gaining traction is to focus on "robust strategies"—meaning strategies that are effective even in the face of an unpredictable future (Lempert and Schlesinger 2000). This approach tries to answer the question: *What actions should we take, given that we cannot predict the future?* It views climate change policy more as a contingency (*what if?*) problem than an optimization problem (*what is the best strategy given the most likely outcome?*). Looking for robust, as opposed to optimal, strategies is essentially scenario-based planning, and can help overcome the paralysis associated with uncertainty.

Perhaps the most critical lesson on how to develop adaptation plans is the importance of involving stakeholders. Stakeholders understand current vulnerabilities, the starting point for understanding future adaptation needs, and often have good ideas on how to reduce them. Involving stakeholders also improves the chance that the adaptation plan is implemented and that adaptation concerns are mainstreamed. This was the case in London where, five years after the *London's Warming* report, original stakeholders are still involved in the city's adaptation strategy.

ECA countries need to act. They can learn from other countries on how to manage uncertainty and assemble the right information to guide climate-resilient practices. But in ECA, perhaps more than in any other region, uncertainty should be a catalyst for action instead of an excuse for inaction. Fixing the region's current weaknesses and tackling its dismal environmental legacy will have immediate and substantial benefits on the welfare of individuals and on future economic growth, regardless of climate change.